COMMONWEALTH of VIRGINIA

DEPARTMENT OF TRANSPORTATION
1401 EAST BROAD STREET
RICHMOND, VIRGINIA 23219 2000

Charles A. Kilpatrick, P.E.
Commissioner

December 18, 2017

The Honorable Terry McAuliffe
Members of the General Assembly
The Joint Legislative Audit and Review Commission
Members of the Commonwealth Transportation Board

Dear Ladies and Gentlemen:

Section 33.2-232 of the *Code of Virginia* directs the Commissioner of Highways to submit an annual report to the Governor, the General Assembly, the Joint Legislative Audit and Review Commission, and the Commonwealth Transportation Board.

To meet the requirements of the legislation, I am submitting the attached report, which includes the information required by § 33.2-232. If you have any questions or need additional information, please let me know.

Sincerely,

Charles A. Kilpatrick. P.
Commissioner of Highways

Attachment

ANNUAL REPORT

2017

Pursuant to:

Section 33.2-232 of the *Code of Virginia*

Virginia Department of Transportation
1401 East Broad Street
Richmond, Virginia 23219
November 30, 2017

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Executive Summary

Section 33.2-232 of the *Code of Virginia* (https://law.lis.virginia.gov/vacode/title33.2/chapter2/section33.2-232/) directs that by November 30 of each year the Commissioner of Highways (Commissioner) is to report in writing to the Governor, the General Assembly, the Joint Legislative Audit and Review Commission and the Commonwealth Transportation Board (CTB). The content of such report shall be specified by the Board and shall contain, at a minimum:

1. The condition of existing transportation assets, using asset management methodology pursuant to § 33.2-352;

2. The methodology used to determine maintenance needs, including an explanation of the transparent methodology used for the allocation of funds from the Highway Maintenance and Operating Fund pursuant to subsection A of § 33.2-352;

3. The allocations to the reconstruction and rehabilitation of functionally obsolete or structurally deficient bridges and to the reconstruction of pavements determined to have a combined condition index of less than 60 and beginning with the November 2020 report, the methodology used to determine allocations of construction funds for state of good repair purposes as defined in § 33.2-369 and any waiver of the cap provided for in subsection B of § 33.2-369;

4. The performance targets and outcomes for (i) the current two-year period starting July 1 of even-numbered years and (ii) the following two-year period starting July 1 of the next even-numbered year. The targets and outcomes shall state what is expected to be achieved, based on funding identified for maintenance and state of good repair purposes, over each two-year period;

5. A listing of prioritized pavement and bridge needs based on the priority ranking system developed by the Board pursuant to § 33.2-369 and a description of the priority ranking system;

6. The Department's (i) strategies for improving safety and security and (ii) strategies and activities to improve highway operations within the Commonwealth, including the use of funds in the Innovation and Technology Transportation Fund established pursuant to § 33.2-1531 and improved incident management;

7. A review of the Department's collaboration with the private sector in delivering services;

8. Traffic modeling results for all federally funded projects requiring a multi-alternative National Environmental Policy Act analysis;

9. A list of transportation projects approved or modified during the prior fiscal year (i) in each transportation district pursuant to § 33.2-214.1, including project costs, and (ii) in each transportation district not subject to § 33.2-214.1; and

10. A listing, by transportation district for the prior fiscal year, of the total number of lane miles of all primary and secondary roads that (i) have been resurfaced with asphalt or sealant and (ii)

based on records of the Department at the close of the fiscal year, reflect a rating of "poor" or "very poor."

The *Virginia Department of Transportation 2017 Annual Report* is submitted in response to Section 33.2-232. Generally, the Virginia Department of Transportation (VDOT) Annual Report presents a snapshot of the Agency's activities and programs including the Commonwealth's road system for the fiscal year that ended June 30, 2017. Unless indicated otherwise, information presented herein is based on FY 2017. Section 33.2-232 requires the CTB to specify the content of this report. The following web address links to the CTB resolution specifying the contents of this report:

http://www.ctb.virginia.gov/resources/2015/sept/reso/Resolution_Agenda_Item_11.pdf

The body of the Annual Report is comprised of five chapters.

Chapter I reports on the requirements set out in items 1 through 5, above and item 10. With the third largest state maintained network of highways and roads in the United States, VDOT uses an asset management process[1] (see Figure 14) along with industry recognized practices to determine the condition of asset inventories and determine funding required to maintain and operate the state maintained assets. While Chapter I discusses performance, condition and the funding needed to maintain these assets, Appendix A provides a more detailed and technical discussion of the needs methodology within the context of VDOT's asset management processes.

Performance metrics are key components of the asset management process and provide one mechanism for setting benchmarks and quantifying success. VDOT's performance metrics are also useful when VDOT is developing recommendations for areas of emphasis going forward.

Chapter I discusses asset management and performance for all assets, both pavements and bridges as well as other assets. Examples of such other assets include tunnels, ferries, safety rest areas, as well as traffic and safety items.

VDOT assesses the needs[2] of the asset inventory it *maintains* annually. To give the reader context on the cost, if the VDOT *maintained* assets were built today, the cost would be approximately $400 billion.

When reviewing this report, the reader should be aware of the following related to the VDOT *maintained* assets:

- VDOT is focused on the performance of core assets (pavements and bridges).
- As of the date of this report, the cost required to bring all of the Commonwealth's pavements and bridges to a condition of fair or better (100% level of performance) is

[1] Asset management process is a systematic process based on economic, engineering and business principles that monitors the performance of transportation assets and aides in making informed decisions about managing the network over the assets' entire lifecycle. More details about VDOT's asset management process may be found in Appendix A of the report.

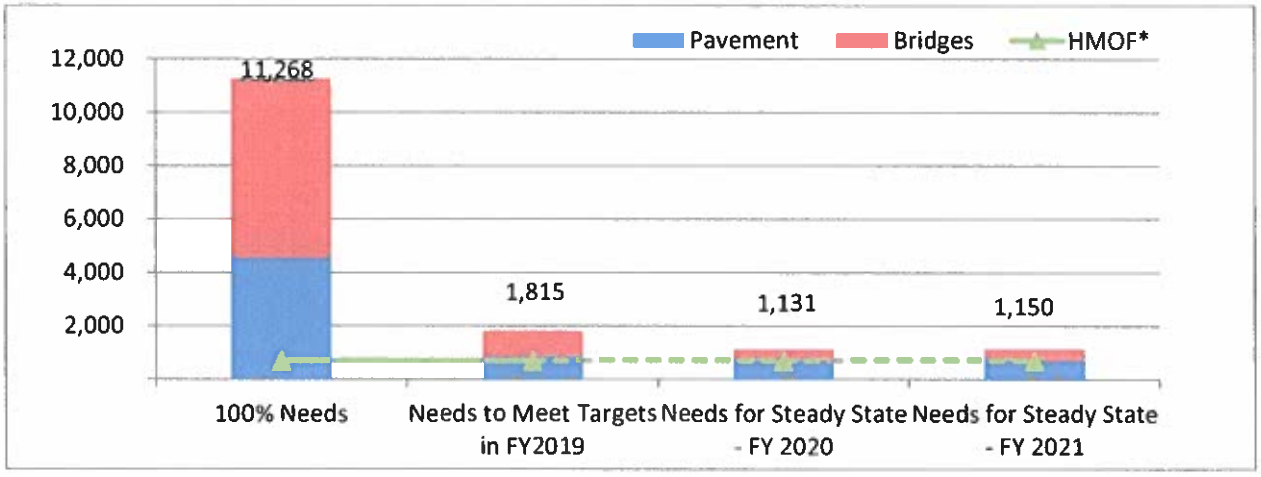
[2] In this report "needs" refer to the costs for existing assets to achieve and/or sustain a State of Good Repair over time, where "State of Good Repair" is defined in Code of Virginia Section 33.2-369.

over $13 billion, the achievement of which is not feasible. Of the $13 billion, VDOT's cost is $11 billion.[3]

- The assets are aging and most were built over 50 years ago.
- VDOT has set statewide performance targets following asset management practice and industry standards (discussed later in the Condition of Existing Assets portion of the report).
- Based on the current statewide performance targets set by VDOT, the cost to fund the needs of pavements and bridges alone is about $1.8 billion. The $1.8 billion excludes any fully funded needs.
- VDOT costs to keep the core assets at a steady state in subsequent years after reaching VDOT's current statewide performance targets would be over $1 billion annually.
- VDOT has only been able to fund a portion of needs required for pavement and bridge assets to achieve statewide performance targets described later in the Summary of VDOT Needs vs. Proposed Funding section.

Figure 1 graphically depicts what is described above.

Figure 1: VDOT Needs and Proposed HMOF Funding For Pavements and Bridges ($ millions)



*HMOF line indicates $700 million.

Note: Amounts presented are estimates based on condition assesssment of current inventory and are subject to change. The needs assessment is performed annually. 100% Needs are shown in 2017 dollars, FY 2019, 2020 and 2021 needs have been adjusted for inflation. Needs to Meet Targets – FY 2019 are inflated 2017 dollars and Steady State Needs – FY 2020/FY 2021 are inflated 2017 dollars.

The Governor's 2015 Omnibus Transportation Bill (Chapter 684, 2015 Acts of Assembly) created the State of Good Repair Program (Code of Virginia Section 33.2-369). The State of Good Repair Program provides funding for work on pavements and bridges. The second enactment of Chapter 684 requires the CTB to develop a priority ranking system for the State of

[3] This represents an update to information provided to the CTB in June of 2017 at which time the cost to bring all of the Commonwealth's pavement and bridges to a condition of fair or better (100% level of performance) was reported as $12 billion.

Good Repair Program. Pursuant to that requirement, the CTB approved, by resolution, the State of Good Repair Prioritization Process Methodology on June 14, 2016. A link to the resolution, including the Prioritization Process Methodology follows:

http://www.ctb.virginia.gov/resources/2016/june/reso/Resolution1.pdf

Chapter II responds to those items set out in item 6, to include VDOT's efforts to improve the safety of the motoring and non-motoring public along with an overview of the agency's security programs and protocols. Safety is paramount when developing and implementing any transportation project or program. This chapter also discusses VDOT's strategies and activities to improve highway operations, including the use of funds in the Innovation and Technology Transportation Fund. The final section of this chapter looks at VDOT's efforts to improve incident management.

Chapter III reports on VDOT's efforts in working with the private sector.

Chapter IV presents traffic modeling results for all federally funded projects requiring a multi-alternative National Environmental Policy Act analysis.

Chapter V addresses projects, by district, both subject to and not subject to § 33.2-214.1, approved or modified during the prior FY 2017.

I.
Condition and Performance of the Existing Transportation Infrastructure

This chapter reports on the condition of the existing transportation assets, the methodology to determine needs, available funds to address needs including State of Good Repair, the performance targets and the predicted performance outcomes based on funding.

Section I.1 of this report summarizes the condition of the Virginia Department of Transportation's (VDOT's) pavement and bridge assets. Section I.2 describes the methodology to determine maintenance and operations needs. Section I.3 describes the State of Good Repair Prioritization Process Methodology and distribution of funding in the State of Good Repair Program, and the draft allocation to VDOT from the Highway Maintenance and Operating Fund (HMOF). Section I.4 summarizes the pavement and bridge performance targets and the expected performance outcomes based on funding identified. Section I.5 provides a summary of Chapter I.

I.1 Condition and Performance Overview

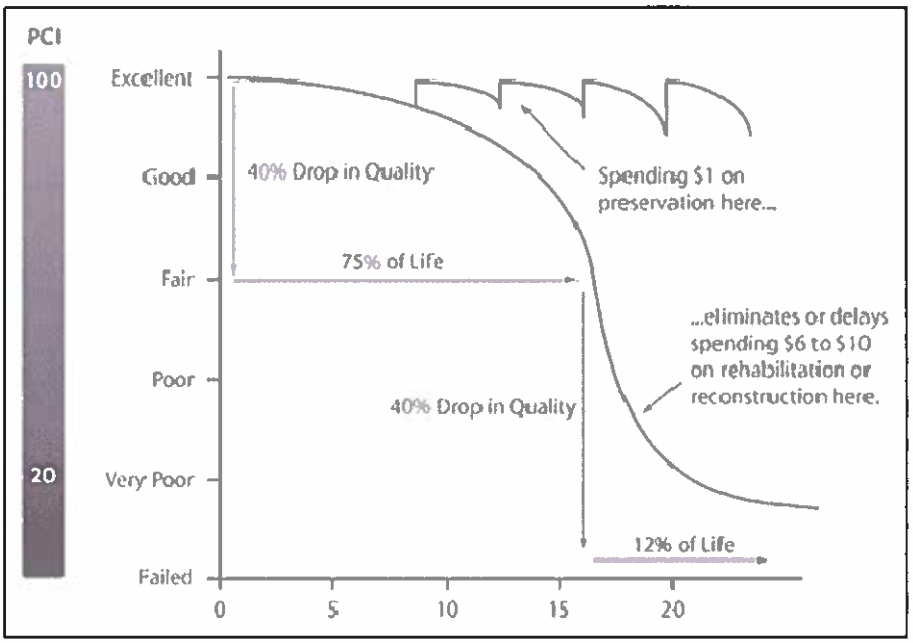
The network of highways and roads maintained by VDOT is the third largest state maintained system in the United States. Approximately 128,000 lane miles of roadway and approximately 19,500 bridges and large culverts are *maintained* by VDOT. VDOT's aging infrastructure and system preservation requires a large portion of the department's resources and focus. VDOT applies an asset management approach to maintaining its core assets: pavements and bridges. The process focuses on proper and timely maintenance, which is critical in ensuring that VDOT avoids more expensive capital replacement in the future. Figure 2 illustrates the impacts asset maintenance timing has on lifecycle costs of an asset. In general, if preventive maintenance is performed earlier in the lifecycle of an asset, the costs will be less when rehabilitation or reconstruction is performed later. For example, with car ownership performing preventive maintenance such as oil changes will assist in extending the life of the car's engine.

The graph depicts spending $1 on preventive maintenance today saves $6 to $10 later as the cost to reconstruct an asset is greater. The funding allocation from the HMOF (VDOT's primary funding for maintaining assets and providing services) is discussed in this chapter. The analysis shows that there is a significant gap between funding needed to timely maintain Virginia's pavement and bridge assets and the availability of such funding. The State of Good Repair Program[4] funding provided by the Governor's 2015 Omnibus Transportation Bill (Chapter 684, 2015 Acts of Assembly), now enacted in Code of Virginia §§ 33.2-358 and 58.1-1741, will assist in closing the gap between needs and the proposed funding.

[4] "State of Good Repair" as defined in § 33.2-369 refers to improvement of deficient pavement conditions and improvement of structurally deficient bridges. See Appendix A for more detail on the State of Good Repair.

VDOT explores ways to close the gap between needs and the proposed funding by using innovative project delivery methods and identifying additional sources of funding such as bonus obligation authority, grants, etc.

Figure 2: Impact of Maintenance Timing on Asset Condition



Note: This graph is based on a 2012 FHWA report on asset sustainability. It illustrates the steep deterioration commonly seen in pavements once they reach a "poor" condition. Timely preventive maintenance creates substantial value by restoring pavements to a high condition and preventing the onset of the rapid deterioration commonly seen in poorly maintained pavements. As noted in the graph, timely preventive treatment can produce a very high return on investment, while underinvestment leads to missed opportunities to prevent rapid degradation.

Besides pavements and bridges, VDOT has other essential transportation assets and services that must be maintained and performed. In this report, needs and allocations are reported in the following maintenance and operations categories:

- Pavements
- Bridges
- Other Services and Repairs
    - Tunnel
    - Emergency and incident management
    - Traffic safety
    - Routine maintenance
    - Facility and other

Condition of Existing Assets

VDOT is responsible for building, maintaining and operating the state's roads, bridges and tunnels. VDOT is broken down into a central office and nine construction districts. The districts are divided into over 30 residencies (several reopened in 2016) which are responsible for work in one to four counties. Figure 3 shows a map of the nine construction districts and Figure 4 shows the counties situated in each district:

Figure 3: Map of Nine Construction Districts

Figure 4: Map of Nine Construction Districts and Counties

Virginia has the third largest state maintained highway system in the country, behind Texas and North Carolina. VDOT is responsible for approximately 128,000 lane miles of roadway and approximately 19,500 bridges and large culverts. VDOT uses an asset management process

along with industry recognized practices to determine the condition of asset inventories and the funding required to maintain and operate these assets.

The asset management process captures the obvious costs of VDOT's assets and services (e.g., inspection of bridges) and less obvious costs (e.g., painting or sweeping of bridges). Effective asset management is comparable to vehicle ownership, which requires routine maintenance (e.g., oil changes or tire rotation) and, at times, replacement costs (e.g., transmission replacement).

VDOT's process focuses on preventive maintenance, rehabilitation and replacement with a goal to prolong the life of long-term transportation assets, which is vital in maintaining the quality of life for Virginians. Proper and timely maintenance is critical in ensuring that VDOT avoids more expensive capital replacement in the future. VDOT's aging infrastructure and system preservation requires a large portion of the department's resources and focus. Figure 2 illustrates the impacts maintenance timing has on lifecycle costs of an asset. If VDOT performs preventive maintenance earlier in the lifecycle of an asset, the costs are less than if rehabilitation or reconstruction is performed later. The figure depicts that spending $1 on preventive maintenance today saves $6 to $10 later as the cost to reconstruct an asset is greater.

Pavement

VDOT reports pavement condition based on annual pavement condition assessments using continuous digital imaging and automated crack detection technology. When conducting condition assessments, the survey vehicle rides over the road surface and records the condition. Figure 5 provides imagery of the survey vehicles used to perform the data collection. The data is collected at highway speeds as the vans are driven along the pavement. Downward images collected during the survey are processed with specialized semi-automated crack detection software for the identification of distresses. The data collected is housed in pavement management software to assist in the review of the pavement condition. Once the pavement condition is reviewed a prioritization (or optimization) process is performed to determine work to be scheduled to maximize the condition of the assets. The pavement assessment is used to develop Critical Condition Index (CCI) values. The CCI is a pavement condition rating scale with values ranging from 0 to 100. Pavement assessed with a CCI value of 60 or above is categorized as being in "Fair condition" or better, also referred to as "sufficient." Figure 6 provides images of pavements in good and poor conditions. More details about the CCI rating are provided in Appendix A.

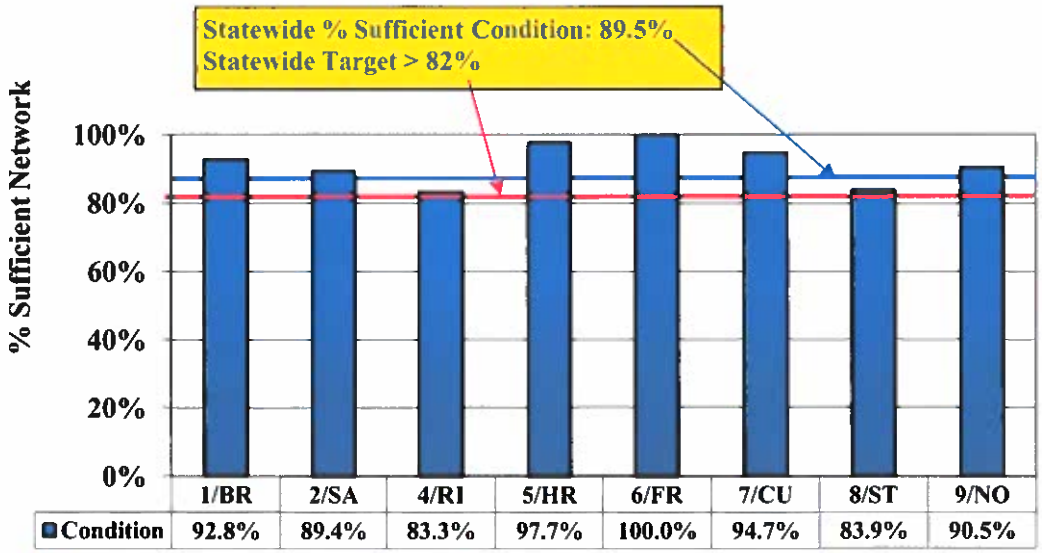
Pavement condition has been assessed on 100 percent of the Interstate and Primary systems and roughly 20 percent of the Secondary system every year since 2006. In 2016, 100 percent of the Secondary network was assessed to create a baseline for condition of all Secondary pavements in a single year.

Figure 5: Pavement Condition Review

Figure 6: Comparison of Pavements in Poor and Good Conditions

Figures 7-9 display the 2017 percent of lane miles with sufficient (Fair or better) CCI pavement condition in the nine VDOT construction districts. The reader should note that District 1/BR represents Bristol District, 2/SA is Salem District, 3/LY is Lynchburg District, 4/RI is Richmond District, 5/HR is Hampton Roads District, 6/FR is Fredericksburg District, 7/CU is Culpeper District, 8/ST is Staunton District and 9/NO is Northern Virginia District.

Figure 7: Percent Sufficient Pavements: Statewide and by District - Interstate (2017)



Note: The Lynchburg District does not have an Interstate network.

Figure 8: Percent Sufficient Pavements: Statewide and By District – Primary (2017)

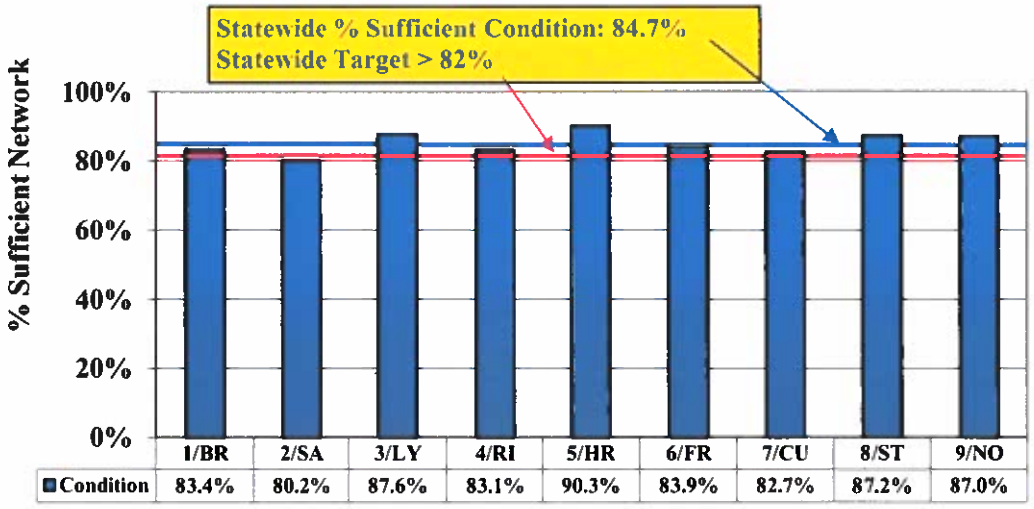
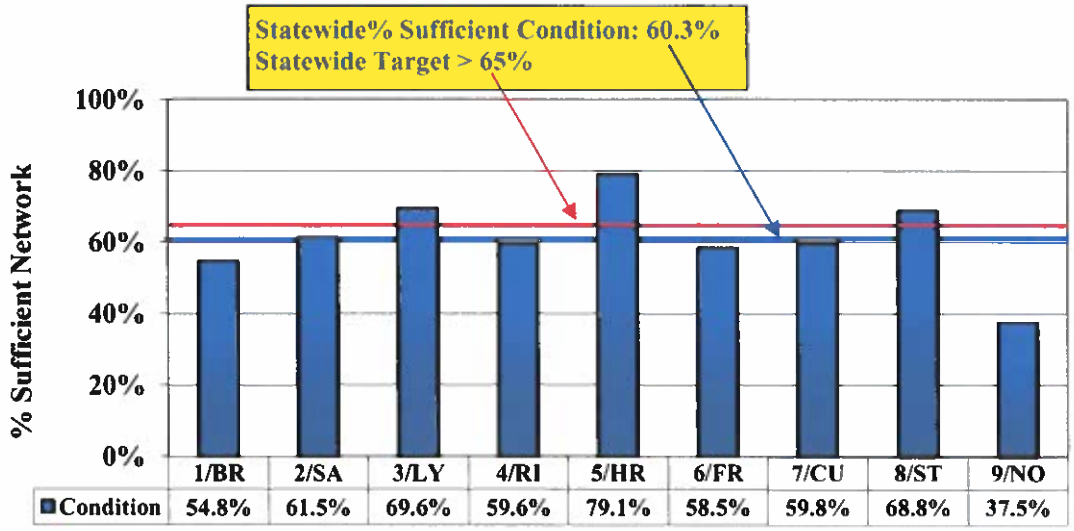


Figure 9: Percent Sufficient Pavements: Statewide and by District – Secondary (2017)



Note: The lower Secondary pavement condition in Northern Virginia District is due primarily to a focus on Interstate and Primary system paving over the past years, when allocations to those systems were increased. VDOT is now focusing more on Secondary pavements. The sufficiency ratings statewide and for the Northern Virginia District are higher than in 2016.

Bridge

There are currently 21,103 structures (bridges and large culverts) located throughout the Commonwealth, of which 13,524 are National Bridge Inventory (NBI)[5] structures and 3,739 are NBI structures on the National Highway System. VDOT maintains 19,456 of these structures, and 1,647 are maintained by localities and private owners. VDOT follows national standards in performing safety inspections and determining general condition of the structures. Condition assessments are performed by certified safety inspection personnel. The inspection program actually requires an individual to complete a "hands-on" review during each inspection. (See Figure 10)

Detailed inspections of bridge structures must be completed at intervals not to exceed 24 months and for large culverts the interval is not to exceed 48 months. VDOT uses a software package, BrM, to store bridge condition and inventory data for each structure and to program, schedule and track inspections. Data collected from inspections are used to evaluate:

- safety
- planning
- budgeting

[5] The National Bridge Inventory includes bridges on public roadways exceeding 20 feet in length. The NBI also includes large culverts with a combined width (as measured along the centerline of the roadway) greater than 20 feet.

- performance of maintenance
- repair
- rehabilitation
- replacement of structures

Figure 10: Bridge Condition Review*

Bridge Structural Elements Diagram

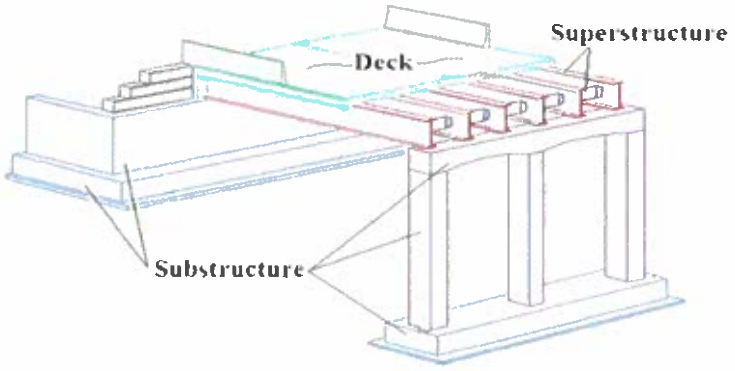
Using the National Bridge Inventory rating scale (established by the FHWA), bridge inspectors rate these structural elements for each bridge.

Deck: The portion of the bridge that directly carries traffic.

Superstructure: The portion of the bridge that supports the deck and connects one substructure element to another.

Substructure: The portion of the bridge that supports the superstructure and distributes all bridge loads to below ground bridge footings.

Culvert: (Not pictured.) A pipe or small structure used for drainage under a road, railroad or other embankment. A culvert with a span length greater than 20 feet is included in the National Bridge Inventory and receives a rating using the NBI scale.



Structural elements of a typical highway bridge

* Bridge Structural Elements Diagram courtesy of Michigan Department of Transportation.

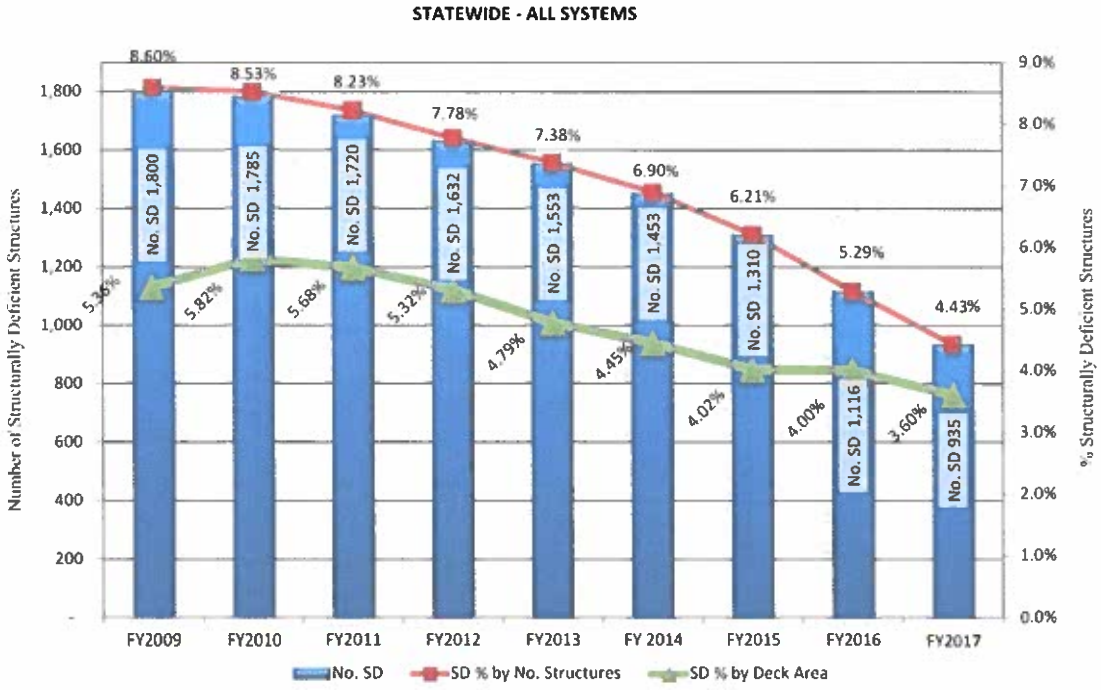
Figure 11 shows examples of bridges in poor and good conditions.

Figure 11: Comparison of Bridges in Poor and Good Conditions

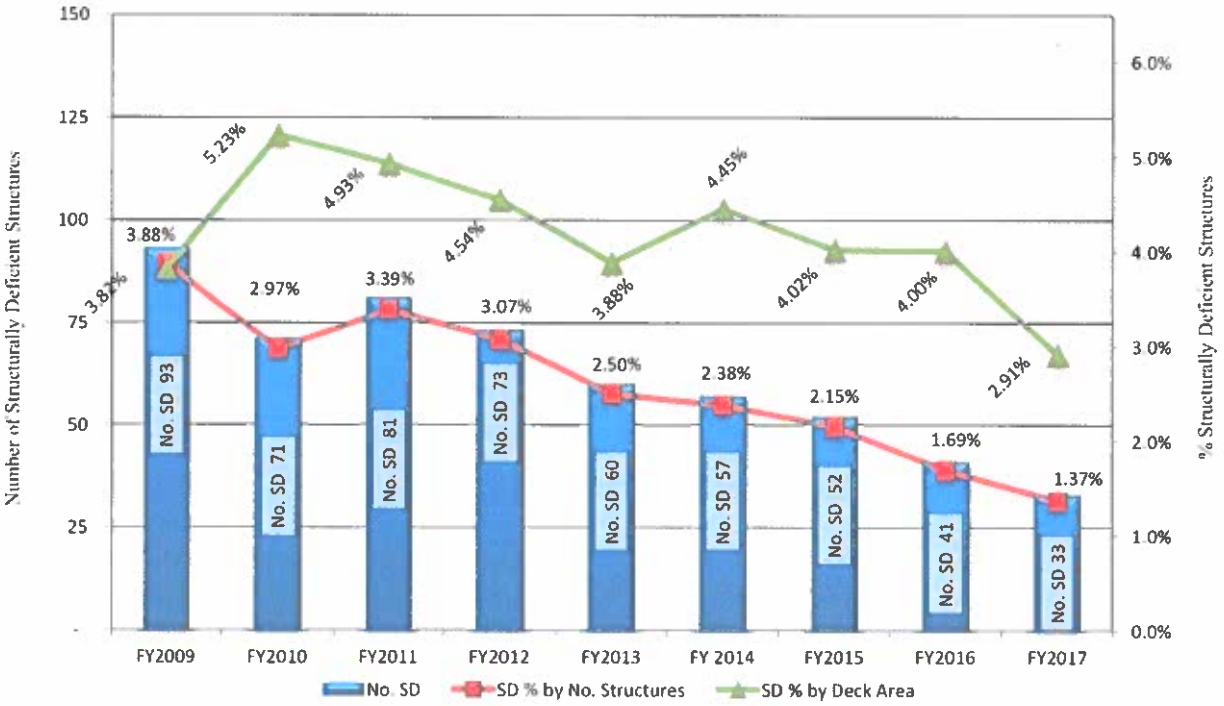
Poor ***Good***

A structure is defined as structurally deficient if one or more of its major components (deck, superstructure, substructure, or culvert) is deficient, which requires the structure to be monitored and/or repaired, or if it lacks adequate strength or waterway clearance. More details about bridge condition and structure deficiency ratings are provided in Appendix A of this report. Figure 12 shows the percentage of and number of structurally deficient structures (bridges and large culverts). It also provides the recent trend in that percentage.

