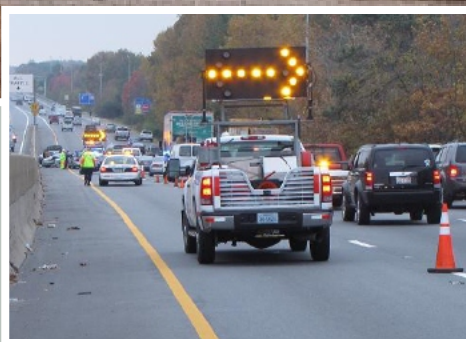
Hampton Roads Regional Safety Study

2013/2014 Update

Part II: Crash Countermeasures

T14-08



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HAMPTON ROADS REGIONAL SAFETY STUDY

2013/2014 UPDATE

PART II: CRASH COUNTERMEASURES

PREPARED BY:

the heartbeat of HAMPTON ROADS TPO
TRANSPORTATION PLANNING ORGANIZATION

JULY 2014

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TITLE:
Hampton Roads Regional Safety Study – 2013/2014 Update
Part II: Crash Countermeasures

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ABSTRACT

In 2001 the Hampton Roads Planning District Commission initiated the Hampton Roads Regional Safety Study, a comprehensive analysis of highway safety throughout the region. This study examined General Crash Data and Trends, Interstate and Intersection Crash Findings, and Crash Analysis and Countermeasures.

This report is the first full update to the original Regional Safety Study. Part I of this report introduced previous HRTPO safety planning efforts, reported the recent trends in roadway safety in Hampton Roads, provided detailed characteristics of crashes in the region, and specified the number and rate of crashes for each mile of freeway and approximately 600 of the busiest intersections throughout the region.

This report (Part II) builds on the results and trends of Part I by examining ways to improve roadway safety – broadly and for specific high crash locations. The following sections are included in Part II:

- Efforts to Improve Roadway Safety – national, statewide, and local
- Potential for Safety Improvement – Freeways and Intersections
- General Crash Countermeasures
    - Selection process, Crash Modification Factors (CMF) and Crash Reduction Factors (CRF), and examples
- High Crash Location Analysis – Freeways and Intersections
    - Collision diagrams, summaries of crash characteristics, site observations and possible causes, benefit-cost analysis, and prioritized recommendations.
- Next Steps

ACKNOWLEDGMENTS

This document was prepared by the Hampton Roads Transportation Planning Organization (HRTPO) in cooperation with the U.S. Department of Transportation (USDOT), Federal Highway Administration (FHWA), Federal Transit Administration (FTA), Virginia Department of Transportation (VDOT), Virginia Department of Rail and Public Transportation (DRPT), and the local jurisdictions and transit agencies within the Hampton Roads metropolitan planning area. The contents of this report reflect the views of the HRTPO. The HRTPO staff is responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the FHWA, FTA, VDOT or DRPT. This report does not constitute a standard, specification, or regulation. FHWA, FTA, VDOT or DRPT acceptance of this report as evidence of fulfillment of the objectives of this program does not constitute endorsement/approval of the need for any recommended improvements nor does it constitute approval of their location and design or a commitment to fund any such improvements. Additional project level environmental impact assessments and/or studies of alternatives may be necessary.

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INTRODUCTION

Each year, there are tens of thousands of crashes on the Hampton Roads roadway network, resulting in tens of thousands of injuries, millions of dollars of damage, and the loss of life. These crashes have a wide range of impacts, not only on the transportation system but on families, friends, and society as a whole.

Because of these impacts, roadway safety has been a priority in the state and metropolitan transportation planning processes. The Hampton Roads Transportation Planning Organization (HRTPO) initiated its regional roadway safety planning efforts with the *Hampton Roads Regional Safety Study* in 2001. This comprehensive three-part report examined general crash data and trends on a regional and jurisdictional level[1], the locations of crashes on Interstates and at arterial intersections throughout the region[2], and crash countermeasures for high crash locations[3].

The *Hampton Roads Regional Safety Study – 2013/2014 Update* provides the first full update to the original Hampton Roads Regional Safety Study. Most of the topics included in this update are similar to those included in the original Regional Safety Study, while incorporating new information and methodologies.

The *Hampton Roads Regional Safety Study – 2013/2014 Update* is produced in two parts. Part I of this report[4] introduced previous HRTPO safety planning efforts, reported the recent trends in roadway safety in Hampton Roads, provided detailed characteristics of crashes in the region, and specified the number and rate of crashes for each mile of freeway and approximately 600 of the busiest intersections throughout the region.

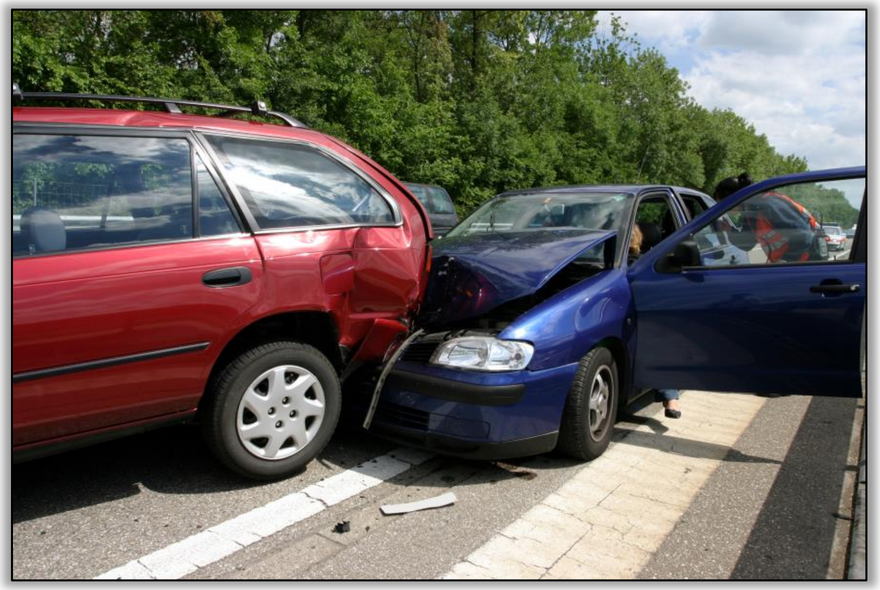


Photo Source: Shutterfly.

This report (Part II) builds on the results and trends of Part I by examining ways to improve roadway safety. The following sections are included in this report:

- **Efforts to Improve Roadway Safety** – There are a number of national, statewide, and local efforts to improve roadway safety. This section describes the four primary categories (or 4 E's) for improving roadway safety (engineering, enforcement and regulation, education, and emergency response) and provides examples of ongoing initiatives including the Highway Safety Improvement Program (HSIP), Road Safety Audits (RSAs), the Virginia Strategic Highway Safety Plan (SHSP), safety laws, and safety programs and educational efforts.

  In addition, new tools have been created to improve roadway safety analysis methods. The American Association of State Highway Transportation Officials (AASHTO) recently released the first edition of the Highway Safety Manual, which includes

[1] Hampton Roads Planning District Commission, *Hampton Roads Regional Safety Study Part I: General Crash Data and Trends*, December 2002.

[2] Hampton Roads Planning District Commission, *Hampton Roads Regional Safety Study Part II: Interstate and Intersection Crash Findings*, May 2003.

[3] Hampton Roads Planning District Commission, *Hampton Roads Regional Safety Study Part III: Crash Analysis and Countermeasures*, February 2004.

[4] Hampton Roads Transportation Planning Organization, *Hampton Roads Regional Safety Study 2013 Update Part I: General Crash Data and Trends*, October 2013.

analytical tools to quantify and predict the number of crashes at various facilities.

- **Potential for Safety Improvement** – This section uses methods described in both the Highway Safety Manual and research conducted by the Virginia Center for Transportation Innovation and Research (VCTIR) to determine the predicted number of crashes at each of the locations included in the Part I report. This predicted number is compared to the expected number of crashes based on crash history to determine those locations with the greatest potential for safety improvement.

- **General Crash Countermeasures** – A wide range of countermeasures exist to address both general and specific roadway safety problems. A description of these various crash countermeasures is included, as are other general strategies to improve roadway safety. Crash reduction and modification factors are also described and included.

- **Location Analysis** – Based on the analysis of locations with the greatest potential for safety improvement, a number of locations throughout Hampton Roads are identified for further study. This section provides a detailed safety analysis on the top 5 freeway segments and the top 10 intersections in Hampton Roads. Collision diagrams, summaries of crash characteristics at each location, site observations and possible causes, expected benefits of potential crash countermeasures, planning level cost estimates, and prioritized recommendations are included.

- **Next Steps** – This section details how the information included in both Part I and Part II of this report will be used in upcoming HRTPO transportation planning efforts.

Efforts to Improve Roadway Safety

Although roadway safety has improved greatly over the last decade in terms of reduced crashes and injuries, there are a wide range of efforts currently underway to continue improving roadway safety.

This section starts by explaining the four major categories for improving roadway safety – "the 4 Es of Safety" – engineering, enforcement and regulation, education, and emergency response. The remainder of this section provides a detailed description of several ongoing efforts to improve roadway safety on a national, statewide, and local level:

- **Highway Safety Manual** – The American Association of State Highway Transportation Officials (AASHTO) recently released the first edition of the Highway Safety Manual, which assists with determining the impact of transportation planning decisions on roadway safety, selecting safety countermeasures, comparing alternatives, and prioritizing safety projects.

- **Virginia Strategic Highway Safety Plan** – Strategic Highway Safety Plans (SHSP) are federally required documents that provide a comprehensive framework for improving statewide roadway safety.

- **Highway Safety Improvement Program** – The Highway Safety Improvement Program (HSIP) is the primary funding mechanism for roadway safety improvements.

- **Road Safety Audits** – A Road Safety Audit (RSA) is a formal and independent safety performance review of an existing or future road or intersection by an experienced team of safety specialists, addressing the safety of all road users.

- **Safety Laws** – Examples of these laws include mandatory safety belt usage, prohibiting driving under the influence of drugs or alcohol, and prohibiting texting while driving.

- **Safety Programs and Educational Efforts** – There are a number of regional, statewide, and national organizations and programs that have been created to improve various roadway safety aspects.

- **Hampton Roads Traffic Incident Management working group** – The Hampton Roads Regional Concept of Transportation Operations – Traffic Incident Management (RCTO-TIM) working group meets on a regular basis to develop and implement strategies to improve emergency response in the region.

The 4 Es of Safety

"The 4 Es of Safety" is a commonly used term by safety professionals that refers to the four primary categories for addressing roadway safety[5]:

1. **Engineering** – roadway and vehicle design improvements
2. **Enforcement and Regulation** – safety laws and their enforcement
3. **Education** – safety information to improve driving behavior
4. **Emergency Response** – includes 911 dispatchers, hospitals, and emergency responders such as police, firefighters, paramedics, and the Safety Service Patrol

In addition to the toolbox of efforts represented by the "4 Es of Safety", William Haddon introduced the concept of improving roadway safety for all phases of the crash – pre-crash, crash, and post-crash (see **Appendix A**).

1- Engineering

Roadway Improvements

Traffic engineers analyze data from police crash reports and site visits in order to recommend roadway-based engineering crash countermeasures. Some countermeasures include removing vegetation obstructions, improving lighting, improving signage, adjusting curves, adding/extending turn lanes, installing rumble strips, adding a protective left-turn phase, and

[5] National Highway Traffic Safety Administration, USDOT Volpe National Transportation Systems Center Research and Innovative Technology Administration, *Technology Applications for Traffic Safety Programs: A Primer*, September 2008.

using traffic calming techniques like roundabouts and speed bumps. Engineers use crash data to identify high-risk problem areas like short interstate ramps, busy intersections, or steep roadway grades to develop a list of potential roadway-based engineering safety improvements to reduce crash rates. These types of roadway-based engineering countermeasures are the primary focus of this report.

Safety systems are being developed to allow roadside devices to communicate with traveling vehicles. Some technologies that can improve the roadway environment include pavement sensors, lighting changes based on weather or time of day, advanced headlamps, and signaling warning systems.

Further research is underway to assist drivers in degraded roadway conditions, such as snow, ice, and fog. Some technologies include infrared reflective lane-edge markings that will enable drivers to stay in their lane during hazardous conditions and avoid roadway departures.

Vehicle Design Improvements

New technologies are being developed to alert drivers to potential unsafe conditions or to take over vehicle control when human reaction time is not sufficient. Many of these improvements are aimed at mitigating road departure crashes, intersection collisions, rear-end collisions, and merging collisions. Partnerships and initiatives, such as Integrated Vehicle-Based Safety Systems, have been created between NHTSA and the automobile industry to develop and incorporate these pre-warning technologies into vehicles to improve overall safety.

According to a news release[6] on February 3, 2014, government officials may start requiring automakers to equip light vehicles with vehicle-to-vehicle (V2V) communication technology as early as 2016. According to NHTSA, V2V communications can provide the vehicle and driver with 360-degree situational awareness to address crash situations. DOT research indicates that safety applications using this technology can address a large majority of crashes between two or more vehicles. NHTSA officials estimate that V2V communications could prevent up to 80 percent of crashes that don't involve drunken drivers or mechanical failure. Transportation officials estimate the cost would be approximately $100-$200 per vehicle. The ultimate benefits of this technology would occur once the nation's entire vehicle fleet is equipped, which could take decades.

Vehicle safety engineers have also made strides in vehicle design to reduce injury severity. Each vehicle undergoes extensive crash tests to reduce the force of potential impacts to the front, sides, and rear. Tests to decrease the likelihood of rollovers are performed regularly. Sensors are strategically placed to effectively deploy air bags at impact. Improved seat belt designs as well as structure reinforcements are being improved to improve safety.

2- Enforcement and Regulation

Law enforcement plays an important role in preventing and lessening the impact of crashes by enforcing traffic safety laws related to seat belt use, speeding, child passenger protection, impaired driving, expired licensing/registration, and distracted driving[7]. The goal is to catch violators in order to protect the general traveling public. Reductions to the number of law enforcement officers due to budget cuts put a major strain on the effectiveness of this safety measure. For this measure to be effective, both traffic regulatory laws and enforcement of those laws are essential.

Adding educational campaigns to enforcement can improve safety by changing driver habits and behavior. One example that has been successful is "Click it or Ticket". Future campaigns for issues such as texting while driving may yield good results if they are properly enforced.

Technology can also play a role for enforcement agencies. Laptops installed in police cars can provide greater detail, such as the latitude and longitude of the crash, which is important information for engineers. Data storage and analysis systems can help traffic law enforcers perform their jobs more efficiently and allow them to track repeat offenders and follow through

[6] Yahoo News, *US wants cars to be able to talk to each other*, Associated Press, Joan Lowy, February 3, 2014.

[7] 9-1-1 Magazine, *The Four E's of Crash Analytics*, Melissa Savage, SAS Institute, Inc., April 2012.

with penalties. Installing cameras at high crash signalized intersections can also help enforce specific violations, such as red-light running.

Law enforcement officers are typically the first responder to arrive at the crash scene and are responsible for capturing important data including:

- Driver information, including license status and conviction history
- Violation committed
- Date and time of crash
- Weather and pavement conditions at the time of the crash
- Fatality and injury information
- Description of vehicles involved, including commercial vehicle data (e.g. driver, load)
- Property damage
- Other crash scene details, such as the reason for the crash

This data is typically stored in a statewide crash database and made available to localities and other planning agencies. This information is used to report state specific crash information to the federal government, which allocates resources to address safety issues and prioritizes traffic safety programs. Through detailed analysis of this crash data, state DOTs, public safety agencies, localities, and planning agencies, such as the HRTPO, can assist in making proactive funding decisions and prioritized safety recommendations based on countermeasures that yield the greatest return on investment.

3 - Education

Educational campaigns and outreach solutions are often tailored to specific causes. Data obtained from crash databases help formulate public educational campaigns towards specific safety issues, such as the National Highway Traffic Safety Administration's "Drive Sober or Get Pulled Over" campaign to discourage drunk driving and the "Click It or Ticket" campaign to increase seat belt usage. NHTSA and other traffic safety organizations allocate education resources on specific issues that are expected to improve safety in terms of reduced crashes, fatalities and injuries.

Continuing to educate motorists – particularly elderly citizens and young inexperienced drivers – through driver education classes and schools are important measures to improve safety. Community educational seminars provide the opportunity to promote safety and distribute material highlighting driving and safety tips. By educating motorists about changes in traffic safety laws, they can remain in compliance and create a safe travel environment. The long-term goal of educational efforts is to teach and promote safe driving techniques and measures in an effort to improve driving habits and overall safety.

There are also a number of campaigns related to the dangers of driving under the influence of drugs or alcohol. Organizations, such as Mothers Against Drunk Driving (MADD), provide outreach to raise awareness of the dangers of drinking and driving. MADD's mission is to stop drunk driving, support the victims of this crime and prevent underage drinking.

4 - Emergency Response

A quick and coordinated emergency response to a crash scene is vital to treating injuries and saving lives of crash victims. Incident detection, verification, first response, evaluation and emergency care are all important components of an effective emergency response system. The emergency response system consists of a comprehensive system of incident detection, emergency medical treatment and transport personnel, including 911 dispatchers, Safety Service Patrol, police, firefighters, paramedics, hospitals, and trauma centers.

Technology and information can be beneficial in providing assistance during emergency situations. An effective measure to reduce incident response times is the installation of 2/10 mile marker signs along interstate highways, which can enable motorists to give precise locations of crashes to 911 dispatchers. Enhanced 911 systems are being developed that pinpoint the exact locations of emergency calls coming from cellphones. Developments are underway for Next Generation 911, which will allow call centers to receive information in a variety of electronic formats such as text, video, and data, in addition to the voice communication that is now available. This technology and additional information will allow emergency responders to receive more detailed real-time information about crash scenes prior to arrival. Finally, Transportation Operations Centers (TOCs) now have the ability to utilize video cameras and other technologies to assist with incident detection and route guidance for emergency management services (EMS).

Data collected from crash scenes can help EMS learn from previous responses and improve future responses to incidents. EMS response data includes items such as response times, probable causes, number of lanes blocked during the incident, what kinds of medical assistance were administered at the scene and whether or not the crash victims were transported to the hospital. This data can be reviewed and analyzed by responders and other stakeholders to adjust policies and procedures that improve efficiencies and save lives.

Highway Safety Manual

The Highway Safety Manual (HSM)[8] is a recently released document that provides safety planning methods and tools to consider when making decisions related to the design and operation of roadways. Developed for the American Association of State Highway and Transportation Officials (AASHTO), the widely accepted HSM provides a quantitative approach to assessing impacts on roadway safety. The HSM provides methods to predict the safety performance of roadways, select safety countermeasures, compare alternatives, and prioritize projects.

Applications of the HSM include:

- Identifying locations with the most potential for crash reduction
- Identifying factors contributing to crashes and potential countermeasures to address these issues
- Conducting economic appraisals of potential improvements and prioritizing projects
- Evaluating the crash reduction benefits of implemented treatments

[8]American Association of State Highway and Transportation Officials, *Highway Safety Manual*, 1st Edition, Volumes 1-3, 2010.

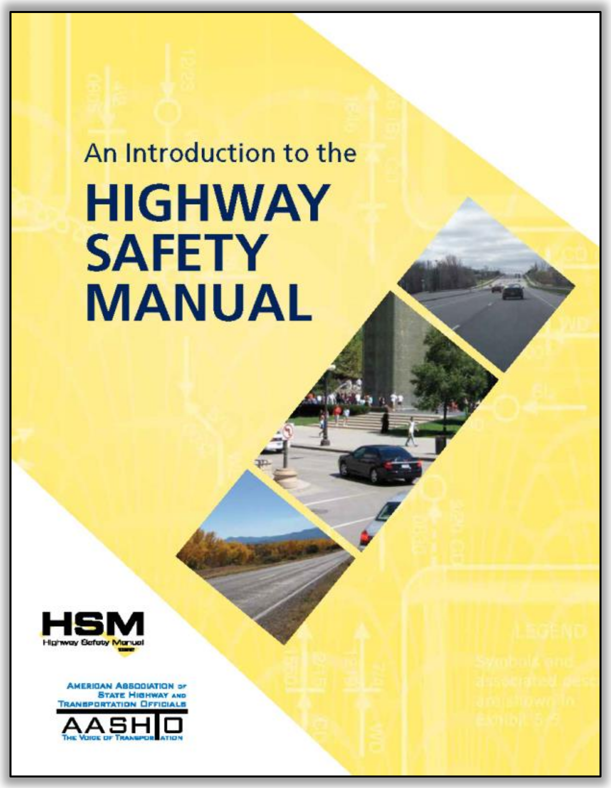


Figure 1 – Highway Safety Manual

- Estimating potential effects on crashes of planning, design, operations, and policy decisions

In addition to the Highway Safety Manual, predictive safety research has been conducted by the Virginia Center for Transportation Innovation and Research (VCTIR) for the Virginia Department of Transportation (VDOT). The purpose of this research is to provide locally derived values for safety prediction models that can used by VDOT to prioritize safety improvements on the roadways they maintain.

The Highway Safety Manual and VCTIR's research are the primary references used for the Potential for Safety Improvement analysis included in this Part II of the Regional Safety Study.

Virginia Strategic Highway Safety Plan

Strategic Highway Safety Plans (SHSP) are statewide, coordinated plans that provide a comprehensive framework for improving roadway safety. This is done by addressing the four E's of transportation safety - education, enforcement and regulation, engineering, and emergency response. Each state must have and regularly update a Strategic Highway Safety Plan based on federal requirements that were created in the SAFETEA-LU legislation in 2005 and also included in the current federal surface transportation authorization program, Moving Ahead for Progress in the 21st Century Act (MAP-21).

The first Virginia Strategic Highway Safety Plan was produced in 2006. The plan instituted a statewide transportation safety charter and committee and established statewide goals for reducing annual deaths and injuries from motor vehicle crashes.

An update to the plan – the 2012-2016 Virginia Strategic Highway Safety Plan – was released in 2012. The plan was produced by VDOT as part of an expanded collaborative effort. A wide variety of Federal, State, local, and private sector stakeholders participated on the steering committee that helped develop the updated plan, including the Department of Motor Vehicles, Department of Education, Department of Health, State Police and Association of Chiefs of Police, and HRTPO staff.

In addition, the SHSP update also involved significant outreach to gather input from stakeholders across the state through a number of regional "road shows." Nearly 130 safety stakeholders attended the five events that were conducted in different regions of the state. Meetings were also conducted for specific safety area teams.

The purpose of Virginia's updated SHSP is to significantly reduce fatalities and serious injuries on all public roads by identifying Virginia's key safety needs and guiding investment decisions. The plan adopted a vision of "Toward Zero Deaths", which is a nationwide policy that all roadway users should arrive safely at their destinations and even one death is unacceptable. The plan also established a statewide goal to reduce deaths and severe injuries by half by the year 2030, and a statewide target of reducing deaths and severe injuries by three percent each year through the horizon year of the plan in 2016.

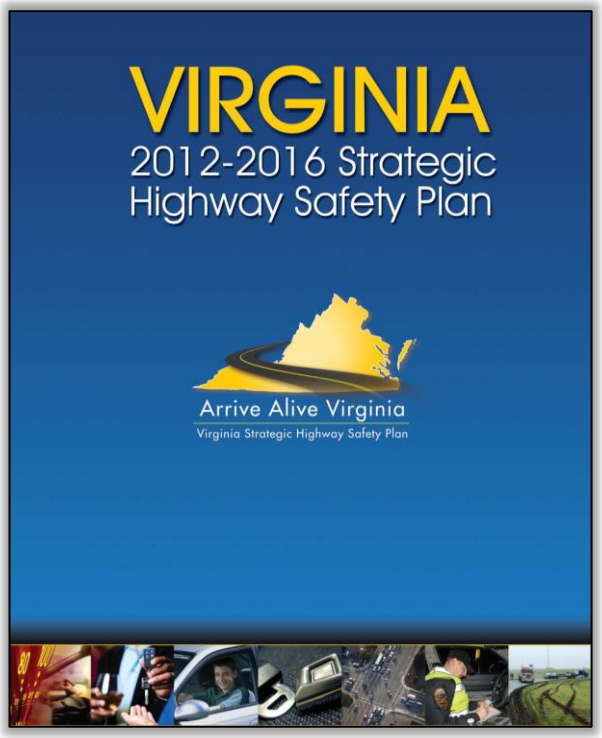


Figure 2 – Virginia Strategic Highway Safety Plan
Image Source: VDOT.

Based on an analysis of statewide crash data, the steering committee decided to focus the SHSP on six critical safety areas with the greatest promise to reduce crashes and serious injuries: 1) speeding, 2) young drivers, 3) occupant protection, 4) impaired driving, 5) roadway departure, and 6) intersections. Because of the importance of crash data to the success of safety improvement functions such as the SHSP, a seventh emphasis area was created to focus on the collection, management, and analysis of crash data.

A number of strategies were developed to address each of the seven emphasis areas. These strategies are:

1 - Speeding

- Implement engineering countermeasures to synchronize traffic flow to prevailing conditions and surroundings with particular attention to high-crash locations.
- Develop and implement a speed campaign incorporating media, enforcement, education, and evaluation where speed-related deaths and severe injuries are elevated.
- Identify and implement effective speed management measures.

2 - Young Drivers

- Review and recommend changes to enhance the effectiveness of Virginia's Graduated Driver Licensing law.
- Review and recommend changes to enhance the effectiveness of Virginia's driver education process.
- Develop and implement strategic and effective educational messages.
- Provide information to judges on young driver issues.
- Implement programs focused on behavior and attitude change on traffic safety among 18-to-20 year olds.

3 - Occupant Protection

- Educate the public on the importance of using safety belts.
- Conduct high-visibility safety belt enforcement campaigns.
- Improve child occupant protection through education, outreach, and enforcement.

4 - Impaired Driving

- Identify and promote initiatives to prevent impaired driving.
- Strenghten DUI enforcement programs.
- Conduct education and training on impaired driving.
- Develop and implement programs to reduce underage drinking and driving.
- Develop and implement programs to decrease recidivism.

5 - Roadway Departure

- Reduce the likelihood of vehicles leaving the travel lanes at high-crash and risk locations by improving the roadway, the roadside, and traffic control devices.
- Minimize the adverse consequences of leaving the roadway by improving the roadside, safety equipment, and traffic control devices.
- Educate roadway users to understand the contributing factors in roadway departure crashes, comply with traffic control devices, and provide proper right-of-way to all users.
- Develop an effective, consistent, and coordinated incident response program in accordance with the National Incident Management System at the state and local level to ensure timely response and incident clearance to reduce secondary crashes.

6 - Intersections

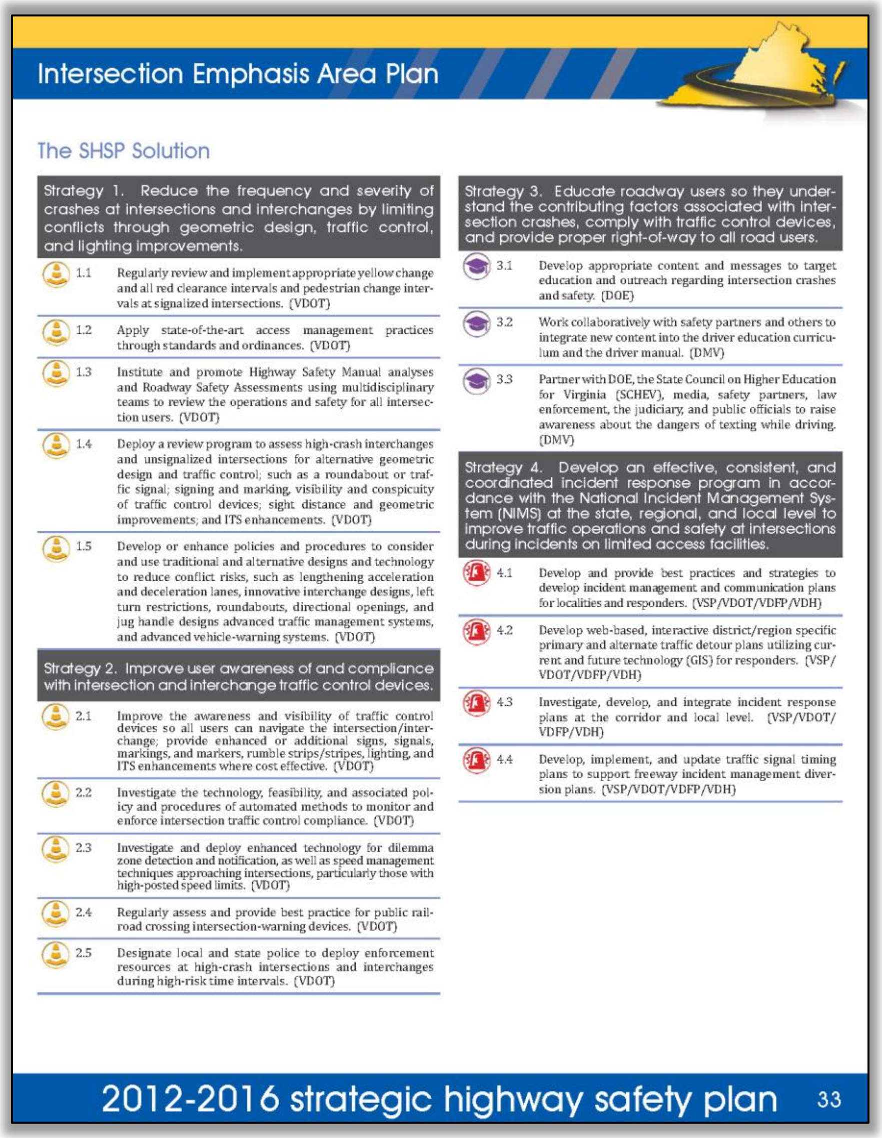
- Reduce the frequency and severity of crashes at intersections and interchanges by limiting conflicts through geometric design, traffic control, and lighting improvements.
- Improve user awareness of and compliance with intersection and interchange traffic control devices.
- Educate roadway users so they understand the contributing factors associated with intersection crashes, comply with traffic control devices, and provide proper right-of-way to all road users.
- Develop an effective, consistent, and coordinated incident response program in accordance with the National Incident Management System at the state, regional, and local level to improve traffic operations and safety at intersection during incidents on limited access facilities.

7 - Data Emphasis

- Maintain the Traffic Records Coordinating Committee with a multidisciplinary membership from DMV, DOT, MPOs, Heal and EMS, Police, the Supreme Court, and other users, such as researchers.
- Continue Traffic Records Electronic Data System (TREDS) enhancements for data integration. Continue to improve data reporting and mapping.
- Monitor and maintain Federal Motor Carrier Safety Administration (FMCSA) objectives and measures for information regarding the commercial vehicle crash reporting system (SafetyNet) and continue to obtain good state data quality ratings.
- Implement improved tools and methodologies for safety analysis and research incorporating highway inventory, traffic, crash, and related data for all public roads.

The SHSP includes a number of action steps (based the four E's) for each of these strategies, as shown in **Figure 3** to the right.

The 2012-2016 Virginia Strategic Highway Safety Plan is available on VDOT's website at **http://www.virginiadot.org/info/hwysafetyplan.asp**.


Intersection Emphasis Area Plan

The SHSP Solution

Strategy 1. Reduce the frequency and severity of crashes at intersections and interchanges by limiting conflicts through geometric design, traffic control, and lighting improvements.

1.1 Regularly review and implement appropriate yellow change and all red clearance intervals and pedestrian change intervals at signalized intersections. (VDOT)

1.2 Apply state-of-the-art access management practices through standards and ordinances. (VDOT)

1.3 Institute and promote Highway Safety Manual analyses and Roadway Safety Assessments using multidisciplinary teams to review the operations and safety for all intersection users. (VDOT)

1.4 Deploy a review program to assess high-crash interchanges and unsignalized intersections for alternative geometric design and traffic control; such as a roundabout or traffic signal; signing and marking, visibility and conspicuity of traffic control devices; sight distance and geometric improvements; and ITS enhancements. (VDOT)

1.5 Develop or enhance policies and procedures to consider and use traditional and alternative designs and technology to reduce conflict risks, such as lengthening acceleration and deceleration lanes, innovative interchange designs, left turn restrictions, roundabouts, directional openings, and jug handle designs advanced traffic management systems, and advanced vehicle-warning systems. (VDOT)

Strategy 2. Improve user awareness of and compliance with intersection and interchange traffic control devices.

2.1 Improve the awareness and visibility of traffic control devices so all users can navigate the intersection/interchange; provide enhanced or additional signs, signals, markings, and markers, rumble strips/stripes, lighting, and ITS enhancements where cost effective. (VDOT)

2.2 Investigate the technology, feasibility, and associated policy and procedures of automated methods to monitor and enforce intersection traffic control compliance. (VDOT)

2.3 Investigate and deploy enhanced technology for dilemma zone detection and notification, as well as speed management techniques approaching intersections, particularly those with high-posted speed limits. (VDOT)

2.4 Regularly assess and provide best practice for public railroad crossing intersection-warning devices. (VDOT)

2.5 Designate local and state police to deploy enforcement resources at high-crash intersections and interchanges during high-risk time intervals. (VDOT)

Strategy 3. Educate roadway users so they understand the contributing factors associated with intersection crashes, comply with traffic control devices, and provide proper right-of-way to all road users.

3.1 Develop appropriate content and messages to target education and outreach regarding intersection crashes and safety. (DOE)

3.2 Work collaboratively with safety partners and others to integrate new content into the driver education curriculum and the driver manual. (DMV)

3.3 Partner with DOE, the State Council on Higher Education for Virginia (SCHEV), media, safety partners, law enforcement, the judiciary, and public officials to raise awareness about the dangers of texting while driving. (DMV)

Strategy 4. Develop an effective, consistent, and coordinated incident response program in accordance with the National Incident Management System (NIMS) at the state, regional, and local level to improve traffic operations and safety at intersections during incidents on limited access facilities.

4.1 Develop and provide best practices and strategies to develop incident management and communication plans for localities and responders. (VSP/VDOT/VDFP/VDH)

4.2 Develop web-based, interactive district/region specific primary and alternate traffic detour plans utilizing current and future technology (GIS) for responders. (VSP/VDOT/VDFP/VDH)

4.3 Investigate, develop, and integrate incident response plans at the corridor and local level. (VSP/VDOT/VDFP/VDH)

4.4 Develop, implement, and update traffic signal timing plans to support freeway incident management diversion plans. (VSP/VDOT/VDFP/VDH)

2012-2016 strategic highway safety plan 33

FIGURE 3 – VIRGINIA STRATEGIC HIGHWAY SAFETY PLAN EXAMPLE STRATEGIES

Image Source: VDOT.

HIGHWAY SAFETY IMPROVEMENT PROGRAM

The primary mechanism for funding roadway safety improvements is the Highway Safety Improvement Program (HSIP). Federal legislation established the Highway Safety Improvement Program in order to achieve a significant reduction in traffic fatalities and serious injuries on public roads. The HSIP requires a data-driven, strategic approach to improving highway safety that focuses on performance.

The first major federal effort to improve roadway safety was The Highway Safety Act of 1966, which provided financial assistance to states to accelerate highway traffic safety programs. Starting in 1992, roadway safety funding was provided as a 10% setaside in funds from the Surface Transportation Program.

In 2005, the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) changed the Hazard Elimination Program to the Highway Safety Improvement Program and established it as a core Federal-aid program. SAFETEA-LU authorized an average of $1.55 billion annually to HSIP between Federal Fiscal Years 2006 and 2009 (including equity bonus allocations), and this average increased to $1.74 billion during SAFETEA-LU extensions in Federal Fiscal Years 2010 through 2012.

Funding for HSIP has been greatly increased under the current federal surface transportation authorization program, Moving Ahead for Progress in the 21st Century Act (MAP-21). As shown in **Figure 5**, over $2.4 billion is allocated annually to the Highway Safety Improvement Program under MAP-21 (inclusive of railway-highway crossing program safety funds).

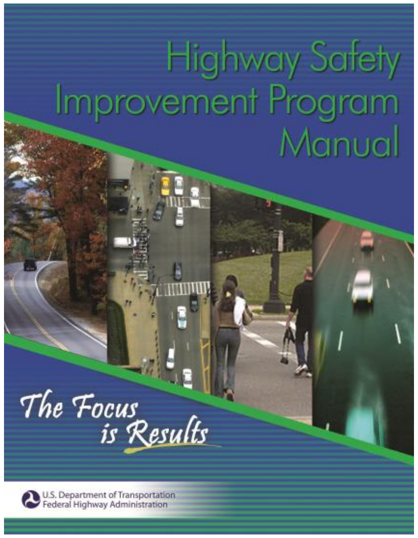


FIGURE 4 – HIGHWAY SAFETY IMPROVEMENT PROGRAM MANUAL
Image Source: FHWA.

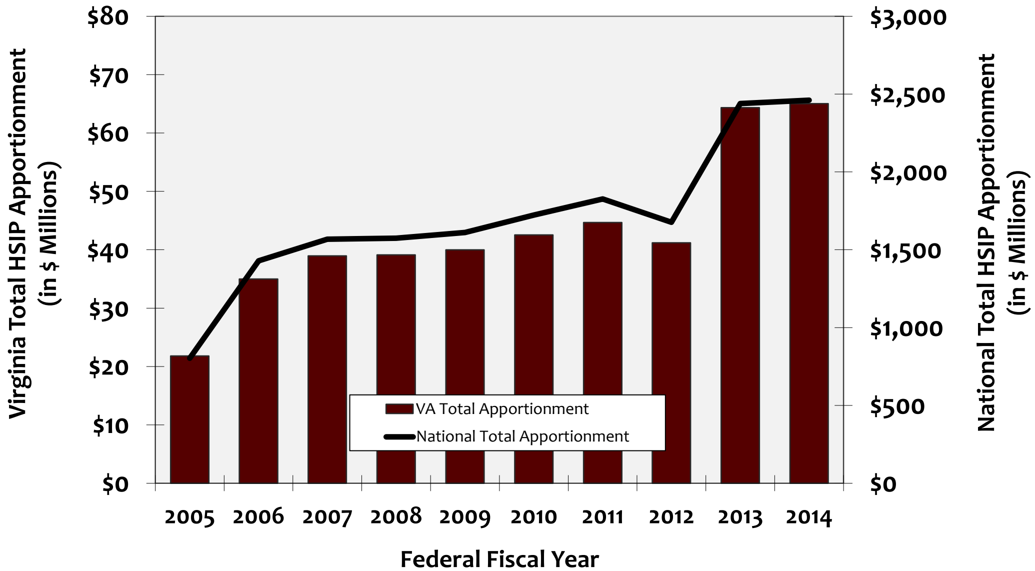


FIGURE 5 – HIGHWAY SAFETY IMPROVEMENT PROGRAM ALLOCATIONS

Source: FHWA.
2005 represents a continuation of TEA-21 funding, 2006-2012 represents SAFETEA-LU funding, and 2013-2014 represents MAP-21 funding. Data includes Railway-Highway Crossing and Equity Bonus allocations, and includes all setasides.

Virginia's HSIP funding has also increased under MAP-21. Virginia received an average apportionment of $38.3 million in Federal Fiscal Years 2006-2009 under SAFETEA-LU, and $42.8 million in Federal Fiscal Years 2010-2012 under SAFETEA-LU extensions. Under MAP-21, Virginia was allocated $64.3 million in HSIP funds in Federal Fiscal Year 2013 and $65.0 million for Fiscal Year 2014.

To be eligible for HSIP funding, a project must be a strategy, activity, or project on a public road that corrects or improves a hazardous road location or feature, or addresses a highway safety problem. Projects must also be consistent with the statewide Strategic Highway Safety Plan to be eligible for HSIP funding.

There are a wide range of project types that are eligible for HSIP funding. These include, but are not limited to:

- Intersection safety improvements
- Pavement and shoulder widening
- Installation of rumble strips or other warning devices
- Improve user awareness of and compliance with intersection and interchange traffic control devices.
- Pedestrian and bicyclist safety improvements
- Safety improvements for people with disabilities
- Rail-roadway grade crossing safety improvements
- Traffic calming features
- Roadside hazard elimination
- Installation, replacement, and improvement of highway signage and pavement markings
- Emergency vehicle priority control
- Installation of traffic control or other warning devices at high crash locations
- Transportation safety planning
- Work zone safety
- Installation of guardrails, barriers, and crash attenuators
- Improvements for high risk rural roads
- Roadway geometric improvements
- Road safety audits
- Truck parking facilities
- Any systemic safety improvements

Federal funds can generally be used to pay for up to 90% of eligible HSIP projects. For those HSIP projects that can be funded at up to 90% of the total cost, VDOT generally pays the remaining 10%. Federal law, however, permits certain types of HSIP projects to be paid for with 100% federal funds. Examples include traffic control signalization, roundabouts, guardrail installation, emergency and transit vehicle priority control pavement markings, and rumble strips.

A number of roadway safety projects using HSIP funding have been completed throughout Hampton Roads in recent years. **Table 1** on pages 12-13 shows the 65 roadway projects that have been completed in Hampton Roads using HSIP funds since 2009. There have also been a number of HSIP projects throughout the region that are not tied to specific locations, such as replacing sign panels, adding shoulders or improving shoulders with rumble strips, and proactive roadway safety funds allocated to jurisdictions.

In addition, many HSIP projects throughout Hampton Roads are either currently underway or are programmed in future years. **Table 2** on page 14 includes these 46 roadway projects that use HSIP funds.

More information on the Highway Safety Improvement Program is available at **http://safety.fhwa.dot.gov/hsip**. In January 2010, FHWA released the *Highway Safety Improvement Manual*[9] – a comprehensive reference intended for state and local transportation safety practitioners working on Highway Safety Improvement Programs and safety projects. VDOT's HSIP page (**http://www.virginiadot.org/business/ted_app_pro.asp**) also provides information on the program, including information on how VDOT selects projects for HSIP funding and an application form for proposed HSIP projects.

Funding sources other than HSIP are also used to improve safety. For example, a turn lane will be constructed in 2015 at the intersection of Route 258 and Four Square Road in Isle of Wight County using Regional Surface Transportation Program (RSTP) funding. Many projects that use Congestion Management and Air Quality (CMAQ) funds – while improving air quality – also have positive impacts on vehicular and pedestrian safety. Signal retimings, turn bay additions, and multi-use paths are examples.

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[9] US Department of Transportation, Federal Highway Administration (FHWA), *Highwasy Safety Improvement (HSIP) Manual*, Report No. FHWA-SA-09-029, January 2010.

UPC	Jurisdiction	Project	Construction End
98454	Chesapeake	I-664 from MMMBT to Rte 13/58/460 - Install/upgrade median cable guardrail	2013
93600	Chesapeake	Military Highway at Old Greenbrier Road - Upgrade to mast arm signals	2013
86607	Chesapeake	Oak Grove Road at Greentree Road - Realign intersection	2013
58428	Chesapeake	George Washington Highway north of Springdale Road - Railroad Crossing Improvements	2012
81446	Chesapeake	Greenbrier Parkway at Fairview Drive - Install traffic signal	2011
86502	Chesapeake	Military Highway at Galberry Road - Install left turn lane	2011
81445	Chesapeake	Mount Pleasant Road near Fall Ridge Lane - Improve Alignment	2011
81444	Chesapeake	Jolliff Road at Airline Boulevard - Signal upgrade	2010
86503	Chesapeake	Margaret Booker Drive from Galberry Road to GW Highway - Construct Sidewalk	2010
77153	Chesapeake	Johnstown Road at Waters Road - Install traffic signal	2009
89901	Hampton	Todds Lane at Whealton Road - Upgrade to mast arm signals	2014
86494	Hampton	Big Bethel Road at Thomas Nelson Drive/West Park Lane - Install left turn lanes	2013
86500	Hampton	Executive Drive at Marcella Road - Install median	2013
93611	Hampton	Armistead Avenue at LaSalle Avenue - Signal Timing Improvements	2011
86497	Hampton	Armistead Avenue at Tidemill Lane - Increase left turn length	2011
93613	Hampton	Todds Lane at Cunningham Drive - Signal Timing Improvements	2011
89905	Hampton	Armistead Avenue at Settlers Landing Road - Signal Timing Improvements	2010
89910	Hampton	Big Bethel Road from Burton Street to North Park Lane - Signal Timing Improvements	2010
93612	Hampton	Fox Hill Road at Clemwood Parkway - Signal Timing Improvements	2010
89908	Hampton	Mercury Boulevard at Woodland Road - Signal Timing Improvements	2010
89907	Hampton	Pembroke Avenue at LaSalle Avenue - Signal Timing Improvements	2010
86478	Hampton	Armistead Avenue at LaSalle Avenue - Intersection Improvements Study	2009
92964	HR Districtwide	Upgrade sign panels to Clearview font on I-264	2011
92963	HR Districtwide	Upgrade sign panels to Clearview font on I-464	2011
14952	Newport News	Warwick Boulevard near Fort Eustis Boulevard - Install railroad cantilever flashing lights	2013
17522	Newport News	Chestnut Avenue at Briarfield Road - Signal Upgrade and Realign Intersection	2011
56604	Newport News	Warwick Blvd near Yorktown Road - Install railroad crossing lights and gates	2011
52559	Newport News	Chestnut Avenue near 39th Street - Improve railroad crossing	2010
56788	Newport News	Denbigh Boulevard at Old Denbigh Boulevard - Close Median Crossover and Remove Signal	2010
19010	Newport News	Canon Boulevard at Middle Ground Boulevard - Install left turn lane and upgrade signal	2009
71453	Newport News	J Clyde Morris Boulevard at Impala Drive - Channelize left turn lane	2009
86499	Norfolk	Military Highway at Azalea Garden Road - Signal Timing Improvements	2013

TABLE 1 – ROADWAY SAFETY PROJECTS USING HSIP FUNDS COMPLETED SINCE 2009

Source: HRTPO analysis of VDOT data.

UPC	Jurisdiction	Project	Construction End
86491	Norfolk	Norview Avenue at Military Highway - Signal Upgrade	2013
100544	Norfolk	Upgrade Citywide Traffic Signals to LED	2013
81443	Norfolk	Military Highway at Virginia Beach Boulevard - Add ped signal heads and replace signal lamps	2012
86496	Norfolk	Monticello Avenue at 26th Street - Upgrade signal and markings	2012
97060	Norfolk	Citywide roadway safety projects	2011
61453	Norfolk	Brambleton Avenue at St Pauls Boulevard - Increase turn radius	2010
58482	Norfolk	Chesapeake Boulevard at Norview Avenue - Improve signing and pavement markings	2010
86492	Norfolk	Colley Avenue at 26th Street - Signal Upgrade	2010
71726	Norfolk	Sewells Point Road at Widgeon Road - Install pedestrian signals, buttons, and sidewalks	2010
64216	Norfolk	Tidewater Drive at Webster Avenue - Install left turn lane	2010
71736	Norfolk	Liberty Street - Raised refuge island	2009
93665	Portsmouth	High Street at Court Street - Signal Upgrade	2013
96038	Portsmouth	Effingham Street at High Street - Signal Upgrade	2012
96035	Portsmouth	Elm Avenue at County Street - Signal Upgrade	2011
96036	Portsmouth	High Street at Tyre Neck Road - Signal Upgrade	2011
96037	Portsmouth	Victory Boulevard at Elmhurst Lane - Signal Upgrade	2011
95986	Portsmouth	Airline Boulevard at Greenwood Road/Hodges Ferry Road - Signal Upgrade	2010
18830	Suffolk	Liberty Street near Washington Street - Interconnect signals with preemption	2011
93641	Virginia Beach	Northampton Boulevard near Pleasure House Road - Install flashing beacons	2013
93661	Virginia Beach	Independence Boulevard at Buckner Road - Construct a left turn lane	2012
90151	Virginia Beach	Independence Boulevard at Lynnhaven Parkway - Improve Right Turn Lane	2012
96784	Virginia Beach	Independence Boulevard from Indian River Road to Holland Road - Pedestrian Improvements	2012
90149	Virginia Beach	London Bridge Road at Drakesmile Road - Remove right turn island	2012
93664	Virginia Beach	North Lynnhaven Road from Kings Grant Road to Virginia Beach Boulevard - Construct sidewalk	2012
90150	Virginia Beach	Dam Neck Road at Galvani Drive - Install Traffic Signal	2011
86508	Virginia Beach	General Booth Boulevard at London Bridge Road - Install pedestrian signals and crosswalks	2011
86504	Virginia Beach	Virginia Beach Boulevard from N Oceana Boulevard to Birdneck Road - Construct sidewalk	2011
86509	Virginia Beach	Norfolk Avenue at Pacific Avenue - Construct sidewalk	2010
86506	Virginia Beach	Virginia Beach Boulevard at Stepney Lane - Install Pedestrian Signals and Crosswalk	2010
81447	Virginia Beach	Pacific Avenue from 5th Street to 43rd Street - Install solar flashing lights	2009
81448	Virginia Beach	Shore Drive from Vista Circle to Kendall Street - Install solar flashing lights	2009
98435	Williamsburg	Route 199 at Route 5 - Signal Upgrade	2012
94127	York	Route 143 and Route 132 - Upgrade signal	2010

Table 1 continued – Roadway Safety Projects Using HSIP Funds Completed since 2009

Source: HRTPO analysis of VDOT data.

UPC	Jurisdiction	Project	Cost Estimate	Total HSIP Allocations	Projected Construction Start	Projected Construction End
94529	Chesapeake	S. Military Hwy and Baugher Ave - Add Aux Left Turn Lane	$243,000	$243,000	2014	2015
104686	Gloucester	George Washington Highway at TC Walker Road - Install traffic signal	$375,000	$375,000	2014	2015
86489	Hampton	Andrews Boulevard at Woodland Road - Construct a left turn lane	$797,000	$480,000	Underway	2014
93626	Hampton	Big Bethel Road at Burton Street - Upgrade Signal	$286,000	$189,000	2013	2014
86501	Hampton	Coliseum Drive at North Coliseum Crossing - Install traffic signal	$283,000	$220,000	Underway	2014
86488	Hampton	Fox Hill Road at Clemwood Parkway - Construct Left Turn Lanes	$858,000	$350,000	2014	2015
104363	Hampton	I-64 EB at LaSalle Avenue Off-ramp - Reconstruction	$540,000	$540,000	2015	2016
89900	Hampton	Kecoughtan Road at Powhatan Parkway - Install Traffic Signal	$252,000	$211,000	2014	2014
86490	Hampton	LaSalle Avenue at Queen Street - Construct a left turn lane	$496,000	$340,000	2014	2015
93614	Hampton	LaSalle Avenue at Tide Mill Lane - Signal Upgrade	$244,000	$244,000	Underway	2014
89903	Hampton	LaSalle Avenue at Victoria Boulevard - Upgrade to mast arm signals	$268,000	$263,000	Underway	2014
86678	Hampton	Magruder Boulevard at Butler Farm Road - Construct NB acceleration lane	$162,000	$118,000	2014	2015
89904	Hampton	Magruder Boulevard at Semple Farm Road - Construct a left turn lane	$167,000	$161,000	2014	2015
89902	Hampton	Mercury Boulevard at Mallory Street - Upgrade Signal	$225,000	$225,000	Underway	2014
81441	Hampton	Pembroke Avenue at Armistead Avenue - Construct a turn lane	$658,000	$700,000	2014	2016
86480	Hampton	Pembroke Avenue at Grimes Road/Shelton Road - Construct a left turn lane	$684,000	$475,000	2013	2014
93601	Hampton	Todds Lane at Farmington Boulevard/Orcutt Avenue - Signal Upgrade	$278,000	$278,000	Underway	2014
89899	Hampton	Todds Lane at Winchester Dr - Install new traffic signal	$208,000	$201,000	Underway	2014
100541	Isle of Wight	Courthouse Highway and North Court Street - Install sidewalk	$875,000	$500,000	Underway	2014
98095	Isle of Wight	Route 17 at Kings Cove Way - Construct Left and Right Turn Lanes	$374,000	$331,000	2016	2016
98096	Isle of Wight	Route 17 at Smiths Neck Road - Extend NB Left Turn Lane and lighting	$348,000	$183,000	2015	2016
98279	James City	Longhill Road at Olde Towne Road - Signal Upgrade and Install Median Barrier	$315,000	$401,000	Underway	2014
97010	James City	Richmond Road at Airport Road - Upgrade signal, pavement markings, and ped access	$434,000	$469,000	Underway	2014
100542	Newport News	Warwick Blvd from Tabbs Ln to Beechmont Dr - Upgrade signal hardware	$350,000	$360,000	2015	2016
100546	Norfolk	Citywide Intersection Improvements	$3,401,000	$3,657,000	2014	2015
102524	Norfolk	Citywide Intersection Improvements - Group 1	$2,457,000	$2,131,000	Underway	2014
102526	Norfolk	Citywide Intersection Improvements - Group 2	$2,951,000	$2,951,000	Underway	2014
96902	Portsmouth	Effingham Blvd at Portsmouth Blvd - Modify Signal and Markings	$315,000	$341,000	Underway	2014
97054	Portsmouth	Frederick Blvd at Portsmouth Blvd - Upgrade signal and construct NB turn lane	$383,000	$413,000	Underway	2014
96908	Portsmouth	GW Highway at Frederick Blvd - Upgrade signal and reconfigure intersection	$551,000	$592,000	Underway	2014
96901	Portsmouth	GW Highway at Greenwood Drive - Upgrade signal and markings	$193,000	$209,000	Underway	2014
96906	Portsmouth	GW Highway between Frederick Blvd and Deep Creek Blvd - Upgrade signals and add sidewalk	$301,000	$318,000	Underway	2014
96905	Portsmouth	Portsmouth Boulevard at City Park Avenue - Upgrade signal & markings	$207,000	$223,000	Underway	2014
96900	Portsmouth	Portsmouth Boulevard at Deep Creek Boulevard - Upgrade signal & markings	$226,000	$244,000	Underway	2014
97011	Portsmouth	Portsmouth Boulevard at Elmhurst Lane - Upgrade signal and extend left turn lane	$473,000	$508,000	Underway	2014
96907	Portsmouth	Towne Point Road at Twin Pines Road - Upgrade signal	$263,000	$285,000	Underway	2014
96904	Portsmouth	Victory Boulevard at Airline Boulevard - Upgrade signal and markings	$251,000	$268,000	Underway	2014
97012	Virginia Beach	First Colonial Road at Donna Drive - Upgrade signal and markings	$414,000	$403,000	Underway	2014
93662	Virginia Beach	General Booth Boulevard at Nimmo Parkway - Intersection Improvements	$497,000	$400,000	Underway	2014
100539	Virginia Beach	Providence Road from Matyiko Drive to Whitehurst Landing Road - Pedestrian Improvements	$495,000	$500,000	2014	2014
100540	Virginia Beach	Shore Drive at Lake Shores Road and Dam Neck Road at Harpers Road - Offset left turn lanes	$1,339,000	$1,309,000	Underway	2014
93631	Virginia Beach	Virginia Beach Boulevard at Mediterranean Avenue - Upgrade signal	$272,000	$261,000	Underway	2014
98098	York	I-64 WB at Route 199 - Lengthen Ramp and Weave and Install VMS	$429,000	$429,000	2015	2016
95423	York	Rochambeau Drive - Install warning signs	$110,000	$110,000	2015	2015
95423	York	Rochambeau Drive at Airport Road - Intersection Improvements (HRRR project)	$518,000	$514,000	2015	2015
104337	York	Route 143 at I-64 EB Ramp Terminal - Install Roundabout	$2,220,000	$2,220,000	2016	2016

TABLE 2 – ROADWAY SAFETY PROJECTS THAT ARE PROGRAMMED OR CURRENTLY UNDER CONSTRUCTION

Source: HRTPO analysis of VDOT data.

ROAD SAFETY AUDITS

According to FHWA, a Road Safety Audit (RSA) is a formal and independent safety performance review of an existing or future road or intersection by an experienced team of safety specialists addressing the safety of all road users[10]. The overall objective of an RSA is to analyze site crash trends and to develop and recommend potential safety countermeasures to mitigate them. FHWA works with state and local jurisdictions to integrate RSAs into the project development process for new road projects and encourages RSAs on existing roadways and intersections.

A number of case studies show that most RSA benefits are qualitative rather than quantitative. Many of these benefits are immeasurable as the audits aim to prevent crashes from occurring. According to RSA pilot studies assessed by FHWA, several benefits of RSAs[11] were found:

- Provide safety beyond established standards
- Identify additional improvements that can be incorporated into the projects
- Introduce designs that reduce the number and severity of crashes
- Create consistency among all projects
- Encourage personnel to think about safety in the course of their normal activities, throughout all stages of a project
- Invite interdisciplinary input
- Enhance the quality of field reviews
- Provide learning experiences for audit team and design team members
- Help reduce costs by identifying safety issues and mitigating them before projects are built
- Integrate multimodal safety concerns
- Help reduce liability claims – a component of both agency and societal costs
- Provide feedback to highway designers that they can apply to other projects as appropriate
- Provide feedback that helps to affirm actions taken and to work through outstanding issues
- Ensure that high quality is maintained throughout a project's life cycle

In many places, Road Safety Audits are referred to as Road Safety Assessments. In May 2008, VDOT released the *VDOT Road Safety Assessment Guidelines*[12] that describes the RSA process within Virginia. VDOT uses RSAs to guide the design and construction of engineering improvements to address several of the key components of *Virginia's Strategic Highway Safety Plan*, including intersection and roadway departure crashes. The VDOT Traffic Engineering Division promotes RSAs as the foundation of transportation safety planning and recommends that RSAs be included throughout the project development and delivery process. VDOT conducts RSAs on existing roadways, candidate Highway Safety Corridors[13], and identified high crash locations.

VDOT has identified eight major steps for conducting an RSA[14]:

1. Select candidate corridor segments or intersections
2. Select members of the assessment team for a specific Highway Safety Corridor
3. Conduct crash analysis and collect background information for the RSA team
4. Hold kick-off meeting
5. Conduct site field review
6. Develop countermeasures
7. Develop an RSA report and hold completion meeting
8. Implement countermeasures and monitor performance

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[10] Federal Highway Administration, http://safety.fhwa.dot.gov/rsa/, as of February 2014.

[11] National Cooperative Highway Research Program, *Road Safety Audits: A Synthesis of Highway Practice*, Synthesis 336, Transportation Research Board, 2004, p.6.

[12] Virginia Department of Transportation, *VDOT Road Safety Assessment Guidelines*, May 2008.

[13] VDOT's Highway Safety Corridors program focuses on reducing the frequency, density, rate, and severity of crashes in selected primary and intersate corridors.

[14] Ibid.

Safety Laws in Virginia

According to Advocates for Highway and Auto Safety – an alliance of consumer, insurance, and health and safety groups that aims to improve roadway safety throughout the country – there are fifteen types of traffic safety laws that help reduce motor vehicle deaths and injuries (**Figure 6**). This list of fifteen traffic safety laws was produced based on government and private research, crash data, and experiences among each state. They address adult occupant protection, child passenger safety, teen driving, impaired driving, and distracted driving. Of these fifteen laws, Virginia currently meets or exceeds eight. One of these laws, primary enforcement of an all-driver text messaging restriction, took effect on July 1, 2013. Recommended laws that are not currently in place in Virginia include a primary enforcement seat belt law, various graduated driver license laws, and a statewide open container law.

Safety Law	Description	Law in VA?	# States with law
Primary Enforcement Seat Belt Law	Allows law enforcement to stop and ticket someone when they see a violation of the seat belt law.	NO	34
Primary Enforcement Seat Belt Law, Rear Seats	Allows law enforcement to stop and ticket someone when they see a violation of the seat belt law in the rear seats of the vehicle.	NO	18
Booster Seat Law	Requires, at a minimum, that children ages 4 through 7 be placed in a child restraint system.	YES	32
Minimum Age 16 for Learner's Permit	A beginning teen driver must be a minimum of 16 years of age to receive a learner's permit.	NO	9
Learner's Stage: 6 Month Holding Period	A beginning teen driver must be supervised by an adult licensed driver at all times. If citation-free for 6 months, they can proceed to the intermediate stage.	YES	47
Learner's Stage: 30-50 Hours Supervised	A beginning teen driver must receive at least 30-50 hours of behind-the-wheel training with an adult licensed driver during the learner's stage.	YES	41
Intermediate Stage: Nighttime Restriction	Prohibits unsupervised nighttime driving during the learner's permit and intermediate stages.	NO	11
Intermediate Stage: Passenger Restriction	Limits the number of teenage passengers that can ride with a teen driver without adult supervision.	NO	29
Teen Cell Phone Restriction	Prohibits the use of all cellular devices except in an emergency during the learner's permit and intermediate stages.	NO	31
Age 18 for Full Licensure	Teen drivers are prohibited from obtaining an unrestricted license before a minimum of 18 years of age.	YES	15
Ignition Interlock Devices	Mandates the installation of ignition interlock devices on the vehicles of all drunk driving offenders.	YES	20
Impaired Driving – Child Endangerment	Creates a separate offense or enhances an existing penalty for impaired driving that endangers a minor.	YES	47
All-Rider Motorcycle Helmet Law	Requires all motorcycle riders, regardless of age, to use a helmet.	YES	20
Open Container Law	Prohibits open containers of alcoholic beverages in the passenger area of a motor vehicle.	NO	40
All-Driver Text Messaging Restriction	Restricts all drivers from text messaging except in an emergency and allows law enforcement to stop and ticket those in violation (primary enforcement).	YES	38

Figure 6 – Safety Laws That Help Reduce Motor Vehicle Deaths and Injuries

Source: Advocates for Highway and Auto Safety. Reflects data as of December 2013.

SAFETY PROGRAMS AND EDUCATIONAL EFFORTS

There are a number of regional, statewide, and national organizations and programs that have been created to improve various aspects of roadway safety. Some of these agencies address safety in a specific geographical region, while others were created to address specific issues such as bike safety or reducing alcohol-related crashes. Examples of some of these efforts are described below.

Drive Safe Hampton Roads

Drive Safe Hampton Roads is a regional organization with the goal of increasing the community's involvement and awareness of transportation safety issues. Founded in 1988, Drive Safe Hampton Roads is comprised of representatives from law enforcement, military, fire safety, commercial carriers, state and local governments, and the general public. Drive Safe Hampton Roads meets quarterly to discuss current safety programs, safety issues, and future safety projects.

More information on Drive Safe Hampton Roads is included on the organization's website at **http://www.drivesafehr.org**.

DRIVE SMART Virginia

DRIVE SMART Virginia is an organization dedicated to raising traffic safety awareness in order to save lives and reduce injuries on the roadways of Virginia.

Founded in 1995, DRIVE SMART Virginia is led by safety advocates including the insurance industry, law enforcement, state and federal governments, military, media, and traffic safety organizations.

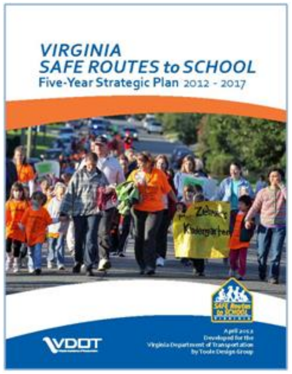
More information on DRIVE SMART Virginia is included on the organization's website at **http://www.drivesmartva.org**.

Safe Routes to School

The Safe Routes to School (SRTS) Program is a federally-funded program created by the 2005 Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) legislation. The purpose of the SRTS program is to:

- Enable and encourage children, including those with disabilities, to walk and bicycle to school
- Make bicycling and walking to school a safer and more appealing transportation alternative, thereby encouraging a healthy and active lifestyle from an early age
- Facilitate the planning, development, and implementation of projects and activities that will improve safety and reduce traffic, fuel consumption, and air pollution in the vicinity of schools

In 2012, the Virginia Department of Transportation (VDOT) Safe Routes to School Program published a five-year strategic plan to guide the commonwealth's work through 2017. The Strategic Plan other information SRTS information is available on VDOT's website at **http://www.virginiadot.org/programs/ted_Rt2_school_pro.asp**



Other Safety Organizations

Many organizations have been formed to improve automobile safety. Below are some examples:

Insurance Institute for Highway Safety (IIHS)
http://www.iihs.org

IIHS is an independent, nonprofit organization that performs research to prevent motor vehicle crashes and reduce injuries in existing crashes. IIHS focuses on a) countermeasures aimed at human, vehicular, and environmental factors in motor vehicle crashes, and b) on interventions that can occur before, during, and after crashes to reduce losses. The IIHS Vehicle Research Center opened in 1992 with a state-of-the-art crash test facility.

Mothers Against Drunk Driving (MADD)
http://www.madd.org

MADD is a nonprofit organization that seeks to stop drunk driving, support the victims of drunk driving crashes, and prevent underage drinking. The organization was founded in 1980 by Candice Lightner after her 13-year-old daughter was killed by a drunk driver.

Safe Kids Worldwide
http://www.safekids.org

Safe Kids Worldwide is a global organization that is dedicated to preventing accidental childhood injuries, the leading killer of children 14 years and under. This organization works with a network of more than 600 coalitions in the United States and partners with organizations in 23 countries worldwide to reduce injuries from motor vehicles, sports, drownings, falls, burns, poisonings and more. Safe Kids administers the standardized National Child Passenger Safety (CPS) Certification Training Program, which certifies child passenger safety technicians and instructors. Safe Kids also promotes seat belt and car seat safety legislation for children.

AAA Foundation for Traffic Safety
http://www.aaafoundation.org

The AAA Foundation for Traffic Safety (AAAFTS), founded in 1947, conducts research for various highway safety issues. The organization's mission is to identify traffic problems, foster research that seeks solutions, and disseminate information and educational materials. AAAFTS has funded over 250 studies designed to determine the causes of traffic crashes, prevent them, and minimize injuries. Focus areas of the foundation include safety patrols, driver education, distracted driving, senior safety and mobility, and teen driving.

AARP Driver Safety Program
http://www.aarp.org/home-garden/transportation/driver_safety

The AARP Driver Safety Program is the nation's first and largest driver safety program designed for drivers age 50 and older. The AARP course is offered in both classroom and online formats and covers issues such as normal changes in vision, hearing, and reaction time associated with aging. The course also provides practical techniques on how to adjust to these changes. Participants learn how to operate their personal vehicles more safely in today's increasingly challenging driving environment and receive a comprehensive review of the "rules of the road," with an emphasis on safety strategies. AARP offers an 8-hour Smart Driver online course, after which participants may be eligible for a reduction in automobile insurance premiums.

HAMPTON ROADS REGIONAL CONCEPT OF TRANSPORTATION OPERATIONS – TRAFFIC INCIDENT MANAGEMENT (RCTO-TIM) WORKING GROUP

In Hampton Roads, the Regional Concept of Transportation Operations – Traffic Incident Management (RCTO-TIM) working group meets on a regular basis to develop and implement strategies to improve emergency response in the region. The RCTO-TIM working group, which is led by VDOT, is comprised of various representatives from the Virginia State Police (VSP), local police, fire and rescue agencies, local traffic engineering and planning departments, HRTPO, as well as other operatoring and first responding agencies.

The goal of the Hampton Roads RCTO-TIM is to reduce the number of injuries incurred by responders – while decreasing the clearance times associated with these incidents. The RCTO-TIM seeks to improve collaboration among the region's planners, operators, and responders to enhance not only highway incident management. One of the major accomplishments of the Hampton Roads RCTO-TIM has been regular post-incident reviews to determine where improvements can be made. One improvement is the adoption of a lane numbering identification system (lanes are numbered L1 and up starting from the interior to the shoulder) used by dispatchers and first responders to quickly locate incidents on freeways.

The Hampton Roads RCTO-TIM has established six primary objectives:

- **Objective 1** - Increase Responder Safety by Eliminating Struck-By Incidents and Fatalities
- **Objective 2** - Decrease Incident Clearance Time
- **Objective 3** - Decrease Secondary Incident Occurrences
- **Objective 4** - Improve Inter-Agency Communication During Incidents
- **Objective 5** - Identify Existing Regional Incident Management Resources and Establish Plan for Inter-Agency
- **Objective 6** - Establish a Regional Incident Management Pro-Active and Post-Incident Review Consortium

More information on the Regional Concept of Transportation Operations – Traffic Incident Management (RCTO-TIM) working group is included at **http://www.hrtpo.org/page/traffic-incident-management**.

Upon review of existing efforts to improve roadway safety, the following sections of this report focus on roadway-based engineering safety improvements to the pre-crash phase for crashes within the Hampton Roads region.

Potential for Safety Improvement

This study aims to determine those locations throughout Hampton Roads, both on the freeway system and at major intersections, where safety improvements may significantly increase safety. This has been aided by new methods and manuals that have been created to improve safety performance measure reporting. AASHTO recently developed the Highway Safety Manual (HSM), and the Virginia Center for Transportation Innovation and Research (VCTIR) has conducted predictive safety research for the Virginia Department of Transportation (VDOT). Both the HSM and VCTIR's research recommend determining the most hazardous locations by examining the difference between the number of "expected" crashes and the number of "predicted" crashes, both of which are described below. This difference is described in this study as the Potential for Safety Improvement[15].

Predicted Crashes

The number of predicted crashes can be determined using procedures included in the HSM and produced by VCTIR. Predicted crashes are calculated with Safety Performance Functions (SPFs). SPFs are regression equations used to estimate the typical crash frequency of a certain type of facility based on a number of factors such as annual average daily traffic, area type, segment length for freeways, control type for intersections, etc. To calculate predicted crashes, Safety Performance Functions are more accurate than crash rates (such as crashes per million vehicle-miles of travel) because the relationship between the number of crashes and traffic volumes is generally not linear, as shown by the red line in **Figure 7**.

The methods and equations used to calculate the number of predicted crashes for freeway segments begins on page 22 and for intersections on page 27.

[15] The term "Potential for Safety Improvement" is used in research done by the Virginia Center for Transportation Innovation and Research (VCTIR). The Highway Safety Manual uses "Excess Expected Average Crash Frequency" to describe this term.

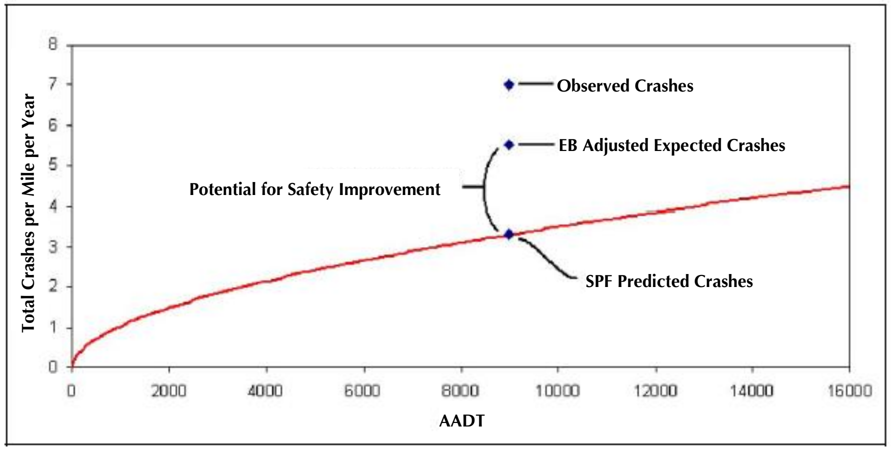


Figure 7 – The Correlation between Observed, Estimated, and Predicted Crashes, and the Potential for Safety Improvement
Source: VCTIR.

Expected Crashes

The Hampton Roads Regional Safety Study uses four years of observed crash data from the years 2009-2012. However, the number of observed crashes that occurs at a given location varies from year to year, especially at locations that experience a low number of crashes in a given year. Four years of observed crash data may or may not represent the number of crashes that could be expected at that location over a longer period of time. To account for this, the number of expected crashes is used in place of observed crashes. The number of expected crashes can be determined by combining the number of observed crashes with the number of predicted crashes, with each being weighted according to their judged validity.

To calculate the number of expected crashes, this study uses the Empirical Bayes method recommended by the HSM and VCTIR's research. The Empirical Bayes method is a procedure for statistical inference in which the prior distribution of a particular measure is estimated from the historical data. The Empirical Bayes method is used in this safety analysis to reduce the regression to the mean impacts and improve the estimate of expected crash frequency at a given location over a period of time based on both the number of observed crashes and the number of predicted crashes calculated from a SPF.

The Empirical Bayes method uses a weighted adjustment factor to combine the observed crash data and predicted crash frequency into a single, weighted figure. The weighted adjustment factor is determined based on the number of predicted crashes using the SPFs and a dispersion parameter (k) – an estimated modeling parameter that indicates how widely crash data is distributed around the estimated mean – associated with the SPF. As the value of k increases, the value of the weighted adjustment factor decreases, which in turn increases the emphasis on the observed crash data rather than the predicted crash frequency.

The methods and equations used to calculate the number of expected crashes for freeway segments begins on page 22 and for intersections on page 27.

The relationship between the number of predicted crashes, observed crashes, the Empirical Bayes method expected crashes, and the Potential for Safety Improvement is shown in **Figure 7** on page 20.

HRTPO staff performed separate analyses of the Potential for Safety Improvement for freeway segments and intersections throughout the region. The regional Potential for Safety Improvement rankings are used to determine the intersections included for further study later in this report.

FREEWAYS

The Highway Safety Manual does not currently have a chapter devoted to analyzing the safety of freeways. This chapter is currently in draft form based on research included in National Cooperative Highway Research Program Report #17-45. HRTPO staff instead used research recently performed by the Virginia Center for Transportation Innovation and Research (VCTIR) for VDOT. As part of "Development of Safety Performance Functions for Freeway and Multilane Highway Segments in Virginia"[16], VCTIR details a methodology to determine the Potential for Safety Improvement on freeway segments based on the number of predicted and expected crashes. A description of this methodology is included below, and a sample calculation for I-64 Eastbound between Yorktown Road and Fort Eustis Boulevard is included in **Appendix B**.

Predicted Crashes

VCTIR developed Safety Performance Functions (SPFs) in order to predict the number of crashes that would be expected to occur on typical freeway segments in Virginia. These freeway SPFs predict crash frequency per year per direction based on the segment's traffic volumes and segment length. The functional form of the freeway segment SPF used in the VCTIR study is:

$$\text{Predicted crash frequency per year per direction} = e^{\alpha} \times (\text{One Direction AADT})^{\beta_1} \times \text{Segment Length}$$

The coefficients included in the above formula (α and $\beta 1$) were developed by VCTIR using historical crash data on freeways throughout Virginia. Sets of coefficients were developed for various situations, depending on environment (rural or urban), the number of lanes, and whether the crashes occur inside or outside of the interchange area (the interchange area is defined as the area between gores of entrance/exit ramps.) These coefficients are included in **Table 3**.

Site Subtype Description	Total Crashes			Fatal + Injury Crashes		
	α	β_1	k	α	β_1	k
Rural freeway segments between interchanges—4 lanes	-6.75	0.80	0.19	-6.89	0.70	0.16
Rural freeway segments between interchanges—6+ lanes	-12.65	1.36	0.27	-7.13	0.72	0.14
Rural freeway segments within an interchange area—4 lanes	-7.56	0.93	0.50	-8.01	0.86	0.44
Rural freeway segments within an interchange area—6+ lanes	-13.11	1.45	0.39	-11.87	1.22	0.30
Urban freeway segments between interchanges—4 lanes	-18.05	1.98	0.65	-18.27	1.88	0.53
Urban freeway segments between interchanges—6 lanes	-12.85	1.45	0.59	-15.64	1.60	0.47
Urban freeway segments between interchanges—8+ lanes	-2.17	0.48	0.58	-5.94	0.71	0.50
Urban freeway segments within an interchange area—4 lanes	-12.05	1.43	0.85	-12.53	1.35	0.74
Urban freeway segments within an interchange area—6 lanes	-11.87	1.40	0.64	-12.44	1.34	0.64
Urban freeway segments within an interchange area—8+ lanes	-13.59	1.54	0.53	-12.74	1.37	0.46

TABLE 3 – VCTIR/VDOT SAFETY PERFORMANCE FUNCTION COEFFICIENTS (α AND β_1) AND DISPERSION PARAMETERS (k)

Source: VCTIR.

The VCTIR method adjusts the annual predicted number of crashes for each freeway segment determined by the SPF to account for local conditions. This is done by determining and using yearly calibration factors, calculated individually for each crash subtype and severity, using the following equation:

$$\text{Yearly calibration factor by type} = \text{Total Yearly Observed Crashes by type} \,/\, \text{Total Yearly Predicted Crashes by type}$$

The adjusted predicted crashes for each location can then be calculated using the following formula:

$$\text{Adjusted predicted crashes by location} = \text{Yearly calibration factor by type} \times \text{Unadjusted predicted crashes by location}$$

This adjusted predicted crashes value is calculated for each location by year, by crash severity (Total crashes, Fatal + Injury crashes, and PDO crashes) and by location of crash (inside or outside of the interchange area).

16 Virginia Center for Transportation Innovation and Research, *Development of Safety Performance Functions for Freeway and Multilane Highway Segments Maintained by VDOT*, May 2014.

Expected Crashes

In order to reduce the effect of annual variations, the Regional Safety Study reports the number of observed crashes that occurred on each freeway segment for a four year period (2009 - 2012). However, the number of crashes observed on a particular freeway segment over the four-year analysis period may or may not represent the "true" safety of that segment, i.e. the number of crashes that would be expected to happen there over a longer period of time. This is especially problematic at locations that experience a low number of crashes. Therefore, the VCTIR research uses the Empirical Bayes method to calculate expected crashes by combining observed crashes and predicted crashes, wherein each is weighted according to their soundness:

- The higher the dispersion parameter (k) associated with the predicted crashes, the less reliable are the predicted crashes, and therefore less weight is given to predicted crashes.
- The higher the number of predicted crashes, the less one expects randomness to affect the number of observed crashes, and therefore greater weight is given to observed crashes.

The weight that is applied to predicted crashes in the Empirical Bayes method is calculated using the following formula:

w = 1 / [1 + (k x Sum of annual adjusted predicted number of crashes)]

These weights are calculated for each crash severity (total and fatal + injury crashes) and location of crash (inside or outside of the interchange area).

A yearly correction factor must also be calculated to account for the effect that annual variations in traffic, weather, and vehicle mix have on crash levels. Yearly correction factors are calculated for each freeway segment as follows:

$$\text{Yearly correction factor} = \text{Adjusted Predicted Crashes in a given year} \;/\; \text{Adjusted Predicted Crashes in Year 1}$$

The expected crashes are then calculated for the first year and subsequent years using the following formulas:

$$\text{Expected crash frequency in year 1 per direction} = (w \times \text{Annual adjusted predicted crashes}) + \left[(1-w) \times \frac{\text{Sum of observed crashes}}{\text{Sum of yearly correction factors}}\right]$$

$$\text{Expected crash frequency in subsequent years} = \text{Expected crash frequency in Year 1} \times \text{Yearly correction factor}$$

The number of expected crashes is calculated for each freeway segment by crash severity and location. The number of expected crashes for each freeway segment is included in **Appendix C**.

Potential for Safety Improvement

The final step is to calculate the difference between the number of expected crashes and the number of predicted crashes on each freeway segment, known as the Potential for Safety Improvement (PSI). **Appendix C** shows PSIs for each of the 218 freeway segments in Hampton Roads, as do **Maps 1 and 2** on pages 25 and 26.

