

Alternatives Analysis

Springfield Road (SR 157) Alternatives Analysis

Henrico County, Virginia

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KITTELSON & ASSOCIATES, INC.
TRANSPORTATION ENGINEERING/PLANNING

Alternatives Analysis

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Section 1
Executive Summary

EXECUTIVE SUMMARY

This report evaluates safety and operational improvements/modifications to a 2.1-mile corridor along Springfield Road (SR 157) between Nuckols Road and US Route 33 (Staples Mill Road) in Henrico County, Virginia. Analyses were performed for existing conditions, future no-build conditions (year 2036), and three future year alternative improvement scenarios for year 2036. The analyses include comparisons of intersection controls, projected Levels of Service, anticipated reduction in crashes using procedures in the American Association of State Highway Transportation Officials' (AASHTO) *Highway Safety Manual* (HSM), and recommended treatments.

The selected cross-sectional elements, intersection and segment treatments, and safety countermeasures for the corridor were selected with the following goals in mind:

- Address anticipated future vehicular demand
- Accommodate bicyclists and pedestrians
- Address identified safety/operational issues
- Consider the current and future land use context of the corridor

The findings allow for a relative comparison of predicted study corridor crashes between identified Alternatives and the no-build condition assuming provision of the identified treatments and safety countermeasures from both a safety and traffic operations perspective. Preliminary estimates of probable cost are also provided for comparative purposes.

HSM methods were applied to calculate the number of expected average annual crashes for existing and future scenarios. The expected average annual crashes are used in a relative manner to prioritize segments, intersections, and improvements. A relative cost benefit calculation for study alternatives has also been prepared focused exclusively on crashes; environmental impacts, right-of-way, and design and construction costs are not included. VDOT has not yet developed statewide calibration factors to adjust the generic HSM methods to specific VDOT facilities. If calibration factors were developed and applied, the expected average annual crashes could be calibrated to represent the specific long-term expected average number of crashes for each site and condition. Those specific crash estimate values could then be used more extensively in activities such as benefit/cost analysis. Without calibration factors, the HSM analysis results reported herein can be used *only* for relative comparisons. The HSM is not intended to be a substitute for the exercise of sound engineering judgment.

EXISTING CONDITIONS

- All study intersections currently operate at VDOT standards (LOS D for signalized intersections/LOS E for unsignalized) or better during the weekday a.m. and p.m. peak hours except the following:
 - SR 157/Francistown Road: The critical westbound left-turn movement operates at LOS F during the weekday a.m. peak hour.

- SR 157/Staples Mill Road: The intersection operates at capacity at LOS E during the weekday a.m. peak hour and LOS F during the weekday p.m. peak hour.
- All study intersections were found to meet or exceed AASHTO minimum guidelines for intersection sight distance except the Hart Mill Drive approach to SR 157.
- There are currently no bicycle facilities and virtually no pedestrian facilities within the study area, which is predominately residential in nature. There is a County park with recreational trails within the study area, and two nearby schools.
- Of the 17 basic study segments formed by local street intersections, five study segments currently meet or exceed both the minimum minor arterial spacing standard of 660 feet, four segments meet or exceed only the collector minimum spacing standard of 440 feet, and seven segments meet neither. Intersection spacing and the presence of private driveways between local streets does not appear to be a factor in the reported crashes; as such, no changes to existing intersection spacing are recommended.

Existing Safety Statistics

- Thirty-two crashes were reported within the study limits for the three-year period between 2008 and 2010.
- Of the 32 reported crashes:
 - 18 occurred between 12:00 p.m. and 5:00 p.m., consistent with higher vehicle volumes during the same time periods
 - 23 were Property Damage Only (PDO), 6 resulted in injury, and 3 fatalities were recorded
 - 16 were fixed-object crashes
 - 19 occurred outside of intersections
- The calculated crash rate on SR 157 (146 crashes per 100 million vehicle miles traveled) is slightly lower than the reported statewide average (150 crashes per 100 million vehicle miles traveled); however, the statewide average aggregates all state facilities. Specific statistics for two-lane undivided facilities are not available.

Existing Conditions Highway Safety Manual (HSM) Analysis

- Intersections and segments were evaluated using Chapter 12 (Urban/Suburban Arterial) procedures in the HSM. The existing corridor also exhibits some roadway characteristics consistent with that of a rural road; as such, certain countermeasures from Chapter 10 (Rural Two Lane Roadways) were also considered.
- The following intersections and segments along the SR 157 study corridor were identified as having high crash frequencies:
 - Intersection

- Nuckols Road
- Wintergreen Road/ Linsey Lakes Drive
- Francistown Road
- Staples Mill Road
- Segments:
 - Jones Road to Olde Milbrooke Way
 - Echo Lake Drive to Old Springfield Road
 - Francistown Road to Staple Mills Road
- The uncalibrated HSM analysis estimates 15.43 expected average annual crashes under existing conditions.

FUTURE NO-BUILD CONDITIONS

Year 2036 No-Build Operations

- All of the study intersections are forecast to continue to operate at LOS D or better during the weekday a.m. and p.m. peak hours except:
 - SR 157/Wintergreen Road/Linsey Lakes Drive: Eastbound approach is forecast to operate at LOS E during the weekday a.m. peak hour.
 - SR 157/Francistown Road: Westbound left-turn movement is forecast to operate at LOS F during both peak hours.
 - SR 157/Staples Mill Road: Operates over capacity at LOS F during both peak hours.
- Changes to existing right-turn treatments were identified at 11 of the 17 study intersections per Figure 3-26 in Appendix F of the VDOT Road Design Manual.

Right-Turn Treatment	SR 157 Cross-Street
Remove existing turn lane and taper	- Olde Milbrooke Way - Linsey Lakes Drive - Olde Hartley Drive
Remove existing taper	- Wintercreek Drive - Warnerwood Court
Reduce existing full turn lane to taper only	- Hart Mill Drive - Bernard Mills Drive - Rigney Terrace
Add a taper	- Wintergreen Road - Echo Lake Drive
Add a full turn lane and taper	- Jacobs Creek Drive

No-Build HSM Analysis

- The uncalibrated HSM analysis predicts 19.37 average annual crashes assuming no changes to the study corridor under design year 2036 no-build traffic conditions.

ALTERNATIVE 1

Alternative 1 Design Changes

Alternative 1 would modify the existing alignment of SR 157 to improve road safety and operations. A summary of improvements is listed below:

- Construct a roadway cross-section (51 feet wide) throughout study limits of SR 157 that includes:
 - 11-foot travel lanes
 - 3-foot paved shoulder
 - 2.5-foot gutter pan and curb (2-foot wide gutter pan, 6-inch wide curb)
 - 4-foot buffer
 - 5-foot sidewalks
- Install a single-lane roundabout at the SR 157/Francistown Road intersection
- Modify the SR 157/Staples Mill Road intersection as follows:
 - Eastbound Approach
 - Construct dual eastbound left-turn lanes with 300 feet of storage to accommodate forecast queues
 - Construct separate eastbound through and right-turn lanes
 - Westbound Approach
 - Construct separate left, through, and right-turn lanes
 - Operate westbound left-turns with protected phasing
 - Northbound Approach
 - Increase the northbound left-turn queue storage from 150 to 350 feet to accommodate forecast queues
 - Signal phasing
 - Replace split phase EB/WB operation with protected left-turn phasing and provide right-turn overlap phasing on all approaches
- Eliminate the Hart Mill Drive approach to SR 157 (use adjacent Bernard Mills Drive access) due to sight distance limitations.
- Realign SR 157 between Olde Hartley Drive and the Echo Lake County Park parking area to increase horizontal curve radii in this segment

Alternative 1 Operations

- All of the study intersections are forecast to operate at LOS D or better during the future year 2036 weekday a.m. and p.m. peak hours assuming provision of the Alternative 1 improvements.

Alternative 1 HSM Safety Analysis

- Alternative 1 was evaluated using Chapter 12 (Urban/Suburban Arterial) procedures in the HSM.
- Alternative 1 is anticipated to result in an eight percent reduction in crashes relative to the no-build scenario.
- Alternative 1 is estimated to save \$6.5 million compared to the no-build scenario over the assumed 25-year service life of the improvements.
 - Roughly 75 percent of the cost savings (\$4.9M) is attributable to improvements to SR 157 between Linsey Lakes Road and Francistown Road.

Alternative 1 Cost Estimate

- A preliminary estimate of probable cost indicates Alternative 1 would cost approximately \$12.3 million to design and construct.

ALTERNATIVE 2

Alternative 2 Design Changes

Alternative 2 involves the partial realignment of SR 157 north of SR 157/Linsey Lake Drive, creating a new east-west road to connect to the existing SR 157/Francistown Road intersection. Approximately 1.5 miles of new road would be constructed.