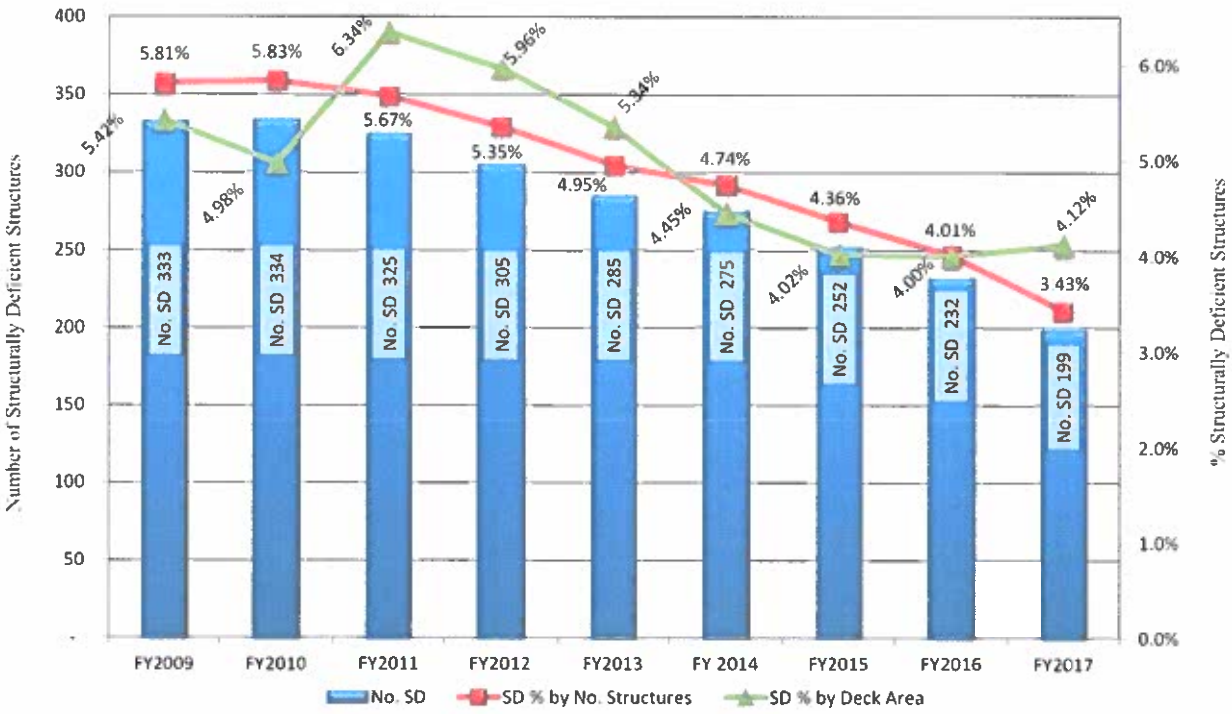
Figure 12: Percentage of and Number of Structurally Deficient Structures



INTERSTATE SYSTEM



PRIMARY SYSTEM



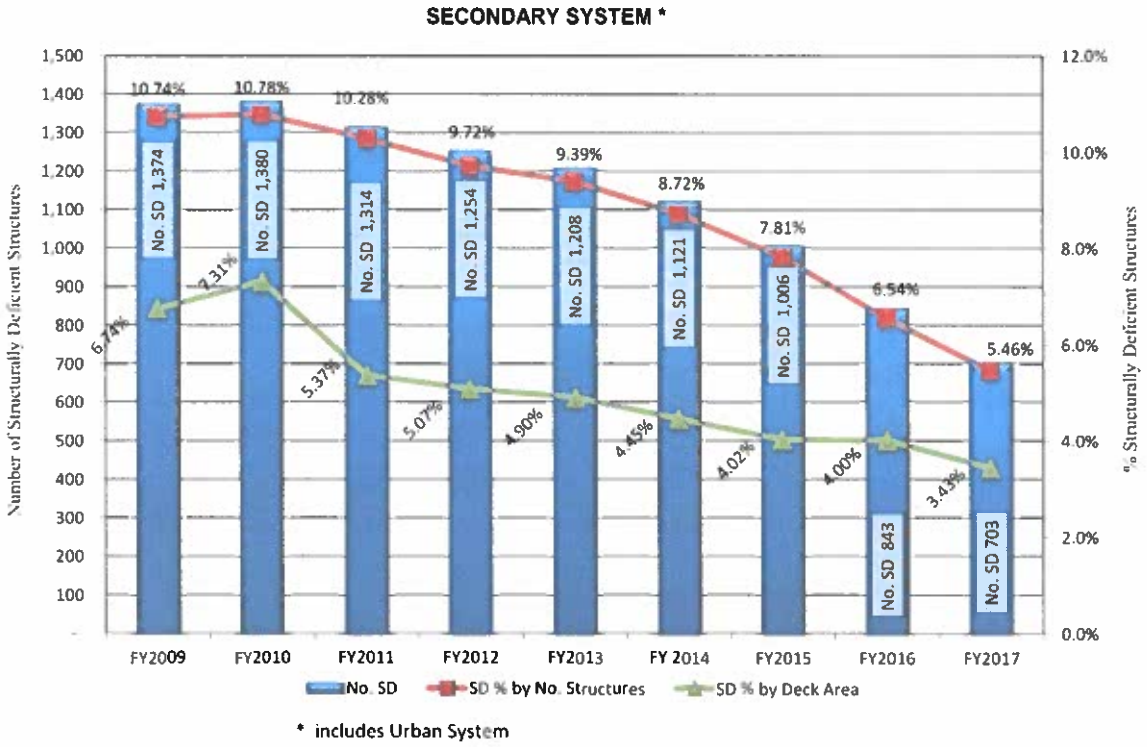
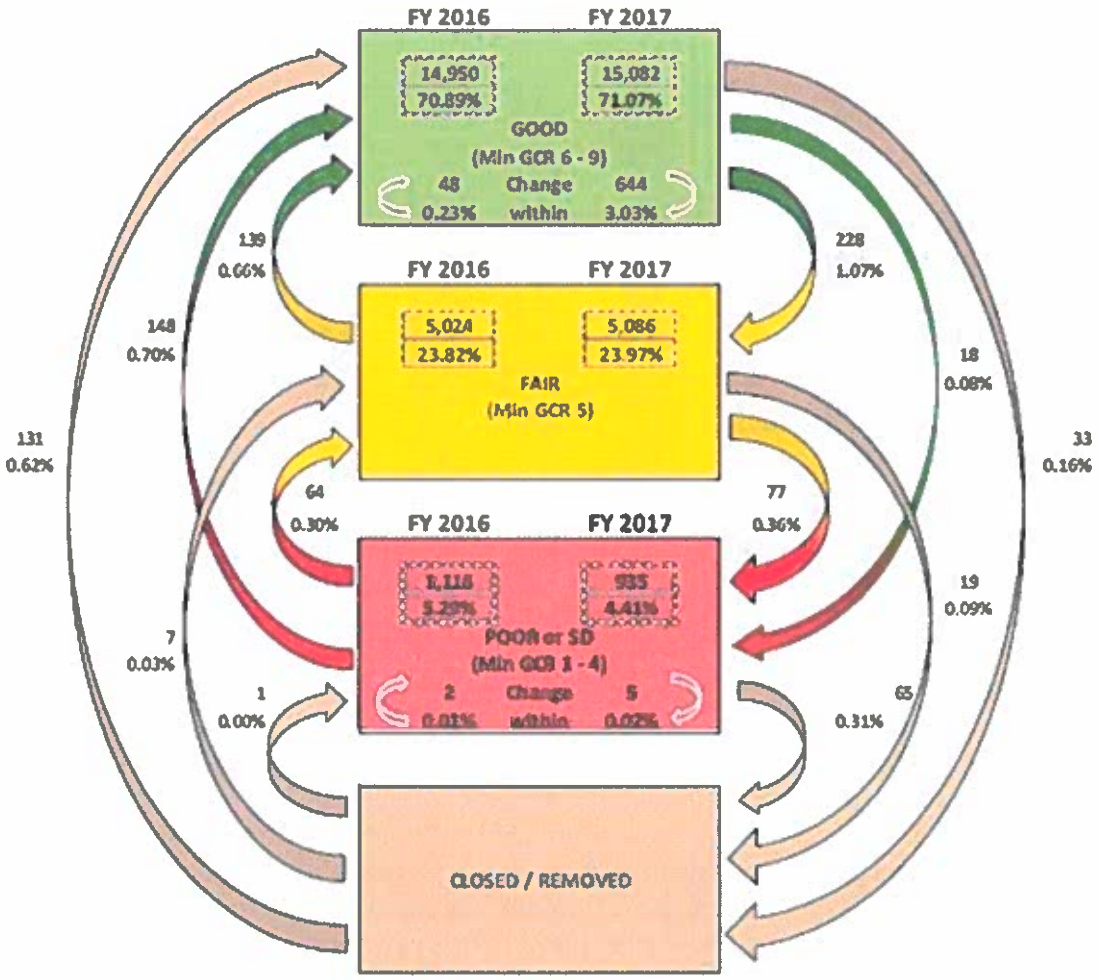


Figure 13 shows the changes to general condition ratings (GCR).[6] From FY 2016 to FY 2017, 323 structures deteriorated to a lower condition category (Good, Fair or Poor), while 351 improved to a higher condition category. In addition, 649 structures deteriorated but stayed within the same condition category, while 50 improved. The figure also shows that 117 structures were closed to the public or removed from the system, a number of which are replacements (the older structure number was replaced with a new structure number in inventory), while 139 were reopened to the public or added to the system.

The large arrows between condition categories (Good, Fair, Poor) track "gross" changes in bridge conditions. The arrows within the condition categories of "Good" and "Poor" are provided to track incremental changes within broad categories and provide more refined data regarding condition changes from one year to another. For example, the chart shows that 48 Good structures improved within the Good category but 644 Good structures deteriorated while staying within Good, thus indicating that the average conditions of the Good structures are decreasing. While fewer bridges are shown in a lower condition rating (Good to Fair, Good to Poor or Fair to Poor), more bridges have decreasing condition ratings. VDOT has funded more preventive maintenance activities in order to remedy the trend.

[6] The general condition rating (GCR) is a nationally established numerical grading system with values that range from 0 (failed condition) to 9 (excellent condition).

Figure 13: Annual Transitions of GCR from FY 2016 to FY 2017



Note: Percentages based on total structures in the inventory from FY16 to FY17 inclusive of those closed and/or removed over that time period.

Explanatory Note: As shown in Figure 13, 228 structures deteriorated from Good to Fair condition, 77 structures dropped from Fair to Poor condition and 18 structures went from Good to Poor condition, which resulted in a total of 323 structures deteriorated to a lower condition category. In the meantime, 139, 64 and 148 structures improved from Fair to Good, from Poor to Fair, and from Poor to Good conditions, respectively, which resulted in a total of 351 structures improved to a higher condition category.

Other Services and Repairs

VDOT is responsible for other essential transportation assets and services that must be maintained or provided. VDOT maintains and operates these other assets and services based on industry practices and engineering principles. However, for these other essential assets, condition data is not readily available; for services, condition assessment is not suitable. Therefore, statewide performance targets are not established for these other assets and services.

These items include, but are not limited to, 7 tunnels, 43 safety rest areas (includes 12 welcome centers), 6 ferries and assets such as signs, signals, guardrail and other highway assets in the VDOT maintained network. Further details on the other assets and services are provided in Appendix A of this report.

I.2 Methodology to Determine Maintenance and Operations Needs

Needs Assessment Generally

For the purpose of this report, needs refer to the maintenance costs required for an asset or infrastructure system to achieve and/or sustain a State of Good Repair over time. The needs assessment also accounts for priorities by asset class and activity if funds are limited. The following types of needs are presented in this report:

- **Unconstrained needs (100% needs)**, which include (1) costs to bring VDOT's deteriorated pavement and structurally deficient bridge assets to the State of Good Repair, (or ultimately the cost for everything) and (2) costs to cover preventative, corrective and restorative maintenance on pavements and bridges.
- **Needs to meet performance targets**, which are costs to meet statewide performance targets for pavements and bridges in FY 2019. Fully funded needs for previous and projected years were excluded.
- **Steady state needs**, which are costs to maintain assets at a steady state once the statewide performance targets for pavements and bridges are achieved.
- **Other service and repair needs**, which are costs to maintain and operate other essential assets and services.

VDOT applies an asset management approach, accepted engineering principles and business practices to identify maintenance and operation's needs. Methodology used to determine maintenance needs is summarized below, while details on the approaches applied are provided in Appendix A and illustrated in Figure 14. The reader should note that the process depicted in Figure 14 initiates with the Asset Inventory & Condition and the process is continuous.

Figure 14: Asset Management Process

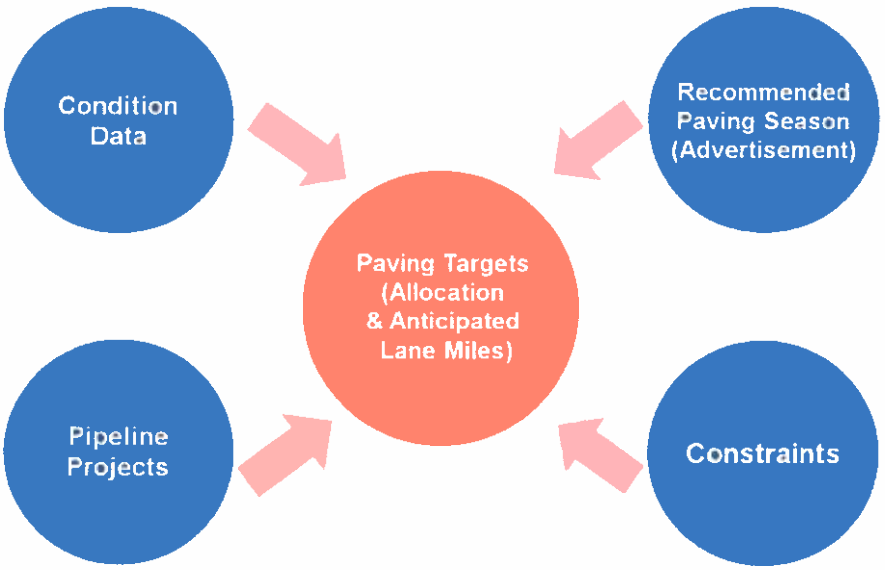
Pavement Needs Methodology

Pavement needs are assessed based on pavement management principles to cost-effectively maintain the pavement asset over the term of its lifecycle. VDOT pavement management business processes use established asset management principles and policies. These include:

- Condition assessment of the pavement network as described in the previous section.
- Setting performance targets and goals, which are
    a. Interstate - 82 percent in sufficient (Fair or better) condition. All sections of Interstate pavements shall be above a CCI rating of 35.
    b. Primary - 82 percent in sufficient (Fair or better) condition.
    c. Secondary - 65 percent in sufficient (Fair or better) condition.
- Optimization by using pavement management software to determine the cost to cover an optimal mix of maintenance strategies from preservation to major rehabilitation with the objective of reducing costs in the long run.
- Performance monitoring and reporting.
- Accounting for costs associated with paving related marking, guardrail, signal loops, rumble strips, shoulders, ramps, patching, turn lanes, bike and pedestrian lanes, traffic control, inspection and contingency.
- Taking into account factors such as traffic volume, maintenance history, and structural and subgrade strength for recommended paving work.
- A process for the Americans with Disabilities Act ramp needs associated with paving activities that makes every effort to construct the required ramps prior to paving.

Figure 15 illustrates the pavement needs assessment process.

Figure 15: Pavement Needs Assessment Process

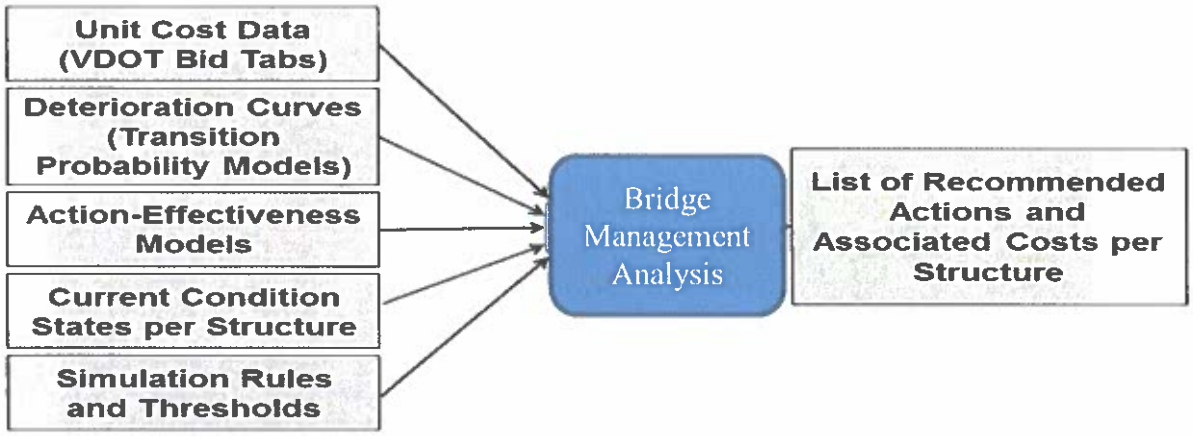


Bridge Needs Methodology

Bridge needs are calculated with a goal of meeting or exceeding the established statewide performance targets. The assessment applies bridge management principles to cost-effectively maintain a bridge's infrastructure over the term of its lifecycle. The process (as illustrated in Figure 16) includes:

- Annual condition rating as described in the previous section.
- Setting a statewide performance target, that is, 95.5 percent in Fair or better condition, based on:
    a. Interstate - 99 percent in Fair or better condition (not structurally deficient)
    b. Primary - 96 percent in Fair or better condition (not structurally deficient)
    c. Secondary - 94 percent in Fair or better condition (not structurally deficient)
- Using nationally recognized bridge management principles and methods to develop work recommendations. These recommendations are generated using unit prices for repair work along with deterioration curves,[7] action-effectiveness models[8] and agency-developed logic to suggest cost-effective work plans.
- Taking into account a variety of factors such as vehicle and truck traffic volumes, detour, highway system, and proximity of structures to critical facilities such as hospitals, schools and fire stations.

Figure 16: Bridge Needs Assessment Process



Note: A transition probability model specifies the likelihood that the condition of a structure will change from one state to another in a stipulated time period.

[7] A deterioration curve tracks asset performance in different condition categories over time.

[8] An action-effectiveness model estimates the impacts of maintenance treatments on structure condition based on the "cause and effect" relationship between maintenance treatments and expected improvements.

Other Services and Repairs

The costs to maintain and operate VDOT's other essential assets and services are determined based on engineering principles, business practices or historical expenditures. A breakdown of methods used to determine needs for the various assets and service areas are provided below. The categories are:

- Tunnel
- Emergency and incident management
- Traffic safety
- Routine maintenance
- Facility and other

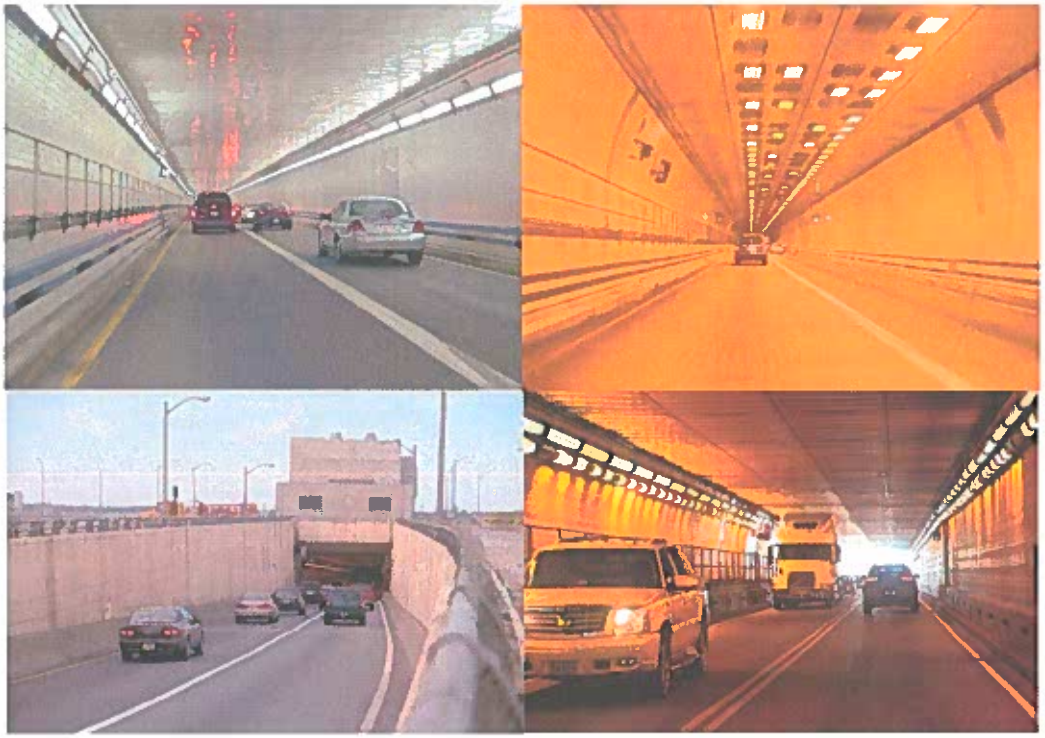
Total amount of needs for this category is provided in Figure 24.

Tunnels

VDOT maintains seven tunnels. Pictures of a few of the tunnels are provided in Figure 17. Tunnel needs include:

- the fixed costs to maintain and operate the facilities 24 hours every day;
- maintenance projects to address risk and safety concerns;
- costs to provide improvements, such as safety training and technology.

Figure 17: Virginia Tunnel Facilities



Emergency and Incident management

Emergency and incident management needs include costs to operate the transportation operations centers, the costs to provide incident response, snow and ice removal (as pictured in Figure 18), safety service patrols, and the costs to maintain technology assets such as traffic cameras, electronic message signs and traffic management systems. The methodology to determine these needs is summarized below.

- Transportation operations centers' and technology assets' needs include, but are not limited to, contractual obligations and fixed costs to operate the facilities.
- Incident response services' needs are determined based on historical expenditures, personnel and equipment costs.
- Snow removal program needs are determined based on historical expenditures along with factors established by the Virginia Transportation Research Council to account for geographical differences among the districts.

Figure 18: Snow Removal Operations

Traffic safety

Traffic needs include the cost of striping roads, maintaining and operating traffic signals and lighting, and maintenance of assets such as traffic signs and guardrail. Examples of traffic safety devices are illustrated in Figure 19. For most traffic assets, needs are determined based on industry accepted lifecycle replacement and repair business rules. Traffic needs also include costs determined through engineering analysis to repair, remove and replace traffic asset ancillary structures such as signal mast arms, highway lighting poles and overhead sign structures. Additionally, traffic asset repair and replacement are often required as part of paving (e.g., restriping pavement markings or installing rumble strips after a pavement overlay).

Figure 19: Traffic Safety Devices

Routine maintenance

The routine maintenance category includes work performed by the residencies,[9] unpaved roads, drainage, vegetation management, sound barriers, sidewalks, bike paths, pedestrian trails and other roadside assets. Figure 20 illustrates examples of routine maintenance activities performed. Routine maintenance needs are calculated primarily based on the recurring cost to maintain drainage pipes and ditches, mow grass, cut brush, trim trees and maintain sound barriers.

Figure 20 Routine Maintenance Operations

Facility and Other

Facility and other needs include all needs not captured in the previous categories. This category includes ferries, rest areas, permitting, facility security, and management and direction. Photographs of safety rest area and ferry facilities are provided in Figure 21. A majority of the needs in this category are primarily determined based on the fixed costs to VDOT (such as equipment, material cost and overhead) in order to deliver the services or programs.

[9] Examples of work performed by the residencies include crack sealing, pot hole patching, slurry seals and sweeping.

Figure 21: Safety Rest Area and Ferry Facilities

Summary of Needs

Figures 22 and 23 summarize the unconstrained pavement and bridge needs (100% needs), which include: (1) costs to bring VDOT's deteriorated pavement and structurally deficient bridge assets to the State of Good Repair (ultimately, the cost of everything) and (2) costs to cover preventive, corrective and restorative maintenance on pavements and bridges. The unconstrained needs are estimated to illustrate the amount of total work needed on the existing assets. It is not realistic or practical for VDOT to meet the 100% unconstrained needs. Figures 22 and 23 also provide the costs for VDOT to meet statewide performance targets for pavements and bridges in FY 2019 and the costs to maintain the two assets in a steady state as of FY 2020 once the relevant statewide performance targets are achieved.

Figure 22: VDOT Needs For Pavements and Bridges
($ millions)

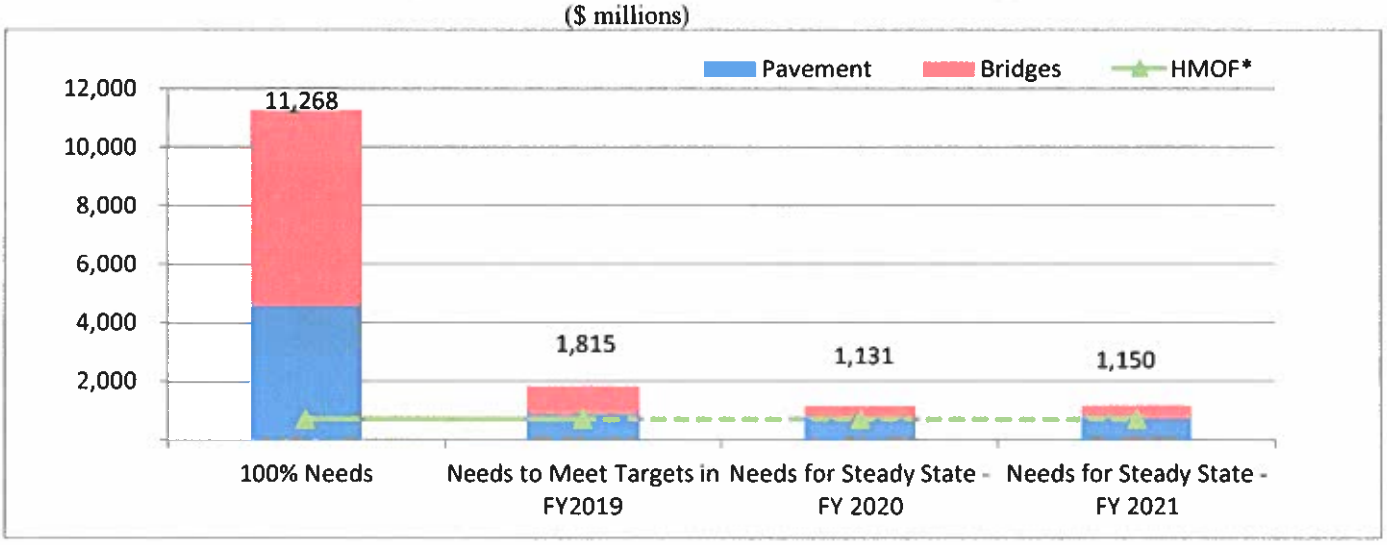
Maintenance and Operations Category	100% Needs*	Needs to Meet Targets in FY 2019***	Steady State Needs (after Targets are met) FY 2020***
Pavement**	$ 4,551	$ 841	$ 695
Bridges	$ 6,717	$ 974	$ 436
Grand Total:	**$ 11,268**	**$ 1,815**	**$ 1,131**

* 100% needs are unconstrained needs that include (1) costs to correct deteriorated pavements and structurally deficient structures (to achieve State of Good Repair), and (2) costs to cover preventive, corrective, and restorative maintenance on pavements and bridges. 100% Needs are shown in 2017 dollars.

** Pavement needs account for costs associated with paving and paving related marking, guardrail, signal loops, rumble strips, shoulders, ramps, patching, turn lanes, bike and pedestrian lanes, traffic control, inspection and contingency.

*** Steady state needs are expenditures required to maintain the targets after they are met. Fully funded needs were excluded. Needs to Meet Targets – FY 2019 are inflated 2017 dollars and Steady State Needs – FY 2020 are inflated 2017 dollars.

Figure 23: VDOT Needs and Proposed HMOF Funding For Pavements and Bridges
($ millions)



*HMOF line indicates $700 million

Note: Amounts presented are estimates based on condition assesssment of current inventory and are subject to change. The needs assessment is performed annually. 100% Needs are shown in 2017 dollars, FY 2019, 2020 and 2021 needs have been adjusted for inflation. Needs to Meet Targets – FY 2019 are inflated 2017 dollars and Steady State Needs – FY 2020/FY 2021 are inflated 2017 dollars.

Figure 24 summarizes the funding needed in FY 2019 for VDOT to meet the pavement and bridge statewide performance targets as well as the funding needed to maintain and operate the other existing transportation infrastructure. Figure 25 shows the needs breakdown graphically.

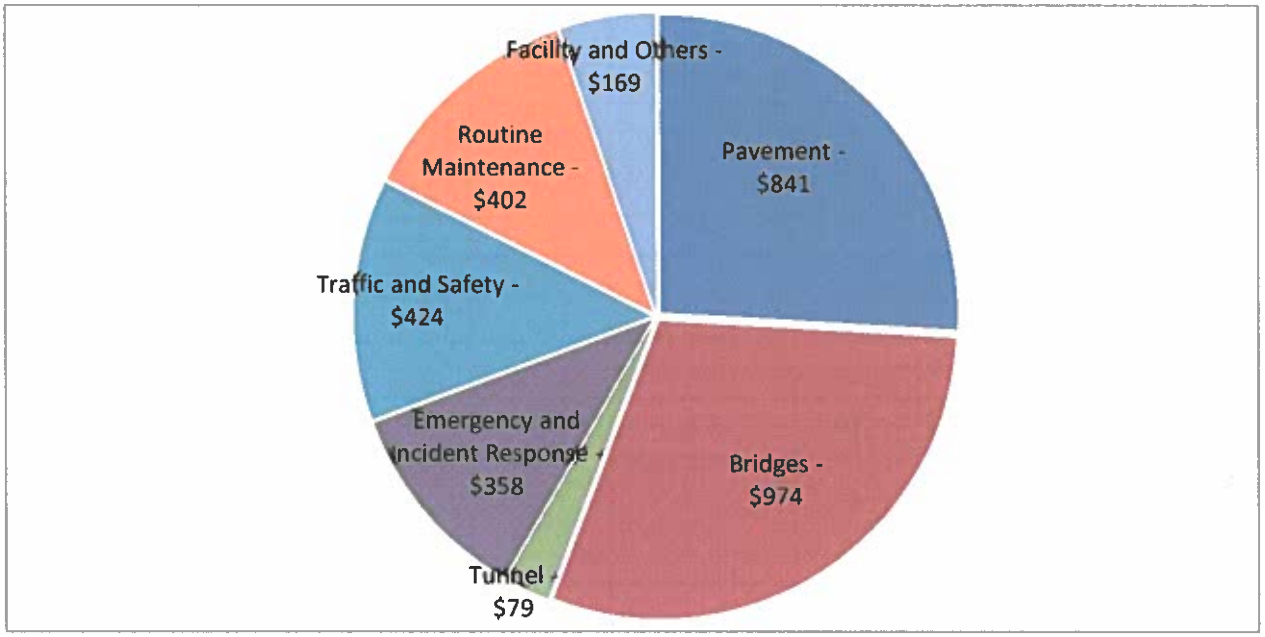
Figure 24: FY 2019 VDOT Needs For Existing Infrastructure by Category
($ millions)

Maintenance and Operations Category	Needs to Meet Performance Targets**	Needs based on business practices/historical expenditures
Pavement*	$ 841	
Bridges	$ 974	
Other Services and Repairs		$ 1,432
Grand Total:	**$ 3,247**	

* Pavement needs account for costs associated with paving and paving related marking, guardrail, signal loops, rumble strips, shoulders, ramps, patching, turn lanes, bike and pedestrian lanes, traffic control, inspection and contingency.

** Fully funded needs for previous and projected years were excluded.

Figure 25: FY 2019 VDOT Needs Breakdown
($ millions)



Special Structures

VDOT maintains and operates structures of all sizes and complexities. Twenty-five of the largest and most complex structures have been identified as specialized major highway assets, or Special Structures. These structures present maintenance funding challenges beyond that of the general bridge inventory and warrant a separate thirty-year needs plan. The Special Structures are grouped into three categories: Tunnels, Movable Bridges and Large/Complex Structures. The structural component of all three categories is captured under the bridge needs.

Figure 26 provides the reader with a list of the Special Structures along with their thirty year needs.