Table 4 on page 24 shows those freeway segments with the highest Potential for Safety Improvement from 2009 to 2012. Also included in Table 4 are the ranks of each freeway segment based on the Equivalent Property Damage Only (EPDO) Crash Rates, which were calculated in Part I of this study.

The freeway segment with the highest Potential for Safety Improvement is I-64 Eastbound between Northampton Boulevard and I-264. The difference between the expected crashes and adjusted predicted crashes on this segment is +127 crashes per year. The next highest freeway segments in terms of PSI are the Eastbound Hampton Roads Bridge-Tunnel (+68), Eastbound Downtown Tunnel (+45), Westbound Hampton Roads Bridge-Tunnel (+43), and I-264 Westbound between I-64 and Newtown Road (+39).

Many segments have a high Potential for Safety Improvement, but don't rank high in terms of EPDO Crash Rate. Two examples include the Northbound Monitor-Merrimac Memorial Bridge-Tunnel (9th highest PSI versus 47th highest EPDO Crash Rate) and I-64 Westbound between I-264 and Indian River Road (10th highest PSI versus 29th highest EPDO Crash Rate).

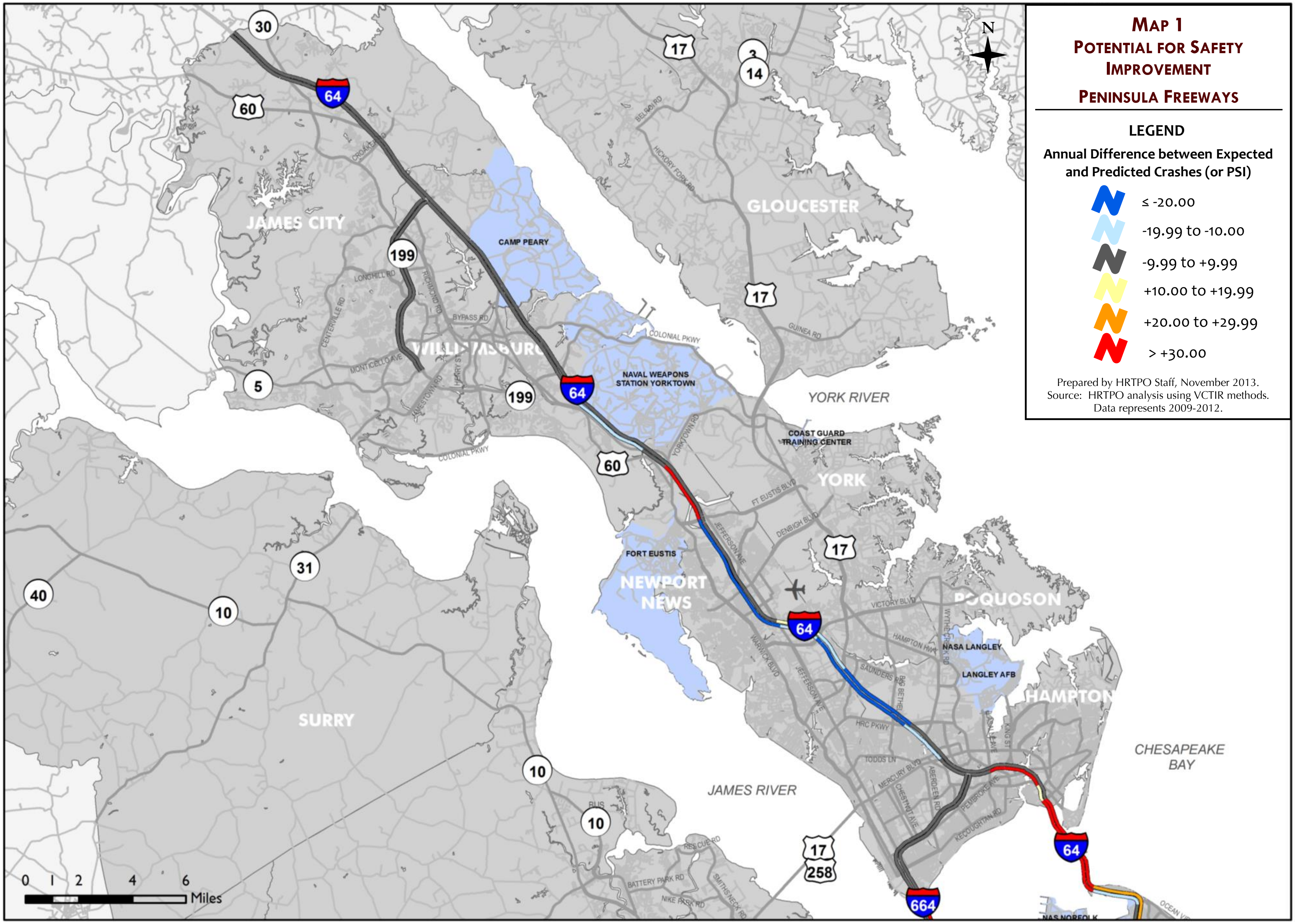
The inverse is also true; many segments have a high EPDO Crash Rate but don't rank high in terms of Potential for Safety Improvement. Examples include the MLK Freeway Northbound between High Street and London Boulevard (2nd highest EPDO Crash Rate versus 79th highest PSI) and I-464 Northbound between South Main Street and I-264 (11th highest EPDO Crash Rate versus 36th highest PSI).

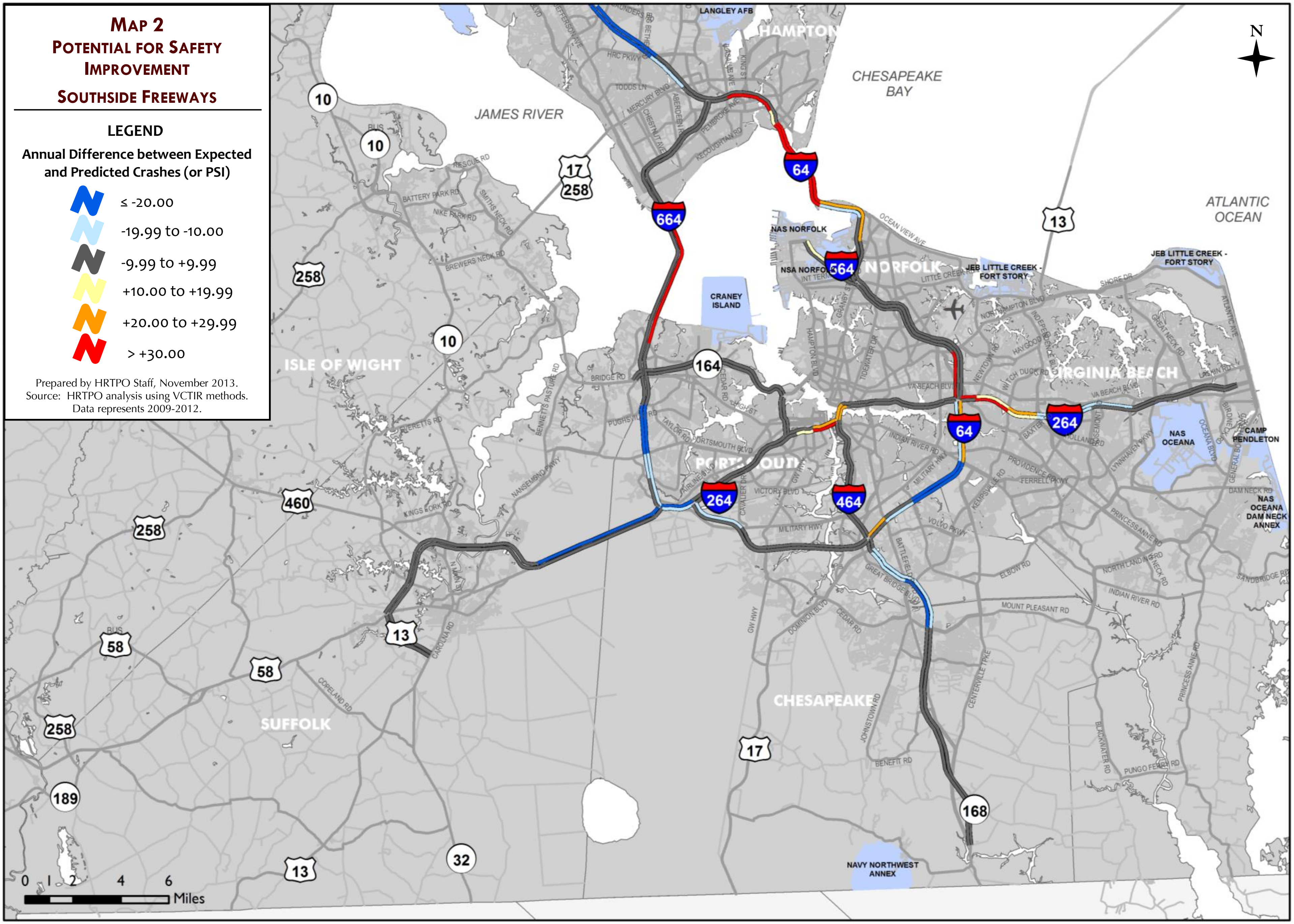
PSI Rank	Jurisdiction	Facility	Segment From	Segment To	Dir	PSI (Annual Expected Crashes - Predicted Crashes)	EPDO Crash Rate Rank
1	NOR	I-64	NORTHAMPTON BLVD	I-264	EB	**126.67**	3
2	HAM/NOR	I-64/HRBT	MALLORY ST	OCEAN VIEW AVE	EB	**67.95**	14
3	PORT/NOR	I-264/DOWNTOWN TUNNEL	EFFINGHAM ST	I-464	EB	**44.60**	1
4	HAM/NOR	I-64/HRBT	MALLORY ST	OCEAN VIEW AVE	WB	**42.62**	18
5	NOR	I-264	I-64	NEWTOWN RD/WCL VA. BEACH	WB	**38.63**	9
6	NN	I-64	YORKTOWN RD	FORT EUSTIS BLVD	EB	**35.65**	19
7	VB	I-264	NEWTOWN RD/ECL NORFOLK	WITCHDUCK RD	EB	**32.91**	22
8	HAM	I-64	ARMISTEAD AVE	SETTLERS LANDING RD	EB	**30.89**	17
9	SUF/NN	I-664/MMMBT	COLLEGE DR	TERMINAL AVE	NB	**30.72**	47
10	NOR/VB	I-64	I-264	INDIAN RIVER RD	WB	**28.64**	29
11	NOR	I-264/BERKLEY BRIDGE	I-464	WATERSIDE/CITY HALL/TIDEWATER	WB	**25.10**	4
12	CHES	I-64	BATTLEFIELD BLVD	I-464	EB	**23.97**	13
13	NOR	I-264/BERKLEY BRIDGE	I-464	WATERSIDE/CITY HALL/TIDEWATER	EB	**23.86**	5
14	NOR	I-64	4TH VIEW AVE	BAY AVE	WB	**23.63**	6
15	NOR	I-64	OCEAN VIEW AVE	4TH VIEW AVE	WB	**23.29**	16
16	PORT/NOR	I-264/DOWNTOWN TUNNEL	EFFINGHAM ST	I-464	WB	**21.01**	10
17	VB	I-264	WITCHDUCK RD	INDEPENDENCE BLVD	WB	**20.61**	23
18	VB	I-264	WITCHDUCK RD	INDEPENDENCE BLVD	EB	**19.20**	31
19	NOR	I-564	ADMIRAL TAUSSIG BLVD	INTERNATIONAL TERMINAL BLVD	NB	**16.64**	12
20	HAM	I-64	SETTLERS LANDING RD	MALLORY ST	EB	**15.93**	7
21	VB	I-264	NEWTOWN RD/ECL NORFOLK	WITCHDUCK RD	WB	**15.56**	27
22	NN	I-64	JEFFERSON AVE	OYSTER POINT RD	WB	**14.84**	26
23	PORT	I-264	DES MOINES AVE	EFFINGHAM ST	EB	**14.05**	8

TABLE 4 – FREEWAY SEGMENTS WITH A POTENTIAL FOR SAFETY IMPROVEMENT GREATER THAN 10

Source: HRTPO analysis using VCTIR methodology. Data included in this table represents the years 2009-2012.

EPDO = Equivalent Property Damage Only. More information on the EPDO Crash Rate is included in Part I of this study.


MAP 1
POTENTIAL FOR SAFETY IMPROVEMENT
PENINSULA FREEWAYS
LEGEND
Annual Difference between Expected and Predicted Crashes (or PSI)
≤ -20.00
-19.99 to -10.00
-9.99 to +9.99
+10.00 to +19.99
+20.00 to +29.99
> +30.00
Prepared by HRTPO Staff, November 2013.
Source: HRTPO analysis using VCTIR methods.
Data represents 2009-2012.
N
JAMES CITY
GLOUCESTER
YORK
NEWPORT NEWS
POQUOSON
HAMPTON
SURRY
CAMP PEARY
NAVAL WEAPONS STATION YORKTOWN
COAST GUARD TRAINING CENTER
FORT EUSTIS
NASA LANGLEY
LANGLEY AFB
YORK RIVER
JAMES RIVER
CHESAPEAKE BAY
0 1 2 4 6 Miles


Map 2
Potential for Safety Improvement
Southside Freeways
LEGEND
Annual Difference between Expected and Predicted Crashes (or PSI)
≤ -20.00
-19.99 to -10.00
-9.99 to +9.99
+10.00 to +19.99
+20.00 to +29.99
> +30.00
Prepared by HRTPO Staff, November 2013.
Source: HRTPO analysis using VCTIR methods.
Data represents 2009-2012.
N
JAMES RIVER
CHESAPEAKE BAY
ATLANTIC OCEAN
HAMPTON
NORFOLK
VIRGINIA BEACH
ISLE OF WIGHT
SUFFOLK
CHESAPEAKE
LANGLEY AFB
NAS NORFOLK
CRANEY ISLAND
JEB LITTLE CREEK - FORT STORY
NAS OCEANA
CAMP PENDLETON
NAS OCEANA DAM NECK ANNEX
NAVY NORTHWEST ANNEX
0 1 2 4 6 Miles

INTERSECTIONS

The intersection analysis performed in this report was done using methods and coefficeints included in the Highway Safety Manual (HSM). The Virginia Center for Transportation Innovation and Research (VCTIR) has produced a report for predicting the Potential for Safety Improvement at intersections[17], but the VCTIR intersection study was based on data from VDOT-maintained roadways only, which are primarily roadways within counties. Most intersections in this study – 517 of the 597 intersections analyzed – are maintained by the cities, not VDOT. Intersections in urban areas such as Norfolk, Portsmouth, and Newport News are not typical of those maintained by VDOT throughout the state. In addition, a preliminary analysis conducted by HRTPO staff showed that Highway Safety Manual SPFs produced predicted crash values on a regional level that were closer to observed values than those SPFs from the VCTIR study.

The Highway Safety Manual includes separate sections on rural two-lane roadways, rural multi-lane highways, and urban and suburban arterials, and each section includes methods for analyzing intersections on these types of roadways. The HSM details methodologies to determine what it calls the Excess Expected Average Crash Frequency – referred to as the Potential for Safety Improvement in this report – for intersections based on the number of predicted and expected crashes. A description of this methodology is included below, and a sample calculation for the intersection of Holland Road and Rosemont Road in Virginia Beach is included in **Appendix B**.

Predicted Crashes

Safety Performance Functions (SPFs) were developed for the Highway Safety Manual in order to predict the number of crashes that would be expected to occur on typical arterial roadways by type. In the case of the intersection SPFs, crash frequency per year is predicted based on the intersection's control type, design, location, entering traffic volumes, and pedestrians.

SPFs are used to calculate predicted crash frequency for crashes by type (multi-vehicle crashes, single vehicle crashes, crashes with pedestrians, and crashes with bicyclists) and crash severity (Total, F+I, or PDO).

The functional form of the multi-vehicle and single vehicle urban intersection SPFs used in the HSM is:

$$\text{Predicted single and multi-vehicle crash frequency per year} = \exp\left[a + (b \times \ln(\text{Major AADT})) + (c \times \ln(\text{Minor AADT}))\right]$$

In the above equation, Major AADT represents the two-way volume on the major roadway leg with the higher traffic volume, and Minor AADT represents the same for the minor legs. The coefficients (a, b, and c) were developed for the Highway Safety Manual using historical crash data throughout the country. Different coefficients are used based on whether the intersection is in a rural or urban environment, the number of legs of the intersection, and the type of control (whether it is controlled by stop signs or a traffic signal). These coefficients are included in **Table 5** on page 28.

Crashes between vehicles and pedestrians in urban areas have a separate Safety Performance Function in the HSM. This SPF is:

Predicted vehicle-pedestrian crash frequency per year

$$= \exp\left[a + (b \times \ln(\text{Total AADT})) + \left(c \times \ln\left(\frac{\text{Minor AADT}}{\text{Major AADT}}\right)\right) + (d \times \ln(\text{PedVol})) + (e \times n_{lanes})\right]$$

In this equation, Total AADT represents the sum of the Major AADT and Minor AADT, as described above. PedVol represents the total daily pedestrians that cross the intersection, which was estimated for each intersection based on default values included in the Highway Safety Manual, and n_{lanes} represents the maximum number of lanes a pedestrian would

[17] Virginia Center for Transportation Innovation and Research, *Safety Performance Functions for Intersections on Highways Maintained by the Virginia Department of Transportation*, October 2010.

have to cross at the intersection at one time. The coefficients (a, b, c, d, and e) are included in **Table 5**.

Crashes between vehicles and bicyclists are also considered in the HSM when determining a predicted number of crashes at urban intersections. This is done simply by factoring the total predicted number of crashes (excluding vehicle-pedestrian crashes) by a set coefficient based on the intersection type. These factors, based on research conducted for the HSM, are 0.016 for 3 leg stop control, 0.011 for 3 leg signal control, 0.018 for 4 leg stop control, and 0.015 for 4 leg signal control.

The total number of predicted crashes at urban intersections is calculated by adding the results of the SPFs for multi-vehicle crashes, single vehicle crashes, vehicle-pedestrian crashes, and vehicle-bicyclist crashes, as shown in the following formula:

Predicted urban intersection crash frequency per year	=	Predicted multi-vehicle crash frequency	+	Predicted single vehicle crash frequency	+	Predicted vehicle-pedestrian crash frequency	+	Predicted vehicle-bicyclist crash frequency

The HSM uses a slightly different SPF prediction methodology for roadways in rural areas than those used for roadways in urban areas. Rural SPFs, while similar to the urban SPFs, do not separately include predictions of single and multiple vehicle, vehicle-pedestrian, or vehicle-bicyclist crashes.

The HSM includes separate methodologies for those intersections involving rural 2-lane roadways and those involving at least one multilane highway. The form of the rural 2-lane SPF is similar to those for urban intersections:

Predicted total rural 2-lane crash frequency per year = exp [a + (b x ln(Major AADT)) + (c x ln(Minor AADT))]

In the above equation, Major AADT represents the two-way volume on the major roadway leg with the higher traffic volume, and Minor AADT represents the same for the minor legs. The coefficients (a, b, and c) are included in Table 5.

The rural 2-lane SPF, however, only produces a predicted number of total crashes at the intersection; there are no separate coefficients to use in the SPF to predict F+I and PDO crashes. Instead, a proportion of total crashes is applied to

Rural 2-lane SPF Coefficients

Site Subtype Description	Total Crashes				% of F+I Crashes	% of PDO Crashes
	a	b	c	k		
Rural 2-Lane Crashes - 3 leg stop control	-9.86	0.79	0.49	0.54	41.5%	58.5%
Rural 2-Lane Crashes - 4 leg stop control	-8.56	0.60	0.61	0.24	43.1%	56.9%
Rural 2-Lane Crashes - 4 leg signal control	-5.13	0.60	0.20	0.11	34.0%	66.0%

Rural Multilane SPF Coefficients

Site Subtype Description	Total Crashes				F + I Crashes			
	a	b	c	k	a	b	c	k
Rural Multilane Crashes - 3 leg stop control	-12.53	1.20	0.24	0.46	-12.66	1.11	0.27	0.57
Rural Multilane Crashes - 4 leg stop control	-10.01	0.85	0.45	0.49	-11.55	0.89	0.53	0.74
Rural Multilane Crashes - 4 leg signal control	-7.18	0.72	0.34	0.28	-6.39	0.64	0.23	0.22

Urban Vehicle-Pedestrian SPF Coefficients

Site Subtype Description	Total Crashes					
	a	b	c	d	e	k
Urban Vehicle-Ped Crashes - 3 leg stop control	--	--	--	--	--	--
Urban Vehicle-Ped Crashes - 3 leg signal control	-6.60	0.05	0.24	0.41	0.09	0.52
Urban Vehicle-Ped Crashes - 4 leg stop control	--	--	--	--	--	--
Urban Vehicle-Ped Crashes - 4 leg signal control	-9.53	0.40	0.26	0.45	0.04	0.24

Urban Single and Multi-Vehicle SPF Coefficients

Site Subtype Description	Total Crashes				F + I Crashes				PDO Crashes			
	a	b	c	k	a	b	c	k	a	b	c	k
Urban Multi-Vehicle - 3 leg stop control	-13.36	1.11	0.41	0.80	-14.01	1.16	0.30	0.69	-15.38	1.20	0.51	0.77
Urban Multi-Vehicle - 3 leg signal control	-12.13	1.11	0.26	0.33	-11.58	1.02	0.17	0.30	-13.24	1.14	0.30	0.36
Urban Multi-Vehicle - 4 leg stop control	-8.90	0.82	0.25	0.40	-11.13	0.93	0.28	0.48	-8.74	0.77	0.23	0.40
Urban Multi-Vehicle - 4 leg signal control	-10.99	1.07	0.23	0.39	-13.14	1.18	0.22	0.33	-11.02	1.02	0.24	0.44
Urban Single-Vehicle - 3 leg stop control	-6.81	0.16	0.51	1.14	--	--	--	--	-8.36	0.25	0.55	1.29
Urban Single-Vehicle - 3 leg signal control	-9.02	0.42	0.40	0.36	-9.75	0.27	0.51	0.24	-9.08	0.45	0.33	0.53
Urban Single-Vehicle - 4 leg stop control	-5.33	0.33	0.12	0.65	--	--	--	--	-7.04	0.36	0.25	0.54
Urban Single-Vehicle - 4 leg signal control	-10.21	0.68	0.27	0.36	-9.25	0.43	0.29	0.09	-11.34	0.78	0.25	0.44

TABLE 5 – HSM SAFETY PERFORMANCE FUNCTION COEFFICIENTS

Source: HSM.
a, b, c, d, and e represent coefficients used in the Unadjusted "Predicted" Crashes equation. k represents the dispersion parameter used in the Empirical Bayes method equations.
-- represents cases where SPF models are not available. Equations are used in their place.

the predicted SPF total crashes in order to estimate F+I and PDO crashes. These proportions are also included in Table 5 on page 28.

For rural intersections where at least one of the roadways is a multilane highway, the SPF is also similar to those for urban intersections:

Predicted total rural multilane crash frequency per year = exp [a + (b x ln(Major AADT)) + (c x ln(Minor AADT))]

In the above equation, Major AADT represents the two-way volume on the major roadway leg with the higher traffic volume, and Minor AADT represents the same for the minor legs. The coefficients (a, b, and c) are included in Table 5 on page 28.

The rural multilane SPF can be used to produce a predicted number of total crashes and F+I crashes at the intersection. The number of predicted PDO crashes can be determined by subtracting the predicted number of F+I crashes from the total number of predicted crashes.

HRTPO staff used the above SPF equations and coefficients to produce an annual predicted number of crashes for the years 2009-2012 at all 597 intersections analyzed as part of the Regional Safety Study. As with the freeway segments shown previously, the predicted crashes at each intersection needed to be adjusted to account for local conditions. This is done by determining and using yearly calibration factors, calculated individually for each intersection type (i.e. rural 3-leg stop controlled intersections, urban 4-leg signalized intersections, etc.). Yearly calibration factors are calculated for each intersection type using the following equation:

Yearly calibration factor by type = Total Yearly Observed Crashes by type / Total Yearly Predicted Crashes by type

The adjusted predicted crashes for each intersection can then be calculated using the following formula:

Adjusted predicted crashes by location = Yearly calibration factor by type x Unadjusted predicted crashes by location

This adjusted predicted crashes value is calculated for each intersection by year and crash type (Total crashes, Fatal + Injury crashes, and PDO crashes). The adjusted predicted crashes are shown for each intersection in **Appendix D**.

Expected Crashes

The Regional Safety Study includes the number of observed crashes that occurred at each of the 597 intersections throughout Hampton Roads annually between 2009 and 2012. However, the number of crashes observed at a particular location over the four-year analysis period may or may not represent the "true" safety of that location, i.e. the number of crashes that would be expected to happen there over a longer period of time. This is especially problematic at intersections that experience a low number of crashes.

Similar to the freeway analysis in this report, the HSM uses the Empirical Bayes method to calculate expected crashes at intersections by combining observed crashes and predicted crashes, wherein each is weighted according to their soundness based on the number of predicted crashes and the dispersion parameter (k), as described further in the freeway section.

The weight that is applied to predicted crashes in the Empirical Bayes method is calculated using the following formula:

w = 1 / [1 + (k x Sum of annual adjusted predicted number of crashes)]

These weights are calculated for each crash type (multiple vehicle, single vehicle, pedestrian, and bicyclist) and severity (Fatal + Injury, Property Damage Only).

A yearly correction factor must also be calculated to account for the effect that annual variations in traffic, weather, and vehicle mix have on crash levels. Yearly correction factors are calculated as follows:

$$\text{Yearly correction factor} = \text{Adjusted Predicted Number of Crashes in a given year} \; / \; \text{Adjusted Predicted Number of Crashes in Year 1}$$

The expected crashes are then calculated for the first year and subsequent years using the following formulas:

$$\text{Expected crash frequency in year 1} = (w \times \text{Annual adjusted predicted crashes}) + \left[(1-w) \times \frac{\text{Sum of observed crashes}}{\text{Sum of yearly correction factors}}\right]$$

$$\text{Expected crash frequency in subsequent years} = \text{Expected crash frequency in Year 1} \times \text{Yearly correction factor}$$

The number of expected crashes is calculated for each intersection by crash type and crash severity. The expected crashes for each intersection are shown in **Appendix D**.

Potential for Safety Improvement

The final step is to calculate the difference between the number of expected crashes and the number of adjusted predicted crashes at each intersection, known as the Potential for Safety Improvement. **Appendix D** includes the Potential for Safety Improvement for each of the 597 intersections in Hampton Roads that are analyzed as part of the Regional Safety Study, as do **Maps 3 and 4** on pages 32 and 33.

Table 6 on page 31 shows those intersections with the highest Potential for Safety Improvement from 2009 to 2012. Also included in Table 6 are the ranks of each intersection based on the annual number of crashes and the Equivalent Property Damage Only (EPDO) Crash Rates, which were both calculated in Part I of this study.

The intersection with the highest Potential for Safety Improvement is Holland Road at Rosemont Road in Virginia Beach. The difference between the expected crashes and adjusted predicted crashes at this intersection is +27.5 crashes per year. This intersection also experienced the most crashes each year between 2009 and 2012 among the 597 intersections analyzed in the Regional Safety Study, and had the highest Equivalent Property Damage Only (EPDO) Crash Rate.

The next highest intersections in terms of Potential for Safety Improvement are Hampton Roads Center Parkway at Big Bethel Road (+22.8), Mercury Boulevard at Power Plant Parkway (+20.7), First Colonial Road at Virginia Beach Boulevard (+18.9), and Mercury Boulevard at Jefferson Avenue (+16.7).

Many intersections have a high Potential for Safety Improvement, but don't rank high in terms of number of crashes or EPDO Crash Rate. Examples include the intersection of Armistead Avenue and LaSalle Avenue, which has the 7th highest PSI among the 597 intersections analyzed in this study but only the 27th highest number of crashes, and the intersection of General Booth Boulevard at Dam Neck Road (6th highest PSI versus 45th highest EPDO Crash Rate).

The inverse is also true. The intersection of Indian River Road at Kempsville Road has the 8th highest number of crashes each year among intersections analyzed in this study but only ranks 79th highest in terms of Potential for Safety Improvement. The intersection of Henry Street at Route 132Y has the 3rd highest EPDO Crash Rate but ranks 55th highest in terms of PSI.

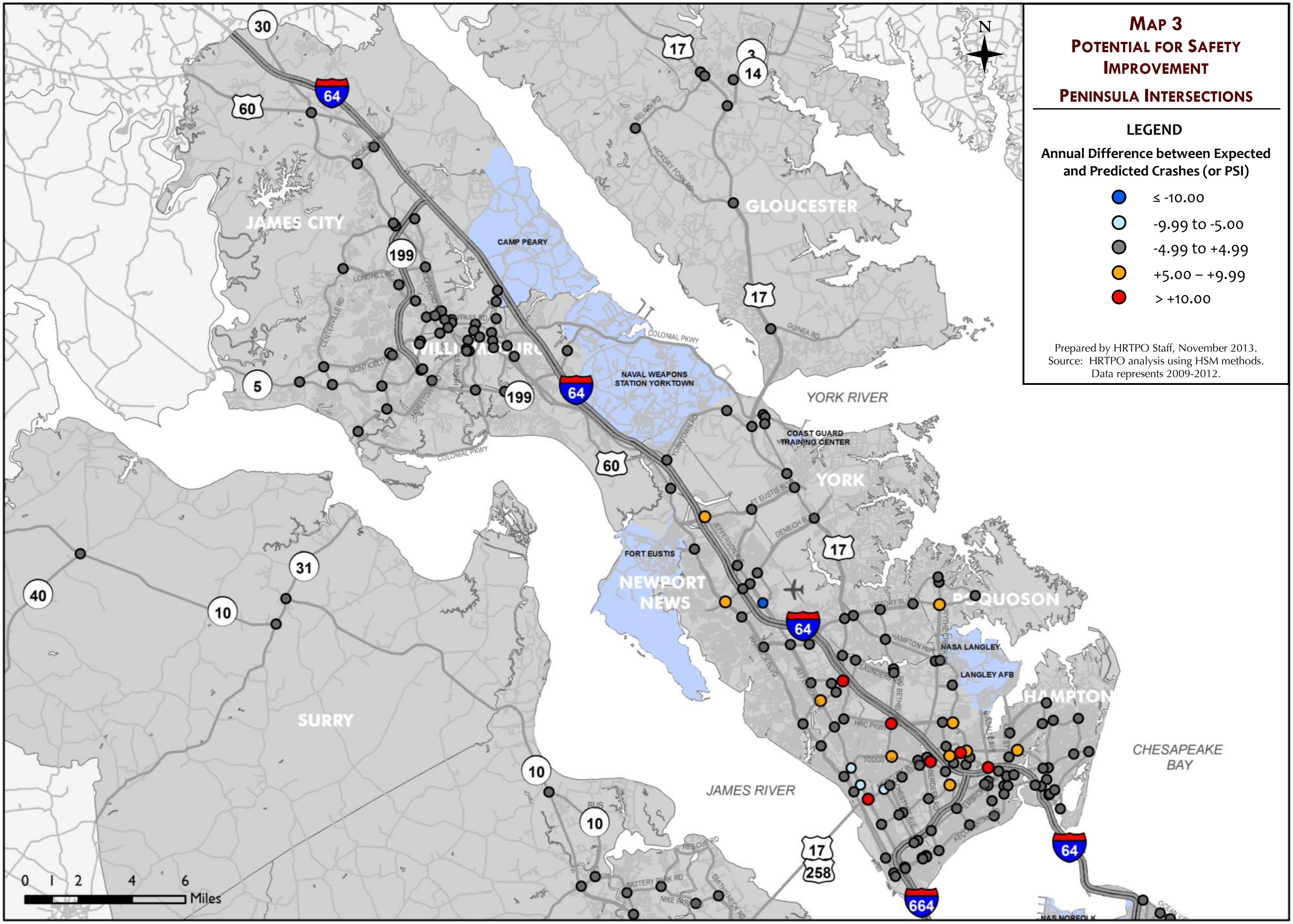
The regional Potential for Safety Improvement rankings are used to determine the intersections included for further study later in this report.

PSI Rank	Jurisdiction	Major Road	Minor Road	PSI (Annual Expected Crashes - Predicted Crashes)	Annual Number of Crashes Rank	EPDO Crash Rate Rank
1	VB	Holland Rd	Rosemont Rd	**27.51**	1	1
2	HAM	HRC Pkwy	Big Bethel Rd	**22.80**	3	5
3	HAM	Mercury Blvd	Power Plant Pkwy/Todds Ln	**20.66**	2	9
4	VB	First Colonial Rd	Va Beach Blvd	**18.88**	6	20
5	NN	Mercury Blvd	Jefferson Ave	**16.71**	4	10
6	VB	General Booth Blvd	Dam Neck Rd	**13.58**	5	45
7	HAM	Armistead Ave	LaSalle Ave	**12.72**	27	12
8	NN	J Clyde Morris Blvd	Diligence Dr	**12.68**	18	2
9	VB	Princess Anne Rd	Dam Neck Rd	**11.69**	7	32
10	VB	Lynnhaven Pkwy	Independence Blvd	**11.14**	22	28
11	HAM	Mercury Blvd	Cunningham Dr	**10.91**	14	21
12	HAM	Mercury Blvd	Coliseum Dr	**9.85**	10	48
13	NOR	Chesapeake Blvd	Norview Ave/Sewells Point Rd	**9.27**	38	14
14	HAM	Todds Ln	Big Bethel Rd	**9.05**	47	16
15	NOR	Little Creek Rd	Chesapeake Blvd	**8.77**	24	33
16	PORT	George Washington Hwy	Victory Blvd	**8.72**	31	6
17	CHES	Battlefield Blvd	Great Bridge Blvd/Kempsville Rd	**8.22**	25	41
18	VB	Lynnhaven Pkwy	Holland Rd	**8.17**	26	94
19	NN	Warwick Blvd	Denbigh Blvd	**7.10**	23	52
20	VB	Va Beach Blvd	Great Neck Rd/London Bridge Rd	**7.02**	15	97
21	VB	Military Hwy	Indian River Rd	**6.93**	20	108
22	VB	Lynnhaven Pkwy	Rosemont Rd	**6.73**	37	42
23	VB	Birdneck Rd	Va Beach Blvd	**6.71**	54	24
24	HAM	Armistead Ave	HRC Pkwy/Armistead Pointe Pkwy	**6.67**	45	29
25	POQ	Wythe Creek Rd	Victory Blvd/Little Florida Rd	**6.55**	78	27
26	VB	First Colonial Rd	Laskin Rd	**6.21**	29	157
27	NN	Jefferson Ave	Fort Eustis Blvd	**5.94**	44	36
28	HAM	Mercury Blvd	Fox Hill Rd/Cherry Acres Dr	**5.65**	46	57
29	HAM	Power Plant Pkwy	Briarfield Rd/Queen St	**5.61**	73	22
30	NN	Jefferson Ave	J Clyde Morris Blvd	**5.42**	12	64
31	HAM	Mercury Blvd	Armistead Ave	**5.23**	16	89
32	VB	Kempsville Rd	Centerville Tpke	**5.21**	40	119
33	VB	Drakesmile Rd/London Bridge Rd	Shipps Corner Rd/London Bridge Rd	**5.07**	48	44
34	CHES	Dominion Blvd	Cedar Rd	**5.05**	51	40

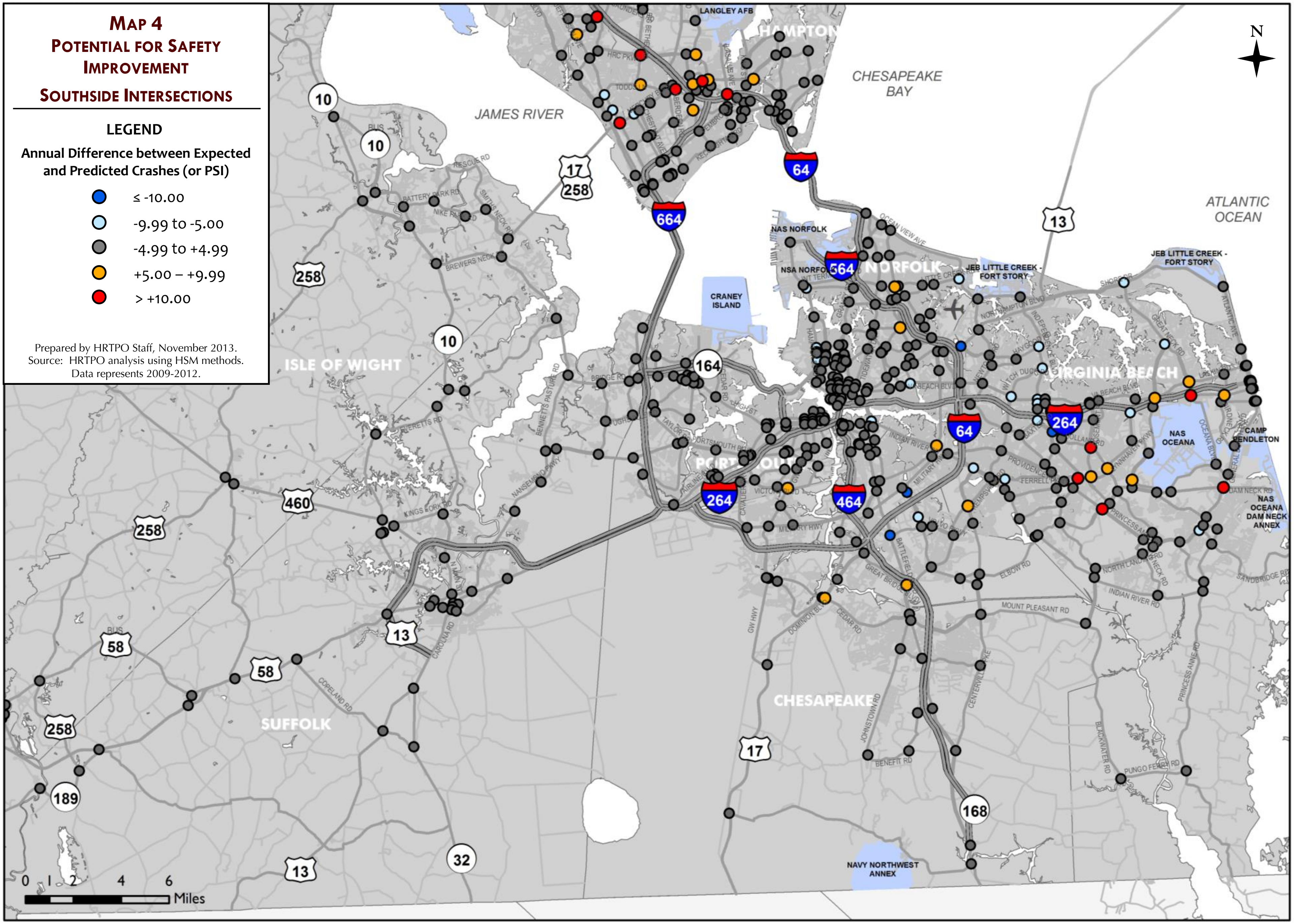
TABLE 6 – INTERSECTIONS WITH A POTENTIAL FOR SAFETY IMPROVEMENT GREATER THAN 5

Source: HRTPO analysis using HSM methodology. Data included in this table represents the years 2009-2012.

EPDO = Equivalent Property Damage Only. More information on the EPDO Crash Rate is included in Part I of this study.



MAP 3
POTENTIAL FOR SAFETY IMPROVEMENT
PENINSULA INTERSECTIONS
LEGEND
Annual Difference between Expected and Predicted Crashes (or PSI)
≤ -10.00
-9.99 to -5.00
-4.99 to +4.99
+5.00 – +9.99
> +10.00
Prepared by HRTPO Staff, November 2013.
Source: HRTPO analysis using HSM methods.
Data represents 2009-2012.
N
JAMES CITY
GLOUCESTER
YORK
NEWPORT NEWS
SURRY
HAMPTON
CAMP PEARY
NAVAL WEAPONS STATION YORKTOWN
COAST GUARD TRAINING CENTER
FORT EUSTIS
NASA LANGLEY
LANGLEY AFB
NAS NORFOLK
YORK RIVER
JAMES RIVER
CHESAPEAKE BAY
COLONIAL PKWY
0 1 2 4 6
Miles


MAP 4
POTENTIAL FOR SAFETY IMPROVEMENT
SOUTHSIDE INTERSECTIONS
LEGEND
Annual Difference between Expected and Predicted Crashes (or PSI)
≤ -10.00
-9.99 to -5.00
-4.99 to +4.99
+5.00 – +9.99
> +10.00
Prepared by HRTPO Staff, November 2013.
Source: HRTPO analysis using HSM methods.
Data represents 2009-2012.
N
JAMES RIVER
CHESAPEAKE BAY
ATLANTIC OCEAN
LANGLEY AFB
HAMPTON
NAS NORFOLK
NSA NORFOLK
NORFOLK
JEB LITTLE CREEK - FORT STORY
CRANEY ISLAND
ISLE OF WIGHT
VIRGINIA BEACH
NAS OCEANA
CAMP PENDLETON
NAS OCEANA DAM NECK ANNEX
PORTSMOUTH
CHESAPEAKE
SUFFOLK
NAVY NORTHWEST ANNEX
0 1 2 4 6
Miles

General Crash Countermeasures

A number of crash countermeasures exist to address roadway safety issues. According to the Highway Safety Manual (HSM), a "countermeasure" is a roadway strategy intended to decrease crash frequency or severity, or both, at a site[18]. The National Cooperative Highway Research Program (NCHRP) and other research programs have conducted studies to evaluate crash countermeasures and their potential. The purpose of this section is to discuss the use and application of crash countermeasures to improve roadway safety in Hampton Roads. The main objectives of this section are to:

- Describe the countermeasure selection process
- Provide examples of factors contributing to the cause of crashes and crash countermeasures for various crash patterns, and
- Assess countermeasure effectiveness using Crash Modification Factors (CMF) and Crash Reduction Factors (CRF) for various safety improvement types.

Countermeasure Selection Process

According to the HSM, there are three primary steps to selecting a countermeasure(s) for a crash site:

1. Identify factors contributing to the cause of crashes at the subject site;
2. Identify countermeasures which may address the contributing factors; and
3. Assess countermeasure effectiveness – benefit/cost analysis.

The process of diagnosing the problem and identifying countermeasures is a skill developed through experience and often involves engineering judgment. Some countermeasures may be identified during a field study, while others may be developed upon analysis of observed crash data patterns using collision diagrams. Many safety problems have multiple solutions (i.e. a combination of countermeasures), thus it is important to identify all available options. Consideration must also be given to what is physically, financially, and politically feasible in each jurisdiction. According to the HSIP Manual[19], three questions should be answered for each type of crash identified:

1. What road user actions lead to the occurrence of crashes?
2. What site conditions contribute to these driver actions?
3. What can be done to reduce the chances of such actions, i.e. what are the potential countermeasures?

1 & 2 - Identifying Causes and Countermeasures

Listed in **Figures 8A - 8L** are examples of probable causes of crashes and corresponding general countermeasures by crash pattern. This list was produced by VDOT for the state's Highway Safety Improvement Program (HSIP) project application process[20]. It is not intended to be a comprehensive list for every crash type – all crashes have unique characteristics that may require additional countermeasures to remedy the problem.

[18] American Association of State Highway and Transportation Officials, *Highway Safety Manual*, 1st Edition, Volumes 1, 2010, p. 6-1.

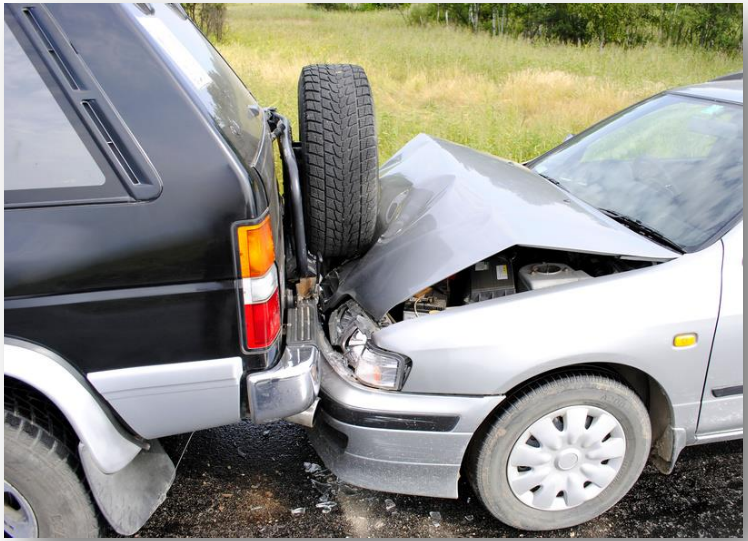
[19] US Department of Transportation, Federal Highway Administration (FHWA), *Highway Safety Improvement (HSIP) Manual*, Report No. FHWA-SA-09-029, January 2010, p. 3-10.

[20] *http://www.virginiadot.org/business/resources/ted_hsip_2011/HSIP_General_Crash_Pattern_and_Countermeasures.pdf*

PROBABLE CAUSE	GENERAL COUNTERMEASURES
Driver not aware of intersection	➤ Install/improve warning signs
	➤ Consider flashing signal
Slippery surface	➤ Overlay pavement
	➤ Provide adequate drainage
	➤ Groove pavement
	➤ Provide "slippery when wet" signs
Large number of turning vehicles	➤ Create left or right-turn lanes
	➤ Prohibit turns
	➤ Increase curb radii
Inadequate roadway lighting	➤ Improve roadway lighting
Lack of adequate gaps	➤ Provide traffic signal (if warranted)
	➤ Provide stop signs
Crossing Pedestrians	➤ Install/improve signing or marking of pedestrian crosswalks
Excessive speed on approach	➤ Reduce speed limit on approaches

FIGURE 8A – REAR-END COLLISIONS AT UNSIGNALIZED INTERSECTIONS

Source: http://www.floridainjurylawyer-blog.com



PROBABLE CAUSE	GENERAL COUNTERMEASURES
Slippery surface	➤ Overlay pavement
	➤ Provide adequate drainage
	➤ Groove pavement
	➤ Reduce speed limit on approaches
	➤ Provide "slippery when wet" signs
Large number of turning vehicles	➤ Create left or right-turn lanes
	➤ Prohibit turns
	➤ Increase curb radii
	➤ Provide special phase for left-turning traffic
Poor visibility of signals	➤ Install/improve advance warning devices
	➤ Install overhead signals
	➤ Install 12 inch signal lenses
	➤ Install visors
	➤ Install back plates
	➤ Relocate signal heads
	➤ Add additional signal heads
	➤ Remove obstacles
	➤ Reduce speed limit on approaches
Inadequate signal timing	➤ Adjust yellow phase
	➤ Provide progression through a set of signalized intersections
	➤ Add all-red clearance phase
Unwarranted signals	➤ Remove signals (see MUTCD)
Inadequate roadway lighting	➤ Improve roadway lighting
Crossing Pedestrians	➤ Install/improve signing or marking of pedestrian crosswalks
	➤ Provide pedestrian "walk" phase

FIGURE 8B – REAR-END COLLISIONS AT SIGNALIZED INTERSECTIONS

PROBABLE CAUSE	GENERAL COUNTERMEASURES
Restricted sight distance	➤ Remove sight obstructions
	➤ Restrict parking near corners
	➤ Install stop signs
	➤ Install warning signs
	➤ Install signal
	➤ Install yield signs
	➤ Channelize intersections
	➤ Install advance markings to supplement signs
	➤ Install guide markings
Large total intersection volume	➤ Install signal
	➤ Reroute through traffic
Excessive speed on approaches	➤ Install rumble strips
Inadequate roadway lighting	➤ Improve roadway lighting
Inadequate advance warning signs	➤ Install advance intersection warning signs
Inadequate traffic control devices	➤ Upgrade traffic control devices
	➤ Increase enforcement

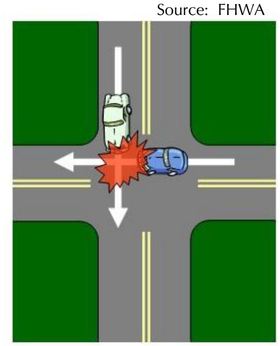
FIGURE 8C – RIGHT-ANGLE COLLISIONS AT UNSIGNALIZED INTERSECTIONS

Source: FHWA

PROBABLE CAUSE	GENERAL COUNTERMEASURES
Restricted sight distance	➤ Remove sight obstructions
	➤ Restrict parking near corners
	➤ Install warning signs
	➤ Reduce speed limit on approaches
	➤ Channelize intersections
	➤ Install advance markings to supplement signs
Excessive speed on approaches	➤ Increase yellow phase
	➤ Install rumble strips
Poor visibility of signals	➤ Install/improve advance warning devices
	➤ Install overhead signals
	➤ Install 12 inch signal lenses
	➤ Install visors
	➤ Install back plates
	➤ Relocate signal heads
	➤ Add additional signal heads
	➤ Add illuminated name signs
Inadequate signal timing	➤ Adjust yellow phase
	➤ Add all-red clearance phase
	➤ Improve controller
	➤ Install signal actuation
	➤ Retime signals
	➤ Provide progression through a set of signalized intersections
Inadequate roadway lighting	➤ Improve roadway lighting
Inadequate advance warning signs	➤ Install advance intersection warning signs
Large total intersection volume	➤ Retime signals
	➤ Add traffic lane

FIGURE 8D – RIGHT-ANGLE COLLISIONS AT SIGNALIZED INTERSECTIONS

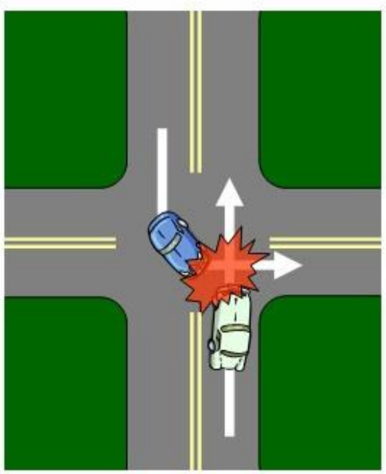
Source: FHWA



PROBABLE CAUSE	GENERAL COUNTERMEASURES
Large volume of left-turns	➤ Create one-way street
	➤ Widen road
	➤ Provide left-turn signal phases
	➤ Prohibit left-turns
	➤ Reroute left-turn traffic
	➤ Channelize intersection
	➤ Install stop signs
	➤ Revise signal sequence
	➤ Provide turning arrows/guide markings
	➤ Provide traffic signal (if warranted)
	➤ Retime traffic signals
Restricted sight distance	➤ Remove obstacles
	➤ Provide adequate channelization
	➤ Provide special phase for left-turning traffic
	➤ Provide left-turn slots
	➤ Install warning signs
Too short yellow phase	➤ Increase yellow phase
	➤ Provide all red phase
Absence of special left-turning phase	➤ Provide special phase for left-turning traffic
Excessive speed on approaches	➤ Reduce speed limit on approaches

FIGURE 8E – LEFT-TURN HEAD-ON COLLISIONS

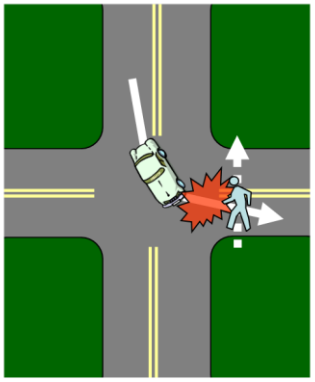
Source: FHWA



PROBABLE CAUSE	GENERAL COUNTERMEASURES
Restricted sight distance	➤ Remove sight obstructions
	➤ Install pedestrian crossings
	➤ Install/improve pedestrian crossing signs
	➤ Reroute pedestrian paths
	➤ Prohibit curb parking near crosswalks
Inadequate protection for pedestrians	➤ Add pedestrian refuge islands
	➤ Install pedestrian barriers
School crossing area	➤ Use crossing guard at school crossing areas
Inadequate signals	➤ Install pedestrian signals
Inadequate phasing signal	➤ Change timing of pedestrian phase
Driver had inadequate warning of frequent mid-block crossings	➤ Prohibit parking
	➤ Install warning signs
	➤ Lower speed limit
	➤ Install pedestrian barriers
Inadequate pavement markings	➤ Install new thermoplastic markings
	➤ Supplement markings with appropriate signing
	➤ Upgrade pavement markings
Inadequate gaps at unsignalized intersections	➤ Provide traffic signal (if warranted)
	➤ Install pedestrian crosswalk and signs
	➤ Install pedestrian signals
Inadequate roadway lighting	➤ Improve roadway lighting
Excessive vehicle speed	➤ Install proper warning signs
	➤ Install pedestrian barriers
	➤ Increase enforcement

FIGURE 8F – PEDESTRIAN-VEHICLE COLLISIONS

Source: FHWA



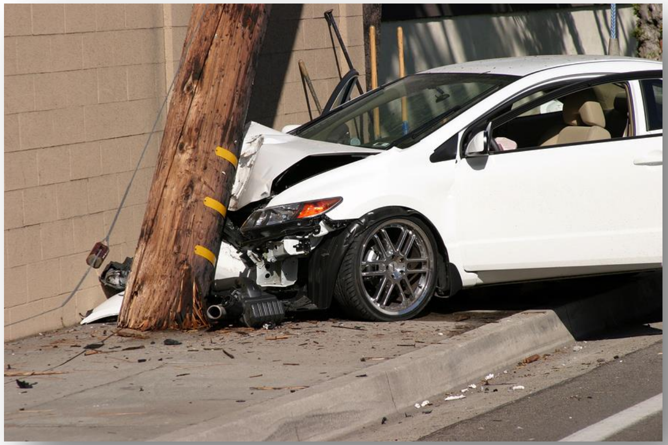
PROBABLE CAUSE	GENERAL COUNTERMEASURES
Slippery pavement	➤ Overlay existing pavement
	➤ Provide adequate drainage
	➤ Groove existing pavement
	➤ Reduce speed limit
	➤ Provide "slippery when wet" signage
Roadway design inadequate for traffic conditions	➤ Widen lanes
	➤ Relocate islands
	➤ Close curb lanes
	➤ Install guardrails
Poor delineation	➤ Install/improve pavement markings
	➤ Install roadside delineators
	➤ Install advance warning signs
Inadequate roadway lighting	➤ Improve roadway lighting
Inadequate shoulder	➤ Upgrade roadway shoulders
Improper channelization	➤ Improve channelization
Inadequate pavement maintenance	➤ Perform road surface repair
Poor visibility	➤ Increase size of signs

FIGURE 8G – RUN-OFF-ROADWAY COLLISIONS

PROBABLE CAUSE	GENERAL COUNTERMEASURES
Obstructions in or too close to roadway	➤ Remove obstacles
	➤ Install barrier curbing
	➤ Install breakaway features to light poles, signposts, etc.
	➤ Install guardrail
	➤ Install crash cushioning devices
Inadequate roadway lighting	➤ Improve roadway lighting
Inadequate pavement markings	➤ Install reflector pavement markings
Inadequate signs, delineators and guardrails	➤ Install reflector paint and/or reflectors on the obstruction
Inadequate roadway design	➤ Provide proper superelevation
	➤ Improve superelevation at curves
	➤ Install appropriate warning signs and delineators
Slippery pavement	➤ Improve skid resistance
	➤ Provide adequate drainage
	➤ Provide "slippery when wet" signage
	➤ Provide wider lanes

FIGURE 8H – FIXED OBJECT COLLISIONS

Source: www.autoinsurance.net



PROBABLE CAUSE	GENERAL COUNTERMEASURES
Inadequate roadway design	➤ Create one-way streets to provide wider lanes
Improper road maintenance	➤ Perform necessary road surface repairs
Inadequate shoulders	➤ Improve shoulders
Excessive vehicle speed	➤ Install median devices
	➤ Remove constrictions such as parked vehicles
Inadequate pavement markings	➤ Install or refurbish center lines, lane lines, and pavement edge lines
	➤ Install reflectorized lines, edges
Inadequate channelization	➤ Install acceleration and deceleration lanes
	➤ Channelize intersection
	➤ Provide turning bays
Inadequate signing	➤ Place direction and lane change signs to give proper advance warning
	➤ Add illuminated name signs

FIGURE 8I – SIDESWIPE AND HEAD-ON COLLISIONS

PROBABLE CAUSE	GENERAL COUNTERMEASURES
Left-turning vehicles	➤ Install median devices
	➤ Install two-way left-turn lanes
Improperly located driveways	➤ If possible, regulate minimum spacing of driveways
	➤ Regulate minimum corner clearance
	➤ If possible, move driveway to side street
	➤ Install curbing to define driveway locations
	➤ If possible, consolidate adjacent driveways
Right-turning vehicles	➤ Provide right-turn lanes
	➤ Restrict parking near driveways
	➤ Increase the width of driveways
	➤ Widen through lanes
	➤ Increase curb radii
Large volume of through traffic	➤ If possible, move driveway to side street
	➤ Construct a local service road
	➤ Reroute through traffic
Large volume of driveway traffic	➤ Signalize driveway
	➤ Provide acceleration and deceleration lanes
	➤ Channelize driveway
Restricted sight distance	➤ Remove sight obstructions
	➤ Restrict parking near driveway
	➤ Install/improve street lighting
	➤ Reduce speed limit
Inadequate roadway lighting	➤ Improve street lighting

FIGURE 8J – DRIVEWAY-RELATED COLLISIONS

PROBABLE CAUSE	GENERAL COUNTERMEASURES
Inadequate pavement markings	➤ Upgrade pavement markings
Slippery pavement	➤ Overlay existing pavement
	➤ Groove existing pavement
	➤ Reduce speed limit
	➤ Provide "slippery when wet" signage
	➤ Skid-proof roadway
Inadequate drainage	➤ Provide adequate drainage

FIGURE 8K – WET-PAVEMENT COLLISIONS

PROBABLE CAUSE	GENERAL COUNTERMEASURES
Poor visibility or lighting	➤ Install/improve street lighting
	➤ Install/improve delineation markings
	➤ Install/improve warning signs
Poor sign quality	➤ Upgrade signing
	➤ Provide illuminated signs
Inadequate channelization or delineation	➤ Install pavement markings
	➤ Improve delineation markings
	➤ Provide raised markers
	➤ Upgrade advance warning signing

FIGURE 8L – NIGHTTIME COLLISIONS

Source: www.southboroughnews.com

3 - Assess Countermeasure Effectiveness – B/C Analysis

An important step toward developing countermeasures for safety issues is assessing the effectiveness of individual or groups of countermeasures prior to the final selection of treatments. This assessment can be accomplished though a benefit/cost (B/C) analysis, which compares all of the expected benefits associated with a countermeasure, expressed in monetary terms, to the cost of implementation. A benefit/cost analysis provides a quantitative measure to help stakeholders prioritize countermeasures and optimize the return on investment[21].

Crash Modification Factors (CMF) and Crash Reduction Factors (CRF)

Crash Modification Factors (CMF) and Crash Reduction Factors (CRF) provide organizations a method for estimating the expected crash reduction and/or benefits for countermeasures. According to the HSIP manual, a CMF is a multiplicative factor used to compute the expected number of crashes after implementing a given countermeasure at a specific site, while a CRF is the percentage crash *reduction* that might be expected after implementing a given countermeasure[22]. The relationship between CMFs and CRFs are relatively simple, as shown in the following equation:

$CMF = 1.0 - CRF/100$

As an example, a CRF of 20(%) results in a CMF of (1.0-20/100) = 0.80. A CRF of 20 means a twenty percent crash reduction can be expected, while a CMF of 0.80 means that 80 percent of existing crashes can be expected after implementing the countermeasure. A CMF > 1.0 or CRF < 0 means an increase in crashes can be expected.

For many high crash locations, more than one treatment may be implemented at the same time. According to the HSIP manual, CMFs are assumed to be multiplicative, i.e. one may multiply them by each other to calculate a combined CMF ($CMF_{combined} = CMF_1 \times CMF_2 \times CMF_3 \times \ldots CMF_i$). It is important to note that one should multiply CMFs together only if the effects of each CMF are independent. Else one may overestimate the combined effect of multiple countermeasures, especially when more than one countermeasure addresses the same crash type. Engineering judgment is necessary when using multiple countermeasures.

To assist safety professionals with this analysis, the Federal Highway Administration (FHWA) released a Desktop Reference for Crash Reduction Factors in September 2008[23]. Based on available data and studies, this reference estimates the crash reduction that is expected if a specific countermeasure or group of countermeasures is implemented. It covers intersections, roadway departure and other non-intersection crashes, and pedestrian crashes.

CMFs are based on research and are generally available for engineering countermeasures. In 2009, FHWA launched the Crash Modification Factors Clearinghouse (www.cmfclearinghouse.org), an online database and search tool designed to provide access to studies that have been published on various types of improvements intended to reduce crashes. The objective of this website is to provide the most up-to-date factors and supporting documentation to help transportation engineers identify countermeasure(s) for their safety needs. Within the website, one can search to find CMFs or submit one's own CMFs to be included in the clearinghouse. Because some papers have not been peer-reviewed, the CMFs are provided with a confidence level rating. The CMF Clearinghouse is maintained by the UNC Highway Safety Research Center with funding from the FHWA.

To assist with HSIP benefit/cost analyses in Virginia, VDOT has published CRFs for various types of safety improvements on the Highway Safety Program (HSP) proposed safety improvement form[24] (**Table 7**). The form is an Excel spreadsheet with accompanying tables intended for proposed

[21] US Department of Transportation, Federal Highway Administration (FHWA), *Highwasy Safety Improvement (HSIP) Manual*, Report No. FHWA-SA-09-029, January 2010, p. 4-3.
[22] Ibid.

[23] US Department of Transportation, Federal Highway Administration (FHWA), *Desktop Reference for Crash Reduction Factors*, Report No. FHWA-SA-08-011, September 2008.
[24] *http://www.virginiadot.org/business/resources/ted_hsip_2011/FY2013-14HSP_Proposal_Form.xls*

safety improvements in Virginia. The CRFs included in this form were developed by VDOT's Traffic Engineering Division safety section and are based on a literature review of the best available research and engineering judgment. The CRFs contained within VDOT's form (reproduced pages) will be used in the next section of this study to conduct the benefit-cost analysis of countermeasures for high crash locations in Hampton Roads.

Photos of select crash countermeasures that are listed in **Table 7** are shown in **Figure 9**.

IMPROVEMENT TYPE	Service Life	Crash Reduction Factor (CRF)			Target Crashes												
		Fatal	Injury	PDO	All	Head On	Rear End	Right Angle	Sideswipe	Left Turn	Right Turn	Fixed Object	Pedestrian	Run Off Road	Overturn	Wet Pavement	Night
Traffic Sign Improvement																	
Warning Sign																	
Curve Warning	10	30%	30%	30%		X								X	X		X
School zone	10	15%	15%	15%	X												
Regulatory Signs																	
Stop Sign (Two-way)	10	30%	30%	30%				X		X	X		X				
Yield	10	25%	25%	25%				X	X								
All-way Stop	10	50%	50%	50%				X		X	X		X				
Guide Sign	10	10%	10%	10%	X												
Variable Message Sign	10	25%	25%	25%	X												
Upgrade signs (Increase size, conspicuity)	10	10%	10%	10%													
Flashing light on sign (Linked to signal)	10	25%	25%	25%			X	X						X			
Flashing light on sign (Flashing all time)	10	10%	10%	10%			X	X									
Intersection Related Warning	10	25%	25%	25%			X	X									
Pavement Condition	10	5%	5%	5%												X	
Eliminate Parking at intersection	10	35%	35%	35%				X	X			X	X				
Prohibit turns	10									X	X		X				
Traffic Signal Improvement																	
Install a Traffic Signal	20							X									
3 legs		34%	34%	34%													
4 legs		67%	67%	67%				X									
Remove Traffic Signal and install 4-way stop	20	24%	24%	24%	X												
Signal upgrading (Hardware)	20	20%	20%	20%	X												
Signal Phasing																	
Add All-Red Interval/Increase yellow time	50	30%	30%	30%				X									
Interconnect and Optimize Signals	5	25%	25%	25%	X												
Add pedestrian phase	20	50%	50%	50%									X				
Optimize Signal Timing	5	10%	10%	10%	X												
Add exclusive left turn phase	20	25%	25%	25%						X							
Add protected/permissive left turn phase	25	10%	10%	10%						X							
Change from Pretimed to Actuated	10					X	X	X	X	X							

TABLE 7 – VDOT HIGHWAY SAFETY PROGRAM (HSP) CRASH REDUCTION FACTORS (CRF)

Source: VDOT

IMPROVEMENT TYPE		Service Life	Crash Reduction Factor (CRF)			Target Crashes												
			Fatal	Injury	PDO	All	Head On	Rear End	Right Angle	Sideswipe	Left Turn	Right Turn	Fixed Object	Pedestrian	Run Off Road	Overturn	Wet Pavement	Night
Channelization Improvements																		
	Add exclusive LT lane (with physical seperation)	8	48%	48%	48%			X			X							
	Increase turn lane length (with physical seperation)	8	15%	15%	15%			X										
	Add Two Way LT lane (with physical seperation)	8	25%	25%	25%			X			X			X	X			
	Add exclusive RT lane (Rural Unsigalized)	8	26%	26%	26%				X	X		X						
	Add exclussive RT lane (Urban Signalized)	8	8%	8%	8%				X	X		X						
	Install Roundabout	20	72%	72%	72%	X												
Pavement Improvement																		
Marking	Improving markings (conspicuity)	7	20%	20%	20%	X											X	X
	Two way Turn Ln (4 lane to 3 lane or 2 to 3)	7	25%	25%	25%					X	X	X					X	X
	Center Line Marking	7	25%	25%	25%		X			X(O)							X	X
	Left Turn Lane	7	25%	25%	25%			X			X						X	X
	Edgeline markings	7	25%	25%	25%								X		X	X		
	Raised Pavement Marking (RPM)	8	15%	15%	15%	X												
	Add-No Passing Zone	7	40%	40%	40%		X			X								
	Install post-mounted Delineators	10	30%	30%	30%													X
	Pedestrian Crosswalk	7	25%	25%	25%									X				
	Widen marking	7	25%	25%	25%										X			
Widening	Widen the shoulder width (paved, ADT>2k)	12					X			X			X		X	X		
	From 0 ft to 2 ft		13%	13%	13%													
	From 2 ft to 4 ft		12%	12%	12%													
	From 4 ft to 6 ft		13%	13%	13%													
	From 6 ft to 8 ft		13%	13%	13%													
	Widen lane width	20				X												
	From 9 ft to 10 ft		13%	13%	13%													
	From 9 ft to 11 ft		30%	30%	30%													
	From 9 ft to 12 ft		33%	33%	33%													
Treatment	Pavement skid resistance overlay	8	25%	25%	25%	X												
	Superelevation	8	25%	25%	25%								X		X	X		
	Rumble Strip at stop controlled approach	8	25%	25%	25%			X	X									
	Shoulder Rumble Strip	8	40%	40%	40%	X												
	Centerline Rumble Strip	8	21%	21%	21%		X			X(O)								

Table 7 – VDOT Highway Safety Program (HSP) Crash Reduction Factors (CRF) (continued)

Source: VDOT

IMPROVEMENT TYPE	Service Life	Crash Reduction Factor (CRF)			Target Crashes												
		Fatal	Injury	PDO	All	Head On	Rear End	Right Angle	Sideswipe	Left Turn	Right Turn	Fixed Object	Pedestrian	Run Off Road	Overturn	Wet Pavement	Night
Construction/Reconstruction																	
Add lanes (without physical seperation)						X	X	X	X	X				X	X		
Lengthen Acceleration/Deceleration Lane	10	10%	10%	10%			X										
Aux Left Turn lane	10	43%	43%	43%			X			X					X		
Aux Right Turn Lane	10	21%	21%	21%			X				X						
Install Pedestrian sidewalk	20	50%	50%	50%									X				
Install median barriers	20	60%	10%	-25%		X			X(O)			X		X	X		
Roadside Improvement																	
New / upgrade guardrail	20	35%	35%	5%		X						X		X	X		
Remove fixed object	10	30%	30%	30%					X			X		X	X		
Relocate fixed object	10	30%	30%	30%								X					
Flatten side slope	20	10%	10%	10%								X		X	X		
Impact Attenuator	10	25%	25%	25%	X												
Install Animal fencing (only collisions with animals)		85%	85%	85%													
Increase roadside clear zone recovery distance	10											X		X	X		
Add 5 ft		10%	10%	10%								X		X	X		
Add 8 ft		20%	20%	20%								X		X	X		
Add 10 ft		25%	25%	25%								X		X	X		
Add 15 ft		35%	35%	35%								X		X	X		
Add 20 ft		45%	45%	45%								X		X	X		
Install Breakable Sign support	10	5%	5%	5%								X					
Realignment Improvement																	
Horizontal alignment changes (general)	25	25%	25%	25%	X												
Redesign Intersection	25	25%	25%	25%	X												
Vertical Alignment/Improve vertical curve	25	25%	25%	25%	X												
Improving the Sight Distance	25	30%	30%	30%	X												
Illumination																	
Install the street light/roadway segment	20	25%	25%	25%													X
Lighting-Intersection and Interchange	20	25%	25%	25%													X

TABLE 7 – VDOT HIGHWAY SAFETY PROGRAM (HSP) CRASH REDUCTION FACTORS (CRF) (CONTINUED)

Source: VDOT

IMPROVEMENT TYPE	Service Life	Crash Reduction Factor (CRF)			Target Crashes												
		Fatal	Injury	PDO	All	Head On	Rear End	Right Angle	Sideswipe	Left Turn	Right Turn	Fixed Object	Pedestrian	Run Off Road	Overturn	Wet Pavement	Night
Regulation Improvement																	
Two-way to One-way operation	20	50%	50%	50%	X												
Convert two-way stop to four way stop	20	47%	47%	47%													
Prohibit Right Turn on Red at sigalized intersections	10	25%	25%	25%				X		X	X		X				
Drainage																	
Provide adequate drainage	10	50%	50%	50%												X	

Crash Reduction Factor (CRF) - the percentage crash reduction that might be expected after implementing a given countermeasure.

"O" under sideswipe crash type indicate opposite sideswipe crashes only.

Note: The above Crash Reduction Factors (CRF) are based on literature review of the best available research and engineering judgement by the Traffic Engineering Division safety section of Virginia Department of Transportation. Variation from these Crash Reduction Factors may only be allowed under the approval of Central Office Traffic Engineering Division.

Final countermeasure selection should be based on sound engineering judgement and should conform to applicable VDOT and FHWA policies and procedures.

Table 7 – VDOT Highway Safety Program (HSP) Crash Reduction Factors (CRF) (continued)

Source: VDOT

Figure 9 – Crash Countermeasure Examples

Photo Source: FHWA

Optimize Change Intervals at Signalized Intersections

Convert Intersection to Roundabout

Interconnect and Optimize Traffic Signals

Add Channelized Right Turn Lane

FIGURE 9 – CRASH COUNTERMEASURE EXAMPLES (CONTINUED)

Photo Source: FHWA

ELIMINATE PARKING AT INTERSECTION

INSTALL FLASHING LIGHT ON SIGN (LINKED TO SIGNAL)

ADD EXCLUSIVE LEFT TURN PHASE

PROHIBIT TURNS

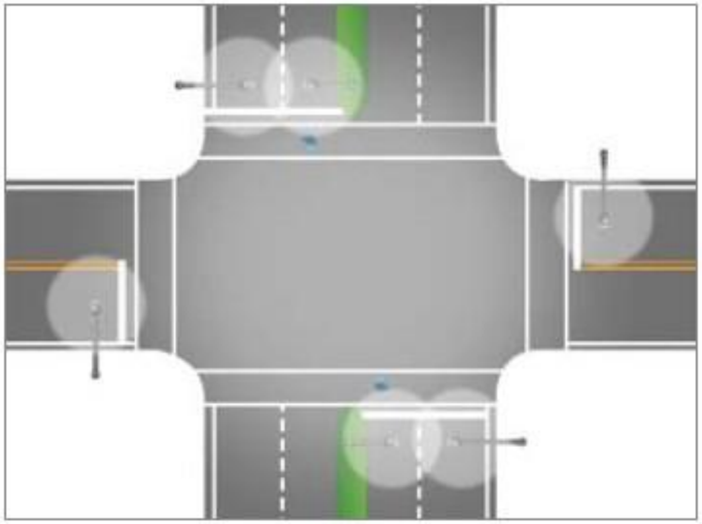
FIGURE 9 – CRASH COUNTERMEASURE EXAMPLES (CONTINUED)

Photo Source: FHWA

IMPROVE PAVEMENT MARKINGS

ADD PEDESTRIAN PHASE

INSTALL SHOULDER RUMBLE STRIP



INSTALL INTERSECTION LIGHTING

LOCATION ANALYSIS

New methods of analyzing roadway safety were previously introduced in this report, including methods from the Virginia Center for Transportation Innovation and Research (VCTIR) and the AASHTO Highway Safety Manual. These methods determine the difference between the number of "expected" crashes – for a particular location – based on crash history and the number of "predicted" crashes based on existing conditions. The difference between the number of "expected" crashes and the number of "predicted" crashes is the Potential for Safety Improvement (PSI).

PSI Rank	Jurisdiction	Facility	Segment From	Segment To	Dir	PSI (Annual Expected Crashes - Predicted Crashes)
1	NOR	I-64	NORTHAMPTON BLVD	I-264	EB	126.67
2	HAM/NOR	I-64/HRBT	MALLORY ST	OCEAN VIEW AVE	EB	67.95
3	PORT/NOR	I-264/DOWNTOWN TUNNEL	EFFINGHAM ST	I-464	EB	44.60
4	HAM/NOR	I-64/HRBT	MALLORY ST	OCEAN VIEW AVE	WB	42.62
5	NOR	I-264	I-64	NEWTOWN RD/WCL VA. BEACH	WB	38.63

TABLE 8 – TOP 5 FREEWAY SEGMENTS WITH THE HIGHEST POTENTIAL FOR SAFETY IMPROVEMENT (PSI)

Source: HRTPO analysis using VCTIR methodology. Data included in this table represents the years 2009-2012.

Freeway segments and intersections throughout Hampton Roads with the highest Potential for Safety Improvement are highlighted in this report for further study and recommendations. The freeway segments in Hampton Roads with the Top 5 highest PSI and the intersections with the Top 10 highest PSI are analyzed in this section.

FREEWAYS

This section provides an analysis of those freeway segments in Hampton Roads with the Top 5 highest Potential for Safety Improvement (**Table 8**). These five segments are the eastbound and westbound Hampton Roads Bridge-Tunnel, eastbound Downtown Tunnel, and segments of I-64 and I-264 approaching the I-64/I-264 interchange in Norfolk.

For each of these five freeway segments, the following information is included:

- A summary sheet, including a map showing the location of the freeway segment, recent traffic volumes, crashes by year and severity, and regional crash levels and rankings.
- The location of crashes on each freeway segment.
- Characteristics of each crash, such as weather, time of day, alcohol use, and the primary driver action leading to the crash.
- Observations and possible causes based on the collision diagram, crash data, and site observations.
- Candidate crash countermeasures

Unlike the intersection analyses completed in the next section, an HSIP benefit-cost analysis for candidate crash countermeasures was not completed for the Top 5 freeway segments because proposed HSIP projects should have cost estimates of less than $1 million. This threshold creates a high number of projects but greatly limits the number of potential freeway projects. Of the 65 roadway projects completed in Hampton Roads using HSIP funds since 2009, only two were on the Interstate system – cable guardrail installation on a portion of I-664 and upgrading sign panels. Additionally, of the 46 HSIP projects that are either currently underway or programmed in future years, only one is on the Interstate system (I-64 ramp lengthening at Route 199).

FREEWAY SEGMENT #1 – I-64 EASTBOUND BETWEEN NORTHAMPTON BOULEVARD AND I-264
NORFOLK

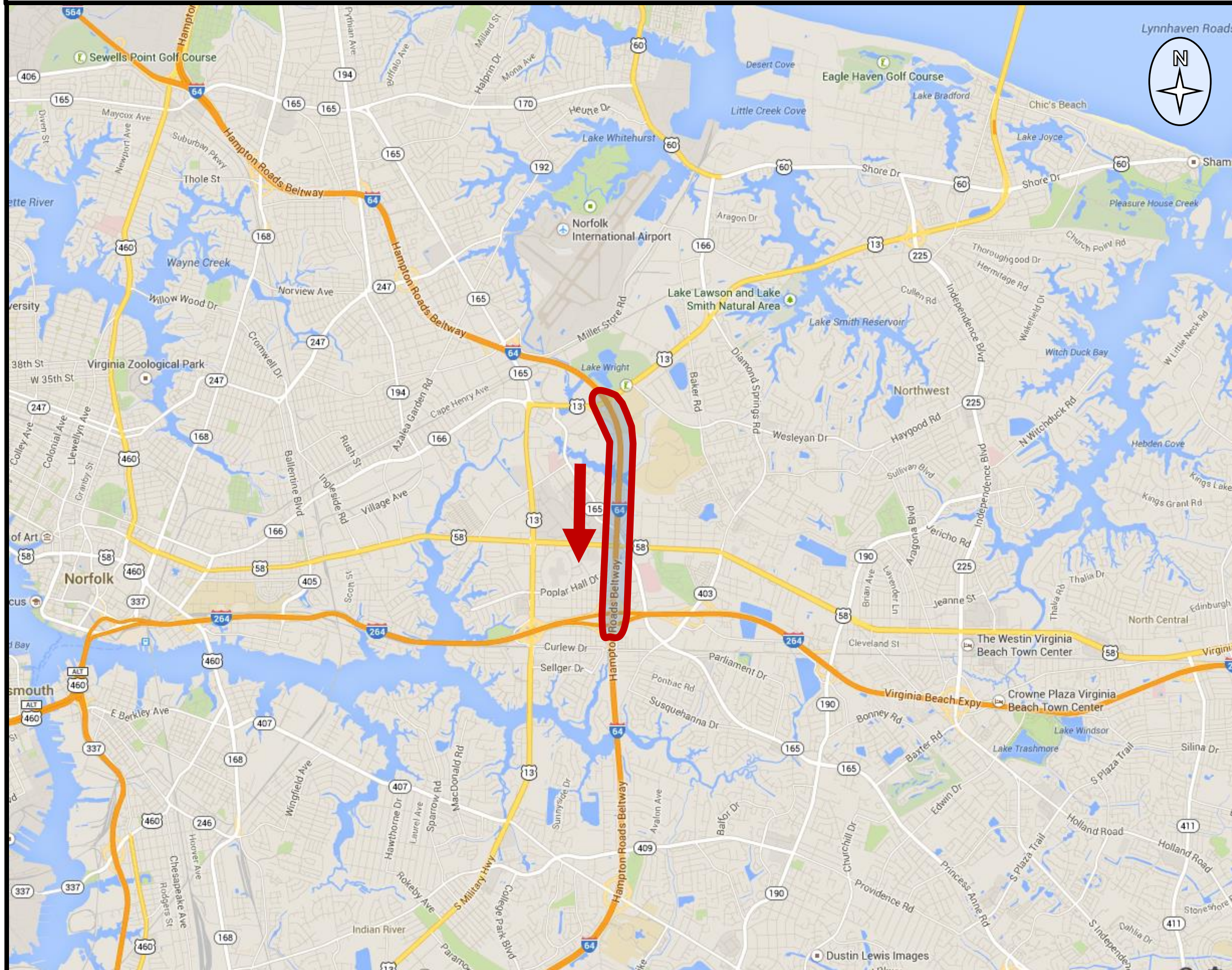


Image source: Google. Data Source: HRTPO analysis of VDOT data. Data included in this table represents the years 2009-2012.
PDO = Property Damage Only Crashes. INJ = Injury Crashes. FAT = Fatality Crashes. F+I = Fatal + Injury Crashes combined.
EPDO = Equivalent Property Damage Only. More information on the EPDO Crash Rate is included in Part I of this study.