Alternative 2 would result in a change in traffic patterns through the network. The component of through traffic currently traveling along the existing Springfield Road alignment would use the new road alignment, leaving only local residential traffic on SR 157 between the point at which the new alignment begins and the SR 157/Francistown Road intersection. A summary of improvements is listed below:

- Realign the northern portion of existing Springfield Road at the western end of the new alignment to intersect the new alignment directly across from Linsey Lakes Drive. A portion of existing Linsey Lakes Drive would be removed to accommodate the realignment, and Wintergreen Road would also be slightly modified.
 - Construct a roadway cross-section (51 feet wide) throughout study limits **except** on the existing section of SR 157 that would serve only local residential traffic (between Linsey Lake Drive and Francistown Road). The cross-section would include:
 - 11-foot travel lanes
 - 3-foot paved shoulder (bike lane)
 - 2.5-foot gutter pan and curb (2-foot wide gutter pan, 6-inch wide curb)
 - 4-foot buffer
 - 5-foot sidewalks

- The portion of existing Springfield Road between Linsey Lake Drive and Francistown Road does not include wholesale cross-sectional improvements but does include strategic spot improvements.
- Install single-lane roundabouts at the SR 157/Wintergreen Road/Linsey Lakes Drive and SR 157/Francistown Road intersections.
- Modify the SR 157/Staples Mill Road intersection as described in Alternative 1.
- Eliminate the Hart Mill Drive approach to SR 157 (use adjacent Bernard Mills Drive access) due to sight distance limitations.
- Realign SR 157 between Olde Hartley Drive and the Echo Lake County Park parking area to increase horizontal curve radii in this segment.

Alternative 2 Operations

- Of the roughly 10,000 Average Daily Traffic (ADT) volumes forecast to be using the Springfield Road corridor in year 2036, approximately 60 percent are anticipated to divert to the new alignment of SR 157.
- All of the study intersections are forecast to operate at LOS D or better during the future year 2036 weekday a.m. and p.m. peak hours assuming provision of the Alternative 2 improvements.

Alternative 2 HSM Safety Analysis

- Alternative 2 was also evaluated using Chapter 12 (Urban/Suburban Arterial) procedures in the HSM.
- Alternative 2 is anticipated to result in an 22 percent reduction in crashes relative to the no-build scenario.
- Alternative 2 is estimated to save \$16.5 million compared to the no-build scenario over the assumed 25-year service life of the improvements.
 - Roughly 86 percent of the cost savings (\$14.2M) is attributable to improvements to SR 157 between Linsey Lakes Road and Francistown Road.

Alternative 2 Cost Estimate

- A preliminary estimate of probable cost indicates Alternative 2 would cost approximately \$18.3 million to design and construct.

ALTERNATIVE 3

Alternative 3 Design Changes

Alternative 3 also involves the partial realignment of SR 157 north of SR 157/Linsey Lake Drive, creating a new east-west road to connect to the existing SR 157/Francistown Road intersection. Approximately 1.5 miles of new road would be constructed. In addition, existing Springfield Road would be severed in the vicinity of Echo Lake Park, essentially creating two cul-de-sacs at Echo Lake Drive on the west side,

and Echo Lake Park on the east side. A service road connection would still be maintained through the abandoned horizontal curve section of road between these two endpoints, still allowing for pedestrian, bicycle, and emergency vehicle movements.

A summary of improvements is listed below:

- Realign the northern portion of existing Springfield Road at the western end of the new alignment to intersect the new alignment directly across from Linsey Lakes Drive. A portion of existing Linsey Lakes Drive would be removed to accommodate the realignment, and Wintergreen Road would also be slightly modified.
- Abandon the section of Springfield Road between Echo Lake Drive and Echo Lake Park, effectively creating two cul-de-sacs. A service road connection would still be maintained through the abandoned sections, allowing for pedestrian, bicycle, and emergency vehicle movements.
 - Construct a roadway cross-section (51 feet wide) throughout study limits **except** on the existing section of SR 157 that would serve only local residential traffic (between Linsey Lake Drive and Francistown Road). The cross-section would include:
 - 11-foot travel lanes
 - 3-foot paved shoulder (bike lane)
 - 2.5-foot gutter pan and curb (2-foot wide gutter pan, 6-inch wide curb)
 - 4-foot buffer
 - 5-foot sidewalks
 - The portion of existing Springfield Road between Linsey Lake Drive and Francistown Road does not include wholesale cross-sectional improvements but does include strategic spot improvements.
- Install single-lane roundabouts at the SR 157/Wintergreen Road/Linsey Lakes Drive and SR 157/Francistown Road intersections.
- Modify the SR 157/Staples Mill Road intersection as described in Alternative 1.
- Eliminate the Hart Mill Drive approach to SR 157 (use adjacent Bernard Mills Drive access) due to sight distance limitations.
- Disconnect SR 157 between Echo Lake Drive and the Echo Lake County Park parking area to provide only pedestrian, bicycle, and emergency vehicle access.

Alternative 3 Operations

- Of the roughly 10,000 Average Daily Traffic (ADT) volumes forecast to be using the Springfield Road corridor in year 2036, approximately 75 percent are anticipated to divert to the new alignment of SR 157 under Alternative 3.
 - Disconnecting the existing Springfield Road alignment between Echo Lake Drive and Echo Lake Park will also introduce localized travel pattern changes for residents along Springfield Road, adding an additional 1,500 ADT to the new alignment of SR 157.

- All of the study intersections are forecast to operate at LOS D or better during the future year 2036 weekday a.m. and p.m. peak hours assuming provision of the Alternative 3 improvements.

Alternative 3 HSM Safety Analysis

- Alternative 3 was also evaluated using Chapter 12 (Urban/Suburban Arterial) procedures in the HSM.
- Alternative 3 is anticipated to result in a 20 percent reduction in crashes relative to the no-build scenario.
- Alternative 3 is estimated to save \$14.7 million compared to the no-build scenario over the assumed 25-year service life of the improvements.
 - Roughly 89 percent of the cost savings (\$13.1M) is attributable to improvements to SR 157 between Linsey Lakes Road and Francistown Road.

Alternative 3 Cost Estimate

- A preliminary estimate of probable cost indicates Alternative 3 would cost approximately \$17.4 million to design and construct.

SUMMARY

Generalized findings are summarized below based on the analyses contained in this report.

- A majority of study intersections operate at LOS D or better today, and are forecast to continue to do so under design year 2036 traffic conditions.
- Single-lane roundabouts are the preferred intersection control form (operations and safety) at the SR 157/Linsey Lakes Drive and SR 157/Francistown Road intersections for all Alternatives as compared to all-way stop control and traffic signal control.
- The identified corridor cross-section and 40 mph design speed are consistent with Urban Minor Arterial functional classifications as noted in Table GS-5 of the VDOT Road Design Manual.
- The following design changes should be considered under all alternatives (unless otherwise noted) to address identified operational and safety issues:
 - Construct turn lane improvements and make signal timing modifications at the SR 157/Staples Mill Road intersection to allow the intersection to operate at LOS D or better under design year 2036 traffic conditions
 - Eliminate the Hart Mill Drive approach to SR 157 (use adjacent Bernard Mills Drive access) due to sight distance limitations
 - Realign SR 157 between Olde Hartley Drive and the Echo Lake County Park parking area to increase horizontal curve radii in this segment (Alternative 1 & 2 only)

- Alternatives 2 and 3 both involve the construction of a new 1.5-mile two-lane roadway between Lindsey Lakes Drive and Francistown Road.
 - Under Alternative 2, the new roadway connection is anticipated to carry approximately 6,000 vehicles per day in the design year 2036, shifting 60 percent of traffic off of the existing SF 157 alignment between the two endpoints of the new alignment.
 - Under Alternative 3, local trip rerouting due to the closure of the existing SR 157 alignment to through traffic at Echo Lake will shift even more vehicles to the new alignment – approximately 7,500 vehicles per day in the design year 2036.
- Alternative 2 is estimated to result in the greatest reduction of average annual crashes (22 percent reduction) within the SR 157 study corridor as compared to the no-build condition.
 - Alternative 3 is estimated to result in a 20 percent reduction
 - Alternative 1 is estimated to result in an eight percent reduction
- Alternative 2 is estimated to result in the greatest overall cost benefit (\$16.5M) compared to the no-build scenario over the assumed 25-year service life of the improvements.
 - Alternative 3 results in a \$14.7M cost benefit
 - Alternative 1 results in a \$6.5M cost benefit
- Alternative 3 results in the greatest cost-benefit percentage (89 percent) when isolating improvements attributable to segments of SR 157 between Lindsey Lakes Road and Francistown Road as compared to Alternative 2 (86 percent) and Alternative 1 (75 percent).
- Alternative 1 is the least expensive alternative, estimated to cost \$12.3M for design and construction.
- The higher costs of Alternatives 2 and 3 (\$18.3M and \$17.4M, respectively) are primarily related to the costs of constructing a new 1.5-mile two-lane roadway between Lindsey Lakes Drive and Francistown Road.