Figure 26: Special Structures 30 Year Needs

	STRUCTURE		ROUTE	YEAR BUILT (AGE)	2018-2027	2028-2037	2038-2047	TOTAL
TUNNELS	BRISTOL	Big Walker Mountain	I-77	1972	$12 M	$2 M	$5 M	$20 M
	BRISTOL	East River Mountain	I-77	1974	$13 M	$3 M	$6 M	$21 M
	HAMPTON ROADS	Hampton Roads Bridge Tunnel	I-64	WBL - 1958 EBL - 1974	$86 M	$51 M	$113 M	$250 M
	HAMPTON ROADS	Monitor Merrimac Memorial Bridge Tunnel	I-664	1992	$142 M	$46 M	$110 M	$298 M
	HAMPTON ROADS	Elizabeth River Downtown Tunnel			*Maintained by Elizabeth River Crossings*			$0 M
	HAMPTON ROADS	Elizabeth River Midtown Tunnel			*Maintained by Elizabeth River Crossings*			$0 M
	NORTHERN VIRGINIA	Rosslyn Tunnel	I-66	1983	$4 M	$2 M	$2 M	$8 M
				Subtotal	$257 M	$103 M	$236 M	$597 M
MOVABLE BRIDGES	RICHMOND	Benjamin Harrison	Rte 156	1967	$56 M	$3 M	$4 M	$63 M
	HAMPTON ROADS	Chincoteague	Rte 175	2010	$1 M	$2 M	$18 M	$21 M
	HAMPTON ROADS	High Rise	I-64	1969	$5 M	$2 M	$0 M	$7 M
	HAMPTON ROADS	Berkley	I-264	WBL - 1952 EBL - 1990	$78 M	$20 M	$18 M	$116 M
	HAMPTON ROADS	Coleman	Rte 175	1996	$9 M	$11 M	$14 M	$33 M
	HAMPTON ROADS	James River	Rte 17	1980	$55 M	$6 M	$25 M	$86 M
	FREDERICKSBURG	Eltham	Rte 30/33	2007	$12 M	$1 M	$9 M	$22 M
	FREDERICKSBURG	Gwynn's Island	Rte 223	1938	$18 M	$1 M	$40 M	$59 M
				Subtotal	$234 M	$45 M	$127 M	$406 M
COMPLEX FIXED SPAN STRUCTURES	BRISTOL	460 Connector	460	2017	$1 M	$0 M	$3 M	$4 M
	SALEM	Smart Road Bridge		2001	$1 M	$1 M	$2 M	$4 M
	RICHMOND	Varina Enon	I-295	1990	$69 M	$20 M	$11 M	$99 M
	RICHMOND	895/Pocahontas Parkway	895		*Maintained by Globalvia*			$0 M
	HAMPTON ROADS	HRBT Approaches	I-64	WBL 1957 EBL 1974	$79 M	$490 M	$15 M	$584 M
	HAMPTON ROADS	Willoughby Bay	I-64	1972	$33 M	$2 M	$0 M	$35 M
	HAMPTON ROADS	MMMBT approaches	I-664	1992	$36 M	$48 M	$20 M	$104 M
	HAMPTON ROADS	James River bridge approaches	Rte 17	1980	$61 M	$38 M	$23 M	$122 M
	HAMPTON ROADS	I-64 High Rise bridge approaches	I-64	1969	$22 M	$13 M	$0 M	$35 M
	FREDERICKSBURG	Norris bridge	Rte 3	1957	$27 M	$258 M	$12 M	$297 M
				Subtotal	$329 M	$869 M	$85 M	$1,283 M
				Total (rounded to $100M)	$0.8 B	$1.0 B	$0.5 B	$2.3 B

Note: Totals may differ from amounts shown due to rounding.

I.3 State of Good Repair Program and the HMOF

Pursuant to items 3 and 5 of § 33.2-232, this section provides details of the State of Good Repair Program and allocations from the HMOF.

State of Good Repair Prioritization Process Methodology

The Governor's 2015 Omnibus Transportation Bill (Chapter 684, 2015 Acts of Assembly) created the State of Good Repair Program. Code of Virginia § 33.2-358 allocates 45% of the construction program to the state of good repair starting in Fiscal Year 2021. The State of Good Repair Program (§ 33.2-369) provides funding for the reconstruction and rehabilitation of deteriorated pavements on the Interstate, Primary and Primary Extensions (both VDOT and locally maintained/owned) as well as the replacement and rehabilitation of structurally deficient bridges (both VDOT and locally maintained/owned) on all systems. Allocation of the funding is based on a needs prioritization methodology. Under the State of Good Repair Program, all nine

construction districts will receive funding, with no district receiving less than 5.5% or more than 17.5% percent of the funds in a given year. However, the CTB has the ability to approve two exceptions or waivers to this funding distribution. The first exception waives the funding cap in order to provide funds for an urgent pavement or bridge project (need) resulting from extraordinary circumstances. The second waiver allows the CTB to reserve 20% of funds for use by the nine districts on Secondary pavements if VDOT does not meet Secondary pavement statewide performance targets.

The second enactment clause of Chapter 684 (2015) required the CTB to develop a priority ranking system for the State of Good Repair Program by July 1, 2016. Pursuant to that requirement, a priority ranking system, the State of Good Repair Prioritization Process Methodology (Prioritization Process), was developed by the CTB and approved by resolution on June 14, 2016. A link to the CTB resolution is included below:

http://www.ctb.virginia.gov/resources/2016/june/reso/Resolution1.pdf

Pursuant to item 5 of § 33.2-232, prioritized needs are provided in the links below:

1) State of Good Repair Projects listed by District (VDOT and localities) Starting page 22
   http://syip.virginiadot.org/reports/233/13A-FY18-FINAL-APPENDIX-A.pdf
2) Paving Projects by District(VDOT)
   http://syip.virginiadot.org/reports/233/13C-FY18-FINAL-APPENDIX-C.pdf
3) Bridge Projects by District(VDOT)
   http://syip.virginiadot.org/reports/233/13D-FY18-FINAL-APPENDIX-D.pdf
4) Primary Extension Projects (localities) Starting page 7
   http://www.ctb.virginia.gov/resources/2017/june/reso/resolution_11_primary_extension.pdf
5) Locality Bridge
   http://www.ctb.virginia.gov/resources/2017/mar/reso/resolution_4_sgr.pdf

A description of the priority ranking system follows.

The Prioritization Process consists of three main steps, which are outlined below.

Step 1 - The Needs Assessment Process

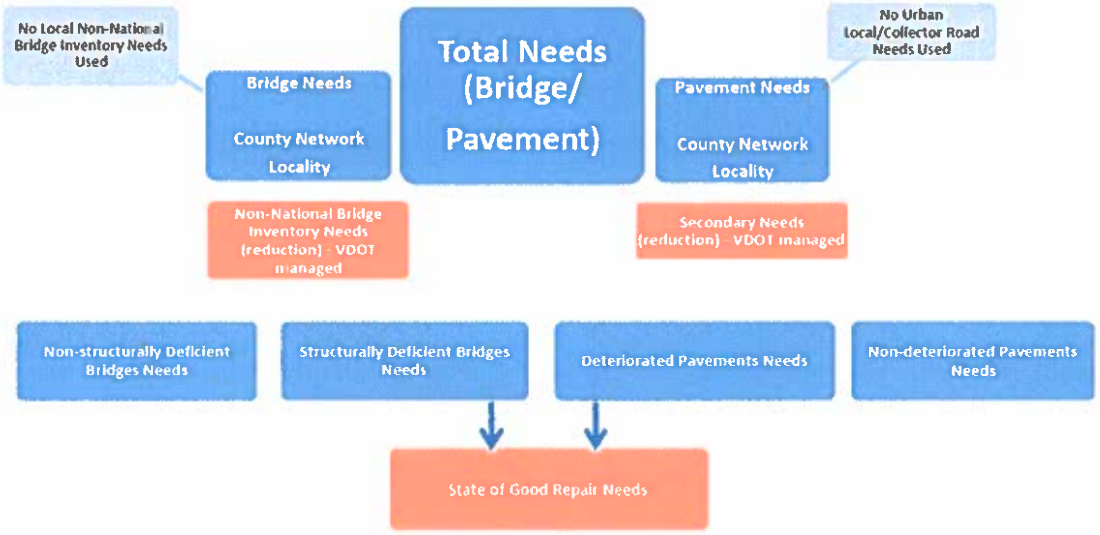
- Unconstrained (100%) needs are collected for pavements and bridges.
  - VDOT collects 100% of the needs for Interstate, Primary and Primary Extensions. Typically only 20% of the needs for Secondary pavements are collected annually. In 2016, VDOT collected 100% of the needs for Secondary pavements to create a baseline.
  - VDOT collects 100% of the needs for VDOT maintained bridges, and localities provide VDOT the needs for structures in the NBI that are owned or maintained by localities.

Step 2 - State of Good Repair Needs and Funding Distribution Methodology

- The needs collected in the Needs Assessment Process are then separated in order to identify deteriorated pavements and structurally deficient bridges (VDOT and locally maintained/owned). Those needs are the State of Good Repair needs. In the process to calculate the State of Good Repair Needs, VDOT's needs are reduced if needs are not available for localities.
    - Pavements – need assessments are not available for localities urban/collector pavement needs; therefore, VDOT's Secondary needs are removed from the needs figure.
    - Bridges – need assessments are not available for the localities Non-NBI needs; therefore, VDOT's Non-NBI needs are removed.

Figure 27 depicts the process to identify the state of good repair needs.

Figure 27 – State of Good Repair Needs Process

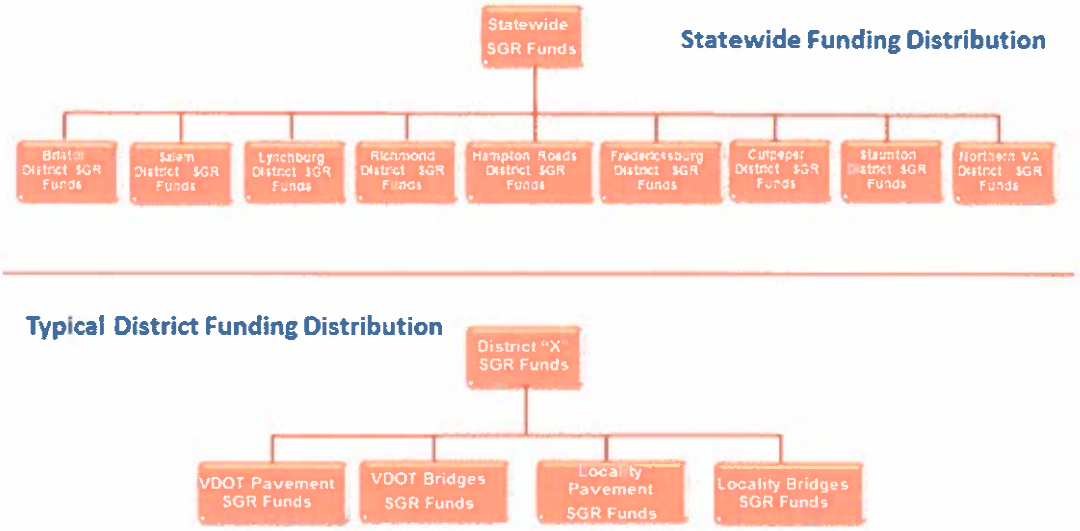


- The State of Good Repair Program needs are the basis for the percentage of funds given to each district with each district receiving no less than 5.5% and no more than 17.5% in a given year.

- Within each district, funding is distributed across four categories:
    - VDOT pavement
    - VDOT bridge
    - Locality pavement
    - Locality bridge

Figure 28 illustrates the statewide funding distribution to each district and then the typical district funding distribution.

Figure 28 – State of Good Repair Program – Needs Based Funding Distribution



Funding is set aside for distribution to each asset category both for VDOT and the localities. The recommended State of Good Repair Program bridge and pavement projects are submitted for inclusion in the Six-Year Improvement Program.

Step 3 - Priority Ranking System Methodology, Generally

Bridge

VDOT and Localities:

- All bridges that are eligible for State of Good Repair Program funding are prioritized based on factors such as condition and cost-effectiveness. A prioritized list of bridges for repairs is developed for each district based on the rankings or scoring.

Pavements

VDOT:

- Each construction district will compile pavement projects based on the number of lane miles of deficient pavement that qualify for State of Good Repair Program. These pavement projects are ranked for recommended funding using criteria such as the road system in which the pavement is located (i.e., Interstate or Primary) and the traffic count for the given section of pavement.

Localities:

- Follow the established primary extension prioritization process approved by the Commonwealth Transportation Board in June 2014.

Additional detail describing the priority ranking system methodology is set forth at the following link. http://www.ctb.virginia.gov/resources/2016/june/reso/Resolution1.pdf

Use of State of Good Repair Funds in 2016

Based on § 33.2-358, the State of Good Repair was not required to receive funding until FY 2021. However, the 2016 and 2017 Appropriations Acts provided funding to the State of Good Repair Program. The State of Good Repair Program funding distribution percentages, presented to the General Assembly in 2015, were used to distribute funds to each district. The unconstrained needs reported in the 2015 Annual Report were separated as illustrated in Figure 27 to determine the State of Good Repair Program needs. (Note: the State of Good Repair Program Needs are the structurally deficient NBI needs and the deteriorated Interstate, Primary and Primary Extensions pavement needs.) The allocation to each district's funding categories was split based on the needs for each asset category (pavement or bridge) and whether the needs were for VDOT or a locality as shown in Figure 28.

Pavements

VDOT's pavement projects were prioritized based on the system (Interstate or Primary). For locally maintained Primary extensions, the existing Primary extension process adopted by the Board on June 18, 2014 was used to fund projects. The link to the resolution relating to the Primary Extension Improvement Program Policy is provided below:

http://www.ctb.virginia.gov/resources/2014/june/reso/Resolution_Agenda_Item_9.pdf.

Bridges

In each district, separate lists of the structurally deficient NBI projects were created for VDOT and the localities. VDOT and the localities are required to indicate the work that will be performed on each bridge to remove the structurally deficient status. Any funds that have not been committed to a project are held in a balance entry under the district for that asset type separated between VDOT and localities.

For FY 2018 the Commonwealth Transportation Board did not approve any exceptions or waivers as allowed for the State of Good Repair Program in VA Code § 33.2-369.

HMOF Allocations

Section 33.2-319 of the Code of Virginia requires maintenance payments to localities. Prior to the VDOT's distribution of the HMOF, the required locality payments are set aside. The same section of the Code of Virginia establishes the method used to compute these payments, which are allocated on a per lane mile amount, based on the number of eligible miles in each locality. For FY 2018, the payment is approximately $442 million. In FY 2019, the maintenance payment to localities is projected to be approximately $455 million.

The HMOF allocations are presented to the CTB annually in June. For VDOT, the allocation is determined through a needs-based and data-driven approach led by a cross functional team within VDOT with representation from the districts. The allocation is determined based on a number of programmatic priorities, including:

- Focus on the core assets (pavements and bridges)
- Provide funding to cover on-going paving work and start-up work for the upcoming year
- Fully fund bridge inspection program
- Fully fund emergency operations such as snow removal

- Provide funding to cover the fixed costs of conducting business at the area headquarters
- Ensure funding to cover other essential activities

Figure 29 illustrates the draft distribution of FY 2019 funding from the HMOF based on the FY 2018 – FY 2023 Six Year Financial Plan. Figure 30 summarizes FY 2019 needs for the existing VDOT maintained assets, the draft allocations from the maintenance and construction (State of Good Repair Program) programs as well as the gap between needs and draft allocations.

Background on the methodology to determine the needs is provided in Appendix A. On the funding side, while VDOT focuses on its pavement and bridge assets, readers should be aware that VDOT must also provide several other essential services and repairs. Many of these services and repairs are interrelated and they can impact pavement and bridge condition. As an example, drainage pipe failures can affect the condition of the overlaying pavement. The FY 2019 draft allocations to these core services and repairs total to approximately $1 billion and include activities such as:

- A $273 million emergency management and incident response program, out of which, $225 million is dedicated to snow removal.
- A $359 million routine maintenance program to cover minimum costs of field maintenance in order to keep the system running. Some examples of such areas are unpaved roads, drainage, vegetation management, bike paths, pedestrian trails, sidewalks and soundwall repair.
- Approximately $140 million traffic safety program to cover costs of areas such as striping roads, maintaining traffic signs, guardrails, signals and highway lights.
- Approximately $169 million to cover the costs of maintaining and operating facilities such as safety rest areas, and ferries and another $39 million to cover the operations of 7 tunnels.

Figure 29: Draft Distribution of FY 2019 Proposed Funding from HMOF
($ millions)

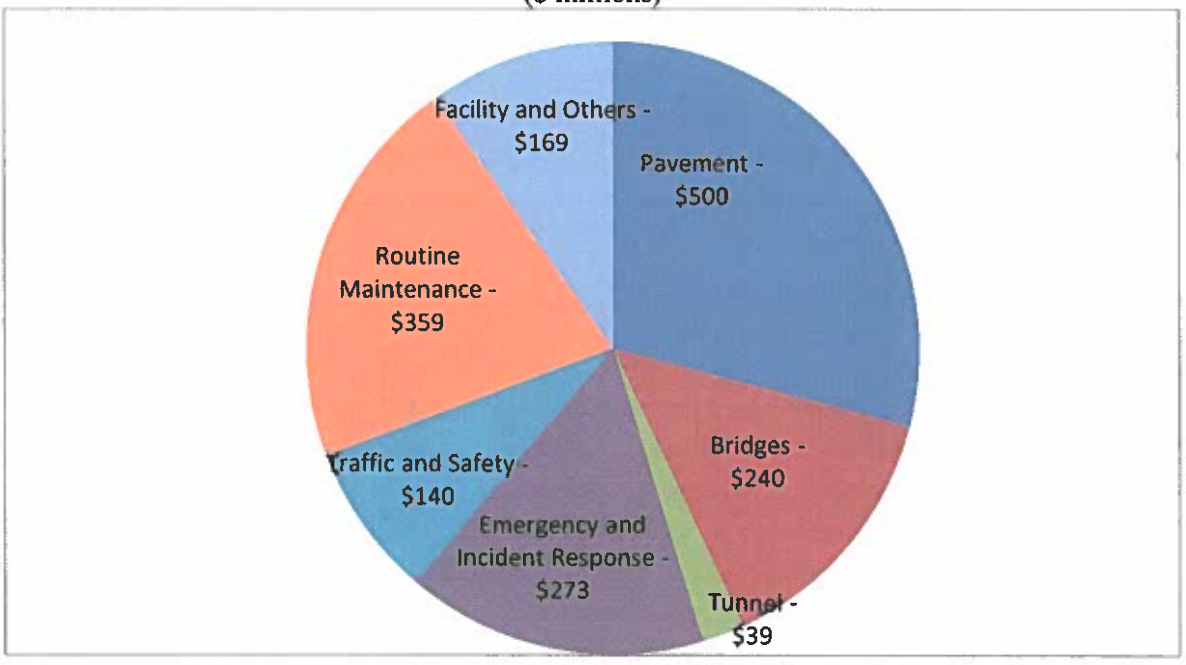


Figure 30: FY 2019 VDOT Annual Needs (to meet existing targets) and Draft Allocations
($ millions)

Category	Annual VDOT Needs*	Draft M&O Allocations	Draft Construction Allocations***	Total Draft Allocation	Difference between Needs and Draft Allocations
Pavement**	$841	$500	$38	$538	($303)
Bridges	$974	$240	$116	$356	($618)
Other Services and Repairs	$1,432	$980	-	$980	($452)
Total	**$3,247**	**$1,720**	**$154**	**$1,874**	**($1,373)**

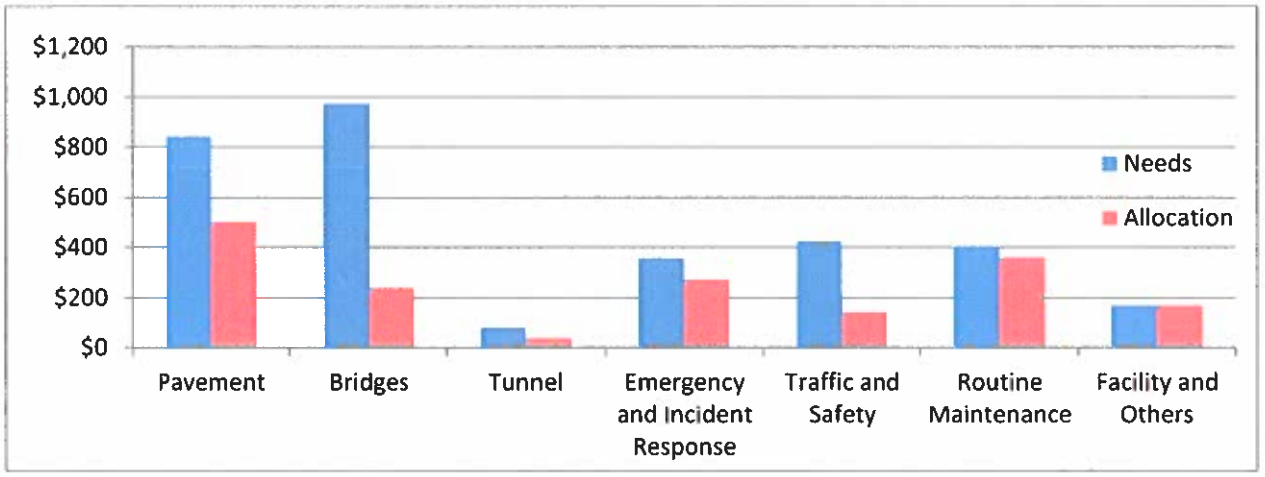
* For purposes of pavement and bridges, the annual needs shown reflect the needs to meet current targets.

** Pavement needs and draft allocation account for costs associated with paving and paving related marking, guardrail, signal loops, rumble strips, shoulders, ramps, patching, turn lanes, bike and pedestrian lanes, traffic control, inspection, and contingency.

*** Draft construction allocations are averaged in order to annualize the allocations and are based on projected funding in the State of Good Repair Program for VDOT. These distributions will recalculate in FY 2019.

Figure 31 illustrates the gap between FY 2019 VDOT needs and proposed allocations from HMOF.

Figure 31: Gap between FY 2019 VDOT Needs and Proposed Allocation from HMOF
($ millions)



VDOT's aging infrastructure and system preservation requires a large portion of the department's resources and focus. As stated earlier in this report and illustrated in Figure 2, timely preservation is critical in lowering long term maintenance costs. If VDOT performs preventive maintenance earlier in the lifecycle of an asset the costs will be less than if rehabilitation or reconstruction is performed later. The graph depicts spending $1 on preventive maintenance today saves $6 to $10 later as the cost to reconstruct an asset is greater. The reported analysis of needs and proposed allocations shows that there is a significant funding gap in order to timely maintain the pavement and bridge assets. The State of Good Repair Program funding, enacted by the Governor's 2015 Omnibus Transportation Bill in §§ 33.2-358 and 58.1-1741 of the Code of Virginia, will assist in closing the gap between needs and the proposed allocations.

I.4 Statewide Performance Targets and Outcomes

As discussed in Section 2 of this Chapter, VDOT's statewide performance targets for pavements are:

- Interstate - 82 percent in sufficient (Fair or better) condition
- Primary - 82 percent in sufficient (Fair or better) condition
- Secondary - 65 percent in sufficient (Fair or better) condition

VDOT's bridge statewide performance target is for 95.5 percent of structures to be in fair or better condition. The target is further broken down as follows:

- Interstate - 99 percent in fair or better condition (not structurally deficient)
- Primary - 96 percent in fair or better condition (not structurally deficient)
- Secondary - 94 percent in fair or better condition (not structurally deficient)

Figures 32 through 37 present the expected statewide performance outcomes for pavements and bridges based on funding through 2025. The solid lines represent performance since 2011 based on funding provided to the pavement and bridge assets through 2016. The faded lines represent trends of deteriorating conditions if no additional funding is to be provided. The remaining lines represent trends of predicted conditions with actions taken to address the State of Good Repair Program needs. The State of Good Repair Program funding referenced in figures 32 to 37 is that set forth in §§ 33.2-358 and 58.1-1741.

Pavement Previous and Forecasted Condition

VDOT's statewide performance targets for pavements are:

- Interstate - 82 percent in sufficient (Fair or better) condition
- Primary - 82 percent in sufficient (Fair or better) condition
- Secondary - 65 percent in sufficient (Fair or better) condition

VDOT estimates that the following percentages of lane miles will be either in Fair or better condition over the next two years:

- Interstate – approximately 90% in 2018 and 2019
- Primary – approximately 83% in 2018 and 2019
- Secondary – approximately 60% in 2018 and 2019

The charts indicate the forecasted paving conditions if the continued annual allocation is received as well as the State of Good Repair Program funding and shows the predicted decline without additional funding.

Figure 32: Previous and Forecasted Pavement Condition (Percent Sufficient) – Interstate

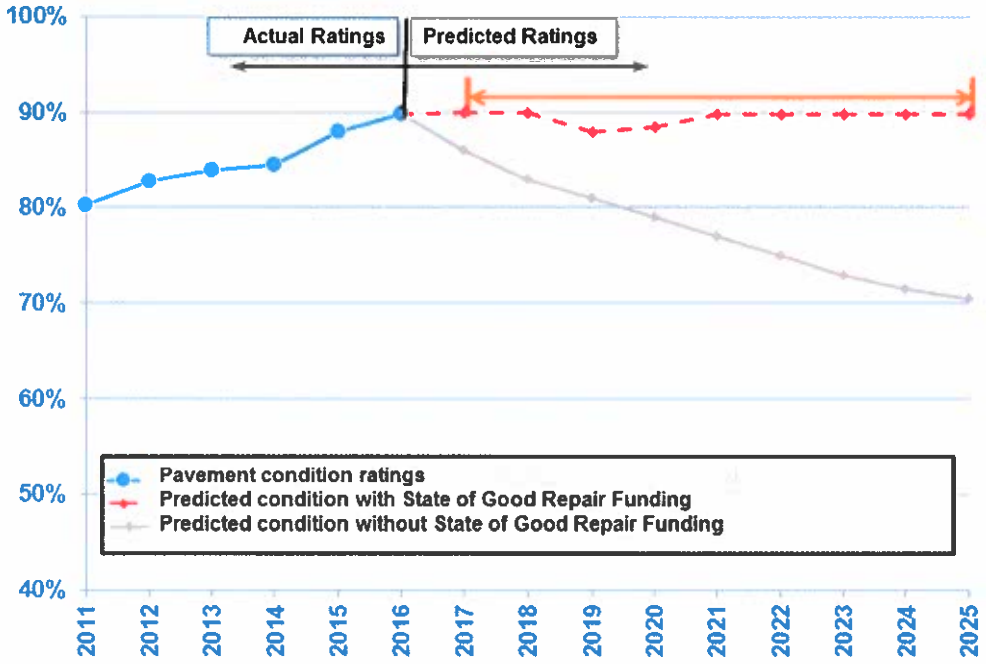


Figure 33: Previous and Forecasted Pavement Condition (Percent Sufficient) – Primary

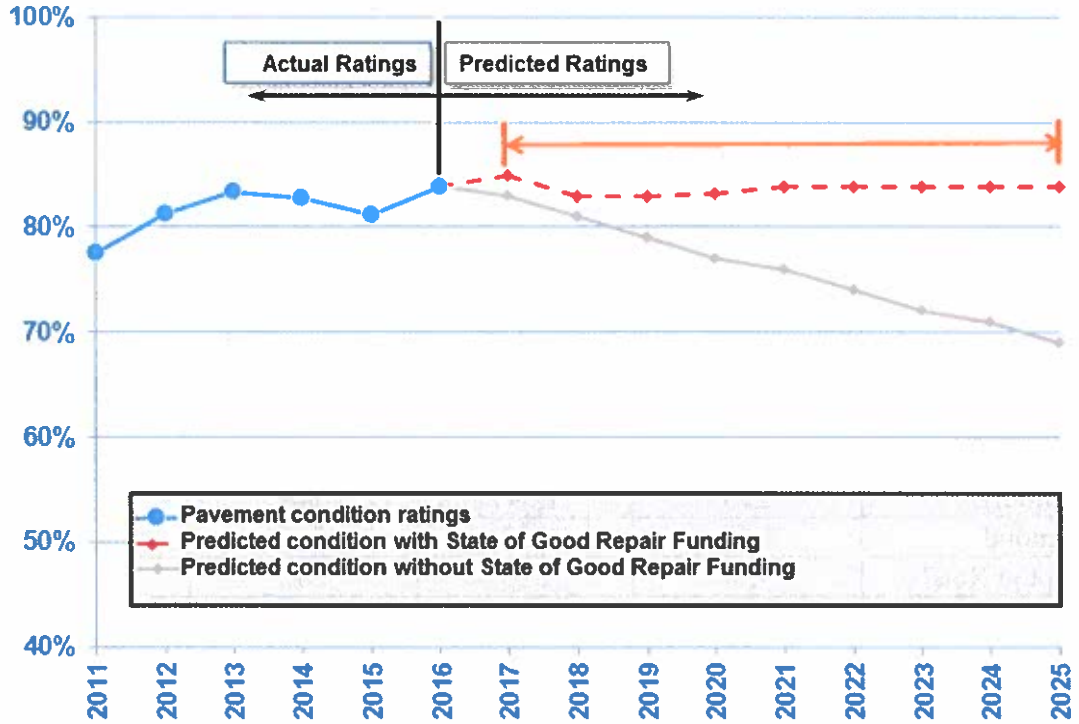
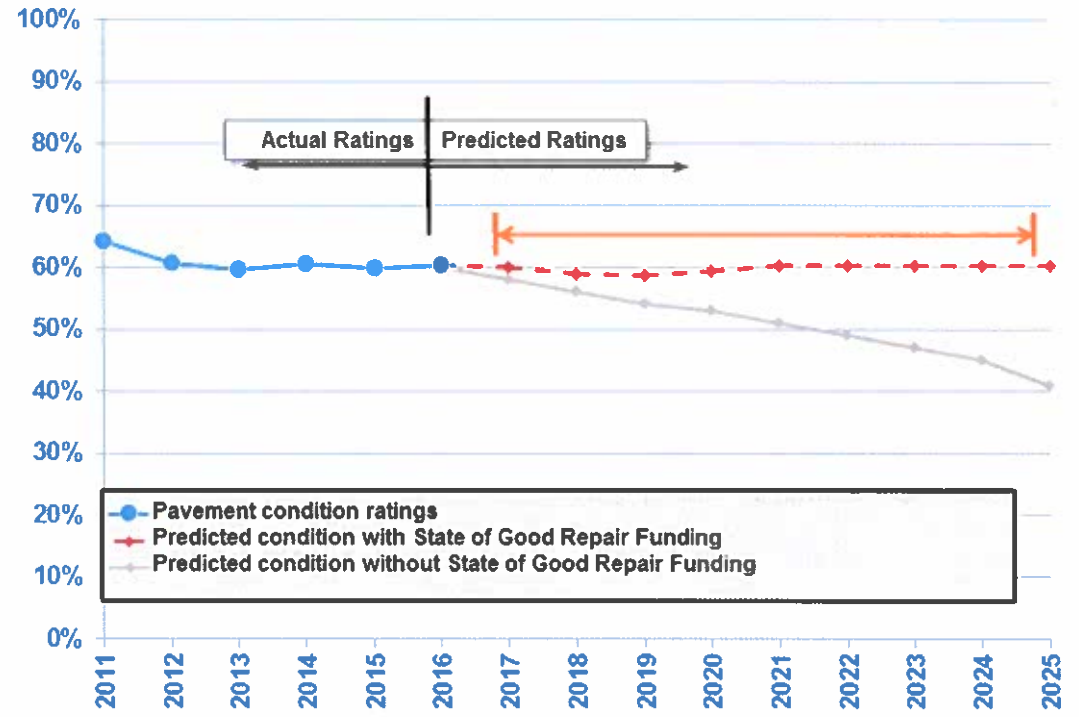


Figure 34: Previous and Forecasted Pavement Condition (Percent Sufficient) – Secondary



Item 10 of § 33.2-232 requires a list, by transportation district for the prior fiscal year, of the total number of lane miles of all primary and secondary roads that (i) have been resurfaced with asphalt or sealant and (ii) based on records of the Department at the close of the fiscal year, reflect a rating of "poor" or "very poor." The following table provides data requested in Item 10 of § 33.2-232.