FREEWAY DATA

ANNUAL AVERAGE DAILY TRAFFIC VOLUMES BY YEAR

I-64 Eastbound between Northampton Blvd and I-264

2009 – 73,000
2010 – 74,000
2011 – 79,000
2012 – 79,000

CRASH DATA

ANNUAL CRASHES BY YEAR AND SEVERITY

Year	Crashes Per Year PDO	INJ	FAT	TOTAL
2009	103	42	0	145
2010	126	50	0	176
2011	133	49	0	182
2012	148	73	0	221

REGIONAL CRASH LEVELS AND RANKING

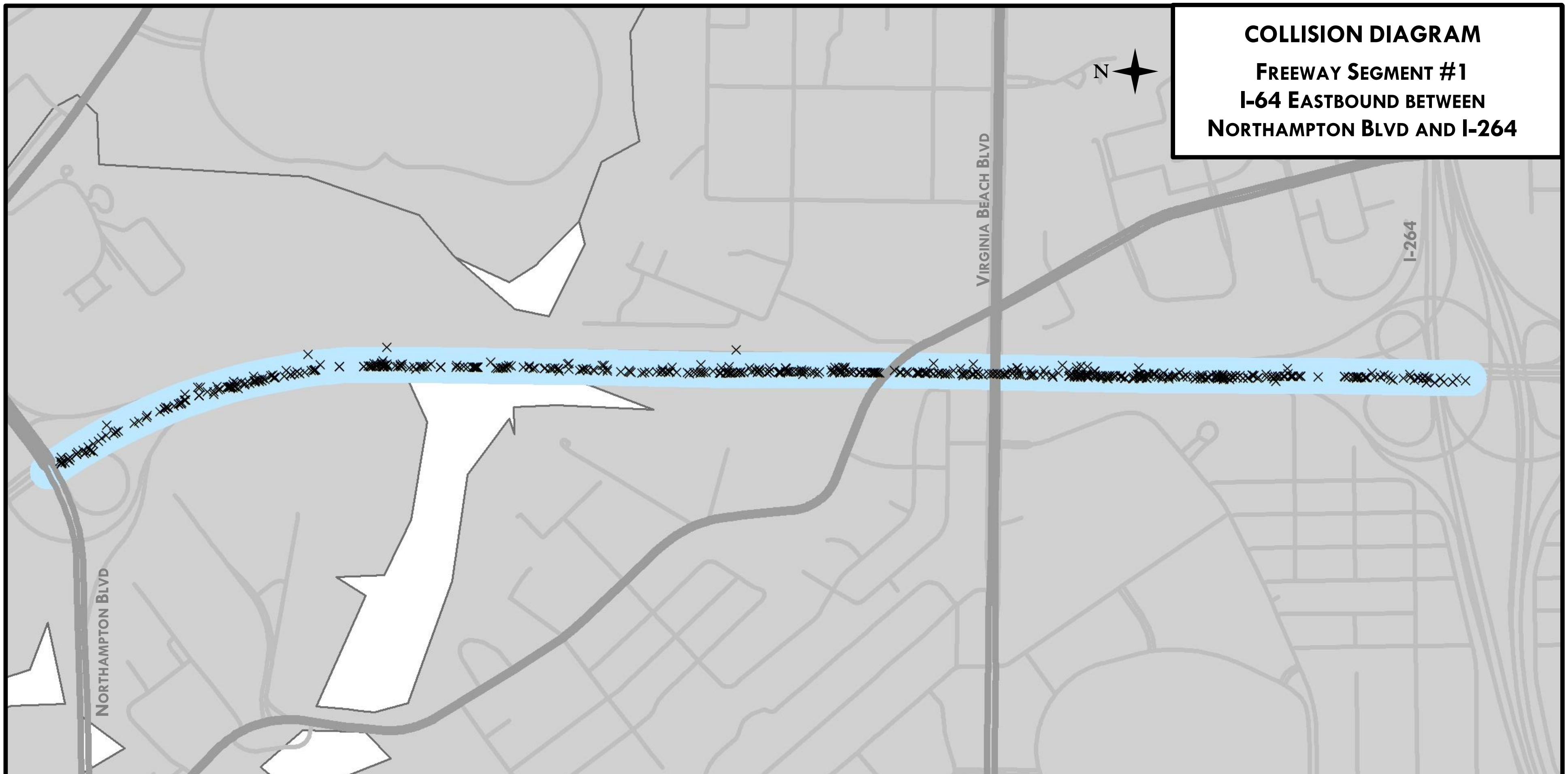
Average Crashes per Year = 181.0 crashes

EPDO Crash Rate = 5.03

Ranks 3rd among 218 freeway segments

Potential for Safety Improvement = +126.7 crashes

Ranks 1st among 218 freeway segments



CRASH CHARACTERISTICS

MOST PREVALENT DRIVER ACTION

Primary Driver Action	I-64 EB - Northampton to I-264	All Safety Study Freeways
Following too close	70.6%	46.3%
Improper/unsafe lane change	9.7%	10.8%
Failure to maintain control	8.8%	20.1%
Exceed speed limit/safe speed	2.5%	4.1%
Avoiding other vehicles	1.1%	1.7%

WEATHER

Weather	I-64 EB - Northampton to I-264	All Safety Study Freeways
Clear/Cloudy	80.9%	79.1%
Mist/Rain/Fog	17.4%	17.3%
Snow/Sleet	0.7%	2.3%
Other/Not Stated	1.0%	1.3%

DRIVING UNDER THE INFLUENCE

Driving Under the Influence	I-64 EB - Northampton to I-264	All Safety Study Freeways
Drinking Involved	2.6%	5.9%

TIME OF DAY

Crash Time	I-64 EB - Northampton to I-264	All Safety Study Freeways
5:00 - 8:59	13.8%	19.2%
9:00 - 14:59	36.2%	27.6%
15:00 - 18:59	41.4%	33.6%
19:00 - 4:59	8.6%	19.7%

Data Source: HRTPO analysis of VDOT data. Data included in this table and map represents the years 2009-2012.

FREEWAY SEGMENT #1 – I-64 EASTBOUND BETWEEN NORTHAMPTON BOULEVARD AND I-264
NORFOLK

OBSERVATIONS & POSSIBLE CAUSES

- Crashes are distributed throughout the entire segment, although the areas with the highest number of crashes are at the Northampton Boulevard on-ramp, and approaching the I-264 off-ramp.
- Backups from the I-264 off-ramp occur on a daily basis and commonly stretch beyond the Kempsville Road overpass.
- Following too close is the primary driver action for 71% of all crashes on this segment, well above the regional freeway average of 46%.
- 78% of all crashes occur between 9:00 am and 7:00 pm, as compared to the regional freeway average of 61%.
- Sight visibility is an issue at the Virginia Beach Boulevard overpass. It is often difficult for eastbound traffic to see the backups from the I-264 off-ramp due to the vertical curvature of the overpass.

- The on-ramp from Northampton Boulevard is only 700 feet in length before tapering. Assuming a design speed of 65 mph on the freeway segment and an entrance curve design speed of 25 mph, the recommended length of the on-ramp is 1,220 feet according to AASHTO standards.

- “Do not cross” lines and signs were installed between the Virginia Beach Boulevard overpass and the I-264 off-ramp in the mid-2000s in order to reduce the number of drivers merging late for the I-264 off-ramp.

CANDIDATE CRASH COUNTERMEASURES

- Reduce congestion by restriping the interchange so that three of the five lanes on I-64 Eastbound are used on the exit, and two lanes are used on the ramp to I-264 Eastbound rather the current one. This will require changes to I-264 Eastbound from Downtown Norfolk.

- Replace the Virginia Beach Boulevard overpass with a bridge that does not restrict the sight distance of I-64 traffic.
- Lengthen the Northampton Boulevard on-ramp to AASHTO standards.

- Consider installing Active Traffic Management (ATM) technologies (which include a queue warning system) to alert drivers of the queue approaching the I-64/I-264 interchange. Studies for an ATM system that was recently installed on I-5 in Seattle indicate an expected 16% reduction in crashes and 30% reduction in injury crashes.
- Reduce congestion levels by implementing or expanding Transportation Demand Management strategies such as telecommuting, alternate work schedules, ridesharing, park and ride lots, and public transportation.

FREEWAY SEGMENT #2 – I-64 EASTBOUND BETWEEN MALLORY STREET AND OCEAN VIEW AVENUE
HAMPTON/NORFOLK

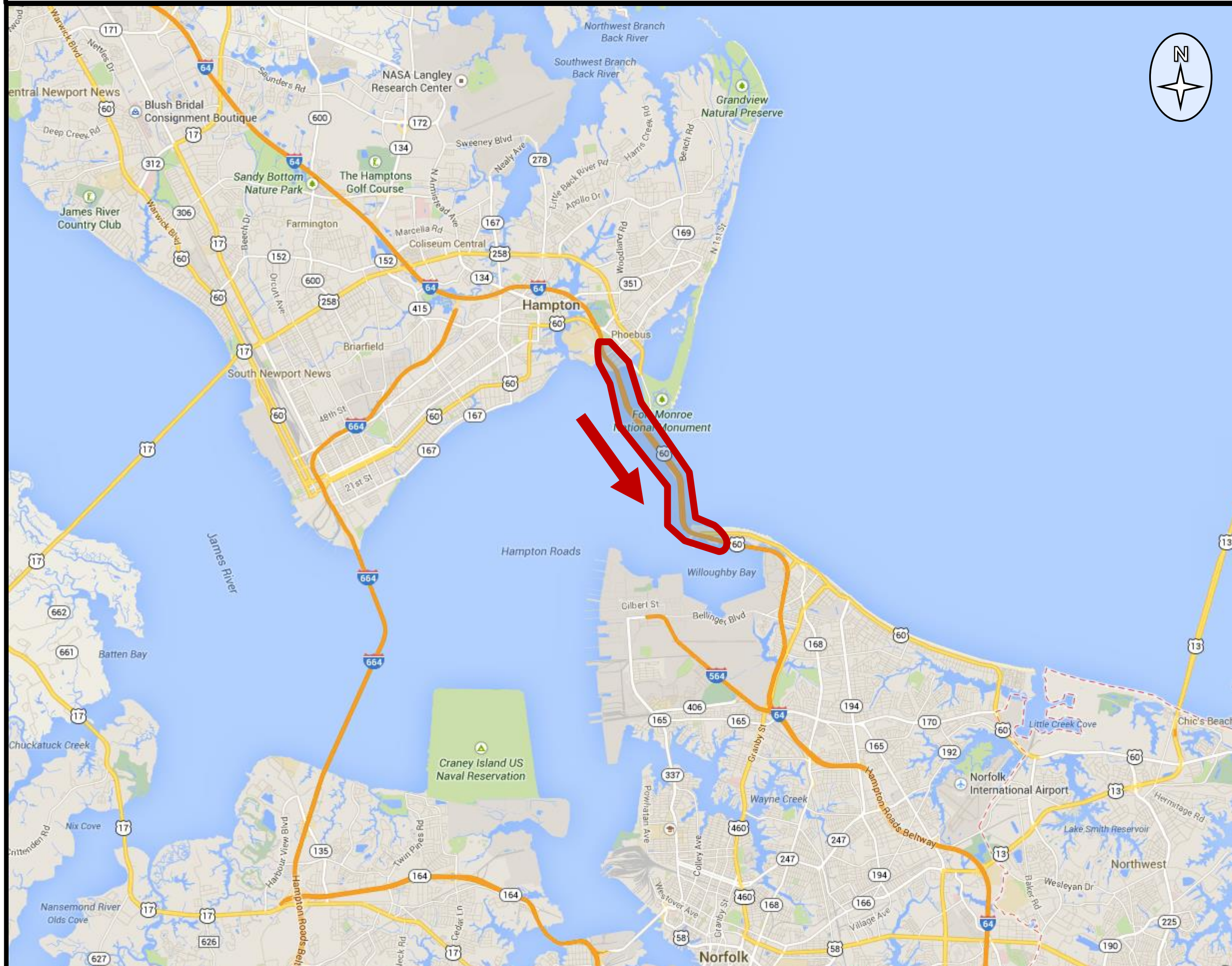


Image source: Google. Data Source: HRTPO analysis of VDOT data. Data included in this table represents the years 2009-2012.
PDO = Property Damage Only Crashes. INJ = Injury Crashes. FAT = Fatality Crashes. F+I = Fatal + Injury Crashes combined.
EPDO = Equivalent Property Damage Only. More information on the EPDO Crash Rate is included in Part I of this study.

FREEWAY DATA

ANNUAL AVERAGE DAILY TRAFFIC VOLUMES BY YEAR

I-64 Eastbound between Mallory Street and Ocean View Ave	2009 – 44,000 2010 – 42,000 2011 – 44,000 2012 – 44,000

CRASH DATA

ANNUAL CRASHES BY YEAR AND SEVERITY

	Crashes Per Year			
Year	PDO	INJ	FAT	TOTAL
2009	85	17	0	102
2010	71	29	0	100
2011	122	46	0	168
2012	137	32	1	170

REGIONAL CRASH LEVELS AND RANKING

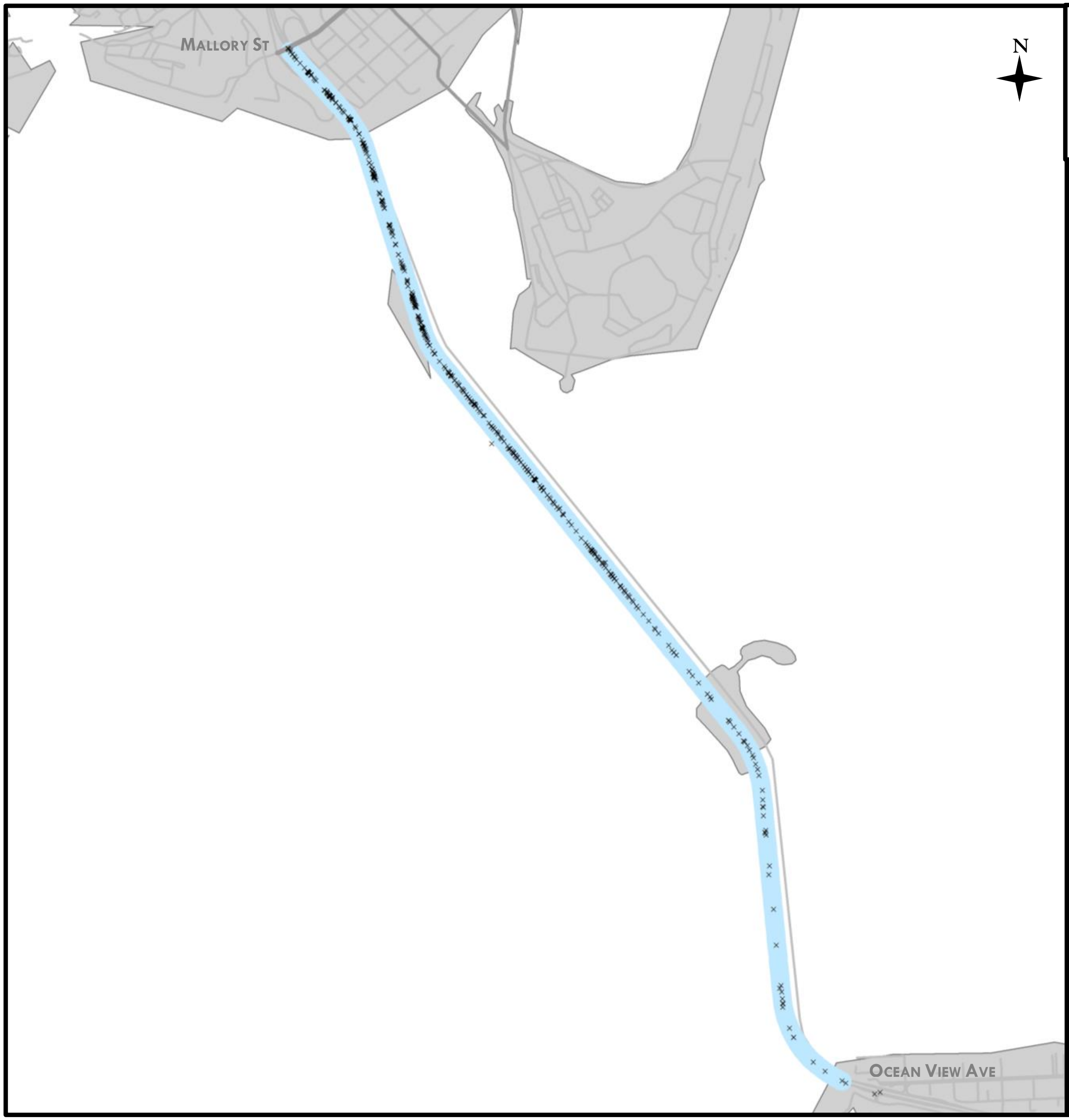
Average Crashes per Year = 135.0 crashes

EPDO Crash Rate = 3.36

Ranks 14th among 218 freeway segments

Potential for Safety Improvement = +68.0 crashes

Ranks 2nd among 218 freeway segments



COLLISION DIAGRAM

FREEWAY SEGMENT #2
I-64 EASTBOUND BETWEEN
MALLORY STREET AND OCEAN VIEW AVE

CRASH CHARACTERISTICS

MOST PREVALENT DRIVER ACTION

Primary Driver Action	I-64 EB - Mallory to Ocean View	All Safety Study Freeways
Following too close	79.8%	46.3%
Failure to maintain control	7.8%	20.1%
Improper/unsafe lane change	3.0%	10.8%
Driver distractions	1.3%	1.1%
Exceed speed limit/safe speed	1.1%	4.1%

WEATHER

Weather	I-64 EB - Mallory to Ocean View	All Safety Study Freeways
Clear/Cloudy	88.7%	79.1%
Mist/Rain/Fog	9.8%	17.3%
Snow/Sleet	0.6%	2.3%
Other/Not Stated	0.9%	1.3%

DRIVING UNDER THE INFLUENCE

Driving Under the Influence	I-64 EB - Mallory to Ocean View	All Safety Study Freeways
Drinking Involved	2.8%	5.9%

TIME OF DAY

Crash Time	I-64 EB - Mallory to Ocean View	All Safety Study Freeways
5:00 - 8:59	21.1%	19.2%
9:00 - 14:59	29.6%	27.6%
15:00 - 18:59	33.9%	33.6%
19:00 - 4:59	15.4%	19.7%

Data Source: HRTPO analysis of VDOT data. Data included in this table and map represents the years 2009-2012.

FREEWAY SEGMENT #2 – I-64 EASTBOUND BETWEEN MALLORY STREET AND OCEAN VIEW AVENUE

HAMPTON/NORFOLK

OBSERVATIONS & POSSIBLE CAUSES

- The areas with the highest number of crashes are at the Mallory Street on-ramp, on the North Island, and within the tunnel itself. The crashes within the tunnel are primarily occurring between the tunnel entrance and the start of the up slope exiting the tunnel.
- Congestion occurs on a regular basis from before the start of this segment at Mallory Street to the tunnel exit.

- Following too close is the primary driver action for 80% of all crashes on this segment, well above the regional freeway average of 46%.
- Although the lane widths within the tunnel are standard 12 foot lanes, there is no shoulder on either side.
- Speed differential within lanes is an issue, particularly on the up slope exiting the tunnel.
- There is a service patrol in place at the tunnel to respond quickly and safety to incidents.

POSSIBLE CRASH COUNTERMEASURES

- Reduce congestion levels at the Hampton Roads Bridge-Tunnel by instituting congestion pricing, or by constructing new capacity such as the Third Crossing.
- Reduce congestion levels at the Hampton Roads Bridge-Tunnel by implementing or expanding Transportation Demand Management strategies such as telecommuting, alternate work schedules, ridesharing, park and ride lots, and public transportation.
- Consider installing Active Traffic Management (ATM) technologies (which include a queue warning system) to alert drivers of the queue approaching the tunnel.

FREEWAY SEGMENT #3 – I-264 EASTBOUND BETWEEN EFFINGHAM STREET AND I-464
PORTSMOUTH/NORFOLK

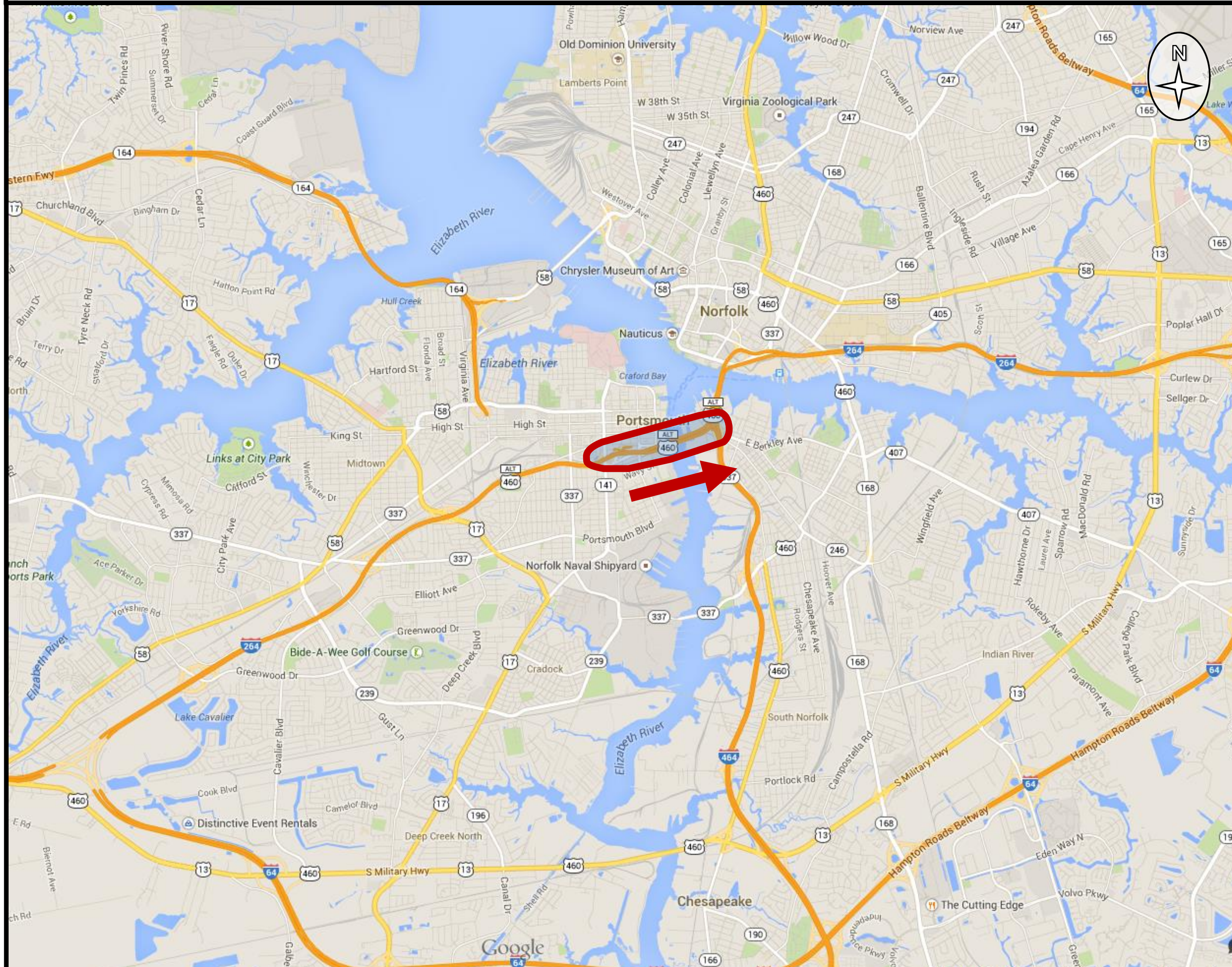


Image source: Google. Data Source: HRTPO analysis of VDOT data. Data included in this table represents the years 2009-2012.
PDO = Property Damage Only Crashes. INJ = Injury Crashes. FAT = Fatality Crashes. F+I = Fatal + Injury Crashes combined.
EPDO = Equivalent Property Damage Only. More information on the EPDO Crash Rate is included in Part I of this study.

FREEWAY DATA

ANNUAL AVERAGE DAILY TRAFFIC VOLUMES BY YEAR

I-264 Eastbound between Effingham Street and I-464

2009 – 44,000
2010 – 43,000
2011 – 44,000
2012 – 44,000

CRASH DATA

ANNUAL CRASHES BY YEAR AND SEVERITY

	Crashes Per Year			
Year	PDO	INJ	FAT	TOTAL
2009	45	24	0	69
2010	33	22	0	55
2011	46	19	0	65
2012	52	23	0	75

REGIONAL CRASH LEVELS AND RANKING

Average Crashes per Year = 66.0 crashes

EPDO Crash Rate = 6.26

Ranks 1st among 218 freeway segments

Potential for Safety Improvement = +44.6 crashes

Ranks 3rd among 218 freeway segments

CRASH CHARACTERISTICS

MOST PREVALENT DRIVER ACTION

Primary Driver Action	I-264 EB - Effingham to I-464	All Safety Study Freeways
Following too close	70.1%	46.3%
Failure to maintain control	8.7%	20.1%
Improper/unsafe lane change	5.3%	10.8%
Exceed speed limit/safe speed	3.8%	4.1%
Did not have right of way	1.5%	0.4%

WEATHER

Weather	I-264 EB - Effingham to I-464	All Safety Study Freeways
Clear/Cloudy	82.6%	79.1%
Mist/Rain/Fog	15.2%	17.3%
Snow/Sleet	1.1%	2.3%
Other/Not Stated	1.1%	1.3%

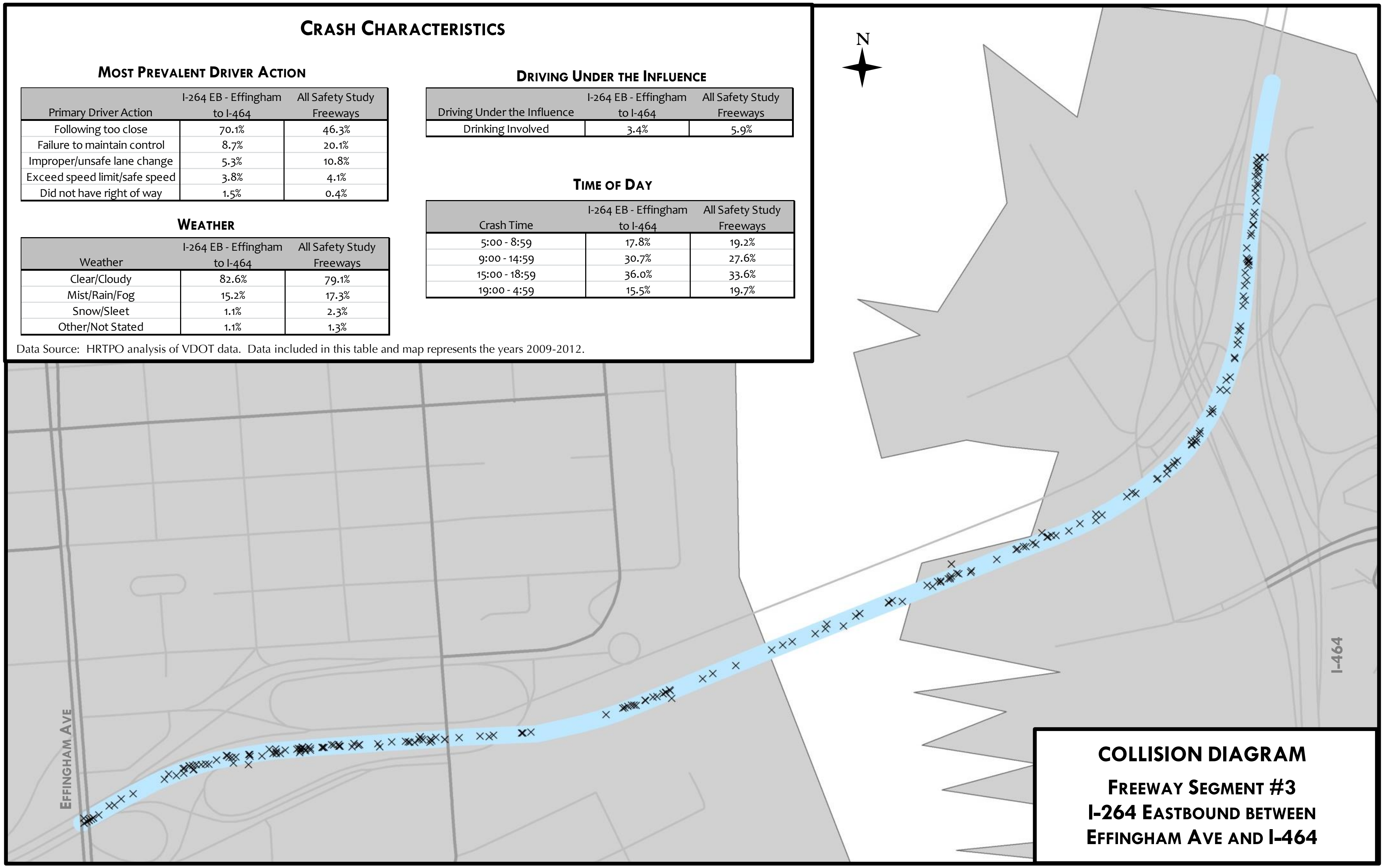
DRIVING UNDER THE INFLUENCE

Driving Under the Influence	I-264 EB - Effingham to I-464	All Safety Study Freeways
Drinking Involved	3.4%	5.9%

TIME OF DAY

Crash Time	I-264 EB - Effingham to I-464	All Safety Study Freeways
5:00 - 8:59	17.8%	19.2%
9:00 - 14:59	30.7%	27.6%
15:00 - 18:59	36.0%	33.6%
19:00 - 4:59	15.5%	19.7%

Data Source: HRTPO analysis of VDOT data. Data included in this table and map represents the years 2009-2012.



COLLISION DIAGRAM

FREEWAY SEGMENT #3
I-264 EASTBOUND BETWEEN EFFINGHAM AVE AND I-464

FREEWAY SEGMENT #3 – I-264 EASTBOUND BETWEEN EFFINGHAM STREET AND I-464
PORTSMOUTH/NORFOLK

OBSERVATIONS & POSSIBLE CAUSES

- The areas with the highest number of crashes are near the tunnel entrance and near the on-ramp from I-464.
- During the 2009-2012 period of this crash analysis, congestion occurred on a regular basis from before the start of this segment at Effingham Avenue to the tunnel exit. However, traffic volumes have dropped and congestion has become nearly nonexistent since tolls were instituted on the Downtown Tunnel on February 1, 2014.

- Following too close is the primary driver action for 70% of all crashes on this segment, well above the regional freeway average of 46%.
- Although the lane widths within the tunnel are standard 12 foot lanes, there is no shoulder on either side.
- Speed differential within lanes is an issue, particularly on the up slope exiting the tunnel.
- There is a service patrol in place at the tunnel to respond quickly and safety to incidents.

POSSIBLE CRASH COUNTERMEASURES

- The number of crashes has likely decreased on this segment due to tolling, which reduced traffic volumes and congestion levels. The number of crashes responded to by the Downtown Tunnel service patrol decreased from 164 crashes in February through April 2013 to 116 crashes in February through April 2014.

FREEWAY SEGMENT #4 – I-64 WESTBOUND BETWEEN OCEAN VIEW AVENUE AND MALLORY STREET
NORFOLK/HAMPTON

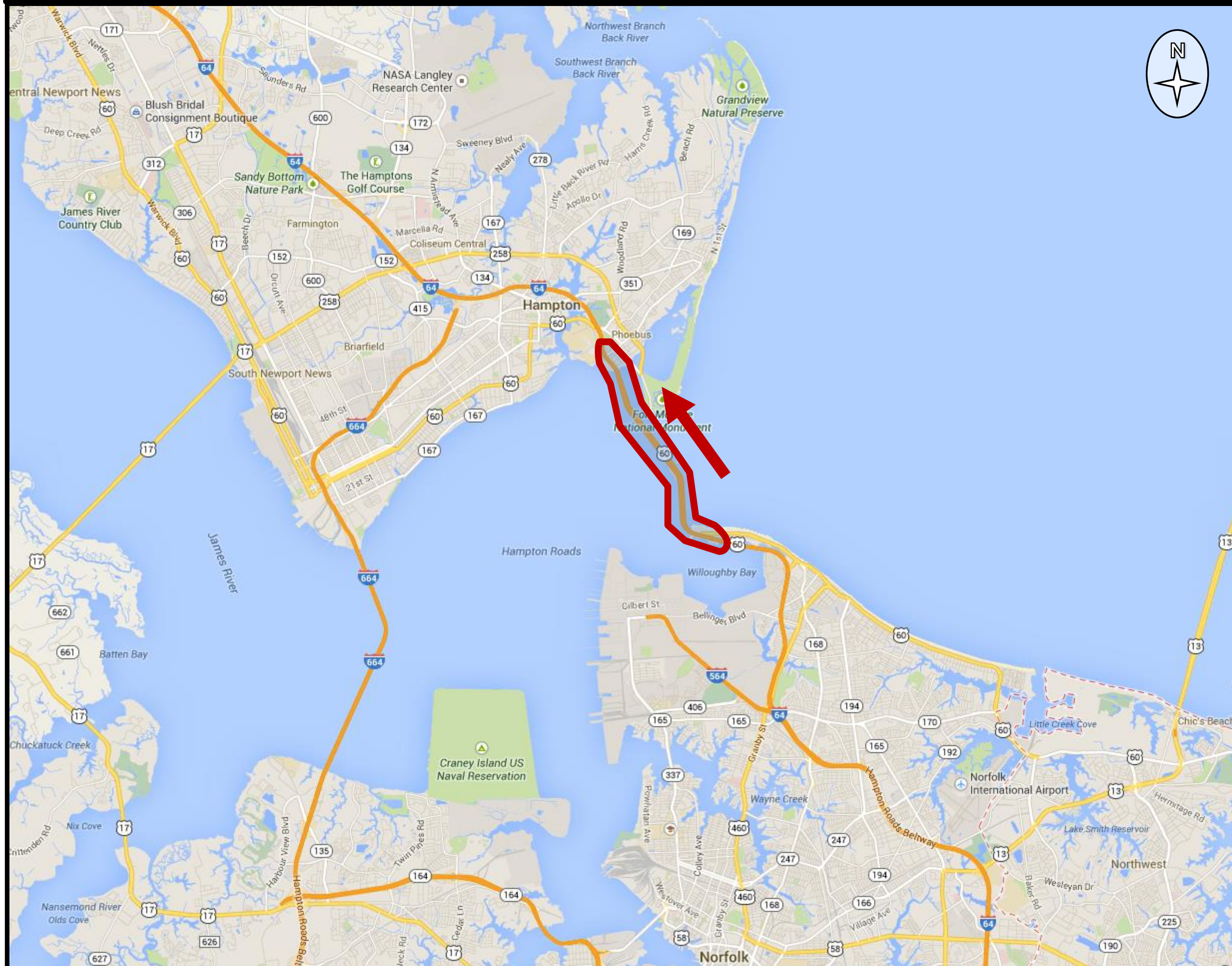


Image source: Google. Data Source: HRTPO analysis of VDOT data. Data included in this table represents the years 2009-2012.
PDO = Property Damage Only Crashes. INJ = Injury Crashes. FAT = Fatality Crashes. F+I = Fatal + Injury Crashes combined.
EPDO = Equivalent Property Damage Only. More information on the EPDO Crash Rate is included in Part I of this study.

FREEWAY DATA

ANNUAL AVERAGE DAILY TRAFFIC VOLUMES BY YEAR

I-64 Westbound between Ocean View Ave and Mallory Street	2009 – 44,000 2010 – 43,000 2011 – 43,000 2012 – 42,000

CRASH DATA

ANNUAL CRASHES BY YEAR AND SEVERITY

Year	Crashes Per Year			
	PDO	INJ	FAT	TOTAL
2009	79	40	0	119
2010	79	27	0	106
2011	77	41	0	118
2012	57	28	0	85

REGIONAL CRASH LEVELS AND RANKING

Average Crashes per Year = 107.0 crashes

EPDO Crash Rate = 2.87

Ranks 18th among 218 freeway segments

Potential for Safety Improvement = +42.6 crashes

Ranks 4th among 218 freeway segments

COLLISION DIAGRAM

FREEWAY SEGMENT #4
I-64 WESTBOUND BETWEEN
OCEAN VIEW AVE AND MALLORY STREET

CRASH CHARACTERISTICS

MOST PREVALENT DRIVER ACTION

Primary Driver Action	I-64 WB - Ocean View to Mallory	All Safety Study Freeways
Following too close	75.3%	46.3%
Failure to maintain control	10.3%	20.1%
Improper/unsafe lane change	3.7%	10.8%
Exceed speed limit/safe speed	1.4%	4.1%
Overcorrection	0.7%	1.7%

WEATHER

Weather	I-64 WB - Ocean View to Mallory	All Safety Study Freeways
Clear/Cloudy	90.9%	79.1%
Mist/Rain/Fog	8.4%	17.3%
Snow/Sleet	0.2%	2.3%
Other/Not Stated	0.5%	1.3%

DRIVING UNDER THE INFLUENCE

Driving Under the Influence	I-64 WB - Ocean View to Mallory	All Safety Study Freeways
Drinking Involved	6.8%	5.9%

TIME OF DAY

Crash Time	I-64 WB - Ocean View to Mallory	All Safety Study Freeways
5:00 - 8:59	7.2%	19.2%
9:00 - 14:59	48.3%	27.6%
15:00 - 18:59	25.4%	33.6%
19:00 - 4:59	19.1%	19.7%

Data Source: HRTPO analysis of VDOT data. Data included in this table and map represents the years 2009-2012.

FREEWAY SEGMENT #4 – I-64 WESTBOUND BETWEEN OCEAN VIEW AVENUE AND MALLORY STREET

NORFOLK/HAMPTON

OBSERVATIONS & POSSIBLE CAUSES

- The areas with the highest number of crashes are near the start of the bridge on Willoughby Spit, on the South Island, and near the middle of the tunnel itself.
- Congestion occurs on a regular basis from before the start of this segment at Ocean View Avenue to the tunnel exit.
- Following too close is the primary driver action for 75% of all crashes on this segment, well above the regional freeway average of 46%.

- Although the lane widths within the tunnel are standard 12 foot lanes, there is no shoulder on either side.
- Speed differential within lanes is an issue, particularly on the up slope exiting the tunnel.
- Midday crashes (9 am to 3 pm) comprise 48% of all crashes, which is well above the regional freeway average of 27%.
- There is a service patrol in place at the tunnel to respond quickly and safety to incidents.

POSSIBLE CRASH COUNTERMEASURES

- Reduce congestion levels at the Hampton Roads Bridge-Tunnel by instituting congestion pricing, or by constructing new capacity such as the Third Crossing.
- Reduce congestion levels at the Hampton Roads Bridge-Tunnel by implementing or expanding Transportation Demand Management strategies such as telecommuting, alternate work schedules, ridesharing, park and ride lots, and public transportation.
- Consider installing Active Traffic Management (ATM) technologies (which include a queue warning system) to alert drivers of the queue approaching the tunnel.

FREEWAY SEGMENT #5 – I-264 WESTBOUND BETWEEN NEWTOWN ROAD AND I-64

NORFOLK

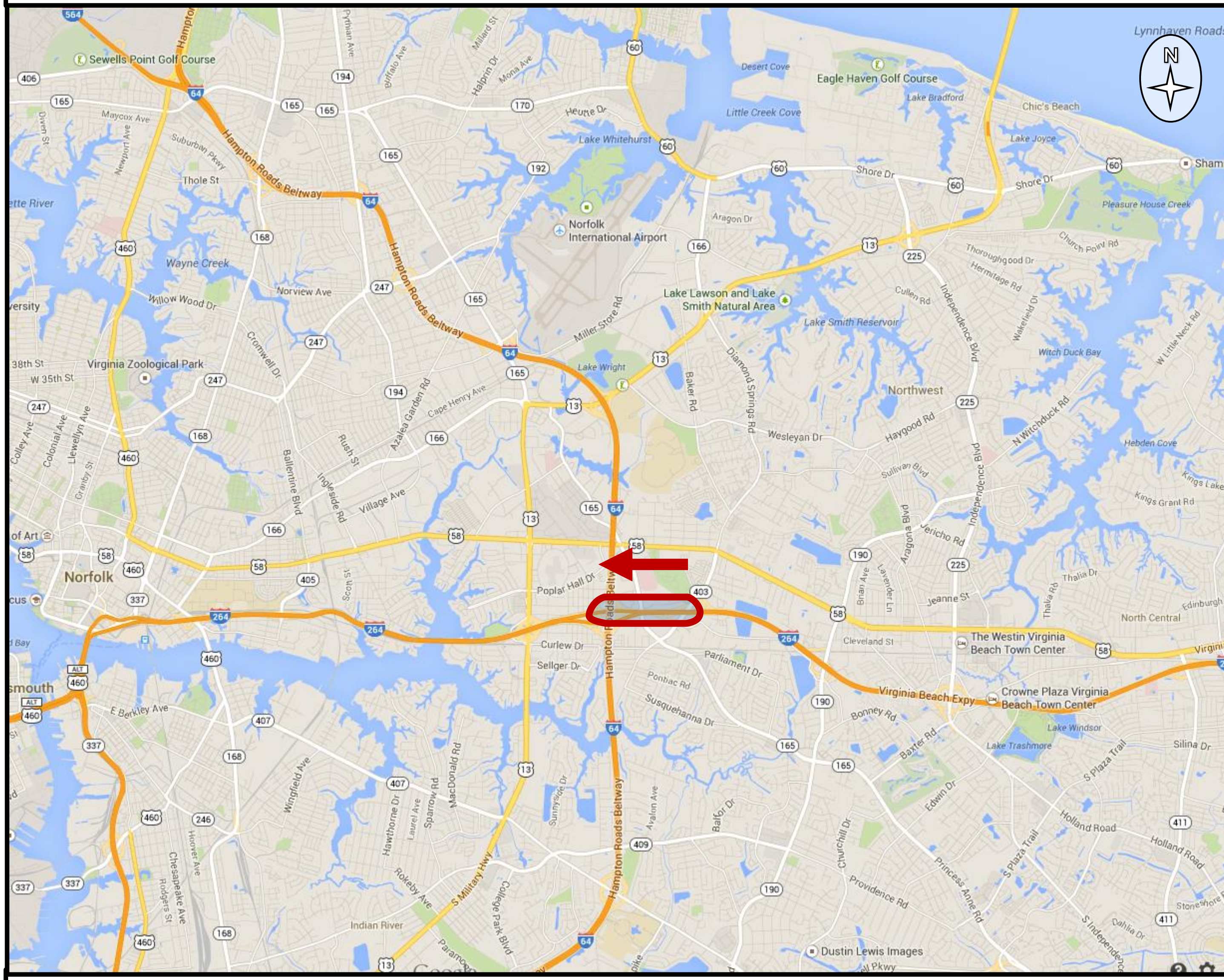


Image source: Google. Data Source: HRTPO analysis of VDOT data. Data included in this table represents the years 2009-2012.
PDO = Property Damage Only Crashes. INJ = Injury Crashes. FAT = Fatality Crashes. F+I = Fatal + Injury Crashes combined.
EPDO = Equivalent Property Damage Only. More information on the EPDO Crash Rate is included in Part I of this study.

FREEWAY DATA

ANNUAL AVERAGE DAILY TRAFFIC VOLUMES BY YEAR

I-64 Westbound between Northampton Blvd and I-264

2009 – 95,000
2010 – 93,000
2011 – 94,000
2012 – 93,000

CRASH DATA

ANNUAL CRASHES BY YEAR AND SEVERITY

	Crashes Per Year			
Year	PDO	INJ	FAT	TOTAL
2009	37	22	1	60
2010	47	19	0	66
2011	49	12	0	61
2012	50	23	0	73

REGIONAL CRASH LEVELS AND RANKING

Average Crashes per Year = 65.0 crashes

EPDO Crash Rate = 4.21

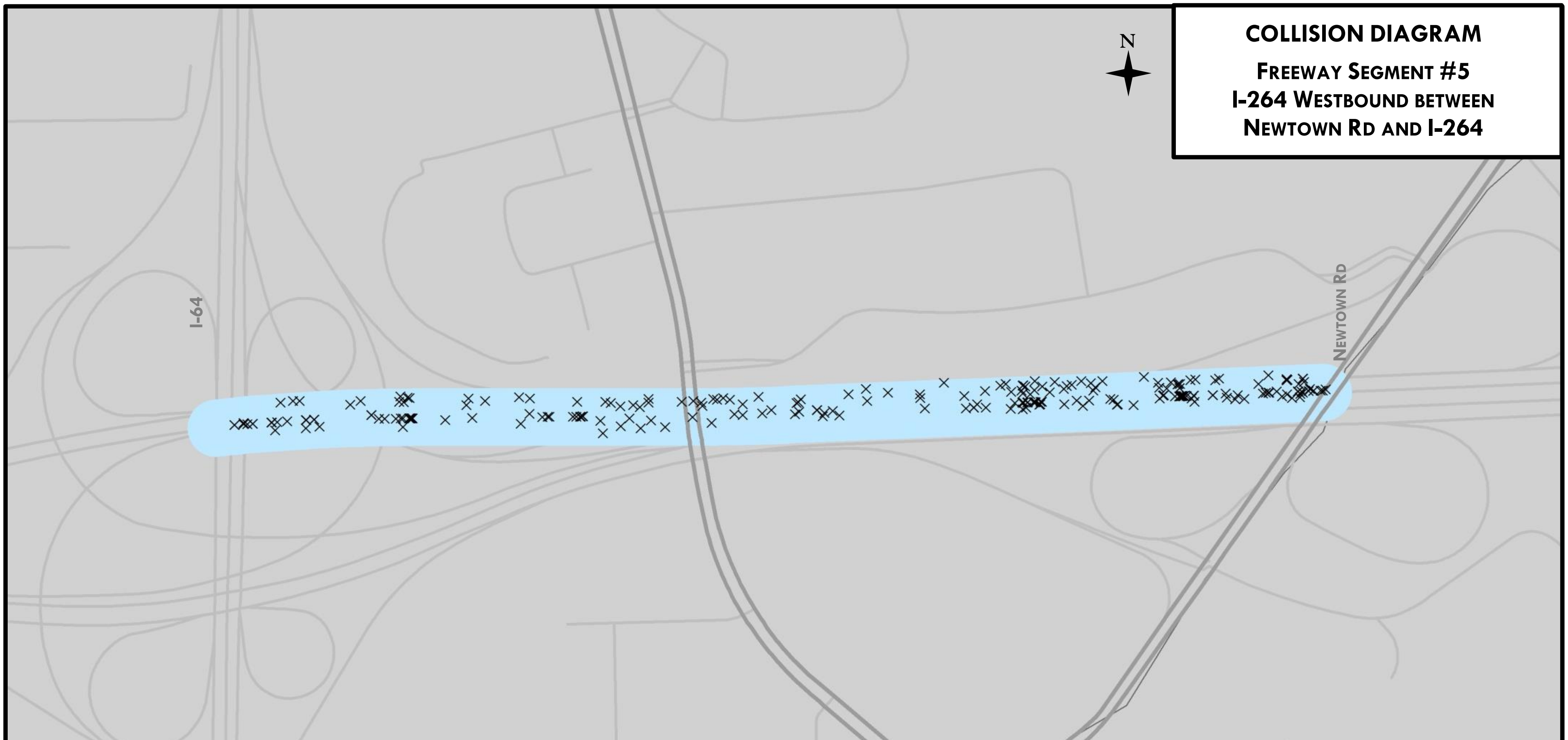
Ranks 9th among 218 freeway segments

Potential for Safety Improvement = +38.6 crashes

Ranks 5th among 218 freeway segments

COLLISION DIAGRAM

FREEWAY SEGMENT #5
I-264 WESTBOUND BETWEEN NEWTOWN RD AND I-264



CRASH CHARACTERISTICS

MOST PREVALENT DRIVER ACTION

Primary Driver Action	I-264 WB - Newtown to I-64	All Safety Study Freeways
Following too close	57.3%	46.3%
Improper/unsafe lane change	13.8%	10.8%
Failure to maintain control	12.3%	20.1%
Exceed speed limit/safe speed	3.5%	4.1%
Avoiding other vehicles	1.5%	1.7%

WEATHER

Weather	I-264 WB - Newtown to I-64	All Safety Study Freeways
Clear/Cloudy	80.8%	79.1%
Mist/Rain/Fog	16.2%	17.3%
Snow/Sleet	2.3%	2.3%
Other/Not Stated	0.8%	1.3%

DRIVING UNDER THE INFLUENCE

Driving Under the Influence	I-264 WB - Newtown to I-64	All Safety Study Freeways
Drinking Involved	2.3%	5.9%

TIME OF DAY

Crash Time	I-264 WB - Newtown to I-64	All Safety Study Freeways
5:00 - 8:59	20.4%	19.2%
9:00 - 14:59	13.8%	27.6%
15:00 - 18:59	53.5%	33.6%
19:00 - 4:59	12.3%	19.7%

Data Source: HRTPO analysis of VDOT data. Data included in this table and map represents the years 2009-2012.

FREEWAY SEGMENT #5 – I-264 WESTBOUND BETWEEN NEWTOWN ROAD AND I-64

NORFOLK

OBSERVATIONS & POSSIBLE CAUSES

- This segment of I-264 is split into 3 mainline lanes and 3 to 4 Collector/Distributor (C/D) lanes.
- Crashes are distributed throughout the entire segment, although the area with the highest number of crashes is between the Newtown Road overpass and the Newtown Road on-ramp.
- Traffic from the Newtown Road on-ramp weaves with I-264 traffic exiting to westbound I-64. The length of the weaving section (2,100') exceeds AASHTO standards for C/D lanes.

- Congestion often occurs on this segment in both the C/D lanes and on the approach to the I-64 off ramp from the mainline.
- Following too close is the primary driver action for 57% of all crashes on this segment, above the regional freeway average of 46%. Improper/unsafe lane change (14%) is also above the regional average of 11%.
- Afternoon peak period crashes (3 pm to 7 pm) comprise 54% of all crashes, which is well above the regional freeway average of 34%.

POSSIBLE CRASH COUNTERMEASURES

- Consider installing a ramp directly from the westbound I-264 mainline to I-64 westbound. This would remove traffic from the I-264 C/D lanes and largely eliminate the weaving issue.
- Consider installing Active Traffic Management (ATM) technologies (which include a queue warning system) to alert drivers of the queue approaching the I-64/I-264 interchange.

INTERSECTIONS

This section provides a detailed analysis of those intersections in Hampton Roads with the Top 10 highest Potential for Safety Improvement (**Table 9**). For each intersection, the following information is included:

- **Summary sheet** – Includes an aerial image of the intersection, recent traffic volumes for each leg of the intersection, crashes by year and severity, and crash levels and rankings.
- **Collision diagram** – Shows the location and type of each crash. Details are also provided for each crash including date, day of week, time of day, crash severity and number of vehicles.
- **Crash data analysis** – Shows crash statistics by collision type, most prevalent driver action, weather, driving under the influence, time of day, and primary collision movements. Regional averages of all of the intersections included within the regional safety study are provided for comparison purposes. For each intersection, a number of data observations are listed.
- **Site observations and possible causes** – Provides observations and possible causes of crashes based on aerial photography and intersection site visits conducted in March 2014 during off-peak periods.
- **Candidate crash countermeasures** – This list was developed by HRTPO staff based on intersection characteristics, collision diagrams, crash data analysis, intersection site visits, and engineering judgment. Additional candidate crash countermeasures may be viable upon further detailed analysis of each intersection (i.e. capacity analysis or site visits during peak periods).
- **Benefit-cost analysis** – Calculates a benefit-to-cost ratio for candidate crash countermeasures based on the expected annualized benefits to the total annualized cost. Higher B/C ratios result in a "bigger bang for your buck" in terms of expected crash reduction benefits compared to the cost to implement the countermeasure. This spreadsheet analysis was developed based on VDOT's Highway Safety Improvement Program HSP Proposed Safety Improvements proposal form (FY2013-14). Crash reduction factors (CRF) were determined using VDOT's Safety Improvements and Corresponding CRFs as a baseline (Table 7 on page 42). When CRFs were not available, the Crash Modification Factors (CMF) Clearinghouse website[1] and/or engineering judgment was used. A 2% projected annual traffic growth rate for the area over the expected life of the improvement was used in the calculation of the traffic growth factor. Estimated project costs for each safety countermeasure were based on VDOT Statewide Planning Level Cost Estimates worksheets[2] and engineering judgment.
- **Recommended crash countermeasures (High B/C)** – Includes a prioritized list of crash countermeasures based on the benefit-cost analysis (B/C ratios higher than 3.0), intersection site visits, and crash data analysis.
- **Other recommended crash countermeasures** – Includes a prioritized list of crash countermeasures based on the benefit-cost analysis (B/C ratios of 3.0 or lower), intersection site visits, and crash data analysis. Even though some safety improvements have a low benefit-to-cost ratio, they are recommended by HRTPO staff

PSI Rank	Jurisdiction	Major Road	Minor Road	PSI (Annual Expected Crashes - Predicted Crashes)
1	VB	Holland Rd	Rosemont Rd	27.51
2	HAM	HRC Pkwy	Big Bethel Rd	22.80
3	HAM	Mercury Blvd	Power Plant Pkwy/Todds Ln	20.66
4	VB	First Colonial Rd	Va Beach Blvd	18.88
5	NN	Mercury Blvd	Jefferson Ave	16.71
6	VB	General Booth Blvd	Dam Neck Rd	13.58
7	HAM	Armistead Ave	LaSalle Ave	12.72
8	NN	J Clyde Morris Blvd	Diligence Dr	12.68
9	VB	Princess Anne Rd	Dam Neck Rd	11.69
10	VB	Lynnhaven Pkwy	Independence Blvd	11.14

TABLE 9 – TOP 10 INTERSECTIONS WITH THE HIGHEST POTENTIAL FOR SAFETY IMPROVEMENT (PSI)

Source: HRTPO analysis using Highway Safety Manual methodology. Data included in this table represents the years 2009-2012.

[1] http://www.cmfclearinghouse.org

[2] VDOT, Statewide Planning Level Cost Estimates, Transportation & Mobility Planning Division, obtained from the City of Virginia Beach engineering staff, January 2009.

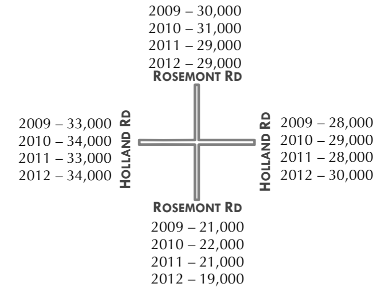
to mitigate existing intersection safety problems, to address capacity/safety-related deficiencies, or as preventative measures due to existing intersection characteristics and conditions (e.g. for intersections with no existing pedestrian crashes, adding sidewalks, crosswalks, and pedestrian signals in order to prevent future bicycle/pedestrian crashes).

INTERSECTION #1 – HOLLAND ROAD AT ROSEMONT ROAD
VIRGINIA BEACH

Image source: Google. Data Source: HRTPO analysis of VDOT data. Data included in this table represents the years 2009-2012.
PDO = Property Damage Only Crashes. INJ = Injury Crashes. FAT = Fatality Crashes. F+I = Fatal + Injury Crashes combined.
EPDO = Equivalent Property Damage Only. More information on the EPDO Crash Rate is included in Part I of this study.

INTERSECTION DATA

ANNUAL AVERAGE DAILY TRAFFIC VOLUMES BY YEAR



Pedestrians Crossing Intersection Daily = 700 (Medium)

Intersection Control = Signalized
Protected/Permitted phasing for all left turns

CRASH DATA

ANNUAL CRASHES BY YEAR AND SEVERITY

	Crashes Per Year			
Year	PDO	INJ	FAT	TOTAL
2009	23	25	0	48
2010	28	9	0	37
2011	20	19	0	39
2012	34	21	0	55

ANNUAL CRASHES BY YEAR AND TYPE

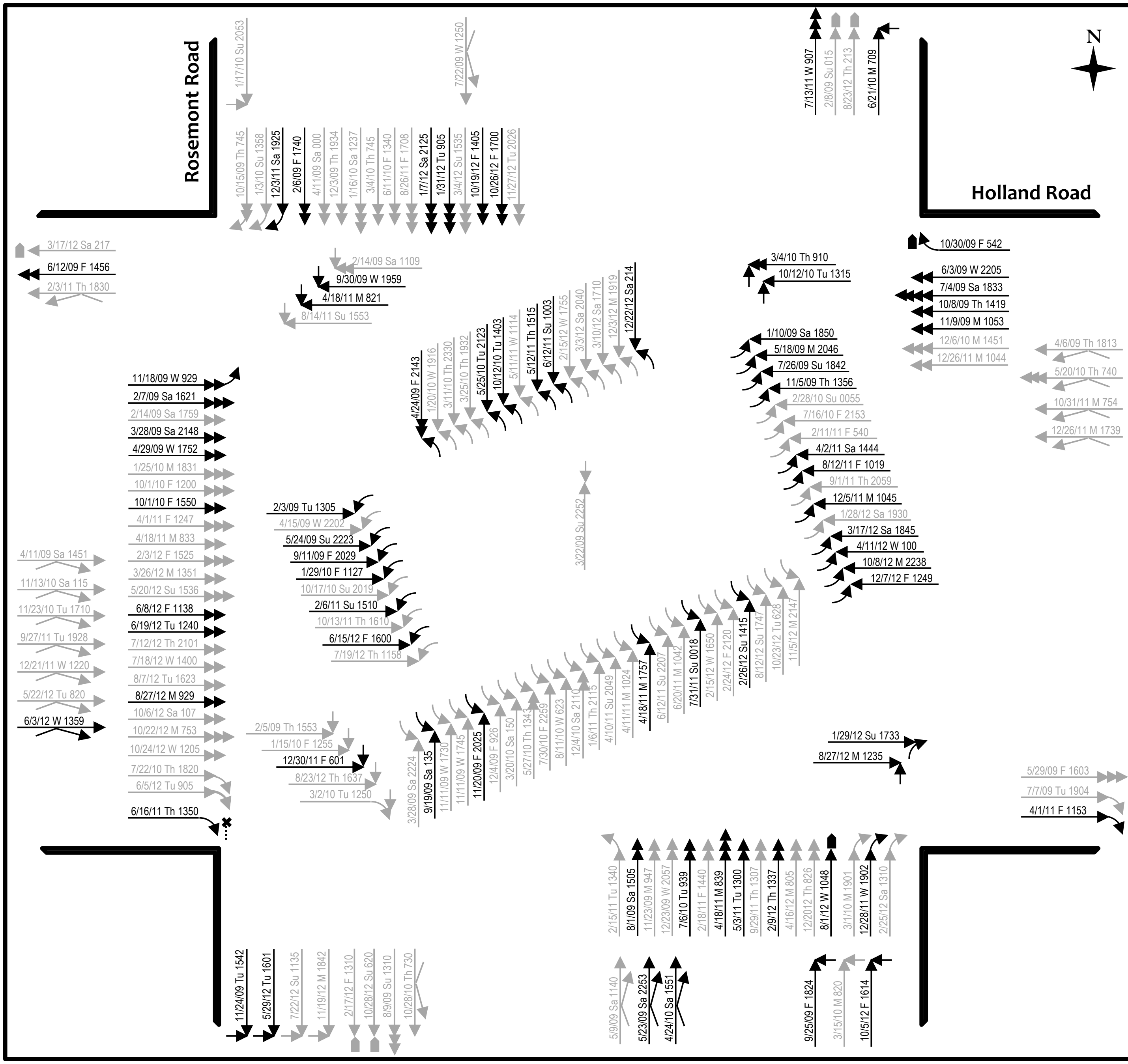
Year	F + I Multi	F + I Single	PDO Multi	PDO Single	Ped	Bike
2009	25	0	21	2	0	0
2010	9	0	28	0	0	0
2011	18	0	20	0	1	0
2012	20	1	30	4	0	0

CRASH LEVELS AND RANKING

Average Crashes per Year = 44.8 crashes
Ranks 1st among 597 intersections

EPDO Crash Rate = 3.86
Ranks 1st among 597 intersections

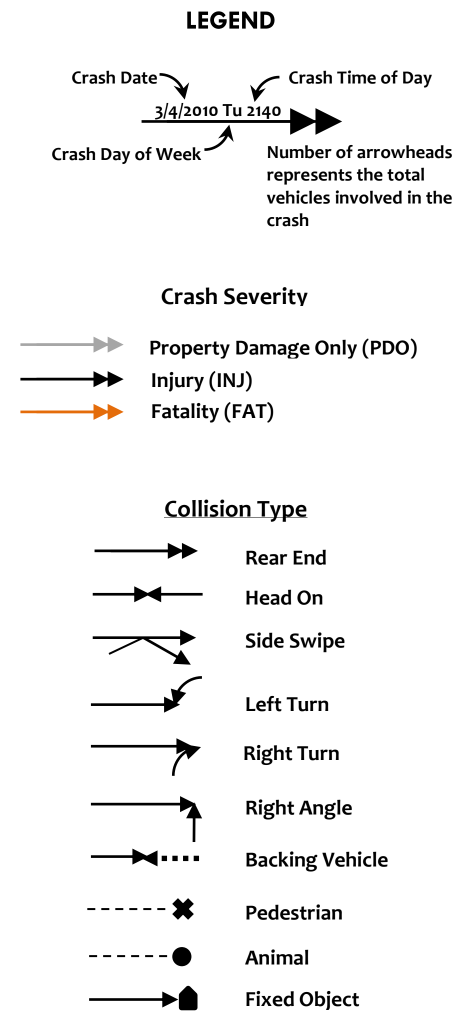
Potential for Safety Improvement = +27.5 crashes
Ranks 1st among 597 intersections



COLLISION DIAGRAM

Intersection #1

Holland Road at Rosemont Road



Data Source: HRTPO analysis of VDOT data. Data included in this diagram represents the years 2009-2012.
Includes crashes located within 250′ of the intersection.

INTERSECTION #1 – HOLLAND ROAD AT ROSEMONT ROAD
VIRGINIA BEACH

CRASH DATA ANALYSIS

COLLISION TYPE

Collision Type	Holland Rd at Rosemont Rd	All Safety Study Intersections
Rear End	36.9%	44.6%
Right Angle	49.7%	34.6%
Head On	2.8%	3.0%
Sideswipe - Same Direction	5.6%	7.0%
Sideswipe - Opposite Direction	0.0%	1.0%
Fixed Object - In Road	0.0%	0.5%
Fixed Object - Off Road	3.9%	4.0%
Bike/Pedestrian	0.6%	1.6%
Animal	0.0%	0.4%
Other	0.6%	3.3%

MOST PREVALENT DRIVER ACTION

Primary Driver Action	Holland Rd at Rosemont Rd	All Safety Study Intersections
Did not have right-of-way	36.2%	17.3%
Following too close	29.3%	33.4%
Disregarded signal	5.2%	10.3%
Hit-and-run	3.4%	3.1%
Improper/Unsafe lane change	2.9%	5.1%

WEATHER

Weather	Holland Rd at Rosemont Rd	All Safety Study Intersections
Clear/Cloudy	88.5%	81.9%
Mist/Rain/Fog	10.3%	15.5%
Snow/Sleet	1.1%	0.7%
Other/Not Stated	0.0%	1.9%

DRIVING UNDER THE INFLUENCE

Driving Under the Influence	Holland Rd at Rosemont Rd	All Safety Study Intersections
Drinking Involved	5.2%	5.8%

TIME OF DAY

Crash Time	Holland Rd at Rosemont Rd	All Safety Study Intersections
5:00 - 8:59	11.2%	12.7%
9:00 - 14:59	34.6%	34.0%
15:00 - 18:59	24.6%	31.0%
19:00 - 4:59	29.6%	22.3%

PRIMARY COLLISION MOVEMENTS

#1  13.4%

#2  13.4%

#3  8.9%

#4  8.9%

#5  8.4%

#6  7.8%

DATA OBSERVATIONS

- 36% of the crashes involve left-turning vehicles and opposing traffic.
- Right angle crashes, crashes involving drivers not having the right-of-way, and overnight crashes are much higher than the regional average.

Data Source: HRTPO analysis of VDOT data. Regionwide data included in the tables represents a summation of those 597 intersections included in the Regional Safety Study, not the region as a whole. All data represents the years 2009-2012.

SITE OBSERVATIONS & POSSIBLE CAUSES

- Left turns on all approaches are controlled by protective-permissive phasing.
- Rosemont Rd approaches have channelized right turn lanes with yield control. Holland Rd approaches have single right turn lanes.

- EB Holland Road and SB Rosemont Road approaches are congested during peak periods. Based on field visit, few vehicles were making left turns during the permissive phase due to heavy through movements.
- The length of the EB Holland Rd left turn lane is not sufficient for given signal timing.

- Pavement markings are worn on the NB Rosemont Rd approach.

- SB Rosemont left turn lane was recently lengthened, however, it is still not sufficient for PM peak period queues for given signal timing (tire tracks in median).

- Tree limbs are partially blocking Yield sign for SB Rosemont Rd channelized right turn lane.
- Red light cameras are installed on EB and WB Holland Rd.
- Right-of-way limited for all approaches.
- Signal heads currently on span wire.
- Some signal heads are missing backplates (NB 5 head, SB 5 head, and SB 3 head).

- "Left Turn YIELD on Green" signs are at street level for all approaches.
- Holland Shoppes (NE quadrant) driveway is close to intersection along NB Rosemont Rd. Four driveways at Soaps N Suds (NW quadrant) are close to intersection.

INTERSECTION #1 – HOLLAND ROAD AT ROSEMONT ROAD
VIRGINIA BEACH

CANDIDATE CRASH COUNTERMEASURES

1) Use protective left turn phasing for all approaches.
2) Add dual left turns for all approaches with protective left turn phasing, including lane line extensions within the intersection. This improvement would require upgrading/replacing the existing span wire with a mast arm signal and optimizing signal timing.
3) Optimize signal timing.
4) Restripe pavement markings for NB Rosemont Rd.
5) Remove existing span wire signal and replace with a mast arms signal with new left turn flashing yellow signal heads and signs for all approaches.
6) Add painted triangle yield lines with YIELD pavement markings and 2nd yield signs in the triangle grass/concrete areas for NB and SB Rosemont Rd channelized right turn lanes. Trim vegetation blocking the yield sign for the SB Rosemont Rd channelized right turn lane.

* Major intersection improvements (i.e. dual left turn lanes, right turn lanes, full signal poles/mast arms) have been proposed by the City of Virginia Beach as a Capital Improvement. Project (CIP).

BENEFIT-COST ANALYSIS

	Safety Countermeasure	Service Life (Years)	Crash Reduction Factor (CRF)			Average Annual Crashes			Estimated Annual Crash Reduction			Cost per Crash			Estimated Annual Benefit			Traffic Growth Factor	Total Annual Benefit
			FAT	INJ	PDO	FAT	INJ	PDO	FAT	INJ	PDO	FAT	INJ	PDO	FAT	INJ	PDO		
1	Protective LT Phasing - All approaches	20	0.25	0.25	0.25	0.0	7.0	9.0	0.0	1.8	2.3	$ 5,000,000	$ 85,000	$ 9,000	$ -	$ 148,750	$ 20,250	1.24	$ 209,419
2	Add dual LT lanes w/lane line extensions, phasing	8	0.48	0.48	0.48	0.0	7.0	9.0	0.0	3.4	4.3	$ 5,000,000	$ 85,000	$ 9,000	$ -	$285,600	$38,880	1.09	$ 355,088
3	Optimize signal timing	5	0.10	0.10	0.10	0.0	18.5	26.3	0.0	1.9	2.6	$ 5,000,000	$ 85,000	$ 9,000	$ -	$ 157,250	$ 23,625	1.06	$ 192,021
4	Restripe pavement markings, NB	7	0.20	0.20	0.20	0.0	5.0	10.8	0.0	1.0	2.2	$ 5,000,000	$ 85,000	$ 9,000	$ -	$ 85,000	$ 19,350	1.08	$ 113,040
5	Mast arms - new LT flashing yellow signals/signs	20	0.19	0.19	0.19	0.0	7.0	9.0	0.0	1.3	1.7	$ 5,000,000	$ 85,000	$ 9,000	$ -	$ 113,050	$ 15,390	1.24	$ 159,158
6	Yield markings & signs (NB,SB), trim veg. (SB)	10	0.25	0.25	0.25	0.0	0.8	1.0	0.0	0.2	0.3	$ 5,000,000	$ 85,000	$ 9,000	$ -	$ 15,938	$ 2,250	1.12	$ 20,313

	Safety Countermeasure	Service Life (Years)	Estimated Project Cost		Annual Initial Cost	Annual Mnt. Cost (if any)	Total Annual Cost
			PE & Construction	R/W & Utility			
1	Protective LT Phasing - All approaches	20	$ 35,000	$ -	$ 2,353		$ 2,353
2	Add dual LT lanes w/lane line extensions, phasing	8	$ 1,575,000	$ 1,968,800	$ 504,837		$ 504,837
3	Optimize signal timing	5	$ 5,000	$ -	$ 1,092		$ 1,092
4	Restripe pavement markings, NB	7	$ 20,000	$ -	$ 3,210		$ 3,210
5	Mast arms - new LT flashing yellow signals/signs	20	$ 375,000	$ 75,000	$ 30,247		$ 30,247
6	Yield markings & signs (NB,SB), trim veg. (SB)	10	$ 16,000	$ -	$ 1,876		$ 1,876

Total Annualized		B/C =
Benefit	Cost	
$ 209,419	$ 2,353	89.02
$ 355,088	$ 504,837	0.70
$ 192,021	$ 1,092	175.88
$ 113,040	$ 3,210	35.21
$ 159,158	$ 30,247	5.26
$ 20,313	$ 1,876	10.83

RECOMMENDED CRASH COUNTERMEASURES (HIGH B/C)

2,3) Add dual left turns for all approaches with protective left turn phasing, including lane line extensions within the intersection. This improvement would require upgrading/replacing the existing span wire with a mast arm signal and optimizing signal timing. Despite the low B/C for this countermeasure, this improvement would also address the capacity deficiencies at this intersection.

4) Restripe pavement markings for NB Rosemont Rd.

6) Add painted triangle yield lines with YIELD pavement markings and 2nd yield signs in the triangle grass/concrete areas for NB and SB Rosemont Rd channelized right turn lanes. Trim vegetation blocking the yield sign for the SB Rosemont Rd channelized right turn lane.

INTERSECTION #2 – HAMPTON ROADS CENTER PARKWAY AT BIG BETHEL ROAD

HAMPTON

Image source: Google. Data Source: HRTPO analysis of VDOT data. Data included in this table represents the years 2009-2012.
PDO = Property Damage Only Crashes. INJ = Injury Crashes. FAT = Fatality Crashes. F+I = Fatal + Injury Crashes combined.
EPDO = Equivalent Property Damage Only. More information on the EPDO Crash Rate is included in Part I of this study.

INTERSECTION DATA

ANNUAL AVERAGE DAILY TRAFFIC VOLUMES BY YEAR

BIG BETHEL RD (north): 2009 – 26,000; 2010 – 25,000; 2011 – 25,000; 2012 – 25,000

HRC PARKWAY (west): 2009 – 21,000; 2010 – 21,000; 2011 – 21,000; 2012 – 21,000

HRC PARKWAY (east): 2009 – 44,000; 2010 – 43,000; 2011 – 43,000; 2012 – 43,000

BIG BETHEL RD (south): 2009 – 23,000; 2010 – 23,000; 2011 – 23,000; 2012 – 23,000

Pedestrians Crossing Int. Daily = 240 (Medium-low)

Intersection Control = Signalized
Protected phasing for all left turns

CRASH DATA

ANNUAL CRASHES BY YEAR AND SEVERITY

Year	Crashes Per Year			
	PDO	INJ	FAT	TOTAL
2009	29	15	0	44
2010	25	13	0	38
2011	22	13	0	35
2012	32	18	0	50

ANNUAL CRASHES BY YEAR AND TYPE

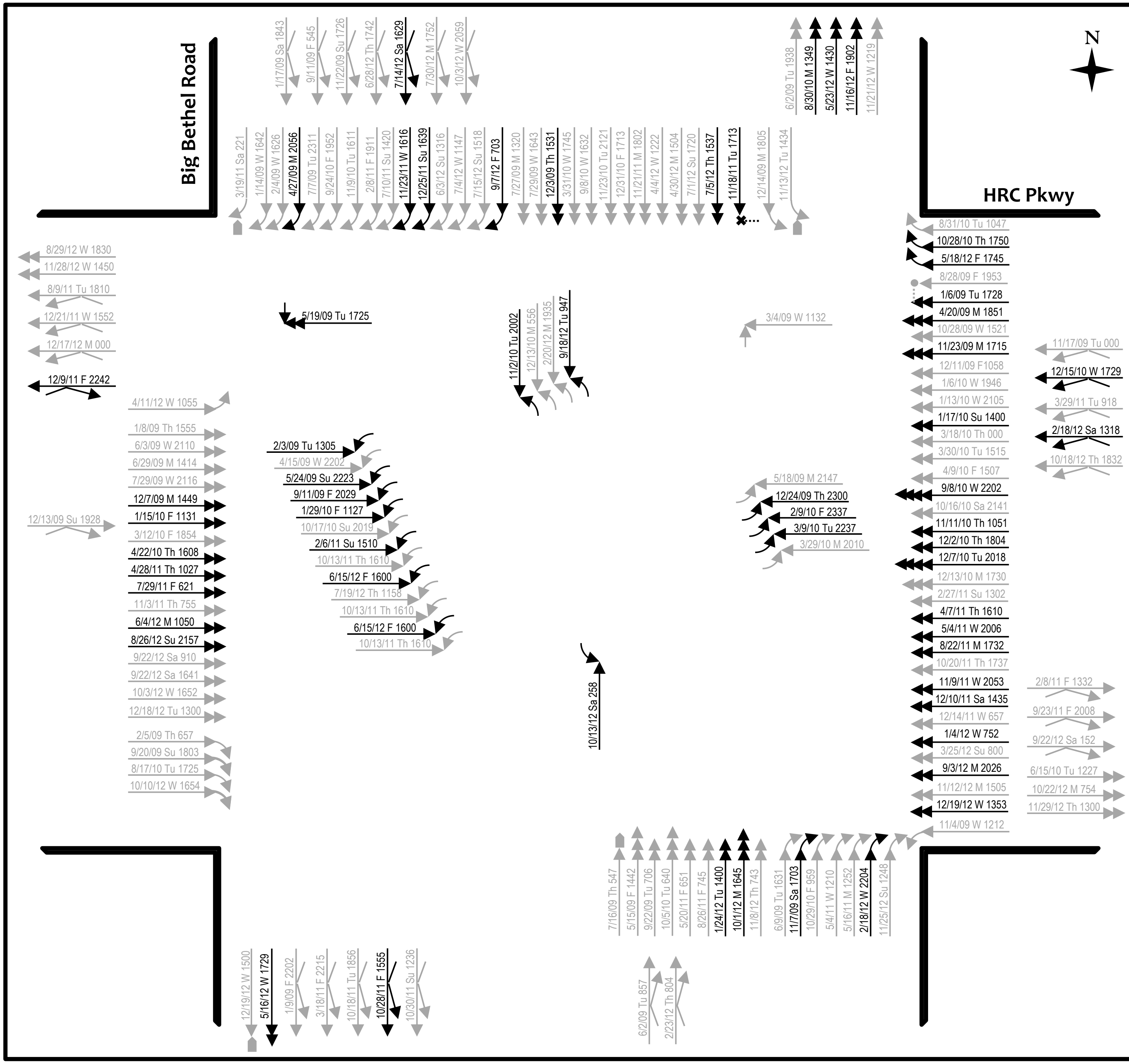
Year	F + I Multi	F + I Single	PDO Multi	PDO Single	Ped	Bike
2009	15	0	28	1	0	0
2010	13	0	25	0	0	0
2011	12	1	21	1	0	0
2012	18	0	30	2	0	0

CRASH LEVELS AND RANKING

Average Crashes per Year = 41.8 crashes
Ranks 3rd among 597 intersections

EPDO Crash Rate = 3.49
Ranks 5th among 597 intersections

Potential for Safety Improvement = +22.8 crashes
Ranks 2nd among 597 intersections



COLLISION DIAGRAM

INTERSECTION #2
HRC PKWY AT BIG BETHEL ROAD

LEGEND

Crash Date
Crash Time of Day
3/4/2010 Tu 2140
Crash Day of Week
Number of arrowheads represents the total vehicles involved in the crash

Crash Severity

- Property Damage Only (PDO)
- Injury (INJ)
- Fatality (FAT)

Collision Type

- Rear End
- Head On
- Side Swipe
- Left Turn
- Right Turn
- Right Angle
- Backing Vehicle
- Pedestrian
- Animal
- Fixed Object

Data Source: HRTPO analysis of VDOT data. Data included in this diagram represents the years 2009-2012. Includes crashes located within 250' of the intersection.

INTERSECTION #2 – HAMPTON ROADS CENTER PARKWAY AT BIG BETHEL ROAD
HAMPTON

CRASH DATA ANALYSIS

COLLISION TYPE

Collision Type	HRC Pkwy at Big Bethel Rd	All Safety Study Intersections
Rear End	64.1%	44.6%
Right Angle	21.6%	34.6%
Head On	1.8%	3.0%
Sideswipe - Same Direction	9.0%	7.0%
Sideswipe - Opposite Direction	0.0%	1.0%
Fixed Object - In Road	0.6%	0.5%
Fixed Object - Off Road	1.8%	4.0%
Bike/Pedestrian	0.6%	1.6%
Animal	0.6%	0.4%
Other	0.0%	3.3%

MOST PREVALENT DRIVER ACTION

Primary Driver Action	HRC Pkwy at Big Bethel Rd	All Safety Study Intersections
Following too close	54.5%	33.4%
Disregarded signal	13.3%	10.3%
Failure to maintain control	9.1%	7.3%
Improper/Unsafe lane change	6.7%	5.1%
Hit-and-run	4.2%	3.1%

WEATHER

Weather	HRC Pkwy at Big Bethel Rd	All Safety Study Intersections
Clear/Cloudy	86.8%	81.9%
Mist/Rain/Fog	10.8%	15.5%
Snow/Sleet	0.6%	0.7%
Other/Not Stated	1.8%	1.9%

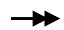
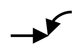
DRIVING UNDER THE INFLUENCE

Driving Under the Influence	HRC Pkwy at Big Bethel Rd	All Safety Study Intersections
Drinking Involved	2.4%	5.8%

TIME OF DAY

Crash Time	HRC Pkwy at Big Bethel Rd	All Safety Study Intersections
5:00 - 8:59	10.8%	12.7%
9:00 - 14:59	24.0%	34.0%
15:00 - 18:59	34.1%	31.0%
19:00 - 4:59	31.1%	22.3%

PRIMARY COLLISION MOVEMENTS

#1		20.4%
#2		16.2%
#3		13.2%
#4		9.0%
#5		7.8%
#6		4.2%

DATA OBSERVATIONS

- Excessive % of the crashes involve rear end collisions (64%), and the top 4 primary collision movements are rear end crashes on each approach.
- Following too close (55%) and disregarding the traffic signal (13%) were the primary driver actions – both higher than the regional average
- 31% of the crashes occurred during nighttime/early morning hours (7pm-4:59am), which is higher than the regional average.
- Excessive number of SB right turn rear end crashes.