Section 2 Introduction

INTRODUCTION

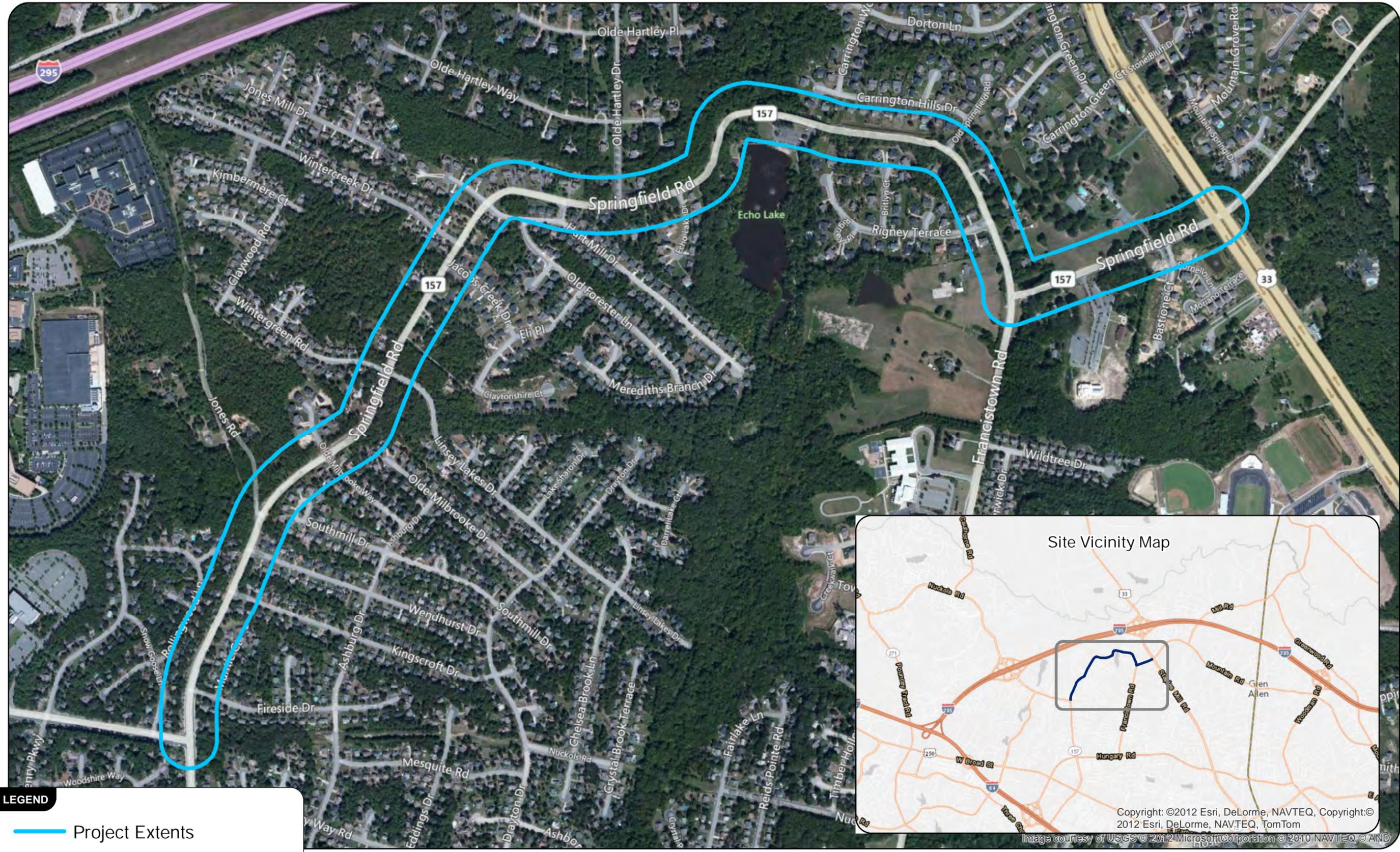
PROJECT DESCRIPTION

Springfield Road, State Route (SR) 157, is located in Henrico County, north of Richmond, Virginia. The Virginia Department of Transportation (VDOT) Central Region Operations (VDOT-CRO) has requested an operational and safety evaluation of three alternatives for the segment of SR 157 between Nuckols Road and Staples Mill Road.

Alternative 1 would modify SR 157 along its existing alignment to improve road safety and operations between the intersections of Nuckols Road and Staples Mill Road (US Route 33). Alternative 2 would develop a partial new alignment for SR 157 within the study area except the existing segment of Springfield Road between Linsey Lake Drive and Francistown Road. Alternative 3 would develop the same partial new alignment as with Alternative 2, but would disconnect existing Springfield Road between Echo Lake Drive and Echo Lake Park to through traffic. A service road connection would be maintained to allow continued pedestrian, bicycle, and emergency vehicle movements, but through vehicles trips would be eliminated.

Corridor Description

The SR 157 study corridor extends from the SR 157/Nuckols Road intersection to the west, to the SR 157/Staples Mill Road intersection to the east. The existing study corridor is approximately 2.1 miles in length. **Figure 1** illustrates the study limits. **Table 1** lists the 17 identified study intersections, number of approaches, and the traffic control device at each intersection.



LEGEND

- Project Extents
- Springfield Road (Site Vicinity Map)

SPRINGFIELD ROAD (SR 157) SITE VICINITY MAP AND PROJECT EXTENTS HENRICO COUNTY, VIRGINIA

Table 1 SR 157 Corridor Study Intersections

Intersection Number	Intersection	Approaches	Traffic Control
1	SR 157/Nuckols Road	3	Signalized
2	SR 157/Fireside Drive	3	Two-way stop control
3	SR 157/Kingscroft Drive	3	Two-way stop control
4	SR 157/Wendhurst Drive	3	Two-way stop control
5	SR 157/Jones Road	3	Two-way stop control
6	SR 157/Olde Milbrooke Way	4	Two-way stop control
7	SR 157/Linsey Lake Drive-Wintergreen Road	4	Two-way stop control
8	SR 157/Jacobs Creek Drive	3	Two-way stop control
9	SR 157/Winter Creek Drive	3	Two-way stop control
10	SR 157/Warnerwood Court-Hart Mill Drive	4	Two-way stop control
11	SR 157/Bernard Mills Drive	3	Two-way stop control
12	SR 157/Old Hartley Drive	3	Two-way stop control
13	SR 157/Echo Lake Drive	3	Two-way stop control
14	SR 157/Old Springfield Road	3	Two-way stop control
15	SR 157/Rigney Terrace	3	Two-way stop control
16	SR 157/Francistown Road	3	Two-way stop control
17	SR 157/Staples Mill Road	4	Signalized

SCOPE OF THE REPORT

This report evaluates the existing and projected design year (2036) conditions of the SR 157 study corridor, analyzes three potential alternatives to improve SR 157, and summarizes the findings and recommendations for both alternatives. Additional details regarding the scope of this report are provided below.

EXISTING AND FUTURE NO-BUILD ANALYSIS

- Existing Conditions Evaluation
 - Existing levels of service (LOS) during the weekday a.m. and p.m. peak hours at the 17 study intersections
 - Existing conditions operational results
 - Crash prediction for existing conditions using the Highway Safety Manual (HSM) methodology
 - The use of the Empirical Bayes (EB) procedure to prioritize segments and intersections for further investigation
- Future Year 2036 No-Build Conditions Evaluation

- Year 2036 traffic volumes using growth rate provided by VDOT-CRO, including Average Annual Daily Traffic (AADT), Directional Hourly Volume (DHV), directional distribution, and heavy vehicle percentages
- Year 2036 traffic conditions and operational analysis
- The prediction of future no-build crashes using the HSM

ALTERNATIVES ANALYSIS

Alternative 1 – Existing Alignment

Alternative 1 would modify the existing alignment of SR 157 to improve road safety and operations. The concept design incorporates a design speed of 40 miles per hour (mph) and includes the following considerations:

- Sight distance
- Addition of turn lanes
- Cross-sectional elements
- Accommodations for bicyclists and pedestrians
- Estimated reduction in crashes

The Alternative 1 analysis:

- Identifies appropriate mitigations at study intersections to obtain a minimum of LOS D in the design year
- Contains warrant analyses and supporting justification for identified mitigations
- Provides an access management analysis of the existing alignment and current intersection locations
- Recommends a typical cross-section and related features necessary to accommodate future traffic demand as well as pedestrians and bicyclists
- Identifies treatments for reducing the frequency and severity of crashes
- Predicts the number of crashes for Alternative 1 based on a HSM analysis
- Calculates the relative benefit of anticipated reduction in crashes
- Calculates an estimate of probable cost for Alternative 1

Alternative 2 – New Alignment

Alternative 2 would develop a partial new alignment for SR 157 within the study area. The new alignment would begin just north of Olde Milbrooke Way and extend eastward approximately 1.5 miles to the SR 157/Francistown Road intersection. The existing portion of SR 157 between these two points would remain largely untouched, but would include strategic spot improvements to address issues identified under current conditions. Alternative 2 improvements also incorporate a design speed of 40 mph and include the following considerations:

- Sight distance
- Addition of turn lanes

- Cross-sectional elements
- Accommodations for bicyclists and pedestrians
- Estimated reduction in crashes.