	(i) Number of Lane miles Resurfaced		(ii) Number of Poor or Very Poor Lane Miles	
District	**Primary**	**Secondary**	**Primary**	**Secondary**
Bristol	340	698	484	4,308
Salem	311	762	526	4,527
Lynchburg	218	1,547	344	3,163
Richmond	260	857	567	5,138
Hampton Roads	133	526	161	1,398
Fredericksburg	162	539	347	3,565
Culpeper	198	556	318	2,595
Staunton	180	766	318	2,460
Northern Virginia	129	1,002	213	6,105
Statewide	**1,931**	**7,253**	**3,278**	**33,259**

Bridge Previous and Forecasted Condition

VDOT's bridge statewide performance target is for 95.5 percent of structures to be in Fair or better condition. The target is further broken down as follows:

- Interstate - 99 percent in Fair or better condition (not structurally deficient)
- Primary - 96 percent in Fair or better condition (not structurally deficient)
- Secondary - 94 percent in Fair or better condition (not structurally deficient)

VDOT estimated that the following percentages of structures will be either in Good or Fair condition (not structurally deficient) at the completion of fiscal years 2018 and 2019:

- Interstate - approximately 97% to 98%
- Primary - approximately 97% to 98%
- Secondary - approximately 93% to 94%

Figure 35: Previous and Forecasted Bridge Condition (Percent of Good and Fair Structures) – Interstate

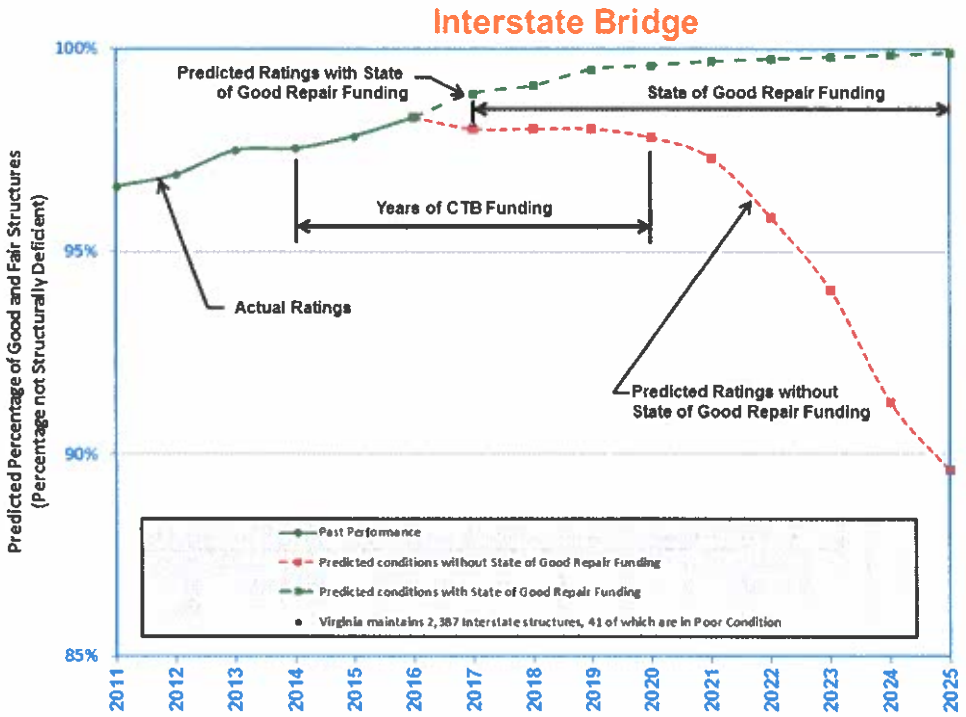


Figure 36: Previous and Forecasted Bridge Condition (Percent of Good and Fair Structures) – Primary

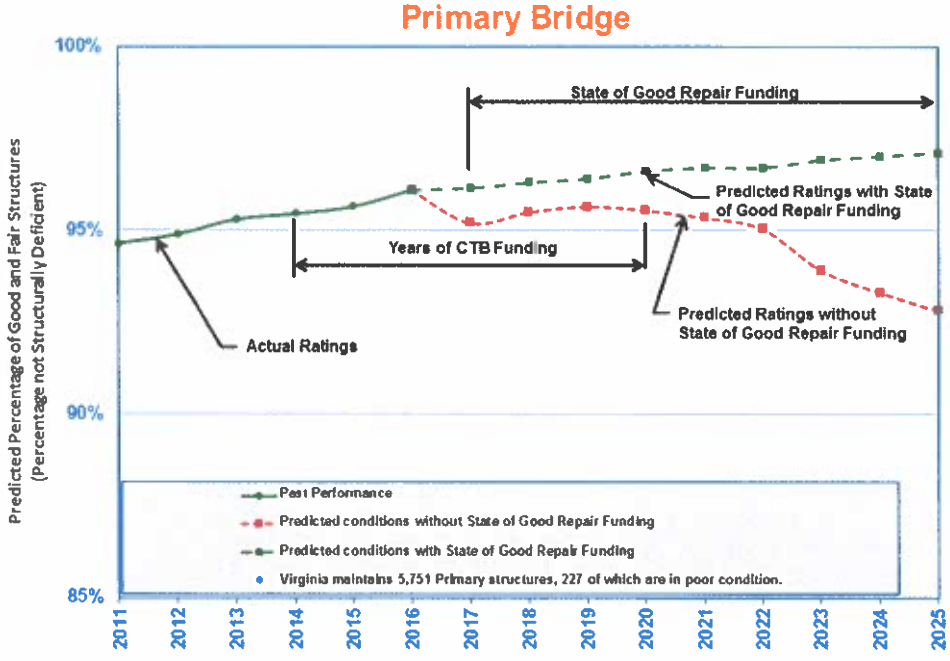
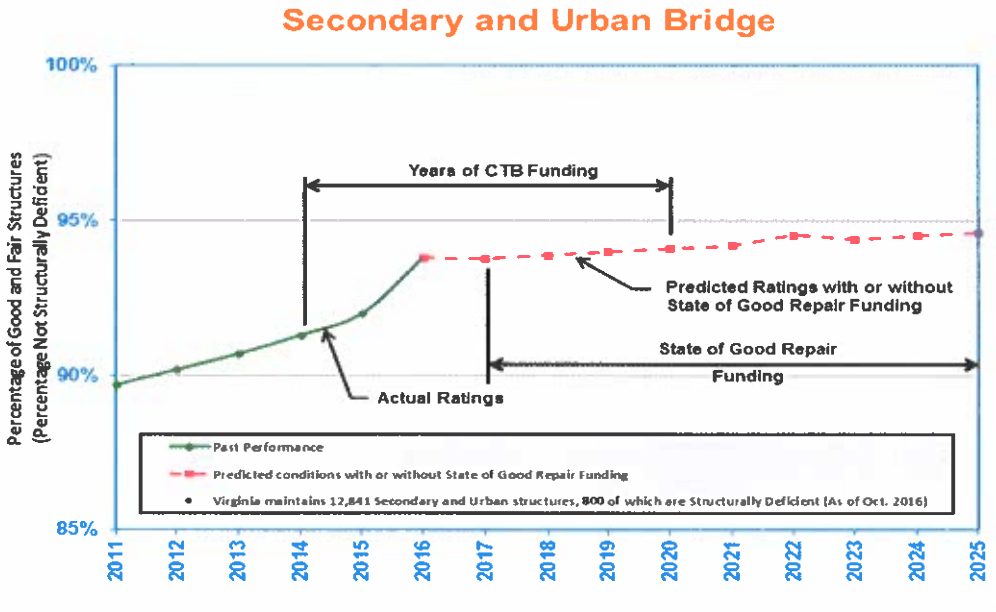


Figure 37: Previous and Forecasted Bridge Condition (Percent of Good and Fair Structures) Secondary



Efforts to Close Funding Gaps to Maintain State of Good Repair

VDOT uses various means and approaches to fill the funding gaps for the State of Good Repair, such as:

- Innovative approaches to delivering projects. On paving projects, VDOT started to apply cost saving measures to maximize available funding. Examples of such measures include the use of in-place recycling, full depth reclamation, thin asphalt mix, and high polymer asphalt mixes as illustrated in Figure 38. On bridge projects, similar cost saving measures are taken through efforts such as improved design practices and use of improved or new materials as pictured in Figure 39.
- Bonus Obligation Authority. VDOT may receive additional federal obligation annually if the state meets annual obligation requirements. In the past, additional funding has been distributed to the core asset areas to provide critical additional resources in bridging the gap.
- Savings in snow removal or other areas are reprogrammed to address the needs for pavements and bridges.

Figure 38: Examples of Cost Saving Measures Applied in Paving Projects

In-place Recycling

Full Depth Reclamation

Thin Asphalt Mix

High Polymer Asphalt Mixes

Figure 39: Examples of Cost Saving Measures Applied in Bridge Projects

Jointless Structure *Stainless Steel Reinforcement* *Stainless Steel Prestressing*

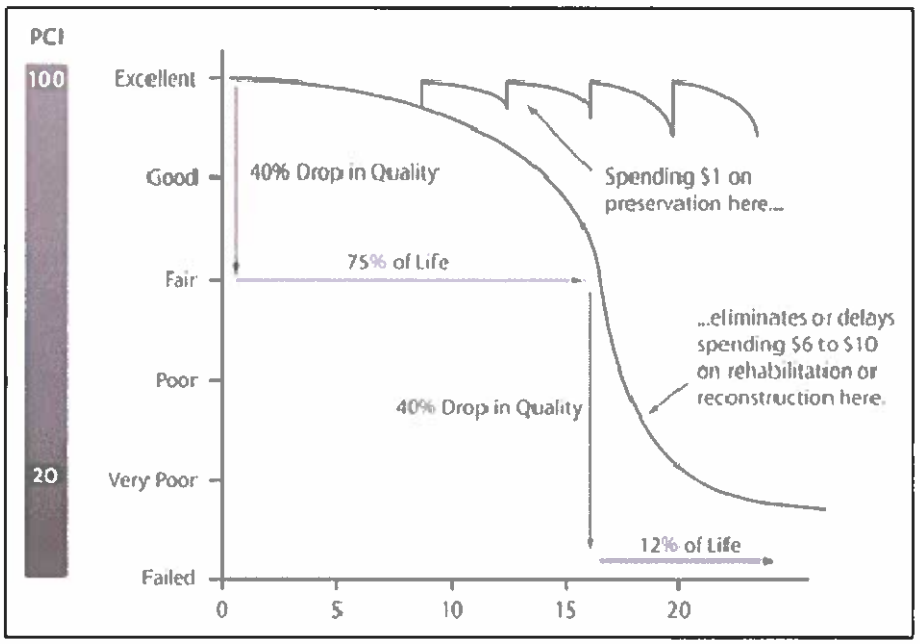
I.5 Conclusion

The estimated FY 2019 costs for VDOT to meet statewide performance targets for pavements and bridges and the costs to maintain and operate other essential assets and services add up to approximately $3.2 billion. Once the statewide performance targets are achieved, the anticipated cost to maintain pavements and bridges in a steady state is estimated at $695 million and $436 million, respectively. The FY 2019 draft allocations from VDOT's maintenance and construction programs total about $1.9 billion. The gap between needs and proposed allocations is $1.4 billion.

In addition, VDOT's aging assets require significant resources and focus. The estimated costs to bring VDOT's deteriorated pavements and structurally deficient bridges to the State of Good

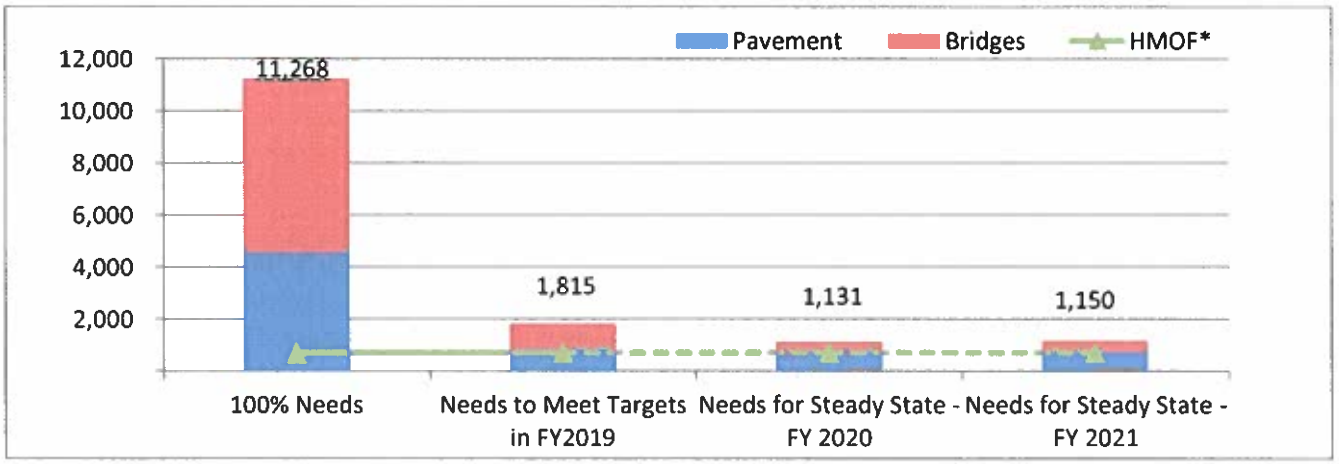
Repair and the costs to cover preventive, corrective, and restorative maintenance on the two assets add up to approximately $11 billion. As illustrated in Figure 40, timely preservation is critical in lowering long term maintenance costs. If VDOT performs preventive maintenance earlier in the lifecycle of an asset the costs will be less than if rehabilitation or reconstruction is performed later. The reported analysis shows that VDOT is facing a significant funding gap in order to timely maintain the pavement and bridge assets as illustrated in Figures 41 and 42.

Figure 40: Impact of Maintenance Timing on Asset Condition



Note: This graph is based on a 2012 FHWA report on asset sustainability. It illustrates the steep deterioration commonly seen in pavements once they reach a "poor" condition. Timely preventive maintenance creates substantial value by restoring pavements to a high condition and preventing the onset of the rapid deterioration commonly seen in poorly maintained pavements. As noted in the graph, timely preventive treatment can produce a very high return on investment, while underinvestment leads to missed opportunities to prevent rapid degradation.

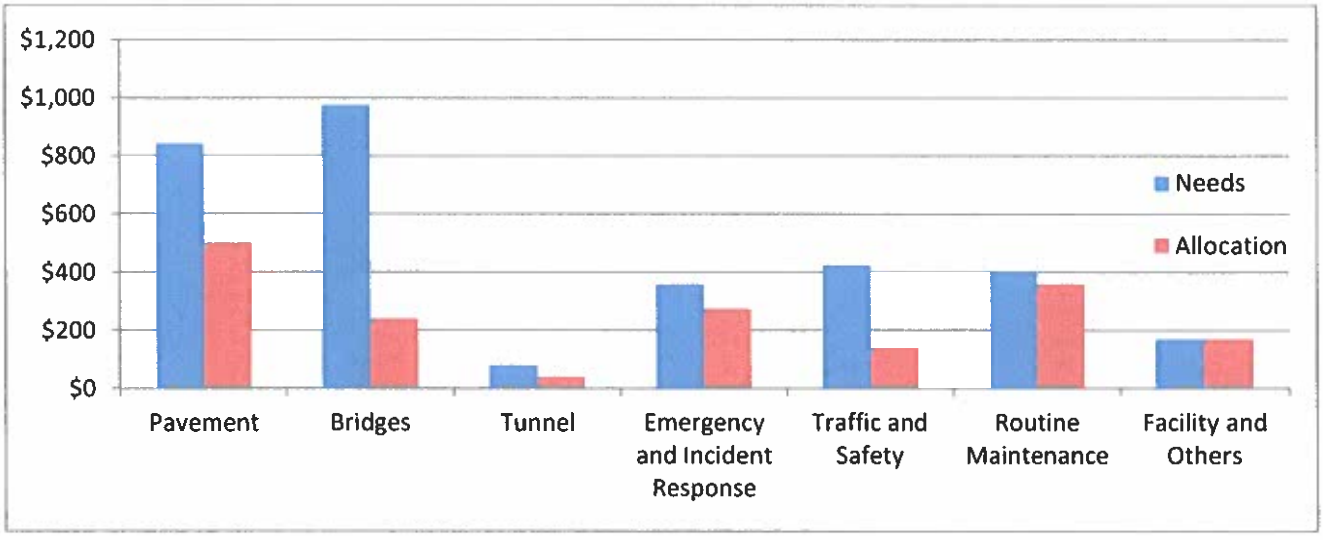
Figure 41: VDOT Needs and Anticipated HMOF Funding for Pavement and Bridges
($ millions)



*HMOF line indicates $700 million.

Note: Amounts presented are estimates based on condition assesssment of current inventory and are subject to change. The needs assessment is performed annually. 100% Needs are shown in 2017 dollars, FY 2019, 2020 and 2021 needs have been adjusted for inflation. Needs to Meet Targets – FY 2019 are inflated 2017 dollars and Steady State Needs – FY 2020/FY 2021 are inflated 2017 dollars.

Figure 42: Gap between FY 2018 VDOT Needs and Proposed Allocations from HMOF
($ millions)



II.
Strategies for Improving Safety and Security, Improving Highway Operations, the Innovation and Technology Transportation Fund and Improving Incident Management

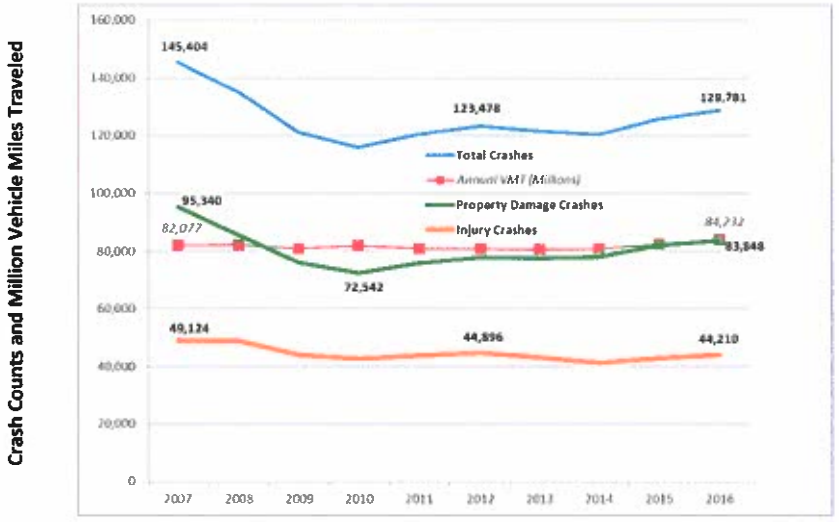
II.1 Safety

A. Safety Overview

Safety is VDOT's highest priority when developing and implementing any transportation project or program and the FY 2018 VDOT Business Plan continues to affirm safety as one of VDOT's overarching Department goals. This overview begins with a brief summary of the safety performance on Virginia's roadways and is followed by an introduction to VDOT's strategies and programs for reducing deaths and injuries caused by crashes on the Commonwealth's highways and streets.

Figure 43 shows the trend in Virginia's highway crashes over the past 10 years that result in property damage only or injuries. Since 2009, when the minimum property damage value for reporting crashes was increased, the number of crashes has experienced a slight increasing trend which roughly mirrors the trend of vehicle miles travelled (VMT) in Virginia. Crashes resulting in injuries held steady during this period while the number of people injured increased by 11.5 percent from 60,367 in 2007 to 67,330 in 2016.

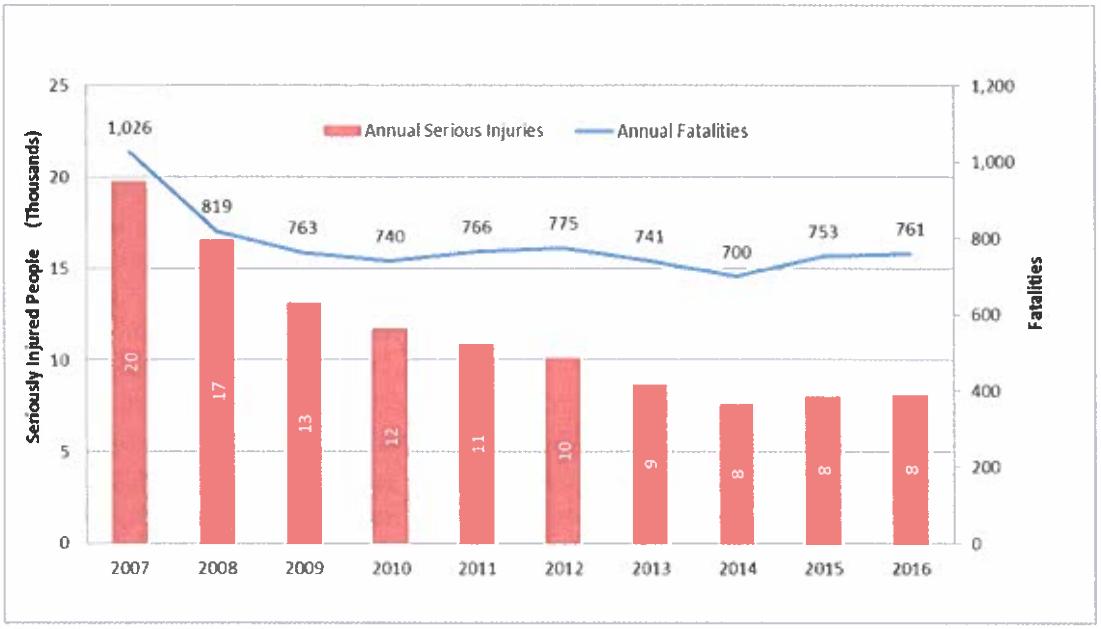
Figure 43: Virginia Crashes and Vehicle Miles Traveled (VMT) - 2007 to 2016



Source: Virginia Department of Motor Vehicles and Transportation
Note: the reporting threshold for property damage crashes was increased from $1,000 to $1,500 in July 2009. Therefore, the count of Property Damage Crashes prior to that date is not comparable to the count subsequent to that date. The same is true for Total Crashes, which includes Property Damage Crashes.

While overall crashes and injury crashes have held steady or increased slightly over the past decade, there has been a significant reduction in traffic crash-related fatalities and serious injuries between 2007 and 2016, which is shown in Figure 44. In 2016, more than 750 people died on Virginia's roadways and about 8,100 suffered serious injuries. After peaking in 2007, the number of traffic crash-related deaths has generally declined though there were increases in 2011, 2012, 2015, and 2016. Generally, serious injuries have experienced a declining trend since 2007, seeing an overall 60% reduction. However, there was a slight increase in serious injuries in 2015 and 2016, the first increase since the Virginia Department of Motor Vehicles (DMV) began tracking injury severity in 1996. VDOT, in conjunction with its safety partners, continues to examine ways to reduce crashes and traffic related deaths and serious injuries.

Figure 44: Fatalities and Serious Injuries on Virginia Highways - 2007 to 2016



An analysis of the crash data shows that while crashes occur throughout Virginia, the majority of crashes are concentrated in the more populous areas of the Commonwealth where more traffic exists, including Northern Virginia, Richmond and Hampton Roads. Travel speed at the time of collision plays a major role in the resulting severity of traffic crashes, and as a result, congested and lower-speed urban areas tend to experience lower severity crashes while the majority of deaths and serious injuries in Virginia tend to occur on rural, higher-speed roadways.

B. Strategies for Improving Safety

All VDOT projects, no matter the goal or motivation for the project, are developed and implemented with the public's safety as a prime consideration. VDOT's targeted safety strategies are implemented primarily through two programs:

1) the federally funded Highway Safety Improvement Program (HSIP). HSIP funds are applied to the highest priority safety needs.[10] VDOT's goal is to apply HSIP funds to projects with the greatest potential to reduce serious injuries and fatalities within a District, taking into consideration the investment, and to track and communicate safety outcomes of completed projects.

2) the Strategic Highway Safety Plan (SHSP). A federal requirement under the HSIP, the SHSP details all VDOT safety partner efforts to improve traffic safety in Virginia, including projects and strategies to improve safety for bicyclists and pedestrians.

These federal programs are coordinated with Commonwealth safety initiatives such as the Strategically Targeted Area Roadway Solutions (STARS) program. STARS is a multidisciplinary program, bringing together planners, traffic engineers, safety engineers, roadway design engineers, maintenance specialists and local stakeholders to jointly identify cost-effective measures aimed at improving safety and reducing congestion. In addition, VDOT District offices can leverage Statewide Planning and Research funding to help identify, plan, conceptually design and ultimately, program projects that reduce congestion and improve safety.

Safety Related Data (Understanding When, Where, and Why)

VDOT creates a pipeline of safety projects to include in the Six-Year Improvement Program (SYIP) each year. Access to robust and accurate crash and highway data is a critical component to selecting safety projects with potential for the most impact. Using information to make better decisions is a key component to VDOT's safety strategies and is integral to the Agency's programs, overall, as well as the Governor's strategic priorities for transportation.[11] VDOT, in cooperation with the Virginia Department of Motor Vehicles (DMV), the Virginia State Police and other local and state agency stakeholders maintain an ongoing effort to improve the access and functionality of crash data in Virginia.[12] The development of new software tools to view, summarize and prepare crash data reports have led to more accurate and up-to-date crash data. DMV now provides crash data to VDOT within one to two months of the occurrence. This compares to a six to nine-month lag in 2013 when a commitment was made by the agencies to shorten the lag time.

VDOT has implemented several key strategies that help provide good data and information in support of choosing HSIP funded safety projects that are the right projects. As examples:

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[10] In accordance with Section 33.2-214.1 of the Code of Virginia, projects funded with HSIP funds are exempt from SMART SCALE, the statewide project prioritization process.

[11] Virginia Department of Transportation 2017 Business Plan Update, page 32.

[12] Comprehensive traffic crash data summaries for the state, produced annually by DMV, can be found at: http://www.dmv.virginia.gov/safety/ There is a menu of options for crash data under the column heading "Highway Safety." In addition, VDOT now provides interactive maps showing the crash location data received from DMV to the public at: http://www.virginiaroads.org/ There is a link for "Virginia Crashes Application" after clicking the "All Mapping Applications" button.

i. VDOT is committed to continually review and improve the Roadway Network System (RNS) inventory and crash data module in response to user recommendations. Further, HSIP staff has developed crash filtering tools using RNS data for area jurisdictions, for example, and route based analysis.
ii. VDOT's HSIP staff continues its annual publication of intersection and roadway segment safety condition ratings based on the types of traffic control and roads in each District. This network safety data is provided to the VDOT Districts and is an important aid in the Districts' identification of priority safety projects to be included in the HSIP six-year plan. This process also supports the identification of locations with safety needs for the VTRANS 2040 plan and for use in evaluating SMART SCALE project proposals.

The Strategic Highway Safety Plan (SHSP) - Engineering, Education, Enforcement and Emergency Response, the 4-E Approach

The SHSP details all safety partner efforts to improve traffic safety in Virginia over a five-year period. Virginia has utilized a cooperative and coordinated multi-agency and inter-disciplinary engineering, education, enforcement and emergency response (4-E) approach to improving highway safety. The recently updated SHSP for the 2017-21 period, developed under VDOT's leadership, will be used to drive investment decisions to improve highway safety and reduce deaths and serious injuries for the next five years.

The SHSP has strategically focused on correcting poor driver behavior and improving roadway elements and traffic control to reduce crashes and their consequences. In 2017 the SHSP established the goal to reduce deaths by 2 percent and serious injuries by 5 percent per year to meet the longer term goal of eliminating deaths and injuries on Virginia's roads and streets. Within the five year SHSP horizon, strategies and action are defined across four broad areas:

1. Human Behavior - strategies developed to impact driver behavior such as speeding, young driver behavior, occupant protection and impaired driving. Impaired driving now includes drinking, drugged, distracted and drowsy drivers.
2. Safe Roadway Infrastructure - strategies developed to impact intersection safety and roadway departure crashes and those with pedestrians and bicyclists.
3. Data Collection, Management and Analysis - strategies to identify Virginia's safety needs and focus on defining VDOT's safety performance.
4. Technology and Partnerships – strategies for advancements in Automated and Connected Vehicles and with EMS and first responders to reduce severe crashes and their outcomes.

The Highway Safety Improvement Program (HSIP)

While all maintenance and construction projects improve the safety of our transportation systems, the use of FHWA funds for the Commonwealth's HSIP facilitates implementation of specific projects and strategies to reduce crashes and their consequences.

VDOT's HSIP is comprised of the following subprograms utilizing the federal funding sources:

- Highway Safety Projects (HSP): 23 USC Section 148
- Bicycle and Pedestrian Safety (BPS) Projects: 23 USC Section 148

- Highway-Rail Grade Crossing (H-RGC) Projects: 23 USC Section 130

Each of these subprograms is focused on reducing crashes on all roads. Highway safety projects target locations at intersections and on roadway segments with above normal incidents of crashes, based on assessment of the highway network. Intersection improvements include advance-warning signing, traffic signal upgrades, crosswalks and pedestrian refuge islands, bike lanes and turn-lane improvements. Roadway segment projects include enhanced pavement friction, curve delineation signing, rumble strips, safety edge, shoulder widening and guardrails or barriers. Typical BPS projects include sidewalks, trails, bicycle lanes and intersection accommodations such as pedestrian signals, ramps and crosswalks. VDOT sets a target of allocating up to 10 percent of the agency's highway safety apportionment to BPS improvements. The H-RGC Program targets higher risk at-grade railroad crossings with projects such as the installation of gates and flashing lights at roadway rail crossings.

These main subprograms are supplemented with two additional federal safety funding sources, 1) Open Container (OC) - Penalty Transfer funds and 2) the High-Risk Rural Road (HRRR) Program. The Open Container - Penalty Transfer (OC) funds are set aside for state safety programs, pursuant to 23 USC Section 154, when a state fails to enact and enforce an open container law that is consistent with the requirements of the federal law. OC funds are programmed on the state's HSIP Section 148 eligible safety improvement projects.

The federal HRRR Program was initially established as a set-aside for safety projects on rural roads. (Recall that in Virginia, analysis of crash data showed that the majority of fatalities and serious injuries occurred on roads functionally classified as rural.) Currently, the HRRR program:

- gives states flexibility on developing methodology for determining "significant safety risk";
- requires a state to obligate (set aside) a portion of its HSIP allocation to HRRRs only if the state's fatality rate on rural roads has increased over the most recent two-year period for which data are available.

Recent rural fatalities have been increasing. As such FHWA notified VDOT that the HRRR set-aside would be invoked for federal Fiscal year 2018.

The resulting distribution of HSIP federal funding for FY 2017 and 2018 is shown in Figure 45.

Figure 45: Virginia's Fiscal Year Federal HSIP Allocation of Funds

(Dollars Thousands)

Year	HSIP HSP + BPS	Penalty Transfer (Open Container)	HSIP-Rail H-RGC	Total
FY 2016-17	$53,123	$20,975	$5,975	$80,073
FY 2017-18	$53,123	$10,629	$1,456	$65,208
Total	$106,246	$31,604	$7,431	$145,281

Highway Safety Six-Year Improvement Plan Development - Choosing the Right Transportation Safety Project

HSIP project planning and development follows a five step process (set forth below) conducted through collaboration with District and Central Office staff:

1. Determine Higher-risk Roadway Locations – Experts review the annual network safety condition rating locations with input from other VDOT and local stakeholders to determine priority intersections and roadway segments warranting detailed safety assessments for potential safety improvement projects;
2. Conduct Detailed Analysis of High-Priority Locations - Conduct detailed crash analysis and field assessment of conditions to determine safety project scopes and complete economic evaluation of feasible projects;
3. Develop Prioritized Safety Project Listing - Prioritize projects in the District based on the number of crashes, benefit-cost effectiveness, and project cost and schedule;
4. Seek Project Funding - Submit prioritized list of projects to Central Office for review and funding consideration;
5. Fund and Deliver Safety Projects - Central Office staff reviews the statewide proposed projects with the available funding to confirm which projects can be programmed in the six-year plan.

In addition to HSIP projects, maintenance paving projects that are federally funded are reviewed for potential safety improvements such as upgraded signing, marking and guardrails.

VDOT has developed an evaluation methodology to assess the benefits of proposed safety improvements. The guidelines, project submittal forms, and benefit-cost spreadsheets can be found at: http://www.virginiadot.org/business/ted_app_pro.asp. For FY 2019, new safety project submittals, the highway and bike and pedestrian, and highway-rail grade crossing safety project proposals will be submitted using VDOT's new electronic application submittal process which can be found at the SMART Portal website at https://smartportal.virginiahb2.org/#/.

After the announcement of the HSIP budget through the next SYIP period, VDOT's staff is briefed on the SHSP eligible projects based on emphasis areas:

- roadway departures;
- intersection crashes;
- pedestrian and bicycle crashes.

The goal is to program safety projects with allocations on different phases in each fiscal year. VDOT has successfully programmed most of its FY 2018-19 and about 81 percent of the estimated FY 2020-23 HSIP allocations on safety projects.

Many of the new FY 2018 SYIP highway safety projects are signing, pavement friction, rumble strip, shoulder and roadside improvements that will reduce or minimize the consequences of roadway departure crashes while staying within the existing right of way. In addition, geometric changes at intersections and systemic improvements to traffic signals and unsignalized intersection signing are programmed over multiple years.

To assess HSIP effectiveness, VDOT conducts a before and after crash reduction analysis of each completed safety project. The crash analysis period for these projects covers the 36 months prior to construction and the same period after the completion year of the safety improvement. These safety projects have led to significant reductions in the number of crashes and severe outcomes. For example, the highway safety projects completed since 2004 resulted in a 70 percent reduction in fatal, and 24 percent reduction in injury, crashes at those locations during the after period.

Bicycle and Pedestrian Safety Projects

VDOT is one of the few state agencies in the nation with a safety program that improves conditions for bicycle and pedestrian users, especially around schools. The VDOT program preceded the federal Safe Routes to School program that was established in 2005 to enable and encourage children, including those with disabilities, to walk and bicycle to school; to make walking and bicycling to school safe and more appealing; and to reduce traffic in the vicinity of schools.[13]

Bicycle and Pedestrian Safety (BPS) improvements are prioritized and programmed using a risk-based analysis. VDOT recognizes that a high potential for risk exists for non-motorized travelers and that some people may not bike or walk because of safety concerns. VDOT uses a ranking system for evaluating BPS project proposals that ranks the proposals by assigning scores to a series of questions about purpose, need and expected risk reductions. Consequently, starting in FY 2004 VDOT began to target programming up to 10 percent of HSIP funds for the non-motorized safety program.

Of the FY 2018 Section 148 (HSIP) funds, about nine percent was programmed on BPS targeted improvements, including sidewalks, multi-use trails and intersection crosswalk treatments. In FY 2018 there are highway safety projects at signalized intersections along with projects providing wider paved shoulders along roadways that also augment non-motorized accommodations.

Finally, the following three bicycle safety recommendations are included in the state Bicycle Policy Plan:

- VDOT should participate in roadway safety assessments for schools that are located on the state highway system, as requested. Where possible, school zone safety assessments should address bicycle access to schools, including street crossings and paved shoulders.
- VDOT should encourage biking and walking to school and provide opportunities for students to have access to bicycle safety education.
- VDOT should encourage college and universities to provide safety education classes similar to League of American Bicyclist education classes.

VDOT has actively pursued implementation of these recommendations. For example, the Agency offers Walkabout Mini-grants where recipients receive a hands-on walking and bicycling

[13] The Safe Routes to School Program (SRTS) does not have dedicated funding under current federal law. Projects submitted under SRTS are eligible for funding under the Federal Surface Transportation Block Grant Program (23 USC 133 (h), established by the Fixing America's Surface Transportation (FAST) Act.

infrastructure survey and written walkabout report for the area around their school. The survey and report are coordinated by the VDOT Local Technical Assistance Coordinator serving their region.

In addition, VDOT sponsors the QuickStart Mini-grants program, which can be used to fund a range of activities that encourage safe walking and bicycling to school.

Virginia's Bicycle Policy Plan can be found at http://www.virginiadot.org/programs/bicycling_and_walking/bicycle_policy_plan.asp.

Highway - Rail Grade Crossing Program (H-RGC)

The H-RGC Program funds safety improvements at highway- rail intersections. In general, the federal share is 90 percent. However, certain projects as described in 23 USC Section 120(c) (1) may be eligible for 100 percent federal funding. The H-RGC program was implemented to reduce risk at public highway-rail grade crossings. Improvements have been initiated across several areas: upgrading gates, traffic control devices and crossing surfaces.

There are two Class I railroad companies operating in Virginia with more than 3,500 miles of track and 1,859 public at grade highway/railroad crossings. Since the inception of the H-RGC program, VDOT has evaluated and upgraded 1,512 (representing over 80%) of these crossings with active warning devices. The remaining 347 crossings remain passive. All crossings are regularly reviewed for purposes of identifying possible upgrades, permanent closure or grade separation projects.

VDOT uses the Federal Railway Administration crash risk prediction methodology as a mathematical procedure to develop a prioritized ranking of grade crossing locations statewide. The priority listing is revised annually based on predicted crash risk. VDOT furnishes the listing to localities and railroads.