Data Source: HRTPO analysis of VDOT data. Regionwide data included in the tables represents a summation of those 597 intersections included in the Regional Safety Study, not the region as a whole. All data represents the years 2009-2012.

SITE OBSERVATIONS & POSSIBLE CAUSES

- All approaches have dual-left turn lanes controlled by protective phasing.
- Hampton Roads Center Pkwy approaches have free flow channelized right turn lanes into receiving lanes on Big Bethel Rd. Big Bethel Rd approaches have channelized right turn lanes with yield control.
- High speed approaches on HRC Pkwy (55 mph speed limit on the east, 45 mph on the west).

- Long distances to the next signalized intersections along HRC Pkwy (0.9 mi west, 1.9 mi east).
- The Westbound Hampton Roads Center Pkwy right turn lane arrow pavement marking is worn.

- Many NB Big Bethel Rd right turning vehicles do not yield – tire tracks on the shoulder are present toward I-64 E ramp from vehicles who avoid EB vehicles.

- High traffic volumes along WB Hampton Roads Center Pkwy from I-64 ramp. Many vehicles weave/merge across 2-3 lanes towards the WB left turn lane, which likely contribute to sideswipe crashes and the high number of rear end collisions.
- No "Entering added lane" sign for EB HRC Pkwy channelized right turn lane (Vehicles are stopping even though they have a receiving lane.

- Flexposts are used on the shoulder of EB HRC Pkwy prior to right turn lane, due to through traffic queues.
- Yield sign for SB Big Bethel Rd channelized right turn lane is angled and difficult to see.
- Vehicles weave on SB Big Bethel Rd just south of the intersection into the left turn lane for the Food Lion/McDonalds shopping plaza (SE quadrant).

INTERSECTION #2 – HAMPTON ROADS CENTER PARKWAY AT BIG BETHEL ROAD
HAMPTON

CANDIDATE CRASH COUNTERMEASURES

1) Add activated flashing signal ahead signs for EB and WB Hampton Roads Center Pkwy and reduce speed limit from 55 mph to 45 mph east of Big Bethel Rd.
2) Add painted triangle yield line with YIELD pavement marking and 2nd yield sign in concrete triangle area for SB Big Bethel channelized right turn lane.
3) Add “Entering added lane” sign for WB HRC Pkwy channelized right turn lane.
4) Add receiving/acceleration lane along WB Hampton Roads Center Pkwy to the west of the intersection from the SB Big Bethel Rd channelized right turn lane. Add “Entering added lane” sign for SB Big Bethel Rd channelized right turn lane.
5) Add receiving/acceleration lane along EB Hampton Roads Center Pkwy (approximately 1,000 feet long) from the NB Big Bethel Rd channelized right turn lane to I-64 east ramp making a continuous lane. Add “Entering added lane” sign for NB Big Bethel Rd channelized right turn.
*According to the City of Hampton, this safety improvement project is under construction.

BENEFIT-COST ANALYSIS

	Safety Countermeasure	Service Life (Years)	Crash Reduction Factor (CRF)			Average Annual Crashes			Estimated Annual Crash Reduction			Cost per Crash			Estimated Annual Benefit			Traffic Growth Factor	Total Annual Benefit
			FAT	INJ	PDO	FAT	INJ	PDO	FAT	INJ	PDO	FAT	INJ	PDO	FAT	INJ	PDO		
1	Activated flashing signal ahead signs (EB, WB)	10	0.25	0.25	0.25	0.0	6.0	6.3	0.0	1.5	1.6	$ 5,000,000	$ 85,000	$ 9,000	$ -	$ 127,500	$ 14,063	1.12	$ 158,107
2	Yield markings & sign (SB RT lane)	10	0.25	0.25	0.25	0.0	1.3	3.8	0.0	0.3	0.9	$ 5,000,000	$ 85,000	$ 9,000	$ -	$ 26,563	$ 8,438	1.12	$ 39,091
3	"Entering added lane" sign (WB)	10	0.10	0.10	0.10	0.0	1.3	0.8	0.0	0.1	0.1	$ 5,000,000	$ 85,000	$ 9,000	$ -	$ 10,625	$ 675	1.12	$ 12,621
4	Rec/Acc lane & "Entering added lane" sign (WB)	8	0.20	0.20	0.20	0.0	1.3	3.8	0.0	0.3	0.8	$ 5,000,000	$ 85,000	$ 9,000	$ -	$ 21,250	$ 6,750	1.09	$ 30,641
5	Rec/Acc lane & "Entering added lane" sign (EB)	8	0.20	0.20	0.20	0.0	0.5	2.8	0.0	0.1	0.6	$ 5,000,000	$ 85,000	$ 9,000	$ -	$ 8,500	$ 4,950	1.09	$ 14,719

	Safety Countermeasure	Service Life (Years)	Estimated Project Cost		Annual Initial Cost	Annual Mnt. Cost (if any)	Total Annual Cost
			PE & Construction	R/W & Utility			
1	Activated flashing signal ahead signs (EB, WB)	10	$ 100,000	$ 30,000	$ 15,240		$ 15,240
2	Yield markings & sign (SB RT lane)	10	$ 7,000	$ -	$ 821		$ 821
3	"Entering added lane" sign (WB)	10	$ 1,500	$ -	$ 176		$ 176
4	Rec/Acc lane & "Entering added lane" sign (WB)	8	$ 441,500	$ 309,100	$ 106,928		$ 106,928
5	Rec/Acc lane & "Entering added lane" sign (EB)	8	$ 351,500	$ -	$ 50,073		$ 50,073

Total Annualized		B/C =
Benefit	Cost	
$ 158,107	$ 15,240	**10.37**
$ 39,091	$ 821	**47.64**
$ 12,621	$ 176	**71.77**
$ 30,641	$ 106,928	**0.29**
$ 14,719	$ 50,073	**0.29**

RECOMMENDED CRASH COUNTERMEASURES (HIGH B/C)

3) Add “Entering added lane” sign for WB HRC Pkwy channelized right turn lane.
2) Add painted triangle yield line with YIELD pavement marking and 2nd yield sign in concrete triangle area for SB Big Bethel channelized right turn lane.
1) Add activated flashing signal ahead signs for EB and WB Hampton Roads Center Pkwy and reduce speed limit from 55 mph to 45 mph east of Big Bethel Rd.

OTHER RECOMMENDED CRASH COUNTERMEASURES

4) Due to excessive number of SB right turn rear end crashes, add receiving/acceleration lane along WB Hampton Roads Center Pkwy to the west of the intersection from the SB Big Bethel Rd channelized right turn lane. Add “Entering added lane” sign for SB Big Bethel Rd channelized right turn lane.

INTERSECTION #3 – MERCURY BOULEVARD AT POWER PLANT PARKWAY
HAMPTON

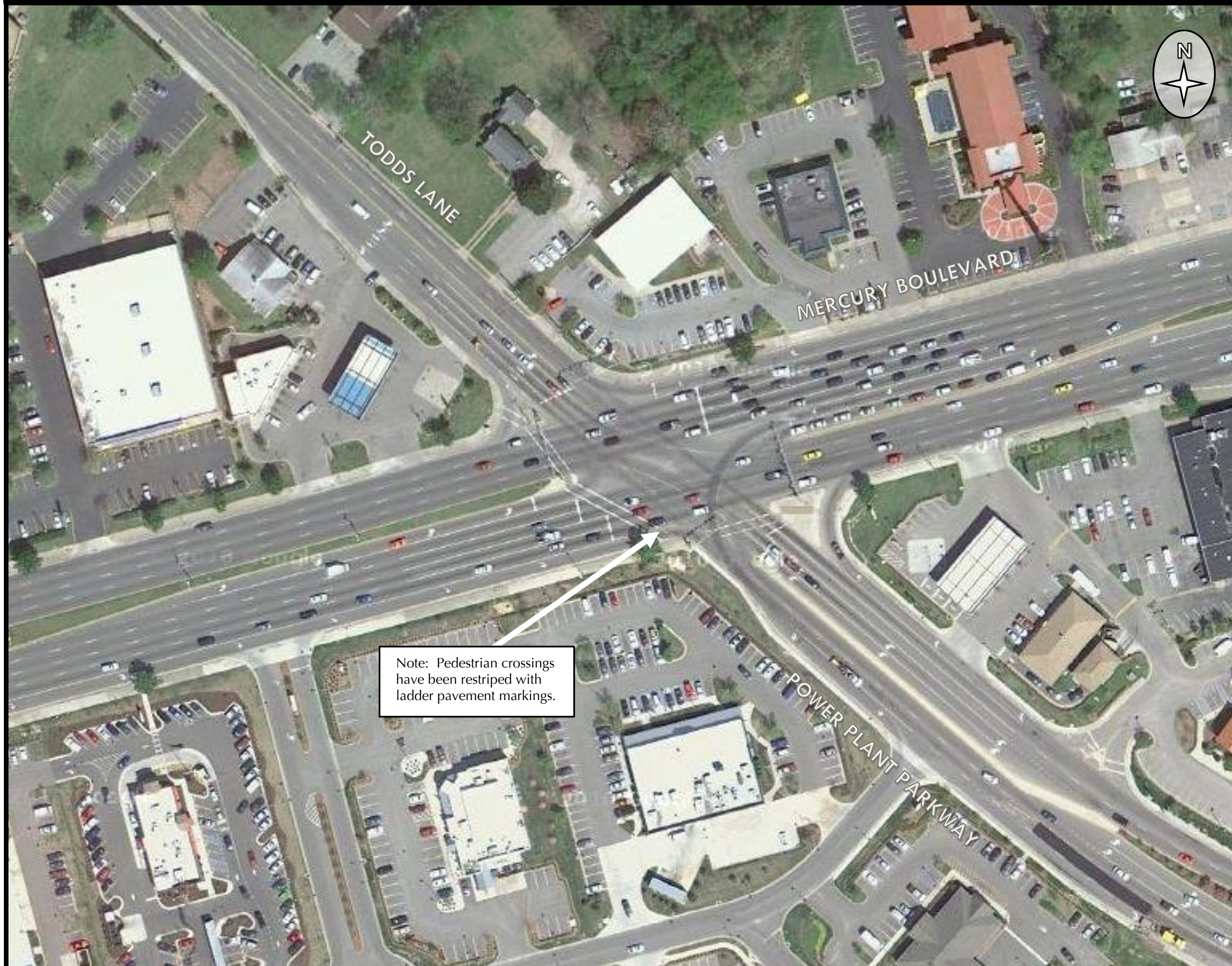


Image source: Google. Data Source: HRTPO analysis of VDOT data. Data included in this table represents the years 2009-2012.
PDO = Property Damage Only Crashes. INJ = Injury Crashes. FAT = Fatality Crashes. F+I = Fatal + Injury Crashes combined.
EPDO = Equivalent Property Damage Only. More information on the EPDO Crash Rate is included in Part I of this study.

INTERSECTION DATA

ANNUAL AVERAGE DAILY TRAFFIC VOLUMES BY YEAR

TODDS LANE: 2009 – 14,000; 2010 – 14,000; 2011 – 14,000; 2012 – 14,000

MERCURY BLVD (west): 2009 – 55,000; 2010 – 57,000; 2011 – 57,000; 2012 – 53,000

MERCURY BLVD (east): 2009 – 61,000; 2010 – 63,000; 2011 – 64,000; 2012 – 59,000

POWER PLANT PKWY: 2009 – 16,000; 2010 – 16,000; 2011 – 16,000; 2012 – 16,000

Pedestrians Crossing Intersection Daily = 700 (Medium)

Intersection Control = Signalized
Protected phasing for all left turns

CRASH DATA

ANNUAL CRASHES BY YEAR AND SEVERITY

Year	Crashes Per Year			
	PDO	INJ	FAT	TOTAL
2009	23	23	0	46
2010	33	14	0	47
2011	22	27	0	49
2012	20	15	0	35

ANNUAL CRASHES BY YEAR AND TYPE

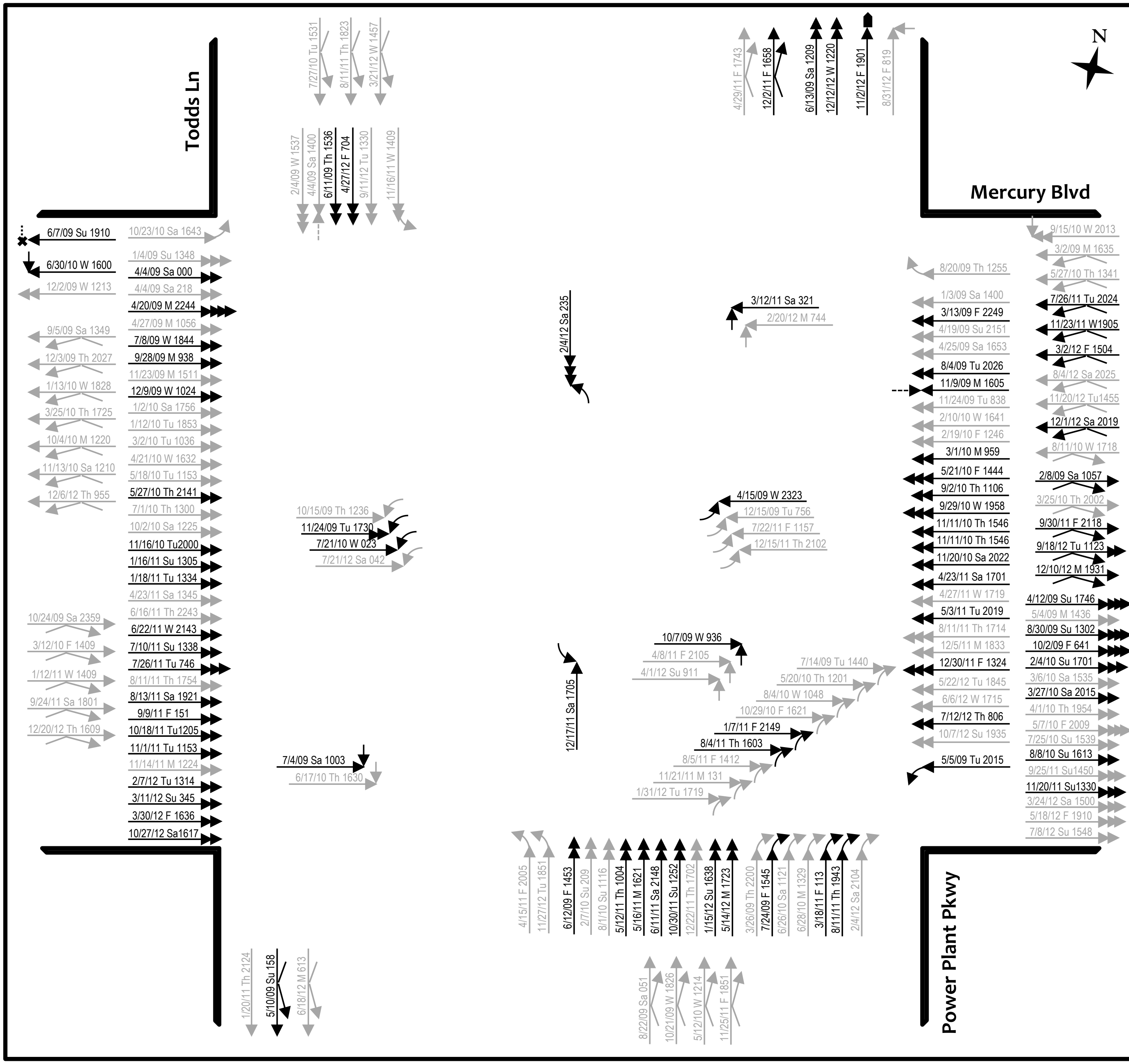
Year	F + I Multi	F + I Single	PDO Multi	PDO Single	Ped	Bike
2009	22	0	23	0	1	0
2010	14	0	33	0	0	0
2011	27	0	21	1	0	0
2012	14	1	20	0	0	0

CRASH LEVELS AND RANKING

Average Crashes per Year = 44.3 crashes
Ranks 2nd among 597 intersections

EPDO Crash Rate = 3.06
Ranks 9th among 597 intersections

Potential for Safety Improvement = +20.7 crashes
Ranks 3rd among 597 intersections



COLLISION DIAGRAM

INTERSECTION #3
MERCURY BLVD AT POWER PLANT PKWY

LEGEND

3/4/2010 Tu 2140

- Crash Date
- Crash Time of Day
- Crash Day of Week
- Number of arrowheads represents the total vehicles involved in the crash

Crash Severity

- Property Damage Only (PDO)
- Injury (INJ)
- Fatality (FAT)

Collision Type

- Rear End
- Head On
- Side Swipe
- Left Turn
- Right Turn
- Right Angle
- Backing Vehicle
- Pedestrian
- Animal
- Fixed Object

Data Source: HRTPO analysis of VDOT data. Data included in this diagram represents the years 2009-2012. Includes crashes located within 250' of the intersection.

INTERSECTION #3 – MERCURY BOULEVARD AT POWER PLANT PARKWAY
HAMPTON

CRASH DATA ANALYSIS

COLLISION TYPE

Collision Type	Mercury Blvd at Power Plant Pkwy	All Safety Study Intersections
Rear End	59.9%	44.6%
Right Angle	22.6%	34.6%
Head On	0.6%	3.0%
Sideswipe - Same Direction	14.1%	7.0%
Sideswipe - Opposite Direction	0.6%	1.0%
Fixed Object - In Road	0.0%	0.5%
Fixed Object - Off Road	0.0%	4.0%
Bike/Pedestrian	0.6%	1.6%
Animal	0.0%	0.4%
Other	1.7%	3.3%

MOST PREVALENT DRIVER ACTION

Primary Driver Action	Mercury Blvd at Power Plant Pkwy	All Safety Study Intersections
Following too close	48.0%	33.4%
Improper/Unsafe lane change	10.7%	5.1%
Did not have right-of-way	9.0%	17.3%
Disregarded signal	5.1%	10.3%
Failure to maintain control	5.1%	7.3%

WEATHER

Weather	Mercury Blvd at Power Plant Pkwy	All Safety Study Intersections
Clear/Cloudy	84.7%	81.9%
Mist/Rain/Fog	14.7%	15.5%
Snow/Sleet	0.0%	0.7%
Other/Not Stated	0.6%	1.9%

DRIVING UNDER THE INFLUENCE

Driving Under the Influence	Mercury Blvd at Power Plant Pkwy	All Safety Study Intersections
Drinking Involved	5.1%	5.8%

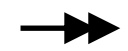
TIME OF DAY

Crash Time	Mercury Blvd at Power Plant Pkwy	All Safety Study Intersections
5:00 - 8:59	5.1%	12.7%
9:00 - 14:59	33.3%	34.0%
15:00 - 18:59	31.6%	31.0%
19:00 - 4:59	29.9%	22.3%

PRIMARY COLLISION MOVEMENTS

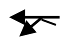
#1  19.8%

#2  14.1%

#3  beyond int. 9.0%

#4  5.6%

#5  5.1%

#6  5.1%

DATA OBSERVATIONS

- Excessive % of the crashes involve rear end collisions (60%) – the top 2 primary collision movements are rear end crashes on EB and WB approaches for Mercury Blvd. 9% of the crashes were along Mercury Blvd EB just beyond the intersection.
- 14% of the crashes were sideswipe – same direction, which is higher than the regional average.
- Following too close (48%) was the primary driver action preceding most crashes, which is higher than the regional average.
- 9 right turn crashes involved NB Power Plant Pkwy right turning vehicles with EB Mercury Blvd vehicles.
- 17 rear end crashes just east of the subject intersection.

Data Source: HRTPO analysis of VDOT data. Regionwide data included in the tables represents a summation of those 597 intersections included in the Regional Safety Study, not the region as a whole. All data represents the years 2009-2012.

SITE OBSERVATIONS & POSSIBLE CAUSES

- Three approaches have dual-left turn lanes – EB Mercury Blvd has single left turn lane. All left turns are controlled by protective phasing.
- SB Todds Ln and NB Power Plant Pkwy approaches have channelized right turn lanes with yield control. Both Mercury Blvd approaches have single right turn lanes.
- Signal faces for EB and WB Mercury Blvd approaches are approximately 180-200 feet beyond the stop lines due to the intersection skew.

- Citgo Stop & Go in the northwest quadrant has several driveways close to the intersection.
- Miller's Neighborhood Store driveway is 130 feet east of NB Power Plant Pkwy right turn bay.
- Many vehicles along WB Mercury Blvd from I-64 weave/merge across 4-5 lanes towards the WB dual left turn lane, which likely contribute to the high number of sideswipe rear end collisions.

- Mercury Blvd EB traffic favors the two rightmost lanes creating long traffic queues due to high commercial-retail south of the subject intersection and the right lane drops at the I-64 east/west ramps. The two inner lanes are underutilized – this corridor may benefit from a different lane configuration similar to WB Mercury Blvd past Coliseum Dr.
- Visibility for NB Power Plant Pkwy right turning vehicles is partially obstructed by the signal mast pole.

- Pavement markings are worn for the SB Todds Ln approach. No crosswalks or pedestrian signals are on the SB Todds Ln and WB Mercury Blvd approaches.

- There are only two small signs that indicate the EB Mercury Blvd right lane is an exit only lane towards I-64.
- No yield bars for the NB and SB channelized right turn lanes.
- No advance signal warning signs for the WB Mercury Blvd approach. The preceding signalized intersection is at Kilgore Ave/Target, approximately 0.65 mi east.

INTERSECTION #3 – MERCURY BOULEVARD AT POWER PLANT PARKWAY
HAMPTON

CANDIDATE CRASH COUNTERMEASURES

1) Add receiving lane along EB Mercury Blvd from NB Power Plant Pkwy free flow channelized right turn lane approximately 400 feet to connect with the right turn lane on EB Mercury Blvd at Power Plant Way. Add "Entering added lane" sign for NB Power Plant Pkwy channelized right turn lane.
2) Add activated flashing signal ahead sign for WB Mercury Blvd approach.

3) Add pedestrian signal and crosswalk with ladder striping for SB Todds Ln approach in order to prevent future bike/ped. crashes (No existing crashes).
4) Relocate stop bars along EB & WB Mercury Blvd closer to the intersection (this may require reconfiguring/restriping of other intersection pavement markings).
5) Add painted triangle yield lines with YIELD pavement markings and 2nd yield signs in the triangle concrete areas for NB Power Plant Pkwy and SB Todds Ln channelized right turn lanes.

BENEFIT-COST ANALYSIS

	Safety Countermeasure	Service Life (Years)	Crash Reduction Factor (CRF)			Average Annual Crashes			Estimated Annual Crash Reduction			Cost per Crash			Estimated Annual Benefit			Traffic Growth Factor	Total Annual Benefit
			FAT	INJ	PDO	FAT	INJ	PDO	FAT	INJ	PDO	FAT	INJ	PDO	FAT	INJ	PDO		
1	Rec lane (EB) & "Entering added lane" sign (NB)	8	0.20	0.20	0.20	0.0	4.0	5.3	0.0	0.8	1.1	$ 5,000,000	$ 85,000	$ 9,000	$ -	$ 68,000	$ 9,450	1.09	$ 84,756
2	Activated flashing signal ahead sign (WB)	10	0.25	0.25	0.25	0.0	3.8	3.5	0.0	0.9	0.9	$ 5,000,000	$ 85,000	$ 9,000	$ -	$ 79,688	$ 7,875	1.12	$ 97,796
3	Ped signal/crosswalk, ladder striping (SB approach)	20	0.50	0.50	0.50	0.0	0.0	0.0	0.0	0.0	0.0	$ 5,000,000	$ 85,000	$ 9,000	$ -	$ -	$ -	1.24	$ -
4	Relocate stop bars (EB, WB)	10	0.10	0.10	0.10	0.0	11.0	11.5	0.0	1.1	1.2	$ 5,000,000	$ 85,000	$ 9,000	$ -	$ 93,500	$ 10,350	1.12	$ 115,987
5	Yield markings & signs (NB/SB RT lanes)	10	0.25	0.25	0.25	0.0	2.5	4.8	0.0	0.6	1.2	$ 5,000,000	$ 85,000	$ 9,000	$ -	$ 53,125	$ 10,688	1.12	$ 71,270

	Safety Countermeasure	Service Life (Years)	Estimated Project Cost		Annual Initial Cost	Annual Mnt. Cost (if any)	Total Annual Cost
			PE & Construction	R/W & Utility			
1	Rec lane (EB) & "Entering added lane" sign (NB)	8	$ 481,500	$ 481,500	$ 137,186		$ 137,186
2	Activated flashing signal ahead sign (WB)	10	$ 50,000	$ 15,000	$ 7,620		$ 7,620
3	Ped signal/crosswalk, ladder striping (SB approach)	20	$ 99,000	$ -	$ 6,654		$ 6,654
4	Relocate stop bars (EB, WB)	10	$ 48,000	$ -	$ 5,627		$ 5,627
5	Yield markings & signs (NB/SB RT lanes)	10	$ 14,000	$ -	$ 1,641		$ 1,641

Total Annualized		B/C =
Benefit	Cost	
$ 84,756	$ 137,186	**0.62**
$ 97,796	$ 7,620	**12.83**
$ -	$ 6,654	**0.00**
$ 115,987	$ 5,627	**20.61**
$ 71,270	$ 1,641	**43.43**

RECOMMENDED CRASH COUNTERMEASURES (HIGH B/C)

5) Add painted triangle yield line with YIELD pavement markings and 2nd yield sign in the triangle concrete area for SB Todds Ln channelized right turn lane.
4) Relocate stop bars along EB & WB Mercury Blvd closer to the intersection (this may require reconfiguring/restriping of other intersection pavement markings).
2) Add activated flashing signal ahead sign for WB Mercury Blvd approach.

OTHER RECOMMENDED CRASH COUNTERMEASURES

3) Add pedestrian signal and crosswalk with ladder striping for SB Todds Ln approach in order to prevent future bike/ped. crashes (No existing crashes). Note: The City of Hampton is in the process of making this safety improvement.

INTERSECTION #4 – FIRST COLONIAL ROAD AT VIRGINIA BEACH BOULEVARD

VIRGINIA BEACH

Image source: Google. Data Source: HRTPO analysis of VDOT data. Data included in this table represents the years 2009-2012.
PDO = Property Damage Only Crashes. INJ = Injury Crashes. FAT = Fatality Crashes. F+I = Fatal + Injury Crashes combined.
EPDO = Equivalent Property Damage Only. More information on the EPDO Crash Rate is included in Part I of this study.

INTERSECTION DATA

ANNUAL AVERAGE DAILY TRAFFIC VOLUMES BY YEAR

First Colonial Rd (north): 2009 – 29,000; 2010 – 30,000; 2011 – 29,000; 2012 – 29,000

Va Beach Blvd (west): 2009 – 33,000; 2010 – 34,000; 2011 – 33,000; 2012 – 29,000

Va Beach Blvd (east): 2009 – 20,000; 2010 – 20,000; 2011 – 20,000; 2012 – 18,000

First Colonial Rd (south): 2009 – 34,000; 2010 – 34,000; 2011 – 33,000; 2012 – 31,000

Pedestrians Crossing Intersection Daily = 700 (Medium)

Intersection Control = Signalized
Protected/Permitted phasing for all left turns

CRASH DATA

ANNUAL CRASHES BY YEAR AND SEVERITY

	Crashes Per Year			
Year	PDO	INJ	FAT	TOTAL
2009	27	7	0	34
2010	20	17	0	37
2011	22	13	0	35
2012	23	8	0	31

ANNUAL CRASHES BY YEAR AND TYPE

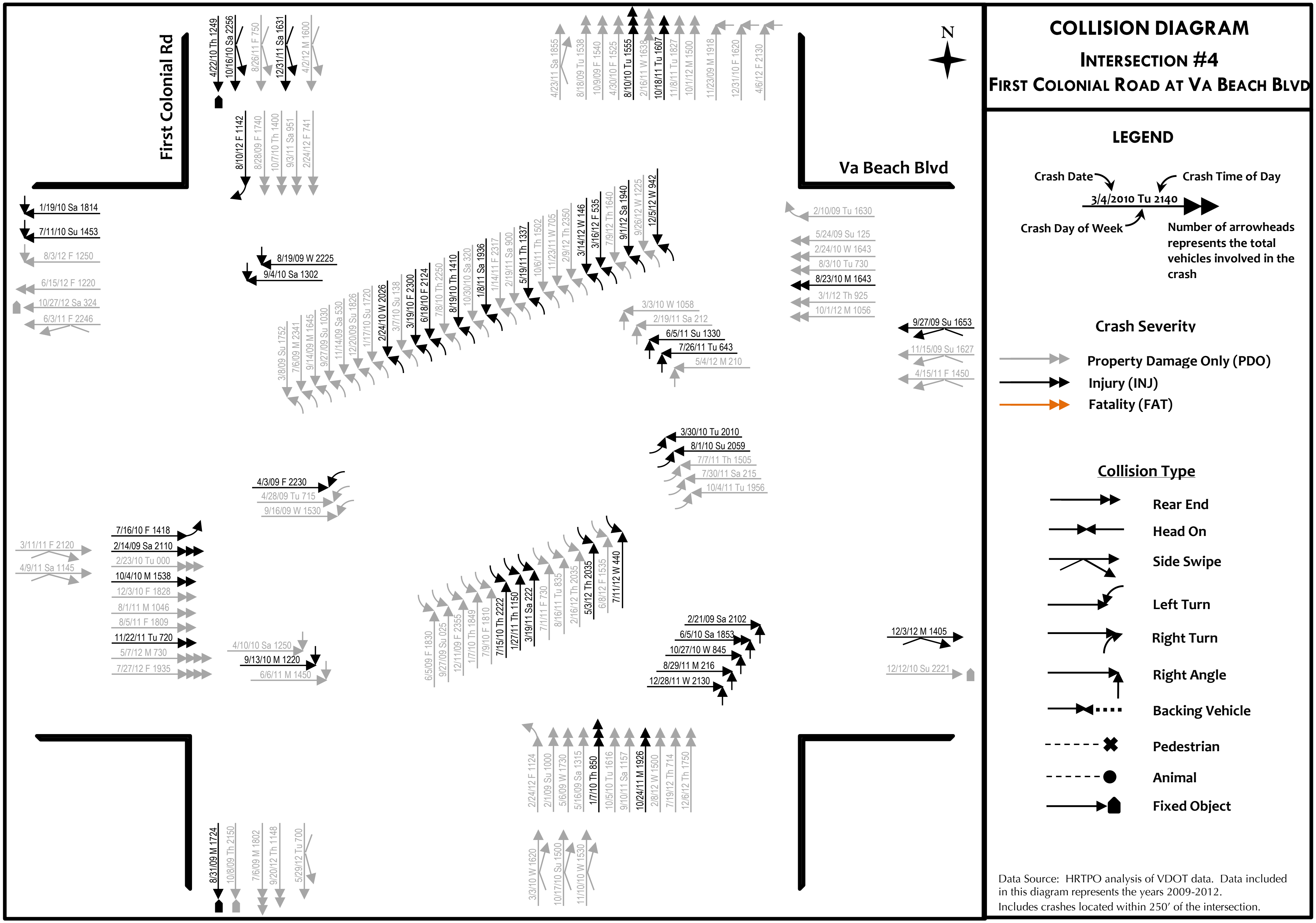
Year	F + I Multi	F + I Single	PDO Multi	PDO Single	Ped	Bike
2009	6	1	26	1	0	0
2010	17	0	20	0	0	0
2011	13	0	22	0	0	0
2012	8	0	22	1	0	0

CRASH LEVELS AND RANKING

Average Crashes per Year = 34.3 crashes
Ranks 6th among 597 intersections

EPDO Crash Rate = 2.64
Ranks 20th among 597 intersections

Potential for Safety Improvement = +18.9 crashes
Ranks 4th among 597 intersections


COLLISION DIAGRAM
INTERSECTION #4
FIRST COLONIAL ROAD AT VA BEACH BLVD
First Colonial Rd
Va Beach Blvd
N
LEGEND
Crash Date
Crash Time of Day
3/4/2010 Tu 2140
Crash Day of Week
Number of arrowheads represents the total vehicles involved in the crash
Crash Severity
Property Damage Only (PDO)
Injury (INJ)
Fatality (FAT)
Collision Type
Rear End
Head On
Side Swipe
Left Turn
Right Turn
Right Angle
Backing Vehicle
Pedestrian
Animal
Fixed Object
4/22/10 Th 1249
10/16/10 Sa 2256
8/26/11 F 750
12/31/11 Sa 1631
4/2/12 M 1600
8/10/12 F 1142
8/28/09 F 1740
10/7/10 Th 1400
9/3/11 Sa 951
2/24/12 F 741
4/23/11 Sa 1855
8/18/09 Tu 1538
10/9/09 F 1540
4/30/10 F 1525
8/10/10 Tu 1555
2/16/11 W 1638
10/18/11 Tu 1607
11/8/11 Tu 1827
10/1/12 M 1500
11/23/09 M 1918
12/31/10 F 1620
4/6/12 F 2130
1/19/10 Sa 1814
7/11/10 Su 1453
8/3/12 F 1250
6/15/12 F 1220
10/27/12 Sa 324
6/3/11 F 2246
8/19/09 W 2225
9/4/10 Sa 1302
2/10/09 Tu 1630
5/24/09 Su 125
2/24/10 W 1643
8/3/10 Tu 730
8/23/10 M 1643
3/1/12 Th 925
10/1/12 M 1056
3/3/10 W 1058
2/19/11 Sa 212
6/5/11 Su 1330
7/26/11 Tu 643
5/4/12 M 210
9/27/09 Su 1653
11/15/09 Su 1627
4/15/11 F 1450
3/8/09 Su 1752
7/6/09 M 2341
9/14/09 M 1645
9/27/09 Su 1030
11/14/09 Sa 530
12/20/09 Su 1826
1/17/10 Su 1720
2/24/10 W 2026
3/7/10 Su 138
3/19/10 F 2300
6/18/10 F 2124
7/8/10 Th 2250
8/19/10 Th 1410
10/30/10 Sa 320
1/8/11 Sa 1936
1/14/11 F 2317
2/19/11 Sa 900
5/19/11 Th 1337
10/6/11 Th 1502
11/23/11 W 705
2/9/12 Th 2350
3/14/12 W 146
3/16/12 F 535
7/9/12 Th 1640
9/1/12 Sa 1940
9/26/12 W 1225
12/5/12 W 942
3/30/10 Tu 2010
8/1/10 Su 2059
7/7/11 Th 1505
7/30/11 Sa 215
10/4/11 Tu 1956
4/3/09 F 2230
4/28/09 Tu 715
9/16/09 W 1530
3/11/11 F 2120
4/9/11 Sa 1145
7/16/10 F 1418
2/14/09 Sa 2110
2/23/10 Tu 000
10/4/10 M 1538
12/3/10 F 1828
8/1/11 M 1046
8/5/11 F 1809
11/22/11 Tu 720
5/7/12 M 730
7/27/12 F 1935
4/10/10 Sa 1250
9/13/10 M 1220
6/6/11 M 1450
6/5/09 F 1830
9/27/09 Su 025
12/11/09 F 2355
1/7/10 Th 1849
7/9/10 F 1810
7/15/10 Th 2222
1/27/11 Th 1150
3/19/11 Sa 222
7/1/11 F 730
8/16/11 Tu 835
2/16/12 Th 2035
5/3/12 Th 2035
6/8/12 F 1535
7/11/12 W 440
2/21/09 Sa 2102
6/5/10 Sa 1853
10/27/10 W 845
8/29/11 M 216
12/28/11 W 2130
12/3/12 M 1405
12/12/10 Su 2221
2/24/12 F 1124
2/1/09 Su 1000
5/6/09 W 1730
5/16/09 Sa 1315
1/7/10 Th 850
10/5/10 Tu 1616
9/10/11 Sa 1157
10/24/11 M 1926
2/8/12 W 1500
7/19/12 Th 714
12/6/12 Th 1750
8/31/09 M 1724
10/8/09 Th 2150
7/6/09 M 1802
9/20/12 Th 1148
5/29/12 Tu 700
3/3/10 W 1620
10/17/10 Su 1500
11/10/10 W 1530
Data Source: HRTPO analysis of VDOT data. Data included in this diagram represents the years 2009-2012.
Includes crashes located within 250' of the intersection.

INTERSECTION #4 – FIRST COLONIAL ROAD AT VIRGINIA BEACH BOULEVARD

VIRGINIA BEACH

CRASH DATA ANALYSIS

COLLISION TYPE

Collision Type	First Colonial Rd at Va Beach Blvd	All Safety Study Intersections
Rear End	32.6%	44.6%
Right Angle	48.1%	34.6%
Head On	2.2%	3.0%
Sideswipe - Same Direction	8.9%	7.0%
Sideswipe - Opposite Direction	3.0%	1.0%
Fixed Object - In Road	0.7%	0.5%
Fixed Object - Off Road	1.5%	4.0%
Bike/Pedestrian	0.0%	1.6%
Animal	0.0%	0.4%
Other	3.0%	3.3%

MOST PREVALENT DRIVER ACTION

Primary Driver Action	First Colonial Rd at Va Beach Blvd	All Safety Study Intersections
Did not have right-of-way	29.6%	17.3%
Following too close	28.9%	33.4%
Disregarded signal	8.1%	10.3%
Improper/Unsafe lane change	7.4%	5.1%
Improper turn	4.4%	3.4%

WEATHER

Weather	First Colonial Rd at Va Beach Blvd	All Safety Study Intersections
Clear/Cloudy	85.2%	81.9%
Mist/Rain/Fog	14.8%	15.5%
Snow/Sleet	0.0%	0.7%
Other/Not Stated	0.0%	1.9%

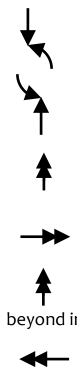
DRIVING UNDER THE INFLUENCE

Driving Under the Influence	First Colonial Rd at Va Beach Blvd	All Safety Study Intersections
Drinking Involved	7.4%	5.8%

TIME OF DAY

Crash Time	First Colonial Rd at Va Beach Blvd	All Safety Study Intersections
5:00 - 8:59	11.9%	12.7%
9:00 - 14:59	23.7%	34.0%
15:00 - 18:59	32.6%	31.0%
19:00 - 4:59	31.9%	22.3%

PRIMARY COLLISION MOVEMENTS



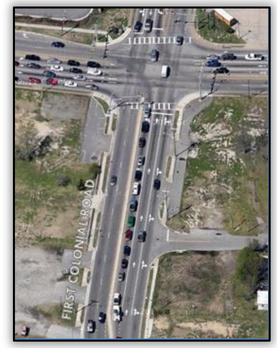
#1	20.0%
#2	10.4%
#3	7.4%
#4	6.7%
#5	5.9%
#6	4.4%

DATA OBSERVATIONS

- The highest collision type was right angle (48%), which is higher than the regional average.
- 30% of the crashes involve left-turning First Colonial Rd vehicles and opposing traffic – 20% involve NB left-turning vehicles and SB through vehicles.
- 30% of crashes involve drivers that did not have the right-of-way.
- Crashes involving drinking (7.4%) were higher than the regional average.
- A high percentage of crashes (32%) occurred during the night/early morning hours (7pm-4:59am)

Data Source: HRTPO analysis of VDOT data. Regionwide data included in the tables represents a summation of those 597 intersections included in the Regional Safety Study, not the region as a whole. All data represents the years 2009-2012.

SITE OBSERVATIONS & POSSIBLE CAUSES



- Left turns on all approaches are controlled by protective-permissive phasing.
- Only EB and WB Va Beach Blvd approaches have exclusive right turn lanes. The NB and SB First Colonial Road approaches have a shared right turn/through lane.

- Intersection is congested during peak periods. NB and SB First Colonial Road left turn lanes are not sufficient for peak period queues for given signal timing. Tire tracks were found in the grass median for SB First Colonial Rd approach.

- NB First Colonial Road is congested during the PM peak period from I-264 back to the Virginia Beach Boulevard intersection. This is primarily due to the length of the left turn bay (200') at the I-264 WB on ramp and the high number of vehicles making this movement.
- 7-Eleven (NE quadrant) has two driveways close to the intersection.

- There is a right turn bay along WB Va Beach Blvd just west of the intersection for Wawa (NW quadrant).

INTERSECTION #4 – FIRST COLONIAL ROAD AT VIRGINIA BEACH BOULEVARD

VIRGINIA BEACH

CANDIDATE CRASH COUNTERMEASURES

1) Improvements are already planned for this intersection as part of a Virginia Beach Capital Improvement Project (CIP #2-072), widening First Colonial Rd to 6 lanes from Oceana Blvd to I-264. It also includes dual left turn lanes, two through lanes, and a continuous right turn lane on the north and south approaches to the intersection. The east and west approaches will consist of a left turn lane, two through lanes and a right turn lane. The total project cost is approximately $25.5 million and construction is currently expected to begin in 2016.

BENEFIT-COST ANALYSIS

No analysis was conducted since intersection improvements are already planned.

INTERSECTION #5 – MERCURY BOULEVARD AT JEFFERSON AVENUE

NEWPORT NEWS

Image source: Google. Data Source: HRTPO analysis of VDOT data. Data included in this table represents the years 2009-2012.
PDO = Property Damage Only Crashes. INJ = Injury Crashes. FAT = Fatality Crashes. F+I = Fatal + Injury Crashes combined.
EPDO = Equivalent Property Damage Only. More information on the EPDO Crash Rate is included in Part I of this study.

INTERSECTION DATA

ANNUAL AVERAGE DAILY TRAFFIC VOLUMES BY YEAR

Jefferson Ave (north): 2009 – 44,000; 2010 – 40,000; 2011 – 41,000; 2012 – 42,000

Mercury Blvd (west): 2009 – 40,000; 2010 – 39,000; 2011 – 40,000; 2012 – 39,000

Mercury Blvd (east): 2009 – 20,000; 2010 – 20,000; 2011 – 20,000; 2012 – 18,000

Jefferson Ave (south): 2009 – 32,000; 2010 – 28,000; 2011 – 29,000; 2012 – 31,000

Pedestrians Crossing Intersection Daily = 700 (Medium)

Intersection Control = Signalized
Protected phasing for all left turns

CRASH DATA

ANNUAL CRASHES BY YEAR AND SEVERITY

Year	Crashes Per Year PDO	INJ	FAT	TOTAL
2009	15	22	0	37
2010	20	23	0	43
2011	20	19	0	39
2012	15	15	0	30

ANNUAL CRASHES BY YEAR AND TYPE

Year	F + I Multi	F + I Single	PDO Multi	PDO Single	Ped	Bike
2009	21	1	14	1	0	0
2010	21	0	19	1	1	1
2011	16	2	20	0	1	0
2012	13	1	15	0	1	0

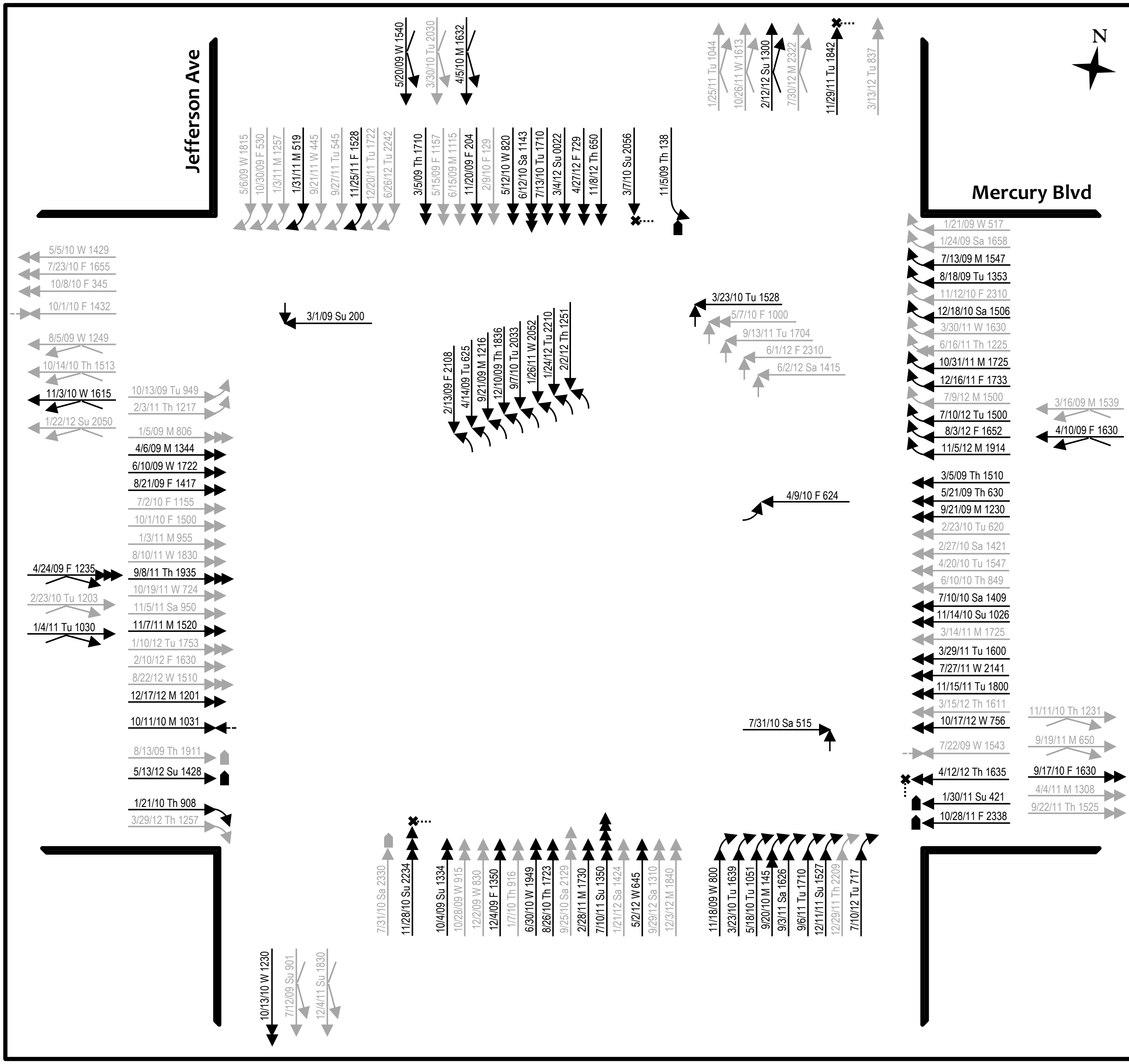
CRASH LEVELS AND RANKING

Average Crashes per Year = 37.3 crashes
Ranks 4th among 597 intersections

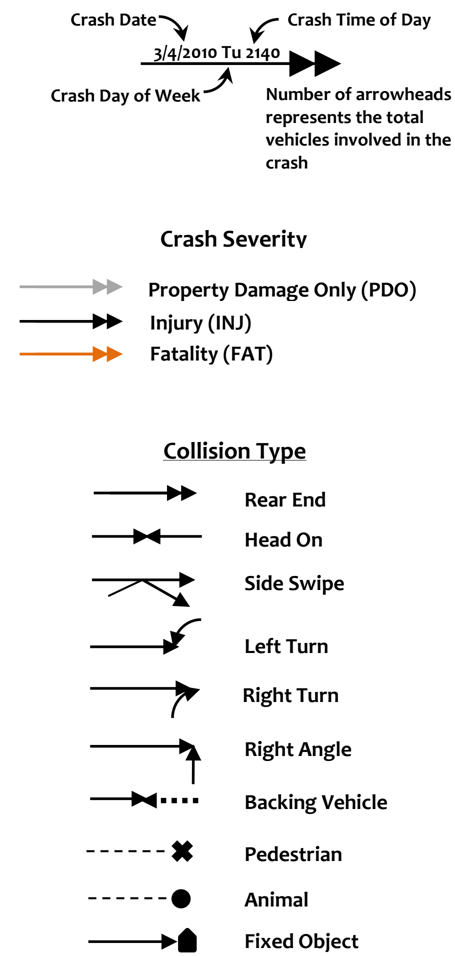
EPDO Crash Rate = 2.92
Ranks 10th among 597 intersections

Potential for Safety Improvement = +16.7 crashes
Ranks 5th among 597 intersections

COLLISION DIAGRAM
INTERSECTION #5
MERCURY BLVD AT JEFFERSON AVE



LEGEND



Data Source: HRTPO analysis of VDOT data. Data included in this diagram represents the years 2009-2012. Includes crashes located within 250' of the intersection.

INTERSECTION #5 – MERCURY BOULEVARD AT JEFFERSON AVENUE
NEWPORT NEWS

CRASH DATA ANALYSIS

COLLISION TYPE

Collision Type	Mercury Blvd at Jefferson Ave	All Safety Study Intersections
Rear End	69.8%	44.6%
Right Angle	10.7%	34.6%
Head On	4.0%	3.0%
Sideswipe - Same Direction	6.7%	7.0%
Sideswipe - Opposite Direction	2.7%	1.0%
Fixed Object - In Road	0.0%	0.5%
Fixed Object - Off Road	1.3%	4.0%
Bike/Pedestrian	2.7%	1.6%
Animal	0.0%	0.4%
Other	2.0%	3.3%

MOST PREVALENT DRIVER ACTION

Primary Driver Action	Mercury Blvd at Jefferson Ave	All Safety Study Intersections
Following too close	55.1%	33.4%
Disregarded signal	7.5%	10.3%
Did not have right-of-way	4.1%	17.3%
Failure to maintain control	2.7%	7.3%
Driver distraction	2.7%	2.1%

WEATHER

Weather	Mercury Blvd at Jefferson Ave	All Safety Study Intersections
Clear/Cloudy	83.2%	81.9%
Mist/Rain/Fog	14.1%	15.5%
Snow/Sleet	0.0%	0.7%
Other/Not Stated	2.7%	1.9%

DRIVING UNDER THE INFLUENCE

Driving Under the Influence	Mercury Blvd at Jefferson Ave	All Safety Study Intersections
Drinking Involved	6.8%	5.8%

TIME OF DAY

Crash Time	Mercury Blvd at Jefferson Ave	All Safety Study Intersections
5:00 - 8:59	14.8%	12.7%
9:00 - 14:59	30.9%	34.0%
15:00 - 18:59	34.2%	31.0%
19:00 - 4:59	20.1%	22.3%

PRIMARY COLLISION MOVEMENTS

#1  10.7%

#2  10.1%

#3  9.4%

#4  9.4%

#5  7.4%

#6 (tie)  &  6.0%

DATA OBSERVATIONS

- 70% of the crashes involve rear end collisions, which is significantly higher than the regional average – the top 2 primary collision movements were on the EB and WB approaches for Mercury Blvd.
- 55% of the crashes were the result of drivers following too close, which is much higher than the regional average.
- 3% of the crashes involved bicyclists/pedestrians, which is higher than the regional average.

Data Source: HRTPO analysis of VDOT data. Regionwide data included in the tables represents a summation of those 597 intersections included in the Regional Safety Study, not the region as a whole. All data represents the years 2009-2012.

SITE OBSERVATIONS & POSSIBLE CAUSES

- All approaches have dual-left turn lanes controlled by protective phasing.
- EB, WB, & NB approaches have large channelized right turn lanes extending approximately 250 feet beyond the intersection – EB/WB are yield control and NB/SB are controlled by a traffic signal. SB approach now has channelized dual right turn lanes (see picture below).

- Mercury Blvd is a 6-lane urban principal arterial with a 35 mph speed limit. Jefferson Ave is a 6-lane urban principal arterial with a 45 mph speed limit.
- Red light cameras are installed on EB & WB Mercury Blvd.
- High pedestrian activity was observed.
- HRT bus stop just south of intersection.

- McDonalds/shopping center (NE quadrant) driveway along WB Mercury Blvd approach is located at the beginning of channelized right turn lane for the WB Mercury Blvd approach, which may confuse right turning vehicles.
- The closest signalized intersection along Mercury Blvd to the west is located approximately 0.6 mi away at River Rd.
- Lane line extensions for EB Mercury Blvd dual left turn lane are worn.

- A traffic signal for EB Mercury Blvd is located approximately 330 feet east of the intersection – this signal controls EB Mercury Blvd movements, WB Mercury Blvd left turns, and NB Jefferson Ave right turns. A driveway into an office building (SE quadrant) is located at this signal.
- Left turns exiting this office building south of Mercury Blvd to SB Jefferson Ave appears difficult for drivers.
- Western leg across Mercury Blvd has a pedestrian signal/phase – no other legs have pedestrian signals/phases.
- Pedestrian crosswalks with parallel markings are on all approaches. Although crosswalks with parallel markings are permitted by the MUTCD, FHWA research has determined they are less visible to motorists than crosswalks with continental/ladder striping.
- There is a railroad overpass located just west of the intersection.

INTERSECTION #5 – MERCURY BOULEVARD AT JEFFERSON AVENUE
NEWPORT NEWS

CANDIDATE CRASH COUNTERMEASURES

1) Repaint pedestrian crosswalks with ladder striping (All legs). Add pedestrian signal/phases and upgrade to ADA compliant handicap ramps (N & S intersection legs).
2) Repaint lane line extension for EB Mercury Blvd dual left turn lane.
3) Optimize signal timing.
4) Close the driveway of the McDonalds/shopping center (NE quadrant) that is located at the beginning of the exclusive free flow right turn lane for the WB Mercury Blvd approach. Access is provided via other nearby driveways.
5) Remove traffic signal just east of the subject intersection and close driveway to/from office building (access is already provided via Jefferson Ave south of the intersection).
6) Add flashing signal ahead signs for the EB Mercury Blvd approach.
7) Move NB, EB, and WB channelized right turn lanes closer to the intersection to reduce right turning vehicle speeds/rear end crashes.
8) Add painted triangles yield lines with YIELD pavement markings and 2nd yield signs in the triangle grass areas for EB and WB Mercury Blvd channelized right turn lanes.

BENEFIT-COST ANALYSIS

#	Safety Countermeasure	Service Life (Years)	Crash Reduction Factor (CRF) FAT	CRF INJ	CRF PDO	Average Annual Crashes FAT	Avg INJ	Avg PDO	Estimated Annual Crash Reduction FAT	Red. INJ	Red. PDO	Cost per Crash FAT	Cost INJ	Cost PDO	Estimated Annual Benefit FAT	Benefit INJ	Benefit PDO	Traffic Growth Factor	Total Annual Benefit
1	Repaint ped crosswalks, add ped signal/ramps	20	0.50	0.50	0.50	0.0	0.8	0.0	0.0	0.4	0.0	$ 5,000,000	$ 85,000	$ 9,000	$ -	$ 31,875	$ -	1.24	$ 39,498
2	Lane line extension for dual LT lanes (EB)	7	0.20	0.20	0.20	0.0	0.3	0.5	0.0	0.1	0.1	$ 5,000,000	$ 85,000	$ 9,000	$ -	$ 4,250	$ 900	1.08	$ 5,579
3	Optimize signal timing	5	0.10	0.10	0.10	0.0	19.8	17.5	0.0	2.0	1.8	$ 5,000,000	$ 85,000	$ 9,000	$ -	$ 167,875	$ 15,750	1.06	$ 194,941
4	Close driveway to McDonalds/shopping ctr	20	0.25	0.25	0.25	0.0	2.8	1.8	0.0	0.7	0.4	$ 5,000,000	$ 85,000	$ 9,000	$ -	$ 58,438	$ 3,938	1.24	$ 77,293
5	Remove signal & close driveway to/from office bldg	20	0.24	0.24	0.24	0.0	2.3	1.5	0.0	0.5	0.4	$ 5,000,000	$ 85,000	$ 9,000	$ -	$ 45,900	$ 3,240	1.24	$ 60,893
6	Activated flashing signal ahead sign (EB)	10	0.25	0.25	0.25	0.0	2.0	3.3	0.0	0.5	0.8	$ 5,000,000	$ 85,000	$ 9,000	$ -	$ 42,500	$ 7,313	1.12	$ 55,634
7	Move RT chann. lanes closer to int. (NB, EB, WB)	10	0.25	0.25	0.25	0.0	5.0	4.5	0.0	1.3	1.1	$ 5,000,000	$ 85,000	$ 9,000	$ -	$ 106,250	$ 10,125	1.12	$ 129,976
8	Yield markings & signs (EB/WB RT lanes)	10	0.25	0.25	0.25	0.0	2.8	3.3	0.0	0.7	0.8	$ 5,000,000	$ 85,000	$ 9,000	$ -	$ 58,438	$ 7,313	1.12	$ 73,434

#	Safety Countermeasure	Service Life (Years)	Estimated Project Cost: PE & Construction	Estimated Project Cost: R/W & Utility	Annual Initial Cost	Annual Mnt. Cost (if any)	Total Annual Cost
1	Repaint ped crosswalks, add ped signal/ramps	20	$ 186,000	$ -	$ 12,502		$ 12,502
2	Lane line extension for dual LT lanes (EB)	7	$ 8,000	$ -	$ 1,284		$ 1,284
3	Optimize signal timing	5	$ 5,000	$ -	$ 1,092		$ 1,092
4	Close driveway to McDonalds/shopping ctr	20	$ 150,000	$ 25,000	$ 11,763		$ 11,763
5	Remove signal & close driveway to/from office bldg	20	$ 200,000	$ 25,000	$ 15,124		$ 15,124
6	Activated flashing signal ahead sign (EB)	10	$ 50,000	$ 15,000	$ 7,620		$ 7,620
7	Move RT chann. lanes closer to int. (NB, EB, WB)	10	$ 960,000	$ 75,000	$ 121,334		$ 121,334
8	Yield markings & signs (EB/WB RT lanes)	10	$ 14,000	$ -	$ 1,641		$ 1,641

Total Annualized Benefit	Total Annualized Cost	B/C =
$ 39,498	$ 12,502	**3.16**
$ 5,579	$ 1,284	**4.34**
$ 194,941	$ 1,092	**178.55**
$ 77,293	$ 11,763	**6.57**
$ 60,893	$ 15,124	**4.03**
$ 55,634	$ 7,620	**7.30**
$ 129,976	$ 121,334	**1.07**
$ 73,434	$ 1,641	**44.74**

RECOMMENDED CRASH COUNTERMEASURES (HIGH B/C)

3) Optimize signal timing.
8) Add painted triangles yield lines with YIELD pavement markings and 2nd yield signs in the triangle grass areas for EB and WB Mercury Blvd channelized right turn lanes.
6) Add flashing signal ahead signs for the EB Mercury Blvd approach.
4) Close the driveway of the McDonalds/shopping center (NE quadrant) that is located at the beginning of the exclusive free flow right turn lane for the WB Mercury Blvd approach. Access is provided via other nearby driveways.
2) Repaint lane line extension for EB Mercury Blvd dual left turn lane.
5) Remove traffic signal just east of the subject intersection and close driveway to/from office building (access is already provided via Jefferson Ave south of the intersection).
1) Repaint pedestrian crosswalks with ladder striping (All legs). Add pedestrian signal/phases and upgrade to ADA compliant handicap ramps (N & S intersection legs).

INTERSECTION #6 – GENERAL BOOTH BOULEVARD AT DAM NECK ROAD
VIRGINIA BEACH

Image source: Google. Data Source: HRTPO analysis of VDOT data. Data included in this table represents the years 2009-2012.
PDO = Property Damage Only Crashes. INJ = Injury Crashes. FAT = Fatality Crashes. F+I = Fatal + Injury Crashes combined.
EPDO = Equivalent Property Damage Only. More information on the EPDO Crash Rate is included in Part I of this study.

INTERSECTION DATA

ANNUAL AVERAGE DAILY TRAFFIC VOLUMES BY YEAR

General Booth Blvd (north):
2009 – 57,000
2010 – 59,000
2011 – 57,000
2012 – 44,000

Dam Neck Rd (west):
2009 – 25,000
2010 – 25,000
2011 – 24,000
2012 – 25,000

Dam Neck Rd (east):
2009 – 17,000
2010 – 18,000
2011 – 17,000
2012 – 17,000

General Booth Blvd (south):
2009 – 31,000
2010 – 32,000
2011 – 30,000
2012 – 27,000

Pedestrians Crossing Intersection Daily = 700 (Medium)

Intersection Control = Signalized
Protected phasing for all left turns

CRASH DATA

ANNUAL CRASHES BY YEAR AND SEVERITY

	Crashes Per Year			
Year	PDO	INJ	FAT	TOTAL
2009	29	6	0	35
2010	37	15	0	52
2011	21	8	0	29
2012	21	8	0	29

ANNUAL CRASHES BY YEAR AND TYPE

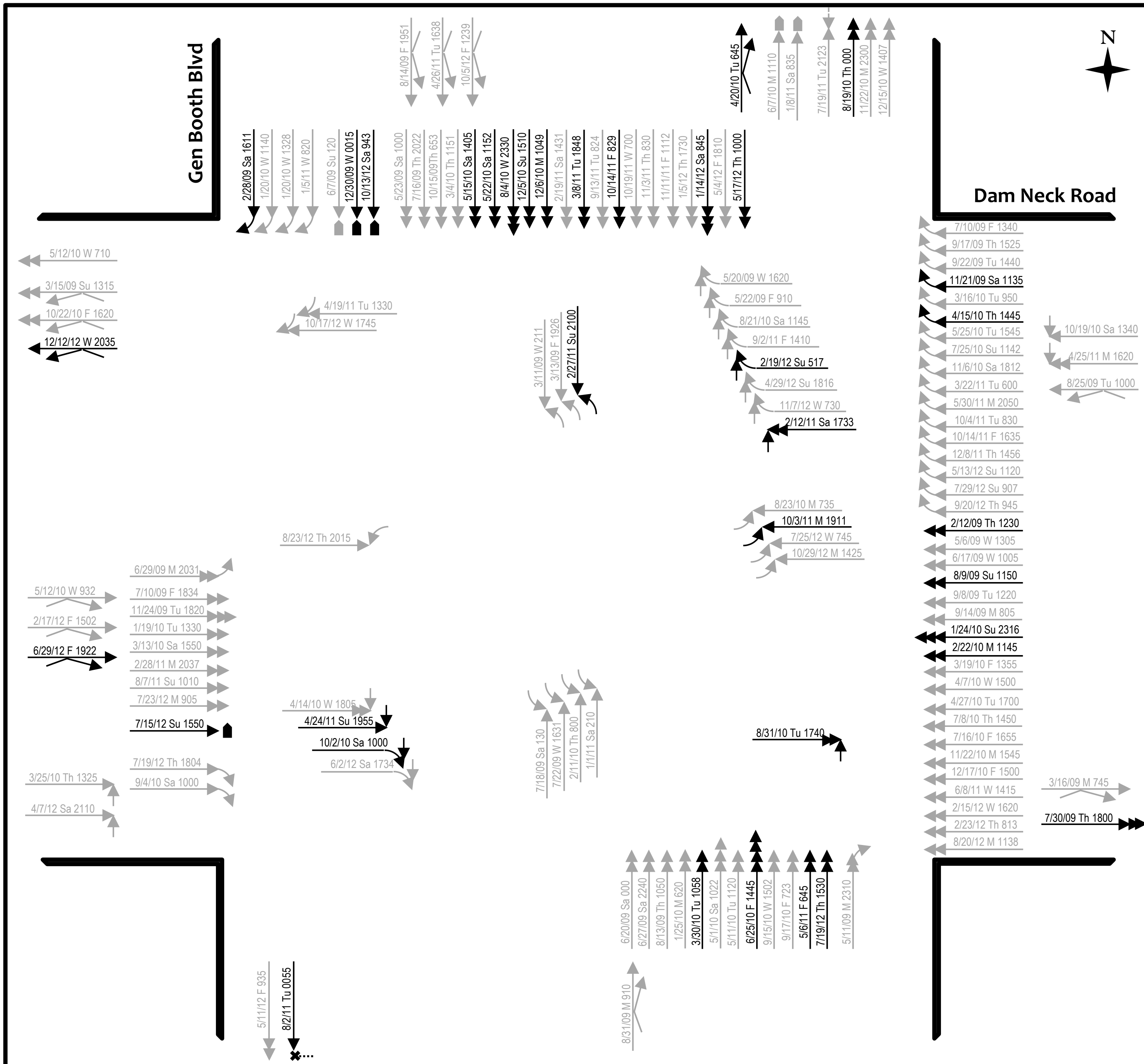
Year	F + I Multi	F + I Single	PDO Multi	PDO Single	Ped	Bike
2009	5	1	28	1	0	0
2010	15	0	36	1	0	0
2011	7	0	20	1	1	0
2012	6	2	21	0	0	0

CRASH LEVELS AND RANKING

Average Crashes per Year = 36.3 crashes
Ranks 5th among 597 intersections

EPDO Crash Rate = 2.24
Ranks 45th among 597 intersections

Potential for Safety Improvement = +13.6 crashes
Ranks 6th among 597 intersections



COLLISION DIAGRAM

INTERSECTION #6
GEN. BOOTH BLVD AT DAM NECK RD

LEGEND

Crash Date — Crash Time of Day

3/4/2010 Tu 2140

Crash Day of Week — Number of arrowheads represents the total vehicles involved in the crash

Crash Severity

- Property Damage Only (PDO)
- Injury (INJ)
- Fatality (FAT)

Collision Type

- Rear End
- Head On
- Side Swipe
- Left Turn
- Right Turn
- Right Angle
- Backing Vehicle
- Pedestrian
- Animal
- Fixed Object

Data Source: HRTPO analysis of VDOT data. Data included in this diagram represents the years 2009-2012. Includes crashes located within 250′ of the intersection.

INTERSECTION #6 – GENERAL BOOTH BOULEVARD AT DAM NECK ROAD

VIRGINIA BEACH

CRASH DATA ANALYSIS

COLLISION TYPE

Collision Type	Gen Booth Blvd at Dam Neck Rd	All Safety Study Intersections
Rear End	62.1%	44.6%
Right Angle	28.3%	34.6%
Head On	2.1%	3.0%
Sideswipe - Same Direction	2.1%	7.0%
Sideswipe - Opposite Direction	0.0%	1.0%
Fixed Object - In Road	0.7%	0.5%
Fixed Object - Off Road	3.4%	4.0%
Bike/Pedestrian	0.7%	1.6%
Animal	0.0%	0.4%
Other	0.7%	3.3%

MOST PREVALENT DRIVER ACTION

Primary Driver Action	Gen Booth Blvd at Dam Neck Rd	All Safety Study Intersections
Following too close	53.1%	33.4%
Did not have right-of-way	13.1%	17.3%
Disregarded signal	4.1%	10.3%
Failure to maintain control	4.1%	7.3%
Improper turn	2.8%	3.4%

WEATHER

Weather	Gen Booth Blvd at Dam Neck Rd	All Safety Study Intersections
Clear/Cloudy	86.2%	81.9%
Mist/Rain/Fog	13.1%	15.5%
Snow/Sleet	0.0%	0.7%
Other/Not Stated	0.7%	1.9%

DRIVING UNDER THE INFLUENCE

Driving Under the Influence	Gen Booth Blvd at Dam Neck Rd	All Safety Study Intersections
Drinking Involved	2.8%	5.8%

TIME OF DAY

Crash Time	Gen Booth Blvd at Dam Neck Rd	All Safety Study Intersections
5:00 - 8:59	15.9%	12.7%
9:00 - 14:59	40.7%	34.0%
15:00 - 18:59	24.1%	31.0%
19:00 - 4:59	19.3%	22.3%

PRIMARY COLLISION MOVEMENTS

#1	13.8%
#2	13.1%
#3	11.7%
#4	8.3%
#5	4.8%
#6	4.8%

DATA OBSERVATIONS

- 62% of the crashes involve rear end collisions, which is significantly higher than the regional average – the top 3 primary collision movements were on the WB Dam Neck Rd and SB General Booth Blvd approaches.
- 13% of the crashes involve rear end collisions with right turning vehicles traveling on WB Dam Neck Rd.
- 53% of the crashes were the result of drivers following too close, which is much higher than the regional average.
- 41% of the crashes occurred during the mid-day hours between 9am-2:59pm.

Data Source: HRTPO analysis of VDOT data. Regionwide data included in the tables represents a summation of those 597 intersections included in the Regional Safety Study, not the region as a whole. All data represents the years 2009-2012.

SITE OBSERVATIONS & POSSIBLE CAUSES

- All approaches have dual left turn lanes controlled by protective phasing.
- NB and SB approaches have single right turn lanes. EB and WB approaches have channelized right turn lanes with yield control – right turning vehicles do not always yield (based on field observations).

- Red light cameras are installed on SB General Booth Blvd & EB Dam Neck Rd.
- 7-Eleven (NE quadrant) driveway is located at the beginning of the channelized right turn lane for the WB Dam Neck Rd approach – which could contribute to rear end crashes.

- Yield sign for WB Dam Neck Rd channelized right turn lane is partially blocked by a crape myrtle tree.
- High volume of WB Dam Neck Rd right turns.

- Along SB General Booth Blvd, a short right turn lane for the Jiffy Lube (NW quadrant) driveway precedes the intersection right turn lane with approximately 75 feet in between. Tire marks were found on the raised curb corner from confused drivers. All crashes may not be included since this location is beyond 250 feet of the intersection, which is outside of the intersection analysis area.

- EB Dam Neck Rd dual left turn bay lengths are not sufficient during peak periods for given signal timing.

INTERSECTION #6 – GENERAL BOOTH BOULEVARD AT DAM NECK ROAD
VIRGINIA BEACH

CANDIDATE CRASH COUNTERMEASURES

1) Extend SB General Booth Blvd right turn lane by approximately 75 feet to connect with right turn lane for Jiffy Lube (All crashes may not be included since this location is beyond 250 feet of the intersection, which is outside of the intersection analysis area).
2) Optimize signal timing.
3) Add receiving lane on NB General Booth Blvd from WB Dam Neck Rd channelized right turn lane, connecting with right turn lane into 7-Eleven. Add "Entering added lane" sign for WB Dam Neck Rd channelized right turn lane.

4) Add painted triangle yield lines with YIELD pavement markings and 2nd yield signs in the concrete/brick triangle areas for EB and WB Dam Neck Rd channelized right turn lanes. Trim vegetation (WB).

* Virginia Beach Capital Improvement. Project (CIP) 2-300.044 has been programmed (FY 14-15 funding) to provide geometric improvements to reduce the severity of the slip lane angle for the WB Dam Neck Rd channelized right turn lane.

BENEFIT-COST ANALYSIS

	Safety Countermeasure	Service Life (Years)	Crash Reduction Factor (CRF)			Average Annual Crashes			Estimated Annual Crash Reduction			Cost per Crash			Estimated Annual Benefit			Traffic Growth Factor	Total Annual Benefit
			FAT	INJ	PDO	FAT	INJ	PDO	FAT	INJ	PDO	FAT	INJ	PDO	FAT	INJ	PDO		
1	Extend SB RT lane 75' to Jiffy Lube RT lane	8	0.15	0.15	0.15	0.0	0.8	1.8	0.0	0.1	0.3	$ 5,000,000	$ 85,000	$ 9,000	$ -	$ 9,563	$ 2,363	1.09	$ 13,050
2	Optimize signal timing	5	0.10	0.10	0.10	0.0	9.3	27.0	0.0	0.9	2.7	$ 5,000,000	$ 85,000	$ 9,000	$ -	$ 78,625	$ 24,300	1.06	$ 109,268
3	Rec lane (NB) & "Entering added lane" sign (WB)	8	0.20	0.20	0.20	0.0	1.3	6.3	0.0	0.3	1.3	$ 5,000,000	$ 85,000	$ 9,000	$ -	$ 21,250	$ 11,250	1.09	$ 35,566
4	Yield markings & signs (EB,WB), trim veg. (WB)	10	0.25	0.25	0.25	0.0	1.5	7.0	0.0	0.4	1.8	$ 5,000,000	$ 85,000	$ 9,000	$ -	$ 31,875	$ 15,750	1.12	$ 53,191

	Safety Countermeasure	Service Life (Years)	Estimated Project Cost		Annual Initial Cost	Annual Mnt. Cost (if any)	Total Annual Cost
			PE & Construction	R/W & Utility			
1	Extend SB RT lane 75' to Jiffy Lube RT lane	8	$ 160,000	$ 112,000	$ 38,748		$ 38,748
2	Optimize signal timing	5	$ 5,000	$ -	$ 1,092		$ 1,092
3	Rec lane (NB) & "Entering added lane" sign (WB)	8	$ 161,500	$ 88,800	$ 35,657		$ 35,657
4	Yield markings & signs (EB,WB), trim veg. (WB)	10	$ 16,000	$ -	$ 1,876		$ 1,876

Total Annualized		B/C =
Benefit	Cost	
$ 13,050	$ 38,748	0.34
$ 109,268	$ 1,092	100.08
$ 35,566	$ 35,657	1.00
$ 53,191	$ 1,876	28.36

RECOMMENDED CRASH COUNTERMEASURES (HIGH B/C)

2) Optimize signal timing.
4) Add painted triangle yield line with YIELD pavement markings and 2nd yield sign in the concrete/brick triangle area for EB Dam Neck Rd channelized right turn lanes.

OTHER RECOMMENDED CRASH COUNTERMEASURES

1) Extend SB General Booth Blvd right turn lane by approximately 75 feet to connect with right turn lane for Jiffy Lube (All crashes may not be included since this location is beyond 250 feet of the intersection, which is outside of the intersection analysis area).

INTERSECTION #7 – ARMISTEAD AVENUE AT LASALLE AVENUE
HAMPTON

Image source: Google. Data Source: HRTPO analysis of VDOT data. Data included in this table represents the years 2009-2012.
PDO = Property Damage Only Crashes. INJ = Injury Crashes. FAT = Fatality Crashes. F+I = Fatal + Injury Crashes combined.
EPDO = Equivalent Property Damage Only. More information on the EPDO Crash Rate is included in Part I of this study.

INTERSECTION DATA

ANNUAL AVERAGE DAILY TRAFFIC VOLUMES BY YEAR

LASALLE AVE (north): 2009 – 13,000; 2010 – 14,000; 2011 – 14,000; 2012 – 14,000

ARMISTEAD AVE (west): 2009 – 21,000; 2010 – 20,000; 2011 – 20,000; 2012 – 20,000

ARMISTEAD AVE (east): 2009 – 13,000; 2010 – 16,000; 2011 – 16,000; 2012 – 16,000

LASALLE AVE (south): 2009 – 19,000; 2010 – 26,000; 2011 – 26,000; 2012 – 26,000

Pedestrians Crossing Int. Daily = 240 (Medium-low)

Intersection Control = Signalized
Protected/Permitted phasing for Armistead Ave left turns
Split phasing for LaSalle Avenue approaches

CRASH DATA

ANNUAL CRASHES BY YEAR AND SEVERITY

Year	Crashes Per Year PDO	INJ	FAT	TOTAL
2009	20	13	0	33
2010	16	9	0	25
2011	9	4	0	13
2012	15	7	0	22

ANNUAL CRASHES BY YEAR AND TYPE

Year	F + I Multi	F + I Single	PDO Multi	PDO Single	Ped	Bike
2009	11	2	20	0	0	0
2010	9	0	16	0	0	0
2011	4	0	9	0	0	0
2012	6	1	13	2	0	0

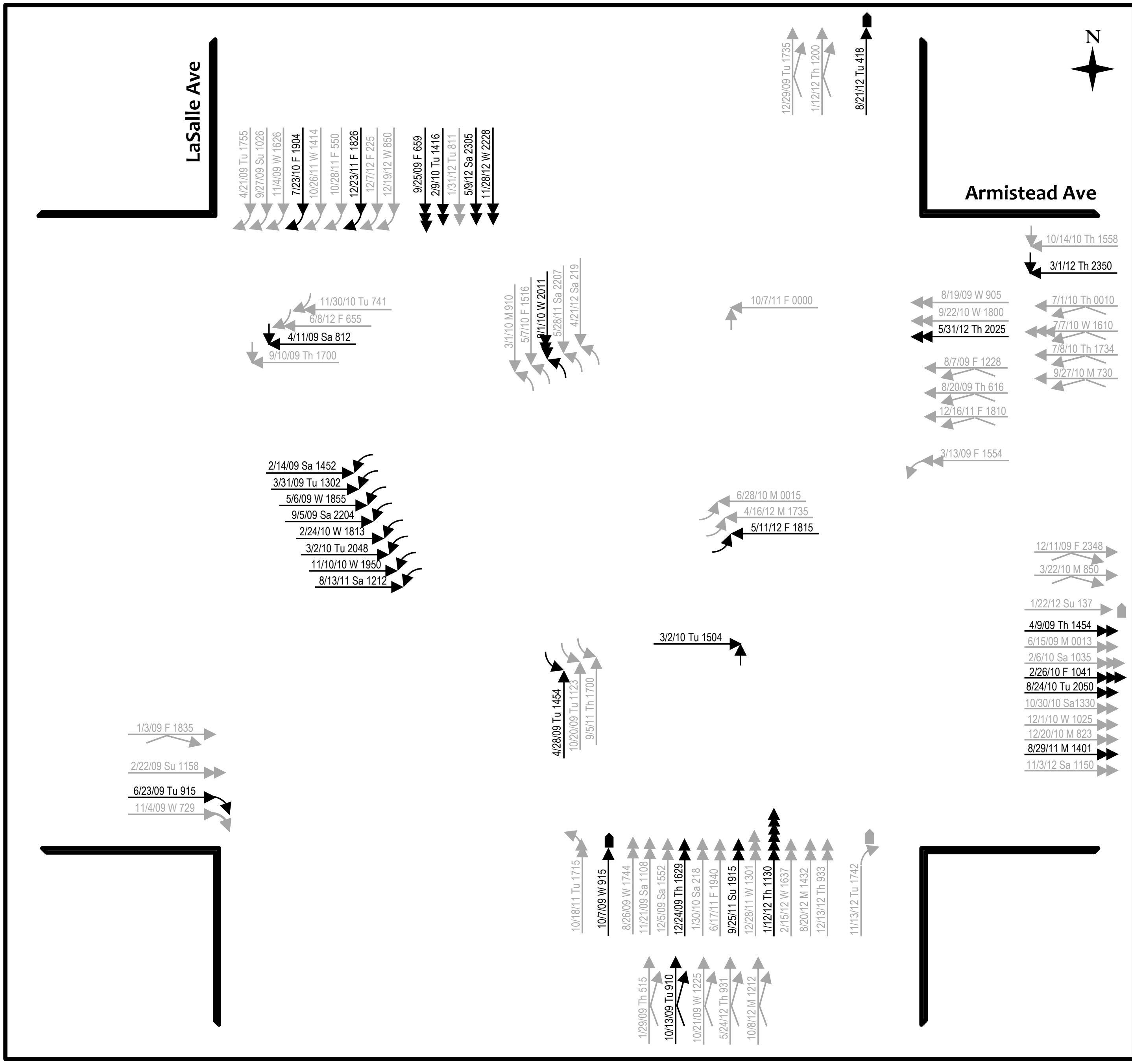
CRASH LEVELS AND RANKING

Average Crashes per Year = 23.3 crashes
Ranks 27th among 597 intersections

EPDO Crash Rate = 2.87
Ranks 12th among 597 intersections

Potential for Safety Improvement = +12.7 crashes
Ranks 7th among 597 intersections

COLLISION DIAGRAM
INTERSECTION #7
ARMISTEAD AVE AT LASALLE AVE



LEGEND

Crash Date
Crash Time of Day
3/4/2010 Tu 2140
Crash Day of Week
Number of arrowheads represents the total vehicles involved in the crash

Crash Severity

Property Damage Only (PDO)
Injury (INJ)
Fatality (FAT)

Collision Type

Rear End
Head On
Side Swipe
Left Turn
Right Turn
Right Angle
Backing Vehicle
Pedestrian
Animal
Fixed Object

Data Source: HRTPO analysis of VDOT data. Data included in this diagram represents the years 2009-2012. Includes crashes located within 250′ of the intersection.