The Alternative 2 analysis:

- Determines of the amount of traffic diverted from the adjacent road network to the new roadway alignment
- Identifies appropriate mitigations at study intersections to obtain a minimum of LOS D in the design year
- Contains warrant analyses and supporting justification for identified mitigations
- Provides an access management analysis of existing alignment and current intersection locations
- Recommends a typical cross-section and related features necessary to accommodate future traffic demand as well as pedestrians and bicyclists
- Identifies treatments for reducing the frequency and severity of crashes
- Predicts the number of crashes for Alternative 2 based on a HSM analysis
- Calculates the relative benefit of anticipated reduction in crashes
- Calculates an estimate of probable cost for Alternative 2

Alternative 3 – New Alignment + Cul-De-Sac

Alternative 3 would develop the same partial new alignment as with Alternative 2, but would disconnect existing Springfield Road between Echo Lake Drive and Echo Lake Park to through traffic. A service road connection would be maintained to allow continued pedestrian, bicycle, and emergency vehicle movements, but through vehicles trips would be eliminated. The existing portion of SR 157 between these two points would also include strategic spot improvements to address issues identified under current conditions. Alternative 3 improvements also incorporate a design speed of 40 mph and include the following considerations:

- Sight distance
- Addition of turn lanes
- Cross-sectional elements
- Accommodations for bicyclists and pedestrians
- Estimated reduction in crashes.

The Alternative 3 analysis:

- Determines of the amount of traffic diverted from the adjacent road network to the new roadway alignment
- Identifies appropriate mitigations at study intersections to obtain a minimum of LOS D in the design year
- Contains warrant analyses and supporting justification for identified mitigations
- Provides an access management analysis of existing alignment and current intersection locations

- Recommends a typical cross-section and related features necessary to accommodate future traffic demand as well as pedestrians and bicyclists
- Identifies treatments for reducing the frequency and severity of crashes
- Predicts the number of crashes for Alternative 3 based on a HSM analysis
- Calculates the relative benefit of anticipated reduction in crashes
- Calculates an estimate of probable cost for Alternative 3

Findings regarding the three alternatives are summarized; including a comparison of the intersection controls analyzed, projected Levels of Service, anticipated reduction in crashes, and recommended improvements.

Section 3
Existing Conditions

EXISTING CONDITIONS

The existing conditions analysis identifies the site conditions and current operational and geometric characteristics of the roadways within the study area. These conditions will be compared with future conditions later in this report.

Kittelson and Associates, Inc. (KAI) staff visited the study area on two separate occasions in April 2012 to collect information regarding site conditions, adjacent land uses, existing traffic operations, sight distance, and transportation facilities in the study area.

SITE CONDITIONS AND ADJACENT LAND USES

SR 157 is currently a two-lane undivided roadway, predominantly bordered by single-family homes. Within the study limits, SR 157 has a posted speed limit of 35 mph between Staples Mill Road and Linsey Lakes Drive, and 45 mph between Linsey Lakes Drive and Nuckols Road. Echo Lake County Park is located east of the SR 157/Echo Lake Drive intersection, and there are two religious institutions located on SR 157 between Francistown Road and Staples Mill Road. There is an existing elementary school just south of the study corridor on Francistown Road and a high-school approximately one-quarter mile south of the SR 157/Staples Mill Road intersection.

The area where the new potential alignment is being considered is partially forested. The western portion of the realignment can be largely accommodated within an existing strip of reserved right of way that has been set aside for such a future connection. The eastern portion of the realignment would impact right-of-way on a single large property roughly bordered by Francistown Road and Echo Lake.

TRANSPORTATION FACILITIES

Existing transportation facilities were inventoried for the study area. These include:

- Roadway characteristics,
- Pedestrian facilities and bicycle facilities, and
- Transit facilities.

Table 2 summarizes these facilities.

Table 2 Existing Transportation Facilities

Roadway	Functional Classification ¹	Number of Lanes	Posted Speed (mph)	Paved Width ² (ft)	Median?	Sidewalks	Bicycle Lanes	On-Street Parking
<i>VDOT Functional Classification</i>								
SR 157 (Nuckols Rd – Francistown Rd)	Urban Collector	2-4 Lanes	35/45	23-26 ft	No	No ³	No	No
SR 157 (Francistown Rd – Staples Mill Rd)	Urban Minor Arterial	2 Lanes	45	23-26 ft	No	No	No	No
Staples Mill Road	Urban Principal Arterial	4-8 Lanes	55	120 ft	Yes (46 ft)	No ⁴	No	No
Nuckols Road	Urban Minor Arterial	4-6 Lanes	45	70 ft	Yes (16 ft)	Yes	No	No
<i>Henrico County Functional Classification</i>								
SR 157 (Nuckols Rd – Linsey Lakes Dr & Francistown Rd – Staples Mill Rd)	Major Collector	2-4 Lanes	35/45	23-26 ft	No	No ³	No	No
SR 157 (Linsey Lakes Dr – Francistown Road)	Minor Collector	2 Lanes	45	23-26 ft	No	No	No	No
Staples Mill Road	Major Arterial	4-8 Lanes	55	120 ft	Yes (46 ft)	No ⁴	No	No
Nuckols Road	Minor Arterial	4-6 Lanes	45	70 ft	Yes (16 ft)	Yes	No	No

¹ VDOT/Henrico County Functional Classification

² Paved width includes median width. Width of SR 157 reflects a typical section within the study corridor; it widens periodically at intersections.

³ Only between SR 157/Nuckols Road and SR 157/Fireside Drive intersections

⁴ Not within study area

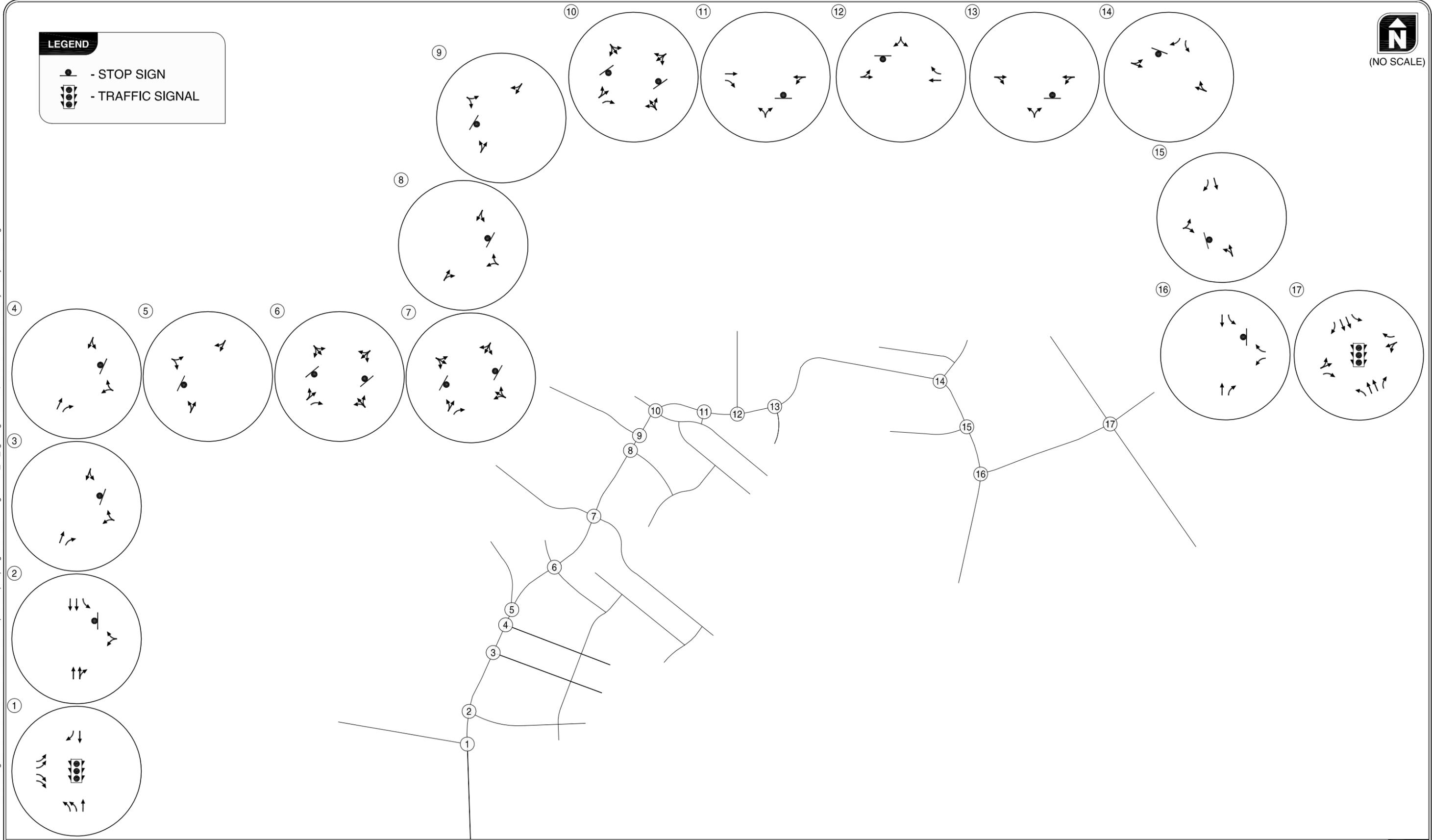
Roadway Facilities

VDOT currently classifies a majority of SR 157 in the study area as an urban collector; a small portion of the study corridor between the SR 157/Francistown Road and SR 157/Staples Mill Road intersections is classified as an urban minor arterial. Henrico County classifies SR 157 as either a major or minor collector throughout the study area. Staples Mill Road and Nuckols Road at either end of the corridor are classified as an Urban Principal Arterial and an Urban Minor Arterial, respectively. SR 157 is predominantly a two-lane road, though it widens at the Staples Mill Road and Nuckols Road intersections to accommodate turn lanes and includes right-turn deceleration and acceleration lanes at several local residential streets. **Figure 2** displays existing lane configurations and traffic control devices at study intersections along the corridor.