In an effort to improve safety on the roadways (and railways), VDOT has completed projects at crossings with no previous crash history after conducting engineering reviews, receiving input from safety partners concerning "near misses" and evaluating the existing geometric and traffic control conditions.

VDOT previously received approximately $5 million each year that is federally apportioned for rail grade crossing improvements, typically funding from 10 to 20 H-RGC projects each year. For FY 2018, most of the federal allocation was programmed to a grade separation project in Suffolk and $90,000 was programmed to the federally mandated highway-railway crossing inventory inspections.

Most of the previously programmed H-RGC projects added gates and flashing lights to provide active warning devices. Some projects upgraded existing lights, and the remaining projects upgraded the crossing surface or adjacent traffic signal preemption equipment.

Open Container-Penalty Transfer Projects (OC)

In accordance with federal law, 23 USC Section 154, Open Container Requirements, Virginia is "penalized" for its existing OC law by having 2.5% of its apportioned highway funds transferred

from the surface transportation program and the national highway performance program to behavioral and infrastructure safety improvement programs. VDOT's FY 2018 penalty amount, $10.69 million, was used for HSIP eligible improvements. VDOT programmed I-95 lane and shoulder additions with rumble strips.

II.2 Security Overview

In April of 2016, VDOT realigned its safety, security and emergency management programs under one division at its Central Office. The new division, Safety, Security and Emergency Management (SSEMD) will further improve and promote a safe work environment and safe highway networks for VDOT employees and the traveling public. The district and residency offices and critical infrastructure (CI) sites will retain local execution of safety, security and emergency response functions with oversight and support from the Central Office's SSEMD. The goal is to provide a single point of contact for safety, security and emergency management and standardize the delivery of these efforts across the agency, align the program with industry standards and best practices to reduce operating costs, and enhance safety, security emergency management and resiliency capabilities.

Strategies for Improving Security

VDOT Infrastructure Protection and Resiliency Enhancements Program (VIPREP) Contract

The VIPREP contract is used to conduct physical security installation or enhancement projects at bridge/tunnel facilities, Transportation Operations Centers, other CI sites and for security projects at non-CI designated facilities and structures. The VIPREP provides critical services to support VDOT's infrastructure and various statewide security systems that must be fully functional at all times to protect VDOT employees, visitors and the travelling public. Typical installation projects under VIPREP include: access control systems, surveillance equipment, motorized gates, fencing, security lighting, and other physical security equipment or protective measures and services.

VDOT Statewide Security Systems Maintenance (SSSM) Program

The SSSM program is conducted through a yearly re-occurring task order issued under the VIPREP contract by the Agency Security Program Area to maintain operation of VDOT's Statewide Security Systems at all facilities and structures. Additionally, the SSSM program includes a preventative maintenance component, installed and spare parts inventory tracking, and individual site security systems location diagrams. This program operates 24 hours a day, every day of the year.

Critical Infrastructure (CI), Protection and Resiliency

Critical Infrastructure is generally defined as systems and assets, whether physical or virtual, so vital to VDOT's mission that the incapacity or destruction of any such system or asset would have a debilitating impact on mobility, security, economic security, public health or safety, or any combination of those matters. The Agency Security Program Area works directly with the facility managers and operators that run these infrastructures and other VDOT facilities, to ensure CI protection, promote resiliency, and identify and prioritize security related projects.

Security Systems Oversight
The Agency Security Program Area provides a single point of contact for the design, type and performance for security equipment, projects, policies and security management systems (SMS). SMS include all systems and equipment that directly and indirectly relate to the physical security of facilities and structures. As an example, the section works directly with its traditional procurement offices and the VDOT Office of Transportation Public-Private Partnerships to ensure consistent and continuous application of VDOT SMS, their maintenance and related policies.

Coordination continues with the Hampton Roads District Office relocation project, the Interstate-66 improvement project, the Richmond District and Virginia State Police (VSP) Joint Operations Center building project as well as the NOVA District Manassas Residency Office building project. This interaction promotes integration of existing and future CI sites and security programs to form a common and consistent level of security for our customers.

Statewide Security Guard Contract
Professional uniformed security services are used by VDOT to assure the safety and protection of specific VDOT buildings, occupants, real and personal property. The contractor provides security officers who are responsible for performing all tasks related to securing specific VDOT assets and additional duties designated within their site's security post orders. The Agency Security Program Area is responsible for providing support and oversight to this program.

Criminal History Records Check Program (CHRC)
The Criminal History Records Check Program ensures that suitable individuals are authorized and assigned to perform work for VDOT, conduct business on behalf of VDOT, and/or are granted access to VDOT's CI, systems, or information which has been deemed "sensitive." The Agency Security Program Area manages the CHRC process established for VDOT personnel through the implementation of VDOT Department Memorandum (DM) 1-25, which provides a framework for the administration and maintenance of VDOT's Criminal History Records Check Program. The CHRC staff is the central point of contact for coordinating statewide fingerprint-based criminal history records checks at VDOT.

Foreign Visitor Clearance Coordination Program
In accordance with the Federal Highway Administration Office of International Programs, VDOT confirms the suitability of foreign visitors and delegations, which are visiting VDOT facilities and assets, to ensure the visit does not contravene US restrictions on interaction with officials from a particular country.

Physical Access Control System (PACS) Program
This program area covers the statewide monitoring, oversight and support to District level PACS operators to ensure consistent PACS operations and to ensure proper data entries for credentials, user group establishment, and that access levels are granted or terminated as needed to maintain business operations.

Credentialing Program (Access and Identification Cards)
VDOT issues Access and Identification Cards (AIC) to employees and contractors who have been deemed suitable through VDOT's CHRC process. The Agency Security Program Area issues these cards locally for VDOT's Central Office operations and monitors and provides oversight and support to District level AIC issuing staff to ensure equipment and supplies are maintained, AIC's are issued in standardized formats and to ensure revoked AIC information is removed from the PACS system so that unauthorized access does not occur.

Security Response Plan Program
The Agency Security Program Area continues work on Security Response Plans (SRPs). The SRPs are comprehensive documents that focus on specific tunnel facility responses to various manmade security threats or incidents. The SRP program is on-going and includes a yearly update process to capture any facility point of contact or operational process changes.

Training Program
The Agency Security Program Area provides, as needed, coordination with facility managers and staff in an effort to maintain awareness of the latest security topics and practices. Training courses are sponsored or coordinated with outside agency stakeholders to support facility requests for training. General training courses included Terrorism Security Awareness Orientation, Incident Response to Terrorist Bombing, Surveillance Detection, Soft Target Awareness, and Improvised Explosive Device awareness and vehicle screening.

II.3 Improving Highway Operations, the Innovation and Technology Transportation Fund and Improving Incident Management

A. Improving Highway Operations Strategies

Operations pertain to managing the Commonwealth's roadways. As stated in VDOT's Business Plan, operations ensures efficient use of the existing transportation system and services to meet customer demand and expectation of a system that is safe and reliable, and to enable the easy movement of goods and people across all modes. Operations involve monitoring roadway conditions and using a variety of strategies and technologies to improve safety, enhance mobility and respond promptly to incidents.

VDOT's operations program has two main areas of focus: (1) mobility, which includes statewide incident management programs, traveler information services, highway monitoring systems, integrated corridor management and active traffic management systems; and (2) safety, which also includes incident management programs, traffic surveillance systems and activities in support of emerging transportation technologies such as connected and automated vehicles. In both areas, VDOT has developed and monitored relevant performance measures.

In 2017, the General Assembly enacted several changes to the Virginia Code relating to traffic incident response and management (Chapter 350 of the 2017 Acts of Assembly). These amendments improve VDOT and its contractors' ability to more quickly access vehicles and cargo that are impeding traffic flow due to a traffic incident by allowing response vehicles to use

highway crossovers and the shoulder, and further allows VDOT and its contractors more authority to remove those vehicles and cargo from the travel lanes. Chapter 350 also requires drivers who are involved in traffic incidents in which no injuries or loss of life have occurred to move the vehicles involved in the incident out of the travel lanes immediately where it is safe to do so.

Together, the amendments to the Virginia Code contained in Chapter 350 provide an opportunity to reduce highway congestion by reducing the duration of highway lane blockage due to those incidents. VDOT believes this will additionally reduce the number of secondary incidents that occur due to congestion and change in traffic patterns caused by the initial incident.

Improvements to the operations program are achieved by both using transportation technologies to improve traffic flow and by reducing the impact of incidents. Technology development is supported by the Innovation and Transportation Technology program. The Incident Management program focuses on initiatives to prevent and mitigate incidents. The following sections present an overview of each program's strategies and activities.

B. The Innovation and Technology Transportation Fund and Program Strategies

The Innovation and Transportation Technology program consists of eight technologies strategies.

1. **Operations traffic management** – to improve corridor efficiency through active traffic management across multiple parallel freeways, arterial highways and transit systems.
2. **Incident and emergency response** – to detect, respond and clear incidents on the roadway, which include collisions, disabled vehicles, weather events, emergencies, and man-made disasters.
3. **Multimodal travel promotion** – to increase multimodal travel by increasing access and improving its efficiency.
4. **Arterial highway management** – to optimize the performance of arterial roadways through signal operations improvements and performance monitoring.
5. **Traveler information** – to provide real time, multi-corridor and multimodal travel information to enable pre-trip and in-route trip planning.
6. **Commercial vehicle/freight** – to manage and support freight mobility.
7. **Conduct emerging technology research** – to promote the development of new technologies to improve safety, convenience and efficiency of travel through connected and autonomous vehicle technologies, and bicycle/pedestrian programs.
8. **Technology infrastructure** – to promote future expansion and resiliency of technologies by deploying and upgrading supporting communication and utility services.

Innovation and Transportation Technology Program Activities

Funding for the Innovation and Transportation Technology program became available per Code of Virginia § 33.2-1531, which established the Innovation and Transportation Technology Fund (ITTF). A total of $99,900,000 was approved by the Commonwealth Transportation Board to fund pilot projects and fully developed initiatives pertaining to high-tech infrastructure improvement to improve mobility, reduce congestion and improve safety. VDOT advanced several transportation technology projects using ITTF and other funding sources. The recent activities by technology program strategy are as follows:

Operations Traffic Management

- **I-95 Hard Shoulder Running** – Evaluating the ability to install a hard shoulder running program on the I-64/I-95 overlap in downtown Richmond to provide additional capacity.
- **Greater Richmond Traffic Operations Center** – Completing the design for a new traffic operations center to provide the ability to house advanced transportation technology equipment and programs to improve mobility. The new facility will be shared with the Virginia State Police to promote event coordination during significant incidents.
- **I-64 Hampton Roads Bridge Tunnel Control Room** – Design plans for an upgrade to the Hampton Roads Bridge Tunnel control room in order to provide greater traffic management capabilities are advancing. Project plans are at 60% complete.
- **I-66 Rosslyn Tunnel Operations** – Installed six cameras to provide traffic and system monitoring.
- **I-95 Ramp Metering** – Evaluating the ability to expand ramp metering on I-95 in Northern Virginia to complement the I-395 ramp metering program.
- **Northern Virginia East-West Travel Integrated Corridor Management (ICM)** – Developed a concept of operations document and implementation plan for an integrated corridor management program and decision support system with state, local and private sector stakeholders. Implementing preliminary components of the ICM program such as parking management systems, ramp metering, and a data warehouse for a future decision support system.

Incident and Emergency Response

- **Camera Integration** – Provided connections for the integration of 143 cameras from local jurisdictions in order to improve situational awareness at VDOT's Traffic Operations Centers and through 511 Virginia.

Multimodal Travel Promotion

- **Greater Richmond Transit – Bus Rapid Transit** – Continue providing project management to support a Department of Rail and Public Transit supported project to install a 7.6 mile bus rapid transit system for Richmond. This system will use technology to improve operations to promote bus travel.
- **Park & Ride Lot Parking Management Systems** – Providing technical support to include parking lot management systems for planned park and ride facilities along the I-66 corridor.

Arterial Highway Management:

- **Arterial Monitoring** – Completed additional design plans to deploy communications, advanced controllers, and traffic cameras on arterial corridors.
- **Real-time Signal Performance** – Installed advanced traffic signal controllers in two VDOT Regions and continue testing signal performance measures to assist with real-time arterial operations. The advanced traffic signal controllers include technology for future connected vehicle programs such as Signal Phasing and Timing (SPaT) data.
- **Advanced Signal Control** – Advertised and awarded a contract to provide advanced transportation controllers and firmware. This technology will allow for real-time signal

and arterial management as well as vehicle to infrastructure capabilities utilizing connected vehicle applications.

Traveler Information:

- **Transportation Data Portal** – Released SmarterRoads.org to provide VDOT's transportation data for third party enterprise and the public's use. The raw data includes road conditions, incidents, traffic signal information, work zones, etc. The SmarterRoad.org effort was a winner of the 2017 Governor's Technology Awards at the Commonwealth of Virginia Innovative Technology Symposium.
- **Next Generation 511** – Developing an update to the 511 system that will include push navigation and notifications with WAZE data. Implementing multimodal options for travel route navigation.

Commercial Vehicle / Freight:

- **Truck Parking Information System** – Designing a real-time truck parking information system for all rest areas on the I-66, I-81, and I-95 corridors. Design plans for the I-64 New Kent County rest areas are also included in this effort.
- **Overheight Detection System Expansions** – Constructing an expanded overheight detection system at the Hampton Roads Bridge Tunnel. Upon completion in late 2017, this project will improve travel reliability on the I-64 corridor by redirecting overheight vehicles from the tunnel to turn around at more convenient locations.

Conduct Emerging Technology Research:

- **Drone Technologies** – Conducted pilot test uses of drone technologies to provide traffic surveillance during peak travel periods.
- **Connected and Autonomous Vehicles** –
    - Supported Commonwealth of Virginia efforts at industry day events to discuss the development of connected and automated vehicle programs.
    - Implemented specific projects such as Signal Phase and Timing (SPaT) and the SmarterRoads.org data portal, which have a direct impact to the connected vehicle programs and are discussed in other sections of this report.
    - Conducted direct testing and demonstration of automated vehicles at Central Office and the Virginia Tech Transportation Institute with transportation executives, industry experts, and research teams.
- **Truck Platooning** – Supported a truck platooning demonstration in Northern Virginia on I-66 to assess its capabilities in a live environment.

Technology Infrastructure:

- **Fiber Optic Communication Expansion** – Acquired additional fiber optic cable to support transportation technology devices through Virginia's Fiber Optic Resource Sharing program along portions of Route 29 between Charlottesville and Culpeper, the City of Roanoke and Lynchburg.
- **Fiber Optic Communications Facilities:** Completing design plans to provide fiber optic communication for devices at the Monitor Merrimac Memorial Bridge Tunnel. Completed design plans to link the Northwestern Regional Traffic Operations Center to

the transportation fiber optic network to provide direct communication to transportation technology devices.

C. Improving Incident Management

Incident Management Program Strategies

Incident management includes the ability to detect, respond and clear incidents as quickly and safely as possible. VDOT partners with both public and private entities to restore traffic flow from natural and man-made incidents. VDOT's partners include law enforcement, fire and rescue, emergency medical services, towing and recovery and hazardous material teams. VDOT's roles in incident management are:

- coordinating incident planning and training activities
- detecting and verifying incident through monitoring systems or safety service patrols
- providing traffic control at the scene
- providing traveler information about the event and potential detours
- coordinating scene clean up
- providing incident command, when applicable
- repairing transportation infrastructure

Specific strategies to support VDOT's roles include:

- **Develop Traffic Incident Management (TIM) programs** – The TIM program promotes a coordinated response among the different individuals and agencies. These coordinated responses support safer and quicker incident clearances to re-open travel lanes faster.
- **Provide Real Time Traffic Information** – Providing information about active incidents enables motorists to consider alternate routes, which reduce traffic demand at the scene. Reduced traffic demand can prevent secondary crashes and provide a safer work area for the responders. There are 522 permanent Changeable Message Signs (CMS) and 117 portable CMS signs across Virginia's interstates and arterial routes to provide real time traffic information.
- **Provide Safety Service Patrols** – Safety Service Patrols (SSP) perform services to support incident management. A large portion of incidents are first detected or verified by SSP. The SSP vehicles often carry the necessary materials to clear simple incidents rapidly. Highways that begin using SSP services experience a reduction in incident lengths. At this time, there are 46 patrols across Virginia providing 815 center lane miles of coverage.
- **Develop Towing and Emergency Relocation Programs** – By having an "instant tow" program, an incident's length is reduced by eliminating the time waiting for resources to arrive. With an "instant tow" concept, towing services and law enforcement are dispatched simultaneously. This process can reduce the incident length by 15 to 40 minutes.
- **Augment On-Scene Recovery Resources** – Pre-staging critical equipment and supplies to clear an incident reduces the time used to locate and deliver them to the scene.
- **Defer Incident Cleanup to Off-Peak Hours** – In accordance with Code of Virginia § 46.2-1212.1, reasonable and prudent options to open a travel lane by first moving damaged assets or cargo to a safer location allows responders to plan the event. Road closures can be scheduled during low volume periods to minimize congestion.

- **Provide Traffic Queue Warnings** – A vehicle and/or signage can warn motorists about an approaching traffic backup to prevent secondary collisions.
- **Detour Route Planning** – Planning for detour routes include selecting the best routes, providing key resources such as route marking signs, and adjusting the alternative route for greater traffic flow by adjusting traffic signals. With proper planning, the impact of a large incident on mobility is reduced.

Incident Management Improvement Activities

VDOT has increased the focus of incident management activities. VDOT has established a Business Plan goal to reduce the median incident duration time by 5 minutes in 5 years. Actions taken to reach this goal are:

Develop Traffic Incident Management (TIM) Programs

- Continue supporting TIM interdisciplinary training with all responders. Over 13,663 responders have attended TIM training. Virginia has one of the highest TIM participation rates in the nation.
- Developed web-based TIM training to promote additional training opportunities.
- Supported the development and implementation of 2017 House Bill 2022 (Chapter 350), which allows TIM service vehicles to use crossovers and protects TIM service operators from liability.

Develop Towing & Emergency Relocation Programs

- Statewide – Supported the development and implementation of 2017 House Bill 2022 (Chapter 350), which requires drivers to move their vehicles involved in non-fatal, non-injury crashes if it is safe to do so.
- Hampton Roads District - Implemented an Instant Tow dispatch program on designated segments.
- Salem District – Implemented an Instant Tow dispatch program. Implemented Emergency Tow contract(s) to support incident clearance during weather events.
- Richmond District – Implementing an Emergency Tow contract to support incident clearance during weather events.

Provide Safety Service Patrols

- SSP routes have been modified to provide greater coverage of high incident events across Virginia focusing on peak periods and high incident areas.

Augment On-Scene Recovery Resources:

- Augmented on-scene recovery resources as appropriate.

Defer Incident Cleanup to Off-Peak Hours

- Best practices are used, as appropriate, by VDOT and contracted staff to minimize traffic impacts to clear incidents.

Provide Traffic Queue Warnings

- Queue warning notifications are implemented, as appropriate, by incident type and severity.

Detour Route Planning

- VDOT is developing freeway traffic incident diversion plans across Virginia. This effort is a multi-year, multi-phase plan. Plans are available for:
    - I-64 between mile markers 143 (Louisa County) to 273 (Virginia Beach);
    - I-66 between mile marker 40 to the District of Columbia;
    - I-81 between exit 220 (Staunton) and the West Virginia State Line;
    - I-95 between mile markers 0 and 170 (Beltway);
    - Virginia 164 (entire route);
    - I-295, I-395, I-495 (entire routes);
    - I-664 between Exit 7 and Exit 15.

III.
Collaborating with the Private Sector

III.1 Collaborating with the Private Sector Overview

VDOT continues to outsource and privatize where supported by good business practices. More than half of VDOT's FY 2017 spending was with private sector vendors. This chapter summarizes VDOT's spending with the private sector and its ongoing efforts to be more efficient by working with the private sector while maintaining management oversight to help ensure effective delivery of services. This section also provides a summary of revenue generated from asset sales and leases.

III.2 VDOT Spending with the Private Sector

VDOT expenditures in FY 2017, excluding debt service and transfer payments, totaled $3.6 billion, of which $2.96 billion was with the private sector. Total agency expenditures were $5.19 billion. Included in the $2.96 billion of private sector spending was the outsourcing of over $310.7 million in interstate maintenance.

Bundled Interstate Maintenance Services (BIMS)
BIMS contracts provide for ordinary and preventive maintenance services, including activities such as repair and replacement of right-of-way assets, and services such as emergency response, severe weather operations and management, and disposal of hazardous materials.

In FY 2017 there were four BIMS contracts being administered by private vendors. Three contracts were for Northern Virginia and one was for Fredericksburg. The annual value of the four BIMS contracts currently in place is approximately $9 million.In addition, VDOT has contracted with a private vendor for the management and maintenance of the Woodrow Wilson Bridge through June 14, 2019.

Safety Rest Areas and Welcome Centers
VDOT continues to administer property management contracts for the 24 hour, seven days a week staffing, preventative maintenance and repair of 43 Safety Rest Areas, which include 12 Welcome Centers (SRA/WC).

Regional Traffic Operations Centers

In 2013, VDOT determined that the statewide Traffic Operation Center services and Active Traffic Management System development could be procured under the Virginia Public Procurement Act. The procurement was advanced and awarded to Serco, Inc. in May 2013. In 2016, the contract was discontinued by mutual agreement. VDOT debundled the services of this original contract and advertised the Traffic Operation Center services and Active Traffic Management System efforts as separate contracts. VDOT is reviewing offeror proposals for the Traffic Operations Center contract. A sole source procurement for operation of the Active Traffic Management System was awarded in September 2016.

Figure 46: Traffic Operations Center – Hampton, VA

III.3 Project Delivery Utilizing Transportation Public Private Partnerships

The Virginia Department of Transportation (VDOT) has long identified advancing public private partnerships as an important component in pursuing the Department's Business Plan. Since the Public-Private Partnership Act's (PPTA) inception in 1995, the Department has delivered 12 PPTA projects valued at $11.292 billion. Three mega projects alone generated economic activity exceeding $5.5 billion dollars, and an estimated 40,700 jobs.

Public Private Partnership projects under Construction

1. **Coalfields Expressway** – (VDOT). This project is a PPTA agreement between VDOT and private sector partners that uses the private sector expertise in earth moving and extracting incidental coal to reduce the cost of constructing the roadway. This innovative partnership with coal companies allows Virginia to advance the project using coal synergy innovation and large scale earthmoving expertise for $2.8 billion, contrasted to an updated cost of $5.1 billion using traditional road building methods. During construction, the project is estimated to create approximately 29,000 construction jobs over 17 years and $4.1 billion in regional and local economic benefits. Once completed, the project is estimated to create 372 service jobs and an annual impact of $41.1 million plus $28.3

million in annual savings from travel efficiencies.

In 2015, Contura Energy, the successor to Alpha Natural Resources, assumed the Assumption and Assignment of the 2002 Comprehensive Agreement. Segments of Hawks Nest are in development and the Poplar Creek sections are underway.

2. **Route 58** – VDOT continues to work with private sector partners Branch Highways on Phase 3, referred to as the Laurel Fork/Tri-County section. Work on the entire 8.2-mile section was completed ahead of schedule in summer 2016. As state funding becomes available, the last remaining 19 miles of the entire Route 58 Corridor Development Program, including Crooked Oak, Lovers Leap, and Vesta sections, will be advanced to completion.

3. **Route 28** – VDOT continues to work with private sector partners Clark/Shirley to develop high-capacity interchanges and widening projects in the Route 28 corridor in Fairfax and Loudoun counties. The Innovation Avenue interchange, one of the interchanges to be built under the agreement, was completed in Spring 2017. In Summer 2017, Southbound Route 28 from Sterling Boulevard to US Route 50 was widened from three to four lanes; while Northbound Route 28 from McLearen Road to Dulles Toll Road was likewise widened from three to four lanes. Further information can be found at http://www.virginiadot.org/projects/northernvirginia/rt_28_spot_widening.asp.

4. **Elizabeth River Crossings** (Downtown/Midtown Tunnels and MLK Extension). The project was completed and opened to traffic in September 2017. VDOT and private sector partner, ERC, now move into the Operations and Maintenance phase of the project for a concession period of 58 years.

   Benefits associated with the project include personal savings for a round trip user of about 30 minutes a day, saving fuel and reducing gas emissions. Hampton Roads Transit will improve route frequency between Norfolk and Portsmouth; this enhancement could spur public transportation use, offering a low cost alternative to driving alone. The Project offers regional economic development benefits estimated at $170 to $254 million. More than $1 billion of construction works were built by local companies. More than 500 direct jobs and more than 1,000 indirect jobs were created through local suppliers and vendors. Increased travel options provide greater accessibility to jobs, educational facilities, medical services, shopping and recreational activities. Finally, the improvements provide a critical link to the various port facilities in the region, supporting the movement of goods in and out of these facilities.

5. **I-395 Express Lanes Extension** – (VDOT/Virginia Department of Rail and Public Transportation – DRPT). This project is an enhancement to the original Comprehensive Agreement for the I-95 Express Lanes project. The project scope will extend the 95 Express Lanes for eight miles north to the D.C. line, increase capacity by adding an additional HOV lane to make three reversible lanes on I-395 and extend the benefits and travel options of the 95 Express Lanes further north.

The Amended Restated Comprehensive Agreement was executed between Transurban and VDOT on June 8, 2017. Construction started immediately following Financial Close, which occurred on July 25, 2017.

Public Private Partnership projects under Procurement

1. **Transform-66:** Outside the Beltway – (VDOT/DRPT). The $2.3 billion I-66 Outside the Beltway Project is a public-private partnership between VDOT, DRPT and private partner, I-66 Express Mobility Partners, a consortium of Cintra, Meridiam, Ferrovial Agroman US and Allan Myers VA Inc. The Comprehensive Agreement and Commercial close were achieved in December 2016. Financial close and construction are anticipated in Fall 2017.[14]

   The I-66 Outside the Beltway Project will include:

   - 22.5 miles of new express lanes alongside three regular lanes from I-495 to University Boulevard in Gainesville;
   - Express lanes that will be dynamically tolled to manage demand for the lanes and provide a reliable, faster trip – available to drivers who choose to pay a toll and free to vehicles with three or more occupants;
   - New and improved bus service and transit routes;
   - New and expanded park and ride lots providing convenient access to the express lanes and more than 4,000 new park and ride spaces;
   - Interchange improvements to enhance safety and reduce congestion, including auxiliary lanes between interchanges where needed.

Public-Private Partnership projects under Development

1. **I-95 Fredericksburg Extension** – (VDOT/DRPT). This project is a component of the Atlantic Gateway Project which will extend the I-95 Express Lanes south to Fredericksburg. The scope includes constructing approximately nine miles of Express Lanes south of the current terminus near Garrisonville Road to Route 17 in Stafford County. This component would complete one of the longest Express Lanes systems in the U.S., from Washington, D.C., to Fredericksburg, and unlock a major point of daily congestion in the region.

   The project public information meetings occurred in March 2017 and VDOT Location and Design Public Hearings are planned for the fall of 2017. Procurement activities may begin in 2018, with construction anticipated in 2019-2022.

2. **Hampton Roads Bridge-Tunnel** – (VDOT/DRPT). The existing 3.5-mile facility consists of two 2-lane immersed-tube tunnels on artificial islands, with trestle bridges to shore. These tunnels opened in 1957 (current westbound lanes) and 1976 (eastbound lanes) and are approximately 7,500 feet long. Traffic on these four lanes exceeds 100,000 vehicles per day during peak summer traffic.

[14] The project reached financial close in November 2017. Initial construction will begin before the end of 2017.

The proposed Hampton Roads Bridge-Tunnel Expansion project will ease this congestion by widening the four-lane segments of the I-64 corridor in the cities of Hampton and Norfolk. The NEPA approval was received June 2017. Including the construction contract, owner's costs, and contingency, the total budget is estimated at $3.3 billion in 2016 dollars. This will make it one of the largest infrastructure projects in the country. The construction contract is expected to be awarded in 2019, with an estimated completion in 2024.

Public-Private Partnership innovative concepts under consideration:

The VDOT P3 Office is also exploring various innovative concepts involving new technologies for infrastructure. The P3 Office would be responsible for working with other VDOT Divisions to develop concepts into projects that may be suitable for procurement under the PPTA. These concepts can include Autonomous Vehicles and Broad-band installation along designated priority highways.

The Department will continue to work with interested parties who may request exploration of other opportunities pursuant to the PPTA.

IV.
Traffic Modeling Results for Federally Funded Projects Requiring a Multi-alternative National Environmental Policy Act Analysis

IV.1 Traffic Modeling Results Background

Item 8 of § 33.2-232 requires that the Commissioner of Highways' Annual Report shall include the: "Traffic modeling results for all federally funded projects requiring a multi-alternative National Environmental Policy Act [NEPA] analysis." This section of the Annual Report presents summary traffic model results for those transportation projects involving a multi-alternative NEPA analysis and having received a decision from the Federal Highway Administration (FHWA) to advance.[15] A discussion of traffic forecasting methodology is set out in Appendix B.

The traffic forecasting process allows planners, engineers and other transportation professionals to estimate the amount of traffic that will exist on the transportation system in the future. It further allows for the detailed assessment of specific project plans and designs, and their possible near-term and long-term impacts. For any major federal action, such as the funding and approval of transportation projects, NEPA requires that proper consideration be given to the environment prior to the project advancing. Review for environmental impacts occurs at the preliminary engineering phase. FHWA may approve a proposed transportation project's advanced engineering design, right of way acquisition, and construction following the environmental review, conducted in accordance with NEPA. For larger transportation projects multiple alternatives are developed and compared in NEPA studies, and traffic forecasting is a primary component of the alternatives' development and comparison.

IV.2 Traffic Modeling Results

The following information on traffic model results is provided for those projects involving a multi-alternative NEPA analysis which have received FHWA approval in the form of a Finding of No Significant Impact or Record of Decision[16] during FY 2017. Four multi-alternative NEPA analyses were completed:

- I-64 Hampton Roads Crossing Study Supplemental Environmental Impact Statement

[15] The report does not include reevaluations. Reevaluations are prepared following an approved NEPA document or decision, prior to a request for FHWA action (i.e., final design, right of way, plan specification and estimate) and are generally necessary when there has been a time lapse of three years or changes have occurred between the previous NEPA approval and the request for action.

[16] As the name implies the Finding of No Significant Impact is issued when the FHWA finds the project to have no significant impacts on the quality of the environment. Alternatively, the Record of Decision is the final step in the environmental review. It identifies the selected project alternative, presents the basis for the decision, identifies all the alternatives considered, specifies the "environmentally preferable alternative," and provides information on the adopted means to avoid, minimize and compensate for environmental impacts.

- I-64 Segment A in Henrico and New Kent Counties, a portion of the I-64 Peninsula Study
- I-64 Segment 3 in York County, a portion of the I-64 Peninsula Study
- I-64 Chesapeake High Rise Bridge Study

Detailed data-documentation of a single large project's traffic analyses could consume hundreds of pages. Instead, this report uses summary tables to show the traffic modeling results and provides project-specific hyperlinks to the publicly available documents that contain detailed discussion of the traffic modeling analyses and the NEPA results.

The multi-alternative Hampton Roads Crossing Study SEIS traffic modeling forecasts:

The Hampton Roads Crossing Study examined options for relieving congestion at the I-64 Hampton Roads Bridge Tunnel and for improving accessibility, transit, emergency evacuation, and military and goods movement along the primary transportation corridors in the Hampton Roads region, including the I-64, I-664, I-564, and Route 164 corridors. Traffic forecasts for the Hampton Roads Crossing Study's alternatives were developed using the Hampton Roads Transportation Planning Organization (HRTPO) travel demand model. Model outputs were post-processed to obtain estimates of design year 2040 daily and peak hour traffic volumes. After completion of the Draft SEIS, the HRTPO released an update of the regional travel demand model on August 8, 2016. The 2016 update incorporates the region's latest adopted land use forecasts for a new horizon year (2040) as well as the transportation improvement projects for the latest adopted long range transportation plan. For the I-64 Hampton Roads Bridge Tunnel (HRBT) Final SEIS, the traffic forecasts and congestion analyses for the 2040 No Build scenario and 2040 Build Preferred Alternative (Alternative A) were updated to use the latest HRTPO socioeconomic data and transportation network improvements.

Draft SEIS study alternatives were developed to accommodate general purpose lanes, HOV lanes, HOT lanes, or lanes tolled/managed in other ways. Among a field of four alternatives, the CTB preferred the build Alternative A and approved it for the project's location on December 7, 2016. The Federal Highway Administration issued a Record of Decision (ROD) for the Hampton Roads Crossing Study on June 12, 2017. The ROD identifies Alternative A as the selected alternative, concludes the National Environmental Policy Act process for the study allowing VDOT to proceed with more detailed procurement and design of the project. Alternative A proposes improvements confined largely to existing right of way that will widen I-64 between I-664 in Newport News and I-564 in Norfolk, including the Hampton Roads Bridge Tunnel portions, consistent with a six-lane facility.

The CTB resolution of approval indicated that the CTB would be briefed on and have the opportunity to endorse a managed lane concept should it be identified and the appropriate analysis and financial plans are in place. As of the publication of the Final SEIS, a managed lane strategy (HOT or HOV lanes) for Alternative A had not yet been determined.