INTERSECTION #7 – ARMISTEAD AVENUE AT LASALLE AVENUE
HAMPTON

CRASH DATA ANALYSIS

COLLISION TYPE

Collision Type	Armistead Ave at LaSalle Ave	All Safety Study Intersections
Rear End	39.8%	44.6%
Right Angle	35.5%	34.6%
Head On	1.1%	3.0%
Sideswipe - Same Direction	15.1%	7.0%
Sideswipe - Opposite Direction	1.1%	1.0%
Fixed Object - In Road	0.0%	0.5%
Fixed Object - Off Road	3.2%	4.0%
Bike/Pedestrian	0.0%	1.6%
Animal	0.0%	0.4%
Other	4.3%	3.3%

MOST PREVALENT DRIVER ACTION

Primary Driver Action	Armistead Ave at LaSalle Ave	All Safety Study Intersections
Following too close	34.1%	33.4%
Did not have right-of-way	19.8%	17.3%
Failure to maintain control	11.0%	7.3%
Improper turn	7.7%	3.4%
Disregarded signal	6.6%	10.3%

WEATHER

Weather	Armistead Ave at LaSalle Ave	All Safety Study Intersections
Clear/Cloudy	83.9%	81.9%
Mist/Rain/Fog	14.0%	15.5%
Snow/Sleet	0.0%	0.7%
Other/Not Stated	2.2%	1.9%

DRIVING UNDER THE INFLUENCE

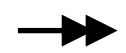
Driving Under the Influence	Armistead Ave at LaSalle Ave	All Safety Study Intersections
Drinking Involved	3.2%	5.8%

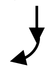
TIME OF DAY

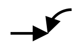
Crash Time	Armistead Ave at LaSalle Ave	All Safety Study Intersections
5:00 - 8:59	14.0%	12.7%
9:00 - 14:59	34.4%	34.0%
15:00 - 18:59	26.9%	31.0%
19:00 - 4:59	24.7%	22.3%

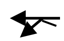
PRIMARY COLLISION MOVEMENTS

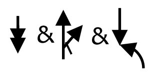
#1  12.9%

#2  beyond int. 10.8%

#3  9.7%

#4  8.6%

#5  7.5%

#6 (tie)  5.4%

DATA OBSERVATIONS

- 15% of the crashes involve sideswipe – same direction collisions, which is more than double the regional average.
- Excessive number of rear end crashes (10) along EB Armistead Ave beyond subject intersection to the Thomas St signal.

Data Source: HRTPO analysis of VDOT data. Regionwide data included in the tables represents a summation of those 597 intersections included in the Regional Safety Study, not the region as a whole. All data represents the years 2009-2012.

SITE OBSERVATIONS & POSSIBLE CAUSES

- Left turns on Armistead Ave approaches are controlled by protective-permissive phasing. NB and SB LaSalle Ave approaches are controlled by split phasing.
- EB approach has a single right turn lane. WB approach has a right turn and a through/right turn lane. NB and SB approaches have channelized right turn lanes with yield control.
- There is only 150 feet on Armistead Ave between the signalized intersections with LaSalle Ave and Thomas St.

- Long traffic queues exist for the leftmost NB left turn lane and vehicles are not utilizing the through/left turn lane on NB LaSalle Ave to WB Armistead Ave because of traffic accessing WB I-64 on ramp.
- NB right turning vehicles are driving on the grass area prior to the right turn ramp.
- Pavement markings on NB LaSalle Ave are worn.
- Higher than expected pedestrian activity was observed. Worn pathways in grass areas were found from pedestrian movements. There are no sidewalks or crosswalks at the intersection.
- HRT bus stops are located just north and west of the intersection.

- There is low visibility of Thomas St signal and no signal ahead signs on the I-64 WB off ramp to WB Armistead Ave.
- There are no signal backplates on the EB and WB Armistead Ave approaches at LaSalle Ave.

- Yield sign on SB LaSalle Ave channelized right turn lane is obstructed by vegetation. Right turn volumes at this location are high.
- "Left Turn YIELD on Green" (LTYOG) sign on WB Armistead Ave is at street level, while the LTYOG sign on EB Armistead Ave is on the mast arm next to the signal head (HRTPO Staff intersection safety analyses show higher number of crashes when the LTYOG signs are at street level versus next to signal heads).

INTERSECTION #7 – ARMISTEAD AVENUE AT LASALLE AVENUE
HAMPTON

CANDIDATE CRASH COUNTERMEASURES

1) Add right turn bay approximately 150 feet long for NB LaSalle Ave prior to channelized right turn lane.
2) Repaint pavement markings for NB LaSalle Ave. Relocate Rte 134 South right turn sign (or make larger) so that is more visible to drivers and does not block other signs.
3) Place “Left Turn YIELD on Green” sign on signal mast arm for WB Armistead Ave.
4) Per HRTPO Coliseum Central Special Events Management Plan Study (Jan 2010), eliminate I-64W exit 265B ramp (Rte 134 west), direct all I-64 exiting traffic (Rte 134 east & west) to exit 265A ramp, keep continuous free flow lane from I-64 exit 265A ramp to SB LaSalle Ave, split/realign I-64 exit 265A ramp to the current signalized intersection just west of the subject intersection (including new dual left and right turn lanes).
5) Extend Patrick St from Thomas St to LaSalle Ave (north of Super 8) as shown in the picture to the right. Restrict turn movements to right in/right out at Thomas St and remove traffic signal.
6) Add sidewalks, crosswalks, and pedestrian signals in order to prevent future bike/pedestrian crashes. (No existing crashes)
7) Add painted triangle yield lines with YIELD pavement markings and 2nd yield signs in the grass triangle areas for NB and SB LaSalle Ave channelized right turn lanes. Trim vegetation (SB).

BENEFIT-COST ANALYSIS

#	Safety Countermeasure	Service Life (Years)	Crash Reduction Factor (CRF) FAT	CRF INJ	CRF PDO	Average Annual Crashes FAT	Avg INJ	Avg PDO	Estimated Annual Crash Reduction FAT	Est INJ	Est PDO	Cost per Crash FAT	Cost INJ	Cost PDO	Estimated Annual Benefit FAT	Benefit INJ	Benefit PDO	Traffic Growth Factor	Total Annual Benefit
1	Extend RT bay (NB)	8	0.15	0.15	0.15	0.0	1.3	3.8	0.0	0.2	0.6	$ 5,000,000	$ 85,000	$ 9,000	$ -	$ 15,938	$ 5,063	1.09	$ 22,981
2	Restripe markings, Rel. sign (NB)	10	0.25	0.25	0.25	0.0	1.3	3.8	0.0	0.3	0.9	$ 5,000,000	$ 85,000	$ 9,000	$ -	$ 26,563	$ 8,438	1.12	$ 39,091
3	LTYOG sign on mast arm (WB)	10	0.10	0.10	0.10	0.0	2.0	0.0	0.0	0.2	0.0	$ 5,000,000	$ 85,000	$ 9,000	$ -	$ 17,000	$ -	1.12	$ 18,987
4	Realign/close I-64 off ramps, turn lanes, signs	25	0.25	0.25	0.25	0.0	0.8	3.0	0.0	0.2	0.8	$ 5,000,000	$ 85,000	$ 9,000	$ -	$ 15,938	$ 6,750	1.31	$ 29,649
5	Extend Patrick St, RT-in/out @ Thomas, Rem. Signal	20	0.24	0.24	0.24	0.0	1.5	5.0	0.0	0.4	1.2	$ 5,000,000	$ 85,000	$ 9,000	$ -	$ 30,600	$ 10,800	1.24	$ 51,301
6	Ped crosswalks, signal, and sidewalks	20	0.50	0.50	0.50	0.0	0.0	0.0	0.0	0.0	0.0	$ 5,000,000	$ 85,000	$ 9,000	$ -	$ -	$ -	1.24	$ -
7	Yield markings & signs (NB,SB),trim veg. (SB)	10	0.25	0.25	0.25	0.0	0.5	3.0	0.0	0.1	0.8	$ 5,000,000	$ 85,000	$ 9,000	$ -	$ 10,625	$ 6,750	1.12	$ 19,406

#	Safety Countermeasure	Service Life (Years)	Estimated Project Cost: PE & Construction	Estimated Project Cost: R/W & Utility	Annual Initial Cost	Annual Mnt. Cost (if any)	Total Annual Cost
1	Extend RT bay (NB)	8	$ 240,000	$ 132,000	$ 52,994		$ 52,994
2	Restripe markings, Rel. sign (NB)	10	$ 16,500	$ -	$ 1,934		$ 1,934
3	LTYOG sign on mast arm (WB)	10	$ 6,000	$ -	$ 703		$ 703
4	Realign/close I-64 off ramps, turn lanes, signs	25	$ 1,067,100	$ 320,100	$ 79,664		$ 79,664
5	Extend Patrick St, RT-in/out @ Thomas, Rem. Signal	20	$ 792,500	$ 554,750	$ 90,556		$ 90,556
6	Ped crosswalks, signal, and sidewalks	20	$ 363,000	$ 272,300	$ 42,702		$ 42,702
7	Yield markings & signs (NB,SB),trim veg. (SB)	10	$ 16,000	$ -	$ 1,876		$ 1,876

Total Annualized Benefit	Total Annualized Cost	B/C =
$ 22,981	$ 52,994	**0.43**
$ 39,091	$ 1,934	**20.21**
$ 18,987	$ 703	**26.99**
$ 29,649	$ 79,664	**0.37**
$ 51,301	$ 90,556	**0.57**
$ -	$ 42,702	**0.00**
$ 19,406	$ 1,876	**10.35**

RECOMMENDED CRASH COUNTERMEASURES (HIGH B/C)

3) Place “Left Turn YIELD on Green” sign on signal mast arm for WB Armistead Ave.
2) Repaint pavement markings for NB LaSalle Ave. Relocate Rte 134 South right turn sign (or make larger) so that is more visible to drivers and does not block other signs.
7) Add painted triangle yield lines with YIELD pavement markings and 2nd yield signs in the grass triangle areas for NB and SB LaSalle Ave channelized right turn lanes. Trim vegetation (SB).

OTHER RECOMMENDED CRASH COUNTERMEASURES

6) Add sidewalks, crosswalks, and pedestrian signals in order to prevent future bike/pedestrian crashes. (No existing crashes)
Note: According to City of Hampton staff, there is currently a project out for bid for this safety improvement.

INTERSECTION #8 – J CLYDE MORRIS BOULEVARD AT DILIGENCE DRIVE

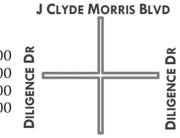
NEWPORT NEWS

Image source: Google. Data Source: HRTPO analysis of VDOT data. Data included in this table represents the years 2009-2012.
PDO = Property Damage Only Crashes. INJ = Injury Crashes. FAT = Fatality Crashes. F+I = Fatal + Injury Crashes combined.
EPDO = Equivalent Property Damage Only. More information on the EPDO Crash Rate is included in Part I of this study.

INTERSECTION DATA

ANNUAL AVERAGE DAILY TRAFFIC VOLUMES BY YEAR

2009 – 33,000
2010 – 33,000
2011 – 34,000
2012 – 34,000



West: 2009 – 11,000; 2010 – 11,000; 2011 – 11,000; 2012 – 11,000

East: 2009 – 4,000; 2010 – 4,000; 2011 – 4,000; 2012 – 4,000

South: 2009 – 33,000; 2010 – 33,000; 2011 – 34,000; 2012 – 34,000

Pedestrians Crossing Intersection Daily = 240 (Medium-Low)

Intersection Control = Signalized
Protected phasing for J Clyde Morris Blvd left turns
Split phasing for Diligence Drive approaches

CRASH DATA

ANNUAL CRASHES BY YEAR AND SEVERITY

Year	Crashes Per Year			
	PDO	INJ	FAT	TOTAL
2009	19	15	0	34
2010	15	14	1	30
2011	7	14	0	21
2012	7	11	0	18

ANNUAL CRASHES BY YEAR AND TYPE

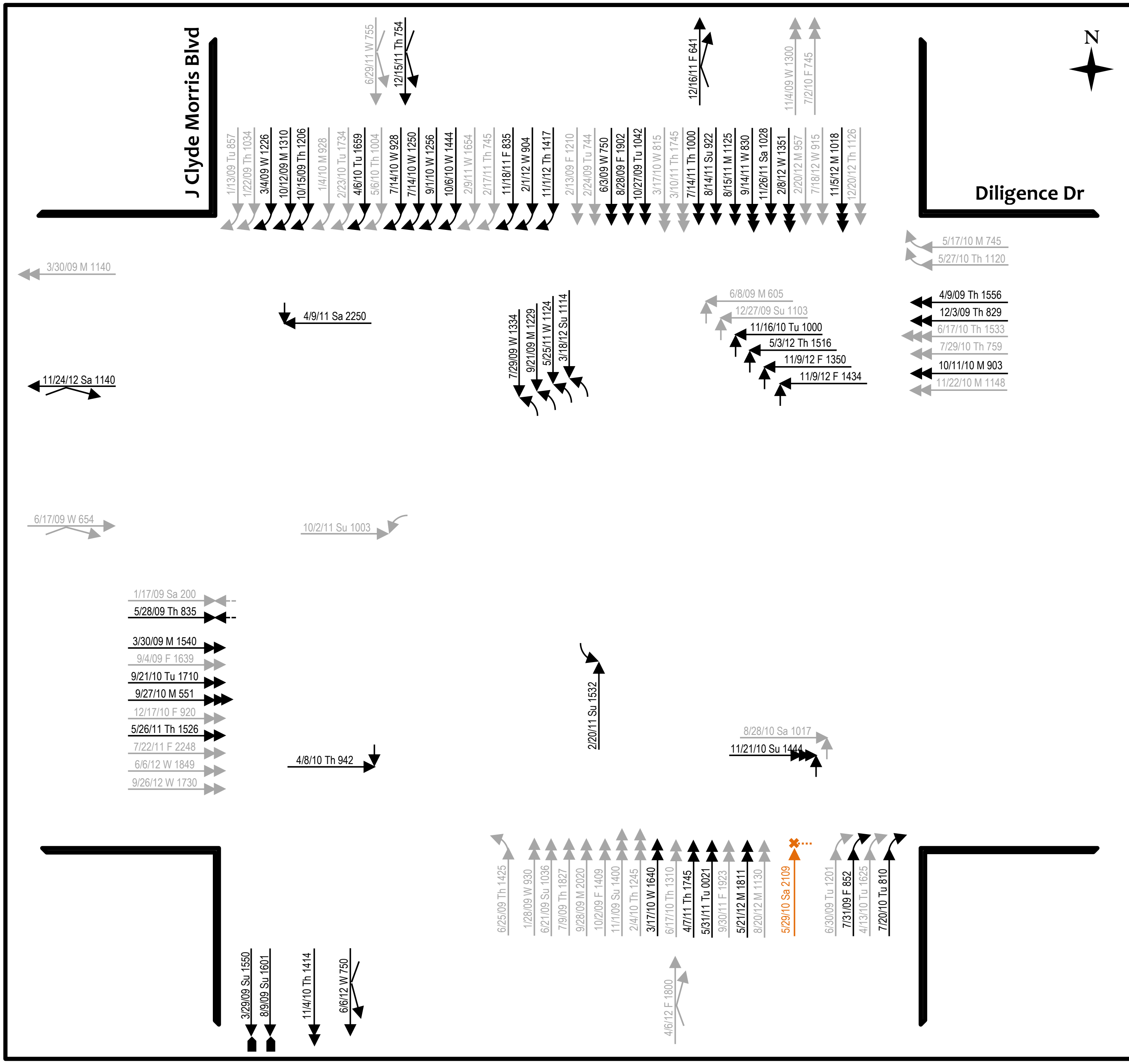
Year	F + I Multi	F + I Single	PDO Multi	PDO Single	Ped	Bike
2009	13	2	19	0	0	0
2010	14	0	15	0	1	0
2011	14	0	7	0	0	0
2012	11	0	7	0	0	0

CRASH LEVELS AND RANKING

Average Crashes per Year = 25.8 crashes
Ranks 18th among 597 intersections

EPDO Crash Rate = 3.75
Ranks 2nd among 597 intersections

Potential for Safety Improvement = +12.7 crashes
Ranks 8th among 597 intersections



COLLISION DIAGRAM

INTERSECTION #8

J CLYDE MORRIS BLVD AT DILIGENCE DR

LEGEND

Crash Date — Crash Time of Day

3/4/2010 Tu 2140

Crash Day of Week — Number of arrowheads represents the total vehicles involved in the crash

Crash Severity

- Property Damage Only (PDO)
- Injury (INJ)
- Fatality (FAT)

Collision Type

- Rear End
- Head On
- Side Swipe
- Left Turn
- Right Turn
- Right Angle
- Backing Vehicle
- Pedestrian
- Animal
- Fixed Object

Data Source: HRTPO analysis of VDOT data. Data included in this diagram represents the years 2009-2012.
Includes crashes located within 250′ of the intersection.

INTERSECTION #8 – J CLYDE MORRIS BOULEVARD AT DILIGENCE DRIVE

NEWPORT NEWS

CRASH DATA ANALYSIS

COLLISION TYPE

Collision Type	J Clyde Morris Blvd at Diligence Dr	All Safety Study Intersections
Rear End	72.8%	44.6%
Right Angle	18.4%	34.6%
Head On	0.0%	3.0%
Sideswipe - Same Direction	2.9%	7.0%
Sideswipe - Opposite Direction	1.0%	1.0%
Fixed Object - In Road	0.0%	0.5%
Fixed Object - Off Road	1.9%	4.0%
Bike/Pedestrian	1.0%	1.6%
Animal	0.0%	0.4%
Other	1.9%	3.3%

MOST PREVALENT DRIVER ACTION

Primary Driver Action	J Clyde Morris Blvd at Diligence Dr	All Safety Study Intersections
Following too close	51.5%	33.4%
Disregarded signal	13.6%	10.3%
Failure to maintain control	4.9%	7.3%
Did not have right-of-way	1.9%	17.3%
Improper/Unsafe lane change	1.9%	5.1%

WEATHER

Weather	J Clyde Morris Blvd at Diligence Dr	All Safety Study Intersections
Clear/Cloudy	86.4%	81.9%
Mist/Rain/Fog	10.7%	15.5%
Snow/Sleet	1.0%	0.7%
Other/Not Stated	1.9%	1.9%

DRIVING UNDER THE INFLUENCE

Driving Under the Influence	J Clyde Morris Blvd at Diligence Dr	All Safety Study Intersections
Drinking Involved	2.9%	5.8%

TIME OF DAY

Crash Time	J Clyde Morris Blvd at Diligence Dr	All Safety Study Intersections
5:00 - 8:59	20.4%	12.7%
9:00 - 14:59	50.5%	34.0%
15:00 - 18:59	21.4%	31.0%
19:00 - 4:59	7.8%	22.3%

PRIMARY COLLISION MOVEMENTS

#1	17.5%
#2	16.5%
#3	13.6%
#4	8.8%
#5	5.8%
#6	5.8%

DATA OBSERVATIONS

- 73% of the crashes involve rear end collisions, and the top 5 primary collision movements are rear end crashes on each through approach and with SB J Clyde Morris Blvd right turning vehicles.
- Following too close (52%) and disregarding the traffic signal (14%) were the primary driver actions – both higher than the regional average.
- 71% of the crashes occurred during the morning/mid-day hours from 5am-2:59pm when most vehicles are entering the City Center at Oyster Point area.

Data Source: HRTPO analysis of VDOT data. Regionwide data included in the tables represents a summation of those 597 intersections included in the Regional Safety Study, not the region as a whole. All data represents the years 2009-2012.

SITE OBSERVATIONS & POSSIBLE CAUSES

- NB, SB & EB approaches have dual-left turn lanes. NB & SB are controlled by protective phasing and EB & WB are split phased.
- NB and EB approaches have single right turn lanes. SB approach has free flow channelized right turn lane (recently improved from yield control).
- WB Diligence Dr operates as a split phase and has one through/right and one through/left turn lane.
- Closest signalized intersection to the north is 0.66 mi away at Louise Dr.

- This is the first signalized intersection south of I-64. The intersection is 900 feet from I-64 east off ramp and 350 feet to I-64 east on ramp.
- Diligence Dr has recently been widened to six lanes to Rock Landing Dr. A lane usage sign for I-64 has been added to EB Diligence Dr.
- Many rear end crashes are occurring along the SB J Clyde Morris Blvd approach from I-64. (These crashes may have improved due to the recent roadway improvements.)
- The "Lane Changers Must Yield" signs for SB J Clyde Morris Blvd right turning vehicles may be confusing to drivers.
- EB left turns are heavy during the PM peak period and SB right turns are heavy during the AM peak period.

- The Burger King (SE quadrant) has three driveways – the northern driveway along J Clyde Morris Blvd is approximately 50 feet from the intersection and within the queuing area.
- The 7-Eleven (NE quadrant) driveway along NB J Clyde Morris Blvd just north of the intersection creates conflicts between vehicles turning right into 7-Eleven and accelerating vehicles leaving the subject intersection.
- No I-64 guide signs are on NB J Clyde Morris Blvd prior to Diligence Dr.

- There is limited advance warning that the right NB lane is exit only at the EB I-64 on ramp – a small sign with limited visibility is located just beyond the Diligence intersection.
- There is no exit only message on the overhead interstate sign along NB J Clyde Morris Blvd.
- Pedestrian crosswalks with parallel markings are on all approaches and are worn. Although crosswalks with parallel markings are permitted by the MUTCD, FHWA research has determined they are less visible to motorists than crosswalks with continental/ladder striping.

INTERSECTION #8 – J CLYDE MORRIS BOULEVARD AT DILIGENCE DRIVE

NEWPORT NEWS

CANDIDATE CRASH COUNTERMEASURES

1) Close the northern driveway for Burger King along J Clyde Morris Blvd (approximately 50 feet from the intersection).
2) Add activated flashing signal ahead sign and large advance signal warning signs for SB J Clyde Morris Blvd Pkwy near I-64.
3) Remove two "Lane Changers Must Yield" signs from SB J Clyde Morris Blvd free flow channelized right turn lane. (No B-C analysis due to recent improvements)
4) Add right turn arrow pavement markings for SB J Clyde Morris Blvd right turn lane. (No B-C analysis due to recent improvements)
5) Add I-64 guide sign on NB J Clyde Morris Blvd before Diligence Dr. Add pavement markings (I-64 shield & EXIT ONLY) in right through lane of NB J Clyde Morris Blvd before and after intersection to indicate I-64 east exit ramp only. Add "Exit Only" to I-64 east overhead sign on NB J Clyde Morris Blvd.
6) Repaint pedestrian crosswalks with ladder striping.

BENEFIT-COST ANALYSIS

	Safety Countermeasure	Service Life (Years)	Crash Reduction Factor (CRF)			Average Annual Crashes			Estimated Annual Crash Reduction			Cost per Crash			Estimated Annual Benefit			Traffic Growth Factor	Total Annual Benefit
			FAT	INJ	PDO	FAT	INJ	PDO	FAT	INJ	PDO	FAT	INJ	PDO	FAT	INJ	PDO		
1	Close northern driveway for Burger King	20	0.25	0.25	0.25	0.0	0.5	0.5	0.0	0.1	0.1	$ 5,000,000	$ 85,000	$ 9,000	$ -	$ 10,625	$ 1,125	1.24	$ 14,560
2	Activ. flashing signal ahead & overhead signs (SB)	10	0.25	0.25	0.25	0.0	2.8	2.0	0.0	0.7	0.5	$ 5,000,000	$ 85,000	$ 9,000	$ -	$ 58,438	$ 4,500	1.12	$ 70,293
5	I-64 guide sign, markings, OH Exit Only sign (NB)	10	0.20	0.20	0.20	0.0	1.5	3.3	0.0	0.3	0.7	$ 5,000,000	$ 85,000	$ 9,000	$ -	$ 25,500	$ 5,850	1.12	$ 35,014
6	Repaint ped crosswalk with ladder striping (All)	7	0.20	0.20	0.20	0.3	0.0	0.0	0.1	0.0	0.0	$ 5,000,000	$ 85,000	$ 9,000	$250,000	$ -	$ -	1.08	$ 270,820

	Safety Countermeasure	Service Life (Years)	Estimated Project Cost		Annual Initial Cost	Annual Mnt. Cost (if any)	Total Annual Cost
			PE & Construction	R/W & Utility			
1	Close northern driveway for Burger King	20	$ 100,000	$ 25,000	$ 8,402		$ 8,402
2	Activ. flashing signal ahead & overhead signs (SB)	10	$ 70,000	$ 15,000	$ 9,965		$ 9,965
5	I-64 guide sign, markings, OH Exit Only sign (NB)	10	$ 13,500	$ -	$ 1,583		$ 1,583
6	Repaint ped crosswalk with ladder striping (All)	7	$ 96,000	$ -	$ 15,409		$ 15,409

Total Annualized Benefit	Total Annualized Cost	B/C =
$ 14,560	$ 8,402	1.73
$ 70,293	$ 9,965	7.05
$ 35,014	$ 1,583	22.12
$ 270,820	$ 15,409	17.58

RECOMMENDED CRASH COUNTERMEASURES (HIGH B/C)

5) Add I-64 guide sign on NB J Clyde Morris Blvd before Diligence Dr. Add pavement markings (I-64 shield & EXIT ONLY) in right through lane of NB J Clyde Morris Blvd before and after intersection to indicate I-64 east exit ramp only. Add "Exit Only" to I-64 east overhead sign on NB J Clyde Morris Blvd.
6) Repaint pedestrian crosswalks with ladder striping.

OTHER RECOMMENDED CRASH COUNTERMEASURES

4) Add right turn arrow pavement markings for SB J Clyde Morris Blvd right turn lane.

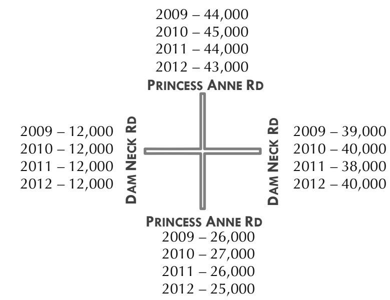
INTERSECTION #9 – PRINCESS ANNE ROAD AT DAM NECK ROAD
VIRGINIA BEACH

Note: During the construction of Princess Anne Rd south of Dam Neck Rd (March 2010-2013), this approach was reduced from 4 to 2 through lanes (via cones) beginning at Concert Dr.

Image source: Google. Data Source: HRTPO analysis of VDOT data. Data included in this table represents the years 2009-2012.
PDO = Property Damage Only Crashes. INJ = Injury Crashes. FAT = Fatality Crashes. F+I = Fatal + Injury Crashes combined.
EPDO = Equivalent Property Damage Only. More information on the EPDO Crash Rate is included in Part I of this study.

INTERSECTION DATA

ANNUAL AVERAGE DAILY TRAFFIC VOLUMES BY YEAR



Pedestrians Crossing Intersection Daily = 240 (Medium-Low)

Intersection Control = Signalized
Protected phasing for all left turns

CRASH DATA

ANNUAL CRASHES BY YEAR AND SEVERITY

Year	Crashes Per Year PDO	INJ	FAT	TOTAL
2009	15	12	0	27
2010	30	14	0	44
2011	23	8	0	31
2012	18	9	0	27

ANNUAL CRASHES BY YEAR AND TYPE

Year	F + I Multi	F + I Single	PDO Multi	PDO Single	Ped	Bike
2009	11	1	14	1	0	0
2010	13	0	30	0	0	1
2011	7	1	22	1	0	0
2012	8	1	17	1	0	0

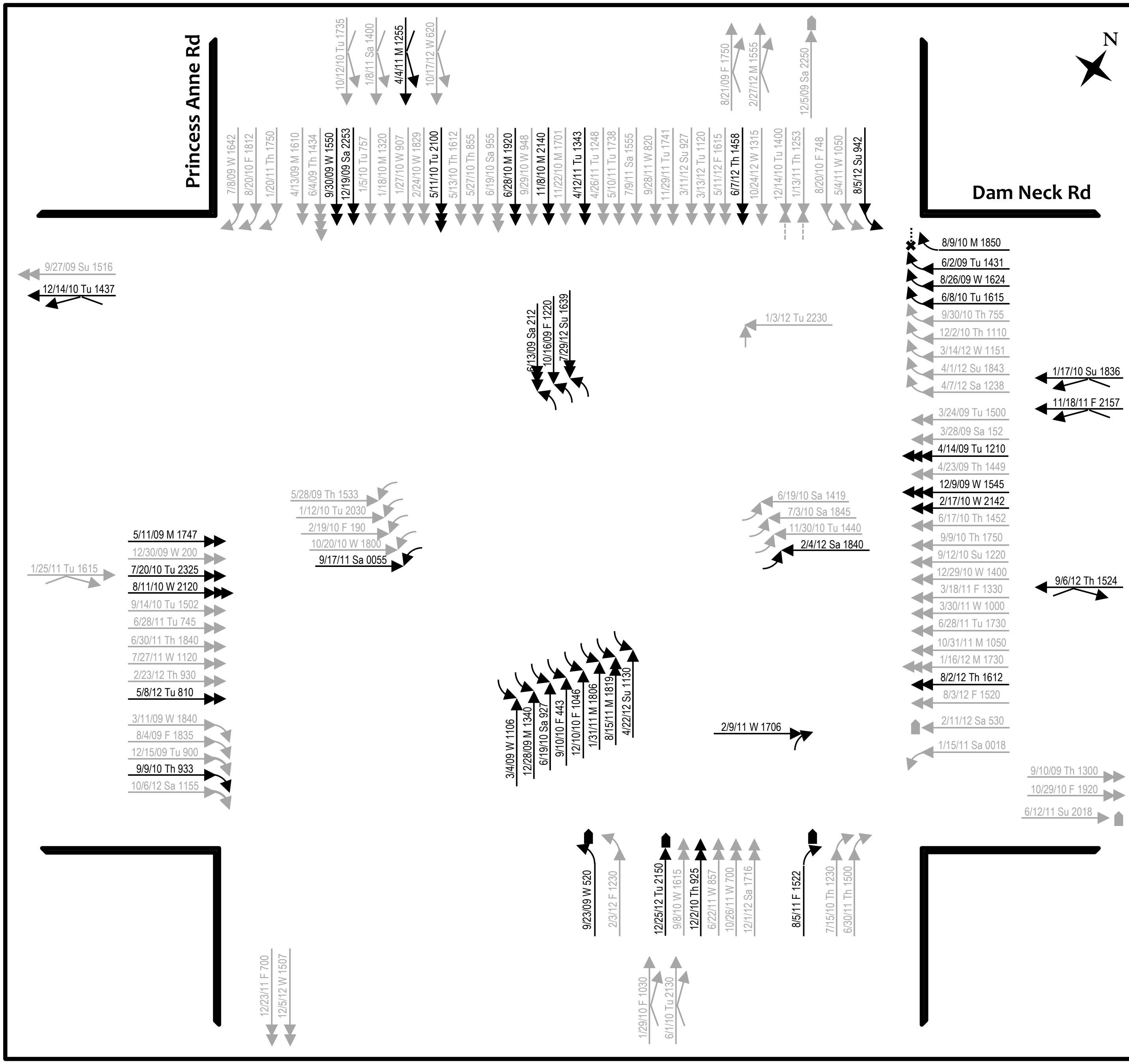
CRASH LEVELS AND RANKING

Average Crashes per Year = 32.3 crashes
Ranks 7th among 597 intersections

EPDO Crash Rate = 2.38
Ranks 32nd among 597 intersections

Potential for Safety Improvement = +11.7 crashes
Ranks 9th among 597 intersections

COLLISION DIAGRAM
INTERSECTION #9
PRINCESS ANNE RD AT DAM NECK RD



LEGEND

Crash Date
Crash Time of Day
3/4/2010 Tu 2140
Crash Day of Week
Number of arrowheads represents the total vehicles involved in the crash

Crash Severity

- Property Damage Only (PDO)
- Injury (INJ)
- Fatality (FAT)

Collision Type

- Rear End
- Head On
- Side Swipe
- Left Turn
- Right Turn
- Right Angle
- Backing Vehicle
- Pedestrian
- Animal
- Fixed Object

Data Source: HRTPO analysis of VDOT data. Data included in this diagram represents the years 2009-2012.
Includes crashes located within 250′ of the intersection.

INTERSECTION #9 – PRINCESS ANNE ROAD AT DAM NECK ROAD

VIRGINIA BEACH

CRASH DATA ANALYSIS

COLLISION TYPE

Collision Type	Princess Anne Rd at Dam Neck Rd	All Safety Study Intersections
Rear End	65.9%	44.6%
Right Angle	20.2%	34.6%
Head On	2.3%	3.0%
Sideswipe - Same Direction	3.9%	7.0%
Sideswipe - Opposite Direction	0.0%	1.0%
Fixed Object - In Road	0.0%	0.5%
Fixed Object - Off Road	3.1%	4.0%
Bike/Pedestrian	0.8%	1.6%
Animal	0.0%	0.4%
Other	3.9%	3.3%

MOST PREVALENT DRIVER ACTION

Primary Driver Action	Princess Anne Rd at Dam Neck Rd	All Safety Study Intersections
Following too close	48.8%	33.4%
Disregarded signal	10.1%	10.3%
Improper/Unsafe lane change	7.8%	5.1%
Did not have right-of-way	3.1%	17.3%
Failure to maintain control	3.1%	7.3%

WEATHER

Weather	Princess Anne Rd at Dam Neck Rd	All Safety Study Intersections
Clear/Cloudy	84.5%	81.9%
Mist/Rain/Fog	14.7%	15.5%
Snow/Sleet	0.8%	0.7%
Other/Not Stated	0.0%	1.9%

DRIVING UNDER THE INFLUENCE

Driving Under the Influence	Princess Anne Rd at Dam Neck Rd	All Safety Study Intersections
Drinking Involved	5.4%	5.8%

TIME OF DAY

Crash Time	Princess Anne Rd at Dam Neck Rd	All Safety Study Intersections
5:00 - 8:59	10.1%	12.7%
9:00 - 14:59	35.7%	34.0%
15:00 - 18:59	38.0%	31.0%
19:00 - 4:59	16.3%	22.3%

PRIMARY COLLISION MOVEMENTS

#1	20.9%
#2	13.2%
#3	7.8%
#4	6.2%
#5	6.2%
#6	4.7%

DATA OBSERVATIONS

- 66% of the crashes involve rear end collisions, which is significantly higher than the regional average
- As expected, the top 2 primary collision movements were on the SB Princess Anne Rd and WB Dam Neck Rd approaches, which have the highest traffic volumes.
- 49% of the crashes were the result of drivers following too close and 8% of the crashes were from improper/unsafe lane changes, which are both higher than the regional average.
- 38% of the crashes occurred during the afternoon peak period from 3pm to 6:59pm.

Data Source: HRTPO analysis of VDOT data. Regionwide data included in the tables represents a summation of those 597 intersections included in the Regional Safety Study, not the region as a whole. All data represents the years 2009-2012.

SITE OBSERVATIONS & POSSIBLE CAUSES

- All approaches have dual-left turn lanes controlled by protective phasing and have single right turn lanes. WB Dam Neck Rd also has a through/right turn lane.
- Princess Anne Rd is an 8-lane urban minor arterial with a 50 mph speed limit (north of the subject intersection) and a 45 mph speed limit (south of the subject intersection). Dam Neck Rd is a 4-lane urban minor arterial with a 45 mph speed limit.
- SB Princess Anne Rd approach has high speeds. Both SB Princess Anne Rd and WB Dam Neck Rd have high traffic volumes – these two approaches also have the highest number of crashes, with a majority being rear ends.

- High right turn volumes on WB Dam Neck Rd.
- Left turn traffic on SB Princess Anne Rd in dual left turn lanes backs up into the through lanes during the PM peak.

- Red light cameras are installed on SB Princess Anne Rd.
- Collision data likely underestimates SB Princess Anne Rd left turn and WB Dam Neck Rd crashes due to the large traffic volumes making these movements.

INTERSECTION #9 – PRINCESS ANNE ROAD AT DAM NECK ROAD

VIRGINIA BEACH

CANDIDATE CRASH COUNTERMEASURES

1) Install flashing light on sign (linked to signal) along SB Princess Anne Rd approach to warn drivers to be prepared to stop.
2) Optimize signal timing.
3) Add overlap phase for right turns on WB Dam Neck Rd. This improvement will require: a) U-turns from left turn lane on SB Princess Anne Rd be prohibited and installing "No U Turn" signs for SB Princess Anne Rd, b) restriping the WB Dam Neck Rd through/right turn lane as a through lane.

4) Add a free flow channelized right turn lane including an "Entering added lane" sign on WB Dam Neck Rd and a receiving/acceleration lane along NB Princess Anne Rd (this improvement will require the relocation of some utilities and three light poles).

BENEFIT-COST ANALYSIS

	Safety Countermeasure	Service Life (Years)	Crash Reduction Factor (CRF)			Average Annual Crashes			Estimated Annual Crash Reduction			Cost per Crash			Estimated Annual Benefit			Traffic Growth Factor	Total Annual Benefit
			FAT	INJ	PDO	FAT	INJ	PDO	FAT	INJ	PDO	FAT	INJ	PDO	FAT	INJ	PDO		
1	Activated flashing signal ahead sign (SB)	10	0.25	0.25	0.25	0.0	2.5	6.3	0.0	0.6	1.6	$ 5,000,000	$ 85,000	$ 9,000	$ -	$ 53,125	$ 14,063	1.12	$ 75,040
2	Optimize signal timing	5	0.10	0.10	0.10	0.0	10.8	21.5	0.0	1.1	2.2	$ 5,000,000	$ 85,000	$ 9,000	$ -	$ 91,375	$ 19,350	1.06	$ 117,548
3	Overlap phase for RTs on WB Dam Neck Rd	5	0.10	0.10	0.10	0.0	1.0	2.0	0.0	0.1	0.2	$ 5,000,000	$ 85,000	$ 9,000	$ -	$ 8,500	$ 1,800	1.06	$ 10,935
4	Chan. RT ln/"Ent Added Ln" sign (WB), rec ln (NB)	8	0.20	0.20	0.20	0.0	1.0	2.0	0.0	0.2	0.4	$ 5,000,000	$ 85,000	$ 9,000	$ -	$ 17,000	$ 3,600	1.09	$ 22,543

	Safety Countermeasure	Service Life (Years)	Estimated Project Cost		Annual Initial Cost	Annual Mnt. Cost (if any)	Total Annual Cost
			PE & Construction	R/W & Utility			
1	Activated flashing signal ahead sign (SB)	10	$ 50,000	$ 15,000	$ 7,620		$ 7,620
2	Optimize signal timing	5	$ 5,000	$ -	$ 1,092		$ 1,092
3	Overlap phase for RTs on WB Dam Neck Rd	5	$ 21,000	$ -	$ 4,585		$ 4,585
4	Chan. RT ln/"Ent Added Ln" sign (WB), rec ln (NB)	8	$ 421,500	$ 295,100	$ 102,084		$ 102,084

Total Annualized		B/C =
Benefit	Cost	
$ 75,040	$ 7,620	9.85
$ 117,548	$ 1,092	107.67
$ 22,543	$ 4,585	4.92
$ 22,543	$ 102,084	0.22

RECOMMENDED CRASH COUNTERMEASURES (HIGH B/C)

2) Optimize signal timing.
1) Install flashing light on sign (linked to signal) along SB Princess Anne Rd approach to warn drivers to be prepared to stop.

OTHER RECOMMENDED CRASH COUNTERMEASURES

4) Add a free flow channelized right turn lane including an "Entering added lane" sign on WB Dam Neck Rd and a receiving/acceleration lane along NB Princess Anne Rd (this improvement will require the relocation of some utilities and three light poles).

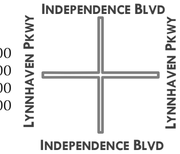
INTERSECTION #10 – LYNNHAVEN PARKWAY AT INDEPENDENCE BOULEVARD
VIRGINIA BEACH

Image source: Google. Data Source: HRTPO analysis of VDOT data. Data included in this table represents the years 2009-2012.
PDO = Property Damage Only Crashes. INJ = Injury Crashes. FAT = Fatality Crashes. F+I = Fatal + Injury Crashes combined.
EPDO = Equivalent Property Damage Only. More information on the EPDO Crash Rate is included in Part I of this study.

INTERSECTION DATA

ANNUAL AVERAGE DAILY TRAFFIC VOLUMES BY YEAR

2009 – 25,000
2010 – 26,000
2011 – 25,000
2012 – 25,000



2009 – 23,000
2010 – 24,000
2011 – 23,000
2012 – 23,000

2009 – 30,000
2010 – 31,000
2011 – 30,000
2012 – 32,000

2009 – 27,000
2010 – 28,000
2011 – 27,000
2012 – 25,000

Pedestrians Crossing Intersection Daily = 700 (Medium)

Intersection Control = Signalized
Protected phasing for NB/SB left turns
Protected/Permitted phasing for EB/WB left turns

CRASH DATA

ANNUAL CRASHES BY YEAR AND SEVERITY

	Crashes Per Year			
Year	PDO	INJ	FAT	TOTAL
2009	14	15	0	29
2010	7	12	0	19
2011	19	16	0	35
2012	11	5	0	16

ANNUAL CRASHES BY YEAR AND TYPE

Year	F + I Multi	F + I Single	PDO Multi	PDO Single	Ped	Bike
2009	14	0	14	0	1	0
2010	11	1	7	0	0	0
2011	16	0	19	0	0	0
2012	5	0	11	0	0	0

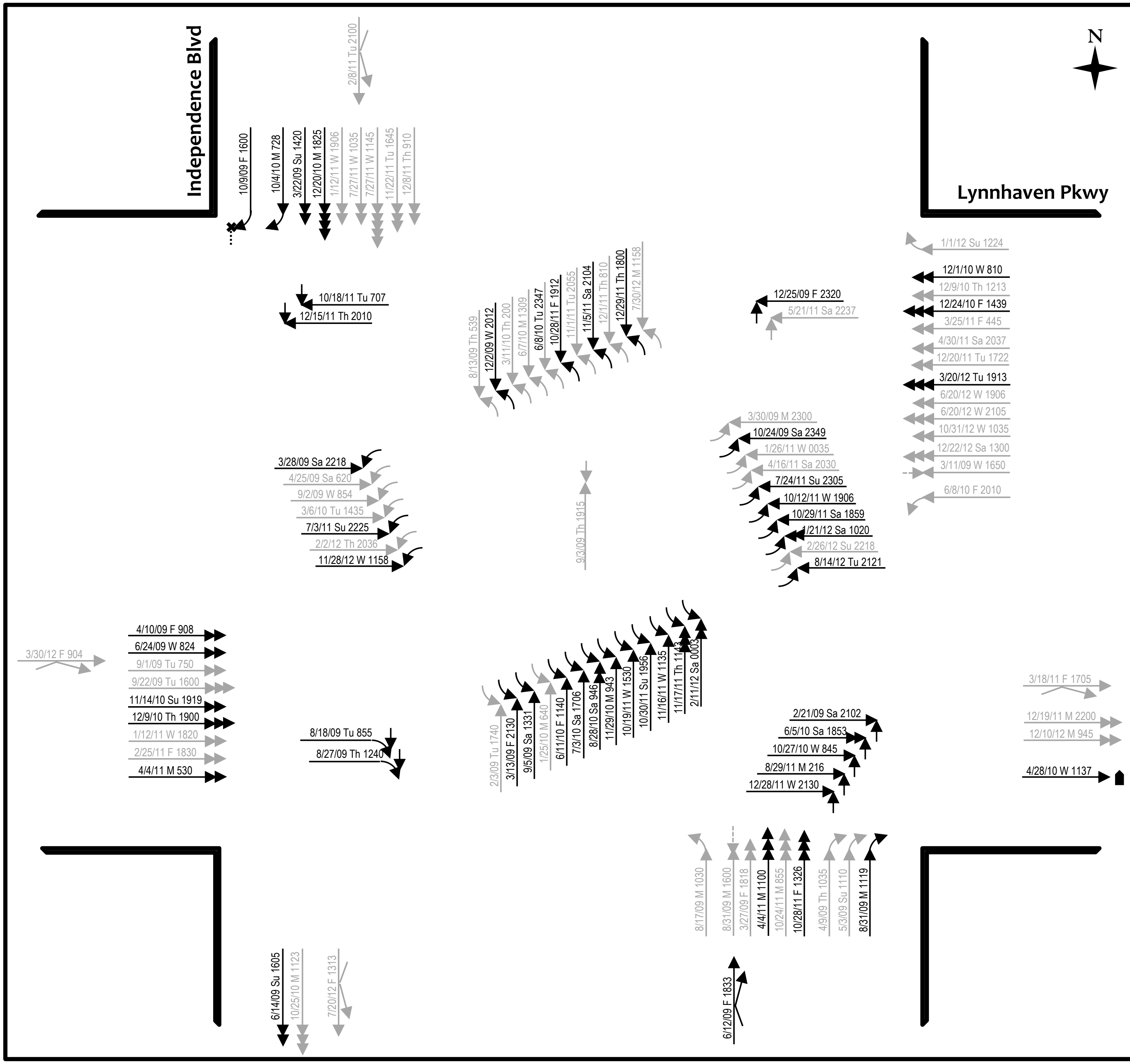
CRASH LEVELS AND RANKING

Average Crashes per Year = 24.8 crashes
Ranks 22nd among 597 intersections

EPDO Crash Rate = 2.45
Ranks 28th among 597 intersections

Potential for Safety Improvement = +11.1 crashes
Ranks 10th among 597 intersections

COLLISION DIAGRAM
INTERSECTION #10
LYNNHAVEN PKWY AT INDEPENDENCE BLVD



LEGEND

Crash Date, Crash Time of Day: 3/4/2010 Tu 2140

Crash Day of Week

Number of arrowheads represents the total vehicles involved in the crash

Crash Severity

- Property Damage Only (PDO)
- Injury (INJ)
- Fatality (FAT)

Collision Type

- Rear End
- Head On
- Side Swipe
- Left Turn
- Right Turn
- Right Angle
- Backing Vehicle
- Pedestrian
- Animal
- Fixed Object

Data Source: HRTPO analysis of VDOT data. Data included in this diagram represents the years 2009-2012.
Includes crashes located within 250′ of the intersection.

INTERSECTION #10 – LYNNHAVEN PARKWAY AT INDEPENDENCE BOULEVARD
VIRGINIA BEACH

CRASH DATA ANALYSIS

COLLISION TYPE

Collision Type	Lynnhaven Pkwy at Independence Blvd	All Safety Study Intersections
Rear End	39.8%	44.6%
Right Angle	35.5%	34.6%
Head On	1.1%	3.0%
Sideswipe - Same Direction	15.1%	7.0%
Sideswipe - Opposite Direction	1.1%	1.0%
Fixed Object - In Road	0.0%	0.5%
Fixed Object - Off Road	3.2%	4.0%
Bike/Pedestrian	0.0%	1.6%
Animal	0.0%	0.4%
Other	4.3%	3.3%

MOST PREVALENT DRIVER ACTION

Primary Driver Action	Lynnhaven Pkwy at Independence Blvd	All Safety Study Intersections
Following too close	39.8%	33.4%
Did not have right-of-way	35.7%	17.3%
Disregarded signal	5.1%	10.3%
Failure to maintain control	4.1%	7.3%
Improper turn	3.1%	3.4%

WEATHER

Weather	Lynnhaven Pkwy at Independence Blvd	All Safety Study Intersections
Clear/Cloudy	76.8%	81.9%
Mist/Rain/Fog	21.2%	15.5%
Snow/Sleet	0.0%	0.7%
Other/Not Stated	2.0%	1.9%

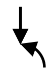
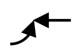
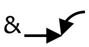
DRIVING UNDER THE INFLUENCE

Driving Under the Influence	Lynnhaven Pkwy at Independence Blvd	All Safety Study Intersections
Drinking Involved	4.0%	5.8%

TIME OF DAY

Crash Time	Lynnhaven Pkwy at Independence Blvd	All Safety Study Intersections
5:00 - 8:59	13.1%	12.7%
9:00 - 14:59	33.3%	34.0%
15:00 - 18:59	18.2%	31.0%
19:00 - 4:59	35.4%	22.3%

PRIMARY COLLISION MOVEMENTS

#1		13.1%
#2		11.1%
#3		11.1%
#4		10.1%
#5		9.1%
#6 (tie)	 & 	7.1%

DATA OBSERVATIONS

- Rear end crashes (40%), right angle crashes (36%) were the top two collision types.
- Excessive sideswipes (15%).
- Crashes involving drivers not having the right-of-way (36%) were higher than the regional average.
- 35% of crashes occurred during night/early morning hours from 7pm – 4:59am – higher than the regional average.

Data Source: HRTPO analysis of VDOT data. Regionwide data included in the tables represents a summation of those 597 intersections included in the Regional Safety Study, not the region as a whole. All data represents the years 2009-2012.

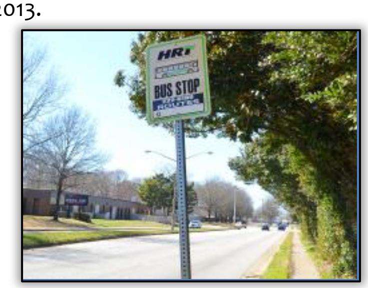
SITE OBSERVATIONS & POSSIBLE CAUSES

- Left turns on EB and WB Lynnhaven Pkwy are controlled by protective-permissive phasing.
- All approaches have right turn lanes – WB Lynnhaven Pkwy approach has a channelized right turn lane with yield control.
- Signal mast arms were recently installed in 2013.

- NB and SB approaches for Independence Blvd have dual-left turn lanes controlled by protective phasing (added in 2013).
- The crash data analyzed for this intersection was from 2009-2012, prior to the city adding dual NB and SB dual left turn lanes along Independence Blvd with protective phasing in 2013. This improvement (adding capacity and changing from protective-permissive to protective phasing) should reduce crashes for Independence Blvd left turns.

- Giving existing signal timing, left turn bays for EB and WB Lynnhaven Pkwy are inadequate during peak periods, based on tire tracks in the grass median areas.
- "Left Turn YIELD On Green" signs for EB & WB Lynnhaven Pkwy approaches were moved from street level to the signal mast arms in 2013.

- NB Independence Blvd channelized right turn lane with yield control was changed to a single right turn lane in 2013.



- HRT Bus Stop (Route 12) along Lynnhaven Pkwy is located just west of the intersection.

INTERSECTION #10 – LYNNHAVEN PARKWAY AT INDEPENDENCE BOULEVARD

VIRGINIA BEACH

CANDIDATE CRASH COUNTERMEASURES

1) Change from protective-permissive to protective phasing for left turns for EB and WB Lynnhaven Pkwy approaches.
2) Extend left turn bay length for both EB & WB Lynnhaven Pkwy approaches.
3) Add painted triangle yield line with YIELD pavement marking and 2nd yield sign in the triangle grass area for the WB Lynnhaven Pkwy channelized right turn lane.

BENEFIT-COST ANALYSIS

	Safety Countermeasure	Service Life (Years)	Crash Reduction Factor (CRF)			Average Annual Crashes			Estimated Annual Crash Reduction			Cost per Crash			Estimated Annual Benefit			Traffic Growth Factor	Total Annual Benefit
			FAT	INJ	PDO	FAT	INJ	PDO	FAT	INJ	PDO	FAT	INJ	PDO	FAT	INJ	PDO		
1	Protective LT Phasing (EB, WB)	20	0.25	0.25	0.25	0.0	2.3	2.0	0.0	0.6	0.5	$ 5,000,000	$ 85,000	$ 9,000	$ -	$ 47,813	$ 4,500	1.24	$ 64,824
2	Extend LT bays (EB, WB)	8	0.15	0.15	0.15	0.0	4.3	5.3	0.0	0.6	0.8	$ 5,000,000	$ 85,000	$ 9,000	$ -	$ 54,188	$ 7,088	1.09	$ 67,055
3	Yield markings & sign (WB RT lane)	10	0.25	0.25	0.25	0.0	0.0	0.5	0.0	0.0	0.1	$ 5,000,000	$ 85,000	$ 9,000	$ -	$ -	$ 1,125	1.12	$ 1,256

	Safety Countermeasure	Service Life (Years)	Estimated Project Cost		Annual Initial Cost	Annual Mnt. Cost (if any)	Total Annual Cost
			PE & Construction	R/W & Utility			
1	Protective LT Phasing (EB, WB)	20	$ 20,000	$ -	$ 1,344		$ 1,344
2	Extend LT bays (EB, WB)	8	$ 320,000	$ 15,000	$ 47,723		$ 47,723
3	Yield markings & sign (WB RT lane)	10	$ 7,000	$ -	$ 821		$ 821

Total Annualized		B/C =
Benefit	Cost	
$ 64,824	$ 1,344	**48.22**
$ 67,055	$ 47,723	**1.41**
$ 1,256	$ 821	**1.53**

RECOMMENDED CRASH COUNTERMEASURES (HIGH B/C)

1) Change from protective-permissive to protective phasing for left turns for EB and WB Lynnhaven Pkwy approaches.

NEXT STEPS

Each year there are tens of thousands of crashes on the Hampton Roads roadway network, resulting in millions of dollars of damage, injuries, and the loss of life. These crashes have a wide range of impacts on families, friends, and society as a whole. Because of these impacts, roadway safety planning is an integral part of the HRTPO transportation planning and programming process.

The Hampton Roads Regional Safety Study – 2013/2014 Update is the first full update to the Regional Safety Study since the original 2002-2004 study. This Hampton Roads Regional Safety Study – 2013/2014 Update:

- Discussed previous HRTPO safety planning efforts
- Reported the recent trends in roadway safety in Hampton Roads
- Provided detailed characteristics of crashes in Hampton Roads
- Specified the number and rate of crashes for each mile of freeway and approximately 600 of the busiest intersections throughout the region
- Highlighted efforts to improve roadway safety based on the 4 E's of safety – engineering, enforcement and regulation, education, and emergency response
- Explained the study's method of determining locations with the highest Potential for Safety Improvement
- Detailed general crash countermeasures
- Provided a thorough analysis of high crash locations, including various crash countermeasure recommendations

Based on the results of this report, a number of next steps are recommended:

- **Implement recommended crash countermeasures at high crash locations** – Within this report, HRTPO staff evaluated the top ten intersections in Hampton Roads with the highest Potential for Safety Improvement. Based on site observations and crash analysis, a list of candidate crash countermeasures was developed. For intersections, each crash countermeasure was evaluated using a benefit-cost (B/C) spreadsheet based on VDOT's Highway Safety Improvement Program Proposed Safety Improvements form (FY2013-14).

  HRTPO staff has recommended a set of crash countermeasures with high B/C (B/C ratios higher than 3.0). For some intersections, additional crash countermeasures were recommended to mitigate existing intersection safety problems, to address capacity/safety-related deficiencies, or as preventative measures due to existing intersection characteristics and conditions.

  The top 10 intersections in which crash countermeasures were recommended are located in three cities in Hampton Roads – Virginia Beach, Hampton, and Newport News. City staffs may use this analysis to seek Highway Safety Improvement Program and/or other available funding to implement these safety improvements.

- **Continue incorporating safety into the HRTPO transportation planning and programming process** – Because of the importance of roadway safety, safety should continue to be an integral part of the metropolitan transportation planning and programming process.

  HRTPO staff will continue to collect crash data from VDOT and DMV on an annual basis, including jurisdictional summaries and data corresponding to each crash. HRTPO staff will continue to periodically analyze this data and incorporate it into regional databases and map shapefiles.

  Safety is incorporated into both the Hampton Roads Long Range Transportation Planning (LRTP) process and the Congestion Management Process (CMP). The HRTPO uses its Project Prioritization Tool to score long range transportation plan candidate projects. HRTPO staff scores each candidate project based its utility, viability, and economic vitality. Roadway safety in the area of the project, based on recent crash history, is considered in the score of the project's utility.

The HRTPO's Congestion Management Process also incorporates roadway safety. Corridors throughout the region are ranked based on a variety of factors, including congestion levels, freight levels, and roadway safety. Those corridors that rank the highest are analyzed in detail and strategies are recommended to improve congestion and mobility in the corridor. Many of these strategies – including geometric, signalization, roadway environment, and incident management improvements – improve safety in addition to congestion.

- **Continue using new roadway safety analysis methods** – This study used a number of new safety analysis methods detailed in the AASHTO Highway Safety Manual and research completed by the Virginia Center for Transportation Innovation and Research (VCTIR). HRTPO staff will continue to monitor this research as it evolves and incorporate new roadway safety analysis methods as they become available.

- **Update the Regional Safety Study on a recurring basis** – In recent years, crash databases produced by VDOT and DMV have been improved. Starting with 2008 crash data, VDOT's crash database includes the location of all reportable crashes on public roadways, regardless of the jurisdiction where it occurred and roadway ownership. Starting with the 2009 data, the latitude and longitude coordinates for each crash are included with the data. These improvements have allowed HRTPO staff to use the VDOT crash database as the sole source of crash location data, making it easier to analyze the data and produce regular updates to the Regional Safety Study. HRTPO staff plans to make updates to the Regional Safety Study on a four-year cycle – the same period as the Congestion Management Process report and Hampton Roads Long Range Transportation Plan.

Public Involvement

HRTPO is fully committed to involving and collaborating with Hampton Roads citizens in a public involvement process that is grounded in community partnership, mutual problem solving and understanding. In other words, a process whereby citizens feel a sense of ownership and satisfaction in knowing their voice has been legitimately heard and their thoughts, ideas, and opinions have the potential to impact future HRTPO decisions. This principle lies at the core of all recent HRTPO public involvement activities.

The HRTPO understands the public to mean all of those who have the potential to affect or be affected by the Hampton Roads transportation system. From bikers to environmental activists, the majority of Hampton Roads citizens have a stake in the future of our transportation system.

Equally important, the HRTPO recognizes that not all communities and its members have enjoyed the same level of access or representation in transportation and other decisions made by public agencies. Therefore, as part of its public involvement strategy, the HRTPO takes special steps and measures to understand and consider the wants, needs, and aspirations of minority, low-income, and other underserved groups in Hampton Roads.

Understanding how important public involvement is, the HRTPO takes every available step to engage the public in conversations promoting mutual understanding and problem solving. It is a process defined by two-way communication and interaction. We want to help create an efficient, equitable Hampton Roads transportation system together and are committed to gaining public input and feedback.

HRTPO knows that while road safety priorities are largely based on data analysis, it is important to engage the public in order to gain the knowledge and perspective of local road users.

Every statistic, figure, and finding presented in the Hampton Roads Regional Safety Study – 2013/2014 Update represents a life – family, friends, and fellow community members. At the end of the day, it is our sincerest hope that the Study will serve as a practical guide for the HRTPO, VDOT, and individual communities in improving roadway safety throughout the region. However, we recognize that the recommendations put forth in the Study are only as valuable as the input and involvement we receive from those they impact – users of the Hampton Roads transportation system.

In consideration of this fact, the HRTPO set out to engage regional stakeholders and community members. Specifically, we invited individuals to review and offer comment on the draft report with the following questions in mind:

The opportunity to comment on the draft study was available from June 4, 2014 to June 18, 2014. Submitted comments, and HRTPO staff responses, are included in **Appendix E.** In addition to a multi-lingual public notice (**Figure 10** on page 110) inviting public comment on the Hampton Roads Regional Safety Study on the HRTPO website (**http://www.hrtpo.org/page/public-comment-opportunities/**), specific efforts were taken to maximize involvement among a wide variety of diverse stakeholders and communities.

Infographic

While individuals were encouraged to review Part II in its entirety, HRTPO staff created an infographic (see **Figure 11** to the right) that allowed for quick and easy digestion of information. Simply put, an infographic is a fun and engaging visual image used to represent information and/or data in the hopes of maximizing the readers' time and increasing the potential for participation and feedback.

The infographic created for Part II sought to introduce readers to the HRTPO, our roadway safety efforts, and how they could have an impact on the development of Part II and, ultimately, the recommendations that followed.

DRAFT Hampton Roads Regional Safety Study Part II Report

The Hampton Roads Transportation Planning Organization (HRTPO), the metropolitan planning organization (MPO) for the Hampton Roads metropolitan planning area, has completed Part II of the *DRAFT Hampton Roads Regional Safety Study – 2013/2014 Update.*

In 2001 the Hampton Roads Planning District Commission initiated the Hampton Roads Regional Safety Study, a comprehensive analysis of highway safety throughout the region. This study examined General Crash Data and Trends, Interstate and Intersection Crash Findings, and Crash Analysis and Countermeasures.

This report is the first full update to the original Regional Safety Study. Part I of this report, which was published in October 2013, introduced previous HRTPO safety planning efforts, reported the recent trends in roadway safety in Hampton Roads, provided detailed characteristics of crashes in the region, and specified the number and rate of crashes for each mile of freeway and approximately 600 of the busiest intersections throughout the region.

Part II builds on the results of Part I by examining ways to improve roadway safety – broadly and for specific locations – including:

- Efforts to improve roadway safety – national, statewide, and local
- A description of general crash countermeasures, including the countermeasure selection process, Crash Modification Factors (CMF) and Crash Reduction Factors (CRF), and examples
- An analysis of the Potential for Safety Improvement (PSI) on freeways and at intersections throughout Hampton Roads
- An analysis of those locations with the top PSIs, including collision diagrams, summaries of crash characteristics, site observations and possible causes, benefit-cost analysis, and prioritized recommendations.
- Next steps

Click Here to view a copy of the draft document.

All interested parties are encouraged to review the draft report and send comments to Mr. Keith Nichols at knichols@hrtpo.org or by mail to 723 Woodlake Drive, Chesapeake, Virginia 23320. **The deadline for comments on this draft report is June 18th, 2014.**

Figure 10 - Part II Public Notice on the HRTPO Website

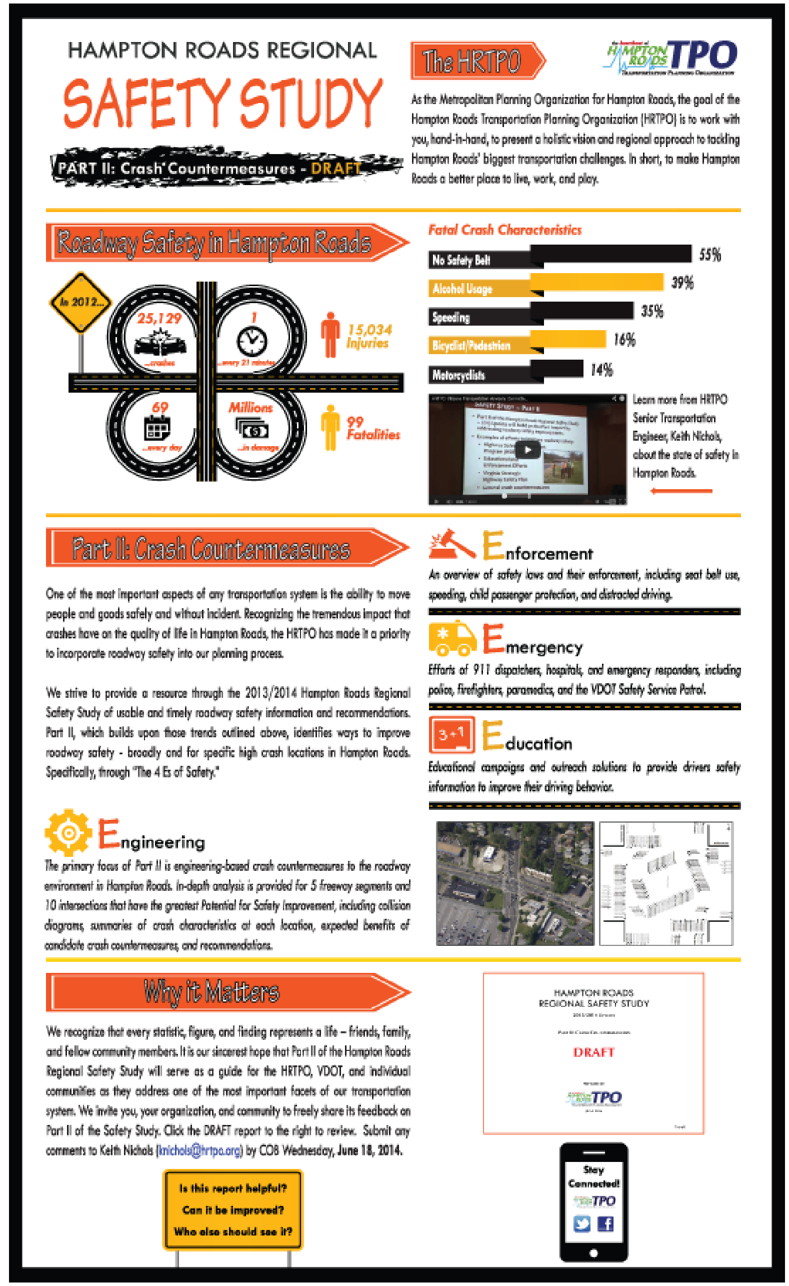


Figure 11 - Part II Infographic

HRTPO News

The infographic, along with an invitation to review and comment, was sent out to the HRTPO's list of more than 3,000 contacts via Constant Contact on June 4, 2014. Nearly 600 or 21 percent of contacts opened the email, beating the industry average of 19.3 percent.

Community Contacts

The HRTPO also sent personal messages to those who reviewed/commented on Part I of the Study and those communities and organizations potentially having an interest in both roadway safety in Hampton Roads and specific recommendations put forth by the report. Special care was taken to explain the importance of Part II to an individual community and/or organization.

Specific community contacts include:

- Drive Safe Hampton Roads
- AAA Tidewater
- Drive Smart Virginia
- Bike Norfolk
- Tidewater Bicycle Association
- Virginia Safe Routes to School
- Newport News Task Force on Aging
- Virginia Sheriffs' Association
- Northampton Civic League
- Chesapeake Transportation Safety Commission
- Newport News Transportation Safety Commission
- Peninsula Bicycling Association
- Princess Anne Plaza Civic League
- Larkspur Civic League
- Farmington Civic Association
- Bellgrade Good Neighbors
- Riverdale Regional Civic Association
- Baycliff Civic League
- Sandbridge Beach Civic League
- Alanton Civic League
- Linkhorn Cove Civic League
- Broad Bay Estates Civic League
- Laurel Cove Civic League
- Broad Bay Point Greens Civic League

This effort proved to have a powerful "ripple effect," with many organizations, such as Drive Safe Hampton Roads, distributing notification to its members.

Social Media

Notification was sent to those who stay connected with the HRTPO via its social media platforms. Specifically, HRTPO used micro-blogging (Twitter), social media (Facebook), and the HRTPO, partner organizations and stakeholder websites as a means of conveying an invitation to review and comment on the Hampton Roads Regional Safety Study. Social media allows the HRTPO to better connect with the diverse individuals that make up Hampton Roads.

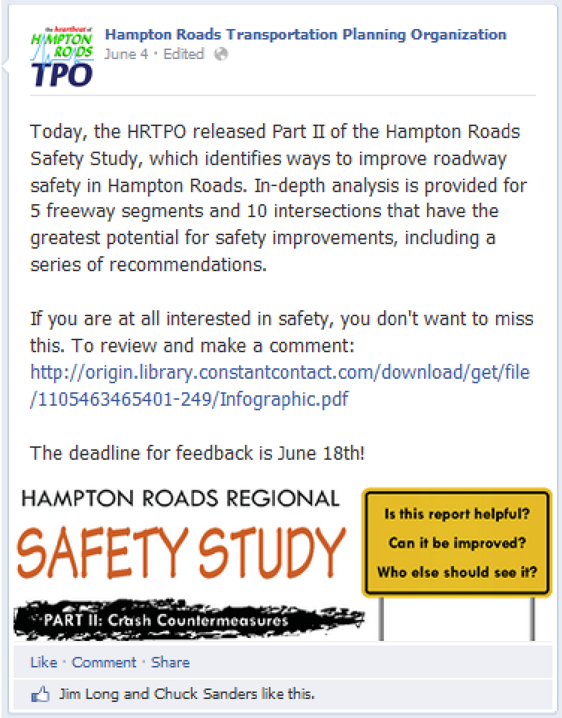


FIGURE 12 - PART II FACEBOOK POST

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Appendix A – Haddon Matrix

	Human	Vehicle/ Equipment	Physical Environment	Socioeconomic
Pre-Crash	Poor vision or reaction time, alcohol, speeding, risk taking	Failed brakes, missing lights, lack of warning systems	Narrow shoulders, ill-timed signals	Cultural norms permitting speeding, red light running, DUI
Crash	Failure to use occupant restraints	Malfunctioning safety belts, poorly engineered air bags	Poorly designed guardrails	Lack of vehicle design regulations
Post-Crash	High susceptibility	Poorly designed fuel tanks	Poor emergency communication systems	Lack of support for EMS and trauma systems

Table A1 – Haddon Matrix
Source: FHWA.

In addition to the toolbox of efforts represented by the "4 Es of Safety" (described in the Efforts to Improve Roadway Safety section of this report), William Haddon highlighted the importance of the pre-crash, crash, and post-crash time periods (**see Table A1**). Haddon's concept from 1980 included a two-dimensional matrix that encourages officials to address safety for all phases of the crash – pre-crash, crash, and post-crash – and not just the causative factors – human, vehicle/equipment, physical environment, and socioeconomic. Each cell within the Haddon Matrix represents an area in which interventions can be identified and implemented to improve overall transportation system safety.

Appendix B - Potential for Safety Improvement Calculation Examples - Freeways and Intersections

This appendix includes examples of the Potential for Safety Improvement calculations completed for each freeway segment and intersection included in this Regional Safety Study report. The freeway example is I-64 Eastbound between Yorktown Road and Fort Eustis Boulevard in Newport News, and the intersection example is Holland Road at Rosemont Road in Virginia Beach.

Because of the importance of the terms "observed", "expected", and "predicted" in these calculations, they are highlighted in this appendix as ***Observed***, ***Expected***, and ***Predicted***.

More information about the Empirical Bayes method and the terms and equations used in this appendix is included in the Potential for Safety Improvement section of this report.

Freeway Example – I-64 Eastbound between Yorktown Road and Fort Eustis Boulevard

The freeway example used in this appendix is I-64 Eastbound between Yorktown Road and Fort Eustis Boulevard. This segment has 2 through lanes in each direction and a length of 2.45 miles. The roadway characteristic and crash data for this segment is shown to the right. The coefficients used in VCTIR's safety performance functions are also included.

Freeway Example Data – I-64 Eastbound between Yorktown Road and Fort Eustis Boulevard

Segment Length: 2.45 miles (2.11 mi. outside interchange area, 0.34 mi. inside interchange area)
Number of Lanes: 4
Area Type: Urban

Observed **Crash and Traffic Volume Data**

	Crashes Outside Interchange Area		Crashes Inside Interchange Area		Total Crashes by Severity			Annual Average Daily Traffic
Year	PDO	F + I	PDO	F + I	PDO	F + I	Total	
2009	36	7	26	6	62	13	75	41,000
2010	23	12	24	8	47	20	67	44,000
2011	44	11	22	4	66	15	81	44,000
2012	58	12	14	5	72	17	89	43,000

Source: HRTPO Analysis of VDOT data.
FAT = Number of crashes with at least one fatality. INJ = Number of crashes with at least one injury but no fatalities.
PDO = Number of crashes with property damage only. F+I = FAT + INJ crashes.

VCTIR/VDOT Safety Performance Function Coefficients

Site Subtype Description	Total Crashes			Fatal + Injury Crashes		
	α	β_1	k	α	β_1	k
Rural freeway segments between interchanges—4 lanes	-6.75	0.80	0.19	-6.89	0.70	0.16
Rural freeway segments between interchanges—6+ lanes	-12.65	1.36	0.27	-7.13	0.72	0.14
Rural freeway segments within an interchange area—4 lanes	-7.56	0.93	0.50	-8.01	0.86	0.44
Rural freeway segments within an interchange area—6+ lanes	-13.11	1.45	0.39	-11.87	1.22	0.30
Urban freeway segments between interchanges—4 lanes	-18.05	1.98	0.65	-18.27	1.88	0.53
Urban freeway segments between interchanges—6 lanes	-12.85	1.45	0.59	-15.64	1.60	0.47
Urban freeway segments between interchanges—8+ lanes	-2.17	0.48	0.58	-5.94	0.71	0.50
Urban freeway segments within an interchange area—4 lanes	-12.05	1.43	0.85	-12.53	1.35	0.74
Urban freeway segments within an interchange area—6 lanes	-11.87	1.40	0.64	-12.44	1.34	0.64
Urban freeway segments within an interchange area—8+ lanes	-13.59	1.54	0.53	-12.74	1.37	0.46

Source: VCTIR. Coefficients used in this example are highlighted.

α and β_1 represent coefficients used in the Unadjusted "Predicted" Crashes equation. k represents the dispersion parameter used in the Empirical Bayes method equations.

Freeway Example (continued)

Step 1 – Calculate Unadjusted *Predicted* Crashes

Calculate the unadjusted *Predicted* crashes for both outside and inside the interchange area by severity for each year, based on the Safety Performance Function equation and coefficients produced by VCTIR:

Annual Unadjusted *Predicted* Crashes =
e^{α} x (One Direction AADT)$^{\beta_1}$ x Segment Length

For 2009:

Outside Interchange:

Annual Unadjusted *Predicted* Total Crashes Outside Interchange
= $e^{-18.05}$ x (41,000)$^{1.98}$ x 2.11 = 41.55 crashes

Annual Unadjusted *Predicted* Fatal + Injury (F+I) Crashes Outside Interchange
= $e^{-18.27}$ x (41,000)$^{1.88}$ x 2.11 = 11.53 crashes

Annual Unadjusted *Predicted* PDO Crashes Outside Interchange
= Total Crashes - (F+I Crashes)
= 41.55 crashes - 11.53 crashes = 30.02 crashes

Inside Interchange:

Annual Unadjusted *Predicted* Total Crashes Inside Interchange
= $e^{-12.05}$ x (41,000)$^{1.43}$ x 0.34 = 7.84 crashes

Annual Unadjusted *Predicted* F+I Crashes Inside Interchange
= $e^{-12.53}$ x (41,000)$^{1.35}$ x 0.34 = 2.08 crashes

Annual Unadjusted *Predicted* PDO Crashes Inside Interchange =
= Total Crashes - (F+I Crashes)
= 7.84 crashes - 2.08 crashes = 5.76 crashes

Total Crashes:

2009 Unadjusted *Predicted* Total Crashes
= Annual Unadjusted *Predicted* Total Crashes Outside Interchange + Annual Unadjusted *Predicted* Total Crashes Inside Interchange
= 41.55 crashes + 7.84 crashes = 49.39 crashes

2009 Unadjusted *Predicted* F+I Crashes
= Annual Unadjusted *Predicted* F+I Crashes Outside Interchange + Annual Unadjusted *Predicted* F+I Crashes Inside Interchange
= 11.53 crashes + 2.08 crashes = 13.61 crashes

2009 Unadjusted *Predicted* PDO Crashes
= Annual Unadjusted *Predicted* Total Crashes - Annual Unadjusted *Predicted* F+I Crashes
= 49.39 crashes - 13.61 crashes = 35.78 crashes

Values for the years 2010-2012 were calculated similarly, differing only due to different AADTs. The following unadjusted *Predicted* crash values were calculated for each year:

Unadjusted *Predicted* Crashes by Year
I-64 Eastbound between Yorktown Road and Fort Eustis Boulevard

	Outside Interchange			Inside Interchange			Segment Total		
Year	Total	F+I	PDO	Total	F+I	PDO	Total	F+I	PDO
2009	41.55	11.53	30.02	7.84	2.08	5.76	49.39	13.61	35.78
2010	47.79	13.16	34.63	8.68	2.28	6.40	56.47	15.44	41.03
2011	47.79	13.16	34.63	8.68	2.28	6.40	56.47	15.44	41.03
2012	45.66	12.61	33.05	8.40	2.21	6.19	54.06	14.82	39.24

Note: Totals in the above table may not be equal due to rounding.