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LEGEND

-  - STOP SIGN
-  - TRAFFIC SIGNAL



EXISTING LANE CONFIGURATIONS AND TRAFFIC CONTROL DEVICES
HENRICO COUNTY, VIRGINIA

Pedestrian and Bicycle Facilities

Field observations revealed no pedestrian or bicycle activity along the study area roadways, though the area is predominately residential, there are schools nearby, and there is a County park at Echo Lake with recreational trails. This suggests that there may be latent demand for increased pedestrian and bicycle activity assuming provision of appropriate facilities. There are no bicycle lanes or bike accommodations on SR 157 within the study area and only approximately 320 feet of sidewalks (between SR 157/Nuckols Road and SR 157/Fireside Drive intersections) currently provided in the site vicinity.

Transit Facilities

Local transit service is not provided in the study area. The Greater Richmond Transit Company (GRTC) website¹ indicates the closest transit route is Route 19, 1.6 miles south of the SR 157/Nuckols Road intersection.

TRAFFIC VOLUMES AND PEAK HOUR OPERATIONS

Manual turning movement counts and Average Daily Traffic (ADT) counts were collected in March 2012. Turning movement counts were obtained at eight intersections over a 12 hour period on March 27, 2012. The ADT counts were collected March 27 and March 28, 2012 using pneumatic road tubes over a 48 hour period. The tubes were placed at 18 locations in the study area, including 14 side streets and four on SR 157. A summary of the counts is shown in **Table 3. Appendix A** contains the traffic count data.

The collected volume data were used to estimate trips at intersections where count data was not obtained to evaluate existing conditions.

The traffic data was analyzed to determine system wide peaks, peak-hour factors, ADT, and heavy vehicle percentages. The data show the system-wide morning and evening peak hours occur between 7:30 – 8:30 a.m. and 5:00 – 6:00 p.m., respectively.

¹ GRTC Route 19 Location http://www.ridegrtc.com/FrontEnd/Download_Files/get_on_bus_downloads/Rt19.pdf

Table 3 SR 157 Average Daily Traffic (ADT) Summary

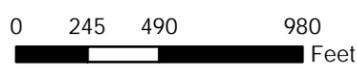
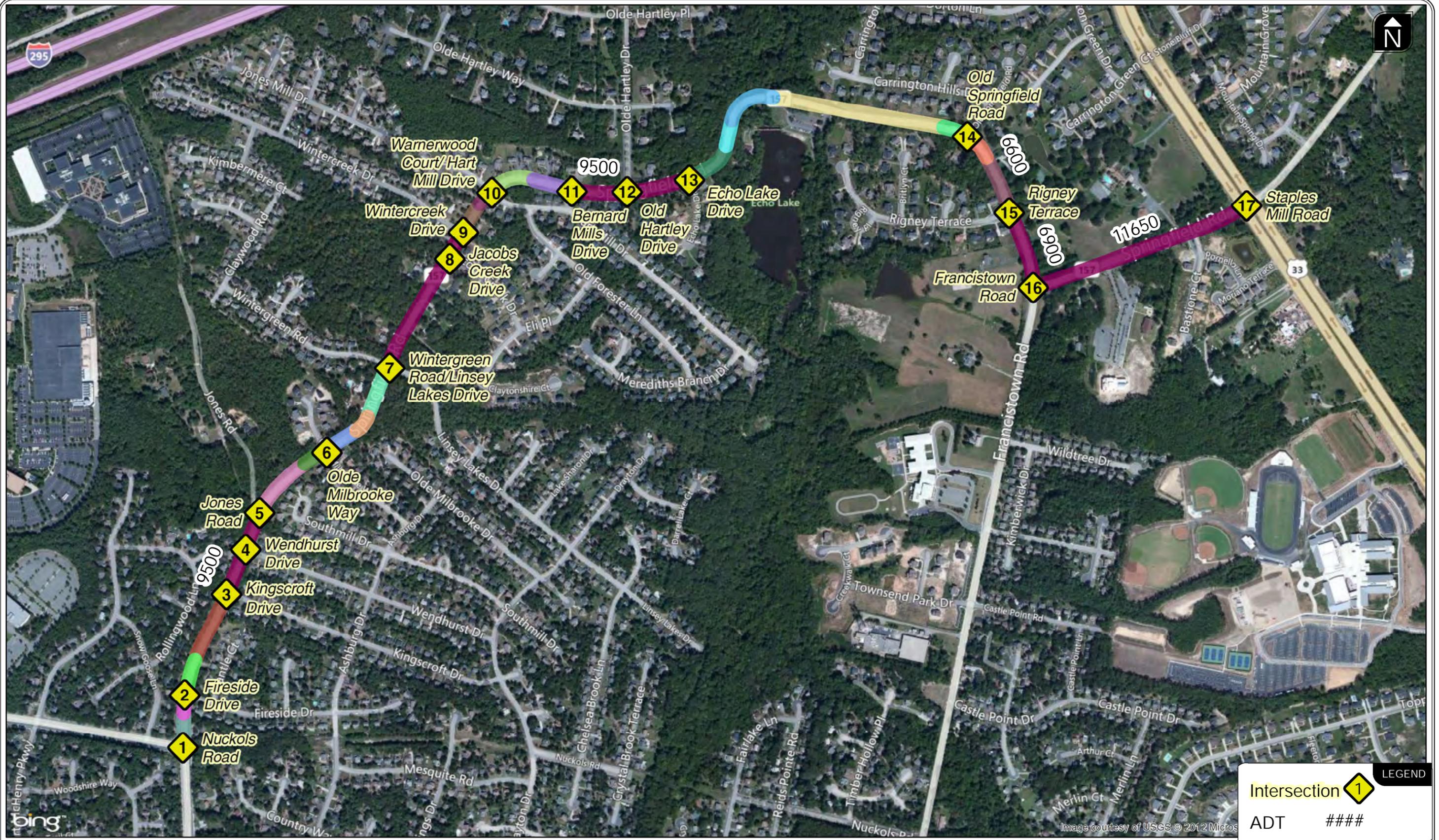
Count Location	ADT
Fireside Drive	750 vehicles
Springfield Road (north of Fireside Road)	9,500 vehicles
Kingscroft Drive	850 vehicles
Wendhurst Drive	900 vehicles
Olde Milbrooke Way	500 vehicles
Lindsey Lakes	1,200 vehicles
Wintergreen Road	1,000 vehicles
Wintercreek Road	950 vehicles
Jacob Creek Drive	400 vehicles
Hart Mill Drive	250 vehicles
Bernard Mills Drive	450 vehicles
Olde Hartley Drive	600 vehicles
Springfield Road (east of Old Springfield Road)	6,600 vehicles
Old Springfield Road	700 vehicles
Rigney Terrace	350 vehicles
Springfield Road (between Rigney Terrace and Francistown Road)	6,900 vehicles
Francistown Road	7,500 vehicles
Springfield Road (between Francistown Road and Staples Mill)	11,650 vehicles

Average Daily Traffic (ADT) volumes on SR 157 range from approximately 6,600 vehicles between Echo Lake Drive and Old Springfield Road to approximately 11,600 vehicles between Francistown Road and Staples Mill Road. **Figure 3** summarizes the recorded existing ADT volumes on Springfield Road.

Henrico County maintains yearly records of traffic volumes and has ADT data for SR 157 extending back to the year 2000². This data shows the average ADT growth for SR 157 between Francistown Road and Staples Mill Road is approximately 3.1 percent annually.

² Henrico County Traffic Counts

<http://www.co.henrico.va.us/works/traffic/>



SPRINGFIELD ROAD (SR 157) EXISTING AVERAGE DAILY TRAFFIC VOLUMES BY SEGMENT
HENRICO COUNTY, VIRGINIA

Current Levels of Service and Volume-to-Capacity Ratios

All level-of-service (LOS) analyses described in this report were performed in accordance with the procedures stated in the 2000 Highway Capacity Manual (Reference 1). A description of level of service and the criteria by which they are determined is presented in **Appendix B**. Appendix B also indicates how level of service is measured and what is generally considered the acceptable range of level of service.

All intersection level-of-service evaluations used the peak 15-minute flow rate during the weekday a.m. and p.m. peak hours. Using the peak 15-minute flow rate ensures the analysis is based on a reasonable worst-case scenario. For this reason, the analysis reflects conditions likely to occur for 15-minutes out of each average peak hour. Signalized intersections were modeled to reflect signal timing plans obtained from VDOT staff. The transportation system will likely operate under conditions better than those described in this report during all other time periods. Synchro 8 was used to analyze all intersection traffic operations.