A summary of 2015 and 2040 daily traffic volumes of the Final Supplemental Environmental Impact Statement (Final SEIS) for the I-64 HRBT, the I-664 Monitor-Merrimac Bridge Tunnel (MMBT) and VA 164 with the various I-64 HRBT study alternatives is provided in a table below. Updated model forecast of the 2040 No Build and the updated 2040 Build Preferred Alternative A daily traffic volume used in the Final SEIS are shown aside those estimates of the older model forecast used for the 2040 Build Alternatives A through D in the Draft Supplemental Environmental Impact Statement (Draft SEIS):

Figure 47: Summary of Daily Traffic Volumes of the Final SEIS for the I-64 HRBT, the I-664 MMBT and VA 164 with the various I-64 HRBT study alternatives

Key Roadway Segment	2015	2040 No Build (updated for the Final SEIS)	*2040 Build Preferred and CTB Approved Alternative A (updated for the Final SEIS)*	2040 Build Alternative A (Draft SEIS)	2040 Build Alternative B (Draft SEIS)	2040 Build Alternative C (Draft SEIS)	2040 Build Alternative D (Draft SEIS)
I-64 HRBT	91,000	101,500	***129,800***	137,300	133,400	103,600	124,200
I-664 MMBT	69,300	85,600	*82,800*	89,200	83,100	127,700	114,900
VA-164	49,000	66,500	*64,300*	64,000	78,400	54,000	55,700

Sources: Table 8-1 on page 136, and table 5-1 on page 77 of the Hampton Roads Crossing Study Final SEIS, April, 2017, Traffic and Transportation Technical Report available at: http://hamptonroadscrossingstudy.org/documents/2017/hrcs_traffic_and_transportation_technical_report.pdf.

I-64 Peninsula Study, I-64 Segment A and I-64 Segment 3

Options to improve a 75 mile length of the I-64 corridor from the I-95 (Exit 190) interchange in the City of Richmond to the Interstate 664 (Exit 264) interchange in the City of Hampton in Virginia were evaluated in the Interstate 64 (I-64) Peninsula Study. In consideration of the length and nature of the project, the I-64 Peninsula Study's envisioned improvements are to be implemented step-wise, where fundable and operationally independent segments of the interstate highway will be improved in a phased-construction approach. I-64 Segment A and I-64 Segment 3 were both assessed in the I-64 Peninsula Study.

The number of lanes on existing I-64 varies through the I-64 Peninsula Study area. At the time of the study (the existing year 2011), travelling east on I-64 from the I-64 Exit 190 interchange with I-95 in Richmond to Exit 197 (Airport Drive) in Henrico County, there were generally three I-64 travel lanes in each direction. After Exit 197 (Airport Drive), there were generally two I-64 travel lanes in each direction. Beginning at mile marker 254 in Newport News and continuing east, I-64 widened to four lanes in each direction with three general purpose lanes and one 2+ person High Occupancy Vehicle (HOV 2) lane during the AM and PM peak periods. Some additional lanes existed between closely spaced interchanges at the eastern end of the corridor to provide for easier merging of traffic on and off of the I-64 mainline.

A number of possible solutions were examined for addressing the improvements needed along the I-64 corridor. Four alternatives, described below, were carried forward for study. On April 17, 2013, after an opportunity for public comment, the CTB endorsed "Alternative 1" to add general purpose lanes to I-64 as the Preferred Alternative with the option to widen to the outside or within the median to be determined on a section-by-section basis.

- The No-Build Alternative serves as a baseline for comparison of future conditions and impacts.

- Alternative 1A/1B became the selected alternative for the project. It involves adding additional general purpose travel lanes to the I-64 mainline to achieve a Level of Service (LOS) C or better in the design year 2040. Although there are numerous possible combinations for adding these lanes, the analysis focused on adding all needed lanes, within the existing right of way to the greatest extent practicable, to either the outside of the existing lanes, which is Alternative 1A, or to the inside of the existing lanes within the median, which is Alternative 1B.

- Alternative 2A/2B involves tolling the entire facility with full toll lanes. However, as of the time of the study, no federal or state agreement has been in place that would allow for tolling I-64 from I-95 in the City of Richmond to I-664 in the City of Hampton. Therefore, these alternatives that involve tolling may or may not ultimately be possible. The existing right of way would be used to the greatest extent practicable to the outside of the existing lanes with Alternative 2A or, to the inside of the existing lanes within the median, which is Alternative 2B. If Alternative 2A or 2B is identified as a Preferred Alternative, subsequent studies will refine the specifics of the tolling, such as whether or not the tolling would encompass the

entire length of the I-64 corridor along with the number and placement of the toll collection stations.

- Alternative 3 involves addition of separated, managed lanes in the median. Managed lanes were examined for the entire length of the I-64 study area from I-95 in the City of Richmond to I-664 in the City of Hampton. As previously described, not all sections of the I-64 corridor have sufficient median area to accommodate the addition of any lanes. In these areas, the facility is proposed to be widened to the outside of the existing general purpose lanes in order to accommodate the managed lanes between the eastbound and westbound general purpose travel lanes. If this alternative is selected as a Preferred Alternative, subsequent studies would refine the specifics of the managed lanes throughout the I-64 corridor.

The I-64 Peninsula Study's Traffic Forecasts

In general, the traffic forecasts for the I-64 Peninsula Study's horizon year of 2040 were derived from applying growth rates to year 2011 balanced traffic volume information, year 2034 modeled volume information, and post-processing. The particular growth rates were determined from reviewing roadway traffic counts in the corridor and from growth related information (adopted local land use plans, population projections, travel projections, employment projections, etc.) of the Tidewater Super Regional Model, a travel demand model.

The scope of the I-64 study area is large. It covers two urban areas that range from I-95 to I-295 in the Richmond area, and from US 17 (Victory Boulevard) to I-664 in the Hampton Roads area. This situation warranted the study, identification and use of different growth rates to cover each of the two urban areas and the rural area extending between them. For each of the three areas, growth rates projected by the travel demand model were averaged and rounded to the nearest 0.1 percent. The travel demand model was selected as the primary source for the overall growth rates, because it is a forward looking tool (unlike the historic growth rates), and incorporates approved land use forecasts and accepted modeling protocols. Historic growth rates can serve as a reasonableness check but should be used with caution, in particular, along extended projects such as the I-64 Peninsula EIS, because they are less able to factor in future development patterns, capacity constraints and diversion to other facilities, new roadway projects, and other factors that influence traffic patterns (such as tolls). The study yielded the following annual growth rates. These represent basic, key factors used in the derivation of the traffic forecasts with the I-64 Peninsula Study:

- Richmond area growth: 0.7% per year
- Peninsula rural area growth: 1.5% per year (Includes I-64 Segment A and I-64 Segment 3.)
- Hampton Roads area growth: 1.1% per year

Source: Page 39 and page 402 (pdf) Appendix E of the October 2012 Traffic/Transportation Technical Memorandum, and Appendix H page 1 and page 13 responses to comments 1.3 and 24.

The growth rates (above) used in the traffic study with the Richmond and Hampton Roads areas are higher than the average growth that was observed from 2000-2010 (which were -0.2% and 0.6%, respectively). However, those 10 years included the effects of the 2008 economic

recession which resulted in nationwide and regional declines in traffic volumes. It is not realistic to expect the slow growth trends of those past ten years to continue over the next 30 years for the urban areas. The growth rate used in the traffic study with the Peninsula rural area is lower than the average growth rate that was seen from 2000-2010 (2.6%). However, growth of such magnitude is unlikely to be sustained over the next 30 years for the Peninsula rural area.

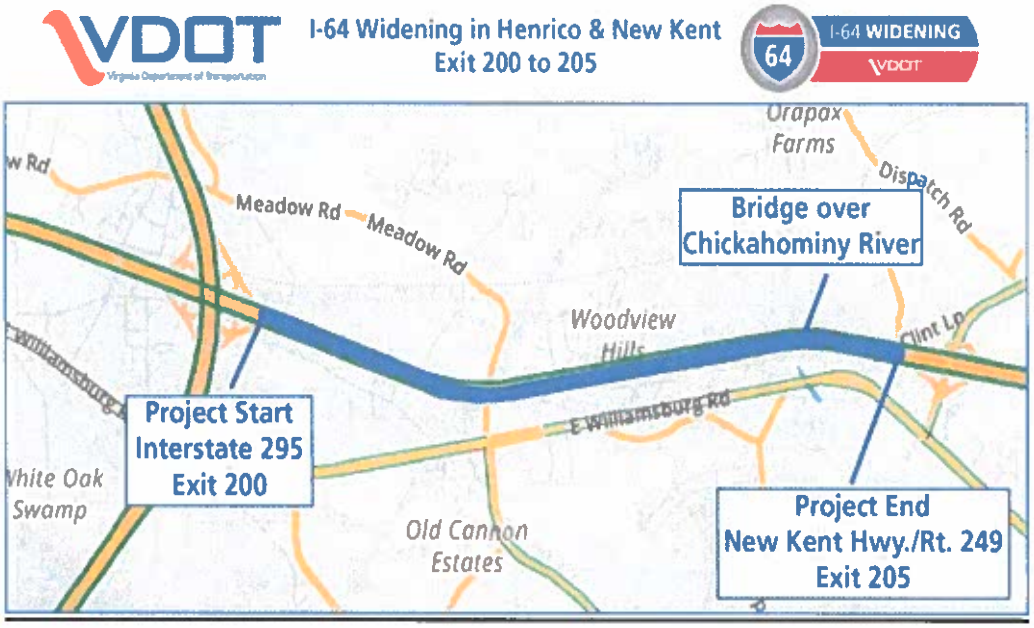
I-64 Segment A

Widening for the Segment A portion of the I-64 Peninsula Study was approved in a Record of Decision dated January 13, 2017, where a general purpose lane will be added mostly in the median for each direction (Alternative 1) without modifying the existing interchanges in the project limits. This five-mile segment of I-64 in Henrico and New Kent Counties is situated in the area where the traffic forecast was derived using the rural area growth rate (1.5%/year) and post processing. The traffic forecast for this segment involves just one section of I-64:

Figure 48: Summary of Daily Traffic Volumes for I-64 Segment A

Average Daily Traffic (ADT) Volume (The selected alternative is shown in bold font)	
I-64 Segment A (from Exit 200 at I-295 to Exit 205 at Bottoms Bridge/Quinton)	
2011Existing	66,500
2040 No-Build	102,200
2040 Alternative 1A/1B	**113,200**
2040 Alternative 2A/2B	106,600
2040 Alternative 3	97,700

Source: Table 41 page 61 of the October, 2013 Traffic/Transportation Technical Memorandum.



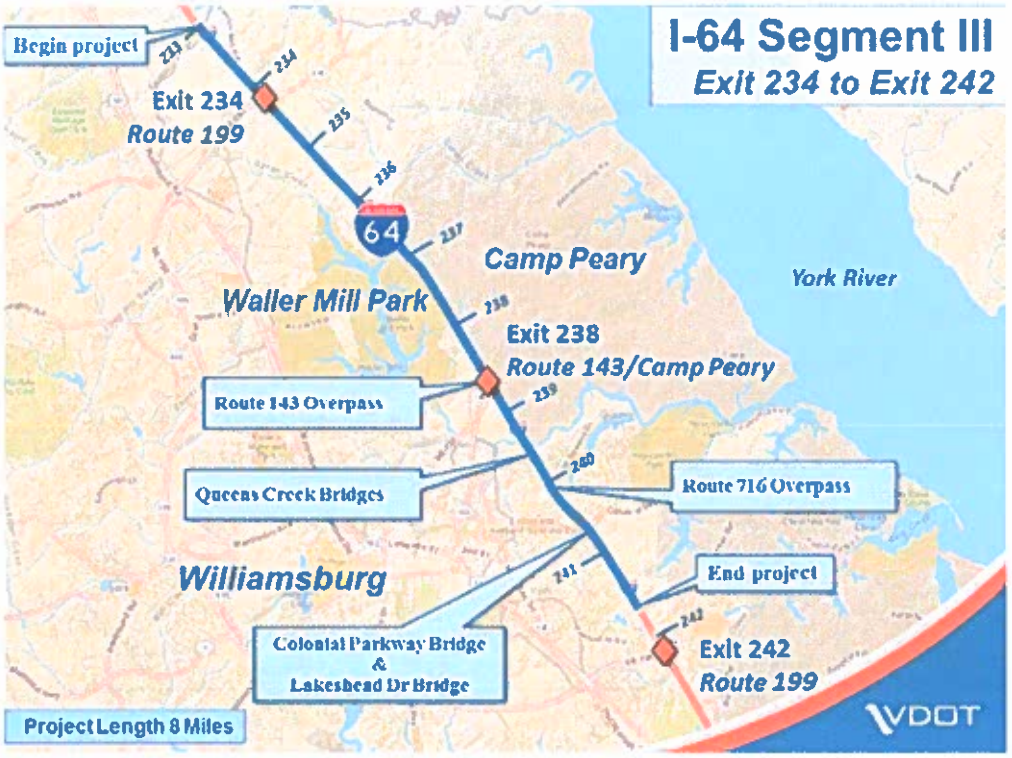
I-64 Segment 3

Widening for the Segment 3 portion of the I-64 Peninsula Study was approved in a Record of Decision dated August 10, 2016. It calls for the addition of one general purpose lane in each direction within the highway median (Alternative 1) without modifying the existing right-of-way within the project limits. This eight-mile segment of I-64 in York County (north of the City of Williamsburg) is situated in the area where the traffic forecast was derived using the rural area growth rate (1.5% per year) and post processing. The traffic forecast for this segment involves two sections of I-64:

Figure 49: Summary of Daily Traffic Volumes for I-64 Segment 3

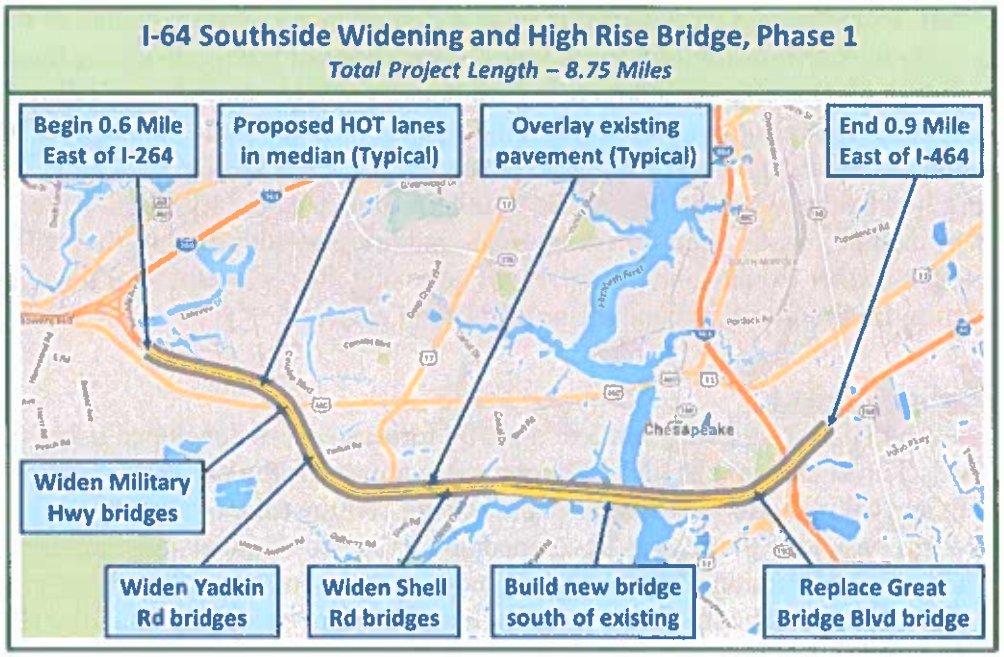
Average Daily Traffic (ADT) Volume (The selected alternative is shown in bold font)		
I-64 Segment 3 (Containing two sections of I-64: one from Exit 234 at Rte. 646 near Lightfoot to Exit 238 at Rte. 143 near Camp Peary; and the other from Exit 238 to Exit 242 at Rte. 199 near Busch Gardens)		
	from Exit 234 to Exit 238	from Exit 238 to Exit 242
2011Existing	61,300	64,000
2040 No-Build	94,800	99,500
2040 Alternative 1A/1B	**107,900**	**107,200**
2040 Alternative 2A/2B	102,000	100,500
2040 Alternative 3	96,600	96,700

Source: Table 41 page 61 of the October, 2013 Traffic/Transportation Technical Memorandum.



I-64 High Rise Bridge in the City of Chesapeake

A Finding of No Significant Impact (FONSI) was issued on August 22, 2016, which provided a key approval for advancing to a first phase for improving I-64 in Chesapeake from 0.6 mile east of I-264 (near Exit 299 at Bowers Hill) to 0.9 mile east of I-464 (near Exit 291). The project covers a total length of 8.75 miles.



There were multiple alternatives considered for the project. Several alternatives were eliminated that did not support adequate traffic flow (Level of Service C) through the study area, and others were eliminated that would incur greater costs, environmental and/or right-of-way impacts than other alternatives. Two eight-lane Candidate Build Alternatives, CBA 1 and CBA 2, were retained for evaluation and were analyzed along with the Existing and the No Build scenarios for the Final Environmental Assessment.

CBA 1 would have included construction of four additional lanes of capacity (two lanes in each direction) on I-64 by year 2040. The eight lanes for this alternative would be general purpose lanes and available for use without any restrictions or tolls. Wherever possible, the additional lanes would be constructed towards the existing median of I-64. A grass median would be maintained west of the Route 17 interchange based on existing median width and spacing needs. Approaching the Route 17 interchange, as the grass median narrows, the eastbound and westbound directions would be separated by a concrete traffic barrier.

CBA 2, the preferred alternative, was selected for implementation in the FONSI. Similar to CBA 1, it provides four additional lanes of capacity (two lanes in each direction) for I-64 by year 2040. CBA-2, however, allows the option for a management option (HOV, HOT, or all tolled) to be applied to the corridor. A decision on a management option would be made by the CTB at a later date. However, some or all of these travel lanes shall be managed lanes using tolls and/or vehicle occupancy restrictions. Additionally, expanded local/express bus service or bus rapid

transit may be accommodated with this alternative. Numerous managed lane scenarios are possible with this alternative depending on the type of strategy selected including, but not limited to, HOV lanes, high occupancy toll (HOT) lanes, occupancy restrictions (at least 2 or 3 occupants), or time of day/day of week restrictions.

The initial phase for the project under CBA 2, calls for addition of one proposed High Occupancy Toll (HOT) lane in each direction with widening mostly in the median of the existing interstate to bring the corridor initially to six lanes. This phase of the roadway configuration will provide three lanes for travel in each direction with one of the three lanes in each direction being a HOT-managed lane (free for eligible vehicles that are HOV-2 or more). This phase includes the construction of a new high-level High Rise Bridge with a fixed span placed aside and south of the existing I-64 bridge where it crosses the Southern Branch of the Elizabeth River. The first phase also will include construction providing road- and bridge-width designs that will accommodate the further expansion to (total) eight lanes and the replacement of the existing bridge's structure for the future, second phase of the I-64 project.

Traffic forecasting approach:
In general, the I-64 High Rise Bridge project's traffic forecasts were developed using the Hampton Roads Travel Demand Model with updates to adjust for the project's study years, certain growth and toll assumptions, and post-processing. At the time of the I-64 high rise bridge study, a new 2013 base year model was developed and validated with existing condition traffic count data. The original version of the model included assessments for a 2009 base year and a future 2034 year network. The model network included all projects contained in the HRTPO Constrained Long Range Plan. Toll rates such as those on the Elizabeth River Tunnels (I-264/Midtown Tunnel and Route 58/Downtown Tunnel) and the planned toll at Route 17/Dominion Boulevard were coded into the future year model based on HRTPO tolling assumptions for those facilities. The updated 2013 and 2034 models were then used to generate the I-64 project's year 2025 (interim year) and year 2040 (design year) forecasts with post-processing. The post-processing used the screenline adjustment and refinement procedures described in *NCHRP 255 Report: Highway Traffic for Urbanized Area Project Planning and Design* (TRB, 1982).

The linear annual growth rate for No Build conditions was 1.01 and the growth rate for the Build Alternatives ranges from approximately 1.02 to 1.03. The traffic study found that increasing the number of travel lanes and capacity along I-64 makes the corridor a more attractive route and attracts traffic from other competing roadways in the region. The traffic study included a toll diversion analysis to quantify the potential diversion of traffic from I-64 to alternative routes due to various tolling scenarios along I-64 associated with the Eight Lane Build – Managed Alternative rather than to determine an ultimate tolling scenario including toll rates. A memorandum documenting the toll diversion study was prepared (Appendix G of the Traffic and Transportation Technical Report) where the findings were:

- There would be minimal traffic diversion from I-64 for the Managed Lanes scenario due to the shifting of some traffic to the Managed Lanes and the remaining available capacity on the I-64 facility itself.

- There would be varying amounts of traffic diversion from I-64 for the All Lanes Tolled scenario due to the implementation of tolling on the facility and the availability of capacity at the other crossings, specifically at the nearby, untolled Route 13/Gilmerton Bridge. It is estimated that 19 percent of traffic would divert from I-64 after the implementation of tolling at the Low per mile rate, and up to 31 percent could divert at the High per-mile toll rate.
- The largest shift in traffic from I-64 after the implementation of tolling is estimated to utilize the nearby untolled Route 13/Gilmerton Bridge, due to its nearby location and its numerous direct connections to the I-64 corridor.
- It is estimated that the overall change (loss) in total crossings of the Elizabeth River would not be significant after the implementation of tolling along the I-64 corridor, as there would be available capacity for most portions of the day at the other crossings to handle any potential traffic shifts from I-64. These overall estimated losses to total crossing traffic range from 2.5 percent in the Low per-mile toll rate to 3.9 percent in the High per-mile toll rate scenario.

The traffic study for the I-64 High Rise Bridge project yielded the following average weekday daily traffic volume estimates. Preferred alternative CBA 2 information is shown in bold font. The year 2040 CBA 2 managed lane scenario of having HOV-2 apply for certain hours would carry the highest daily volume. A daily traffic volume range is shown for two High Rise Bridge scenarios involving certain user fees where: 1) all lanes would be toll lanes in each direction, or 2) two general purpose lanes and two HOT lanes would be operated in in each direction.

Figure 50: Summary of Daily Traffic Volumes for I-64 High Rise Bridge in the City of Chesapeake

I-64 Chesapeake High Rise bridge Project Segment	2013 Existing	2040 No Build	2040 Build CBA 1 (Four Additional General Purpose Lanes)	**2040 Build CBA 2 (Four Additional Managed Lanes)**
From I-664/I-264 To Rte. 13	78,400	105,900	127,300	**127,300** (HOV-2)
From Rte. 13 To Rte. 17	75,600	108,800	133,500	**133,500** (HOV-2)
From Rte. 17 To Rte. 190 (including High Rise Bridge)	85,600	110,400	142,000	**142,000** (HOV-2) **114,700 – 97,900** (for a toll road with a low to high rate price fee where all of the lanes are tolled) **139,200 – 137,800** (for the mix of 2 general purpose lanes and a low to high rate price fee for use of 2 HOT lanes, free for eligible HOVs, in each direction)
From Rte. 190 To I-464	83,200	107,600	136,900	**136,900** (HOV-2)

Sources: Table 1-2, page 4 of the October, 2014 Draft EA, and Table 7-1 on page 29, Table 7-3 on page 31, Table 7-5 on page 33, and Table 7-7 on page 34 of the October, 2014 Traffic and Transportation Technical Report.

V.
Smart Scale and non-Smart Scale Projects

Item 9 of § 33.2-232 requires that the Commissioner of Highways' Annual Report shall include:

> A list of transportation projects approved or modified during the prior fiscal year (i) in each transportation district pursuant to § 33.2-214.1, including project costs, and (ii) in each transportation district not subject to § 33.2-214.1; (Section 33.2-214.1 are projects evaluated and selected using the statewide prioritization process, Smart Scale.)

Each year the Commonwealth Transportation board must approve a Six-Year Improvement Program (SYIP) showing all funded transportation projects proposed for development or study for the next six years. The following link accesses the SYIP database, which contains the approved projects.

http://syip.virginiadot.org/Pages/allProjects.aspx

The database can be accessed by the public by way of VDOT's public web site. The database is menu driven, user friendly, and, provides easy access to details for each project such as a brief description, the VDOT District in which the project is located, the locality in which the project is located, estimated cost of the project and the road system on which the project is located. There is also a data field that flags whether or not the project was subject to the prioritization process of § 33.2-214.1 (Smart Scale) so the projects can be filtered to show, by District, Smart Scale projects only. All projects selected through Smart Scale that were approved in FY 2017 are preceded by #HB2. Type #HB2 in the SYIP database Keyword box, then click the Search button. For the list of FY 2018 Smart Scale projects, type #SMART18 in the Keyword box.

Appendix A
VDOT's Asset Management Process

Appendix A provides a detailed summary of the methodology used to determine maintenance and operations needs within the context of VDOT's asset management processes.

1. Definitions

1. Asset Management Process

Asset management process is a systematic process based on economic, engineering and business principles that monitors the performance of transportation assets. It utilizes data for managing various assets within the transportation network and aides in making 'informed decisions' about managing the network over the entire lifecycle of the assets as it relates to network performance. One major focus of the asset management process is improving decision-making strategies for resource allocation purposes within the transportation infrastructure framework.

2. State of Good Repair

A state of good repair refers to a desirable operating condition of an asset or system. State of good repair requires timely repair and replacement to be performed on assets; that is, maintenance be performed at critical midlife points and replacements be performed at the end of their useful lives.

According to the Code of Virginia § 33.2-369, the state of good repair refers to the reconstruction and rehabilitation of structurally deficient bridges and the reconstruction and rehabilitation of deteriorated pavements.

3. Pavement Condition

Each year, pavement condition data is collected on the entire Interstate and Primary systems and approximately 20 percent of the Secondary system. In 2016, 100 percent of the Secondary network was assessed. The annual pavement inspection, which generally takes place during late fall through winter, uses automated and nationally recognized state of the art data collection equipment. The data collected are processed and interpreted according to the methods detailed in the VDOT Pavement Distress Identification Manual and is summarized to produce the Critical Condition Index (CCI).

CCI values are presented on a scale of 0 to 100 with 100 representing a pavement with no visible distress. As shown below in Figure 51, CCI values are grouped into five ranges corresponding to pavement condition categories: excellent, good, fair, poor, very poor. In general, pavement sections rated with a CCI value below 60 are considered 'deficient' or 'deteriorated' and should be further evaluated for maintenance and rehabilitation activities. Pavement sections with CCI of 60 or above are considered 'sufficient'.

Figure 51: Pavement Condition Category Based on Critical Condition Index

Pavement Condition	Index Scale (CCI)
Excellent	90 and above
Good	70-89
Fair	60-69
Poor	50-59
Very Poor	49 and below

4. National Bridge Inventory (NBI) and Non National Bridge Inventory (Non-NBI)
NBI includes bridges on public roadways exceeding 20 feet in length. The NBI also includes large culverts with a width (as measured along the centerline of the roadway) greater than 20 feet. Federal regulations require NBI structures to receive detailed inspections at regular intervals not exceeding 24 months.

Non-NBI includes: bridges measuring 20 feet or less in length and large culverts having an opening of 36 square feet or greater with a width (as measured along the centerline of the roadway) of 20 feet or less. VDOT policy requires that non-NBI bridges be inspected at intervals not exceeding 24 months and non-NBI culverts be inspected at intervals not exceeding 48 months.

5. Structure Condition
VDOT defines structure conditions by identifying structurally deficient structures using FHWA's criteria.

A structure is defined as structurally deficient (SD) if one or more of its major components (deck, superstructure, substructure, or culvert) is deficient, thus requiring the structure to be monitored and/or repaired, or if it lacks adequate strength or waterway clearance. When one or more of a structure's major components have a General Condition Rating (GCR) of four (4) or less it is defined as a structurally deficient structure. The GCR is a nationally established numerical grading system with values that range from 0 (failed condition) to 9 (excellent condition). GCRs are assigned to each major component of each structure during regular inspections and are reported in inspection reports.

VDOT's global performance measure for structures is based on the percentage of Structurally Deficient (SD) structures in the Department's inventory. VDOT's goal is to have no more than 4.5% percent of the structure inventory rated as structurally deficient. The number of structurally deficient structures in the VDOT NBI/non-NBI inventory at the end of FY 2017 was 935 (4.43%), of which 715 are NBI structures. During FY 2017, the percentage of structurally deficient structures was reduced by 0.86% (using number of structures) or 0.40% (using deck area of structures). Nationally, 9.1% of the NBI structures were structurally deficient as of December, 2016.

6. Needs Assessment
Needs refer to costs to restore, repair and or replace an asset or infrastructure system. It also accounts for the issue of how to set priorities by asset class and activity if funds are limited.

Unconstrained Needs
The unconstrained needs include (1) costs to bring VDOT's deteriorated pavement and structurally deficient bridge assets to the state of good repair, (or, ultimately, the cost for everything) and (2) costs to cover preventative, corrective, and/or restorative maintenance on pavements and bridges.

Needs to reach performance targets
Needs to reach performance targets are the costs to achieve pavement and bridge performance targets by districts in FY 2019. At the time of this report fully funded projects are not considered in this report. Fully funded means funds in current and projected years.

Needs to maintain steady state
These are the costs to maintain assets at a steady state once performance targets for pavements and bridges are achieved.

Other service and repair needs
These are costs to maintain and operate other essential assets and services.

2. Methodology to Determine Paving Needs

VDOT currently maintains 127,917 total lane miles of network. Each year, VDOT inspects and rates 100 percent of the Interstate and Primary system mileage, and in 2016, VDOT inspected and rated 100 percent of the Secondary system mileage. The data collected is used to produce the Critical Condition Index (CCI). CCI values are then used to determine pavement condition ratings of excellent, good, fair, poor and very poor. In general, pavement sections with a CCI value below 60 (poor and very poor) are considered 'deficient' and should be further evaluated for maintenance and rehabilitation activities. Pavement sections with a CCI value of at least 60 (fair or better) are considered 'sufficient'.

The pavement condition data is an important input to develop estimates of pavement maintenance and rehabilitation needs through an optimization analysis. In this report, two types of pavement needs are presented: 1) needs to reach pavement performance targets; and 2) unconstrained pavement needs (or unconstrained needs) for maintenance and rehabilitation activities to correct existing conditions.

A. Needs to Reach Pavement Statewide Performance Targets

Statewide performance target based needs are estimated costs to perform different categories of maintenance work to achieve pavement statewide performance targets by districts. VDOT has three performance measures for pavements. The performance goals are:

- Interstate - 82% in sufficient (fair or better) condition
- Primary - 82% in sufficient (fair or better) condition
- Secondary - 65% in sufficient (fair or better) condition

Needs for four categories of maintenance work are assessed for pavement assets: preventive maintenance (PM), corrective maintenance (CM), restorative maintenance (RM), and reconstruction (RC).

Interstate and Primary Pavement Needs

To develop the Interstate and Primary pavement needs, the pavement condition data is loaded into the Pavement Management System (PMS) which then optimizes the selection of pavement maintenance activities on the Interstate and Primary network. These needs estimates are provided through a process called multi-constraint optimization analysis, which develops an optimal work plan (a series of pavement maintenance activities applied to specific sections on the total network) to achieve a single objective (minimizing cost) against multiple condition-based constraints (performance targets) in a given year of the total six year analysis.

Secondary Pavement Needs

In 2016, 100 percent of the Secondary network was collected to create a baseline for condition of all secondary pavements in a single year.

Prior to 2016, Secondary system hard surface pavement needs were derived by multiplying the number of lane miles in inventory by a "best estimate" deterioration rate to estimate the number of lane miles that will be in different maintenance categories in the next period if no treatments are applied. The deterioration rates represent the percent of lane miles that are expected to move into a maintenance category annually. The change in lane miles in each maintenance category from one period to the next represents the number of lane miles that must receive treatments in order to maintain the same distribution in condition over time. The distribution of condition can be changed from one period to the next by increasing or decreasing the recommended number of lane miles receiving each treatment type.

Using deterioration rates, the number of lane miles in each maintenance category/pavement type, and the unit cost of each treatment type, the needs to maintain or improve the current condition of the hard surfaced Secondary pavement from one year to the next are calculated using the following formula:

$$SPaveNeeds^{j+1} = \sum_i Inventory_i^j * (Deterioration\ Rate_i^j + Improvement\ Rate_i^j) * Unit\ Cost_i$$

Where:

- $SPaveNeeds^{j+1}$ = Cost of treatments necessary to maintain the condition of Secondary hard surfaced pavement from period j to period $j+1$
- $Inventory_i^j$ = lane miles in maintenance category i in period j.
- $Deterioration\ Rate_i^j$ = percent of lane miles in period j that are expected to drop into a maintenance category i
- $Improvement\ Rate_i^j$ = percent of lane miles in period j that are required to improve in order to meet performance goals. Improvement rates vary by district depending on paving condition and any remaining gaps in funding needed to reach the district's performance goals.
- $Unit\ Cost_i^j$ = the unit cost of treatment for maintenance category i in period j.

The summation, $\sum_i$, is across all combinations of pavement types (plant mix and non-plant mix) and maintenance treatments (PM, CM, RM).

Other Added Factors

Pavement needs account for maintenance of traffic (MOT), Construction Engineering Inspection cost (CEI) and contingency along with a number of other added costs, including needs for ramp, patching prior to paving, paving related traffic engineering asset work, and the pavement portion of contracted Interstate maintenance costs. Specifically,

- Ramp needs were reported in the FY 2014 needs assessment. They were determined as 15% of the Interstate mainline hard surface needs.
- Patching prior to paving needs was reported in the FY 2014 needs assessment. They were determined as 10% of the mainline hard surface needs for Northern Virginia district and 7% for the rest of the state.
- Paving related traffic engineering items such as pavement markings, guardrail, rumble strips, and signal loops affected by pavement treatments, etc., were included in the pavement needs analysis. Needs for these assets are accounted for through their own needs analysis.
- Needs for paving related traffic engineering items were determined based on estimated mileages of paving to be treated and assumptions regarding the frequencies or quantities of traffic assets to be affected or replaced as result of the paving projects. The details are discussed in the traffic asset needs documentation.
- Needs for contracted Interstate maintenance paving work are determined based on contract values. In order not to double count interstate pavement ordinary maintenance needs, tasks assumed to be covered by the contracted Interstate maintenance scope are excluded.