Freeway Example (continued)

Step 2 – Calculate Yearly Calibration Factors

Yearly calibration factors must be calculated individually for each crash subtype (i.e. rural 4 lanes, urban 8+ lanes, etc.) and severity (i.e. total crashes, F+I crashes) using the following steps:

1) Sum together the unadjusted *Predicted* crashes by year for every freeway segment of each crash subtype and severity. The results are shown below:

Unadjusted *Predicted* Crashes by Subtype, Severity, and Year

Site Subtype Description	2009	2010	2011	2012
Rural freeway segments—4 lanes, Total crashes	173	174	172	174
Rural freeway segments—6+ lanes, Total crashes	-	-	-	-
Urban freeway segments—4 lanes, Total crashes	2083	2212	2160	2143
Urban freeway segments—6 lanes, Total crashes	908	892	896	891
Urban freeway segments—8+ lanes, Total crashes	1940	1954	1952	1927
Rural freeway segments—4 lanes, F+I crashes	54	54	54	54
Rural freeway segments—6+ lanes, F+I crashes	-	-	-	-
Urban freeway segments—4 lanes, F+I crashes	582	616	602	598
Urban freeway segments—6 lanes, F+I crashes	275	270	271	269
Urban freeway segments—8+ lanes, F+I crashes	610	615	614	605
Rural freeway segments—4 lanes, PDO crashes	119	120	119	120
Rural freeway segments—6+ lanes, PDO crashes	-	-	-	-
Urban freeway segments—4 lanes, PDO crashes	1501	1596	1558	1545
Urban freeway segments—6 lanes, PDO crashes	634	622	625	622
Urban freeway segments—8+ lanes, PDO crashes	1330	1339	1337	1322

2) Sum together the ***Observed*** number of crashes by year for each crash subtype and severity. The results are shown to the right:

***Observed* Crashes by Subtype, Severity, and Year**

Site Subtype Description	2009	2010	2011	2012
Rural freeway segments—4 lanes, Total crashes	146	143	141	182
Rural freeway segments—6+ lanes, Total crashes	-	-	-	-
Urban freeway segments—4 lanes, Total crashes	1,628	1,557	1,684	1,691
Urban freeway segments—6 lanes, Total crashes	689	688	622	735
Urban freeway segments—8+ lanes, Total crashes	1,676	1,702	1,662	1,715
Rural freeway segments—4 lanes, F+I crashes	64	60	63	70
Rural freeway segments—6+ lanes, F+I crashes	-	-	-	-
Urban freeway segments—4 lanes, F+I crashes	506	509	527	500
Urban freeway segments—6 lanes, F+I crashes	242	228	228	242
Urban freeway segments—8+ lanes, F+I crashes	609	596	591	636
Rural freeway segments—4 lanes, PDO crashes	82	83	78	112
Rural freeway segments—6+ lanes, PDO crashes	-	-	-	-
Urban freeway segments—4 lanes, PDO crashes	1,122	1,048	1,157	1,191
Urban freeway segments—6 lanes, PDO crashes	447	460	394	493
Urban freeway segments—8+ lanes, PDO crashes	1,067	1,106	1,071	1,079

3) Calculate yearly calibration factors for each crash subtype and severity by dividing the ***Observed*** number of crashes by the unadjusted ***Predicted*** number of crashes. The results are shown below:

Yearly Calibration Factors

Site Subtype Description	2009	2010	2011	2012
Rural freeway segments—4 lanes, Total crashes	0.845	0.823	0.817	1.044
Rural freeway segments—6+ lanes, Total crashes	-	-	-	-
Urban freeway segments—4 lanes, Total crashes	0.782	0.704	0.780	0.789
Urban freeway segments—6 lanes, Total crashes	0.758	0.771	0.694	0.825
Urban freeway segments—8+ lanes, Total crashes	0.864	0.871	0.852	0.890
Rural freeway segments—4 lanes, F+I crashes	1.193	1.114	1.177	1.296
Rural freeway segments—6+ lanes, F+I crashes	-	-	-	-
Urban freeway segments—4 lanes, F+I crashes	0.870	0.826	0.876	0.837
Urban freeway segments—6 lanes, F+I crashes	0.880	0.845	0.841	0.900
Urban freeway segments—8+ lanes, F+I crashes	0.998	0.969	0.962	1.051
Rural freeway segments—4 lanes, PDO crashes	0.688	0.692	0.656	0.931
Rural freeway segments—6+ lanes, PDO crashes	-	-	-	-
Urban freeway segments—4 lanes, PDO crashes	0.747	0.657	0.743	0.771
Urban freeway segments—6 lanes, PDO crashes	0.706	0.739	0.630	0.792
Urban freeway segments—8+ lanes, PDO crashes	0.802	0.826	0.801	0.816

Calibration factors used in this example are highlighted.

FREEWAY EXAMPLE (CONTINUED)

Step 3 – Calculate Adjusted *Predicted* Crashes

Using the yearly calibration factors calculated in the previous step, the unadjusted ***Predicted*** crash values produced in Step 1 were converted into adjusted ***Predicted*** crash values, based on the following equation:

Adjusted ***Predicted*** Crashes = Yearly Calibration Factor x Unadjusted ***Predicted*** Crashes.

Calculations for 2009 follow:

2009 Adjusted ***Predicted*** Total Crashes Outside Interchange =
2009 Yearly Calibration Factor x 2009 Unadjusted ***Predicted*** Total Crashes Outside Interchange

= 0.782 x 41.55 crashes = 32.48 crashes

2009 Adjusted ***Predicted*** F+I Crashes Outside Interchange =
2009 Yearly Calibration Factor x 2009 Unadjusted ***Predicted*** F+I Crashes Outside Interchange

= 0.870 x 11.53 crashes = 10.03 crashes

2009 Adjusted ***Predicted*** PDO Crashes Outside Interchange =
2009 Yearly Calibration Factor x 2009 Unadjusted ***Predicted*** PDO Crashes Outside Interchange

= 0.747 x 30.02 crashes = 22.44 crashes

Values for 2009 inside the interchange area and 2010-2012 were calculated similarly. The following adjusted ***Predicted*** crash values were calculated for each year:

Adjusted *Predicted* Crashes by Year
I-64 Eastbound between Yorktown Road and Fort Eustis Boulevard

Year	Outside Interchange			Inside Interchange			Segment Total		
	Total	F+I	PDO	Total	F+I	PDO	Total	F+I	PDO
2009	32.48	10.03	22.44	6.13	1.81	4.31	38.61	11.84	26.75
2010	33.64	10.88	22.73	6.11	1.89	4.20	39.74	12.77	26.93
2011	37.26	11.53	25.71	6.77	2.00	4.75	44.03	13.53	30.46
2012	36.03	10.55	25.47	6.63	1.85	4.77	42.66	12.40	30.24

Note: Totals in the above table may not be equal due to rounding.

Step 4 – Calculate Yearly Correction Factors

Unlike the yearly calibration factors calculated in Step 2, the yearly correction factors create a ratio of the adjusted ***Predicted*** number of crashes in a given year to the adjusted ***Predicted*** number of crashes in the first analysis year (2009). The equation is as follows:

Yearly Correction Factor = Adjusted ***Predicted*** Number of Crashes in a given year/Adjusted ***Predicted*** Number of Crashes in Year 1.

Using 2011 Total Crashes outside the interchange area as an example:

2011 Yearly Correction Factor = Adjusted ***Predicted*** Number of Crashes in a given year/Adjusted ***Predicted*** Number of Crashes in Year 1.

= 37.26/32.48 = 1.15

The following yearly correction factors were calculated for each year:

Yearly Correction Factors
I-64 Eastbound between Yorktown Road and Fort Eustis Boulevard

Year	Outside Interchange			Inside Interchange			Segment Total		
	Total	F+I	PDO	Total	F+I	PDO	Total	F+I	PDO
2009	1	1	1	1	1	1	1	1	1
2010	1.04	1.08	1.01	1.00	1.04	0.97	1.03	1.08	1.01
2011	1.15	1.15	1.15	1.10	1.10	1.10	1.14	1.14	1.14
2012	1.11	1.05	1.14	1.08	1.02	1.11	1.10	1.05	1.13

Freeway Example (continued)

Step 5 – Calculate *Expected* Crashes

The number of ***Expected*** crashes is calculated using the following steps:

1) Calculate the weights to be assigned through the Empirical Bayes method to the ***Predicted*** crashes by crash type and location using the following formula:

> w = 1 / [1 + (k x Sum of annual adjusted ***Predicted*** number of crashes)]

The weights assigned to the ***Observed*** crashes is 1-w.

For I-64 Eastbound between Yorktown Road and Fort Eustis Blvd:

Total Crashes Outside Interchange:

$w_{total,outside}$ = 1 / [1 + (k x Sum of annual adjusted ***Predicted*** number of crashes)]

$w_{total,outside}$ = 1 / [1 + (0.65 x (32.48 + 33.64 + 37.26 + 36.03)] = 0.011

Total Crashes Inside Interchange:

$w_{total,inside}$ = 1 / [1 + (k x Sum of annual adjusted ***Predicted*** number of crashes)]

$w_{total,inside}$ = 1 / [1 + (0.85 x (6.13 + 6.11 + 6.77 + 6.63)] = 0.044

F+I Crashes Outside Interchange:

$w_{F+I,outside}$ = 1 / [1 + (k x Sum of annual adjusted ***Predicted*** number of crashes)]

$w_{F+I,outside}$ = 1 / [1 + (0.53 x (10.03 + 10.88 + 11.53 + 10.55)] = 0.042

F+I Crashes Inside Interchange:

$w_{F+I,inside}$ = 1 / [1 + (k x Sum of annual adjusted ***Predicted*** number of crashes)]

$w_{F+I,inside}$ = 1 / [1 + (0.74 x (1.81 + 1.89 + 2.00 + 1.85)] = 0.152

2) Calculate the ***Expected*** annual number of crashes using the Empirical Bayes method. The ***Expected*** number of crashes, by crash location and severity, is calculated for the first year using the following equation:

> ***Expected*** Number of Crashes = (w x Annual Adjusted ***Predicted*** Crashes) + [(1-w) x (Sum of Annual ***Observed*** Crashes)/(Sum of Yearly Correction Factors)]

For the second and each subsequent year, the ***Expected*** annual number of crashes, by crash type and severity, is calculated using the following equation:

> ***Expected*** Number of Crashes = (***Expected*** Number of Crashes in Year 1 x Yearly Correction Factor)

For I-64 Eastbound between Yorktown Road and Fort Eustis Blvd for the year 2009:

Total Crashes Outside Interchange:

$N_{expected,2009}$ = ($w_{total,outside}$ x Annual Adjusted ***Predicted*** Crashes) + [(1 - $w_{total,outside}$) x (Sum of Annual ***Observed*** Total Crashes)/(Sum of Yearly Correction Factors)]

$N_{expected,2009}$ = (0.011 x 32.48 crashes) + [(1 – 0.011) x (43 + 35 + 55 + 70) / (1 + 1.04 + 1.15 +1.11)]

$N_{expected,2009}$ = (0.011 x 32.48 crashes) + [(0.989) x (203) / (4.30)]

$N_{expected,2009}$ = 47.1 crashes

FREEWAY EXAMPLE (CONTINUED)

Total Crashes Inside Interchange:

$N_{expected,2009}$ = ($w_{total,inside}$ x Annual Adjusted ***Predicted*** Crashes) + [(1 - $w_{total,inside}$) x (Sum of Annual ***Observed*** Total Crashes)/(Sum of Yearly Correction Factors)]

$N_{expected,2009}$ = (0.044 x 6.13 crashes) + [(1 – 0.044) x (32 + 32 + 26 + 19) / (1 + 1.00 + 1.10 +1.08)]

$N_{expected,2009}$ = (0.044 x 6.13 crashes) + [(0.956) x (109) / (4.18)]

$N_{expected,2009}$ = 25.2 crashes

F+I Crashes Outside Interchange:

$N_{expected,2009}$ = ($w_{F+I,outside}$ x Annual Adjusted ***Predicted*** Crashes) + [(1 - $w_{F+I,outside}$) x (Sum of Annual ***Observed*** Total Crashes)/(Sum of Yearly Correction Factors)]

$N_{expected,2009}$ = (0.042 x 10.03 crashes) + [(1 – 0.042) x (7 + 12 + 11 + 12) / (1 + 1.08 + 1.15 +1.05)]

$N_{expected,2009}$ = (0.042 x 10.03 crashes) + [(0.958) x (42) / (4.28)]

$N_{expected,2009}$ = 9.8 crashes

F+I Crashes Inside Interchange:

$N_{expected,2009}$ = ($w_{F+I,inside}$ x Annual Adjusted ***Predicted*** Crashes) + [(1 - $w_{F+I,inside}$) x (Sum of Annual ***Observed*** Total Crashes)/(Sum of Yearly Correction Factors)]

$N_{expected,2009}$ = (0.152 x 1.81 crashes) + [(1 – 0.152) x (6 + 8 + 4 + 5) / (1 + 1.04 + 1.10 +1.02)]

$N_{expected,2009}$ = (0.152 x 1.81 crashes) + [(0.848) x (23) / (4.16)]

$N_{expected,2009}$ = 4.9 crashes

PDO Crashes Outside Interchange:

$N_{expected,2009}$ = Total Crashes Outside Interchange – F+I Crashes Outside Interchange

$N_{expected,2009}$ = 47.1 crashes – 9.8 crashes

$N_{expected,2009}$ = 37.3 crashes

PDO Crashes Inside Interchange:

$N_{expected,2009}$ = Total Crashes Inside Interchange – F+I Crashes Inside Interchange

$N_{expected,2009}$ = 25.2 crashes – 4.9 crashes

$N_{expected,2009}$ = 20.3 crashes

The following ***Expected*** annual number of crashes is calculated for each year:

Observed **Crash and Traffic Volume Data (from page 111)**

Year	Crashes Outside Interchange Area		Crashes Inside Interchange Area		Total Crashes by Severity			Annual Average Daily Traffic
	PDO	F + I	PDO	F + I	PDO	F + I	Total	
2009	36	7	26	6	62	13	75	41,000
2010	23	12	24	8	47	20	67	44,000
2011	44	11	22	4	66	15	81	44,000
2012	58	12	14	5	72	17	89	43,000

Source: HRTPO Analysis of VDOT data.
FAT = Number of crashes with at least one fatality. INJ = Number of crashes with at least one injury but no fatalities.
PDO = Number of crashes with property damage only. F+I = FAT + INJ crashes.

Expected **Crashes by Year Using the Empirical Bayes Method**
I-64 Eastbound between Yorktown Road and Fort Eustis Boulevard

Year	Outside Interchange			Inside Interchange			Segment Total		
	Total	F+I	PDO	Total	F+I	PDO	Total	F+I	PDO
2009	47.1	9.8	37.3	25.2	4.9	20.3	72.3	14.7	57.6
2010	48.8	10.6	38.2	25.1	5.2	19.9	73.9	15.8	58.1
2011	54.1	11.3	42.8	27.8	5.5	22.3	81.9	16.8	65.1
2012	52.3	10.3	42.0	27.2	5.1	22.2	79.5	15.4	64.1

Note: Totals in the above table may not be equal due to rounding.

FREEWAY EXAMPLE (CONTINUED)

Step 6 – Determine the Potential for Safety Improvement

The final step is to calculate the Potential for Safety Improvement, which is the difference between the number of ***Expected*** crashes and the number of adjusted ***Predicted*** crashes at each location.

The ***Expected*** crashes by year for I-64 Eastbound between Yorktown Road and Fort Eustis Boulevard using the Empirical Bayes method are as follows:

2009 – 72.3 crashes
2010 – 73.9 crashes
2011 – 81.9 crashes
2012 – 79.5 crashes
Average Annual ***Expected*** Crashes = 2009-2012 average = 76.9 crashes

The adjusted ***Predicted*** crashes by year for I-64 Eastbound between Yorktown Road and Fort Eustis Boulevard are as follows:

2009 – 38.6 crashes
2010 – 39.7 crashes
2011 – 44.0 crashes
2012 – 42.7 crashes
Average Annual Adjusted ***Predicted*** Crashes = 2009-2012 average = 41.3 crashes

The Potential for Safety Improvement = Average Annual ***Expected*** Crashes – Average Annual Adjusted ***Predicted*** Crashes

= 76.9 crashes – 41.3 crashes = ***+ 35.6 crashes***

This difference ranks the segment of I-64 Eastbound between Yorktown Road and Fort Eustis Boulevard 6th highest among the 218 freeway segments analyzed in the Hampton Roads Regional Safety Study. By comparison, this segment of freeway ranked 19th highest in the region in terms of the Equivalent Property Damage Only (EPDO) Crash Rate.

Intersection Example – Holland Road at Rosemont Road

HRTPO staff analyzed intersections in this study using methods and coefficients established in the Highway Safety Manual (HSM). The intersection example used in this appendix is Holland Road at Rosemont Road in Virginia Beach. The data used for the intersection example is shown below:

HSM Safety Performance Function Coefficients

Rural 2-lane SPF Coefficients

Site Subtype Description	Total Crashes a	b	c	k	% of F+I Crashes	% of PDO Crashes
Rural 2-Lane Crashes - 3 leg stop control	-9.86	0.79	0.49	0.54	41.5%	58.5%
Rural 2-Lane Crashes - 4 leg stop control	-8.56	0.60	0.61	0.24	43.1%	56.9%
Rural 2-Lane Crashes - 4 leg signal control	-5.13	0.60	0.20	0.11	34.0%	66.0%

Rural Multilane SPF Coefficients

Site Subtype Description	Total Crashes				F + I Crashes			
	a	b	c	k	a	b	c	k
Rural Multilane Crashes - 3 leg stop control	-12.53	1.20	0.24	0.46	-12.66	1.11	0.27	0.57
Rural Multilane Crashes - 4 leg stop control	-10.01	0.85	0.45	0.49	-11.55	0.89	0.53	0.74
Rural Multilane Crashes - 4 leg signal control	-7.18	0.72	0.34	0.28	-6.39	0.64	0.23	0.22

Urban Vehicle-Pedestrian SPF Coefficients

Site Subtype Description	Total Crashes a	b	c	d	e	k
Urban Vehicle-Ped Crashes - 3 leg stop control	--	--	--	--	--	--
Urban Vehicle-Ped Crashes - 3 leg signal control	-6.60	0.05	0.24	0.41	0.09	0.52
Urban Vehicle-Ped Crashes - 4 leg stop control	--	--	--	--	--	--
Urban Vehicle-Ped Crashes - 4 leg signal control	-9.53	0.40	0.26	0.45	0.04	0.24

Urban Single and Multi-Vehicle SPF Coefficients

Site Subtype Description	Total Crashes				F + I Crashes				PDO Crashes			
	a	b	c	k	a	b	c	k	a	b	c	k
Urban Multi-Vehicle - 3 leg stop control	-13.36	1.11	0.41	0.80	-14.01	1.16	0.30	0.69	-15.38	1.20	0.51	0.77
Urban Multi-Vehicle - 3 leg signal control	-12.13	1.11	0.26	0.33	-11.58	1.02	0.17	0.30	-13.24	1.14	0.30	0.36
Urban Multi-Vehicle - 4 leg stop control	-8.90	0.82	0.25	0.40	-11.13	0.93	0.28	0.48	-8.74	0.77	0.23	0.40
Urban Multi-Vehicle - 4 leg signal control	-10.99	1.07	0.23	0.39	-13.14	1.18	0.22	0.33	-11.02	1.02	0.24	0.44
Urban Single-Vehicle - 3 leg stop control	-6.81	0.16	0.51	1.14	--	--	--	--	-8.36	0.25	0.55	1.29
Urban Single-Vehicle - 3 leg signal control	-9.02	0.42	0.40	0.36	-9.75	0.27	0.51	0.24	-9.08	0.45	0.33	0.53
Urban Single-Vehicle - 4 leg stop control	-5.33	0.33	0.12	0.65	--	--	--	--	-7.04	0.36	0.25	0.54
Urban Single-Vehicle - 4 leg signal control	-10.21	0.68	0.27	0.36	-9.25	0.43	0.29	0.09	-11.34	0.78	0.25	0.44

Source: Highway Safety Manual. Coefficients used in this example are highlighted.
a, b, c, d, and e represent coefficients used in the Unadjusted "Predicted" Crashes equation. k represents the dispersion parameter used in the Empirical Bayes method equations.
-- represents cases where SPF models are not available. Equations from the HSM are used in their place.

Intersection Example Data – Holland Road at Rosemont Road

Intersection Type: 4 leg signalized intersection
Area Type: Urban
Daily Pedestrian Volume Crossing Intersection: 700 (Medium per HSM)
Maximum number of lanes crossed by pedestrian: 6 lanes

***Observed* Crash Data**

Year	Crashes Per Year PDO	F + I	TOTAL	F + I Multi	F + I Single	PDO Multi	PDO Single	Pedestrian	Bike
2009	23	25	48	25	0	21	2	0	0
2010	28	9	37	9	0	28	0	0	0
2011	20	19	39	18	0	20	0	1	0
2012	34	21	55	20	1	30	4	0	0

Source: HRTPO analysis of VDOT data. F + I equals Fatal plus Injury crashes.

Traffic Volume Data

Year	AADT Major	AADT Minor
2009	33,000	30,000
2010	34,000	31,000
2011	33,000	29,000
2012	34,000	29,000

Source: VDOT.

Intersection Example (continued)

Step 1 – Calculate the Unadjusted *Predicted* Number of Crashes

Calculate the unadjusted *Predicted* crashes for each intersection by year and severity, based on the Safety Performance Function equation and coefficients included in the Highway Safety Manual.

For urban roadways, separate SPF calculations are conducted to determine the predicted number of single-vehicle crashes, multi-vehicle crashes, vehicle-pedestrian crashes, and vehicle-bicyclist crashes.

For single and multi-vehicle crashes, the SPF provided by the HSM is as follows:

Predicted single and multi-vehicle crash frequency per year = exp [a + (b x ln(Major AADT)) + (c x ln(Minor AADT))]

For the intersection of Holland Road at Rosemont Road for the year 2009:

Multi-Vehicle Crashes:

2009 Unadjusted *Predicted* Multi-Vehicle F+I Crashes
= exp [a + (b x ln(Major AADT)) + (c x ln(Minor AADT))]
= exp [-13.14 + (1.18 x ln (33000)) + (0.22 x ln(30000))]
= exp (-13.14 + 12.28 + 2.27)
= 4.08 crashes

2009 Unadjusted *Predicted* Multi-Vehicle PDO Crashes
= exp [a + (b x ln(Major AADT)) + (c x ln(Minor AADT))]
= exp [-11.02 + (1.02 x ln (33000)) + (0.24 x ln(30000))]
= exp (-11.02 + 10.61 + 2.47)
= 7.90 crashes

2009 Unadjusted *Predicted* Total Multi-Vehicle Crashes
= Unadjusted *Predicted* Multi-Vehicle F+I Crashes + Unadjusted *Predicted* Multi-Vehicle PDO Crashes
= 4.08 crashes + 7.90 crashes = 11.97 crashes

Single-Vehicle Crashes:

2009 Unadjusted *Predicted* Single-Vehicle F+I Crashes
= exp [a + (b x ln(Major AADT)) + (c x ln(Minor AADT))]
= exp [-9.25 + (0.43 x ln (33000)) + (0.29 x ln(30000))]
= exp (-9.25 + 4.47 + 2.99)
= 0.17 crashes

2009 Unadjusted *Predicted* Single-Vehicle PDO Crashes
= exp [a + (b x ln(Major AADT)) + (c x ln(Minor AADT))]
= exp [-11.34 + (0.78 x ln (33000)) + (0.25 x ln(30000))]
= exp (-11.34 + 8.12 + 2.58)
= 0.52 crashes

2009 Unadjusted *Predicted* Total Single-Vehicle Crashes
= Unadjusted *Predicted* Single Vehicle F+I Crashes + Unadjusted *Predicted* Single Vehicle PDO Crashes
= 0.17 crashes + 0.52 crashes = 0.69 crashes

The HSM provides the following SPF for vehicle-pedestrian crashes:

Predicted vehicle-pedestrian crash frequency per year

$$= \exp\left[a + (b \times \ln(\text{Total AADT})) + \left(c \times \ln\left(\frac{\text{Minor AADT}}{\text{Major AADT}}\right)\right) + (d \times \ln(\text{PedVol})) + (e \times n_{lanes})\right]$$

For the intersection of Holland Road at Rosemont Road for the year 2009:

2009 Unadjusted *Predicted* Vehicle-Pedestrian Crashes
= exp [a + (b x ln(Total AADT)) + (c x ln(Minor AADT/Major AADT)) + (d x ln(PedVol)) + (e x n_{lanes})]

INTERSECTION EXAMPLE (CONTINUED)

= exp [-9.53 + (0.40 x ln(33000 + 30000)) + (0.26 x ln(30000/33000) + (0.45 x ln(700)) + (0.04 x 6)]
= exp (-9.53 + 4.42 – 0.02 + 2.95 + 0.24)
= 0.14 crashes

For vehicle-bicyclist crashes, rather than use SPFs, the HSM recommends factoring the total predicted number of crashes (excluding vehicle-pedestrian crashes) by a set coefficient based on the intersection type. These factors, based on research conducted for the HSM, are 0.016 for 3 leg stop control, 0.011 for 3 leg signal control, 0.018 for 4 leg stop control, and 0.015 for 4 leg signal control:

For the intersection of Holland Road at Rosemont Road for the year 2009:

2009 Unadjusted ***Predicted*** Vehicle-Bicyclist Crashes
= f_{bike} x Predicted Crashes (excluding vehicle-pedestrian crashes)
= 0.015 x (11.97 crashes + 0.69 crashes)
= 0.19 crashes

The total number of predicted crashes is calculated by adding the predicted multi-vehicle crashes, single-vehicle crashes, vehicle-pedestrian crashes, and vehicle-bicyclist crashes.

For the intersection of Holland Road at Rosemont Road for the year 2009:

2009 Unadjusted ***Predicted*** Total Crashes
= 2009 Unadjusted ***Predicted*** Total Multi-Vehicle Crashes + 2009 Unadjusted ***Predicted*** Total Single-Vehicle Crashes + 2009 Unadjusted ***Predicted*** Vehicle-Pedestrian Crashes + 2009 Unadjusted ***Predicted*** Vehicle-Bicyclist Crashes
= 11.97 crashes + 0.69 crashes + 0.14 crashes + 0.19 crashes
= 13.00 crashes

2009 Unadjusted ***Predicted*** F+I Crashes
= 2009 Unadjusted ***Predicted*** Multi-Vehicle F+I Crashes + 2009 Unadjusted ***Predicted*** Single-Vehicle F+I Crashes + 2009 Unadjusted ***Predicted*** Vehicle-Pedestrian Crashes + 2009 Unadjusted ***Predicted*** Vehicle-Bicyclist Crashes
= 4.08 crashes + 0.17 crashes + 0.14 crashes + 0.19 crashes
= 4.58 F+I crashes

2009 Unadjusted ***Predicted*** PDO Crashes
= 2009 Unadjusted ***Predicted*** Multi-Vehicle PDO Crashes + 2009 Unadjusted ***Predicted*** Single-Vehicle PDO Crashes
= 7.90 crashes + 0.52 crashes
= 8.42 PDO crashes

The following unadjusted ***Predicted*** crash values are calculated for each year:

Unadjusted *Predicted* Crashes by Year
Holland Road at Rosemont Road

Year	Crashes Per Year Total	F+I	PDO	F + I Multi	F + I Single	Pedestrian	Bike	PDO Multi	PDO Single
2009	13.00	4.58	8.42	4.08	0.17	0.14	0.19	7.90	0.52
2010	13.51	4.77	8.75	4.25	0.17	0.15	0.20	8.21	0.54
2011	12.89	4.54	8.35	4.05	0.17	0.14	0.19	7.83	0.52
2012	13.30	4.69	8.61	4.19	0.17	0.14	0.19	8.08	0.53

Note: Numbers are not necessarily equal due to rounding from each equation.

Intersection Example (continued)

Step 2 – Calculate Yearly Calibration Factors

The unadjusted ***Predicted*** crash values produced in Step 1 must be adjusted to account for local conditions and yearly variations in crash levels. To account for this, calibration factors are calculated for each year using the following steps:

1) Sum together the unadjusted ***Predicted*** crashes by year for every intersection of each intersection type. The results are shown below:

Unadjusted *Predicted* Crashes by Intersection Type and Year

Site Subtype Description	2009	2010	2011	2012
Rural 2-Lane Crashes - 3 leg stop control	44.41	46.17	43.52	42.98
Rural 2-Lane Crashes - 4 leg stop control	*	*	*	*
Rural 2-Lane Crashes - 4 leg signal control	*	*	*	*
Rural Multilane Crashes - 3 leg stop control	*	*	*	*
Rural Multilane Crashes - 4 leg stop control	*	*	*	*
Rural Multilane Crashes - 4 leg signal control	*	*	*	*
Urban - 3 leg stop control	112.92	119.32	118.89	116.37
Urban - 3 leg signal control	272.44	280.27	291.95	288.08
Urban - 4 leg stop control	53.29	56.29	56.73	55.73
Urban - 4 leg signal control	3311.44	3366.47	3484.11	3392.69

* Intersection types that do not have a large enough sample size to produce unique calibration factors.

2) Sum together the ***Observed*** number of crashes by year for each intersection type. The results are shown to the right:

Observed **Crashes by Intersection Type and Year**

Site Subtype Description	2009	2010	2011	2012
Rural 2-Lane Crashes - 3 leg stop control	22	32	26	17
Rural 2-Lane Crashes - 4 leg stop control	*	*	*	*
Rural 2-Lane Crashes - 4 leg signal control	*	*	*	*
Rural Multilane Crashes - 3 leg stop control	*	*	*	*
Rural Multilane Crashes - 4 leg stop control	*	*	*	*
Rural Multilane Crashes - 4 leg signal control	*	*	*	*
Urban - 3 leg stop control	82	65	80	87
Urban - 3 leg signal control	290	257	307	297
Urban - 4 leg stop control	57	50	58	41
Urban - 4 leg signal control	3,666	3,428	3,361	3,636

* Intersection types that do not have a large enough sample size to produce unique calibration factors.

3) Calculate yearly calibration factors for each intersection type by dividing the ***Observed*** number of crashes by the unadjusted ***Predicted*** number of crashes. The results are shown below:

Yearly Calibration Factors

Site Subtype Description	2009	2010	2011	2012
Rural 2-Lane Crashes - 3 leg stop control	0.495	0.693	0.597	0.396
Rural 2-Lane Crashes - 4 leg stop control	1	1	1	1
Rural 2-Lane Crashes - 4 leg signal control	1	1	1	1
Rural Multilane Crashes - 3 leg stop control	1	1	1	1
Rural Multilane Crashes - 4 leg stop control	1	1	1	1
Rural Multilane Crashes - 4 leg signal control	1	1	1	1
Urban - 3 leg stop control	0.726	0.545	0.673	0.748
Urban - 3 leg signal control	1.064	0.917	1.052	1.031
Urban - 4 leg stop control	1.070	0.888	1.022	0.736
Urban - 4 leg signal control	1.107	1.018	0.965	1.072

Calibration factors used in this example are highlighted.

INTERSECTION EXAMPLE (CONTINUED)

Step 3 – Calculate Adjusted *Predicted* Crashes

Using the yearly calibration factors calculated in the previous step, the unadjusted ***Predicted*** crash values that were produced in Step 1 were converted into adjusted ***Predicted*** crash values, based on the following equation:

Adjusted ***Predicted*** Crashes = Yearly Calibration Factor x Unadjusted ***Predicted*** Crashes.

Examples using 2009 data are as follows:

2009 Adjusted ***Predicted*** Total Crashes = 2009 Yearly Calibration Factor x 2009 Unadjusted ***Predicted*** Total Crashes

= 1.107 x 13.00 crashes = 14.39 crashes

2009 Adjusted ***Predicted*** F+I Crashes = 2009 Yearly Calibration Factor x 2009 Unadjusted ***Predicted*** F+I Crashes

= 1.107 x 4.58 crashes = 5.07 crashes

2009 Adjusted ***Predicted*** PDO Crashes = 2009 Yearly Calibration Factor x 2009 Unadjusted ***Predicted*** PDO Crashes

= 1.107 x 8.42 crashes = 9.32 crashes

The following adjusted ***Predicted*** crash values are calculated for each year:

Adjusted *Predicted* Crashes by Year
Holland Road at Rosemont Road

	Crashes Per Year			F + I	F + I	PDO	PDO		
Year	Total	F+I	PDO	Multi	Single	Multi	Single	Pedestrian	Bike
2009	14.39	5.07	9.32	4.51	0.19	8.74	0.58	0.16	0.21
2010	13.76	4.85	8.91	4.33	0.17	8.36	0.55	0.15	0.20
2011	12.44	4.38	8.06	3.90	0.16	7.56	0.50	0.14	0.18
2012	14.25	5.03	9.22	4.49	0.18	8.65	0.57	0.15	0.21

Note: Numbers are not necessarily equal due to rounding from each equation.

Step 4 – Calculate Annual Correction Factors

The yearly correction factors create a ratio of the adjusted ***Predicted*** number of crashes in a given year to the adjusted ***Predicted*** number of crashes in the first analysis year (2009) at each intersection, using the following equation:

Yearly Correction Factor = Adjusted ***Predicted*** Number of Crashes in a given year/Adjusted ***Predicted*** Number of Crashes in Year 1.

The following yearly correction factors are calculated for each year:

Yearly Correction Factors
Holland Road at Rosemont Road

	Yearly Correction Factors		
Year	Total	F+I	PDO
2009	1	1	1
2010	0.96	0.96	0.96
2011	0.87	0.86	0.86
2012	0.99	0.99	0.99

INTERSECTION EXAMPLE (CONTINUED)

Step 5 – Calculate *Expected* Crashes

The number of ***Expected*** crashes is calculated using the following steps:

1) Calculate the weights to be assigned through the Empirical Bayes method to the ***Observed*** and ***Predicted*** crashes by crash type and severity. Weights are calcuated for each intersection using the following formula:

w = 1 / [1 + (k x Sum of annual adjusted ***Predicted*** number of crashes)]

For the intersection of Holland Road at Rosemont Road:

F+I Multi-Vehicle Crashes:

$w_{F+I,Multi}$ = 1 / [1 + (k x Sum of annual adjusted ***Predicted*** number of crashes)]

$w_{F+I,Multi}$ = 1 / [1 + (0.33 x (4.51 + 4.33 + 3.90 + 4.49)] = 0.150

F+I Single-Vehicle Crashes:

$w_{F+I,Single}$ = 1 / [1 + (k x Sum of annual adjusted ***Predicted*** number of crashes)]

$w_{F+I,Single}$ = 1 / [1 + (0.09 x (0.19 + 0.17 + 0.16 + 0.18)] = 0.941

PDO Multi-Vehicle Crashes:

$w_{PDO,Multi}$ = 1 / [1 + (k x Sum of annual adjusted ***Predicted*** number of crashes)]

$w_{PDO,Multi}$ = 1 / [1 + (0.44 x (8.74 + 8.36 + 7.56 + 8.65)] = 0.064

PDO Single-Vehicle Crashes:

$w_{PDO,Single}$ = 1 / [1 + (k x Sum of annual adjusted ***Predicted*** number of crashes)]

$w_{PDO,Single}$ = 1 / [1 + (0.44 x (0.58 + 0.55 + 0.50 + 0.57)] = 0.508

Pedestrian Crashes:

w_{Ped} = 1 / [1 + (k x Sum of annual adjusted ***Predicted*** number of crashes)]

w_{Ped} = 1 / [1 + (0.24 x (0.16 + 0.15 + 0.14 + 0.15)] = 0.876

Bicyclist Crashes:

w_{Bike} = 1 / [1 + (k x Sum of annual adjusted ***Predicted*** number of crashes)]

w_{Bike} = 1 / [1 + (0 x (0.21 + 0.20 + 0.18 + 0.21)] = 1.000

2) Calculate the ***Expected*** annual number of crashes using the Empirical Bayes method. The ***Expected*** number of crashes, by crash type and severity, is calculated *for the first year* using the following equation:

Expected Number of Crashes = (w x Annual Adjusted ***Predicted*** Crashes) + [(1-w) x (Sum of Annual ***Observed*** Crashes)/(Sum of Yearly Correction Factors)]

Observed **Crash Data (from page 118)**

Year	Crashes Per Year PDO	Crashes Per Year F + I	Crashes Per Year TOTAL	F + I Multi	F + I Single	PDO Multi	PDO Single	Pedestrian	Bike
2009	23	25	48	25	0	21	2	0	0
2010	28	9	37	9	0	28	0	0	0
2011	20	19	39	18	0	20	0	1	0
2012	34	21	55	20	1	30	4	0	0

Source: HRTPO analysis of VDOT data. F + I equals Fatal plus Injury crashes.

For Holland Road at Rosemont Road for the year 2009:

F+I Multi-Vehicle Crashes:

$N_{expected,2009}$ = ($w_{F+I,Multi}$ x Annual Adjusted ***Predicted*** Crashes) + [(1 - $w_{F+I,Multi}$) x (Sum of Annual ***Observed*** Total Crashes)/(Sum of Yearly Correction Factors)]

Intersection Example (continued)

$N_{expected,2009}$ = (0.150 x 4.51 crashes) + [(1 – 0.150) x (25 + 9 + 18 + 20) / (1 + 0.96 + 0.86 + 0.99)]
$N_{expected,2009}$ = (0.150 x 4.51 crashes) + [(0.850) x (72) / (3.82)]
$N_{expected,2009}$ = 16.7 crashes

F+I Single-Vehicle Crashes:
$N_{expected,2009}$ = ($w_{F+I,Single}$ x Annual Adjusted ***Predicted*** Crashes) + [(1 - $w_{F+I,Single}$) x (Sum of Annual ***Observed*** Total Crashes)/(Sum of Yearly Correction Factors)]
$N_{expected,2009}$ = (0.941 x 0.19 crashes) + [(1 – 0.941) x (0 + 0 + 0 + 1) / (1 + 0.96 + 0.86 + 0.99)]
$N_{expected,2009}$ = (0.941 x 0.19 crashes) + [(0.059) x (1) / (3.82)]
$N_{expected,2009}$ = 0.19 crashes

PDO Multi-Vehicle Crashes:
$N_{expected,2009}$ = ($w_{PDO,Multi}$ x Annual Adjusted ***Predicted*** Crashes) + [(1 - $w_{PDO,Multi}$) x (Sum of Annual ***Observed*** Total Crashes)/(Sum of Yearly Correction Factors)]
$N_{expected,2009}$ = (0.064 x 8.74 crashes) + [(1 – 0.064) x (21 + 28 + 20 + 30) / (1 + 0.96 + 0.86 + 0.99)]
$N_{expected,2009}$ = (0.064 x 8.74 crashes) + [(0.936) x (99) / (3.81)]
$N_{expected,2009}$ = 24.9 crashes

PDO Single-Vehicle Crashes:
$N_{expected,2009}$ = ($w_{PDO,Single}$ x Annual Adjusted ***Predicted*** Crashes) + [(1 - $w_{PDO,Single}$) x (Sum of Annual ***Observed*** Total Crashes)/(Sum of Yearly Correction Factors)]
$N_{expected,2009}$ = (0.508 x 0.58 crashes) + [(1 – 0.508) x (2 + 0 + 0 + 4) / (1 + 0.96 + 0.86 + 0.99)]
$N_{expected,2009}$ = (0.508 x 0.58 crashes) + [(0.492) x (6) / (3.81)]
$N_{expected,2009}$ = 1.1 crashes

Pedestrian Crashes:
$N_{expected,2009}$ = (w_{Ped} x Annual Adjusted ***Predicted*** Crashes) + [(1 - w_{Ped}) x (Sum of Annual ***Observed*** Total Crashes)/(Sum of Yearly Correction Factors)]
$N_{expected,2009}$ = (0.876 x 0.16 crashes) + [(1 – 0.876) x (0 + 0 + 1 + 0) / (1 + 0.96 + 0.86 + 0.99)]
$N_{expected,2009}$ = (0.876 x 0.16 crashes) + [(0.124) x (1) / (3.82)]
$N_{expected,2009}$ = 0.2 crashes

Bicyclist Crashes:
$N_{expected,2009}$ = (w_{Bike} x Annual Adjusted ***Predicted*** Crashes) + [(1 - w_{Bike}) x (Sum of Annual ***Observed*** Total Crashes)/(Sum of Yearly Correction Factors)]
$N_{expected,2009}$ = (1.000 x 0.21 crashes) + [(1 – 1.000) x (0 + 0 + 0 + 0) / (1 + 0.96 + 0.86 + 0.99)]
$N_{expected,2009}$ = (1.000 x 0.21 crashes) + [(0.0) x (0) / (3.82)]
$N_{expected,2009}$ = 0.2 crashes

For subsequent years, the ***Expected*** annual number of crashes, by crash type and severity, is calculated using the following equation:

Expected Number of Crashes = (***Expected*** Number of Crashes in Year 1 x Yearly Correction Factor)

The following ***Expected*** number of crashes is calculated for each year:

***Expected* Crashes by Year Using the Empirical Bayes Method**
Holland Road at Rosemont Road

Year	Crashes Per Year Total	Crashes Per Year F+I	Crashes Per Year PDO	F + I Multi	F + I Single	PDO Multi	PDO Single	Pedestrian	Bike
2009	43.3	17.3	26.0	16.7	0.2	24.9	1.1	0.2	0.2
2010	41.4	16.6	24.8	16.0	0.2	23.8	1.0	0.2	0.2
2011	37.4	15.0	22.4	14.5	0.2	21.5	0.9	0.2	0.2
2012	42.9	17.2	25.7	16.6	0.2	24.6	1.1	0.2	0.2

Note: Numbers are not necessarily equal due to rounding from each equation.

Intersection Example (continued)

Step 6 – Determine the Potential for Safety Improvement

The final step is to calculate the Potential for Safety Improvement, which is the difference between the number of ***Expected*** crashes and the number of adjusted ***Predicted*** crashes at each location.

The ***Expected*** crashes by year for the intersection of Holland Road and Rosemont Road using the Empirical Bayes method are as follows:

2009 – 43.3 crashes
2010 – 41.4 crashes
2011 – 37.4 crashes
2012 – 42.9 crashes
Average Annual ***Expected*** Crashes = 2009-2012 average = 41.2 crashes

The adjusted ***Predicted*** crashes by year for the intersection of Holland Road at Rosemont Road are as follows:

2009 – 14.4 crashes
2010 – 13.8 crashes
2011 – 12.4 crashes
2012 – 14.3 crashes
Average Annual Adjusted ***Predicted*** Crashes = 2009-2012 average = 13.7 crashes

The Potential for Safety Improvement = Average Annual ***Expected*** Crashes – Average Annual Adjusted ***Predicted*** Crashes

= 41.2 crashes – 13.7 crashes = ***+ 27.5 crashes***

This difference ranks the intersection of Holland Road at Rosemont Road highest among the 597 intersections analyzed in the Hampton Roads Regional Safety Study. This intersection also ranked highest in the region in terms of the annual number of crashes and the Equivalent Property Damage Only (EPDO) Crash Rate.

Appendix C – Potential for Safety Improvement - Freeways

Juris-diction	Facility	Segment From	Segment To	Dir	Distance (miles)	Average Annual Observed Crashes (2009-2012) PDO	INJ	FAT	Total	2009 Expected Total Crashes	2009 Adjusted Predicted Crashes	2010 Expected Total Crashes	2010 Adjusted Predicted Crashes	2011 Expected Total Crashes	2011 Adjusted Predicted Crashes	2012 Expected Total Crashes	2012 Adjusted Predicted Crashes	Average Annual Expected Total Crashes	Average Annual Adjusted Predicted Crashes	Potential for Safety Improvement
JCC	I-64	NEW KENT CL	RTE 30	EB	2.69	4.0	2.0	0.0	6.0	6.31	9.94	6.15	9.69	5.92	9.33	7.80	12.29	6.54	10.31	-3.77
JCC	I-64	NEW KENT CL	RTE 30	WB		6.3	2.8	0.0	9.0	8.93	9.97	8.43	9.41	8.38	9.35	10.71	11.95	9.11	10.17	-1.06
JCC	I-64	RTE 30	CROAKER RD (RTE 607)	EB	4.34	10.3	6.0	0.0	16.3	15.95	17.97	15.11	17.02	15.01	16.91	19.72	22.21	16.44	18.53	-2.08
JCC	I-64	RTE 30	CROAKER RD (RTE 607)	WB		8.5	6.3	0.0	14.8	14.67	17.70	13.89	16.77	13.80	16.66	17.63	21.28	15.00	18.10	-3.10
JCC/YC	I-64	CROAKER RD (RTE 607)	RTE 199/646	EB	2.79	5.0	5.0	0.3	10.3	10.06	12.42	9.80	12.10	9.74	12.02	12.77	15.76	10.59	13.08	-2.48
JCC/YC	I-64	CROAKER RD (RTE 607)	RTE 199/646	WB		4.0	4.0	0.3	8.3	8.34	12.26	8.34	12.27	8.07	11.87	10.59	15.57	8.84	12.99	-4.16
YC	I-64	RTE 199/646	RTE 143	EB	4.29	10.3	9.5	0.3	20.0	18.62	16.96	18.64	16.97	18.02	16.41	23.02	20.97	19.57	17.83	1.75
YC	I-64	RTE 199/646	RTE 143	WB		12.5	8.0	0.5	21.0	19.64	17.38	19.13	16.93	19.00	16.82	24.95	22.08	20.68	18.30	2.38
YC	I-64	RTE 143	RTE 199 (EAST OF WILLIAMSBURG)	EB	3.88	16.3	10.3	0.3	26.8	23.64	16.18	24.28	16.60	24.12	16.49	30.02	20.54	25.52	17.45	8.06
YC	I-64	RTE 143	RTE 199 (EAST OF WILLIAMSBURG)	WB		11.8	9.0	0.0	20.8	18.97	15.22	19.00	15.24	18.88	15.14	24.12	19.35	20.24	16.24	4.00
YC	I-64	RTE 199 (EAST OF WILLIAMSBURG)	GROVE CONNECTOR	EB	1.14	11.3	6.3	0.0	17.5	18.01	19.21	16.22	17.30	17.97	19.16	17.49	18.57	17.42	18.56	-1.14
YC	I-64	RTE 199 (EAST OF WILLIAMSBURG)	GROVE CONNECTOR	WB		10.3	3.8	0.0	14.0	14.02	16.37	13.17	15.39	14.59	17.05	14.76	17.25	14.13	16.52	-2.38
YC/JCC/NN	I-64	GROVE CONNECTOR	RTE 143 (NORTH)	EB	3.50	26.3	11.3	0.0	37.5	35.59	46.74	36.65	48.48	38.87	51.29	39.33	51.90	37.61	49.60	-11.99
YC/JCC/NN	I-64	GROVE CONNECTOR	RTE 143 (NORTH)	WB		45.5	17.0	0.0	62.5	58.23	50.62	60.15	52.34	66.64	57.98	64.49	56.09	62.38	54.26	8.12
NN	I-64	RTE 143 (NORTH)	YORKTOWN RD	EB	0.88	12.3	5.0	0.3	17.5	16.74	12.72	16.47	12.58	17.47	13.31	17.68	13.47	17.09	13.02	4.07
NN	I-64	RTE 143 (NORTH)	YORKTOWN RD	WB		9.5	4.5	0.3	14.3	14.54	12.90	13.09	11.62	14.50	12.87	14.68	13.02	14.20	12.60	1.60
NN	I-64	YORKTOWN RD	FORT EUSTIS BLVD	EB	2.45	61.8	16.3	0.0	78.0	72.34	38.61	73.91	39.74	81.88	44.03	79.52	42.66	76.91	41.26	35.65
NN	I-64	YORKTOWN RD	FORT EUSTIS BLVD	WB		27.5	11.5	0.0	39.0	37.67	40.41	36.81	39.74	40.78	44.03	39.63	42.66	38.73	41.71	-2.99
NN	I-64	FORT EUSTIS BLVD	JEFFERSON AVE	EB	4.86	54.0	18.5	0.3	72.8	66.58	90.71	69.91	96.32	77.45	106.70	75.51	103.75	72.36	99.37	-27.00
NN	I-64	FORT EUSTIS BLVD	JEFFERSON AVE	WB		73.5	31.0	0.3	104.8	107.84	98.66	97.10	88.83	107.57	98.41	104.56	95.53	104.27	95.36	8.91
NN	I-64	JEFFERSON AVE	OYSTER POINT RD	EB	1.60	8.0	4.5	0.3	12.8	12.47	31.04	13.53	33.13	13.23	32.39	13.58	33.37	13.20	32.48	-19.28
NN	I-64	JEFFERSON AVE	OYSTER POINT RD	WB		31.8	16.0	0.3	48.0	46.08	31.75	48.02	32.88	46.94	32.15	48.26	33.15	47.33	32.48	14.84
NN	I-64	OYSTER POINT RD	J C MORRIS BLVD	EB	1.64	9.3	4.3	0.0	13.5	14.07	37.06	14.19	37.37	13.66	36.09	14.05	37.25	13.99	36.94	-22.95
NN	I-64	OYSTER POINT RD	J C MORRIS BLVD	WB		10.8	7.5	0.5	18.8	19.30	37.02	19.12	36.86	18.69	36.03	19.18	37.16	19.07	36.77	-17.69
NN/HAM	I-64	J C MORRIS BLVD	HRC PARKWAY	EB	3.14	26.5	13.8	0.0	40.3	37.90	70.45	41.78	76.74	40.85	75.02	41.77	76.94	40.57	74.79	-34.22
NN/HAM	I-64	J C MORRIS BLVD	HRC PARKWAY	WB		28.5	13.0	0.8	42.3	41.54	71.75	42.85	73.65	41.89	72.00	43.29	74.58	42.39	72.99	-30.60
HAM	I-64	HRC PARKWAY	MAGRUDER BLVD	EB	0.77	4.0	2.3	0.0	6.3	6.58	17.29	6.90	18.10	6.75	17.69	6.96	18.26	6.80	17.83	-11.03
HAM	I-64	HRC PARKWAY	MAGRUDER BLVD	WB		5.0	1.8	0.0	6.8	6.98	16.49	7.40	17.40	7.15	16.82	7.37	17.38	7.22	17.02	-9.80
HAM	I-64	MAGRUDER BLVD	MERCURY BLVD	EB	1.04	12.0	5.5	0.0	17.5	17.36	29.65	18.37	31.19	17.67	30.07	18.18	30.98	17.89	30.47	-12.58
HAM	I-64	MAGRUDER BLVD	MERCURY BLVD	WB		13.8	6.8	0.0	20.5	20.22	28.12	21.00	29.07	20.53	28.41	21.14	29.33	20.72	28.73	-8.01
HAM	I-64	MERCURY BLVD	I-664	EB	0.96	13.0	8.5	0.0	21.5	20.77	22.75	21.79	23.67	21.30	23.14	21.68	23.68	21.39	23.31	-1.93
HAM	I-64	MERCURY BLVD	I-664	WB		12.3	5.5	0.0	17.8	17.46	25.05	18.39	26.32	17.98	25.73	18.25	26.17	18.02	25.82	-7.80
HAM	I-64	I-664	ARMISTEAD AVE	EB	0.88	15.3	7.3	0.0	22.5	21.61	16.15	22.56	16.86	20.82	15.56	24.12	18.03	22.28	16.65	5.63
HAM	I-64	I-664	ARMISTEAD AVE	WB		9.5	3.3	0.0	12.8	11.21	15.34	13.73	18.77	12.36	16.89	14.32	19.58	12.91	17.64	-4.74
HAM	I-64	ARMISTEAD AVE	SETTLERS LANDING RD	EB	2.01	37.5	17.3	0.0	54.8	53.82	21.47	51.10	20.38	45.98	18.33	54.64	21.79	51.39	20.49	30.89
HAM	I-64	ARMISTEAD AVE	SETTLERS LANDING RD	WB		15.3	9.3	0.0	24.5	24.91	28.20	21.81	24.68	24.16	27.34	26.75	30.27	24.41	27.62	-3.22
HAM	I-64	SETTLERS LANDING RD	MALLORY ST	EB	0.54	19.0	5.5	0.0	24.5	23.19	6.80	22.04	6.46	20.52	6.02	24.39	7.15	22.54	6.61	15.93
HAM	I-64	SETTLERS LANDING RD	MALLORY ST	WB		5.8	1.3	0.0	7.0	7.32	8.19	7.22	8.07	6.49	7.26	7.47	8.36	7.13	7.97	-0.85
HAM/NOR	I-64/HRBT	MALLORY ST	OCEAN VIEW AVE	EB	3.88	103.8	31.0	0.3	135.0	140.00	69.03	115.16	56.75	139.65	68.85	141.32	69.68	134.03	66.08	67.95
HAM/NOR	I-64/HRBT	MALLORY ST	OCEAN VIEW AVE	WB		73.0	34.0	0.0	107.0	114.35	68.69	98.38	59.10	108.98	65.47	105.27	63.24	106.74	64.12	42.62
NOR	I-64	OCEAN VIEW AVE	4TH VIEW AVE	EB	1.82	11.3	5.3	0.0	16.5	16.79	29.84	15.12	26.87	16.75	29.76	17.70	31.51	16.59	29.50	-12.90
NOR	I-64	OCEAN VIEW AVE	4TH VIEW AVE	WB		37.0	18.0	0.0	55.0	54.55	31.22	51.33	29.38	54.41	31.14	57.54	32.93	54.46	31.17	23.29
NOR	I-64	4TH VIEW AVE	BAY AVE	EB	1.01	6.8	2.3	0.0	9.0	8.96	13.90	8.07	12.52	8.94	13.87	10.88	16.92	9.21	14.30	-5.09
NOR	I-64	4TH VIEW AVE	BAY AVE	WB		26.0	12.8	0.0	38.8	37.44	13.82	35.38	13.06	37.34	13.78	39.66	14.65	37.46	13.83	23.63
NOR	I-64	BAY AVE	I-564/LITTLE CREEK RD	EB	1.81	25.8	10.3	0.3	36.3	35.38	31.55	31.86	28.41	35.29	31.47	42.06	37.55	36.15	32.24	3.90
NOR	I-64	BAY AVE	I-564/LITTLE CREEK RD	WB		22.0	11.0	0.0	33.0	32.91	29.90	30.96	28.15	32.83	29.83	34.71	31.56	32.85	29.86	2.99
NOR	I-64 REV	I-564/LITTLE CREEK RD	TIDEWATER DR	R		3.5	0.8	0.0	4.3	4.19	4.79	3.77	4.31	4.58	5.24	4.64	5.30	4.30	4.91	-0.61
NOR	I-64	I-564/LITTLE CREEK RD	TIDEWATER DR	EB	1.17	11.0	5.3	0.0	16.3	16.30	20.42	16.10	20.24	16.08	20.13	16.80	21.03	16.32	20.45	-4.13
NOR	I-64	I-564/LITTLE CREEK RD	TIDEWATER DR	WB		20.3	10.0	0.3	30.5	31.00	24.89	31.87	25.57	30.56	24.54	27.71	22.40	30.29	24.35	5.93
NOR	I-64 REV	TIDEWATER DR	CHESAPEAKE BLVD	R		4.5	1.8	0.0	6.3	5.51	4.26	6.14	4.74	6.02	4.66	6.88	5.31	6.14	4.74	1.39
NOR	I-64	TIDEWATER DR	CHESAPEAKE BLVD	EB	1.04	12.3	5.3	0.3	17.8	17.27	18.00	18.03	18.79	17.49	18.24	18.29	19.05	17.77	18.52	-0.75
NOR	I-64	TIDEWATER DR	CHESAPEAKE BLVD	WB		20.5	7.3	0.3	28.0	27.70	18.20	28.17	18.50	24.72	16.24	29.38	19.30	27.49	18.06	9.43

Source: HRTPO analysis of VDOT data. Includes an analysis of VDOT data using VCTIR methods.

FAT = Number of crashes with at least one fatality. INJ = Number of crashes with at least one injury but no fatalities. PDO = Number of crashes with property damage only. F+I = FAT + INJ crashes.

Appendix C (continued) – Potential for Safety Improvement - Freeways

Juris-diction	Facility	Segment From	Segment To	Dir	Distance (miles)	Average Annual Observed Crashes (2009-2012) PDO	INJ	FAT	Total	2009 Expected Total Crashes	2009 Adjusted Predicted Crashes	2010 Expected Total Crashes	2010 Adjusted Predicted Crashes	2011 Expected Total Crashes	2011 Adjusted Predicted Crashes	2012 Expected Total Crashes	2012 Adjusted Predicted Crashes	Average Annual Expected Total Crashes	Average Annual Adjusted Predicted Crashes	Potential for Safety Improvement
NOR	I-64 REV	CHESAPEAKE BLVD	NORVIEW AVE	R	0.97	0.5	0.3	0.0	0.8	1.01	3.97	0.91	3.57	1.11	4.34	1.12	4.39	1.04	4.07	-3.03
NOR	I-64	CHESAPEAKE BLVD	NORVIEW AVE	EB		14.0	10.0	0.5	24.5	25.16	20.06	26.14	20.84	21.06	16.79	24.46	19.50	24.20	19.30	4.91
NOR	I-64	CHESAPEAKE BLVD	NORVIEW AVE	WB		12.3	7.3	0.0	19.5	21.32	22.78	16.91	18.06	19.11	20.41	20.82	22.24	19.54	20.88	-1.33
NOR	I-64 REV	NORVIEW AVE	MILITARY HWY	R	1.22	0.0	0.0	0.0	0.0	0.35	4.99	0.31	4.50	0.38	5.46	0.39	5.53	0.36	5.12	-4.76
NOR	I-64	NORVIEW AVE	MILITARY HWY	EB		15.8	6.5	0.3	22.5	22.51	29.49	23.79	31.18	23.48	30.78	20.28	26.53	22.52	29.49	-6.98
NOR	I-64	NORVIEW AVE	MILITARY HWY	WB		17.8	7.3	0.3	25.3	25.35	26.32	25.78	26.76	22.71	23.58	26.99	28.02	25.21	26.17	-0.96
NOR	I-64 REV	MILITARY HWY	NORTHAMPTON BLVD	R	1.07	0.0	0.0	0.0	0.0	0.35	4.38	0.31	3.94	0.38	4.79	0.38	4.85	0.35	4.49	-4.14
NOR	I-64	MILITARY HWY	NORTHAMPTON BLVD	EB		8.8	6.5	0.3	15.5	15.44	17.63	16.08	18.38	15.53	17.75	15.16	17.32	15.55	17.77	-2.22
NOR	I-64	MILITARY HWY	NORTHAMPTON BLVD	WB		19.3	9.5	0.3	29.0	28.58	25.08	29.67	26.05	26.15	22.95	31.07	27.27	28.87	25.34	3.53
NOR	I-64 REV	NORTHAMPTON BLVD	I-264	R	2.12	2.0	1.0	0.0	3.0	3.16	8.68	2.85	7.81	3.46	9.49	3.50	9.60	3.24	8.90	-5.65
NOR	I-64	NORTHAMPTON BLVD	I-264	EB		127.5	53.5	0.0	181.0	172.71	50.36	175.83	51.34	179.93	52.86	188.01	55.23	179.12	52.45	126.67
NOR	I-64	NORTHAMPTON BLVD	I-264	WB		37.3	16.8	0.3	54.3	54.16	55.61	54.15	55.48	53.40	54.83	55.80	57.29	54.38	55.81	-1.43
NOR/VB	I-64	I-264	INDIAN RIVER RD	EB	2.50	30.8	14.0	0.0	44.8	46.22	57.53	45.08	56.43	43.07	54.12	44.49	56.01	44.71	56.02	-11.31
NOR/VB	I-64	I-264	INDIAN RIVER RD	WB		52.3	31.3	0.0	83.5	82.80	54.27	83.51	54.74	81.64	53.51	84.52	55.38	83.12	54.47	28.64
VB/CHES	I-64	INDIAN RIVER RD	GREENBRIER PKWY	EB	2.66	16.3	8.3	0.0	24.5	25.23	56.70	25.74	57.79	23.41	52.94	25.38	57.18	24.94	56.15	-31.21
VB/CHES	I-64	INDIAN RIVER RD	GREENBRIER PKWY	WB		12.5	11.8	0.0	24.3	24.14	52.70	25.04	54.42	24.14	52.58	25.22	54.94	24.63	53.66	-29.02
CHES	I-64	GREENBRIER PKWY	BATTLEFIELD BLVD	EB	1.42	18.0	9.8	0.0	27.8	26.62	22.22	27.41	22.84	27.91	23.16	28.00	23.33	27.49	22.89	4.60
CHES	I-64	GREENBRIER PKWY	BATTLEFIELD BLVD	WB		8.8	5.5	0.0	14.3	15.21	26.37	15.07	26.19	15.00	26.00	12.96	23.06	14.56	25.41	-10.84
CHES	I-64	BATTLEFIELD BLVD	I-464	EB	1.08	33.8	12.8	0.0	46.5	44.29	20.96	44.67	21.14	46.64	22.08	46.40	21.96	45.50	21.53	23.97
CHES	I-64	BATTLEFIELD BLVD	I-464	WB		8.0	3.8	0.0	11.8	12.04	20.62	12.14	20.80	11.87	20.33	12.40	21.25	12.11	20.75	-8.64
CHES	I-64	I-464	GEORGE WASHINGTON HWY	EB	4.38	46.3	18.0	0.8	65.0	68.63	65.31	58.94	56.01	68.46	65.14	62.94	59.74	64.74	61.55	3.19
CHES	I-64	I-464	GEORGE WASHINGTON HWY	WB		35.8	15.0	0.5	51.3	52.97	59.06	42.99	47.92	50.20	55.97	59.00	65.81	51.29	57.19	-5.90
CHES	I-64	GEORGE WASHINGTON HWY	MILITARY HWY	EB	1.53	8.3	3.8	0.3	12.3	13.10	19.56	11.79	17.61	13.06	19.51	11.94	17.82	12.47	18.62	-6.15
CHES	I-64	GEORGE WASHINGTON HWY	MILITARY HWY	WB		12.0	6.5	0.0	18.5	19.69	18.59	17.73	16.74	17.64	16.69	18.85	17.82	18.48	17.46	1.01
CHES	I-64	MILITARY HWY	I-264&664	EB	2.31	8.5	4.0	0.3	12.8	13.46	29.52	12.74	27.92	13.42	29.44	12.90	28.33	13.13	28.80	-15.67
CHES	I-64	MILITARY HWY	I-264&664	WB		12.0	5.3	0.3	17.5	19.33	29.15	16.54	24.93	17.39	26.19	17.60	26.51	17.72	26.69	-8.98
CHES/PORT	I-264	I-64&664	GREENWOOD DR	EB	1.65	2.0	4.0	0.0	6.0	6.69	13.47	6.02	12.13	6.24	12.61	6.32	12.76	6.32	12.74	-6.43
CHES/PORT	I-264	I-64&664	GREENWOOD DR	WB		4.0	2.8	0.0	6.8	7.19	13.47	6.93	12.89	6.69	12.61	7.26	13.60	7.02	13.14	-6.12
PORT	I-264	GREENWOOD DR	VICTORY BLVD	EB	1.31	4.8	2.8	0.3	7.8	8.29	9.48	7.47	8.53	7.73	8.82	7.83	8.93	7.83	8.94	-1.11
PORT	I-264	GREENWOOD DR	VICTORY BLVD	WB		10.0	4.0	0.0	14.0	14.48	10.06	13.04	9.06	13.53	9.39	13.70	9.50	13.69	9.50	4.18
PORT	I-264	VICTORY BLVD	PORTSMOUTH BLVD	EB	0.75	3.3	0.3	0.0	3.5	3.75	5.51	3.82	5.61	3.44	5.04	4.08	5.99	3.77	5.54	-1.77
PORT	I-264	VICTORY BLVD	PORTSMOUTH BLVD	WB		3.0	2.0	0.3	5.3	5.36	5.37	5.19	5.20	4.67	4.68	5.83	5.84	5.26	5.27	-0.01
PORT	I-264	PORTSMOUTH BLVD	FREDERICK BLVD	EB	0.91	3.3	1.8	0.0	5.0	5.27	7.39	5.36	7.51	4.82	6.76	5.47	7.67	5.23	7.33	-2.10
PORT	I-264	PORTSMOUTH BLVD	FREDERICK BLVD	WB		3.5	3.8	0.0	7.3	7.37	8.05	7.83	8.55	6.45	7.04	7.66	8.36	7.33	8.00	-0.67
PORT	I-264	FREDERICK BLVD	DES MOINES AVE	EB	0.96	9.8	4.3	0.0	14.0	13.38	9.15	14.14	9.67	12.25	8.37	14.55	9.95	13.58	9.28	4.30
PORT	I-264	FREDERICK BLVD	DES MOINES AVE	WB		6.3	5.0	0.0	11.3	11.18	9.82	11.37	9.99	9.83	8.64	12.15	10.68	11.13	9.79	1.35
PORT	I-264	DES MOINES AVE	EFFINGHAM ST	EB	0.72	13.3	9.0	0.0	22.3	20.03	6.20	21.23	6.57	18.33	5.67	21.78	6.74	20.34	6.29	14.05
PORT	I-264	DES MOINES AVE	EFFINGHAM ST	WB		3.8	2.3	0.0	6.0	6.03	6.63	6.39	7.02	5.29	5.81	6.55	7.21	6.06	6.67	-0.60
PORT/NOR	I-264/DOWNTOWN TUNNEL	EFFINGHAM ST	I-464	EB	1.12	44.0	22.0	0.0	66.0	66.27	20.17	57.17	17.38	66.10	20.11	66.89	20.36	64.11	19.50	44.60
PORT/NOR	I-264/DOWNTOWN TUNNEL	EFFINGHAM ST	I-464	WB		28.8	15.3	0.5	44.5	45.96	23.85	39.83	20.64	44.12	22.87	44.65	23.14	43.64	22.63	21.01
NOR	I-264/BERKLEY BRIDGE	I-464	WATERSIDE/CITY HALL/TIDEWATER	EB	0.72	24.8	15.3	0.0	40.0	39.00	14.99	38.85	14.84	37.52	14.24	38.71	14.60	38.52	14.66	23.86
NOR	I-264/BERKLEY BRIDGE	I-464	WATERSIDE/CITY HALL/TIDEWATER	WB		24.3	15.3	0.0	39.5	40.64	14.09	40.12	13.87	35.31	12.04	36.90	12.58	38.24	13.14	25.10
NOR	I-264	WATERSIDE/CITY HALL/TIDEWATER	BRAMBLETON AVE	EB	0.91	9.8	5.0	0.0	14.8	15.40	17.86	15.15	17.61	14.45	16.83	14.71	17.18	14.93	17.37	-2.44
NOR	I-264	WATERSIDE/CITY HALL/TIDEWATER	BRAMBLETON AVE	WB		12.0	9.5	0.0	21.5	20.73	15.50	20.91	15.63	20.44	15.28	21.36	15.96	20.86	15.59	5.27
NOR	I-264	BRAMBLETON AVE	BALLENTINE BLVD	EB	0.85	9.8	7.5	0.0	17.3	17.54	18.31	17.43	18.21	16.79	17.56	17.29	18.09	17.26	18.04	-0.78
NOR	I-264	BRAMBLETON AVE	BALLENTINE BLVD	WB		13.3	10.8	0.0	24.0	23.31	17.93	23.50	18.09	22.98	17.68	23.60	18.25	23.35	17.99	5.36
NOR	I-264	BALLENTINE BLVD	MILITARY HWY	EB	2.43	29.8	19.3	0.3	49.3	49.50	49.10	49.27	49.01	47.54	47.41	49.02	49.01	48.83	48.63	0.20
NOR	I-264	BALLENTINE BLVD	MILITARY HWY	WB		23.0	22.0	0.3	45.3	44.97	49.30	44.78	49.23	43.78	48.13	45.74	50.29	44.82	49.24	-4.42
NOR	I-264	MILITARY HWY	I-64	EB	0.78	13.3	7.8	0.0	21.0	20.78	18.86	20.96	19.02	20.49	18.59	21.41	19.43	20.91	18.97	1.93
NOR	I-264	MILITARY HWY	I-64	WB		10.0	5.5	0.3	15.8	15.80	18.95	15.94	19.11	15.58	18.68	16.28	19.52	15.90	19.06	-3.16

Source: HRTPO analysis of VDOT data. Includes an analysis of VDOT data using VCTIR methods.
FAT = Number of crashes with at least one fatality. INJ = Number of crashes with at least one injury but no fatalities. PDO = Number of crashes with property damage only. F+I = FAT + INJ crashes.

APPENDIX C (CONTINUED) – POTENTIAL FOR SAFETY IMPROVEMENT - FREEWAYS

Juris-diction	Facility	Segment From	Segment To	Dir	Distance (miles)	Average Annual Observed Crashes (2009-2012) PDO	INJ	FAT	Total	2009 Expected Total Crashes	2009 Adjusted Predicted Crashes	2010 Expected Total Crashes	2010 Adjusted Predicted Crashes	2011 Expected Total Crashes	2011 Adjusted Predicted Crashes	2012 Expected Total Crashes	2012 Adjusted Predicted Crashes	Average Annual Expected Total Crashes	Average Annual Adjusted Predicted Crashes	Potential for Safety Improvement
NOR	I-264	I-64	NEWTOWN RD/WCL VA. BEACH	EB	0.74	18.0	12.0	0.0	30.0	30.15	27.41	29.64	26.91	29.73	27.03	29.89	27.11	29.85	27.11	2.73
NOR	I-264	I-64	NEWTOWN RD/WCL VA. BEACH	WB		45.8	19.0	0.3	65.0	64.02	25.15	63.23	24.80	62.47	24.52	64.59	25.33	63.58	24.95	38.63
VB	I-264	NEWTOWN RD/ECL NORFOLK	WITCHDUCK RD	EB	1.47	42.8	29.0	0.0	71.8	71.31	38.33	70.94	38.10	70.31	37.79	71.97	38.63	71.13	38.22	32.91
VB	I-264	NEWTOWN RD/ECL NORFOLK	WITCHDUCK RD	WB		41.0	23.8	0.5	65.3	65.47	49.80	64.58	49.10	63.84	48.55	65.97	50.16	64.96	49.40	15.56
VB	I-264	WITCHDUCK RD	INDEPENDENCE BLVD	EB	1.27	35.5	19.0	0.0	54.5	53.52	34.48	53.06	34.20	53.67	34.56	55.61	35.82	53.97	34.77	19.20
VB	I-264	WITCHDUCK RD	INDEPENDENCE BLVD	WB		31.8	25.8	0.3	57.8	56.93	36.44	56.41	36.08	57.12	36.59	58.65	37.54	57.28	36.66	20.61
VB	I-264	INDEPENDENCE BLVD	ROSEMONT RD	EB	2.36	28.5	13.5	0.0	42.0	42.12	56.36	42.48	56.85	41.09	55.04	42.94	57.51	42.16	56.44	-14.28
VB	I-264	INDEPENDENCE BLVD	ROSEMONT RD	WB		23.0	14.8	0.0	37.8	38.21	54.09	38.10	54.01	37.25	52.80	38.03	54.08	37.90	53.75	-15.85
VB	I-264	ROSEMONT RD	LYNNHAVEN PKWY	EB	1.72	18.5	11.8	0.0	30.3	31.08	37.90	30.67	37.38	29.65	36.14	30.29	36.90	30.42	37.08	-6.66
VB	I-264	ROSEMONT RD	LYNNHAVEN PKWY	WB		13.5	10.0	0.3	23.8	23.81	37.72	24.02	38.04	23.15	36.79	24.53	38.86	23.88	37.85	-13.97
VB	I-264	LYNNHAVEN PKWY	LASKIN RD	EB	1.48	20.8	12.0	0.3	33.0	33.82	29.89	33.25	29.32	32.09	28.26	32.66	28.69	32.96	29.04	3.92
VB	I-264	LYNNHAVEN PKWY	LASKIN RD	WB		10.8	7.5	0.0	18.3	18.50	27.37	18.66	27.60	17.91	26.60	18.37	27.39	18.36	27.24	-8.88
VB	I-264	LASKIN RD	FIRST COLONIAL RD	EB	1.19	5.5	5.3	0.0	10.8	10.91	16.67	10.73	16.51	10.22	15.84	10.40	16.24	10.57	16.32	-5.75
VB	I-264	LASKIN RD	FIRST COLONIAL RD	WB		4.5	3.8	0.0	8.3	8.59	17.86	8.47	17.71	8.28	17.32	8.47	17.79	8.45	17.67	-9.22
VB	I-264	FIRST COLONIAL RD	BIRDNECK RD	EB	1.48	2.8	3.0	0.3	6.0	6.56	9.14	6.33	8.83	5.40	7.52	6.42	8.94	6.18	8.61	-2.43
VB	I-264	FIRST COLONIAL RD	BIRDNECK RD	WB		2.8	4.5	0.0	7.3	7.48	9.35	7.60	9.50	6.84	8.55	7.72	9.64	7.41	9.26	-1.85
VB	I-264	BIRDNECK RD	PARKS AVE	EB	0.49	2.3	1.5	0.0	3.8	3.17	1.11	2.92	1.02	2.63	0.92	3.12	1.09	2.96	1.03	1.93
VB	I-264	BIRDNECK RD	PARKS AVE	WB		0.5	1.0	0.0	1.5	1.36	1.08	1.23	0.98	1.11	0.88	1.32	1.05	1.26	1.00	0.26
CHES	I-464	I-64	MILITARY HWY	NB	1.00	4.5	2.8	0.0	7.3	6.95	6.74	7.07	6.85	6.70	6.49	7.97	7.71	7.17	6.95	0.23
CHES	I-464	I-64	MILITARY HWY	SB		4.3	1.3	0.0	5.5	5.34	5.51	5.43	5.60	5.18	5.34	6.16	6.35	5.53	5.70	-0.17
CHES	I-464	MILITARY HWY	FREEMAN AVE	NB	0.97	3.5	2.0	0.0	5.5	5.30	4.70	5.39	4.78	5.15	4.57	6.13	5.43	5.49	4.87	0.62
CHES	I-464	MILITARY HWY	FREEMAN AVE	SB		2.0	1.3	0.0	3.3	3.27	4.04	3.33	4.11	3.21	3.96	3.81	4.71	3.40	4.20	-0.80
CHES	I-464	FREEMAN AVE	POINDEXTER ST	NB	1.90	5.5	3.8	0.0	9.3	9.13	8.68	9.28	8.83	8.35	7.95	9.92	9.44	9.17	8.73	0.45
CHES	I-464	FREEMAN AVE	POINDEXTER ST	SB		2.5	1.5	0.0	4.0	4.18	7.19	4.25	7.31	4.10	7.05	4.54	7.82	4.27	7.34	-3.08
CHES/NOR	I-464	POINDEXTER ST	SOUTH MAIN ST	NB	1.14	3.0	2.3	0.0	5.3	5.52	7.43	4.97	6.69	5.50	7.41	5.57	7.50	5.39	7.26	-1.87
CHES/NOR	I-464	POINDEXTER ST	SOUTH MAIN ST	SB		2.0	1.3	0.0	3.3	3.36	4.84	3.02	4.36	3.65	5.28	3.70	5.34	3.43	4.95	-1.52
NOR	I-464	SOUTH MAIN ST	I-264	NB	0.61	5.3	4.3	0.0	9.5	8.34	3.71	7.51	3.34	9.01	3.98	9.12	4.02	8.50	3.76	4.74
NOR	I-464	SOUTH MAIN ST	I-264	SB		0.8	1.0	0.0	1.8	1.80	2.97	1.62	2.68	1.96	3.22	1.99	3.26	1.84	3.03	-1.19
NOR	I-564	ADMIRAL TAUSSIG BLVD	INTERNATIONAL TERMINAL BLVD	NB	1.87	17.8	7.3	0.0	25.0	22.25	5.21	20.03	4.69	22.19	5.19	22.46	5.26	21.73	5.09	16.64
NOR	I-564	ADMIRAL TAUSSIG BLVD	INTERNATIONAL TERMINAL BLVD	SB		9.3	2.0	0.0	11.3	11.48	6.46	9.32	5.24	10.33	5.80	10.45	5.87	10.40	5.84	4.55
NOR	I-564	INTERNATIONAL TERMINAL BLVD	I-64	NB	0.90	7.3	3.3	0.0	10.5	9.75	7.10	9.92	7.22	8.92	6.49	11.63	8.46	10.06	7.32	2.74
NOR	I-564	INTERNATIONAL TERMINAL BLVD	I-64	SB		11.0	4.3	0.0	15.3	13.45	4.20	13.67	4.28	12.30	3.85	14.62	4.57	13.51	4.22	9.29
CHES	I-664	I-64 & I-264	ROUTES 13/58/460	NB	1.70	9.5	3.0	0.3	12.8	11.73	32.36	13.23	37.51	13.53	38.77	14.77	42.75	13.31	37.85	-24.53
CHES	I-664	I-64 & I-264	ROUTES 13/58/460	SB		10.8	3.5	0.3	14.5	16.70	38.20	15.28	35.33	13.08	29.61	14.88	33.67	14.98	34.20	-19.22
CHES	I-664	ROUTES 13/58/460	DOCK LANDING RD	NB	1.25	8.5	2.5	0.3	11.3	9.93	21.14	11.90	25.12	14.19	29.92	10.47	22.26	11.62	24.61	-12.99
CHES	I-664	ROUTES 13/58/460	DOCK LANDING RD	SB		7.3	6.0	0.5	13.8	13.18	17.18	14.10	18.49	12.55	16.34	15.81	20.73	13.91	18.18	-4.27
CHES	I-664	DOCK LANDING RD	PORTSMOUTH BLVD	NB	1.14	4.5	2.0	0.3	6.8	5.78	15.68	6.51	17.59	7.84	21.14	8.58	23.12	7.18	19.38	-12.21
CHES	I-664	DOCK LANDING RD	PORTSMOUTH BLVD	SB		3.0	3.0	0.3	6.3	6.67	19.46	7.21	21.37	6.40	18.61	6.48	18.83	6.69	19.57	-12.88
CHES	I-664	PORTSMOUTH BLVD	PUGHSVILLE RD	NB	2.06	7.5	5.3	0.0	12.8	11.51	31.30	13.46	36.55	16.14	43.84	11.62	31.59	13.18	35.82	-22.64
CHES	I-664	PORTSMOUTH BLVD	PUGHSVILLE RD	SB		7.5	3.5	0.0	11.0	11.46	32.85	12.66	36.61	10.94	31.30	10.58	30.23	11.41	32.75	-21.34
CHES/SUF	I-664	PUGHSVILLE RD	BRIDGE RD	NB	1.57	6.5	1.8	0.0	8.3	8.19	12.79	8.95	13.96	7.49	11.70	9.57	14.93	8.55	13.34	-4.79
CHES/SUF	I-664	PUGHSVILLE RD	BRIDGE RD	SB		7.8	3.0	0.0	10.8	10.91	12.58	11.92	13.74	9.26	10.68	11.43	13.18	10.88	12.54	-1.66
SUF	I-664	BRIDGE RD	WESTERN FWY	NB	0.15	1.3	0.8	0.0	2.0	1.63	1.37	1.65	1.38	1.62	1.37	1.85	1.55	1.69	1.42	0.27
SUF	I-664	BRIDGE RD	WESTERN FWY	SB		0.0	0.8	0.0	0.8	0.83	1.01	0.86	1.05	0.76	0.93	0.83	1.02	0.82	1.00	-0.18
SUF	I-664	WESTERN FWY	COLLEGE DR	NB	1.41	6.3	1.3	0.0	7.5	7.38	11.09	7.50	11.27	7.06	10.61	9.15	13.75	7.77	11.68	-3.91
SUF	I-664	WESTERN FWY	COLLEGE DR	SB		6.5	0.8	0.0	7.3	7.68	9.94	7.43	9.61	6.69	8.65	7.95	10.28	7.44	9.62	-2.18
SUF/NN	I-664/MMMBT	COLLEGE DR	TERMINAL AVE	NB	6.13	58.3	22.3	0.3	80.8	78.15	48.22	75.17	46.39	83.28	51.39	84.28	52.01	80.22	49.50	30.72
SUF/NN	I-664/MMMBT	COLLEGE DR	TERMINAL AVE	SB		36.5	17.5	0.0	54.0	49.70	42.83	51.26	44.23	56.78	49.00	57.46	49.59	53.80	46.41	7.39
NN	I-664	TERMINAL AVE	23RD ST	NB	0.92	0.8	0.8	0.0	1.5	1.66	5.93	2.06	7.34	2.02	7.23	2.62	9.34	2.09	7.46	-5.37
NN	I-664	TERMINAL AVE	23RD ST	SB		4.3	0.5	0.0	4.8	5.81	8.58	5.17	7.66	4.65	6.89	4.30	6.37	4.98	7.38	-2.39

Source: HRTPO analysis of VDOT data. Includes an analysis of VDOT data using VCTIR methods.
FAT = Number of crashes with at least one fatality. INJ = Number of crashes with at least one injury but no fatalities. PDO = Number of crashes with property damage only. F+I = FAT + INJ crashes.