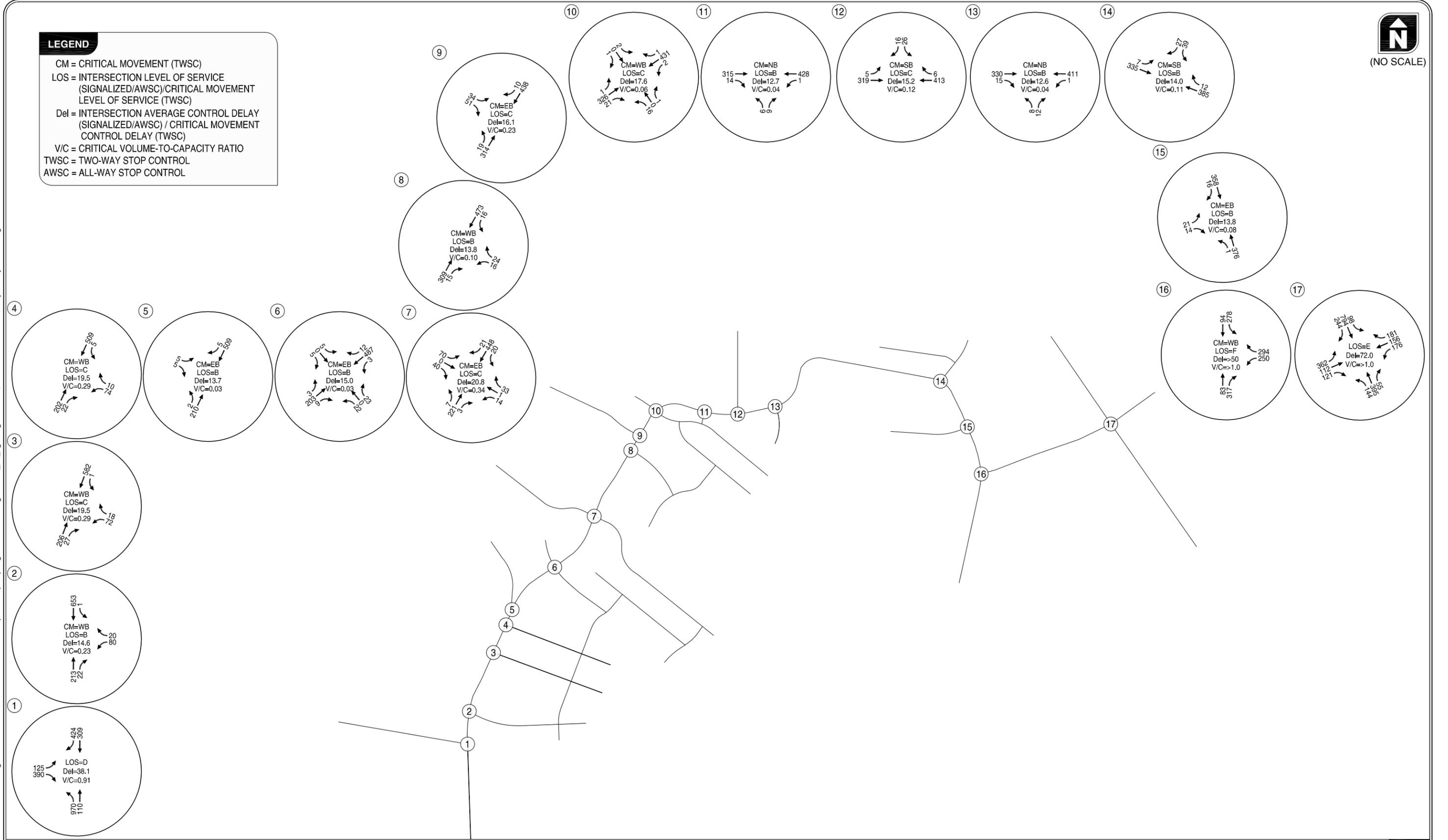
Figure 4 and **Figure 5** summarize the existing conditions intersection operational results during the weekday a.m. and p.m. peak hours, respectively. **Figure 6** and **Figure 7** summarize existing lane group levels of service. **Table 4** summarizes the LOS for the study intersections under the weekday a.m. and p.m. peak hour existing traffic conditions. All of the study intersections currently operate at acceptable levels of service during the weekday a.m. and p.m. peak hours except SR 157/Francistown Road which currently operates at LOS F during the weekday a.m. peak hour. **Appendix C** contains the existing conditions operational worksheets.



(NO SCALE)

LEGEND

CM = CRITICAL MOVEMENT (TWSC)
 LOS = INTERSECTION LEVEL OF SERVICE (SIGNALIZED/AWSC)/CRITICAL MOVEMENT LEVEL OF SERVICE (TWSC)
 Del = INTERSECTION AVERAGE CONTROL DELAY (SIGNALIZED/AWSC) / CRITICAL MOVEMENT CONTROL DELAY (TWSC)
 V/C = CRITICAL VOLUME-TO-CAPACITY RATIO
 TWSC = TWO-WAY STOP CONTROL
 AWSC = ALL-WAY STOP CONTROL



EXISTING TRAFFIC CONDITIONS
WEEKDAY AM PEAK HOUR
HENRICO COUNTY, VIRGINIA

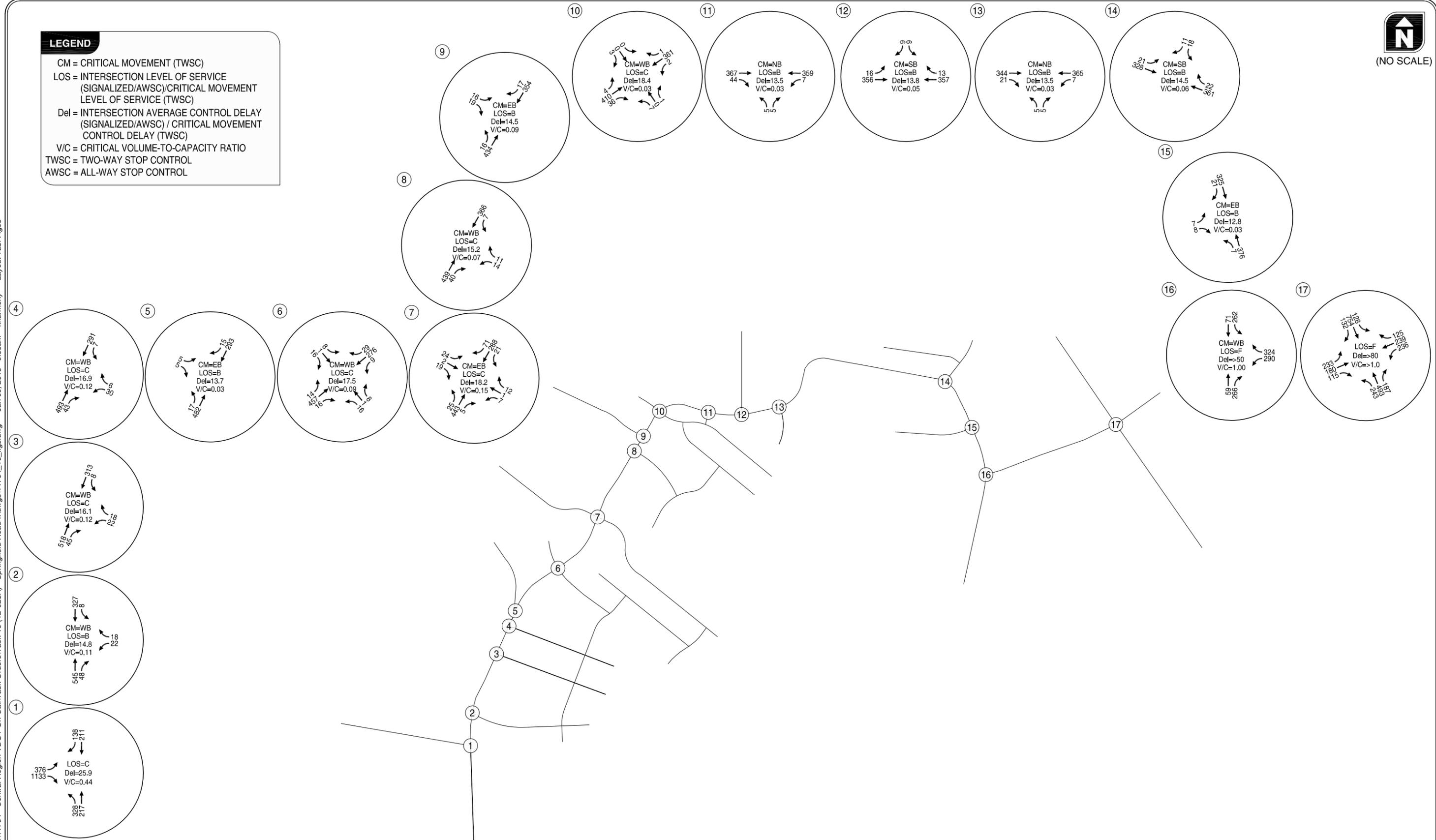
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(NO SCALE)