B. Unconstrained Pavement Needs

Pavement condition data is also used to feed the maintenance decision trees to determine the unconstrained maintenance needs for the pavement assets. Unconstrained needs analysis establishes the maintenance and rehabilitation needs to appropriately correct the existing pavement conditions assuming funding is not a constraint. It provides an idea of the amount and type of work needed on the entire network. To determine the needed treatment for a particular section, the decision trees are used in conjunction with distress quantity and severity, and the condition index as inputs from the condition data. Traffic level, structural condition, and maintenance history are provided as additional inputs wherever these are available for the selection of treatment. Unconstrained needs are also used in many cases as the first indicator of the needed treatment, which is further refined by field inspections, detailed project level analysis, overall needs of the network and available budget.

3. Methodology to Determine Bridge Needs

Bridge needs include needs for the following two types of assets:

- Bridge and large structures
- Non-structure portion of movable bridges

A. Bridge and Large Culvert Structures

There are currently 21,103 structures (bridges and large culverts) located throughout the Commonwealth, of which 13,524 are NBI structures and 3,739 are NBI structures on the National Highway System (NHS). VDOT maintains 19,456 of these structures, and 1,647 are maintained by localities and private owners.

The needs for the statewide bridge program are analyzed and developed to include two types: (1) costs to meet bridge performance goals; and (2) funding required to replace all structurally deficient structures and to repair remaining structures.

Needs Based on Meeting Bridge Performance Goals

VDOT reports performance based needs for the amount of money required to meet its performance goals. The bridge performance target is for 95.5 percent of structures to be in fair or better condition. By system the targets are:

- Interstate - 99 percent in fair or better condition (not structurally deficient)
- Primary - 96 percent in fair or better condition (not structurally deficient)
- Secondary - 94 percent in fair or better condition (not structurally deficient)

VDOT reports performance based needs for the following categories:

- Bridge inspection
- Planned Preventive Maintenance (PPM)
- Restorative Maintenance (RM)
- Major Rehabilitation and Full Replacement
- Special Structures Needs
- Hauling Permit

Bridge Inspection Needs

Safety inspection activities are performed at the district level by both state forces and consultants. Cost estimates for inspection activities are developed annually by each district based on projected quantity of structures due for inspection and the cost to perform the inspection. Inspection needs also include costs for safety inspections on VDOT maintained tunnel facilities.

Planned Preventive Maintenance (PPM)

PPM is a general term for maintenance tasks that slow deterioration and prolong the life of a maintainable structure. It includes any planned activity performed in advance of a need for repair or in advance of accumulated deterioration so as to avoid such occurrences and reduce or arrest the rate of future deterioration. It does not include corrective repairs to existing damage. The activities, however, may correct minor defects as a secondary benefit. Preventive maintenance is planned, cyclical and not condition-based. Examples of PPM include joint replacement, deck washing, drain cleaning, thin-bonded deck overlays, vegetation removal, bearing cleaning, and spot or zone painting. Ideally, these tasks should be performed at regularly scheduled intervals. PPM is performed on bridges with GCR of six or more and is an important investment in the life of existing assets.

The approach to assessing PPM needs begins with a set of criteria used to identify which bridges are candidates for PPM. The number of bridge components meeting the requirements for treatment across all bridges meeting the selection criteria are summed by system and by district, and then multiplied by the unit cost of PPM. Finally, a frequency factor is applied that represents the fraction of the candidates that should be treated each year in order to ensure PPM treatments occur on every bridge with fixed regularity.

As an example, District "A" has 1,000 linear feet (LF) of pourable joints meeting the selection criteria. Pourable joints cost an average of $68.74/LF to replace and should be replaced every 6 years. The annual preventive maintenance need for pourable joints for District "A" is determined as follows:

(1000 LF * $68.74/LF)/6 year frequency = $11,457

Restorative Maintenance (RM)
RM tasks are performed to repair damaged bridge elements and thereby restore or improve their condition. RM tasks are recommended for bridges in fair or satisfactory condition (GCR 5 or 6). These tasks are performed on an as-needed basis based on field inspections.

Major Rehabilitation and Full Replacement
Replacement and rehabilitation (replacement of one or two major components such as deck and superstructure) needs are computed by determining the number of structures that require replacement or rehabilitation. This is done by comparing the number of poor structures with the performance targets for each highway system (95.5% of the entire bridge inventory not structurally deficient and 99% of the Interstate bridges, 96% of the Primary bridges and 94% of the Secondary bridges not structurally deficient).

The needs effort begins by determining the number of structures that need to be rehabilitated or replaced in order to meet these targets by the end of the fiscal year. This number is based on the projected number of SD structures at year's end less the allowable number per the above-mentioned targets, less the number of bridges that will be taken out of SD status due to VDOT's construction and maintenance efforts.

Using the list of specific bridges and the recommended actions for each bridge a square foot unit cost for each structure requiring work is applied based on the nature of the work required. The unit costs for each work action are developed from bid prices from the previous year(s) with appropriate multipliers applied. The square footage of each structure is determined by using the current deck area as listed in the inventory and adding a "growth factor" for replacement projects under the recognition that replacement structures are generally significantly larger than the original structure that is being replaced.

The decision to replace a bridge rather than undergo a major rehabilitation or repair is based on the net present value of the cost of rehabilitation or repair and projected future maintenance expenses versus the net present value of the cost to replace the bridge.

Special Structure Needs
Starting with the CY 2015 needs assessment, the needs for a small group of special structures are highlighted separately. These are structures that are important, older and generally very large. For the CY 2017 needs assessment, a list of those structures was identified to be addressed within FY 2019 based on structure condition and agency priority. Needs were then determined based on the condition states of the specific structures, the actions required and the estimated costs to perform the needed actions. VDOT is currently assessing the needs and strategies to address the maintenance and replacement requirements associated with special structures that are approaching the end of their service lives. This may lead to considerable investment in the future.

Hauling Permit Needs
These are VDOT's staffing needs to perform hauling/overweight vehicle permit analysis. In addition, VDOT performs route analyses for all structures crossed by all overweight single trip permit vehicles. This includes load rating analyses for the vehicles. Hauling permit needs were determined based on personnel costs along with an additive to cover overhead costs.

Needs to Replace All Structurally Deficient Structures and Repair Remaining Structures
The performance based needs presented above do not represent the total funding required to improve all of the structures. Rather, VDOT reports needs for the amount of money required to meet its performance goals. VDOT has implemented performance goals that address structures in good, fair and poor condition. The total funding required to improve all of the structures is considerably higher than the amount required to meet the above referenced performance goals.

B. Movable Bridges (Non Structure Portion)

A movable bridge is one that allows for passage of large boats or barges by lifting, swinging, or turning thus providing additional vertical clearance between the waterway and the bridge deck. VDOT has eight movable span bridges across the state; five in the Hampton Roads area and three in Central Virginia. A ninth bridge, the Woodrow Wilson Memorial Bridge which spans the Potomac River between Virginia and Maryland is jointly owned by the two states. Maryland is responsible for the day-to-day maintenance and operations. Movable bridge needs are divided into three separate categories: overarching program needs, fixed cost needs, and facility project needs.

Overarching Program Needs
Overarching program needs are assigned to the Central Office, which has programmatic oversight for all special facilities. Included in this category is the development of Emergency Response Plans (ERPs) for movable bridges. The overarching movable bridge needs are recommended improvements based on the latest movable bridge risk assessment.

Fixed Cost Needs
Fixed cost needs include personnel, overhead, equipment, materials, and essential services and contracts. Those needs are further subdivided into preventative maintenance, corrective maintenance, movable bridge operations and project administration. The majority of the needs in the maintenance and operations categories are based on contract values. The remainder,

including management and direction, and utilities, are based on budgeted positions and historical expenditures.

Facility Project Needs

Facility project needs are based primarily on the preliminary movable bridge risk assessment, along with some additional needs identified by the regions. Projects identified as "high-risk" in the risk assessment are given priority. High risk projects have a high probability of occurrence and/or moderate to severe impacts.

4. State of Good Repair Needs

The following charts show the unconstrained needs for pavements and bridges. The unconstrained needs are then reduced as illustrated in Figure 27 of Chapter 1, reproduced here, to define the state of good repair needs. Development of the state of good repair needs is explained using the next several charts.

Figure 27 (from Chapter I): State of Good Repair Program Needs Process

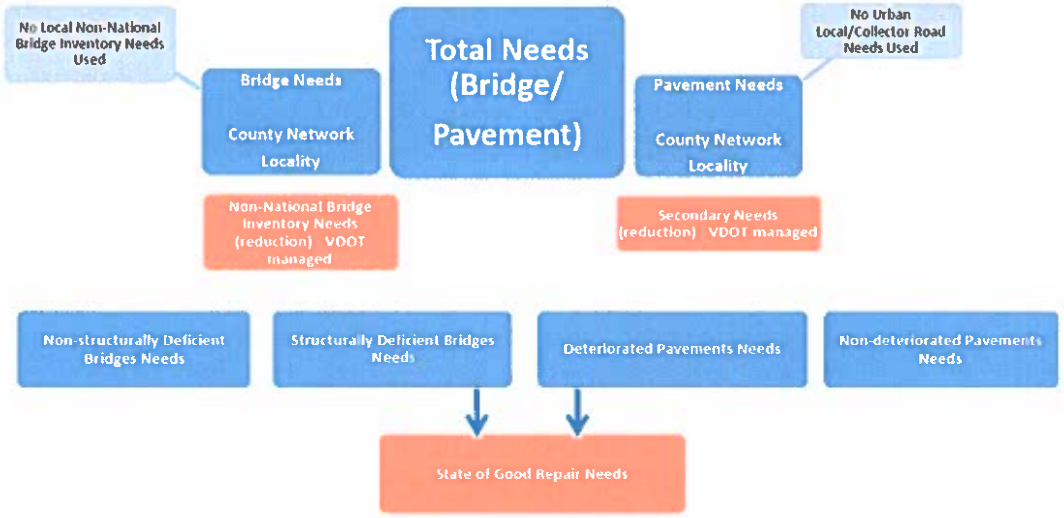


Figure 51: FY 2019 Total Unconstrained Bridge and Pavement Needs ($ millions)

FY 2019 Total Unconstrained Bridge and Pavement Needs ($ millions)										
	VDOT Maintained					Locally Maintained				VDOT & Locally Maintained
District	Interstate	Primary	Secondary	Urban	VDOT Total	Primary	Secondary	Urban	Locality Total	Grand Total
Bristol	$243.2	$562.8	$436.1	$0.0	$1,242.1	$53.1	$0.1	$101.9	$155.2	**$1,397.3**
Culpeper	$115.1	$215.3	$323.0	$0.0	$653.4	$82.3	$0.3	$16.5	$99.1	**$752.6**
Fredericksburg	$75.8	$657.6	$273.0	$0.0	$1,006.4	$25.5	$0.0	$1.3	$26.8	**$1,033.2**
Hampton Roads	$946.8	$389.9	$190.3	$34.9	$1,561.8	$916.8	$0.4	$140.8	$1,058.0	**$2,619.8**
Lynchburg	$0.0	$370.4	$330.3	$0.0	$700.7	$52.6	$0.0	$20.6	$73.2	**$773.8**
Northern Virginia	$249.3	$372.4	$781.5	$1.6	$1,404.8	$45.0	$5.9	$11.6	$62.4	**$1,467.2**
Richmond	$822.4	$767.5	$582.2	$94.3	$2,266.5	$200.5	$0.3	$43.1	$243.9	**$2,510.4**
Salem	$251.5	$444.9	$564.3	$1.2	$1,261.9	$112.7	$0.0	$26.0	$138.8	**$1,400.7**
Staunton	$336.6	$411.0	$414.3	$8.5	$1,170.3	$51.5	$2.6	$20.6	$74.7	**$1,245.0**
Grand Total	**$3,040.7**	**$4,191.8**	**$3,894.9**	**$140.5**	**$11,267.9**	**$1,540.0**	**$9.5**	**$382.6**	**$1,932.1**	**$13,200.0**

Figure 51 shows the total unconstrained needs for both bridges and pavements broken down by VDOT maintained vs locally maintained. From these needs the bridge and pavement unconstrained needs are analyzed separately.

Bridge:

The left side of Figure 27 represents how the State of Good Repair Program needs are determined for bridges. Figure 52 represents the total unconstrained needs for bridges including NBI as well as non-NBI bridges.

Figure 52: FY 2019 Total Unconstrained Bridge Needs ($ millions)

FY 2019 Total Unconstrained Bridge Needs ($ millions)										
	VDOT Maintained					Locally Maintained				
District	Interstate	Primary	Secondary	Urban	VDOT Total	Interstate	Primary	Secondary	Urban	Locality Total	Grand Total
Bristol	$177.9	$320.8	$235.0	$0.0	$733.7	$0.0	$35.7	$0.1	$101.9	$137.8	**$871**
Culpeper	$47.7	$88.9	$143.5	$0.0	$280.0	$0.0	$71.4	$0.3	$16.5	$88.2	**$368**
Fredericksburg	$56.6	$522.7	$76.5	$0.0	$655.8	$0.0	$20.6	$0.0	$1.3	$21.9	**$677**
Hampton Roads	$859.2	$302.1	$99.5	$34.9	$1,295.7	$0.0	$512.5	$0.4	$140.8	$653.7	**$1,949**
Lynchburg	$0.0	$195.2	$147.8	$0.0	$343.0	$0.0	$19.1	$0.0	$20.6	$39.7	**$382**
Northern Virginia	$175.6	$250.0	$131.1	$1.6	$558.3	$0.0	$8.7	$5.9	$11.6	$26.1	**$584**
Richmond	$584.3	$563.3	$280.1	$94.3	$1,522.1	$0.0	$136.1	$0.3	$43.1	$179.5	**$1,701**
Salem	$177.5	$241.0	$234.7	$1.2	$654.4	$0.0	$66.3	$0.0	$26.0	$92.3	**$746**
Staunton	$163.6	$232.1	$269.4	$8.5	$673.5	$0.0	$14.1	$2.6	$20.6	$37.3	**$710**
Grand Total	**$2,242.3**	**$2,716.2**	**$1,617.6**	**$140.5**	**$6,716.6**	**$0.0**	**$884.5**	**$9.5**	**$382.6**	**$1,276.6**	**$7,993**

The total needs are then broken down further for VDOT and Localities into NBI and Non-NBI. Figure 53 depicts NBI and non-NBI needs for VDOT, and Figure 54 depicts NBI and non-NBI needs for Localities

Figure 53: FY 2019 VDOT Bridge Needs ($ millions)

FY 2019 VDOT Bridge Needs ($ millions)											
	NBI Needs					Non-NBI needs					
istrict	Interstate	Primary	Secondary	Urban	NBI Total	Interstate	Primary	Secondary	Urban	Non-NBI Total	Grand Total
ristol	$173.9	$307.5	$197.1	$0.0	$678.5	$3.9	$13.4	$37.9	$0.0	$55.2	$733.7
ulpeper	$45.7	$82.7	$127.1	$0.0	$255.5	$1.9	$6.1	$16.4	$0.0	$24.5	$280.0
redericksburg	$54.7	$519.1	$69.3	$0.0	$643.1	$1.9	$3.6	$7.2	$0.0	$12.7	$655.8
ampton Roads	$857.3	$299.9	$96.3	$33.9	$1,287.4	$1.9	$2.2	$3.2	$1.0	$8.3	$1,295.7
ynchburg	$0.0	$188.0	$138.7	$0.0	$326.7		$7.3	$9.0	$0.0	$16.3	$343.0
orthern Virginia	$169.8	$228.0	$123.3	$1.1	$522.2	$5.8	$22.0	$7.8	$0.5	$36.1	$558.3
ichmond	$578.9	$558.4	$268.4	$94.3	$1,500.0	$5.4	$4.9	$11.7	$0.0	$22.1	$1,522.1
alem	$174.4	$231.1	$212.2	$1.2	$619.0	$3.0	$9.9	$22.4	$0.0	$35.4	$654.4
taunton	$157.3	$218.8	$230.3	$8.4	$614.8	$6.3	$13.3	$39.2	$0.0	$58.7	$673.5
rand Total	$2,212.0	$2,633.6	$1,462.6	$139.0	$6,447.2	$30.3	$82.6	$154.9	$1.5	$269.4	$6,716.6

Figure 54: FY 2019 Locality Bridge Needs ($ millions)

FY 2019 Locality Bridge Needs ($ millions)											
	NBI Needs					Non-NBI needs					
District	Interstate	Primary	Secondary	Urban	NBI Total	Interstate	Primary	Secondary	Urban	Non-NBI Total	Grand Total
Bristol	$0.0	$35.7	$0.1	$101.9	$137.7	$0.0	$0.0	$0.0	$0.1	$0.1	$137.8
Culpeper	$0.0	$71.4	$0.3	$15.9	$87.6	$0.0	$0.0		$0.6	$0.6	$88.2
Fredericksburg	$0.0	$20.6	$0.0	$1.3	$21.9	$0.0				$0.0	$21.9
Hampton Roads	$0.0	$512.4	$0.3	$140.8	$653.5	$0.0	$0.2	$0.0	$0.0	$0.2	$653.7
Lynchburg	$0.0	$19.1	$0.0	$20.6	$39.7	$0.0	$0.0	$0.0	$0.0	$0.0	$39.7
Northern Virginia	$0.0	$8.7	$5.9	$11.6	$26.1	$0.0		$0.0	$0.0	$0.0	$26.1
Richmond	$0.0	$136.1	$0.3	$43.1	$179.5	$0.0	$0.0	$0.0	$0.0	$0.0	$179.5
Salem	$0.0	$66.2	$0.0	$26.0	$92.2	$0.0	$0.1	$0.0	$0.1	$0.1	$92.3
Staunton	$0.0	$14.1	$1.0	$20.6	$35.7	$0.0	$0.0	$1.6	$0.0	$1.6	$37.3
Grand Total	$0.0	$884.3	$7.8	$381.8	$1,273.9	$0.0	$0.2	$1.6	$0.7	$2.6	$1,276.6

The State of Good Repair program focuses on structurally deficient bridges. Figure 55 provides a breakdown of VDOT's NBI needs into non-structurally deficient and structurally deficient, and Figure 56 provides the breakdown of non-structurally deficient and structurally deficient for Localities.

Figure 55: FY 2019 VDOT NBI Bridge Needs ($ millions)

FY 2019 VDOT NBI Bridge Needs ($ millions)											
	Non-Structurally Deficient					Structurally Deficient					
District	Interstate	Primary	Secondary	Urban	Non-SD Total	Interstate	Primary	Secondary	Urban	SD Total	Grand Total
Bristol	$75.0	$142.9	$81.6	$0.0	$299.5	$98.9	$164.5	$115.5		$379.0	$678.5
Culpeper	$45.7	$46.9	$52.1	$0.0	$144.7	$0.0	$35.9	$75.0	$0.0	$110.9	$255.5
Fredericksburg	$28.3	$90.6	$25.6	$0.0	$144.5	$26.4	$428.5	$43.7		$498.6	$643.1
Hampton Roads	$602.0	$111.7	$49.4	$33.9	$797.0	$255.2	$188.2	$47.0	$0.0	$490.4	$1,287.4
Lynchburg	$0.0	$83.4	$59.4	$0.0	$142.8	$0.0	$104.5	$79.4		$183.9	$326.7
Northern Virginia	$144.2	$102.0	$88.0	$1.1	$335.2	$25.6	$126.1	$35.3	$0.0	$186.9	$522.1
Richmond	$244.1	$160.2	$118.8	$10.2	$533.4	$334.8	$398.2	$149.5	$84.1	$966.6	$1,500.0
Salem	$73.6	$123.2	$79.9	$1.2	$278.0	$100.8	$107.9	$132.3	$0.0	$341.0	$619.0
Staunton	$116.4	$95.4	$75.0	$0.5	$287.3	$40.9	$123.4	$155.2	$7.9	$327.5	$614.8
Grand Total	**$1,329.3**	**$956.3**	**$629.8**	**$46.9**	**$2,962.3**	**$882.8**	**$1,677.2**	**$832.8**	**$92.1**	**$3,484.8**	**$6,447.1**

Figure 56: FY 2019 Locality NBI Bridge Needs ($ millions)

FY 2019 Locality NBI Bridge Needs ($ millions)										
	Non-Structurally Deficient				Structurally Deficient					
District	Primary	Secondary	Urban	Non-SD Total	Interstate	Primary	Secondary	Urban	SD Total	Grand Total
Bristol	$3.3	$0.1	$7.0	$10.4	$0.0	$32.4	$0.0	$94.9	$127.4	$137.7
Culpeper	$1.2	$0.3	$0.4	$1.9	$0.0	$70.2	$0.0	$15.5	$85.7	$87.6
Fredericksburg	$1.4	$0.0	$1.3	$2.7	$0.0	$19.2	$0.0	$0.0	$19.2	$21.9
Hampton Roads	$116.5	$0.2	$86.3	$203.0	$0.0	$395.8	$0.1	$54.6	$450.5	$653.5
Lynchburg	$19.1	$0.0	$3.0	$22.0	$0.0	$0.0	$0.0	$17.7	$17.7	$39.7
Northern Virginia	$8.7	$4.5	$10.1	$23.3	$0.0	$0.0	$1.3	$1.5	$2.8	$26.1
Richmond	$56.6	$0.3	$10.7	$67.6	$0.0	$79.5	$0.0	$32.4	$111.9	$179.5
Salem	$21.1	$0.0	$13.7	$34.8	$0.0	$45.1	$0.0	$12.3	$57.4	$92.2
Staunton	$9.1	$0.3	$10.1	$19.5	$0.0	$5.0	$0.6	$10.5	$16.1	$35.7
Grand Total	**$236.9**	**$5.8**	**$142.5**	**$385.2**	**$0.0**	**$647.4**	**$2.0**	**$239.3**	**$888.7**	**$1,273.9**

Figure 57 shows the State of Good Repair Program Bridge needs. It consists of the needs for NBI bridges which are structurally deficient for VDOT as well as Localities.

Figure 57: FY 2019 Total State of Good Repair Bridge Needs ($ millions)

FY 2019 Total State of Good Repair Bridge Needs ($ millions)											
	VDOT Maintained Structurally Deficient NBI					Locally Maintained Structurally Deficient NBI					
strict	Interstate	Primary	Secondary	Urban	VDOT Total	Interstate	Primary	Secondary	Urban	Locality Total	Grand Total
istol	$98.9	$164.5	$115.5		$379.0	$0.0	$32.4	$0.0	$94.9	$127.4	$506.4
ılpeper	$0.0	$35.9	$75.0	$0.0	$110.9	$0.0	$70.2	$0.0	$15.5	$85.7	$196.6
edericksburg	$26.4	$428.5	$43.7		$498.6	$0.0	$19.2	$0.0	$0.0	$19.2	$517.8
ampton Roads	$255.2	$188.2	$47.0	$0.0	$490.4	$0.0	$395.8	$0.1	$54.6	$450.5	$940.9
nchburg	$0.0	$104.5	$79.4		$183.9	$0.0	$0.0	$0.0	$17.7	$17.7	$201.5
orthern Virginia	$25.6	$126.1	$35.3	$0.0	$186.9	$0.0	$0.0	$1.3	$1.5	$2.8	$189.7
chmond	$334.8	$398.2	$149.5	$84.1	$966.6	$0.0	$79.5	$0.0	$32.4	$111.9	$1,078.5
lem	$100.8	$107.9	$132.3	$0.0	$341.0	$0.0	$45.1	$0.0	$12.3	$57.4	$398.4
aunton	$40.9	$123.4	$155.2	$7.9	$327.5	$0.0	$5.0	$0.6	$10.5	$16.1	$343.7
rand Total	$882.8	$1,677.2	$832.8	$92.1	$3,484.8	$0.0	$647.4	$2.0	$239.3	$888.7	$4,373.6

Pavements

The right side of Figure 27 represents how the State of Good Repair Program needs are determined for pavements. Figure 58 represents the total unconstrained needs for pavements.

Figure 58: FY 2019 Total Unconstrained Pavement Needs ($ millions)

FY 2019 Total Unconstrained Pavement Needs ($ millions)							
	VDOT Maintained				Locally Maintained		VDOT & Locally Maintained
District	Interstate	Primary	Secondary	VDOT Total	Primary Extensions	Locality Total	Grand Total
Bristol	$65.4	$242.0	$201.1	$508.4	$17.4	$17.4	$525.8
Culpeper	$67.4	$126.4	$179.5	$373.4	$10.9	$10.9	$384.3
Fredericksburg	$19.1	$134.9	$196.5	$350.5	$4.9	$4.9	$355.4
Hampton Roads	$87.6	$87.8	$90.7	$266.1	$404.3	$404.3	$670.4
Lynchburg	$0.0	$175.1	$182.5	$357.6	$33.5	$33.5	$391.1
Northern Virginia	$73.7	$122.3	$650.4	$846.5	$36.3	$36.3	$882.8
Richmond	$238.1	$204.2	$302.1	$744.4	$64.4	$64.4	$808.8
Salem	$74.0	$203.9	$329.6	$607.5	$46.4	$46.4	$654.0
Staunton	$173.0	$178.9	$144.9	$496.8	$37.4	$37.4	$534.2
Grand Total	**$798.4**	**$1,475.6**	**$2,277.3**	**$4,551.3**	**$655.5**	**$655.5**	**$5,206.8**

Figure 59 represents VDOT's pavement needs broken down as deteriorated or non-deteriorated.

Figure 59: FY 2019 Total VDOT Pavement Needs ($ millions)

FY 2019 Total VDOT Pavement Needs ($ millions)									
	Deteriorated Pavements				Non-Deteriorated Pavements				
District	Interstate	Primary	Secondary	Deteriorated Total	Interstate	Primary	Secondary	Non-Deteriorated Total	Grand Total
Bristol	$12.4	$97.7	$155.3	$265.3	$53.0	$144.3	$45.8	$243.0	$508.4
Culpeper	$12.8	$57.4	$136.0	$206.2	$54.6	$69.0	$43.5	$167.2	$373.4
Fredericksburg	$0.0	$64.9	$143.7	$208.6	$19.1	$70.0	$52.7	$141.9	$350.5
Hampton Roads	$10.9	$26.4	$62.2	$99.6	$76.6	$61.4	$28.5	$166.5	$266.1
Lynchburg	$0.0	$65.9	$118.7	$184.6	$0.0	$109.3	$63.8	$173.0	$357.6
Northern Virginia	$20.4	$48.5	$547.5	$616.3	$53.3	$73.9	$103.0	$230.1	$846.5
Richmond	$131.6	$103.5	$241.8	$476.9	$106.5	$100.7	$60.3	$267.6	$744.4
Salem	$27.4	$113.1	$235.7	$376.3	$46.6	$90.8	$93.9	$231.3	$607.5
Staunton	$80.4	$61.3	$106.0	$247.7	$92.6	$117.6	$38.9	$249.1	$496.8
Grand Total	**$296.0**	**$638.6**	**$1,746.9**	**$2,681.6**	**$502.4**	**$836.9**	**$530.4**	**$1,869.7**	**$4,551.3**

Figure 60 represents Localities pavement needs broken down as deteriorated or non-deteriorated.

Figure 60: FY 2019 Total Locality Pavement Needs ($ millions)

FY 2019 Total Locality Pavement Needs ($ millions)					
	Deteriorated Pavements		Non-Deteriorated Pavements		
District	Primary Extensions	Deteriorated Total	Primary Extensions	Non-Deteriorated Total	Grand Total
Bristol	$13.7	$13.7	$3.7	$3.7	$17.4
Culpeper	$7.9	$7.9	$3.0	$3.0	$10.9
Fredericksburg	$3.7	$3.7	$1.2	$1.2	$4.9
Hampton Roads	$343.6	$343.6	$60.7	$60.7	$404.3
Lynchburg	$26.2	$26.2	$7.3	$7.3	$33.5
Northern Virginia	$30.1	$30.1	$6.2	$6.2	$36.3
Richmond	$51.9	$51.9	$12.5	$12.5	$64.4
Salem	$34.7	$34.7	$11.7	$11.7	$46.4
Staunton	$29.0	$29.0	$8.4	$8.4	$37.4
Grand Total	**$540.9**	**$540.9**	**$114.6**	**$114.6**	**$655.5**

Figure 61 represents the State of Good Repair Program pavement needs consisting of deteriorated interstate and primary systems for VDOT and deteriorated Primary Extension for Localities. The Localities do not report the secondary system, and therefore, VDOT does not

include secondary system needs when determining the State of Good Repair Program pavement needs.

Figure 61: FY 2019 Total State of Good Repair Pavement Needs ($ millions)

FY 2019 Total State of Good Repair Pavement Needs ($ millions)						
	VDOT Maintained Deteriorated Pavements			Locally Maintained Deteriorated Pavements		VDOT & Locally Maintained
District	Interstate	Primary	VDOT Total	Primary Extensions	Locality Total	Grand Total
Bristol	$12.4	$97.7	$110.1	$13.7	$13.7	$123.8
Culpeper	$12.8	$57.4	$70.2	$7.9	$7.9	$78.1
Fredericksburg	$0.0	$64.9	$64.9	$3.7	$3.7	$68.6
Hampton Roads	$10.9	$26.4	$37.3	$343.6	$343.6	$380.9
Lynchburg	$0.0	$65.9	$65.9	$26.2	$26.2	$92.1
Northern Virginia	$20.4	$48.5	$68.9	$30.1	$30.1	$99.0
Richmond	$131.6	$103.5	$235.0	$51.9	$51.9	$286.9
Salem	$27.4	$113.1	$140.6	$34.7	$34.7	$175.3
Staunton	$80.4	$61.3	$141.7	$29.0	$29.0	$170.8
Grand Total	**$296.0**	**$638.6**	**$934.6**	**$540.9**	**$540.9**	**$1,475.5**

5. Methodology to Determine Needs for Other Assets or Services

Besides pavements and bridges, there are a wide range of essential transportation assets and services that must be maintained and improved for which condition data are not collected and performance targets are not established in the manner targets are set for pavements and bridges. These include, but are not limited to, 7 tunnels, 43 safety rest areas (includes 12 Welcome Centers) and 6 ferries in addition to assets such as sign assemblies, signalized intersections, guardrail and thousands of other highway assets in the VDOT maintained network. The costs to maintain and operate other essential assets and services are determined based on engineering principles and business practice or historical expenditures. A breakdown of methods used to determine needs for the various non pavement or bridge assets and service areas are provided below. Needs related to non-pavement or non-bridge assets were calculated by inflating the CY 2015 needs by the Consumer Price Index (CPI).

A. Tunnels

VDOT maintains and operates seven tunnel facilities. Figure 62 summarizes the names and locations of the tunnels. A 2012 Tunnels Baseline Assessment, Risk Analysis and Investment Plan provides a high level review of operating conditions for all river and mountain tunnels. As part of the project, available inspection reports were reviewed and maintenance projects were recommended.

Figure 62: Virginia Tunnels

Tunnels	Route	Linkage	Year Constructed
Eastern Region			
Hampton Roads Bridge Tunnel (HRBT)	I-64	Hampton/Newport News to Norfolk/ Virginia Beach	
West Bound Lane (WBL)			1957
East Bound Lane (EBL)			1976
Monitor Merrimac Memorial Bridge Tunnel (MMMBT)	I-664	Hampton/Newport News to Suffolk /Chesapeake	1992
I-564 Runway Tunnel	I-564	Under runway at Norfolk Naval Station	1977
Elizabeth River Downtown Tunnel (DT)[1]	I-264	Norfolk and Portsmouth	
West Bound Lane (WBL)			1952
East Bound Lane (EBL)			1987
Elizabeth River Midtown Tunnels (MTT)[1]	Rt 58	Norfolk and Portsmouth	
East Bound Lane (EBL)			1962
West Bound Lane (WBL)			2016
Northern Region			
Rosslyn Tunnel	I-66	Arlington	1983
Southwestern Region			
Big Walker Mountain Tunnel (BWMT)	I-77	Bland to Wytheville	1972
East River Mountain Tunnel (ERMT)[2]	I-77	Rocky Gap, Virginia to Bluefield, West Virginia	1974
Extended Overpass Tunnel	US-460	Montgomery, under ramps near I-81 interchange	2002

[1] On July 13, 2012, VDOT transferred maintenance and operation of Elizabeth River Downtown Tunnel and Elizabeth River Midtown Tunnel to the Elizabeth River Consortium in a Public-Private Transportation Act project. VDOT maintains ownership of these facilities.
[2]East River Mountain Tunnel is jointly owned by Virginia and West Virginia. The facility is operated by VDOT.

Tunnel needs are divided into three separate categories: overarching program needs, fixed cost needs and facility project needs.

Overarching Program Needs
Overarching program needs are reported under the Central Office, which has programmatic oversight for all special facilities. Included in this category is a ventilation analysis covering multiple facilities, development of training and inspection programs and installation of a Computerized Maintenance Management System (CMMS).

Fixed Cost Needs
Fixed cost needs include personnel, overhead, equipment, materials, and essential services and contracts.

Facility Project Needs
Facility project needs were based primarily on the tunnel investment plan included as part of the Tunnels Baseline Assessment, Risk Analysis, and Investment Plan along with some additional needs provided by the VDOT Operations Regions. Projects identified as "high-risk" in the Tunnels Baseline Assessment, Risk Analysis, and Investment Plan were given priority. High risk projects have a high probability of occurrence and/or severe to moderate impacts. The majority are associated with fire safety.

B. Emergency and Incident Response

Emergency and incident management needs include needs related to the operation of the traffic operations centers (TOCs), maintenance and operation of technology assets such as traffic cameras, electronic message signs, and other traffic management systems, as well as incident response and snow and ice operations.