APPENDIX C (CONTINUED) – POTENTIAL FOR SAFETY IMPROVEMENT - FREEWAYS

Juris-diction	Facility	Segment From	Segment To	Dir	Distance (miles)	Average Annual Observed Crashes (2009-2012)				2009 Expected Total Crashes	2009 Adjusted Predicted Crashes	2010 Expected Total Crashes	2010 Adjusted Predicted Crashes	2011 Expected Total Crashes	2011 Adjusted Predicted Crashes	2012 Expected Total Crashes	2012 Adjusted Predicted Crashes	Average Annual Expected Total Crashes	Average Annual Adjusted Predicted Crashes	Potential for Safety Improvement
						PDO	INJ	FAT	Total											
NN	I-664	23RD ST	CHESTNUT AVE	NB	1.69	7.8	3.8	0.0	11.5	12.28	16.63	10.92	14.79	10.29	13.93	13.36	18.09	11.71	15.86	-4.15
NN	I-664	23RD ST	CHESTNUT AVE	SB		15.8	6.5	0.5	22.8	23.42	17.09	20.90	15.25	19.67	14.35	25.47	18.58	22.36	16.32	6.04
NN/HAM	I-664	CHESTNUT AVE	ABERDEEN RD	NB	0.68	3.0	1.8	0.0	4.8	5.08	6.78	4.57	6.09	4.47	5.96	5.75	7.66	4.97	6.62	-1.65
NN/HAM	I-664	CHESTNUT AVE	ABERDEEN RD	SB		3.8	1.3	0.0	5.0	5.44	6.85	4.90	6.18	4.41	5.56	5.91	7.45	5.17	6.51	-1.34
HAM	I-664	ABERDEEN RD	POWER PLANT PKWY	NB	1.29	4.3	2.3	0.0	6.5	6.49	12.53	6.60	12.74	6.39	12.34	8.15	15.73	6.91	13.34	-6.43
HAM	I-664	ABERDEEN RD	POWER PLANT PKWY	SB		2.8	2.5	0.0	5.3	5.97	13.21	5.42	11.98	4.87	10.78	6.50	14.37	5.69	12.58	-6.89
HAM	I-664	POWER PLANT PKWY	I-64	NB	1.38	11.8	5.5	0.0	17.3	18.46	15.95	15.58	13.47	15.15	13.09	19.37	16.74	17.14	14.82	2.32
HAM	I-664	POWER PLANT PKWY	I-64	SB		8.0	1.8	0.0	9.8	9.95	15.06	9.75	14.76	8.78	13.28	11.62	17.58	10.03	15.17	-5.14
CHES	CHESAPEAKE EXPWY	GALLBUSH RD	BATTLEFIELD BLVD (NEAR INDIAN CF	NB	2.61	0.8	0.8	0.0	1.5	1.54	1.06	1.65	1.13	1.11	0.78	1.13	0.79	1.36	0.94	0.42
CHES	CHESAPEAKE EXPWY	GALLBUSH RD	BATTLEFIELD BLVD (NEAR INDIAN CF	SB		1.0	1.0	0.0	2.0	1.81	1.02	1.93	1.08	1.31	0.74	1.33	0.75	1.59	0.90	0.69
CHES	CHESAPEAKE EXPWY	BATTLEFIELD BLVD (NEAR INDIAN CF	HILLCREST PKWY	NB	2.63	1.3	0.0	0.0	1.3	1.16	0.99	1.22	1.05	0.85	0.72	0.86	0.73	1.02	0.87	0.15
CHES	CHESAPEAKE EXPWY	BATTLEFIELD BLVD (NEAR INDIAN CF	HILLCREST PKWY	SB		0.5	0.5	0.0	1.0	1.03	1.03	1.08	1.09	0.76	0.76	0.77	0.77	0.91	0.91	0.00
CHES	CHESAPEAKE EXPWY	HILLCREST PKWY	BATTLEFIELD BLVD (S OF GREAT BRID	NB	2.21	1.0	0.3	0.0	1.3	1.50	4.22	1.51	4.29	1.77	5.03	1.79	5.09	1.64	4.66	-3.01
CHES	CHESAPEAKE EXPWY	HILLCREST PKWY	BATTLEFIELD BLVD (S OF GREAT BRID	SB		0.8	0.5	0.0	1.3	1.54	4.35	1.56	4.41	1.82	5.17	1.85	5.23	1.69	4.79	-3.10
CHES	CHESAPEAKE EXPWY	BATTLEFIELD BLVD (S OF GREAT BRID	HANBURY RD	NB	0.59	0.8	0.5	0.0	1.3	0.97	1.01	0.99	1.02	1.29	1.32	1.31	1.33	1.14	1.17	-0.03
CHES	CHESAPEAKE EXPWY	BATTLEFIELD BLVD (S OF GREAT BRID	HANBURY RD	SB		1.0	0.5	0.0	1.5	1.09	0.75	1.13	0.77	1.51	1.02	1.53	1.03	1.31	0.89	0.42
CHES	CHESAPEAKE EXPWY	HANBURY RD	MT PLEASANT RD	NB	1.31	1.5	0.8	0.0	2.3	2.71	6.78	2.74	6.88	2.50	6.22	2.63	6.57	2.65	6.61	-3.97
CHES	CHESAPEAKE EXPWY	HANBURY RD	MT PLEASANT RD	SB		0.5	1.0	0.0	1.5	2.03	6.84	2.05	6.93	1.86	6.28	1.97	6.63	1.98	6.67	-4.69
CHES	CHESAPEAKE EXPWY	MT PLEASANT RD	BATTLEFIELD BLVD (N OF GREAT BRI	NB	2.31	6.3	4.8	0.0	11.0	10.62	24.00	10.89	24.83	11.47	26.05	11.90	27.09	11.22	25.49	-14.27
CHES	CHESAPEAKE EXPWY	MT PLEASANT RD	BATTLEFIELD BLVD (N OF GREAT BRI	SB		1.8	2.8	0.0	4.5	4.73	24.13	4.86	24.94	5.11	26.18	5.31	27.22	5.00	25.62	-20.61
CHES	CHESAPEAKE EXPWY	BATTLEFIELD BLVD (N OF GREAT BRI	DOMINION BLVD	NB	1.90	5.0	2.0	0.0	7.0	7.00	19.86	6.99	19.98	7.55	21.55	7.84	22.40	7.35	20.95	-13.60
CHES	CHESAPEAKE EXPWY	BATTLEFIELD BLVD (N OF GREAT BRI	DOMINION BLVD	SB		3.0	3.5	0.0	6.5	6.52	19.90	6.49	20.01	7.02	21.58	7.27	22.44	6.83	20.98	-14.16
CHES	CHESAPEAKE EXPWY	DOMINION BLVD	I-64	NB	0.57	5.0	1.3	0.0	6.3	6.36	10.49	6.47	10.67	6.13	10.11	6.91	11.41	6.47	10.67	-4.20
CHES	CHESAPEAKE EXPWY	DOMINION BLVD	I-64	SB		3.0	1.0	0.0	4.0	4.35	10.49	4.43	10.67	4.20	10.11	4.73	11.41	4.43	10.67	-6.25
PORT	M L K FREEWAY	HIGH ST	LONDON BLVD	NB	0.25	1.0	0.8	0.0	1.8	0.36	0.21	0.32	0.19	0.36	0.21	0.36	0.21	0.35	0.20	0.15
PORT	M L K FREEWAY	HIGH ST	LONDON BLVD	SB		0.8	0.3	0.0	1.0	0.25	0.12	0.23	0.11	0.25	0.12	0.26	0.12	0.25	0.12	0.13
PORT	M L K FREEWAY	LONDON BLVD	WESTERN FREEWAY/MIDTOWN TUN	NB	0.98	2.3	2.8	0.0	5.0	4.24	2.70	4.52	2.88	3.70	2.35	5.76	3.66	4.56	2.90	1.66
PORT	M L K FREEWAY	LONDON BLVD	WESTERN FREEWAY/MIDTOWN TUN	SB		1.8	0.8	0.3	2.8	2.60	2.74	2.77	2.92	2.26	2.39	3.52	3.72	2.79	2.94	-0.16
YC	ROUTE 199	MOORETOWN RD	I-64	EB	0.85	5.0	0.8	0.0	5.8	4.24	1.39	4.14	1.35	4.58	1.50	4.64	1.52	4.40	1.44	2.96
YC	ROUTE 199	MOORETOWN RD	I-64	WB		3.0	2.0	0.0	5.0	3.74	1.39	3.65	1.35	4.04	1.50	4.09	1.52	3.88	1.44	2.44
YC	ROUTE 199	RICHMOND RD (RTE 60)	MOORETOWN RD	EB	0.73	2.5	0.8	0.0	3.3	2.53	1.16	2.12	0.97	2.35	1.07	2.38	1.08	2.34	1.07	1.27
YC	ROUTE 199	RICHMOND RD (RTE 60)	MOORETOWN RD	WB		1.3	0.3	0.0	1.5	1.45	1.16	1.21	0.97	1.34	1.07	1.35	1.08	1.34	1.07	0.27
JCC	ROUTE 199	RICHMOND RD (RTE 60)	LONGHILL RD (RTE 612)	EB	2.94	2.0	1.3	0.0	3.3	3.22	3.92	3.14	3.84	3.48	4.25	3.53	4.30	3.34	4.08	-0.73
JCC	ROUTE 199	RICHMOND RD (RTE 60)	LONGHILL RD (RTE 612)	WB		3.0	1.5	0.0	4.5	4.32	3.67	4.24	3.59	4.70	3.98	4.75	4.03	4.50	3.82	0.69
JCC	ROUTE 199	LONGHILL RD (RTE 612)	MONTICELLO AVE (RTE 321)	EB	1.89	1.5	0.5	0.0	2.0	2.47	4.35	2.08	3.67	2.31	4.07	2.33	4.12	2.30	4.05	-1.76
JCC	ROUTE 199	LONGHILL RD (RTE 612)	MONTICELLO AVE (RTE 321)	WB		2.5	4.0	0.0	6.5	6.55	4.37	5.54	3.69	6.14	4.09	6.21	4.14	6.11	4.07	2.04
JCC	ROUTE 199	MONTICELLO AVE (RTE 321)	JOHN TYLER HWY (RTE 5)	EB	1.30	1.8	0.8	0.0	2.5	3.11	3.06	2.28	2.26	2.53	2.51	2.56	2.54	2.62	2.59	0.03
JCC	ROUTE 199	MONTICELLO AVE (RTE 321)	JOHN TYLER HWY (RTE 5)	WB		1.5	1.0	0.3	2.8	3.18	3.17	2.37	2.35	2.63	2.61	2.66	2.64	2.71	2.69	0.02
SUF	SOUTHWEST SUFFOLK BYPA	HOLLAND RD	CAROLINA RD	NB	2.55	0.3	1.5	0.0	1.8	1.28	0.77	1.15	0.69	1.28	0.77	1.29	0.78	1.25	0.75	0.50
SUF	SOUTHWEST SUFFOLK BYPA	HOLLAND RD	CAROLINA RD	SB		1.0	0.8	0.0	1.8	1.32	0.71	1.19	0.64	1.32	0.71	1.33	0.72	1.29	0.70	0.59
SUF	SUFFOLK BYPASS	HOLLAND RD	PITCHKETTLE RD	EB	1.69	1.3	0.3	0.0	1.5	1.96	6.19	1.86	5.85	2.06	6.48	2.08	6.56	1.99	6.27	-4.28
SUF	SUFFOLK BYPASS	HOLLAND RD	PITCHKETTLE RD	WB		3.0	1.0	0.0	4.0	4.20	6.58	3.95	6.20	4.38	6.87	4.43	6.96	4.24	6.65	-2.41
SUF	SUFFOLK BYPASS	PITCHKETTLE RD	PRUDEN BLVD	EB	1.63	0.5	2.0	0.0	2.5	3.09	6.81	3.02	6.71	2.57	5.60	2.73	5.96	2.85	6.27	-3.42
SUF	SUFFOLK BYPASS	PITCHKETTLE RD	PRUDEN BLVD	WB		2.8	0.5	0.0	3.3	3.82	6.81	3.75	6.71	3.17	5.60	3.37	5.96	3.53	6.27	-2.74
SUF	SUFFOLK BYPASS	PRUDEN BLVD	GODWIN BLVD	EB	1.06	3.5	2.3	0.0	5.8	6.23	6.27	6.02	6.08	5.16	5.12	5.43	5.40	5.71	5.72	-0.01
SUF	SUFFOLK BYPASS	PRUDEN BLVD	GODWIN BLVD	WB		2.3	1.0	0.0	3.3	3.84	6.21	3.72	6.02	3.14	5.06	3.31	5.34	3.50	5.66	-2.16
SUF	SUFFOLK BYPASS	GODWIN BLVD	WILROY RD	EB	1.85	3.0	2.0	0.0	5.0	5.70	15.22	5.61	15.04	5.02	13.30	5.25	13.92	5.39	14.37	-8.98
SUF	SUFFOLK BYPASS	GODWIN BLVD	WILROY RD	WB		3.0	1.8	0.3	5.0	5.71	14.96	5.63	14.81	5.00	13.05	5.23	13.67	5.39	14.12	-8.73
SUF	SUFFOLK BYPASS	WILROY RD	ROUTES 13/58/460	EB	2.02	2.8	3.0	0.0	5.8	6.45	12.14	6.27	11.79	5.71	10.76	6.02	11.33	6.11	11.51	-5.39
SUF	SUFFOLK BYPASS	WILROY RD	ROUTES 13/58/460	WB		2.8	2.0	0.0	4.8	5.24	11.68	5.10	11.36	4.63	10.30	4.88	10.87	4.96	11.05	-6.09

Source: HRTPO analysis of VDOT data. Includes an analysis of VDOT data using VCTIR methods.
FAT = Number of crashes with at least one fatality. INJ = Number of crashes with at least one injury but no fatalities. PDO = Number of crashes with property damage only. F+I = FAT + INJ crashes.

APPENDIX C (CONTINUED) – POTENTIAL FOR SAFETY IMPROVEMENT - FREEWAYS

Juris-diction	Facility	Segment From	Segment To	Dir	Distance (miles)	Average Annual Observed Crashes (2009-2012) PDO	INJ	FAT	Total	2009 Expected Total Crashes	2009 Adjusted Predicted Crashes	2010 Expected Total Crashes	2010 Adjusted Predicted Crashes	2011 Expected Total Crashes	2011 Adjusted Predicted Crashes	2012 Expected Total Crashes	2012 Adjusted Predicted Crashes	Average Annual Expected Total Crashes	Average Annual Adjusted Predicted Crashes	Potential for Safety Improvement
SUF/CHES	ROUTE 13/58/460	SUFFOLK BYPASS	I-664	EB	6.11	19.8	18.3	0.3	38.3	39.77	48.51	39.59	48.29	33.34	40.68	41.42	50.53	38.53	47.00	-8.48
SUF/CHES	ROUTE 13/58/460	SUFFOLK BYPASS	I-664	WB		10.3	12.8	0.0	23.0	24.24	48.38	24.13	48.16	20.32	40.57	25.24	50.39	23.48	46.88	-23.39
SUF	WESTERN FWY	BRIDGE RD	I-664	EB	0.74	0.5	0.8	0.0	1.3	1.03	1.03	0.93	0.93	1.03	1.03	1.04	1.04	1.01	1.01	0.00
SUF	WESTERN FWY	BRIDGE RD	I-664	WB		0.5	1.0	0.0	1.5	1.30	1.00	1.17	0.90	1.29	1.00	1.31	1.01	1.27	0.98	0.29
SUF	WESTERN FWY	I-664	COLLEGE DR	EB	0.57	1.3	1.3	0.0	2.5	2.75	2.82	2.37	2.44	2.29	2.37	2.31	2.39	2.43	2.51	-0.08
SUF	WESTERN FWY	I-664	COLLEGE DR	WB		1.0	0.3	0.3	1.5	1.90	2.69	1.64	2.32	1.58	2.24	1.60	2.27	1.68	2.38	-0.70
SUF/PORT	WESTERN FWY	COLLEGE DR	TOWN POINT RD	EB	1.21	0.5	1.0	0.0	1.5	1.98	6.25	1.78	5.62	1.97	6.23	2.07	6.57	1.95	6.17	-4.22
SUF/PORT	WESTERN FWY	COLLEGE DR	TOWN POINT RD	WB		0.8	1.5	0.0	2.3	2.68	6.25	2.41	5.62	2.67	6.23	2.82	6.57	2.65	6.17	-3.52
PORT	WESTERN FWY	TOWN POINT RD	CEDAR LN	EB	1.31	1.3	0.8	0.0	2.0	2.49	8.21	2.40	7.94	2.48	8.19	2.51	8.28	2.47	8.15	-5.68
PORT	WESTERN FWY	TOWN POINT RD	CEDAR LN	WB		0.8	1.3	0.0	2.0	2.49	8.24	2.39	7.97	2.48	8.22	2.51	8.31	2.47	8.18	-5.71
PORT	WESTERN FWY	CEDAR LN	APM BLVD	EB	1.00	1.8	0.8	0.0	2.5	2.84	5.42	2.75	5.27	2.83	5.41	2.87	5.47	2.82	5.39	-2.57
PORT	WESTERN FWY	CEDAR LN	APM BLVD	WB		0.3	1.5	0.0	1.8	2.10	5.07	2.03	4.95	2.09	5.06	2.12	5.12	2.09	5.05	-2.96
PORT	WESTERN FWY	APM BLVD	WEST NORFOLK RD	EB	0.61	0.3	0.8	0.0	1.0	1.40	3.17	1.37	3.10	1.40	3.17	1.42	3.20	1.40	3.16	-1.76
PORT	WESTERN FWY	APM BLVD	WEST NORFOLK RD	WB		0.5	0.5	0.0	1.0	1.39	3.17	1.36	3.10	1.39	3.17	1.40	3.20	1.39	3.16	-1.78
PORT	WESTERN FWY	WEST NORFOLK RD	MLK FREEWAY/MIDTOWN TUNNEL	EB	1.78	5.3	3.0	0.0	8.3	8.44	10.28	8.21	9.98	8.42	10.26	8.52	10.38	8.40	10.22	-1.83
PORT	WESTERN FWY	WEST NORFOLK RD	MLK FREEWAY/MIDTOWN TUNNEL	WB		2.0	1.3	0.0	3.3	3.72	10.43	3.62	10.12	3.71	10.41	3.75	10.53	3.70	10.37	-6.67

Source: HRTPO analysis of VDOT data. Includes an analysis of VDOT data using VCTIR methods.
FAT = Number of crashes with at least one fatality. INJ = Number of crashes with at least one injury but no fatalities. PDO = Number of crashes with property damage only. F+I = FAT + INJ crashes.

Appendix D – Potential for Safety Improvement - Intersections

Juris-diction	Major Road	Minor Road	Average Annual Observed Crashes (2009-2012) PDO	INJ	FAT	Total	2009 Expected Total Crashes	2009 Adjusted Predicted Crashes	2010 Expected Total Crashes	2010 Adjusted Predicted Crashes	2011 Expected Total Crashes	2011 Adjusted Predicted Crashes	2012 Expected Total Crashes	2012 Adjusted Predicted Crashes	Average Annual Expected Total Crashes	Average Annual Adjusted Predicted Crashes	Potential for Safety Improvement
CHES	Airline Blvd	Jolliff Rd	1.3	2.5	0.0	3.8	2.80	2.80	2.85	2.85	2.70	2.70	2.57	2.57	2.73	2.73	0.00
CHES	Atlantic Ave	Old Atlantic Ave/Martin Ave	0.8	1.3	0.0	2.0	2.82	4.44	2.79	4.38	2.35	3.69	2.60	4.08	2.64	4.15	-1.51
CHES	Atlantic Ave	Providence Rd	1.0	2.0	0.0	3.0	3.34	4.42	3.27	4.32	2.91	3.85	3.23	4.27	3.19	4.22	-1.03
CHES	Bainbridge Blvd	Freeman Ave	2.8	1.3	0.0	4.0	3.96	3.36	4.03	3.41	3.90	3.30	4.31	3.65	4.05	3.43	0.62
CHES	Bainbridge Blvd	Great Bridge Blvd	1.3	1.3	0.0	2.5	2.75	2.62	2.38	2.27	2.30	2.19	1.63	1.56	2.26	2.16	0.10
CHES	Battlefield Blvd	Campostella Rd	4.5	4.3	0.0	8.8	9.07	7.22	8.91	7.09	7.77	6.19	8.64	6.88	8.60	6.85	1.75
CHES	Battlefield Blvd	Cedar Rd	6.3	5.5	0.0	11.8	12.32	13.59	11.81	13.02	10.63	11.72	11.69	12.89	11.62	12.81	-1.19
CHES	Battlefield Blvd	Centerville Tpke	0.8	1.3	0.0	2.0	1.71	2.32	1.39	1.89	2.14	2.91	2.36	3.21	1.90	2.58	-0.68
CHES	Battlefield Blvd	Gallbush Rd	3.5	1.8	0.0	5.3	5.19	8.38	4.77	7.70	4.40	7.10	5.11	8.25	4.87	7.86	-2.99
CHES	Battlefield Blvd	Great Bridge Blvd/Kempsville Rd	12.8	11.0	0.0	23.8	22.85	14.25	22.54	14.04	20.26	12.63	21.62	13.48	21.82	13.60	8.22
CHES	Battlefield Blvd	Hanbury Rd	5.3	2.8	0.0	8.0	7.44	5.41	6.84	4.97	5.59	4.06	6.12	4.45	6.50	4.72	1.77
CHES	Battlefield Blvd	Hillcrest Pkwy	4.0	2.0	0.0	6.0	4.29	2.99	3.95	2.75	5.72	3.98	5.61	3.90	4.89	3.41	1.49
CHES	Battlefield Blvd	Johnstown Rd/Mount Pleasant Rd	10.0	4.3	0.0	14.3	13.78	10.16	13.34	9.83	13.58	10.01	14.37	10.59	13.77	10.15	3.62
CHES	Battlefield Blvd	Old Battlefield Blvd	3.0	1.5	0.0	4.5	4.66	6.96	4.29	6.40	3.77	5.63	4.36	6.51	4.27	6.37	-2.10
CHES	Battlefield Blvd	Volvo Pkwy	3.8	7.5	0.0	11.3	12.83	23.50	12.62	23.08	11.74	21.45	12.43	22.74	12.40	22.69	-10.29
CHES	Benefit Rd	Johnstown Rd	0.0	0.8	0.0	0.8	0.27	0.30	0.22	0.24	0.29	0.31	0.31	0.34	0.27	0.30	-0.02
CHES	Benefit Rd	Sign Pine Rd	0.3	0.3	0.0	0.5	0.28	0.25	0.22	0.20	0.32	0.29	0.36	0.32	0.30	0.27	0.03
CHES	Bruce Rd	Tyre Neck Rd	0.5	0.8	0.0	1.3	1.91	3.84	1.80	3.61	1.49	3.00	1.65	3.31	1.71	3.44	-1.73
CHES	Butts Station Rd	Elbow Rd	0.0	0.5	0.0	0.5	0.88	1.46	0.72	1.19	0.96	1.60	1.06	1.76	0.90	1.50	-0.60
CHES	Campostella Rd	Berkley Ave Ext	1.3	0.8	0.0	2.0	3.23	5.87	3.42	6.22	2.81	5.11	2.40	4.37	2.97	5.39	-2.43
CHES	Campostella Rd	Liberty St/Border Rd	2.0	3.5	0.0	5.5	4.57	3.53	4.24	3.28	3.65	2.82	3.68	2.85	4.04	3.12	0.92
CHES	Centerville Tpke	Butts Station Rd	2.5	1.5	0.0	4.0	3.72	3.01	3.11	2.52	3.98	3.22	4.42	3.58	3.81	3.08	0.72
CHES	Centerville Tpke	Elbow Rd	1.3	2.8	0.0	4.0	2.48	2.52	2.39	2.43	2.52	2.56	2.72	2.76	2.53	2.57	-0.04
CHES	Centerville Tpke	Ethridge Manor Blvd	0.5	0.5	0.0	1.0	1.40	1.91	1.10	1.50	1.30	1.77	1.41	1.93	1.30	1.78	-0.48
CHES	Dominion Blvd	Bainbridge Blvd	3.5	1.3	0.0	4.8	4.71	4.39	3.59	3.35	3.87	3.62	4.25	3.98	4.10	3.84	0.27
CHES	Dominion Blvd	Cedar Rd	8.8	7.8	0.0	16.5	17.19	11.83	15.96	10.99	14.98	10.31	16.64	11.45	16.20	11.14	5.05
CHES	Dominion Blvd	Great Bridge Blvd	6.0	4.5	0.0	10.5	11.75	13.72	11.11	12.97	10.43	12.19	11.07	12.93	11.09	12.95	-1.86
CHES	George Washington Hwy	Canal Dr	0.8	3.0	0.0	3.8	4.28	5.90	3.82	5.28	3.69	5.06	3.77	5.17	3.89	5.35	-1.47
CHES	George Washington Hwy	Military Hwy	4.3	5.5	0.0	9.8	9.28	8.53	9.05	8.32	8.22	7.55	9.54	8.75	9.02	8.29	0.74
CHES	George Washington Hwy/Dominion Blvd	George Washington Hwy	1.0	2.0	0.0	3.0	2.07	1.58	1.56	1.19	1.90	1.45	2.11	1.61	1.91	1.46	0.45
CHES	George Washington Hwy/Mill Creek Pkwy	George Washington Hwy/Old Mill Rd	5.5	2.5	0.0	8.0	7.96	8.60	7.32	7.91	6.65	7.18	7.39	7.98	7.33	7.92	-0.59
CHES	George Washington Hwy/Moses Grandy Trail	George Washington Hwy	2.8	0.8	0.0	3.5	4.10	5.41	3.07	4.06	3.63	4.79	4.03	5.33	3.71	4.90	-1.19
CHES	Great Bridge Blvd	Campostella Rd	0.3	0.5	0.0	0.8	1.71	2.99	1.47	2.57	1.47	2.58	1.03	1.81	1.42	2.49	-1.07
CHES	Greenbrier Pkwy	Eden Way	7.0	8.3	0.0	15.3	16.74	26.71	16.39	26.13	14.37	22.94	15.73	25.11	15.81	25.22	-9.42
CHES	Greenbrier Pkwy	Volvo Pkwy	4.0	6.8	0.0	10.8	11.54	16.75	11.29	16.37	9.96	14.46	10.66	15.48	10.86	15.77	-4.90
CHES	Greenbrier Pkwy	Woodlake Dr	4.5	3.8	0.0	8.3	9.94	21.93	9.81	21.61	8.93	19.69	9.00	19.85	9.42	20.77	-11.35
CHES	Hillcrest Pkwy	Edinburgh Pkwy	0.5	0.3	0.0	0.8	1.41	2.54	1.30	2.33	1.23	2.21	1.37	2.46	1.33	2.39	-1.06
CHES	Johnstown Rd	Hanbury Rd	0.5	0.3	0.0	0.8	0.65	0.61	0.59	0.56	0.65	0.62	0.61	0.58	0.63	0.59	0.03
CHES	Jolliff Rd	Dock Landing Rd	0.8	0.3	0.0	1.0	0.58	0.51	0.54	0.47	0.64	0.56	0.63	0.55	0.60	0.52	0.08
CHES	Kempsville Rd	Greenbrier Pkwy/Butts Station Rd	5.0	4.8	0.0	9.8	10.88	12.11	10.47	11.65	9.14	10.18	10.06	11.20	10.14	11.28	-1.15
CHES	Kempsville Rd	Volvo Pkwy	2.8	2.5	0.0	5.3	7.20	12.31	7.16	12.23	5.05	8.67	5.37	9.22	6.19	10.61	-4.41
CHES	Liberty St	22nd St	0.0	0.8	0.0	0.8	1.35	2.13	1.33	2.10	1.02	1.61	1.11	1.75	1.20	1.90	-0.69
CHES	Liberty St	Old Atlantic Ave/Latham Ave	0.8	0.8	0.0	1.5	1.89	2.04	1.82	1.97	1.40	1.52	1.52	1.65	1.66	1.80	-0.14
CHES	Liberty St	Poindexter St	1.0	0.3	0.0	1.3	1.36	1.39	1.23	1.26	1.20	1.23	1.15	1.19	1.23	1.27	-0.03
CHES	Military Hwy	Campostella Rd	2.5	4.5	0.0	7.0	7.86	9.86	7.92	9.92	5.15	6.51	5.72	7.23	6.66	8.38	-1.72
CHES	Military Hwy	Canal Dr	2.5	2.5	0.0	5.0	7.47	10.80	5.18	7.52	4.60	6.68	4.13	6.02	5.34	7.75	-2.41
CHES	Military Hwy	Cavalier Blvd/I-64 Ramp	2.5	2.5	0.0	5.0	5.45	5.49	5.33	5.36	4.26	4.29	4.73	4.77	4.94	4.98	-0.04
CHES	Military Hwy	Greenbrier Pkwy	5.0	2.8	0.0	7.8	9.59	13.53	9.19	12.96	7.12	10.04	7.84	11.07	8.44	11.90	-3.46
CHES	Moses Grandy Trail	Cedar Rd/Sebriell Way	0.0	0.3	0.0	0.3	1.34	3.37	1.24	3.13	1.20	3.03	1.33	3.36	1.28	3.22	-1.94
CHES	Moses Grandy Trail	Cedar Rd/Shipyard Rd	1.8	1.5	0.0	3.3	3.31	3.35	3.07	3.11	2.97	3.01	3.29	3.33	3.16	3.20	-0.04

Source: HRTPO analysis of VDOT data. Includes an analysis of VDOT data using HSM methods.
FAT = Number of crashes with at least one fatality. INJ = Number of crashes with at least one injury but no fatalities. PDO = Number of crashes with property damage only. F+I = FAT + INJ crashes.

APPENDIX D (CONTINUED) – POTENTIAL FOR SAFETY IMPROVEMENT - INTERSECTIONS

Juris-diction	Major Road	Minor Road	Average Annual Observed Crashes (2009-2012) PDO	INJ	FAT	Total	2009 Expected Total Crashes	2009 Adjusted Predicted Crashes	2010 Expected Total Crashes	2010 Adjusted Predicted Crashes	2011 Expected Total Crashes	2011 Adjusted Predicted Crashes	2012 Expected Total Crashes	2012 Adjusted Predicted Crashes	Average Annual Expected Total Crashes	Average Annual Adjusted Predicted Crashes	Potential for Safety Improvement
CHES	Mount Pleasant Rd	Centerville Tpke	7.0	3.0	0.0	10.0	10.19	6.04	10.10	5.99	7.92	4.69	8.80	5.21	9.25	5.48	3.77
CHES	Mount Pleasant Rd	Fentress Airfield Rd	0.8	2.0	0.0	2.8	2.53	2.26	3.91	3.48	2.64	2.35	1.69	1.51	2.69	2.40	0.30
CHES	Poindexter St	Bainbridge Blvd	1.0	1.0	0.0	2.0	2.40	3.71	2.23	3.44	1.72	2.66	1.86	2.88	2.05	3.17	-1.12
CHES	Portsmouth Blvd	Dock Landing Rd	5.3	5.8	0.0	11.0	10.61	8.03	10.64	8.04	9.69	7.33	10.28	7.78	10.30	7.80	2.51
CHES	Portsmouth Blvd	Jolliff Rd	0.3	0.5	0.0	0.8	1.69	4.13	1.68	4.10	1.79	4.37	1.88	4.60	1.76	4.30	-2.54
CHES	Portsmouth Blvd	Taylor Rd	4.5	3.0	0.0	7.5	9.11	13.03	8.75	12.51	7.86	11.24	8.35	11.95	8.52	12.18	-3.66
CHES	Providence Rd	Campostella Rd	3.0	4.8	0.0	7.8	7.66	5.54	7.64	5.52	6.12	4.43	6.80	4.92	7.06	5.10	1.95
CHES	Pughsville Rd/Taylor Rd	Taylor Rd/Lynnhurst Blvd	1.5	2.8	0.0	4.3	4.97	8.32	4.85	8.11	4.37	7.33	4.57	7.66	4.69	7.85	-3.16
CHES	Route 17	Ballahack Rd	0.5	0.3	0.0	0.8	1.04	2.59	1.04	2.59	1.08	2.69	1.07	2.66	1.05	2.63	-1.58
CHES	Taylor Rd	Bruce Rd	3.8	3.8	0.0	7.5	7.93	7.91	7.63	7.61	6.77	6.76	7.18	7.17	7.38	7.36	0.01
CHES	Towne Point Rd	Churchland Blvd	1.3	2.3	0.0	3.5	4.63	8.03	4.46	7.72	3.41	5.94	3.71	6.46	4.05	7.04	-2.99
CHES	Volvo Pkwy	Eden Way	3.3	3.3	0.0	6.5	6.84	7.92	6.72	7.78	6.63	7.68	7.21	8.34	6.85	7.93	-1.08
CHES	Western Branch Blvd	Poplar Hill Rd	3.3	2.8	0.0	6.0	6.67	6.73	6.13	6.19	5.49	5.54	5.96	6.02	6.06	6.12	-0.06
CHES	Western Branch Blvd	Taylor Rd	3.5	4.3	0.0	7.8	7.62	6.85	7.12	6.40	6.42	5.77	7.14	6.41	7.08	6.36	0.72
CHES	Western Branch Blvd/Bridge Rd	Churchland Blvd	1.3	2.3	0.0	3.5	3.78	6.46	3.51	6.01	3.48	5.94	3.85	6.58	3.66	6.25	-2.59
FR	Armory Dr	College Dr	3.0	4.0	0.0	7.0	6.80	4.80	6.30	4.44	5.92	4.18	6.18	4.37	6.30	4.45	1.85
FR	Clay St	College Dr/Hunterdale Rd	1.3	1.3	0.0	2.5	1.74	1.21	1.61	1.13	1.48	1.03	1.62	1.13	1.61	1.13	0.49
FR	Fourth Ave	High St	0.3	0.0	0.0	0.3	0.54	0.58	0.50	0.54	0.45	0.48	0.48	0.51	0.49	0.53	-0.04
FR	High St	Fairview Dr	1.0	0.3	0.0	1.3	1.27	1.10	1.09	0.94	1.22	1.05	0.69	0.59	1.07	0.92	0.15
FR	Hunterdale Rd	Fairview Dr	0.3	0.3	0.0	0.5	1.30	2.31	1.25	2.22	1.12	1.99	1.23	2.19	1.22	2.18	-0.95
FR	Second Ave	High St	2.0	1.3	0.0	3.3	2.71	1.86	2.58	1.77	2.33	1.60	2.26	1.55	2.47	1.70	0.77
FR	Second Ave	Main St	1.3	0.5	0.0	1.8	1.75	1.42	1.66	1.35	1.50	1.22	1.53	1.24	1.61	1.31	0.30
FR	Second Ave	Mechanic St	1.3	0.5	0.0	1.8	2.09	2.20	1.80	1.90	1.67	1.76	1.62	1.71	1.80	1.89	-0.10
FR	South St	College Dr	0.8	0.3	0.0	1.0	1.38	1.49	1.24	1.34	1.36	1.47	1.31	1.41	1.33	1.43	-0.10
FR	South St	High St	0.5	0.3	0.0	0.8	1.06	1.44	1.02	1.38	0.93	1.26	0.99	1.34	1.00	1.36	-0.36
FR	South St	Pretlow St	0.5	0.8	0.0	1.3	1.73	2.18	1.48	1.87	1.65	2.08	1.13	1.43	1.50	1.89	-0.39
GLO	Hickory Fork Rd	Belroi Rd	2.0	0.3	0.0	2.3	1.85	1.26	2.66	1.82	2.20	1.50	1.42	0.97	2.03	1.39	0.65
GLO	Main St	Route 3/14	1.3	2.0	0.0	3.3	4.40	7.78	4.04	7.16	3.83	6.78	4.26	7.53	4.13	7.31	-3.18
GLO	Route 17	Belroi Rd	1.8	2.5	0.3	4.5	4.67	5.35	4.32	4.94	3.85	4.42	4.30	4.93	4.29	4.91	-0.62
GLO	Route 17	Guinea Rd	2.3	4.0	0.0	6.3	7.69	11.47	7.10	10.58	6.48	9.67	6.75	10.10	7.01	10.45	-3.45
GLO	Route 17	Hickory Fork Rd	2.5	1.8	0.0	4.3	4.94	6.22	4.28	5.39	4.71	5.94	4.36	5.49	4.57	5.76	-1.19
GLO	Route 17	Route 14	1.0	1.3	0.0	2.3	2.21	2.08	2.22	2.10	2.21	2.08	2.22	2.10	2.22	2.09	0.13
GLO	Route 17	Route 17 Bus North	1.5	0.8	0.0	2.3	3.17	6.02	2.93	5.55	2.61	4.95	2.85	5.41	2.89	5.48	-2.59
GLO	Route 17	Route 17 Bus South (Main St)	4.3	3.5	0.0	7.8	8.92	11.46	8.50	10.92	7.77	9.99	8.32	10.69	8.38	10.77	-2.39
GLO	Route 17	Route 33/198	1.3	3.8	0.0	5.0	5.44	12.78	5.46	12.85	5.44	12.78	5.74	13.49	5.52	12.97	-7.45
HAM	Aberdeen Rd	Briarfield Rd	6.8	4.3	0.0	11.0	10.82	6.53	9.22	5.56	8.74	5.27	9.71	5.86	9.62	5.80	3.82
HAM	Armistead Ave	Convention Center Blvd/Reese Dr	1.5	0.8	0.0	2.3	2.68	4.26	2.34	3.73	2.22	3.53	2.46	3.92	2.43	3.86	-1.43
HAM	Armistead Ave	HRC Pkwy/Armistead Pointe Pkwy	11.5	6.3	0.0	17.8	18.12	10.50	15.55	9.01	14.09	8.17	15.65	9.07	15.86	9.19	6.67
HAM	Armistead Ave	LaSalle Ave	15.0	8.3	0.0	23.3	21.29	7.99	20.05	7.53	18.99	7.13	21.10	7.92	20.36	7.64	12.72
HAM	Armistead Ave	Pembroke Ave	6.0	4.8	0.0	10.8	10.30	4.95	8.17	3.92	8.36	4.01	9.28	4.46	9.03	4.34	4.69
HAM	Armistead Ave	Rip Rap Rd	5.3	3.0	0.0	8.3	7.16	4.95	7.19	4.96	6.81	4.70	7.42	5.12	7.15	4.93	2.21
HAM	Big Bethel Rd	Saunders Rd	1.8	2.3	0.0	4.0	3.64	3.27	3.37	3.04	3.87	3.48	3.57	3.21	3.61	3.25	0.36
HAM	Big Bethel Rd	Semple Farm Rd	1.0	1.3	0.0	2.3	1.95	2.64	1.76	2.38	2.02	2.73	1.85	2.50	1.89	2.56	-0.67
HAM	Coliseum Dr	Convention Center Blvd	0.0	0.0	0.0	0.0	0.23	0.25	0.20	0.21	0.23	0.25	0.22	0.24	0.22	0.24	-0.02
HAM	Coliseum Dr	Cunningham Dr	7.3	6.0	0.0	13.3	12.72	8.36	13.14	8.63	10.83	7.12	12.04	7.91	12.18	8.01	4.17
HAM	Coliseum Dr	Pine Chapel Rd	1.0	1.0	0.0	2.0	2.36	2.73	2.04	2.36	1.93	2.24	2.04	2.36	2.10	2.42	-0.33
HAM	Commander Sheppard Blvd	Armistead Ave	1.5	1.3	0.0	2.8	2.57	3.83	2.66	3.96	3.05	4.55	2.99	4.46	2.82	4.20	-1.38
HAM	Commander Sheppard Blvd	Wythe Creek Rd	7.0	0.8	0.0	7.8	8.15	7.33	8.26	7.44	7.83	7.05	8.70	7.83	8.24	7.41	0.82
HAM	Cunningham Dr/Todds Ln	Todds Ln/Lakeshore Dr	5.8	1.8	0.0	7.5	8.83	7.84	7.36	6.53	6.98	6.19	7.75	6.87	7.73	6.86	0.87
HAM	Fox Hill Rd	Harris Creek Rd	3.0	1.0	0.0	4.0	4.93	6.54	4.25	5.64	4.02	5.34	4.28	5.68	4.37	5.80	-1.43

Source: HRTPO analysis of VDOT data. Includes an analysis of VDOT data using HSM methods.

FAT = Number of crashes with at least one fatality. INJ = Number of crashes with at least one injury but no fatalities. PDO = Number of crashes with property damage only. F+I = FAT + INJ crashes.

Appendix D (continued) - Potential for Safety Improvement - Intersections

Juris-diction	Major Road	Minor Road	Average Annual Observed Crashes (2009-2012)				2009 Expected Total Crashes	2009 Adjusted Predicted Crashes	2010 Expected Total Crashes	2010 Adjusted Predicted Crashes	2011 Expected Total Crashes	2011 Adjusted Predicted Crashes	2012 Expected Total Crashes	2012 Adjusted Predicted Crashes	Average Annual Expected Total Crashes	Average Annual Adjusted Predicted Crashes	Potential for Safety Improvement
			PDO	INJ	FAT	Total											
HAM	Fox Hill Rd	Woodland Rd	2.0	2.3	0.0	4.3	4.06	5.03	3.33	4.13	3.82	4.74	3.57	4.42	3.70	4.58	-0.88
HAM	Fox Hill Rd/Silver Isles Blvd	Old Buckroe Rd	1.0	0.8	0.0	1.8	2.19	2.43	1.88	2.08	2.16	2.39	1.96	2.16	2.05	2.26	-0.22
HAM	Harris Creek Rd	Little Back River Rd	1.0	0.0	0.0	1.0	1.31	1.18	1.02	0.92	1.18	1.06	0.85	0.76	1.09	0.98	0.11
HAM	HRC Pkwy	Big Bethel Rd	27.0	14.8	0.0	41.8	43.60	18.74	38.79	16.67	36.74	15.79	40.82	17.54	39.99	17.18	22.80
HAM	HRC Pkwy	Coliseum Dr	5.8	3.8	0.0	9.5	9.89	8.90	7.54	6.79	8.34	7.51	8.18	7.36	8.49	7.64	0.85
HAM	Ignolls Rd	Mercury Blvd	0.0	0.0	0.0	0.0	0.71	1.20	0.63	1.07	0.60	1.01	0.65	1.09	0.65	1.09	-0.45
HAM	Kecoughtan Rd	LaSalle Ave	2.0	2.0	0.0	4.0	3.58	2.49	2.99	2.08	2.85	1.98	3.06	2.12	3.12	2.17	0.95
HAM	Kecoughtan Rd	Powhatan Pkwy	1.8	2.5	0.0	4.3	3.37	2.11	2.40	1.51	2.76	1.74	1.95	1.23	2.62	1.65	0.97
HAM	Kecoughtan Rd	Victoria Blvd	1.0	1.0	0.0	2.0	2.43	2.99	1.85	2.29	1.76	2.17	1.94	2.39	1.99	2.46	-0.47
HAM	King St	Little Back River Rd	3.8	4.3	0.0	8.0	8.67	7.14	7.15	5.89	6.77	5.58	6.97	5.75	7.39	6.09	1.30
HAM	King St	Rip Rap Rd	3.8	2.8	0.0	6.5	5.42	3.66	4.51	3.04	5.17	3.49	4.66	3.14	4.94	3.33	1.61
HAM	LaSalle Ave	Pembroke Ave	6.5	3.8	0.0	10.3	7.31	6.36	9.31	8.10	8.82	7.68	9.80	8.53	8.81	7.67	1.14
HAM	LaSalle Ave	Settlers Landing Rd	4.0	3.8	0.0	7.8	7.58	5.54	6.97	5.09	6.60	4.82	7.34	5.36	7.12	5.20	1.92
HAM	LaSalle Ave	Victoria Blvd	2.0	1.3	0.0	3.3	3.77	5.04	3.42	4.57	3.25	4.34	3.58	4.79	3.50	4.69	-1.18
HAM	Magruder Blvd	Commander Sheppard Blvd/Semple Farm Rd	5.0	3.0	0.0	8.0	9.86	11.38	7.60	8.79	7.20	8.33	8.35	9.65	8.25	9.54	-1.28
HAM	Mallory St	County St	1.5	0.3	0.0	1.8	2.74	3.50	2.31	2.95	2.19	2.79	2.42	3.09	2.41	3.08	-0.67
HAM	Mallory St	Mellen St	1.3	1.0	0.0	2.3	2.82	3.51	2.39	2.98	2.27	2.82	2.51	3.12	2.50	3.11	-0.61
HAM	Mallory St	Pembroke Ave	0.8	0.3	0.0	1.0	1.49	1.89	1.25	1.58	1.44	1.82	1.02	1.29	1.30	1.64	-0.35
HAM	Mercury Blvd	Aberdeen Rd	11.5	7.8	0.0	19.3	20.61	20.91	19.69	19.97	18.66	18.92	19.19	19.47	19.54	19.82	-0.28
HAM	Mercury Blvd	Armistead Ave	15.8	10.8	0.3	26.8	29.31	23.59	28.25	22.73	24.08	19.39	25.69	20.69	26.83	21.60	5.23
HAM	Mercury Blvd	Big Bethel Rd	10.8	9.5	0.0	20.3	21.67	19.78	19.93	18.18	18.88	17.22	19.38	17.69	19.97	18.22	1.75
HAM	Mercury Blvd	Chestnut Ave	2.5	2.3	0.3	5.0	6.01	7.82	4.51	5.87	5.44	7.08	5.99	7.80	5.49	7.14	-1.66
HAM	Mercury Blvd	Coliseum Dr	19.0	10.8	0.0	29.8	30.37	20.02	29.44	19.41	27.60	18.19	28.14	18.55	28.89	19.04	9.85
HAM	Mercury Blvd	Cunningham Dr	17.3	11.5	0.0	28.8	33.13	19.82	25.23	15.09	23.90	14.30	26.42	15.81	27.17	16.26	10.91
HAM	Mercury Blvd	Fox Hill Rd/Cherry Acres Dr	10.3	7.5	0.0	17.8	18.82	12.54	16.56	11.03	15.68	10.45	16.63	11.08	16.92	11.27	5.65
HAM	Mercury Blvd	Mallory St	5.0	3.5	0.0	8.5	8.19	4.13	6.81	3.43	6.45	3.25	6.52	3.29	6.99	3.52	3.47
HAM	Mercury Blvd	Pembroke Ave	5.5	4.8	0.0	10.3	9.37	6.14	8.62	5.65	8.16	5.35	9.07	5.94	8.81	5.77	3.04
HAM	Mercury Blvd	Power Plant Pkwy/Todds Ln	24.5	19.8	0.0	44.3	45.38	23.65	43.20	22.51	41.62	21.69	42.40	22.11	43.15	22.49	20.66
HAM	Mercury Blvd	Roanoke Ave/Whealton Rd	3.5	2.5	0.0	6.0	7.25	14.60	6.33	12.74	5.87	11.82	6.48	13.05	6.48	13.05	-6.57
HAM	Pembroke Ave	Aberdeen Rd	4.8	3.8	0.0	8.5	6.85	3.26	6.68	3.18	6.47	3.08	6.70	3.19	6.68	3.18	3.50
HAM	Pembroke Ave	King St	2.3	3.0	0.0	5.3	4.02	3.20	3.51	2.79	3.32	2.64	3.59	2.86	3.61	2.87	0.74
HAM	Pembroke Ave	Old Buckroe Rd	4.0	1.8	0.0	5.8	5.91	4.08	4.23	2.92	4.01	2.76	4.44	3.06	4.65	3.20	1.44
HAM	Pembroke Ave	Woodland Rd	5.8	4.0	0.0	9.8	9.06	4.86	6.99	3.75	6.62	3.56	7.35	3.95	7.50	4.03	3.47
HAM	Power Plant Pkwy	Briarfield Rd/Queen St	7.0	6.8	0.0	13.8	14.17	7.56	11.55	6.17	10.94	5.85	11.52	6.16	12.04	6.43	5.61
HAM	Power Plant Pkwy	Pine Chapel Rd	3.8	1.3	0.0	5.0	5.29	4.49	4.13	3.51	4.73	4.02	4.29	3.64	4.61	3.91	0.69
HAM	Powhatan Pkwy	Pembroke Ave	4.8	4.0	0.0	8.8	9.17	7.37	8.43	6.78	7.99	6.42	8.26	6.65	8.46	6.80	1.66
HAM	Settlers Landing Rd	Armistead Ave	3.0	2.0	0.0	5.0	5.87	6.05	4.67	4.81	4.42	4.55	4.91	5.06	4.97	5.12	-0.15
HAM	Settlers Landing Rd	Kecoughtan Rd	1.3	1.0	0.0	2.3	3.10	3.54	2.25	2.56	2.58	2.93	2.53	2.87	2.62	2.97	-0.36
HAM	Settlers Landing Rd	Tyler St/I-64 Ramp	6.5	3.8	0.0	10.3	10.44	5.93	8.56	4.87	8.11	4.61	8.47	4.81	8.89	5.06	3.84
HAM	Settlers Landing Rd/Queen St	Pembroke Ave	3.0	1.8	0.0	4.8	4.87	3.63	4.07	3.03	3.85	2.87	4.28	3.19	4.27	3.18	1.09
HAM	Todds Ln	Aberdeen Rd/Hunt Club Blvd	5.0	1.8	0.0	6.8	7.47	7.06	6.53	6.17	6.19	5.84	6.87	6.49	6.77	6.39	0.38
HAM	Todds Ln	Big Bethel Rd	11.0	6.5	0.3	17.8	18.85	7.99	14.66	6.21	13.89	5.88	15.43	6.54	15.71	6.65	9.05
HAM	Woodland Rd	County St	2.0	2.5	0.0	4.5	3.39	3.86	2.91	3.30	3.33	3.79	3.25	3.69	3.22	3.66	-0.44
HAM	Woodland Rd	Mercury Blvd	5.5	6.0	0.0	11.5	10.19	5.54	9.80	5.32	9.29	5.04	10.11	5.49	9.85	5.35	4.50
IW	Battery Park Rd	Nike Park Rd	1.0	0.3	0.0	1.3	1.52	1.87	1.46	1.79	1.47	1.81	1.40	1.73	1.46	1.80	-0.34
IW	Benns Church Blvd	Brewers Neck Rd	2.8	1.3	0.0	4.0	4.54	5.95	4.13	5.41	4.99	6.54	4.64	6.08	4.58	5.99	-1.42
IW	Benns Church Blvd/Route 10 Bypass	Church St S	2.3	0.5	0.0	2.8	3.65	5.89	3.33	5.37	3.75	6.04	3.68	5.93	3.60	5.81	-2.20
IW	Bus Route 58/258 (Carrsville Hwy)	Route 258	0.0	0.3	0.0	0.3	1.01	1.87	0.93	1.72	0.79	1.46	0.89	1.66	0.90	1.68	-0.77
IW	Carrollton Blvd	Brewers Neck Blvd	3.8	1.5	0.0	5.3	5.54	6.99	4.83	6.09	5.60	7.06	5.63	7.11	5.40	6.81	-1.41
IW	Carrollton Blvd	Smiths Neck Rd	2.5	1.3	0.0	3.8	4.74	9.49	4.45	8.91	4.13	8.27	4.66	9.32	4.50	9.00	-4.50

Source: HRTPO analysis of VDOT data. Includes an analysis of VDOT data using HSM methods.
FAT = Number of crashes with at least one fatality. INJ = Number of crashes with at least one injury but no fatalities. PDO = Number of crashes with property damage only. F+I = FAT + INJ crashes.

Appendix D (continued) - Potential for Safety Improvement - Intersections

Juris-diction	Major Road	Minor Road	Average Annual Observed Crashes (2009-2012) PDO	INJ	FAT	Total	2009 Expected Total Crashes	2009 Adjusted Predicted Crashes	2010 Expected Total Crashes	2010 Adjusted Predicted Crashes	2011 Expected Total Crashes	2011 Adjusted Predicted Crashes	2012 Expected Total Crashes	2012 Adjusted Predicted Crashes	Average Annual Expected Total Crashes	Average Annual Adjusted Predicted Crashes	Potential for Safety Improvement
IW	Church St	Main St	0.3	0.0	0.0	0.3	1.41	3.49	1.42	3.50	1.20	2.96	1.33	3.29	1.34	3.31	-1.97
IW	Church St S	Battery Park Rd	1.3	0.0	0.0	1.3	2.43	4.54	2.46	4.58	2.11	3.93	2.33	4.35	2.33	4.35	-2.02
IW	Nike Park Rd	Titus Creek Dr	2.5	1.3	0.0	3.8	3.24	2.52	4.80	3.73	3.91	3.04	2.51	1.95	3.62	2.81	0.81
IW	Route 10 Bypass	Main St	3.3	2.3	0.0	5.5	5.46	5.60	5.35	5.49	5.60	5.73	6.22	6.37	5.66	5.80	-0.14
IW	Route 10 Bypass/Old Stage Hwy	Bus Rte 10 N (Old Stage Hwy)	0.8	0.5	0.0	1.3	1.10	1.03	1.55	1.46	1.32	1.24	0.91	0.86	1.22	1.15	0.07
IW	Route 460	Court St/Church St/Bank St	0.8	0.8	0.0	1.5	2.03	3.96	1.87	3.65	2.00	3.91	2.22	4.34	2.03	3.96	-1.93
IW	Route 460 (Windsor Blvd)	Route 258 (Prince Blvd)	3.3	0.5	0.0	3.8	4.20	4.22	3.86	3.88	3.91	3.93	4.34	4.37	4.07	4.10	-0.03
IW	Smiths Neck Rd	Titus Creek Dr	1.5	1.3	0.0	2.8	2.46	2.36	3.61	3.47	2.96	2.85	1.89	1.82	2.73	2.63	0.11
JCC	Barhamsville Rd/Richmond Rd	Richmond Rd/Rochambeau Dr	1.8	2.5	0.0	4.3	4.11	4.22	4.04	4.14	3.84	3.93	4.28	4.39	4.07	4.17	-0.10
JCC	Centerville Rd	Longhill Rd	0.8	3.0	0.0	3.8	3.82	2.99	3.11	2.44	3.58	2.81	2.52	1.97	3.26	2.55	0.71
JCC	Croaker Rd	Rochambeau Dr	2.0	1.5	0.0	3.5	2.75	2.33	2.91	2.47	2.76	2.34	3.12	2.64	2.88	2.45	0.44
JCC	Depue Dr/Ironbound Rd	Ironbound Rd/Galt Dr	1.0	0.3	0.0	1.3	1.97	2.93	2.16	3.21	2.04	3.04	2.05	3.05	2.05	3.06	-1.01
JCC	Depue Dr/Longhill Rd	Longhill Rd	0.0	0.5	0.0	0.5	0.88	2.38	0.86	2.38	1.07	2.95	1.10	3.04	0.98	2.69	-1.71
JCC	Ironbound Rd	News Rd	0.3	1.3	0.0	1.5	1.55	1.95	1.27	1.59	1.48	1.85	1.39	1.74	1.42	1.78	-0.36
JCC	Ironbound Rd	Strawberry Plains Rd	0.5	0.5	0.0	1.0	1.35	2.19	1.52	2.48	1.44	2.35	1.56	2.53	1.47	2.39	-0.92
JCC	Jamestown Rd	Greensprings Rd/Rte 359	0.5	0.3	0.0	0.8	1.17	1.94	1.81	2.98	2.08	3.43	1.49	2.45	1.64	2.70	-1.06
JCC	Jamestown Rd	Sandy Bay Rd	1.8	2.0	0.0	3.8	2.65	2.60	4.17	4.06	3.95	3.84	4.37	4.25	3.79	3.69	0.10
JCC	John Tyler Hwy	Centerville Rd	0.8	1.5	0.0	2.3	1.36	1.02	1.15	0.87	1.42	1.07	1.54	1.16	1.37	1.03	0.34
JCC	John Tyler Hwy	Ironbound Rd	2.0	2.8	0.0	4.8	4.62	3.54	3.78	2.90	3.59	2.75	3.87	2.97	3.96	3.04	0.93
JCC	John Tyler Hwy/Strawberry Plains Rd	John Tyler Hwy	0.3	0.0	0.0	0.3	0.69	0.97	0.56	0.79	0.70	0.98	0.76	1.06	0.68	0.95	-0.27
JCC	Longhill Rd	Olde Towne Rd/Devon Rd	2.5	4.0	0.0	6.5	6.16	5.21	5.70	4.82	5.40	4.57	5.60	4.73	5.72	4.83	0.88
JCC	Merrimac Trail	Penniman Rd	2.5	4.3	0.0	6.8	6.57	4.53	5.64	3.90	5.35	3.70	5.91	4.09	5.87	4.05	1.81
JCC	Monticello Ave	Centerville Rd	0.5	1.5	0.0	2.0	1.88	2.87	1.77	2.71	1.68	2.57	1.86	2.84	1.80	2.75	-0.95
JCC	Monticello Ave	Ironbound Rd	5.0	3.0	0.0	8.0	8.40	7.49	8.40	7.49	7.96	7.10	8.27	7.37	8.26	7.36	0.89
JCC	Monticello Ave	News Rd	2.0	1.3	0.0	3.3	5.08	13.90	4.63	12.66	4.40	12.02	4.85	13.26	4.74	12.96	-8.22
JCC	Monticello Ave/John Tyler Hwy	John Tyler Hwy	0.3	0.3	0.0	0.5	1.00	1.10	0.44	0.49	0.51	0.56	0.50	0.55	0.61	0.67	-0.06
JCC	Mooretown Rd	Rochambeau Dr	2.5	1.5	0.0	4.0	2.72	1.52	2.58	1.44	2.99	1.67	2.96	1.65	2.81	1.57	1.24
JCC	Richmond Rd	Centerville Rd	3.5	4.8	0.0	8.3	8.41	8.27	7.68	7.55	7.28	7.15	8.04	7.91	7.85	7.72	0.13
JCC	Richmond Rd	Croaker Rd	1.3	1.8	0.0	3.0	3.57	5.87	3.58	5.87	3.40	5.57	3.78	6.21	3.58	5.88	-2.30
JCC	Richmond Rd	Lightfoot Rd	3.5	2.8	0.0	6.3	6.53	6.14	6.37	5.98	6.05	5.68	6.74	6.33	6.42	6.03	0.39
JCC	Richmond Rd	Olde Towne Rd	2.0	3.3	0.0	5.3	3.88	3.13	4.37	3.54	5.01	4.06	4.88	3.96	4.53	3.67	0.86
JCC	Route 199	Henry St/Kingspoint Dr	1.5	3.3	0.0	4.8	5.23	9.01	4.63	7.98	4.38	7.56	4.87	8.40	4.78	8.24	-3.46
JCC	Route 199	John Tyler Hwy	6.3	3.8	0.0	10.0	11.11	13.47	9.94	12.05	9.42	11.42	10.46	12.69	10.23	12.41	-2.18
JCC	Route 199	Quarterpath Rd/Mounts Bay Rd	3.3	4.3	0.0	7.5	8.00	11.10	7.13	9.89	6.75	9.37	7.50	10.41	7.35	10.20	-2.85
NN	25th St	Buxton Ave	2.8	2.5	0.0	5.3	3.85	1.64	2.68	1.14	2.46	1.04	2.65	1.13	2.91	1.24	1.67
NN	25th St	Chestnut Ave	0.8	1.3	0.0	2.0	1.14	0.79	0.97	0.67	0.92	0.63	0.98	0.68	1.00	0.69	0.31
NN	25th St	Roanoke Ave	0.3	0.5	0.0	0.8	0.66	0.68	0.54	0.55	0.51	0.52	0.54	0.55	0.56	0.58	-0.02
NN	26th St	Chestnut Ave	0.5	1.3	0.0	1.8	0.74	0.53	0.52	0.37	0.49	0.35	0.54	0.38	0.57	0.41	0.17
NN	26th St	Roanoke Ave	0.8	0.3	0.0	1.0	0.65	0.45	0.42	0.29	0.40	0.28	0.44	0.31	0.48	0.33	0.14
NN	Briarfield Rd	Roanoke Ave	0.5	0.8	0.0	1.3	1.61	1.87	1.35	1.57	1.28	1.48	1.37	1.59	1.40	1.63	-0.22
NN	Chestnut Ave	39th St	2.5	2.3	0.0	4.8	3.53	2.08	3.47	2.04	3.28	1.94	3.53	2.08	3.45	2.04	1.42
NN	Chestnut Ave	Briarfield Rd	3.0	1.5	0.0	4.5	3.71	2.17	3.53	2.06	3.34	1.95	3.59	2.10	3.54	2.07	1.47
NN	Denbigh Blvd	McManus Blvd	4.3	3.3	0.0	7.5	7.00	5.39	6.20	4.78	7.11	5.48	6.67	5.14	6.74	5.20	1.55
NN	Denbigh Blvd	Richneck Rd	1.0	1.8	0.0	2.8	2.12	3.45	1.55	2.52	1.92	3.12	2.02	3.28	1.90	3.09	-1.19
NN	Fort Eustis Blvd	Richneck Rd	2.0	0.8	0.0	2.8	3.16	2.80	2.62	2.33	3.02	2.68	2.17	1.93	2.74	2.44	0.31
NN	HRC Pkwy/Harpersville Rd	Harpersville Rd/Terrace Dr	4.3	4.8	0.0	9.0	8.21	6.77	7.49	6.18	7.12	5.87	7.87	6.48	7.67	6.32	1.35
NN	Huntington Ave	23rd St	0.3	0.3	0.0	0.5	0.90	1.23	0.80	1.10	0.76	1.04	0.83	1.14	0.82	1.13	-0.31
NN	Huntington Ave	26th St	1.5	2.0	0.0	3.5	3.24	2.80	3.21	2.77	3.03	2.61	3.36	2.90	3.21	2.77	0.44
NN	Huntington Ave	39th St	2.0	1.8	0.0	3.8	3.47	2.97	3.50	2.99	3.31	2.84	3.28	2.81	3.39	2.90	0.49
NN	J Clyde Morris Blvd	Diligence Dr	12.0	13.5	0.3	25.8	24.60	11.32	22.63	10.41	22.13	10.18	24.59	11.31	23.49	10.80	12.68

Source: HRTPO analysis of VDOT data. Includes an analysis of VDOT data using HSM methods.
FAT = Number of crashes with at least one fatality. INJ = Number of crashes with at least one injury but no fatalities. PDO = Number of crashes with property damage only. F+I = FAT + INJ crashes.

Appendix D (continued) - Potential for Safety Improvement - Intersections

Juris-diction	Major Road	Minor Road	Average Annual Observed Crashes (2009-2012) PDO	INJ	FAT	Total	2009 Expected Total Crashes	2009 Adjusted Predicted Crashes	2010 Expected Total Crashes	2010 Adjusted Predicted Crashes	2011 Expected Total Crashes	2011 Adjusted Predicted Crashes	2012 Expected Total Crashes	2012 Adjusted Predicted Crashes	Average Annual Expected Total Crashes	Average Annual Adjusted Predicted Crashes	Potential for Safety Improvement
NN	J Clyde Morris Blvd	Harpersville Rd/Old Oyster Point Rd	9.0	7.3	0.0	16.3	16.11	13.18	14.81	12.12	14.03	11.48	15.59	12.76	15.14	12.39	2.75
NN	J Clyde Morris Blvd	Thimble Shoals Blvd	6.5	4.5	0.0	11.0	11.99	10.84	10.92	9.86	10.67	9.64	11.79	10.65	11.34	10.25	1.10
NN	Jefferson Ave	25th St	0.0	1.0	0.0	1.0	1.41	2.54	1.04	1.88	0.99	1.78	1.09	1.98	1.13	2.04	-0.91
NN	Jefferson Ave	26th St	0.3	2.3	0.0	2.5	2.18	2.33	1.93	2.06	1.82	1.95	2.03	2.17	1.99	2.13	-0.14
NN	Jefferson Ave	Bland Blvd	15.8	10.0	0.0	25.8	28.40	40.92	25.38	36.57	24.94	35.93	28.48	41.03	26.80	38.61	-11.81
NN	Jefferson Ave	Briarfield Rd	3.5	3.8	0.0	7.3	8.15	10.14	6.45	8.04	6.34	7.90	7.51	9.35	7.11	8.86	-1.74
NN	Jefferson Ave	Center Ave	2.8	3.0	0.3	6.0	6.80	12.64	5.65	10.52	5.50	10.22	6.26	11.65	6.05	11.26	-5.20
NN	Jefferson Ave	Denbigh Blvd	11.5	13.5	0.0	25.0	25.76	24.39	23.96	22.68	23.57	22.29	26.93	25.45	25.06	23.71	1.35
NN	Jefferson Ave	Fort Eustis Blvd	11.0	7.3	0.0	18.3	18.86	12.43	16.34	10.77	16.04	10.57	18.45	12.16	17.43	11.48	5.94
NN	Jefferson Ave	Harpersville Rd	5.8	10.5	0.3	16.5	19.75	24.16	14.25	17.58	13.50	16.65	15.18	18.70	15.67	19.27	-3.60
NN	Jefferson Ave	J Clyde Morris Blvd	13.5	15.8	0.0	29.3	33.93	27.56	26.22	21.36	26.06	21.22	30.13	24.51	29.08	23.67	5.42
NN	Jefferson Ave	Main St	3.0	5.3	0.0	8.3	9.20	15.67	8.50	14.46	7.86	13.38	9.17	15.58	8.68	14.77	-6.09
NN	Jefferson Ave	Oyster Point Rd	16.0	13.8	0.0	29.8	32.19	30.01	26.67	24.88	26.24	24.47	30.08	28.05	28.80	26.85	1.94
NN	Jefferson Ave	Richneck Rd	1.5	2.5	0.0	4.0	5.55	10.08	5.15	9.37	4.30	7.85	4.92	8.96	4.98	9.06	-4.08
NN	Jefferson Ave	Thimble Shoals Blvd	10.8	10.8	0.0	21.5	22.89	20.50	19.49	17.47	19.24	17.23	22.24	19.91	20.96	18.78	2.19
NN	Jefferson Ave	Yorktown Rd	4.5	3.3	0.0	7.8	7.21	5.14	6.25	4.45	5.92	4.22	6.09	4.34	6.37	4.54	1.83
NN	Mercury Blvd	Jefferson Ave	17.5	19.8	0.0	37.3	37.51	19.27	32.85	16.88	32.15	16.51	34.97	17.97	34.37	17.66	16.71
NN	Oyster Point Rd	Canon Blvd	7.8	6.0	0.0	13.8	15.35	18.06	14.43	16.97	13.67	16.08	14.62	17.20	14.52	17.08	-2.56
NN	Roanoke Ave	39th St	1.0	2.3	0.0	3.3	1.66	0.93	1.25	0.70	1.18	0.66	1.26	0.70	1.34	0.75	0.59
NN	Saunders Rd/Harpersville Rd	Harpersville Rd	0.8	0.8	0.0	1.5	1.70	1.90	1.45	1.62	1.67	1.87	1.63	1.82	1.61	1.80	-0.19
NN	Thimble Shoals Blvd	Diligence Dr	1.3	1.3	0.0	2.5	2.70	3.03	2.18	2.44	2.49	2.80	2.45	2.74	2.45	2.75	-0.30
NN	Warwick Blvd	Shellabarger Dr/Ashton Green Blvd	4.0	4.3	0.0	8.3	9.79	10.49	7.74	8.31	7.34	7.87	8.15	8.75	8.25	8.86	-0.60
NN	Warwick Blvd	Bland Blvd	5.8	6.5	0.0	12.3	14.13	16.15	11.97	13.70	11.34	12.98	12.50	14.31	12.49	14.29	-1.80
NN	Warwick Blvd	Center Ave	1.0	2.8	0.0	3.8	4.38	6.08	3.83	5.33	3.63	5.05	4.03	5.61	3.97	5.52	-1.55
NN	Warwick Blvd	Denbigh Blvd	12.8	11.3	0.0	24.0	26.49	18.36	22.34	15.50	21.17	14.68	22.68	15.74	23.17	16.07	7.10
NN	Warwick Blvd	Harpersville Rd	4.0	1.8	0.0	5.8	6.81	8.29	6.13	7.46	5.80	7.06	6.41	7.80	6.29	7.65	-1.36
NN	Warwick Blvd	J Clyde Morris Blvd	8.5	2.5	0.0	11.0	14.73	17.32	10.83	12.70	10.26	12.03	11.31	13.27	11.78	13.83	-2.04
NN	Warwick Blvd	Main St	2.3	1.0	0.0	3.3	4.44	8.68	4.00	7.82	3.79	7.41	4.12	8.04	4.09	7.99	-3.90
NN	Warwick Blvd	Oyster Point Rd	8.5	8.8	0.0	17.3	19.03	15.69	16.46	13.59	15.60	12.88	17.24	14.23	17.08	14.10	2.98
NN	Warwick Blvd	Yorktown Rd	4.0	1.0	0.0	5.0	5.15	2.33	3.45	1.56	4.26	1.93	4.36	1.98	4.31	1.95	2.36
NOR	21st St	Llewellyn Ave	0.3	1.3	0.0	1.5	2.45	4.47	2.27	4.15	2.13	3.88	2.31	4.23	2.29	4.18	-1.89
NOR	26th St	Llewellyn Ave	3.5	1.8	0.0	5.3	4.12	2.23	3.97	2.14	3.59	1.94	4.68	2.53	4.09	2.21	1.88
NOR	27th St	Llewellyn Ave	2.5	1.8	0.0	4.3	3.99	2.80	3.81	2.68	3.48	2.44	3.72	2.61	3.75	2.63	1.12
NOR	Admiral Taussig Blvd	Hampton Blvd	3.3	2.3	0.0	5.5	6.42	9.82	5.90	9.03	5.65	8.64	6.48	9.91	6.11	9.35	-3.24
NOR	Azalea Garden Rd	Robin Hood Rd	0.3	0.8	0.0	1.0	1.78	2.96	1.71	2.83	1.54	2.55	1.42	2.36	1.61	2.68	-1.07
NOR	Azalea Garden Rd	Sewells Point Rd	1.0	2.3	0.0	3.3	4.00	5.18	3.68	4.77	3.49	4.52	3.27	4.25	3.61	4.68	-1.07
NOR	Berkley Ave	Berkley Ave Ext/Fauquier St	0.5	0.3	0.0	0.8	1.65	3.44	1.65	3.45	1.43	3.00	1.43	3.00	1.54	3.22	-1.68
NOR	Berkley Ave	South Main St	2.0	1.5	0.0	3.5	3.84	3.40	3.56	3.15	3.35	2.96	3.04	2.69	3.45	3.05	0.40
NOR	Berkley Ave	State St	1.8	0.8	0.0	2.5	3.02	3.60	3.01	3.58	2.64	3.14	2.50	2.97	2.79	3.32	-0.53
NOR	Berkley Ave/Indian River Rd	Indian River Rd/Marsh St	0.3	0.3	0.0	0.5	1.28	2.86	1.28	2.88	1.11	2.50	1.33	2.98	1.25	2.80	-1.56
NOR	Boush St	City Hall Ave	1.5	0.0	0.0	1.5	2.55	5.50	2.27	4.91	2.51	5.44	2.38	5.14	2.43	5.25	-2.82
NOR	Boush St/Llewellyn Ave	Va Beach Blvd	2.0	0.8	0.0	2.8	2.38	2.40	2.29	2.31	2.08	2.09	2.29	2.31	2.26	2.28	-0.02
NOR	Brambleton Ave	Boush St	3.5	4.0	0.0	7.5	8.80	15.27	8.16	14.18	7.66	13.31	8.03	13.95	8.16	14.18	-6.01
NOR	Brambleton Ave	Church St	2.8	3.5	0.0	6.3	6.60	10.83	6.38	10.47	5.75	9.44	5.29	8.71	6.01	9.86	-3.86
NOR	Brambleton Ave	Colley Ave	5.0	3.3	0.0	8.3	9.53	13.81	8.76	12.71	8.30	12.04	8.83	12.80	8.86	12.84	-3.98
NOR	Brambleton Ave	Duke St	3.0	3.0	0.0	6.0	7.48	12.49	6.88	11.49	6.52	10.88	6.70	11.20	6.89	11.51	-4.62
NOR	Brambleton Ave	Monticello Ave	4.0	2.3	0.0	6.3	7.03	7.77	6.65	7.36	6.13	6.77	6.73	7.44	6.63	7.33	-0.70
NOR	Brambleton Ave	Park Ave	7.3	7.5	0.3	15.0	15.24	15.86	16.01	16.65	13.28	13.82	14.25	14.84	14.69	15.29	-0.60
NOR	Brambleton Ave	St Pauls Blvd	7.8	6.3	0.0	14.0	14.53	12.41	13.50	11.54	12.66	10.82	14.45	12.35	13.79	11.78	2.01
NOR	Brambleton Ave	Tidewater Dr	5.0	6.3	0.0	11.3	11.54	12.68	11.01	12.08	10.06	11.05	11.58	12.72	11.05	12.13	-1.09

Source: HRTPO analysis of VDOT data. Includes an analysis of VDOT data using HSM methods.

FAT = Number of crashes with at least one fatality. INJ = Number of crashes with at least one injury but no fatalities. PDO = Number of crashes with property damage only. F+I = FAT + INJ crashes.

Appendix D (continued) - Potential for Safety Improvement - Intersections

Juris-diction	Major Road	Minor Road	Average Annual Observed Crashes (2009-2012) PDO	INJ	FAT	Total	2009 Expected Total Crashes	2009 Adjusted Predicted Crashes	2010 Expected Total Crashes	2010 Adjusted Predicted Crashes	2011 Expected Total Crashes	2011 Adjusted Predicted Crashes	2012 Expected Total Crashes	2012 Adjusted Predicted Crashes	Average Annual Expected Total Crashes	Average Annual Adjusted Predicted Crashes	Potential for Safety Improvement
NOR	Campostella Rd	Indian River Rd	2.3	3.3	0.0	5.5	6.02	8.89	6.30	9.28	5.25	7.74	6.11	9.00	5.92	8.73	-2.81
NOR	Campostella Rd	Wilson Rd	1.0	1.0	0.0	2.0	3.37	10.16	3.22	9.71	2.93	8.83	3.59	10.81	3.28	9.88	-6.60
NOR	Chesapeake Blvd	Bayview Blvd	6.0	4.5	0.0	10.5	10.01	7.91	9.21	7.27	8.72	6.89	9.50	7.50	9.36	7.39	1.97
NOR	Chesapeake Blvd	Cromwell Dr	3.3	4.0	0.0	7.3	7.46	6.52	7.37	6.44	6.50	5.68	6.69	5.85	7.00	6.12	0.88
NOR	Chesapeake Blvd	Johnstons Rd	5.0	7.5	0.0	12.5	11.98	8.82	11.25	8.28	10.01	7.37	11.60	8.53	11.21	8.25	2.96
NOR	Chesapeake Blvd	Norview Ave/Sewells Point Rd	9.0	10.3	0.3	19.5	17.03	7.12	16.63	6.95	14.84	6.20	15.26	6.38	15.94	6.66	9.27
NOR	Chesapeake Blvd	Robin Hood Rd	0.8	0.5	0.0	1.3	1.73	3.12	1.59	2.87	1.71	3.09	1.54	2.78	1.64	2.96	-1.32
NOR	Church St	26th St	3.0	2.0	0.0	5.0	5.72	5.94	5.58	5.79	4.97	5.16	5.21	5.41	5.37	5.57	-0.20
NOR	Church St	27th St	2.3	5.0	0.0	7.3	6.39	4.13	5.92	3.82	5.57	3.59	6.17	3.98	6.01	3.88	2.13
NOR	Church St	Granby St	0.8	1.3	0.0	2.0	2.91	5.66	2.53	4.92	2.87	5.59	2.80	5.45	2.78	5.41	-2.63
NOR	Church St	Monticello Ave	1.5	0.0	0.0	1.5	3.14	10.79	2.93	10.07	2.74	9.40	3.09	10.60	2.98	10.21	-7.24
NOR	Church St	Princess Anne Rd	3.0	2.3	0.0	5.3	5.43	6.99	5.34	6.88	4.73	6.09	4.64	5.98	5.03	6.49	-1.45
NOR	Church St	Va Beach Blvd	1.8	3.3	0.0	5.0	5.19	5.47	5.09	5.36	4.52	4.77	4.88	5.15	4.92	5.19	-0.27
NOR	City Hall Ave	Monticello Ave	0.8	0.3	0.0	1.0	1.20	1.25	1.07	1.11	1.19	1.24	0.96	1.00	1.11	1.15	-0.04
NOR	Colley Ave	21st St	2.8	2.8	0.0	5.5	5.11	5.68	5.01	5.56	4.46	4.95	4.95	5.50	4.88	5.42	-0.54
NOR	Colley Ave	26th St	3.0	2.0	0.0	5.0	5.09	4.16	5.02	4.10	4.44	3.62	5.05	4.12	4.90	4.00	0.90
NOR	Colley Ave	27th St	3.3	3.8	0.0	7.0	6.69	5.11	6.61	5.04	5.81	4.44	6.31	4.81	6.35	4.85	1.50
NOR	Colley Ave	38th St	3.5	0.5	0.0	4.0	4.71	4.38	4.37	4.06	4.10	3.82	4.56	4.24	4.43	4.13	0.31
NOR	Colley Ave	Olney Rd	0.8	2.8	0.0	3.5	3.74	5.62	3.44	5.16	3.25	4.88	3.28	4.93	3.43	5.15	-1.72
NOR	Duke St/Virginia Beach Blvd	Olney Rd	3.3	1.0	0.0	4.3	3.40	1.84	3.23	1.75	2.95	1.60	3.39	1.83	3.24	1.76	1.49
NOR	Granby St	38th St	1.8	0.5	0.0	2.3	2.98	6.53	2.89	6.33	2.60	5.69	3.01	6.60	2.87	6.29	-3.41
NOR	Granby St	Bay Ave	1.3	0.5	0.0	1.8	2.50	3.20	2.30	2.94	2.18	2.79	2.18	2.79	2.29	2.93	-0.64
NOR	Granby St	Bayview Blvd	4.0	1.8	0.0	5.8	6.73	7.60	6.52	7.36	5.87	6.62	6.37	7.19	6.37	7.19	-0.82
NOR	Granby St	Little Creek Rd	8.0	4.5	0.3	12.8	13.39	13.23	12.32	12.17	10.53	10.41	12.70	12.54	12.24	12.09	0.15
NOR	Granby St	Ocean Ave	1.0	0.8	0.0	1.8	2.28	2.64	2.10	2.43	1.99	2.30	1.88	2.18	2.06	2.39	-0.33
NOR	Granby St	Thole St	1.8	3.5	0.0	5.3	5.68	7.12	5.03	6.32	5.61	7.04	5.32	6.66	5.41	6.78	-1.37
NOR	Granby St	Willow Wood Dr	3.3	2.3	0.0	5.5	5.89	7.53	5.49	7.04	5.82	7.44	5.85	7.48	5.76	7.37	-1.61
NOR	Hampton Blvd	26th St	2.8	0.8	0.0	3.5	4.32	4.81	3.59	3.99	4.23	4.71	3.18	3.55	3.83	4.26	-0.43
NOR	Hampton Blvd	27th St	1.0	1.5	0.0	2.5	3.64	10.91	3.37	10.11	3.26	9.78	3.76	11.26	3.51	10.51	-7.01
NOR	Hampton Blvd	38th St	1.8	2.0	0.0	3.8	4.13	10.46	3.83	9.70	3.69	9.35	4.13	10.47	3.94	10.00	-6.05
NOR	Hampton Blvd	Azalea Ct	2.0	1.3	0.0	3.3	4.64	10.50	4.30	9.74	4.04	9.15	4.69	10.61	4.42	10.00	-5.58
NOR	Hampton Blvd	Int Terminal Blvd	10.0	5.8	0.0	15.8	15.24	12.43	14.15	11.54	13.64	11.12	16.82	13.71	14.96	12.20	2.76
NOR	Hampton Blvd	Jamestown Crescent	3.3	4.0	0.0	7.3	7.19	6.14	6.24	5.33	7.28	6.22	7.15	6.13	6.96	5.95	1.01
NOR	Hampton Blvd	Little Creek Rd	3.5	2.5	0.0	6.0	7.14	14.38	6.63	13.36	6.41	12.90	6.63	13.36	6.70	13.50	-6.80
NOR	Hampton Blvd	Princess Anne Rd	4.0	4.8	0.0	8.8	8.63	8.35	8.00	7.73	7.50	7.24	8.99	8.68	8.28	8.00	0.28
NOR	Indian River Rd	Wilson Rd	1.0	0.5	0.0	1.5	2.47	4.03	2.46	4.02	2.14	3.50	2.39	3.90	2.37	3.86	-1.49
NOR	Kempsville Rd/Princess Anne Rd	Newtown Rd	4.3	2.5	0.0	6.8	8.08	11.23	7.79	10.83	7.04	9.79	6.78	9.43	7.43	10.32	-2.89
NOR	Little Creek Rd	Azalea Garden Rd	3.0	6.0	0.0	9.0	9.57	9.00	8.97	8.43	8.34	7.84	8.33	7.85	8.80	8.28	0.52
NOR	Little Creek Rd	Chesapeake Blvd	12.3	11.8	0.0	24.0	25.59	15.24	22.85	13.61	21.45	12.77	16.90	10.10	21.70	12.93	8.77
NOR	Little Creek Rd	Halprin Dr	5.8	6.5	0.0	12.3	11.24	8.04	10.40	7.44	9.79	7.01	9.97	7.14	10.35	7.41	2.95
NOR	Little Creek Rd	Military Hwy	6.0	6.3	0.0	12.3	12.96	15.35	11.67	13.83	10.96	12.99	11.37	13.48	11.74	13.91	-2.17
NOR	Little Creek Rd	Sewells Point Rd	1.3	1.0	0.0	2.3	3.55	8.34	3.29	7.74	3.09	7.27	3.20	7.53	3.28	7.72	-4.44
NOR	Llewellyn Ave	38th St	1.0	0.5	0.0	1.5	2.30	3.42	2.33	3.47	2.01	2.98	2.23	3.31	2.22	3.30	-1.08
NOR	Llewellyn Ave	Princess Anne Rd	1.5	0.5	0.0	2.0	2.56	2.77	2.46	2.66	2.21	2.39	2.47	2.68	2.43	2.63	-0.20
NOR	Military Hwy	Azalea Garden Rd	5.0	5.8	0.0	10.8	10.58	8.64	9.92	8.10	8.83	7.21	9.19	7.51	9.63	7.86	1.76
NOR	Military Hwy	Johnstons Rd	3.3	3.5	0.3	7.0	7.75	9.21	7.56	8.98	6.76	8.02	6.34	7.55	7.10	8.44	-1.33
NOR	Military Hwy	Lowery Rd	6.3	6.3	0.0	12.5	13.25	14.93	12.57	14.16	11.24	12.67	11.95	13.47	12.25	13.81	-1.55
NOR	Military Hwy	Northampton Blvd/Princess Anne Rd	6.8	7.3	0.0	14.0	15.81	19.99	15.00	18.96	13.45	17.01	14.69	18.59	14.74	18.64	-3.90
NOR	Military Hwy	Norview Ave	6.0	4.3	0.3	10.5	11.08	11.13	10.69	10.73	9.66	9.70	8.98	9.03	10.10	10.15	-0.04
NOR	Military Hwy	Robin Hood Rd	5.0	4.8	0.0	9.8	11.42	15.28	10.98	14.68	9.71	12.99	10.37	13.88	10.62	14.21	-3.59

Source: HRTPO analysis of VDOT data. Includes an analysis of VDOT data using HSM methods.
FAT = Number of crashes with at least one fatality. INJ = Number of crashes with at least one injury but no fatalities. PDO = Number of crashes with property damage only. F+I = FAT + INJ crashes.
Portsmouth crash data represents the years 2011-2012. Portsmouth crash data from 2009 and 2010 was not used due to incomplete data.