LEGEND

CM = CRITICAL MOVEMENT (TWSC)
 LOS = INTERSECTION LEVEL OF SERVICE (SIGNALIZED/AWSC)/CRITICAL MOVEMENT LEVEL OF SERVICE (TWSC)
 Del = INTERSECTION AVERAGE CONTROL DELAY (SIGNALIZED/AWSC) / CRITICAL MOVEMENT CONTROL DELAY (TWSC)
 V/C = CRITICAL VOLUME-TO-CAPACITY RATIO
 TWSC = TWO-WAY STOP CONTROL
 AWSC = ALL-WAY STOP CONTROL



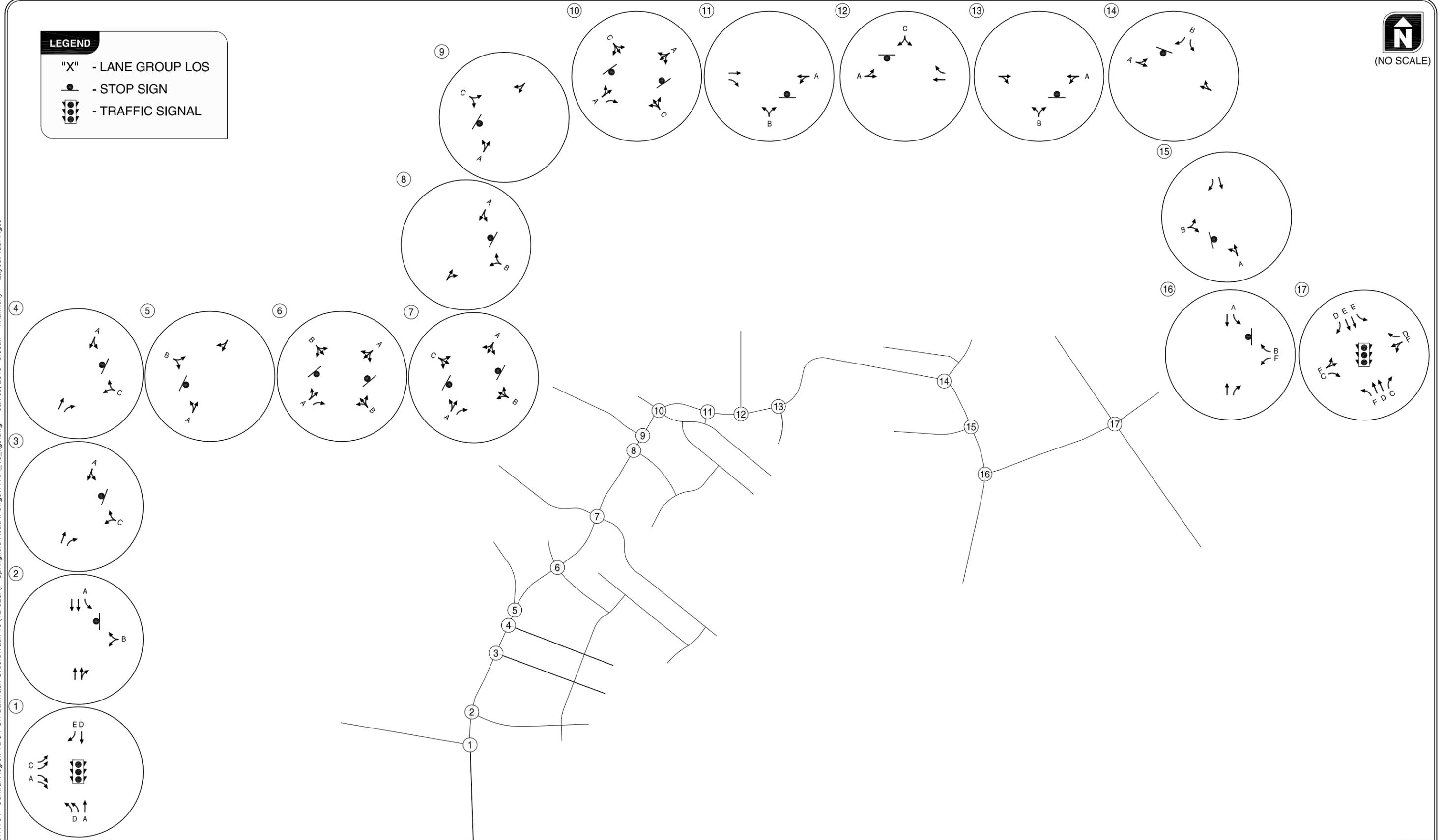
EXISTING TRAFFIC CONDITIONS
WEEKDAY PM PEAK HOUR
HENRICO COUNTY, VIRGINIA

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LEGEND

- "X" - LANE GROUP LOS
- - STOP SIGN
- ⬆️⬆️⬆️ - TRAFFIC SIGNAL

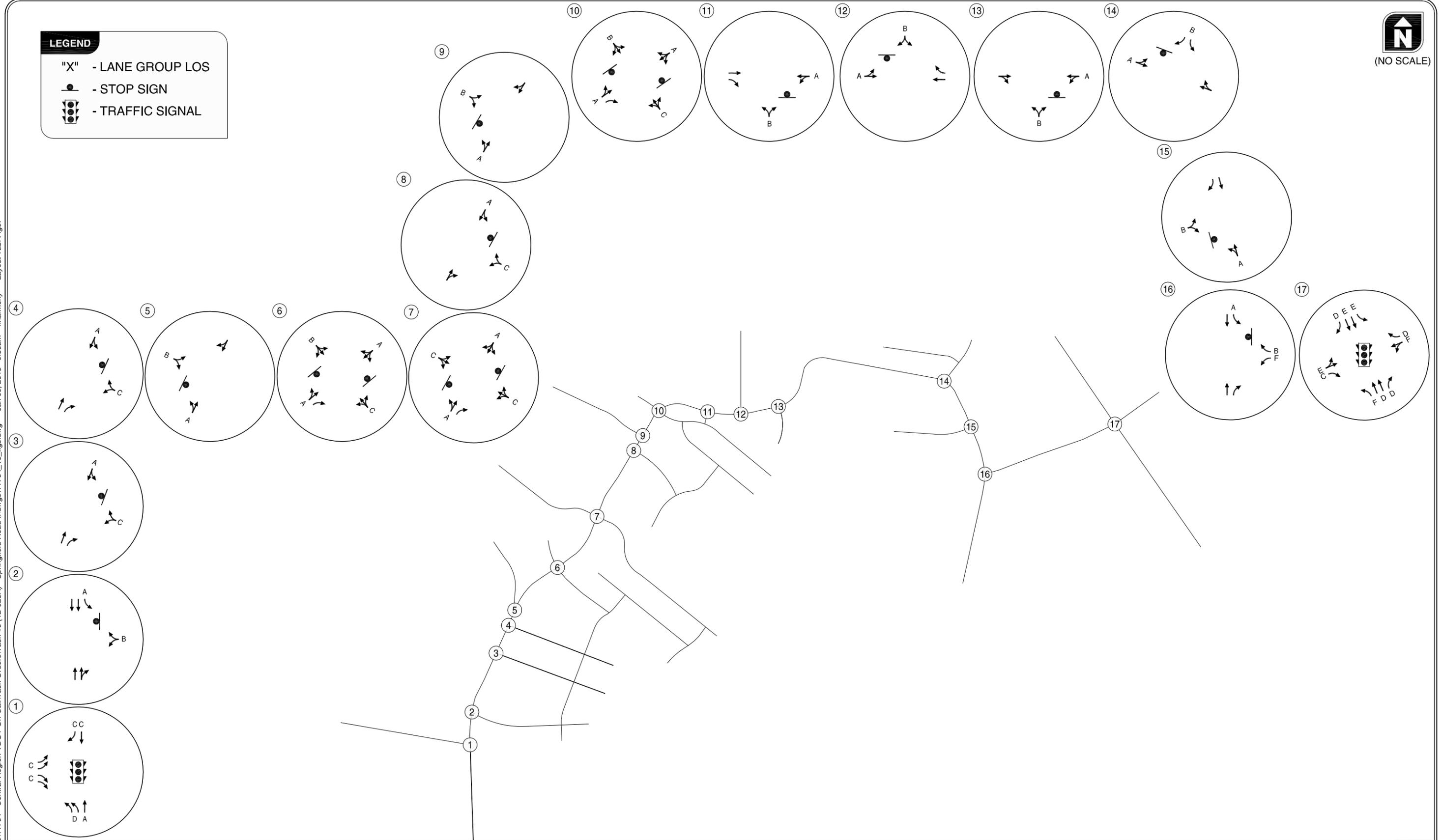


EXISTING LANE GROUP LEVEL OF SERVICE
WEEKDAY AM PEAK HOUR
HENRICO COUNTY, VIRGINIA

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LEGEND

- "X" - LANE GROUP LOS
- - STOP SIGN
- 🚦 - TRAFFIC SIGNAL



EXISTING LANE GROUP LEVEL OF SERVICE
WEEKDAY PM PEAK HOUR
HENRICO COUNTY, VIRGINIA

Table 4 Levels of Service, 95th Percentile Back of Queue and Delay Results - Existing Conditions