Transportation Operations Centers (TOCs)
TOCs were created in order to enhance traffic flow and safety on Virginia's roadways. VDOT is responsible for centers in five geographic locations that monitor traffic conditions via cameras and other technology. TOCs are located in Northern Virginia (NOVA), Richmond, Hampton Roads (HR), Salem and Staunton. The five operations regions are responsible for the maintenance of these centers. The primary functions of the TOCs include:

- Regional traffic management and congestion management
- Incident management and emergency operations
- Intelligent Transportation System (ITS) device monitoring
- Traveler information

Also included in TOC operations are management of the Advanced Traffic Management System (ATMS) and the Safety Service Patrol (SSP) program.

An ATMS is a computerized transportation communication system that gathers data from the various ITS devices deployed in the field. The system enables the TOCs to detect traffic incidents and congestion rapidly, dispatch resources to the incident scene and smooth the flow of traffic. The ATMS is also able to disseminate real-time information to motorists using devices such as dynamic message signs and highway advisory radio.

The SSP assists stranded motorists and provides traffic control during various incidents, including traffic accidents and road work. Services provided by the SSP include:

- Jump starts, tire changes, and water for overheating radiators
- One gallon of gas for motorists who have run out of fuel
- Access to a telephone to contact a wrecker service, directions and a state map
- Removal of roadway debris
- Limited first aid services

TOC needs consist of both TOC contract needs and internal VDOT needs. The needs are determined at the regional level.

TOC Contract Needs

VDOT manages TOC operations through contract services. TOC contract needs are determined at the regional and statewide program levels. TOC contract needs include seven components: TOC floor operations, statewide ATMS, SSP, program management and governance, ITS field maintenance, general support services and innovative solutions. The first five components are considered core services, or the services that must be performed and the remaining two are other services, which may be added to the contract through task orders.

VDOT Internal TOC Needs

Although a contractor is responsible for daily TOC operations, VDOT retains the responsibility for facility maintenance and overhead, program development and expansion and oversight of the statewide TOC programs. Internal needs are based on known salaries of personnel assigned to TOC programs, existing contracts, and historical expenditures.

The overarching program needs associated with TOC operations are reported at the statewide level. These include TOC program oversight, maintenance of the existing ATMS, and expansion of the SSP.

At the regional level, needs for facility maintenance, utilities, telecommunications, software maintenance, towing contracts, supplies and equipment are reported under the operating regions to include costs related to personnel, equipment, TOC control room operations, overhead, program administration and ITS architecture.

Technology Assets

Technology assets include ITS assets, such as cameras, traffic sensors, dynamic message signs, high occupancy vehicle gates, lane control systems, dynamic ramp metering, active traffic management systems, and communications infrastructure such as agency-owned copper, coaxial, ethernet, and fiber optic cables and associated conduit systems. Technology assets are used extensively by VDOT's five TOCs to monitor traffic conditions and manage traffic flow and incidents. Regular preventative maintenance and quick responses to disabled components are essential for the effective, uninterrupted operation of traffic signals, and freeway surveillance and management systems.

At the time of this report, interim contracts are in place that cover ordinary and preventative maintenance on ITS assets as well as emergency maintenance. These activities fall under the ITS Field Maintenance service category of the TOC contract, which includes preventative, repair, and emergency maintenance activities on all ITS assets on the VDOT maintained network. The contracts do not include replacement of components that have reached the end of their useful lives. Lifecycle replacement of ITS assets remains an internal VDOT function. Needs for technology assets include two components: the ITS field maintenance component of the TOC contract and lifecycle replacement of ITS assets.

ITS Field Maintenance
ITS field maintenance needs are determined based on the TOC contract pricing. The pricing is estimated based on the cost to maintain the current ITS asset inventory in each region for one year.

Lifecycle Replacement
In addition to ITS field maintenance needs, lifecycle replacement needs are assessed for technology assets such as changeable message signs (CMS), portable changeable message signs (PCMS) and traffic cameras.

The lifecycle replacement analysis assumes the components, rather than the complete asset assemblies, will be replaced at the end of their expected lives. Therefore, the component level replacement costs and lifecycle replacement assumptions are extracted from on-going contracts, field practices and industry standards. Management of Traffic (MOT) costs have been factored into replacement unit costs.

The lifecycle replacement needs are estimated using the following equation:

$$RPNeedsj = \sum_{i} RPCosti * RPRi * INVij * Inflationj$$

Where:

- RPNeedsj = replacement needs in year j
- RPCosti = replacement cost of component i
- RPRi = replacement rate of component i (or 1/Expected Service Life of Component i)
- INVij = inventory of component i in year j
- Inflationj = inflation factor to adjust needs to fiscal year j dollars

Incident Management
Incident management needs include costs of state or contract labor and support services for unexpected or unplanned events that impede traffic flow. VDOT responds primarily to four categories of incidents: weather-related, major or minor crashes, hazardous material spills and terrorist attacks. Incident management does not include dead animal removal, planned traffic control events, tree or storm debris removal, or motorist assistance safety patrols.

VDOT's maintenance crew and highway operations staff are responsible for incident clearance and management jointly. The operations staff focuses primarily on initial response, internal and external agency coordination, and public communication. Operations staff performs these activities in conjunction with the regional TOCs. Maintenance personnel focus primarily on emergency repairs to protect life and prevent additional damage, re-establishing reasonable temporary access and performing permanent restoration to repair or replace damaged assets so that they may function as well as they did prior to the incident.

The maintenance and operations aspects of incident management are based on different methods for calculating their respective incident clearance and management needs. On the maintenance side, incident clearance and management needs are reported for districts only and are determined based on a three year average of historical expenditures. On the operations side, incident clearance and management needs were estimated based on costs to cover personnel, overhead and equipment expenses.

Snow and Ice

The total needs for snow and ice are established by executive management based on the recent historical expenditures for snow and ice removal. This total minus a $30 million reserve is then distributed to the districts based on a model developed by the Virginia Transportation Research Council that takes into account the average annual snow fall, lane miles, traffic density, topography and unit costs for snow removal. In addition, the cost of enhancing Automated Vehicle Locating capabilities of the fleet to support snow and ice activities is also included.

Operations Programs

Needs for the following operations programs are reported in addition to the above categories:

- Disaster support operations
- Program Development
- Call Center Operations
- Field Operations Support
- Engineering Program
- 511 program for Virginia Traffic and Travel Information System

Disaster Support Operations

Disaster support operations are VDOT operations to aid in disaster clean up and recovery. These activities include: the Emergency Operations Center; traffic control to mitigate hazards such as downed trees or power lines, or to close roads; storm damage assessment and inspections in conjunction with the Federal Emergency Management Agency and the Federal Highway Administration; clean up and disposal of debris such as branches, trees, mud, silt or building wreckage; operations support such as answering phones and logging data; and assistance provided to the Department of Emergency Management.

The needs for disaster support operations are highly variable. Currently, VDOT has no assessment tool which allows for prediction of these types of events. Therefore, needs are based largely on historical expenditures. Central Office needs were tied directly to the previous fiscal year's expenditures. District needs were calculated by distributing the past year's statewide expenditure (less the Central Office expenditures) equally across the nine operational units. The equal distribution approach ensures that all districts have needs assessed even if no expenditures were recorded in that district in the prior year.

Program Development

Program development includes researching and analyzing available technologies for use in conceptual ITS projects which may be implemented in the future. The program includes activities such as:

- Management of the ITS Architecture Program and an ITS Project Estimating System

- Creating long term operations/ITS strategies for project development in the statewide operations investment plan
- Overseeing operations asset management for needs based budgeting
- Expanding new operations technology development (i.e., active traffic management systems and integrated corridor management efforts)
- Supporting the planning and project management activities of the Statewide Tunnels Oversight Committee
- Development and analysis of transportation system performance measures to support the Fixing America's Surface Transportation Act (the current federal transportation program) requirements and to improve the performance of the transportation system.

The needs are captured based on the latest reported budget for essential services and contracts related to ITS program development objectives and initiatives. These include projects, studies and initiatives related to enhancement of the statewide ITS system and compliance with FHWA and other federal requirements.

The needs are also based on a list of services and initiatives such as:

- Recurring annual costs for certain services
- Estimates from previous similar efforts
- Specific financial commitments

Call Center Operations

VDOT operates two Customer Service Centers (CSCs). The Primary facility is located in the Salem district with a backup facility located in Northern Virginia. The CSCs were first opened in April of 2010 and were designed to combine traffic, maintenance and public information calls in one overarching information system. These facilities provide the public with access to a customer service representative to answer questions, direct maintenance requests, and initiate a call-back when necessary. CSCs are staffed and operated 24 hours per day, each day of the year. The needs are captured based on the latest budget and reflect the following costs:

- Personnel
- Overhead (office supplies, utilities, satellite and phone service, etc.)
- Contracts

Field Operations Support

Field operations support includes activities which enhance the efficiency, productivity or safety of operations on or in VDOT roadways or facilities. These activities include maintenance of critical information software and equipment, weather monitoring, securing critical infrastructure, incident simulation exercises and incident response. Superload Program Planning for oversize or overweight loads traversing Commonwealth roadways is also included in this needs category. The needs are based on the latest budget and account for a combination of:

- Historical expenditures
- Existing contracts
- Information provided by industry vendors
- IT requirements and resources required from the Virginia State Police

Engineering Program
The engineering program includes all project costs involved in the deployment of ITS assets, supporting communication, software and systems. It also includes developing specifications and request for proposals as well as procurement services for deployment. When regional projects are developed, the preliminary work conducted prior to the establishment of a UPC by non-VDOT resources (e.g. consultants or contractors) is covered under this program. The needs are based on the latest budget and account for essential services and contracts related to ITS program objectives and initiatives.

511 Virginia Traffic and Travel Information System
511 Virginia provides free real-time information about road conditions, construction delays and other incidents to the traveling public via phone, web, mobile, e-mail or SMS text. In 2013 VDOT contracted Iteris, Inc. for the design, development, operation and maintenance of a new enhanced phone and web-based system. The enhanced 511 Virginia traffic and travel information system initiative includes all project costs involved in the maintenance, operation and deployment of 511 software and systems.

The needs are based on the latest budget and account for essential services related to the 511 Virginia program objectives and initiatives. Needs also include the following upgrades and enhancements in addition to regular operations and maintenance:

- Improved voice recognition software to enable better communications using the latest technology
- Easy-to-use menu with more functionality to enable quicker access to desired traffic information
- New features that use "push" notification technology to deliver personalized, real-time traffic information on roads of interest
- Mobile solutions to include apps for iPhone, Droid and Blackberry
- Enhanced, more robust 511 Virginia website

C. Traffic and Safety

Traffic needs include the cost of striping roads, maintaining and operating traffic signals and lighting, and maintenance of assets such as traffic signs and guardrail.

Guardrail and End Treatment
Guardrails are barriers installed on the right-of-way to reduce the potential for, and severity of, accidents involving vehicles running off the road. Guardrails are designed to gently contain, hold and redirect a vehicle back onto the roadway if it should leave the travel lane. Guardrails may also be used to separate two-way traffic.

End treatments, or guardrail terminals, are safety devices designed to fit at the end of a run of guardrail. The purpose of the end treatment is two-fold: (1) to maintain the tension necessary for the run of guardrail to function properly, and (2) to minimize damage to a vehicle and its occupants if the end of the run of guardrail is hit. The type of end treatment used corresponds with and works in conjunction with the guardrail type used. Needs are determined based on estimated inventory, replacement frequency and unit costs.

Two types of guardrail and end treatment needs are reported: 1) paving-related needs, and 2) the remaining maintenance and operations needs, which are labeled as lifecycle needs. Inventories, unit costs and activity frequencies for each of the two needs categories were identified and estimated separately.

Pavement markings, markers, and messages

VDOT uses three separate asset types to classify and track traffic control markings, markers and messages on pavement. For all three asset types, the needs are established based on (1) estimated inventory, (2) frequency of replacement based on a combination of asset lifecycle and needs for replacements triggered by paving related activities and (3) unit costs based on an analysis of recent construction costs.

Pavement Markings

Pavement markings are longitudinal lines which delineate vehicular paths of travel along the roadway by marking the center line of the road, lanes of travel, edges of pavement, etc. Center lines delineate the lanes of an undivided roadway and separate traffic flowing in opposite directions. Lane lines separate lanes that flow in the same direction. Pavement markings also include no-passing zone markings and channelizing markings.

Pavement Markers

Pavement markers are metal castings that are glued (epoxied) onto the pavement and hold lenses that may protrude slightly above the pavement surface providing increased visibility. The casting is set at an angle, so that snowplow blades will not cause damage. Pavement markers provide improved retro-reflectivity (amount of light reflected back from the surface) during wet, night time conditions.

Pavement Messages

Pavement messages are transverse lines such as stop bars, cross walks and yield lines, and any words or symbols that convey important regulatory, warning or guidance information. Pavement messages can be pre-formed or marked on site.

Lighting

Highway lighting is a raised light source with one or more fixtures on a single pole along the side of the road or in parking areas. Highway lights provide illumination for travel ways, parking lots, and pedestrian walkways. The primary purpose of highway lighting is to promote safety at night by enhancing visibility, improve traffic flow by helping drivers delineate roadway and surroundings and to illuminate long underpasses and tunnels.

A highway lighting asset consists of the lighting fixture, photocell or photoelectric control, structural system-mounting brackets, pole, mast arm, transformer base and foundation. There is also electrical equipment including the electric service cabinet, junction box, conduit and wiring. A luminaire is a complete lighting unit (or fixture), including the light source, reflector(s), lens, and housing.

The highway lighting needs assessment accounted for the following activities and/or needs categories:

- Re-lamping and electronic repairs
- Lifecycle replacements
- Lighting operations (power bills)
- Structure repairs
- Underground utility infrastructure replacement along I-395/495 and I-66 in the Northern Region

Ordinary maintenance and repair activities for lighting include replacing lamp bulbs, fuses, ballast, and electrical repairs. Replacement is far more involved and costly, typically consisting of complete light, pole and wiring system change out.

Lighting maintenance is delivered through a combination of service contracts and in-house VDOT staff. Some regions have contracts for "as needed" maintenance, to include labor, materials, equipment, traffic control and supervision and 24/7emergency response capabilities. Regions also have lighting repair crews staffed with VDOT employees for nighttime inspection and repair activities. On the interstate roadways, interstate maintenance contractors are responsible for repair activities, including bulb replacement and minor electrical repairs.

Lighting needs are modeled using a lifecycle approach for re-lamping, repair, and replacement. Repairs to components other than the structure (i.e. ballast, wiring, fixture, etc.) are made on an as needed basis, generally when a failure is detected. Repair and replacement needs for non-structure lighting components are based on an assumed frequency of repair work, estimated actual work history data or field staff knowledge.

In addition to lifecycle replacement needs, the following lighting needs are also included:

Operations Needs
Highway lighting electric service needs are determined based on historical expenditures.

Structure Repair Needs
Structure repair needs were based on inspection data provided in accordance with VDOT's ancillary structures program requirements.

Signal
VDOT defines traffic signals as signalized intersections and flashers. Traffic signals are not just the signal heads mounted on mast arms or span wires. Each "signal" in the signal inventory represents a signalized intersection with all the components that make that intersection work properly. According to the Manual on Uniform Traffic Control Devices for Streets and Highway, section 1A.13, item 86 (MUTCD, 2009), a traffic signal is a power-operated traffic control device by which traffic is warned or directed to take some specific action. These devices do not include signals at toll plazas, power-operated signs, illuminated pavement markers, warning lights, or steady-burning electric lamps.

Traffic signals help manage intersecting streams of automobile and truck, pedestrian, and cyclist traffic by assigning the right-of-way to individual streams in turn. They are placed where volumes of traffic or crash histories justify their need, where crossings near schools require

signal control, or as part of a coordinated signal plan to ensure a smooth, progressive flow of vehicles. A signalized intersection consists of both structural and non-structural components. The signal structure consists of a pole, foundation, and either span wires or a mast arm (the latter being the current standard). Most intersections will have four signal structures.

The needs for signals are derived from a statewide modeled approach that takes into consideration the following aspects of the signalized intersections:

- Preventative Maintenance
- Repair
- Lifecycle replacement
- Operations
- Payments to Others (Arlington)
- Paving related replacement of signal detector loops

Preventative Maintenance

Preventative maintenance activities include a set of checks and procedures performed at regularly scheduled intervals for the upkeep of signal equipment. They include inspection, record keeping, cleaning and replacement depending on the function and rated service life of the components. The needs for preventative maintenance are based on the estimated inventory, anticipated frequency of the activities and annualized unit cost estimated based on existing contracts.

Repair

Repair or corrective maintenance includes work required to restore a damaged or deteriorated asset to design, functionality and capability. The needs for repair maintenance are based on the estimated inventory, anticipated frequency of repair maintenance and the annualized unit cost.

Lifecycle Replacement

Lifecycle replacement refers to the replacement or complete restoration of assets that cannot be repaired. If the asset no longer functions, is obsolete, or does not conform to current federal or state mandates for design performance, then it must be replaced or overhauled. For the purposes of the needs assessment, replacement is assumed to occur at the end of the estimated service life or when a component is rendered inoperable by pavement activities. Replacement can be broken out into three categories:

- structural replacement
- non-structural replacement
- paving-related replacement

The replacement needs for signals are based on the anticipated inventory, frequency of replacement and cost of the replacement.

Operations

Operational needs include electrical and communications services necessary for the signal system to function properly, reviewing and updating timing plans, monitoring signal

operations (through signal control software), and dispatching crews to address operating concerns, etc. Examples of operating costs include:

- Metered electric costs
- Phone bills
- Network communications costs
- Software licensing agreements
- Signal Optimization

The operations needs for signals are largely based on the historical costs of utilities and the other operational aspects of the signal which are annualized into a unit cost and then applied to the inventory of signals.

Payments to Arlington County

VDOT makes payments to Arlington County for maintenance and operation of the VDOT owned signalized intersections within the county. The needs for payments to Arlington are based on the anticipated payments per signalized intersection and the number of signalized intersections for which payments are received. Both the operational and replacement component of this need are calculated.

Signs

Traffic signs are devices mounted on a support above the level of the roadway with images or messages intended to communicate specific information to road users. Standard traffic signs are regulated in size, color, shape and message by the federal government and conform to the Federal Highway Administration's MUTCD.

VDOT signs are typically made of 0.100 gauge aluminum, covered with reflective sheeting, and contain either a silk-screened or pressed-on reflective message or image. VDOT uses over 900,000 standard and custom signs on the roadway ranging from deer crossing to speed limit signs. A single sign asset includes the support and any panels hanging on the support. The asset consists of the entire sign assembly. Sign supports can be made of metal, wood, or concrete. In addition, there are overhead signs, which are bridge parapet mounted or mounted over butterfly, cantilever, high mast or overhead span structures.

Maintenance activities for signs include the replacement of ground mounted signs, overhead signs, and parapet mounted signs, as well as repairs to sign panels and structures, resetting sign posts, and sign condition assessment.

Sign needs are assessed using a repair and lifecycle replacement modeling approach which determines needs as the product of estimated inventory, frequency of maintenance activity and the unit cost of maintenance activities.

Traffic Service

Traffic Engineering needs also include needs for services provided such as:

- Traffic System Planning and Engineering
- Traffic Counts Program
- Traffic Engineering Studies

- Integrated Directional Signing Program
- Payments to Railroads

Traffic System Planning and Engineering
This program covers signal system planning, analysis, and engineering activities, including but not limited to signal system planning and engineering related to the development of new signal installations or the replacement of existing signals and signal preliminary engineering. These needs are largely historically based and reflect:

- Projected staffing levels
- Contracted projects
- Operations engineering supplies, equipment and signal operating system contract (e.g. Management Information System for Traffic contract)

Traffic Counts Program
VDOT conducts a traffic monitoring program where traffic count data are gathered from sensors in or along streets and highways and other sources. The mission is to systematically collect traffic data to meet VDOT's data needs and external reporting requirements. Some of the major data uses are:

- To support required reporting to the Federal Highway Administration
- Calculation of Annual Average Daily Traffic estimates on major public roadways
- Calculation of Vehicles per Day estimates on the state maintained local road network
- Calculation of Vehicle Miles of Travel (VMT) and generation of VMT reports for state public roadways
- Support travel demand modeling and long range transportation planning
- Support engineering and development for a wide range of project types

The needs are largely based on historical expenditures. The needs reflect the following:

- The program's staffing level
- Use of consultants to deliver program objectives
- Contractual and data procurement prices

Traffic Engineering Studies
The traffic engineering studies program covers the oversight of traffic control device specifications and standards, highway operations studies and highway network performance evaluations activities related to traffic engineering. The needs are largely based on historical expenditures and reflect the following projected staffing levels:

- Consultant fees for traffic studies (traffic signal studies, speed & safety studies, corridor safety & capacity assessment/implementation, intersection improvements, etc.)
- Office overhead (mobile phones, office supplies, office incidentals, janitorial contract, custodial purchases, staff professional memberships, reference materials, safety shoes & apparel, etc.)

Integrated Directional Signing Program
The Integrated Directional Signing Program (IDSP) was developed to provide Virginia motorist service businesses, attractions, tourist destinations and other specific points of interest with a single contact if they desire to have their location identified on a road sign along the state controlled and maintained roadway system. Signs under this program provide motorists with directional guidance and information about travel service businesses or particular points of interest. Four types of signs or Signing Programs are included in the IDSP. They are as follows:

- Specific Travel Service Signs
- Tourist-Oriented Directional Signs
- Supplemental Guide Signs
- General Motorist Service Signs

The needs are derived largely from historical expenditures and include an administrative and field component.

Payments to Railroads
VDOT tracks its payments to railroads and the needs associated with these are historically based.

D. Routine Maintenance

Routine maintenance category includes drainage, vegetation management, sound barrier management and incidental management needs.

Drainage
Drainage assets are integral components of a safe and structurally sound roadway infrastructure. Inadequate or improperly maintained drainage assets are responsible for most pavement failure and soil erosion. Failure of the drainage system can flood roadways and result in failure of pavement and other critical assets. Hence, one of the most important duties of maintenance personnel is the repair and maintenance of the highway drainage system. The highway drainage system includes pipes, ditches (paved and unpaved), edge and under drains, gutters, inlet and outlet structures, catch basins, drop inlets, manholes, storm sewers and storm water basins. However, only the needs for cross pipes, ditches, curb and gutter, drop inlets, and storm water basins are broken out separately. For cross pipe, ditches, drop inlets, and curb and gutter, needs are based on an analytical approach considering estimated inventory, frequency of work activities and unit cost of those activities. For Storm water basins, needs are based on historical expenditures. The needs for the other components of the drainage system are captured in the incidental maintenance needs.

Vegetation Management
The Primary function of managed vegetation (roadsides) is the prevention and control of erosion in direct support of the traveled roadway. Roadsides delineate pavement edges, ramps, and merging and opposing lanes, act as a background for signs or signals, screen out conflicting or unsightly views, function as a crash barrier, reduce headlight annoyance, perform as snow fence and will dampen noise levels in urban areas. Roadside vegetation management ensures that the above functions are realized. The vegetation management program works to ensure that ditch

lines are not clogged with vegetation, heavy cuttings do not clog grates, inlets and pipe lines, and the roadside vegetation is not a fire hazard. The control of vegetation is also essential in providing adequate sight distance on the roadway and unobstructed views of signs and other roadside appurtenances. The needs for vegetation management are subdivided into the needs to manage:

- turf
- brush and trees
- wildflower program

Turf

Turf needs are based on a modeled approach that takes into consideration estimated inventory, frequency of work activities and unit cost of those activities.

Brush and Tree

Brush and tree needs are primarily based on a modeled approach that takes into consideration estimated inventory, frequency of work activities and unit cost of those activities. The need for the management of trees also includes a component for the removal of trees, which is based on historical expenditures.

Wildflower Program

The wildflower program is directly funded from the proceeds of license plate fees from the Virginia Department of Motor Vehicles. As such the needs are based on the anticipated revenue from these fees.

The needs to manage other components of vegetation management such as the use of inmate labor, management of roadside flowers and ornamental plants are included in the Incidental Maintenance needs.

Sound Barriers

A sound barrier, also known as a noise barrier or sound wall, is a structure that is designed to reduce highway traffic noise experienced by homeowners, businesses and pedestrians. Sound barrier needs are approximated assuming total replacements and then estimated using costs based on contract prices in place when needs are compiled.

Incidental Maintenance Needs

This category includes assets previously assessed based on historical expenditures that are no longer tracked in VDOT's current financial reporting system. Examples include sidewalks, bike paths, retaining walls, and waysides. In previous iterations of the needs assessment, those assets that were not migrated to the Cardinal financial management system with dedicated cost centers were estimated using the historical data that was available and making an adjustment for inflation. The other roadside needs assessment cost centers were created to account for assessing needs for these components of the Maintenance and Operations Program. The other roadside needs assessment cost centers include seventeen of the assets formerly captured with dedicated cost accounting codes. All of these are now captured under several different cost centers within the Cardinal System. Analysis of the previous expenditures captured for these assets indicated that they comprised approximately 1.65% of the Maintenance and Operations Program;

therefore, they are now accounted for by allocating 1.65% of the total needs assessment for the Maintenance and Operations Program to this category.

E. Facility and Others

Facility and other needs include all needs not captured in the previous categories. This category includes management and direction, ferry management, safety rest area management, permitting, and facility security management. The following discussion summarizes needs for the main items under this category.

Management and Direction

Management and direction refers to the cost to provide program management, oversight and program administration. It includes salary and overhead expenses for staff providing the management and direction function.

Ferry Management

A ferry is a boat or ship used to transport vehicles and people across a body of water. VDOT operates three ferry services, all in the Eastern part of the state. The Jamestown-Scotland Ferry is the largest ferry service in VDOT's network. It provides 24 hour a day service with a four vessel fleet. The Merry Point and Sunny Bank Ferries each operate limited hours with one vessel each. Figure 64 lists VDOT's ferry services and their locations.

Figure 64: Virginia Ferry Service

Ferry Service	Water Crossing	Vessel	Type	Capacity	Route	County	Initial Service Year
Eastern Region*							
Jamestown-Scotland	James River	Pocahontas	Motorized Double Ended	70 cars	31	James City / Surry	1995
		Surry		50 cars			1979
		Williamsburg		50 cars			1983
		Virginia		28 cars			1936
Central Region**							
Merry Point	Corrotoman River	Cable Operated		6 Passengers	604	Lancaster	1983
Sunny Bank	Little Wicomico River	Northumberland	Cable	6 Passengers	644	Northumberland	1985

* Hampton Roads District
**Fredericksburg District

Safety Rest Area Management

Safety rest areas provide traveler services and short-term car and truck parking for drivers to rest. These facilities include buildings, pavements, shelters, tables, water/waste water treatment systems, utility infrastructure, HVAC systems, parking lots, ramps, curb and gutter, lighting, fencing and landscaping. At safety rest areas, services include ensuring that all property and amenities are open and available 24 hours a day, each day of the year and that the rest areas are safe, clean, fully functional, adequately supplied and compliant with all federal and state regulations governing limited access highways and buildings in the Commonwealth. The needs for safety rest area management come from the Safety Rest Area and Welcome Center Program

Management Plan prepared by VDOT. The needs are separated based on the following categories:

- Operations, including payments to the Virginia Tourism Commission, Program Overhead, Property Management and Maintenance, Site Inspections, and Site Utilities
- Pavement Rehabilitation and Reconstruction
- Pedestrian Safety and Security, including Americans with Disabilities Act Compliance, Lighting, and Security Video Management System
- Preservation of Assets, including Drainage/Stormwater System, Electrical, HVAC, Pavement Preventative Maintenance, Shoulder Maintenance, Wastewater Works, and Waterworks
- Program Administration, including Architectural, Engineering and Environmental Services and Program Support Services, Comment Card Program, and Construction Inspections

Permitting
Needs for land use permits are determined based on past-year expenditures.

Facility Security Management
The facility security management program intends to protect VDOT's critical infrastructure (CI). This needs category covers costs for security at designated CI locations as well as maintenance of security equipment and maintaining agency compliance with state and federal CI regulations. The needs were primarily based on actual statewide security systems maintenance program needs as well as critical infrastructure mandated projects and initiatives, critical infrastructure security projects and estimated personnel needs.

Appendix B
Traffic Forecasting Methodology

Traffic forecasting is a multifaceted process, and the methods used vary significantly depending on factors such as the size of the project, the environment, and density of the study area. Transportation projects are often large, complex and costly, and local, regional, state and federal entities must be able to find project solutions that meet current transportation needs while also providing capacity and efficiency to allow for future growth in the demand on our transportation system. Planners and engineers apply forecasting techniques to projects of all sizes, ranging from spot-improvements to the corridor level to regional and statewide transportation projects. Regional differences also play a key role in the forecasting process. Traffic patterns differ from dense urban centers to sparsely populated rural areas. VDOT works closely with local and regional partners (such as metropolitan planning organizations and planning district commissions) to identify the population, employment, land use(s), development patterns and other factors that impact traffic distribution and growth.

Depending on the project, the traffic analyses can entail any number of a wide variety of modeling and analysis types, including: travel demand modeling, operational analysis and simulation models. VDOT uses:

- CUBE travel demand modeling software to maintain a statewide travel demand model, a super-regional model, and 10 MPO travel demand models
- Highway Capacity Software to conduct capacity analysis on almost all capacity expansion projects
- Synchro software to conduct operational analysis for intersections and arterials
- CORSIM and VISSIM software to conduct microsimulation analysis for operational improvements
- SIDRA for roundabout analysis
- BPR and CAP-X spreadsheet models to analyze person throughput and hours of delay with the SMART SCALE statewide prioritization process pursuant to Code of Virginia 33.2-214.1

For most multi-alternative NEPA analyses, VDOT uses regional travel demand models to assist in the development of traffic forecasts. A travel demand model is a tool used to support the transportation planning process. It is useful in developing traffic forecasts, testing alternative transportation scenarios, and evaluating transportation systems. A model is developed using demographic, survey, and transportation network data. Demographic and survey data are used to develop the mathematical equations necessary for modeling trip generation and distribution. Highway and transit data are used to develop the transportation network such as number of lanes, speed limit, road capacity, transit schedules and fares, etc.

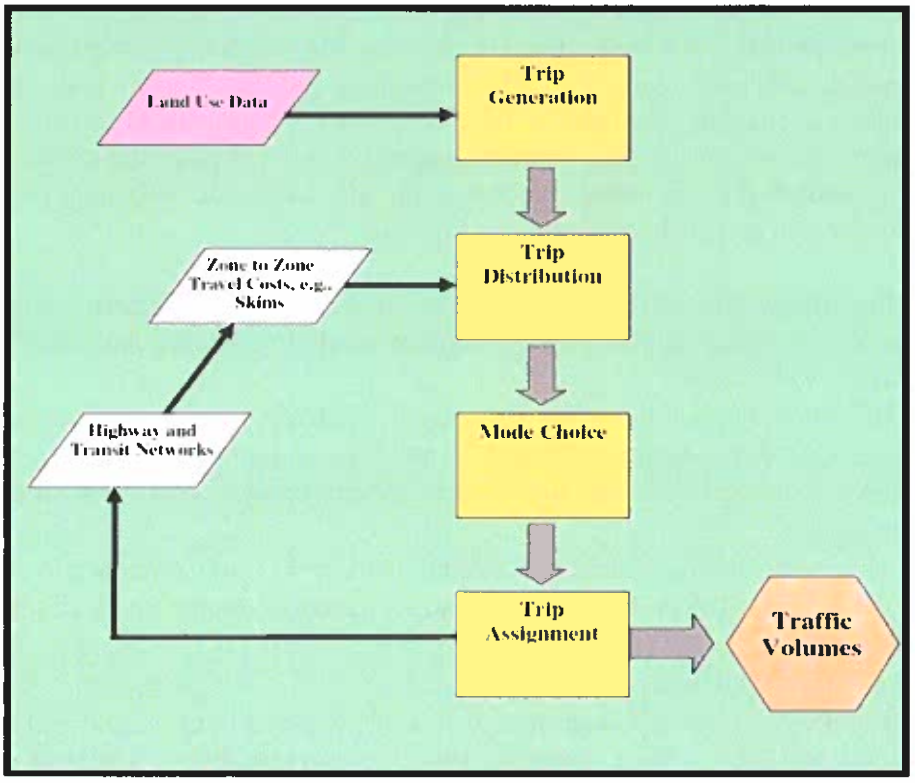
The most common method used worldwide and in the United States is the traditional four-step travel demand model approach. This approach uses sequential steps:

1. Trip Generation = How many trips will be made?
2. Trip Distribution = Where will the trips go?

3. Mode Choice = What mode of transportation will the trips use?
4. Trip Assignment = What route will the trips take?

Demographic and other necessary model data are aggregated to Transportation Analysis Zones (TAZs) to be input into the model. TAZs generally follow census geography and are typically a combination of census blocks and/or census block groups.

The Four-Step Travel Demand Forecasting Process



Traffic models are calibrated and updated using the latest available estimates and assumptions for population, land use, travel, employment, congestion, and economic activity provided by local and regional partners. On a regional and sub-regional level, the travel demand model is calibrated against existing traffic counts. However, at a local level, the travel demand model can have errors on a link-by-link basis. Therefore, further adjustments or post processing of the model's daily outputs is required prior to its use in an analysis. Traffic forecasts typically need to be post-processed or refined using accepted national standard procedures such as those outlined in the Transportation Research Board's NCHRP Report 765 on Analytical Travel Forecasting Approaches for Project-Level Planning and Design. Information on Virginia's urban travel demand forecasting process is documented at http://www.virginiadot.org/projects/resources/vtm/VTM_Policy_Manual_Version_1.pdf.

VDOT project related NEPA information and technical documentation on completed modeling and traffic analysis (environmental impact statements, operational analyses, and interchange modification or justification studies) is available either from the internet via VDOT's public web

site (http://www.virginiadot.org/projects/default.asp) or can be requested in hardcopy by contacting VDOT's District Public Affairs Officer.