Appendix D (continued) - Potential for Safety Improvement - Intersections

Juris-diction	Major Road	Minor Road	Average Annual Observed Crashes (2009-2012) PDO	INJ	FAT	Total	2009 Expected Total Crashes	2009 Adjusted Predicted Crashes	2010 Expected Total Crashes	2010 Adjusted Predicted Crashes	2011 Expected Total Crashes	2011 Adjusted Predicted Crashes	2012 Expected Total Crashes	2012 Adjusted Predicted Crashes	Average Annual Expected Total Crashes	Average Annual Adjusted Predicted Crashes	Potential for Safety Improvement
NOR	Monticello Ave	21st St	1.0	1.0	0.0	2.0	2.80	5.18	2.76	5.10	2.44	4.51	3.97	7.32	2.99	5.53	-2.54
NOR	Monticello Ave	26th St	3.5	8.5	0.0	12.0	9.63	5.03	9.51	4.96	8.39	4.38	10.20	5.32	9.43	4.92	4.51
NOR	Monticello Ave	27th St	3.5	4.3	0.0	7.8	6.85	5.11	6.76	5.05	5.97	4.46	7.04	5.26	6.65	4.97	1.69
NOR	Monticello Ave	Princess Anne Rd	2.8	3.3	0.0	6.0	5.52	5.07	5.45	5.01	4.81	4.42	8.20	7.51	5.99	5.50	0.49
NOR	Monticello Ave	Va Beach Blvd	3.0	3.5	0.0	6.5	6.91	8.67	6.62	8.31	6.02	7.56	6.64	8.35	6.55	8.22	-1.67
NOR	Northampton Blvd	Kempsville Rd/USAA Dr	3.0	3.8	0.5	7.3	7.72	11.92	7.23	11.17	6.73	10.38	7.47	11.54	7.29	11.25	-3.96
NOR	Northampton Blvd	Wesleyan Dr	9.8	6.3	0.0	16.0	17.40	29.70	15.77	26.92	14.94	25.50	18.59	31.71	16.68	28.45	-11.78
NOR	Norview Ave	Azalea Garden Rd	2.0	1.3	0.0	3.3	3.55	4.70	3.33	4.41	3.09	4.10	3.12	4.13	3.27	4.34	-1.06
NOR	Ocean View Ave	4th View St	1.3	2.3	0.0	3.5	3.03	2.82	2.86	2.66	2.99	2.78	2.79	2.59	2.92	2.71	0.21
NOR	Ocean View Ave	Chesapeake Blvd	2.5	3.3	0.0	5.8	3.96	2.99	3.45	2.60	3.91	2.95	3.91	2.95	3.81	2.87	0.94
NOR	Ocean View Ave	Granby St	1.8	0.5	0.0	2.3	2.55	3.66	2.25	3.23	2.52	3.62	2.39	3.42	2.43	3.48	-1.05
NOR	Princess Anne Rd	Azalea Garden Rd	3.0	3.3	0.0	6.3	6.36	7.97	5.85	7.33	5.55	6.94	5.39	6.75	5.79	7.25	-1.46
NOR	Princess Anne Rd	Ballentine Blvd	3.5	2.8	0.0	6.3	7.07	7.47	6.50	6.87	5.86	6.19	6.27	6.63	6.43	6.79	-0.36
NOR	Princess Anne Rd	Colley Ave	0.8	1.8	0.0	2.5	2.45	2.76	2.34	2.64	2.14	2.41	2.62	2.95	2.39	2.69	-0.30
NOR	Princess Anne Rd	Ingleside Rd	2.3	2.8	0.0	5.0	5.73	7.59	5.35	7.09	4.74	6.29	5.10	6.75	5.23	6.93	-1.70
NOR	Princess Anne Rd	Park Ave/Lead St	1.8	3.0	0.0	4.8	4.68	7.38	4.52	7.12	4.07	6.43	3.35	5.30	4.15	6.56	-2.41
NOR	Princess Anne Rd	Sewells Point Rd	2.5	2.8	0.0	5.3	5.98	7.70	5.50	7.09	5.21	6.71	5.14	6.63	5.46	7.03	-1.57
NOR	S Main St	Bainbridge Blvd	0.5	0.0	0.0	0.5	0.44	0.40	0.34	0.30	0.41	0.37	0.75	0.67	0.48	0.43	0.05
NOR	S Main St	Liberty St	0.5	1.0	0.0	1.5	1.29	1.32	1.22	1.25	1.12	1.15	2.08	2.14	1.43	1.46	-0.04
NOR	Sewells Point Rd	Johnstons Rd	0.8	0.5	0.0	1.3	1.80	2.54	1.73	2.44	1.57	2.21	1.50	2.12	1.65	2.33	-0.68
NOR	Sewells Point Rd	Robin Hood Rd	1.5	1.8	0.0	3.3	3.52	3.78	3.26	3.50	3.07	3.29	3.06	3.29	3.23	3.47	-0.24
NOR	Shore Dr	Little Creek Rd	2.8	4.3	0.0	7.0	7.87	13.52	7.24	12.43	6.64	11.41	7.14	12.26	7.22	12.40	-5.18
NOR	St Pauls Blvd	City Hall Ave	6.3	1.5	0.0	7.8	9.28	13.85	8.94	13.35	8.09	12.07	8.56	12.77	8.72	13.01	-4.29
NOR	St Pauls Blvd	Market St/I-264 Ramp	4.3	2.5	0.0	6.8	7.88	15.00	7.60	14.46	6.87	13.07	7.26	13.83	7.40	14.09	-6.69
NOR	St Pauls Blvd	Monticello Ave	1.3	1.5	0.0	2.8	2.92	4.17	2.64	3.78	2.88	4.12	2.69	3.85	2.78	3.98	-1.20
NOR	Tidewater Dr	Bayview Blvd	4.3	3.5	0.0	7.8	7.74	6.13	7.12	5.64	6.75	5.34	7.34	5.82	7.24	5.73	1.50
NOR	Tidewater Dr	Cromwell Dr	4.8	6.0	0.0	10.8	11.51	12.55	10.77	11.75	10.33	11.27	11.60	12.64	11.05	12.05	-1.00
NOR	Tidewater Dr	Lafayette Blvd	2.0	5.0	0.0	7.0	7.96	11.83	7.32	10.88	6.94	10.31	7.16	10.64	7.35	10.91	-3.57
NOR	Tidewater Dr	Norview Ave	2.5	3.8	0.0	6.3	5.82	6.41	5.08	5.59	5.75	6.33	5.66	6.22	5.58	6.14	-0.56
NOR	Tidewater Dr	Princess Anne Rd	4.0	7.0	0.0	11.0	11.03	11.98	10.25	11.14	9.61	10.44	9.52	10.34	10.10	10.97	-0.87
NOR	Tidewater Dr	Thole St/I-64 Ramp	2.0	5.3	0.3	7.5	8.77	12.09	8.07	11.12	7.65	10.53	7.94	10.96	8.11	11.17	-3.07
NOR	Tidewater Dr	Va Beach Blvd	5.8	5.8	0.0	11.5	11.44	11.05	10.71	10.35	9.97	9.63	11.46	11.07	10.89	10.52	0.37
NOR	Tidewater Dr	Willow Wood Dr	3.0	2.8	0.0	5.8	5.20	7.10	4.59	6.28	5.29	7.23	5.47	7.49	5.14	7.02	-1.89
NOR	Va Beach Blvd	Azalea Garden Rd	1.0	1.5	0.0	2.5	3.71	10.01	3.99	10.74	3.23	8.73	3.53	9.53	3.62	9.75	-6.14
NOR	Va Beach Blvd	Ballentine Blvd	3.8	3.5	0.0	7.3	7.74	10.23	7.49	9.90	6.74	8.92	8.79	11.60	7.69	10.16	-2.47
NOR	Va Beach Blvd	Ingleside Rd	2.5	3.0	0.0	5.5	5.97	8.85	5.72	8.48	5.20	7.71	6.87	10.16	5.94	8.80	-2.86
NOR	Va Beach Blvd	Kempsville Rd	3.3	2.5	0.0	5.8	7.21	11.93	6.94	11.48	6.28	10.39	6.42	10.62	6.71	11.11	-4.39
NOR	Va Beach Blvd	Newtown Rd	9.0	7.5	0.0	16.5	17.17	17.11	16.35	16.28	14.96	14.91	18.53	18.43	16.75	16.68	0.07
NOR	Va Beach Blvd	Park Ave	2.5	3.0	0.0	5.5	5.01	4.96	4.69	4.63	4.37	4.32	6.02	5.95	5.02	4.96	0.06
NOR	Waterside Dr	St Pauls Blvd/Water St	2.5	2.3	0.0	4.8	6.27	10.92	5.97	10.40	5.47	9.52	5.86	10.21	5.89	10.26	-4.37
NOR	Wilson Rd/22nd St	Berkley Ave Ext	1.5	1.5	0.0	3.0	2.42	2.08	2.31	1.98	2.08	1.79	2.29	1.97	2.27	1.95	0.32
POQ	East Yorktown Rd/Wythe Creek Rd	Poquoson Ave/Kelsor Dr	0.8	0.0	0.0	0.8	1.45	1.90	1.32	1.72	1.25	1.63	1.34	1.75	1.34	1.75	-0.41
POQ	Hunt's Neck Rd/East Yorktown Rd	East Yorktown Rd	1.8	0.0	0.0	1.8	1.60	1.16	1.34	0.97	1.53	1.11	1.45	1.05	1.48	1.07	0.41
POQ	Little Florida Rd	Poquoson Ave	1.0	0.8	0.0	1.8	1.71	1.34	1.21	0.95	1.49	1.17	1.64	1.29	1.51	1.19	0.32
POQ	Wythe Creek Rd	Victory Blvd/Little Florida Rd	8.5	4.5	0.0	13.0	11.44	4.39	10.73	4.12	10.16	3.90	10.21	3.92	10.64	4.08	6.55
PORT	Airline Blvd	Elmhurst Ln	1.5	1.0	0.0	2.5	-	-	-	-	2.71	3.29	2.99	3.63	2.85	3.46	-0.62
PORT	Airline Blvd	Greenwood Dr	3.0	7.0	0.0	10.0	-	-	-	-	6.24	4.07	6.93	4.52	6.59	4.30	2.29
PORT	Airline Blvd	High St	6.0	5.5	0.0	11.5	-	-	-	-	9.21	6.22	9.54	6.44	9.37	6.33	3.04
PORT	Airline Blvd	Portsmouth Blvd/McLean St	7.5	4.5	0.0	12.0	-	-	-	-	9.24	5.22	9.45	5.34	9.35	5.28	4.07
PORT	Cedar Ln	Coast Guard Blvd/Rte 164 Ramp	2.0	0.5	0.0	2.5	-	-	-	-	2.83	3.35	3.14	3.72	2.99	3.54	-0.55

Source: HRTPO analysis of VDOT data. Includes an analysis of VDOT data using HSM methods.
FAT = Number of crashes with at least one fatality. INJ = Number of crashes with at least one injury but no fatalities. PDO = Number of crashes with property damage only. F+I = FAT + INJ crashes.
Portsmouth crash data represents the years 2011-2012. Portsmouth crash data from 2009 and 2010 was not used due to incomplete data.

Appendix D (continued) – Potential for Safety Improvement - Intersections

Juris-diction	Major Road	Minor Road	Average Annual Observed Crashes (2009-2012) PDO	INJ	FAT	Total	2009 Expected Total Crashes	2009 Adjusted Predicted Crashes	2010 Expected Total Crashes	2010 Adjusted Predicted Crashes	2011 Expected Total Crashes	2011 Adjusted Predicted Crashes	2012 Expected Total Crashes	2012 Adjusted Predicted Crashes	Average Annual Expected Total Crashes	Average Annual Adjusted Predicted Crashes	Potential for Safety Improvement
PORT	Cedar Ln	W Norfolk Rd	3.0	0.5	0.0	3.5	-	-	-	-	3.47	3.48	3.84	3.85	3.65	3.67	-0.01
PORT	Churchland Blvd	Tyre Neck Rd	1.0	0.5	0.0	1.5	-	-	-	-	1.96	2.23	2.12	2.41	2.04	2.32	-0.28
PORT	Churchland Blvd	W Norfolk Rd/Academy Ave	1.5	1.0	0.0	2.5	-	-	-	-	2.70	2.77	2.76	2.84	2.73	2.81	-0.08
PORT	Crawford Pkwy	Court St	0.5	0.0	0.0	0.5	-	-	-	-	0.22	0.17	0.24	0.19	0.23	0.18	0.05
PORT	Crawford St	High St	0.5	0.0	0.0	0.5	-	-	-	-	1.44	1.92	1.57	2.09	1.50	2.00	-0.50
PORT	Crawford St	London Blvd	0.0	0.0	0.0	0.0	-	-	-	-	1.17	1.86	1.28	2.02	1.23	1.94	-0.71
PORT	Deep Creek Blvd	Greenwood Dr	1.0	1.5	0.0	2.5	-	-	-	-	1.90	1.89	2.05	2.03	1.97	1.96	0.01
PORT	Effingham St	County St	6.0	4.0	0.0	10.0	-	-	-	-	8.35	6.31	8.86	6.69	8.61	6.50	2.11
PORT	Effingham St	Crawford Pkwy	1.5	1.0	0.0	2.5	-	-	-	-	2.63	2.75	2.92	3.05	2.77	2.90	-0.13
PORT	Effingham St	High St	3.5	2.0	0.0	5.5	-	-	-	-	6.01	7.71	6.41	8.22	6.21	7.97	-1.75
PORT	Effingham St	London Blvd	1.5	0.5	0.0	2.0	-	-	-	-	3.67	8.18	3.86	8.59	3.77	8.38	-4.62
PORT	Effingham St/GW Hwy	Portsmouth Blvd	4.5	2.0	0.0	6.5	-	-	-	-	6.87	7.71	7.85	8.82	7.36	8.27	-0.90
PORT	Elm Ave	County St	1.5	2.5	0.0	4.0	-	-	-	-	2.71	2.31	2.94	2.50	2.83	2.41	0.42
PORT	Elm Ave	Victory Blvd/Williams Ave	1.0	0.0	0.0	1.0	-	-	-	-	1.78	2.19	1.92	2.37	1.85	2.28	-0.43
PORT	Elmhurst Ln	Garwood Ave	1.0	1.5	0.0	2.5	-	-	-	-	0.82	0.50	0.88	0.54	0.85	0.52	0.34
PORT	Frederick Blvd	Airline Blvd	7.5	6.5	0.0	14.0	-	-	-	-	12.30	9.13	13.49	10.01	12.89	9.57	3.33
PORT	Frederick Blvd	Deep Creek Blvd	3.5	6.0	0.0	9.5	-	-	-	-	6.98	6.67	8.05	7.69	7.51	7.18	0.33
PORT	Frederick Blvd	Portsmouth Blvd	3.5	5.0	0.0	8.5	-	-	-	-	6.58	5.09	7.26	5.62	6.92	5.36	1.57
PORT	Frederick Blvd	Turnpike Rd	6.0	6.0	0.0	12.0	-	-	-	-	11.29	12.41	12.54	13.79	11.91	13.10	-1.19
PORT	George Washington Hwy	Elm Ave	3.5	5.0	0.0	8.5	-	-	-	-	5.63	4.33	6.56	5.03	6.10	4.68	1.42
PORT	George Washington Hwy	Frederick Blvd	7.0	3.0	0.0	10.0	-	-	-	-	8.59	5.83	8.58	5.82	8.58	5.83	2.75
PORT	George Washington Hwy	Greenwood Dr	2.5	8.5	0.0	11.0	-	-	-	-	6.79	3.96	6.61	3.85	6.70	3.90	2.79
PORT	George Washington Hwy	Victory Blvd	12.0	9.5	0.0	21.5	-	-	-	-	16.59	8.43	18.88	9.59	17.73	9.01	8.72
PORT	Greenwood Dr	Cavalier Blvd	2.5	1.5	0.0	4.0	-	-	-	-	3.76	3.92	3.85	4.02	3.80	3.97	-0.17
PORT	Greenwood Dr	Garwood Ave	4.0	4.0	0.0	8.0	-	-	-	-	5.59	3.33	6.17	3.67	5.88	3.50	2.38
PORT	Harbor Dr	Turnpike Rd	0.0	0.0	0.0	0.0	-	-	-	-	0.77	1.23	0.83	1.33	0.80	1.28	-0.49
PORT	High St	Cedar Ln/Sterling Point Dr	3.5	5.5	0.0	9.0	-	-	-	-	7.87	8.61	9.07	9.91	8.47	9.26	-0.79
PORT	High St	Churchland Blvd	2.0	1.0	0.0	3.0	-	-	-	-	4.07	7.12	4.50	7.87	4.29	7.49	-3.20
PORT	High St	Court St	1.5	2.5	0.0	4.0	-	-	-	-	2.20	1.76	2.35	1.89	2.28	1.82	0.45
PORT	High St	Elm Ave	3.5	2.5	0.0	6.0	-	-	-	-	5.08	3.93	5.61	4.35	5.35	4.14	1.21
PORT	High St	Frederick Blvd	1.5	1.0	0.0	2.5	-	-	-	-	3.81	6.75	3.87	6.86	3.84	6.81	-2.97
PORT	High St	Harbor Dr/MLK Fwy	3.5	2.5	0.0	6.0	-	-	-	-	5.20	4.16	5.78	4.62	5.49	4.39	1.10
PORT	High St	Tyre Neck Rd	5.0	2.5	0.0	7.5	-	-	-	-	7.22	6.35	8.02	7.05	7.62	6.70	0.92
PORT	London Blvd	Court St	1.5	0.0	0.0	1.5	-	-	-	-	1.74	1.61	1.87	1.73	1.80	1.67	0.13
PORT	London Blvd	Elm Ave	1.0	0.5	0.0	1.5	-	-	-	-	3.33	7.09	3.53	7.52	3.43	7.30	-3.87
PORT	Portcentre Pkwy	Portsmouth Blvd	1.5	1.5	0.0	3.0	-	-	-	-	2.92	2.32	2.05	1.63	2.49	1.98	0.51
PORT	Portsmouth Blvd	Deep Creek Blvd	1.0	2.0	0.0	3.0	-	-	-	-	2.66	2.72	2.94	3.01	2.80	2.86	-0.06
PORT	Portsmouth Blvd	Elm Ave	4.0	3.5	0.0	7.5	-	-	-	-	4.29	2.64	4.59	2.82	4.44	2.73	1.71
PORT	Portsmouth Blvd	Elmhurst Ln	4.5	4.0	0.0	8.5	-	-	-	-	7.45	6.98	7.89	7.39	7.67	7.19	0.48
PORT	Portsmouth Blvd	Victory Blvd/California Ave	2.0	2.0	0.0	4.0	-	-	-	-	3.28	5.70	3.44	5.98	3.36	5.84	-2.48
PORT	Turnpike Rd/Portsmouth Blvd	Portsmouth Blvd	1.0	2.5	0.0	3.5	-	-	-	-	3.14	3.25	2.82	2.92	2.98	3.08	-0.11
PORT	Twin Pines Rd/Towne Point Rd	Towne Point Rd/Centenary Dr	1.5	4.5	0.0	6.0	-	-	-	-	5.48	6.31	5.79	6.68	5.64	6.49	-0.85
PORT	Victory Blvd	Airline Blvd	2.5	2.0	0.0	4.5	-	-	-	-	5.72	8.51	5.99	8.91	5.86	8.71	-2.85
PORT	Victory Blvd	Deep Creek Blvd	1.5	1.0	0.0	2.5	-	-	-	-	2.72	4.08	2.81	4.22	2.77	4.15	-1.38
PORT	Victory Blvd	Greenwood Dr	5.0	4.0	0.0	9.0	-	-	-	-	7.63	6.02	8.43	6.65	8.03	6.33	1.70
PORT	West Norfolk Rd	Tyre Neck Rd	0.5	0.5	0.0	1.0	-	-	-	-	1.14	1.22	1.24	1.33	1.19	1.28	-0.09
SH	Main St (Rte 35/58 Bus)	Meherrin Rd (Rte 35/58 Bus)	0.0	0.0	0.0	0.0	0.90	1.59	0.75	1.34	0.88	1.56	0.69	1.22	0.80	1.43	-0.62
SH	Route 189	Pretlow Rd	0.3	0.0	0.0	0.3	0.31	0.39	0.44	0.55	0.38	0.47	0.27	0.34	0.35	0.44	-0.09
SH	Route 258	Route 189	0.0	0.5	0.0	0.5	0.59	0.88	0.84	1.25	0.72	1.07	0.46	0.69	0.65	0.97	-0.32
SH	Route 35	General Thomas Hwy (Rte 671)	0.8	0.0	0.0	0.8	0.69	0.72	0.97	1.01	0.83	0.87	0.59	0.61	0.77	0.81	-0.04

Source: HRTPO analysis of VDOT data. Includes an analysis of VDOT data using HSM methods.

FAT = Number of crashes with at least one fatality. INJ = Number of crashes with at least one injury but no fatalities. PDO = Number of crashes with property damage only. F+I = FAT + INJ crashes.

Appendix D (continued) - Potential for Safety Improvement - Intersections

Juris-diction	Major Road	Minor Road	Average Annual Observed Crashes (2009-2012) PDO	INJ	FAT	Total	2009 Expected Total Crashes	2009 Adjusted Predicted Crashes	2010 Expected Total Crashes	2010 Adjusted Predicted Crashes	2011 Expected Total Crashes	2011 Adjusted Predicted Crashes	2012 Expected Total Crashes	2012 Adjusted Predicted Crashes	Average Annual Expected Total Crashes	Average Annual Adjusted Predicted Crashes	Potential for Safety Improvement
SH	Route 35	Ivor Rd (Route 616)	0.3	0.0	0.0	0.3	0.36	0.56	0.50	0.78	0.46	0.72	0.35	0.54	0.42	0.65	-0.23
SH	Route 35	Route 186	0.0	0.0	0.0	0.0	0.26	0.69	0.36	0.96	0.32	0.85	0.22	0.60	0.29	0.78	-0.49
SH	Route 460	Route 616 (Main St)	0.3	0.5	0.0	0.8	1.02	1.16	0.86	0.98	1.00	1.13	1.08	1.23	0.99	1.13	-0.14
SH	Route 58	Bus Route 58 (Camp Pkwy)	0.5	0.3	0.0	0.8	1.12	3.56	1.11	3.53	1.12	3.56	1.13	3.59	1.12	3.56	-2.44
SH	Route 58	Bus Route 58 (Jerusalem Rd)	0.8	1.5	0.0	2.3	2.32	3.40	2.00	2.94	2.30	3.37	2.30	3.38	2.23	3.27	-1.04
SUF	Bennetts Pasture Rd	Kings Hwy	1.3	1.8	0.0	3.0	2.54	1.97	2.45	1.90	2.22	1.72	2.38	1.85	2.40	1.86	0.54
SUF	Bridge Rd	Bennetts Pasture Rd/Bennetts Creek Ln	2.3	1.8	0.0	4.0	4.35	7.91	4.04	7.33	3.79	6.89	4.37	7.93	4.14	7.51	-3.37
SUF	Bridge Rd	College Dr	4.5	5.3	0.0	9.8	9.93	8.05	9.14	7.41	9.07	7.35	10.08	8.17	9.56	7.74	1.81
SUF	Bridge Rd	Crittenden Rd	1.5	1.8	0.0	3.3	2.82	2.56	2.59	2.35	2.69	2.43	2.76	2.50	2.71	2.46	0.25
SUF	Bridge Rd	Harbour View Blvd	4.8	5.0	0.0	9.8	8.71	7.70	7.84	6.94	8.45	7.45	8.55	7.54	8.39	7.41	0.98
SUF	Bridge Rd	Shoulders Hill Rd/Knotts Neck Rd	5.3	2.5	0.0	7.8	8.02	10.13	7.70	9.73	7.53	9.52	8.45	10.68	7.93	10.01	-2.09
SUF	Bridge Rd	Town Point Rd/Western Fwy Ramp	2.5	0.8	0.0	3.3	3.49	3.18	2.89	2.64	3.67	3.36	2.64	2.42	3.17	2.90	0.27
SUF	Carolina Rd	Copeland Rd	1.0	0.3	0.0	1.3	1.32	1.37	1.32	1.37	1.27	1.32	1.25	1.30	1.29	1.34	-0.05
SUF	Carolina Rd/Whaleyville Blvd	Carolina Rd	2.0	0.5	0.0	2.5	2.21	2.35	1.66	1.76	1.98	2.12	2.18	2.33	2.01	2.14	-0.13
SUF	College Dr	Hampton Roads Pkwy	3.3	3.0	0.0	6.3	6.57	6.53	6.07	6.03	5.37	5.34	5.61	5.58	5.90	5.87	0.03
SUF	College Dr	Harbour View Blvd/Armistead Rd	0.8	1.0	0.0	1.8	2.35	3.50	2.09	3.11	1.63	2.43	1.16	1.73	1.81	2.69	-0.89
SUF	Constance Rd	Pinner St/Wilroy Rd	2.8	2.8	0.3	5.8	5.72	5.12	5.66	5.06	4.58	4.09	5.06	4.52	5.26	4.70	0.56
SUF	Constance Rd	Pitchkettle Rd/Prentis St	0.8	1.3	0.0	2.0	2.12	2.43	2.17	2.48	1.66	1.90	1.78	2.05	1.93	2.21	-0.28
SUF	Everetts Rd	Lake Prince Dr	0.3	0.0	0.0	0.3	0.31	0.38	0.43	0.53	0.37	0.46	0.26	0.32	0.34	0.42	-0.08
SUF	Godwin Blvd	Everetts Rd	0.8	0.3	0.0	1.0	1.08	1.60	1.55	2.31	1.21	1.81	0.78	1.16	1.15	1.72	-0.57
SUF	Godwin Blvd	Kings Fork Rd	2.3	3.8	0.0	6.0	4.85	3.16	4.44	2.90	4.84	3.16	4.72	3.08	4.71	3.07	1.64
SUF	Godwin Blvd	Kings Hwy	1.3	1.5	0.0	2.8	2.53	2.25	3.60	3.20	2.81	2.50	1.83	1.63	2.69	2.40	0.30
SUF	Harbour View Blvd	Hampton Roads Pkwy/River Club Dr	1.3	1.3	0.0	2.5	3.68	7.21	3.56	6.98	2.57	5.05	2.84	5.58	3.16	6.20	-3.04
SUF	Holland Rd/S Quay Rd	Ruritan Blvd	0.0	0.0	0.0	0.0	0.24	0.57	0.34	0.80	0.29	0.68	0.19	0.45	0.27	0.62	-0.36
SUF	Holland Rd/Suffolk Bypass	Holland Rd (Bus Rte 58)	5.5	4.0	0.0	9.5	8.68	7.47	7.73	6.66	8.63	7.42	8.41	7.23	8.36	7.20	1.17
SUF	Kings Fork Rd	Pitchkettle Rd	0.0	0.5	0.0	0.5	0.47	0.52	0.69	0.77	0.62	0.69	0.39	0.43	0.54	0.60	-0.06
SUF	Kings Fork Rd	Providence Rd	0.5	0.0	0.0	0.5	0.40	0.38	0.58	0.55	0.55	0.52	0.36	0.34	0.47	0.45	0.03
SUF	Kings Hwy	Crittenden Rd	0.8	0.3	0.0	1.0	0.88	0.77	1.28	1.12	0.96	0.84	0.61	0.53	0.93	0.82	0.12
SUF	Main St	Constance Rd	8.0	6.0	0.0	14.0	14.23	10.83	11.68	8.89	10.46	7.97	11.62	8.85	12.00	9.14	2.86
SUF	Main St	Finney Ave	4.0	3.5	0.0	7.5	7.36	6.37	7.18	6.21	5.78	5.01	6.38	5.52	6.67	5.78	0.90
SUF	Main St	Market St	1.3	2.0	0.0	3.3	2.91	3.25	2.65	2.98	2.58	2.87	2.51	2.80	2.66	2.97	-0.31
SUF	Main St	Washington St	3.8	3.3	0.0	7.0	7.12	6.87	6.95	6.69	5.59	5.39	6.18	5.96	6.46	6.23	0.23
SUF	Main St/Pruden Blvd	Godwin Blvd	4.0	2.8	0.0	6.8	8.77	11.09	7.28	9.22	6.62	8.38	7.35	9.32	7.51	9.50	-2.00
SUF	Nansemond Pkwy	Bennetts Pasture Rd	2.0	2.0	0.0	4.0	3.11	1.44	2.35	1.09	2.91	1.35	3.20	1.49	2.89	1.34	1.55
SUF	Nansemond Pkwy	Kings Hwy	0.5	0.5	0.0	1.0	1.15	1.30	0.95	1.08	1.07	1.21	1.17	1.32	1.08	1.23	-0.14
SUF	Nansemond Pkwy	Shoulders Hill Rd/Northgate Commerce Pkwy	1.3	1.5	0.0	2.8	2.55	3.45	2.58	3.49	2.47	3.34	2.73	3.68	2.58	3.49	-0.91
SUF	Nansemond Pkwy	Wilroy Rd	2.0	0.8	0.0	2.8	2.05	2.01	1.79	1.75	2.02	1.98	1.97	1.93	1.96	1.92	0.04
SUF	Pinner St	Finney Ave	0.5	0.5	0.0	1.0	1.65	2.74	1.60	2.65	1.33	2.20	1.43	2.37	1.50	2.49	-0.99
SUF	Portsmouth Blvd	Nansemond Pkwy/Washington St	3.5	7.0	0.0	10.5	9.20	7.37	9.06	7.25	7.78	6.24	8.47	6.80	8.63	6.92	1.72
SUF	Pruden Blvd (Rte 460)	Kings Fork Rd	1.5	1.3	0.0	2.8	3.74	5.94	3.48	5.52	2.82	4.49	3.12	4.96	3.29	5.23	-1.94
SUF	Pruden Blvd (Rte 460)	Lake Prince Dr/Providence Rd	1.3	0.8	0.3	2.3	2.54	3.84	2.19	3.32	2.48	3.76	2.76	4.18	2.49	3.78	-1.28
SUF	Pughsville Rd	Townpoint Rd	0.3	0.8	0.0	1.0	1.27	1.82	1.09	1.56	1.24	1.78	0.88	1.26	1.12	1.60	-0.48
SUF	Route 189	Route 272	0.0	0.5	0.0	0.5	0.43	0.42	0.61	0.59	0.54	0.52	0.37	0.36	0.49	0.47	0.01
SUF	Route 58	Buckhorn Dr	1.0	0.5	0.0	1.5	1.76	2.93	1.77	2.95	1.67	2.79	1.67	2.79	1.72	2.86	-1.15
SUF	Route 58	Lummis Rd	1.3	2.3	0.0	3.5	3.49	3.96	3.49	3.96	3.55	4.02	3.72	4.22	3.56	4.04	-0.48
SUF	Route 58	Route 189 (Holland)	0.5	0.5	0.0	1.0	1.19	2.04	1.03	1.76	1.14	1.95	1.18	2.02	1.14	1.94	-0.81
SUF	Route 58	Route 272	0.5	0.3	0.0	0.8	1.13	3.21	1.13	3.21	1.07	3.03	1.08	3.08	1.10	3.13	-2.03
SUF	Shoulders Hill Rd	Pughsville Rd/Rabey Farm Rd	3.0	1.5	0.0	4.5	2.94	2.45	2.86	2.38	3.16	2.63	3.15	2.63	3.03	2.52	0.50
SUF	Washington St	Market St/Wellons St	0.3	0.3	0.0	0.5	1.27	2.38	1.10	2.07	0.92	1.72	0.99	1.85	1.07	2.01	-0.94
SUF	Washington St	Pinner St	1.3	1.3	0.0	2.5	2.88	3.07	2.58	2.75	2.86	3.04	1.91	2.03	2.55	2.72	-0.17

Source: HRTPO analysis of VDOT data. Includes an analysis of VDOT data using HSM methods.

FAT = Number of crashes with at least one fatality. INJ = Number of crashes with at least one injury but no fatalities. PDO = Number of crashes with property damage only. F+I = FAT + INJ crashes.

Appendix D (continued) - Potential for Safety Improvement - Intersections

Juris-diction	Major Road	Minor Road	Average Annual Observed Crashes (2009-2012) PDO	INJ	FAT	Total	2009 Expected Total Crashes	2009 Adjusted Predicted Crashes	2010 Expected Total Crashes	2010 Adjusted Predicted Crashes	2011 Expected Total Crashes	2011 Adjusted Predicted Crashes	2012 Expected Total Crashes	2012 Adjusted Predicted Crashes	Average Annual Expected Total Crashes	Average Annual Adjusted Predicted Crashes	Potential for Safety Improvement
SUF	Washington St/Holland Rd	Constance Rd	1.0	0.8	0.0	1.8	1.84	1.82	1.64	1.61	1.68	1.65	1.60	1.58	1.69	1.66	0.02
SUF	Whaleyville Blvd	Copeland Rd	0.5	0.8	0.0	1.3	1.67	2.42	1.73	2.50	1.45	2.09	1.44	2.08	1.57	2.27	-0.70
SUR	Route 10	Route 31 (North)	0.3	0.5	0.0	0.8	0.77	1.13	0.70	1.04	0.69	1.02	0.85	1.25	0.75	1.11	-0.36
SUR	Route 10	Route 31 (South)	0.0	0.5	0.0	0.5	0.58	0.87	0.82	1.24	0.72	1.09	0.51	0.77	0.66	0.99	-0.34
SUR	Route 10	Route 40	0.5	0.3	0.0	0.8	0.95	1.23	0.98	1.27	0.99	1.28	1.02	1.32	0.99	1.28	-0.29
VB	Atlantic Ave	17th St/Va Beach Blvd	0.5	0.0	0.0	0.5	1.41	1.96	1.26	1.74	1.38	1.92	1.03	1.43	1.27	1.76	-0.49
VB	Atlantic Ave	21st St	1.8	0.5	0.0	2.3	1.80	1.49	1.61	1.33	1.76	1.45	1.35	1.12	1.63	1.35	0.28
VB	Atlantic Ave	22nd St	0.5	0.3	0.0	0.8	1.10	1.19	0.99	1.07	1.08	1.17	0.97	1.05	1.04	1.12	-0.09
VB	Atlantic Ave	31st St	0.8	1.0	0.0	1.8	1.51	1.45	1.35	1.29	1.49	1.42	1.27	1.21	1.41	1.34	0.06
VB	Atlantic Ave	9th St/Norfolk Ave	0.3	0.3	0.0	0.5	1.14	1.41	0.88	1.08	0.96	1.19	0.83	1.02	0.95	1.18	-0.23
VB	Atlantic Ave/Pacific Ave	Atlantic Ave	0.8	0.0	0.0	0.8	1.86	3.34	1.62	2.90	1.84	3.30	1.72	3.09	1.76	3.16	-1.40
VB	Birdneck Rd	Norfolk Ave	5.3	2.8	0.0	8.0	6.42	3.67	5.96	3.41	5.60	3.20	8.09	4.63	6.52	3.73	2.79
VB	Birdneck Rd	Va Beach Blvd	9.3	7.3	0.0	16.5	16.51	9.37	15.80	8.97	14.39	8.17	15.41	8.75	15.53	8.81	6.71
VB	Blackwater Rd	Pungo Ferry Rd	0.5	0.5	0.0	1.0	0.84	0.70	1.23	1.02	1.02	0.85	0.54	0.45	0.91	0.75	0.15
VB	Bonney Rd	Constitution Dr	0.5	0.5	0.0	1.0	1.55	3.16	1.54	3.14	1.35	2.75	1.50	3.06	1.49	3.03	-1.54
VB	Centerville Tpke	Lynnhaven Pkwy	3.0	3.8	0.0	6.8	6.80	5.59	6.30	5.18	5.92	4.87	6.99	5.75	6.50	5.35	1.16
VB	Constitution Dr	Columbus St	0.5	0.3	0.0	0.8	1.49	2.17	1.41	2.06	1.30	1.89	1.67	2.43	1.47	2.14	-0.67
VB	Dam Neck Rd	Drakesmile Rd	10.5	3.5	0.0	14.0	13.53	9.71	12.28	8.81	13.36	9.59	14.16	10.15	13.33	9.56	3.77
VB	Dam Neck Rd	Harpers Rd	5.0	4.8	0.0	9.8	9.66	8.85	9.27	8.49	8.39	7.69	9.59	8.79	9.23	8.45	0.77
VB	Dam Neck Rd	Holland Rd	13.8	6.3	0.0	20.0	20.15	17.25	19.66	16.84	17.55	15.03	21.55	18.46	19.73	16.90	2.83
VB	Dam Neck Rd	London Bridge Rd	12.3	6.8	0.0	19.0	20.01	16.94	19.55	16.55	17.43	14.76	20.10	17.02	19.27	16.32	2.95
VB	Dam Neck Rd	Rosemont Rd	6.3	6.0	0.0	12.3	11.59	8.73	10.43	7.87	11.14	8.39	11.31	8.51	11.12	8.38	2.74
VB	Diamond Springs Rd	Wesleyan Dr	3.0	4.0	0.0	7.0	7.28	8.05	7.12	7.87	6.35	7.02	7.17	7.92	6.98	7.71	-0.73
VB	Diamond Springs Rd/Newtown Rd	Newtown Rd	2.8	3.0	0.0	5.8	5.18	4.29	4.69	3.89	5.12	4.24	5.25	4.35	5.06	4.19	0.87
VB	Drakesmile Rd/London Bridge Rd	Shipps Corner Rd/London Bridge Rd	11.0	6.5	0.0	17.5	17.22	11.91	16.33	11.29	15.01	10.38	17.19	11.89	16.44	11.37	5.07
VB	Ferrell Pkwy	Indian Lakes Blvd	7.0	5.3	0.0	12.3	14.37	21.93	13.91	21.21	12.52	19.10	11.54	17.62	13.09	19.96	-6.88
VB	Ferrell Pkwy/Indian River Rd	Indian River Rd	5.3	6.3	0.0	11.5	12.89	17.57	10.01	13.65	11.61	15.78	12.67	17.22	11.80	16.06	-4.26
VB	First Colonial Rd	Laskin Rd	15.0	6.8	0.0	21.8	22.76	16.10	21.52	15.23	19.83	14.03	20.80	14.71	21.22	15.02	6.21
VB	First Colonial Rd	Va Beach Blvd	23.0	11.3	0.0	34.3	36.02	15.18	33.37	14.06	30.43	12.82	30.73	12.95	32.64	13.75	18.88
VB	General Booth Blvd	Birdneck Rd	4.5	2.3	0.0	6.8	7.43	10.13	7.08	9.66	6.47	8.83	6.93	9.45	6.98	9.52	-2.54
VB	General Booth Blvd	Dam Neck Rd	27.0	9.3	0.0	36.3	39.72	24.46	37.87	23.33	34.28	21.11	29.40	18.04	35.32	21.74	13.58
VB	General Booth Blvd	London Bridge Rd/Red Mill Blvd	12.0	8.5	0.0	20.5	23.42	19.69	22.23	18.69	20.41	17.16	17.32	14.59	20.85	17.53	3.32
VB	General Booth Blvd	Nimmo Pkwy	8.5	4.5	0.0	13.0	15.14	16.42	14.25	15.45	13.20	14.30	11.66	12.64	13.56	14.70	-1.14
VB	General Booth Blvd	Oceana Blvd/Prosperity Rd	11.8	7.0	0.0	18.8	21.66	26.22	20.66	25.01	18.74	22.69	15.61	18.91	19.17	23.21	-4.04
VB	General Booth Blvd/Princess Anne Rd	Princess Anne Rd/Tuscany Dr	5.0	4.5	0.0	9.5	11.77	18.06	11.22	17.21	10.26	15.73	8.92	13.72	10.54	16.18	-5.64
VB	Great Neck Rd	First Colonial Rd/Laurel Cove Dr	7.0	2.5	0.0	9.5	11.51	19.94	10.91	18.91	10.03	17.38	9.93	17.20	10.59	18.36	-7.76
VB	Holland Rd	Nimmo Pkwy	2.0	0.0	0.0	2.0	0.13	0.00	0.13	0.00	0.13	0.00	0.13	1.71	0.13	0.43	-0.30
VB	Holland Rd	Rosemont Rd	26.3	18.5	0.0	44.8	43.25	14.39	41.37	13.76	37.39	12.44	42.86	14.25	41.22	13.71	27.51
VB	Holland Rd	South Plaza Trail	9.0	4.8	0.0	13.8	15.12	13.69	14.55	13.16	13.18	11.93	13.69	12.39	14.14	12.79	1.34
VB	Holland Rd/Independence Blvd	Independence Blvd	6.0	3.3	0.0	9.3	11.23	36.36	10.75	34.82	9.65	31.25	10.49	33.97	10.53	34.10	-23.57
VB	Independence Blvd	Baxter Rd/South Blvd	14.5	8.3	0.0	22.8	24.70	32.53	23.59	31.07	21.23	27.95	22.68	29.86	23.05	30.35	-7.30
VB	Independence Blvd	Bonney Rd/Euclid Rd	21.8	7.5	0.0	29.3	31.73	28.87	30.51	27.76	27.27	24.81	28.22	25.64	29.43	26.77	2.67
VB	Independence Blvd	Columbus St	9.5	7.3	0.0	16.8	19.40	28.33	18.34	26.78	16.67	24.35	16.87	24.66	17.82	26.03	-8.21
VB	Independence Blvd	Haygood Rd/Wishart Rd	7.3	2.8	0.0	10.0	11.61	19.88	10.60	18.15	9.91	16.96	10.17	17.41	10.57	18.10	-7.53
VB	Independence Blvd	Pembroke Blvd	5.8	4.5	0.0	10.3	12.02	17.95	10.82	16.17	10.25	15.32	11.11	16.60	11.05	16.51	-5.46
VB	Independence Blvd	South Plaza Trail	5.3	7.0	0.0	12.3	12.39	12.78	12.09	12.46	10.80	11.14	12.36	12.74	11.91	12.28	-0.37
VB	Independence Blvd	Virginia Beach Blvd	19.3	11.0	0.0	30.3	33.47	39.20	31.78	37.23	28.76	33.69	29.74	34.83	30.94	36.23	-5.30
VB	Indian River Rd	Centerville Tpke/Parkland Ln	11.8	7.3	0.0	19.0	21.19	31.09	20.04	29.40	18.47	27.09	18.80	27.59	19.62	28.79	-9.17
VB	Indian River Rd	Independence Blvd	1.3	0.8	0.0	2.0	2.23	2.62	1.70	2.00	1.93	2.26	2.23	2.62	2.02	2.37	-0.35
VB	Indian River Rd	Kempsville Rd	18.0	13.3	0.0	31.3	32.96	30.62	31.51	29.27	28.72	26.68	30.97	28.77	31.04	28.83	2.21

Source: HRTPO analysis of VDOT data. Includes an analysis of VDOT data using HSM methods.
FAT = Number of crashes with at least one fatality. INJ = Number of crashes with at least one injury but no fatalities. PDO = Number of crashes with property damage only. F+I = FAT + INJ crashes.

Appendix D (continued) - Potential for Safety Improvement - Intersections

Juris-diction	Major Road	Minor Road	Average Annual Observed Crashes (2009-2012) PDO	INJ	FAT	Total	2009 Expected Total Crashes	2009 Adjusted Predicted Crashes	2010 Expected Total Crashes	2010 Adjusted Predicted Crashes	2011 Expected Total Crashes	2011 Adjusted Predicted Crashes	2012 Expected Total Crashes	2012 Adjusted Predicted Crashes	Average Annual Expected Total Crashes	Average Annual Adjusted Predicted Crashes	Potential for Safety Improvement
VB	Indian River Rd	Lynnhaven Pkwy	4.0	4.5	0.0	8.5	7.29	5.87	6.78	5.46	5.92	4.77	9.49	7.63	7.37	5.93	1.44
VB	Indian River Rd	Providence Rd	6.8	6.5	0.0	13.3	14.41	13.17	13.83	12.64	12.56	11.48	13.46	12.30	13.56	12.40	1.17
VB	Indian River Rd	West Neck Rd	2.0	2.5	0.0	4.5	3.97	2.32	3.39	1.98	3.79	2.22	2.62	1.53	3.44	2.02	1.42
VB	Indian River Rd (West)	Elbow Rd	1.8	1.0	0.0	2.8	2.01	2.34	1.53	1.78	1.86	2.17	2.20	2.55	1.90	2.21	-0.31
VB	Indian River Rd/Elbow Rd	Indian River Rd (East)	1.5	1.5	0.0	3.0	2.31	2.38	2.01	2.07	2.28	2.35	2.25	2.32	2.21	2.28	-0.07
VB	Indian River Rd/Indian Lakes Blvd	Indian River Rd/Settlers Park Dr	1.5	2.0	0.0	3.5	3.92	6.14	3.83	5.99	3.36	5.26	4.42	6.91	3.88	6.08	-2.20
VB	Kempsville Rd	Centerville Tpke	12.0	7.3	0.0	19.3	19.74	14.15	18.69	13.39	17.20	12.33	18.00	12.90	18.41	13.19	5.21
VB	Kempsville Rd	Providence Rd	6.3	4.0	0.0	10.3	11.62	12.82	11.16	12.31	10.13	11.17	10.14	11.19	10.76	11.87	-1.11
VB	Laskin Rd	Birdneck Rd	7.5	3.8	0.0	11.3	12.00	11.22	11.15	10.43	10.45	9.78	12.05	11.27	11.41	10.67	0.74
VB	London Bridge Rd	International Pkwy	4.3	2.5	0.0	6.8	6.68	7.38	5.93	6.55	6.60	7.29	6.22	6.87	6.36	7.02	-0.67
VB	London Bridge Rd	Potters Rd	5.3	1.8	0.0	7.0	7.84	8.73	7.52	8.37	6.83	7.60	8.82	9.84	7.75	8.64	-0.88
VB	Lynnhaven Pkwy	Holland Rd	15.0	8.8	0.0	23.8	24.08	15.51	25.58	16.48	20.98	13.51	21.12	13.60	22.94	14.77	8.17
VB	Lynnhaven Pkwy	Independence Blvd	12.8	12.0	0.0	24.8	24.29	12.71	23.32	12.20	21.16	11.07	24.71	12.92	23.37	12.22	11.14
VB	Lynnhaven Pkwy	International Pkwy/Mall Entrance	7.3	3.8	0.0	11.0	12.77	16.36	11.75	15.04	11.13	14.25	11.63	14.89	11.82	15.13	-3.31
VB	Lynnhaven Pkwy	Potters Rd	11.5	8.3	0.0	19.8	21.95	28.98	20.46	27.01	19.13	25.25	20.95	27.66	20.63	27.22	-6.60
VB	Lynnhaven Pkwy	Rosemont Rd	10.5	9.3	0.0	19.8	18.98	11.98	18.27	11.53	16.54	10.44	19.21	12.11	18.25	11.51	6.73
VB	Lynnhaven Pkwy	Salem Rd	4.5	3.0	0.0	7.5	7.95	7.72	7.79	7.56	6.93	6.73	7.46	7.24	7.53	7.31	0.22
VB	Military Hwy	Indian River Rd	16.5	9.3	0.0	25.8	26.62	19.39	25.85	18.83	23.19	16.89	26.38	19.22	25.51	18.58	6.93
VB	Military Hwy	Providence Rd	4.3	3.3	0.0	7.5	8.61	10.46	8.21	9.98	7.50	9.12	7.90	9.61	8.05	9.79	-1.74
VB	Nimmo Pkwy	Upton Dr	4.5	3.3	0.0	7.8	7.22	4.40	6.64	4.05	6.29	3.83	6.99	4.26	6.79	4.13	2.65
VB	North Landing Rd	Indian River Rd	2.5	1.0	0.0	3.5	4.00	4.15	3.98	4.13	3.49	3.62	3.20	3.32	3.67	3.80	-0.14
VB	North Landing Rd	Salem Rd	1.0	0.0	0.0	1.0	1.53	1.99	1.25	1.63	1.42	1.84	1.29	1.69	1.37	1.79	-0.42
VB	North Landing Rd	West Neck Rd	3.0	0.8	0.0	3.8	4.16	4.27	4.10	4.22	3.62	3.72	3.43	3.53	3.83	3.94	-0.11
VB	North Landing Rd/Princess Anne Rd	Princess Anne Rd	2.3	1.3	0.0	3.5	4.11	6.19	3.72	5.62	4.06	6.12	3.94	5.93	3.96	5.97	-2.01
VB	Northampton Blvd	Diamond Springs Rd	13.0	7.3	0.0	20.3	22.95	27.86	20.92	25.40	19.66	23.87	21.29	25.84	21.20	25.74	-4.54
VB	Oceana Blvd	Harpers Rd	4.8	2.0	0.0	6.8	6.79	6.23	5.89	5.41	6.47	5.94	5.89	5.41	6.26	5.75	0.51
VB	Pacific Ave	21st St	6.5	3.5	0.0	10.0	9.59	6.45	8.82	5.93	8.36	5.62	9.44	6.34	9.05	6.08	2.97
VB	Pacific Ave	22nd St	7.3	4.0	0.0	11.3	9.16	4.11	9.01	4.04	8.46	3.80	9.56	4.29	9.05	4.06	4.99
VB	Pacific Ave	Laskin Rd	5.0	1.3	0.0	6.3	7.26	8.43	6.68	7.76	6.33	7.35	6.97	8.09	6.81	7.91	-1.10
VB	Pacific Ave	Norfolk Ave	1.5	0.5	0.0	2.0	2.86	5.56	3.43	6.65	3.07	5.96	3.26	6.32	3.15	6.12	-2.97
VB	Pacific Ave	Va Beach Blvd	6.0	3.5	0.0	9.5	8.93	6.34	9.14	6.49	8.22	5.84	8.00	5.68	8.57	6.09	2.48
VB	Princess Anne Rd	Baxter Rd	8.5	5.8	0.0	14.3	15.07	14.16	14.43	13.56	13.14	12.34	13.14	12.35	13.94	13.10	0.84
VB	Princess Anne Rd	Dam Neck Rd	21.5	10.8	0.0	32.3	33.05	20.63	31.31	19.55	28.63	17.87	31.43	19.62	31.11	19.42	11.69
VB	Princess Anne Rd	Holland Rd	4.0	0.5	0.0	4.5	3.87	4.89	3.48	4.39	3.82	4.83	3.74	4.73	3.73	4.71	-0.98
VB	Princess Anne Rd	Independence Blvd	10.0	4.3	0.0	14.3	16.11	18.92	15.30	17.97	14.04	16.49	14.95	17.56	15.10	17.74	-2.64
VB	Princess Anne Rd	Indian River Rd	1.3	1.0	0.0	2.3	2.38	3.54	2.40	3.56	2.08	3.08	2.31	3.42	2.29	3.40	-1.11
VB	Princess Anne Rd	Kempsville Rd/Witchduck Rd	5.0	5.0	0.3	10.3	11.66	15.53	11.13	14.82	10.16	13.53	10.11	13.48	10.76	14.34	-3.58
VB	Princess Anne Rd	Lynnhaven Pkwy	16.3	10.5	0.0	26.8	28.15	24.43	27.11	23.52	24.53	21.29	27.25	23.65	26.76	23.22	3.54
VB	Princess Anne Rd	Nimmo Pkwy	2.8	1.0	0.0	3.8	4.32	5.04	3.88	4.51	4.27	4.98	4.02	4.68	4.12	4.80	-0.68
VB	Princess Anne Rd	Plaza Trail/Providence Rd	6.5	3.8	0.0	10.3	10.97	13.16	10.85	13.02	9.56	11.47	10.31	12.37	10.42	12.51	-2.08
VB	Princess Anne Rd	Pungo Ferry Rd	0.8	1.3	0.0	2.0	2.01	2.06	1.74	1.78	1.93	1.97	1.22	1.25	1.72	1.77	-0.04
VB	Princess Anne Rd	Salem Rd/Windsor Oaks Blvd	4.5	5.0	0.0	9.5	9.83	13.58	9.72	13.41	8.57	11.83	8.96	12.37	9.27	12.80	-3.53
VB	Princess Anne Rd	Seaboard Rd (North)	4.8	2.0	0.0	6.8	6.58	5.42	6.31	5.21	5.73	4.73	6.37	5.25	6.25	5.15	1.09
VB	Princess Anne Rd	Seaboard Rd (South)	1.0	0.3	0.0	1.3	1.34	1.10	1.09	0.90	1.24	1.02	1.38	1.14	1.27	1.04	0.23
VB	Princess Anne Rd/Sandbridge Rd	Upton Dr/Princess Anne Rd	4.0	2.5	0.0	6.5	6.72	6.67	6.54	6.48	5.86	5.81	6.13	6.08	6.31	6.26	0.05
VB	Rosemont Rd	Bonney Rd/I-264 Ramp	12.0	3.5	0.3	15.8	16.47	11.39	15.92	11.01	14.35	9.93	15.95	11.03	15.67	10.84	4.83
VB	Rosemont Rd	South Plaza Trail	5.5	2.3	0.0	7.8	8.75	11.43	8.31	10.86	7.62	9.96	7.96	10.40	8.16	10.66	-2.50
VB	Salem Rd	Dam Neck Rd/Elbow Rd	6.5	3.5	0.0	10.0	9.02	5.21	8.87	5.12	7.84	4.53	7.83	4.52	8.39	4.85	3.54
VB	Salem Rd	Independence Blvd	4.3	2.3	0.0	6.5	6.48	4.95	6.40	4.89	5.65	4.31	5.39	4.11	5.98	4.57	1.41
VB	Shore Dr	Diamond Springs Rd	5.3	1.8	0.3	7.3	7.59	12.82	7.04	11.89	6.61	11.17	7.53	12.73	7.19	12.15	-4.96

Source: HRTPO analysis of VDOT data. Includes an analysis of VDOT data using HSM methods.
FAT = Number of crashes with at least one fatality. INJ = Number of crashes with at least one injury but no fatalities. PDO = Number of crashes with property damage only. F+I = FAT + INJ crashes.

Appendix D (continued) - Potential for Safety Improvement - Intersections

Juris-diction	Major Road	Minor Road	Average Annual Observed Crashes (2009-2012) PDO	INJ	FAT	Total	2009 Expected Total Crashes	2009 Adjusted Predicted Crashes	2010 Expected Total Crashes	2010 Adjusted Predicted Crashes	2011 Expected Total Crashes	2011 Adjusted Predicted Crashes	2012 Expected Total Crashes	2012 Adjusted Predicted Crashes	Average Annual Expected Total Crashes	Average Annual Adjusted Predicted Crashes	Potential for Safety Improvement
VB	Shore Dr	Great Neck Rd	6.5	3.5	0.0	10.0	11.33	17.64	10.49	16.32	9.33	14.52	10.17	15.82	10.33	16.08	-5.75
VB	Shore Dr	Independence Blvd/Little Creek Gate 5	4.0	3.5	0.0	7.5	8.21	10.12	7.47	9.21	7.07	8.73	7.94	9.80	7.67	9.46	-1.79
VB	Shore Drive/Atlantic Ave	Atlantic Ave	0.8	0.5	0.0	1.3	1.67	2.49	1.28	1.91	1.47	2.18	1.40	2.07	1.45	2.16	-0.71
VB	Va Beach Blvd	Constitution Dr	11.8	4.8	0.0	16.5	17.57	16.51	16.89	15.87	15.31	14.39	17.01	15.98	16.70	15.69	1.01
VB	Va Beach Blvd	Great Neck Rd/London Bridge Rd	19.0	9.5	0.3	28.8	30.89	23.21	29.81	22.41	26.91	20.23	25.41	19.09	28.26	21.24	7.02
VB	Va Beach Blvd	Lynnhaven Pkwy	2.8	4.5	0.0	7.3	7.98	12.71	7.17	11.44	7.88	12.56	6.74	10.68	7.44	11.85	-4.41
VB	Va Beach Blvd	Rosemont Rd	10.5	5.0	0.0	15.5	17.29	23.05	16.35	21.80	14.76	19.67	16.40	21.86	16.20	21.59	-5.39
VB	Va Beach Blvd	South Plaza Trail/Little Neck Rd	9.3	5.3	0.0	14.5	16.09	19.59	15.32	18.65	13.73	16.71	15.26	18.57	15.10	18.38	-3.28
VB	Va Beach Blvd	Witchduck Rd	6.8	5.3	0.3	12.3	13.85	19.97	12.82	18.49	12.07	17.40	12.55	18.09	12.82	18.49	-5.67
VB	Wesleyan Dr/Haygood Rd	Haygood Rd	1.3	1.0	0.0	2.3	2.82	5.49	2.74	5.33	2.46	4.78	2.46	4.80	2.62	5.10	-2.48
WMB	Boundary St	Francis St	0.5	0.5	0.0	1.0	0.96	1.56	0.97	1.57	1.19	1.94	1.20	1.95	1.08	1.76	-0.68
WMB	Boundary St	Jamestown Rd	1.0	1.0	0.0	2.0	1.97	2.20	1.87	2.11	2.31	2.60	2.48	2.79	2.16	2.42	-0.26
WMB	Bypass Rd	Route 132	2.3	1.8	0.0	4.0	4.20	6.26	5.02	7.47	4.77	7.09	5.31	7.90	4.82	7.18	-2.36
WMB	Capitol Landing Rd/Merrimac Trail	Merrimac Trail	1.3	1.3	0.0	2.5	2.53	2.68	2.10	2.22	2.42	2.56	1.70	1.80	2.19	2.32	-0.13
WMB	Colonial Pkwy	Route 132Y	0.0	0.0	0.0	0.0	0.47	0.73	0.37	0.57	0.44	0.67	0.48	0.74	0.44	0.68	-0.24
WMB	Francis St	Henry St	1.8	2.3	0.0	4.0	4.07	3.04	2.82	2.12	2.67	2.00	2.88	2.16	3.11	2.33	0.78
WMB	Henry St	Route 132Y	3.3	3.8	0.0	7.0	4.13	1.16	3.75	1.06	4.46	1.26	4.81	1.36	4.29	1.21	3.08
WMB	Ironbound Rd	Longhill Rd	0.3	0.5	0.0	0.8	1.03	1.46	0.93	1.31	1.15	1.62	1.26	1.78	1.09	1.54	-0.45
WMB	Ironbound Rd	Treyburn Dr	0.0	0.3	0.0	0.3	0.82	1.29	0.72	1.13	0.83	1.30	0.79	1.25	0.79	1.24	-0.45
WMB	Lafayette St	Henry St	1.3	1.0	0.0	2.3	2.30	2.49	2.27	2.47	2.15	2.34	2.32	2.52	2.26	2.45	-0.20
WMB	Lafayette St/York St	Page St/Francis St	1.5	0.5	0.0	2.0	2.43	3.45	3.00	4.25	2.84	4.03	2.91	4.12	2.80	3.96	-1.17
WMB	Monticello Ave	Treyburn Dr	0.3	0.0	0.0	0.3	1.14	3.43	1.37	4.09	1.29	3.87	1.44	4.30	1.31	3.92	-2.61
WMB	Page St	Second St	1.0	0.8	0.0	1.8	2.06	2.93	1.94	2.76	2.23	3.17	2.18	3.11	2.10	2.99	-0.89
WMB	Page St/Capitol Landing Rd	Bypass Rd	1.3	3.0	0.0	4.3	4.88	4.42	4.28	3.87	4.92	4.45	3.54	3.21	4.40	3.99	0.42
WMB	Richmond Rd	Bypass Rd	2.5	1.5	0.0	4.0	4.33	5.53	3.95	5.04	4.53	5.78	4.38	5.58	4.30	5.49	-1.19
WMB	Richmond Rd	Ironbound Rd	0.8	2.3	0.0	3.0	3.81	8.32	3.63	7.93	3.44	7.52	3.66	7.99	3.64	7.94	-4.30
WMB	Richmond Rd	Lafayette St/Monticello Ave	2.8	2.0	0.0	4.8	4.77	6.04	4.94	6.26	4.68	5.93	4.91	6.21	4.83	6.11	-1.28
WMB	Route 199	Jamestown Rd	5.5	5.8	0.0	11.3	12.61	13.93	11.27	12.45	10.67	11.79	11.86	13.10	11.60	12.82	-1.22
YC	Ballard St	Colonial Pkwy	0.3	0.8	0.0	1.0	1.32	1.51	1.31	1.49	1.51	1.72	1.07	1.22	1.30	1.49	-0.18
YC	Ballard St	Cook Rd	0.0	0.3	0.0	0.3	0.51	0.69	0.48	0.66	0.57	0.78	0.62	0.85	0.54	0.74	-0.20
YC	Bypass Rd	Waller Mill Rd	2.0	2.0	0.0	4.0	4.04	5.28	4.78	6.24	4.53	5.91	5.01	6.53	4.59	5.99	-1.40
YC	Cook Rd	Goosley Rd	0.3	1.5	0.0	1.8	1.31	0.86	2.04	1.35	1.65	1.09	1.04	0.69	1.51	1.00	0.51
YC	George Washington Hwy	Cook Rd/York Warwick Dr	3.0	2.5	0.0	5.5	6.33	9.97	5.79	9.13	5.49	8.65	6.07	9.56	5.92	9.33	-3.41
YC	George Washington Hwy	Denbigh Blvd/Goodwin Neck Rd	3.8	3.5	0.0	7.3	8.60	13.72	7.46	11.90	7.28	11.61	8.09	12.90	7.85	12.53	-4.68
YC	George Washington Hwy	Fort Eustis Blvd	6.5	5.8	0.0	12.3	13.32	13.34	12.24	12.27	11.60	11.62	13.28	13.30	12.61	12.63	-0.02
YC	George Washington Hwy	Goosley Rd	3.5	1.5	0.0	5.0	6.09	8.85	5.87	8.52	5.56	8.07	6.13	8.90	5.91	8.58	-2.67
YC	George Washington Hwy	Victory Blvd	8.5	6.0	0.0	14.5	16.24	18.53	14.98	17.10	14.19	16.20	16.13	18.40	15.38	17.56	-2.17
YC	Hampton Hwy	Big Bethel Rd	3.0	3.8	0.0	6.8	7.94	8.84	6.84	7.62	6.48	7.22	7.16	7.98	7.10	7.91	-0.81
YC	Old Williamsburg Rd	Goosley Rd	2.0	1.0	0.0	3.0	2.97	2.47	2.66	2.21	3.06	2.55	2.15	1.79	2.71	2.25	0.46
YC	Route 143	Rochambeau Dr/I-64 Ramp	5.5	4.3	0.0	9.8	8.46	5.05	8.80	5.25	8.34	4.98	9.27	5.53	8.72	5.20	3.51
YC	Route 143	Route 132	3.0	2.0	0.0	5.0	3.87	2.97	3.88	2.98	4.46	3.43	4.38	3.37	4.15	3.19	0.96
YC	Route 199	Penniman Rd/Tranquility Dr	1.3	0.3	0.0	1.5	1.83	1.75	1.70	1.63	1.97	1.89	1.40	1.35	1.72	1.65	0.07
YC	Second St/Merrimac Trail	Merrimac Trail	2.5	0.5	0.0	3.0	3.94	6.14	4.15	6.47	3.40	5.30	3.76	5.85	3.81	5.94	-2.13
YC	Victory Blvd	Big Bethel Rd	3.5	3.0	0.0	6.5	6.14	5.10	6.31	5.23	5.98	4.96	6.30	5.22	6.18	5.13	1.06
YC	Victory Blvd	East Yorktown Rd/Carys Chapel Rd	1.8	1.3	0.0	3.0	3.45	4.96	3.56	5.12	3.37	4.85	3.53	5.08	3.48	5.00	-1.53
YC	Victory Blvd	Hampton Hwy	8.0	3.8	0.0	11.8	11.52	11.62	11.78	11.89	11.16	11.26	11.98	12.09	11.61	11.71	-0.10
YC	Waller Mill Rd	Mooretown Rd	0.5	0.5	0.0	1.0	0.78	0.64	0.65	0.53	0.80	0.66	0.88	0.72	0.78	0.64	0.14

Source: HRTPO analysis of VDOT data. Includes an analysis of VDOT data using HSM methods.

FAT = Number of crashes with at least one fatality. INJ = Number of crashes with at least one injury but no fatalities. PDO = Number of crashes with property damage only. F+I = FAT + INJ crashes.

Appendix E – Public Comment and Review Period

The Hampton Roads Regional Safety Study 2013/2014 Update: Part II report was released for public comment from June 4, 2014 through June 18, 2014. All public comments and HRTPO staff responses are included below.

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HRTPO Public Comment (via email)

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From: Regina DelVecchio
Sent: Wednesday, June 04, 2014
Subject: Comments on DRAFT Hampton Roads Regional Safety Study - Part II

As a daily commuter from the Peninsula (Hampton) to Southside (VAB), I am not surprised by the top 5 crash locations for intersections and freeways in the HRTPO region. Overall, the analyses presented in the study are comprehensive. I have two comments for consideration:

1) The study introduces limited solutions for congestion mitigation at the HRBT and approaches assuming that congestion is the primary contributor of crashes. Did you consider other solutions such as commuter ferry service, park and ride lots, ridesharing programs, incentive programs, other TDM strategies that will reduce volumes, or just congestion pricing and a third crossing?
2) There is no mention of distracted driving as a potential police report category, or proposed policy for driving while on the phone. Distracted driving, specifically related to cell phone use, has contributed to many crashes across the country and deserves honorable mention for a potential area of improvement. http://www.ghsa.org/html/stateinfo/laws/cellphone_laws.html

Thank you for the opportunity to comment,

Gina

HRTPO Staff Response:

Thank you for taking the time to review Part II of the Hampton Roads Regional Safety Study and providing us with your comments.

You make a good point in your first comment regarding the congestion mitigation strategies we have listed for the congested freeway segments. As part of our Congestion Management Process we look at many of these TDM strategies, and we also work closely with TRAFFIX to develop TDM strategies for the region (http://hrtpo.org/page/transportation-demand-management). We will be sure to update the Safety Study to include them as well.

Regarding your comment about cell phone use, there is a place on crash reports where police have the ability to record whether cell phone use was the cause of the crash. However, this information has to be self-reported by the driver to the policeman filling out the crash report. Because of this, the data that is out there on the number of crashes caused by cell phone use very much underrepresents the actual number of crashes. In Part I of our Regional Safety Study we looked at crashes caused by Driver Distractions but did not further delve into the data regarding crashes caused by cell phone use because of this issue.

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HRTPO Public Comment (via email)

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From: Kim Hummel
Sent: Wednesday, June 04, 2014
Subject: DRAFT Hampton Roads Regional Safety Study - Part II

I have read most of this study as regards transportation and traffic safety in the Hampton Roads region. I applaud the study's thorough approach to a wide variety of traffic issues. However, I am disappointed that there has been a lack of emphasis on enforcement (police on the roadways). I think the Number One way to improve traffic safety in my experience is to slow traffic down and enforce the speed limits. And, yes, I think it was very interesting that drivers following too closely is a major problem; I observe that problem in my driving all the time. So if traffic would slow down and space itself out as recommended by driver safety programs, many of the observed problems would go away. It seems to me that the speed jockeys make it tough on everybody else.

I do not question the value of the analysis done in this updated study. I am a little surprised that some freeway segments did not make it into the Top Five or the Top Ten lists. One area that is a periodic concern to me is I-64 between Battlefield Boulevard and Greenbriar Parkway. In that segment you have to weave through traffic in order to get far enough over into the right lane to make it onto Greenbriar. And generally this is done at speed because of the surrounding traffic. I find this extremely dangerous. This is a prime example of where slowing traffic down would make a big difference. But there is not sufficient police coverage in this area or anywhere generally in Hampton Roads. I wish some the highway programs would provide more funding to boost area road patrols. I agree that state and local budget cuts have hampered this very important enforcement function. I think it needs to be brought back. It seems to me that safety for the driving public should be the primary goal of any highway program.

Sincerely,

Kim E. Hummel

HRTPO Staff Response:

Thank you for taking the time to review the Hampton Roads Regional Safety Study Part II report and sending us your comments.

We definitely agree that enforcement is a key part of the overall safety solution in our region, and the study emphasizes the importance of enforcement in the section detailing the four E's of safety (which also includes education, engineering, and emergency response).

Although all four E's of safety are included in this report, the study primarily focuses on engineering countermeasures. The primary reason for this is that the goal of the report was to find the best locations throughout Hampton Roads to improve with Highway Safety Improvement Program funding, which is designated for engineering improvements.

Most of the funding for the other E's of safety (and enforcement in particular) comes from sources that are largely outside of our control such as DMV grants. This funding source is addressed in full detail in Virginia's Highway Safety Plan (https://www.dmv.virginia.gov/safety/highway_safety_plan.pdf), which is updated annually by DMV.

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HRTPO Public Comment (via email)

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From: Tina Harvey
Sent: Thursday, June 05, 2014
Subject: Safety Study

Thank you for sharing that with us. I was wondering do we track cell phone accidents.

Thank you

Tina Harvey

HRTPO Staff Response:

Thank you for taking the time to review the report and provide us with your comments. Police have the ability to record whether cell phone use was the cause of the crash on the reports that they fill out. However, this information has to be self-reported by the driver to the policeman filling out the crash report. Because of that, the data on the number of crashes caused by cell phone use is likely very underrepresented compared to the actual number.

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HRTPO Public Comment (via email)

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From: Karen Guerra
Sent: Friday, June 06, 2014 Subject: Input for draft HRTPO safety flyer

Hi Keith,

I would like to share my opinion that I would like to see the safety statistics for pedestrians in more detail. More specifically, I think it is important to at least break out the bicycle vs pedestrian incidents and, just as you have indicated for drivers, to include the number of injuries as well as the number of deaths for each.

The reason I think this is important is mostly self serving, in that I am a cyclist and am highly concerned about the seeming lack of awareness, respect, and enforcement of driver/cyclist safety in our area. But I also think it will help to strike more of a direct chord with the public as opposed to just lumping "anything that's not in a car" into one category.
Just my two cents.

Thanks!
Karen

HRTPO Staff Response:

Thank you for taking the time to review the Hampton Roads Regional Safety Study Part II report and providing us with your comments. I wanted to inform you that we have looked at bicyclist and pedestrian crashes, both as part of our Regional Safety Study and in other planning efforts we do here.

In Part I of our Regional Safety Study (see page 9 at http://hrtpo.org/uploads/docs/HR%20Regional%20Safety%20Study%202013%20PART%20I%20Final%20Report.pdf), we looked at the type of crashes that have occurred throughout the region, and as part of that we looked at crashes, injuries, and fatalities involving bicyclists and pedestrians.

We also looked at bicyclist/pedestrian crashes as part of the Active Transportation section in our annual State of Transportation Report (see page 39 at http://hrtpo.org/uploads/docs/060414TTAC-Enclosure%2010-The%20State%20of%20Transportation%20in%20Hampton%20Roads%202014%20Final%20Report.pdf).

And finally, information regarding the location of bicyclist and pedestrian crashes has been provided to staff in our office that work more directly on Active Transportation planning. More information on their efforts, which include developing a regional active transportation facilities map and plan, is available in the following presentation that they made last week: http://hrtpo.org/uploads/docs/P14-Regional_Active_Transportation_Map.pdf .

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HRTPO Public Comment (via email)

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From: thenyefactory@gmail.com [mailto:thenyefactory@gmail.com] On Behalf Of The Nye Factory inc.
Sent: Monday, June 09, 2014
Subject: Re: DRAFT Hampton Roads Regional Safety Study - Part II

FYI: Your report should have an executive summary or "Layman's" section that would provide action steps to what we can do to change/improve the situation. Clear action items that are defined for people within the region ie: everyday drivers, engineers, enforcement personnel and educators.

(Also take a look at some other infographics like the one below to better communicate the gap between bike/ped crashes and the amount of funding/investment to that travel mode. Its interesting that 16% of crashes are bike/ped related yet very little % of capital resources are invested in the "E" areas with regards to non-motorists travelers)

For me mobility is about efficiently moving people to places with the least impact economically and environmentally...I believe an investment in Green Infrastructure Networks (http://www.epa.gov/region03/green/infrastructure.html) & alternative transportation methods (http://www.transalt.org) would help clear our congested corridors, provide cleaner air quality along with the associated health benefits & a build better connected region.

Jonathan

HRTPO Staff Response:

Thank you for taking the time to review the Hampton Roads Regional Safety Study and providing us with your comments. It's good to hear about your efforts with alternative transportation methods. We also address some of these types of improvements in our Congestion Management Process work. Information on the Congestion Management Process is available at http://hrtpo.org/page/congestion-management.

Although the Regional Safety Study report includes information on all four E's of safety (enforcement, engineering, education, and emergency response), the purpose of this report was to look at locations where we should concentrate on making engineering improvements with Highway Safety Improvement Program (HSIP) funding. Based on our analysis, we made recommendations for the most cost effective countermeasures that each jurisdiction should attempt to obtain HSIP funding for. Areas like enforcement and education are not eligible to be funded with these HSIP funds.

There are safety documents that handle these other aspects of safety such as enforcement and education. Examples of these documents include the Virginia Strategic Highway Safety Plan (http://www.virginiadot.org/info/hwysafetyplan.asp) and the Virginia DMV's Highway Safety Plan (https://www.dmv.virginia.gov/safety/highway_safety_plan.pdf).

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HRTPO Public Comment (via email)

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From: Harrison, Sgt J.
Sent: Thursday, June 12, 2014
Subject: FW: Drive Safe - Hampton Roads Regional Safety Study - Part II

Good Afternoon,

That was a very interesting report. I have shared it with several folks within my agency. One thing that came up was, is there any way a table could be included outlining what the 597 intersections were and the raw data scores of each intersection? We might be able to use such data to target enforcement projects around intersections.

SGT. JOHN HARRISON
Police Planner
Office of the Chief of Police
Hampton Police Division

HRTPO Staff Response:

Thank you for taking the time to review the Hampton Roads Regional Safety Study Part II report. Appendix D of the report includes the Potential for Safety Improvement scores for all 597 intersections that were analyzed as part of the study, alphabetized by jurisdiction and by the name of the major roadway. Those intersections with the highest Potential for Safety Improvement scores would likely be the ones where you would consider targeting enforcement projects.

If you would like me to provide you more information regarding how these 597 intersections (or just the ones in Hampton) were scored, please feel free to ask me.