Intersection Information					AM Peak Hour			PM Peak Hour			
Intersection	Traffic Control	Approach	Lane Group	Existing/ Proposed turn-lane lengths	LOS	Back of Queue (feet)	Delay (sec)	LOS	Back of Queue (feet)	Delay (sec)	
Nuckols Road & Springfield Road	Signalized	EB	EBL	275	C	50	22.9	C	137	26.2	
			EBR	175	A	64	7.6	C	50	26.8	
		EB Approach				B		11.3	C		26.6
		NB	NBL	225	D	#406	42.1	D	137	37.5	
			NBT		A	51	8.7	A	99	9.3	
		NB Approach				D		38.7	C		26.3
		SB	SBT		D	#330	54.8	C	167	22	
			SBR		E	#432	57.2	C	42	23.3	
		SB Approach				E		56.2	C		22.5
Overall LOS				D		38.1	C		25.9		
Fireside Drive &	Unsignalized	WB	WBLR		B	22	14.6	B	9	14.8	
			WB Approach				B		14.6	B	
		NB	NBTR			0	0		0	0	
			NB Approach								0
		SB	SBL		A	0	7.8	A	1	8.9	
			SBT			0	0		0	0	
		SB Approach						0		0.2	
Overall LOS				A		1.5	A		0.7		
Kingscroft Drive & Springfield Road	Unsignalized	WB	WBLR		C	30	19.5	C	10	16.1	
			WB Approach				C		19.5	C	
		NB	NBT			0	0		0	0	
			NBR			0	0		0	0	
		NB Approach						0		0	
		SB	SBLT		A	0	0	A	1	0.3	
			SB Approach						0		0.3
Overall LOS				A		1.9	A		0.8		
Wendhurst Drive & Springfield Road	Unsignalized	WB	WBLR		C	30	19.5	C	10	16.9	
			WB Approach				C		19.5	C	
		NB	NBT			0	0		0	0	
			NBR			0	0		0	0	
		NB Approach						0		0	
		SB	SBLT		A	0	0.1	A	1	0.3	
			SB Approach						0.1		0.3
Overall LOS				A		2.1	A		0.8		
Jones Road & Springfield Road	Unsignalized	EB	EBLR		B	2	13.7	B	2	13.7	
			EB Approach				B		13.7	B	
		NB	NBLT		A	0	0.1	A	1	0.4	
			NB Approach						0.1		0.4
		SB	SBTR			0	0		0	0	
			SB Approach						0		0
		Overall LOS				A		0.2	A		0.4
Olde Millbrooke Way & Springfield Road	Unsignalized	EB	EBLTR		B	2	15	B	5	13.6	
			EB Approach				B		15	B	
		WB	WBLTR		B	10	14.2	C	7	17.5	
			WB Approach				B		14.2	C	
		NB	NBLT		A	0	0.2	A	1	0.4	
			NBR			0	0		0	0	
		NB Approach						0.2		0.4	
		SB	SBLTR		A	0	0.1	A	1	0.3	
			SB Approach						0.1		0.3
Overall LOS				A		1.1	A		1.2		
Wintergreen Road & Springfield Road	Unsignalized	EB	EBLTR		C	37	20.8	C	13	18.2	
			EB Approach				C		20.8	C	
		WB	WBLTR		B	9	13.1	C	5	15.7	
			WB Approach				B		13.1	C	
		NB	NBLT		A	1	0.3	A	2	0.7	
			NBR			0	0		0	0	
		NB Approach						0.3		0.7	
		SB	SBLTR		A	1	0.5	A	2	0.7	
SB Approach						0.5		0.7			

Intersection Information					AM Peak Hour			PM Peak Hour			
Intersection	Traffic Control	Approach	Lane Group	Existing/ Proposed turn-lane lengths	LOS	Back of Queue (feet)	Delay (sec)	LOS	Back of Queue (feet)	Delay (sec)	
		Overall LOS			B		3.7	A		1.9	
Jacobs Creek Drive & Springfield Road	Unsignalized	WB	WBLR		B	8	13.8	C	6	15.2	
		WB Approach			B		13.8	C		15.2	
		NB	NBTR			0	0		0	0	
		NB Approach					0			0	
		SB	SBLT		A	1	0.4	A	1	0.2	
		SB Approach						0.4			0.2
		Overall LOS			A		0.9	A		0.5	
Wintercreek Drive & Springfield Road	Unsignalized	EB	EBLR		C	22	16.1	B	8	14.5	
		EB Approach			C		16.1	B		14.5	
		NB	NBLT		A	2	0.7	A	1	0.5	
		NB Approach						0.7		0.5	
		SB	SBTR			0	0		0	0	
		SB Approach						0		0	
		Overall LOS			A		1.8	A		0.8	
Warnerwood Ct & Springfield Road	Unsignalized	EB	EBLTR		C	1	15.4	B	0	10.6	
		EB Approach			C		15.4	B		10.6	
		WB	WBLTR		C	5	17.6	C	3	18.4	
		WB Approach			C		17.6	C		18.4	
		NB	NBLT		A	0	0	A	0	0.1	
			NBR			0	0		0	0	
		NB Approach						0		0.1	
		SB	SBLTR		A	0	0.1	A	0	0.1	
		SB Approach						0.1		0.1	
Overall LOS			A		0.5	A		0.3			
Springfield Road & Bernard Mills Drive	Unsignalized	EB	EBT			0	0		0	0	
			EBR			0	0		0	0	
		EB Approach						0		0	
		WB	WBLT		A	0	0	A	1	0.2	
		WB Approach						0		0.2	
		NB	NBLR		B	3	12.7	B	2	13.5	
		NB Approach			B		12.7	B		13.5	
Overall LOS			A		0.3	A		0.3			
Springfield Road & Olde Hartley Drive	Unsignalized	EB	EBLT		A	0	0.2	A	1	0.5	
		EB Approach					0.2			0.5	
		WB	WBT			0	0		0	0	
			WBR			0	0		0	0	
		WB Approach						0		0	
		SB	SBLR		C	10	15.2	B	4	13.8	
		SB Approach			C		15.2	B		13.8	
Overall LOS			A		0.9	A		0.6			
Springfield Road & Echo Lake Drive	Unsignalized	EB	EBTR			0	0		0	0	
		EB Approach					0			0	
		WB	WBLT		A	0	0	A	1	0.2	
		WB Approach						0		0.2	
		NB	NBLR		B	3	12.6	B	2	13.5	
		NB Approach			B		12.6	B		13.5	
Overall LOS			A		0.3	A		0.3			
Springfield Road & Old Springfield Road	Unsignalized	EB	EBLT		A	0	0.2	A	2	0.7	
		EB Approach					0.2			0.7	
		WB	WBTR			0	0		0	0	
		WB Approach						0		0	
		SB	SBL		B	10	14	B	5	14.5	
		SB Approach			B		14	B		14.5	
Overall LOS			A		1.2	A		0.9			
Rigney Terrace & Springfield Road	Unsignalized	EB	EBLR		B	7	13.8	B	3	12.8	
		EB Approach			B		13.8	B		12.8	
		NB	NBLT		A	0	0	A	0	0.2	
		NB Approach						0		0.2	
		SB	SBT			0	0		0	0	
			SBR			0	0		0	0	
		SB Approach						0		0	

Intersection Information					AM Peak Hour			PM Peak Hour			
Intersection	Traffic Control	Approach	Lane Group	Existing/ Proposed turn-lane lengths	LOS	Back of Queue (feet)	Delay (sec)	LOS	Back of Queue (feet)	Delay (sec)	
		Overall LOS			A		0.6	A		0.4	
Springfield Road & Francistown Road	Unsignalized	WB	WBL		F	273	111.5	F	271	89.2	
			WBR		B	36	10.6	B	39	10.5	
		WB Approach				F		57	E		47.7
		NB	NBT				0	0		0	0
			NBR				0	0		0	0
		NB Approach						0			0
		SB	SBL			A	27	9.4	A	22	8.9
			SBT				0	0		0	0
		SB Approach						7			7
Overall LOS				A		25.5	A		24.8		
Springfield Road & Staples Mill Road	Signalized	EB	EBLT		F	#654	121.4	E	#528	74.8	
			EBR	575	C	49	34.5	C	47	34.7	
		EB Approach				F		103.8	E		66
		WB	WBLT			F	#482	111.4	F	#738	267.8
			WBR			D	63	41.1	D	71	41.2
		WB Approach				F		86.6	F		220.7
		NB	NBL	150		F	#246	96.6	F	#438	310.4
			NBT			D	203	40	D	251	43.7
			NBR	125		C	35	34.3	D	82	37.3
		NB Approach				D		53.2	F		112.5
		SB	SBL	200		E	134	57.8	E	167	63.5
			SBT			E	#464	64.7	E	#418	57.1
			SBR	125		D	161	39.5	D	111	37.9
SB Approach				E		58.7	E		55.4		
Overall LOS				E		72	F		106.8		

*The '#' indicates 95th percentile volume exceeds capacity queue may be longer and the queue shown is the maximum after two cycles.

Sight Distance

Existing intersection sight distance was measured at all study intersections and compared against the recommended minimum guidelines for the existing conditions set forth in the standard reference American Association of State Highway Transportation Officials (AASHTO) *A Policy on Geometric Design of Highways and Streets, 6th Edition* (Reference 2). All of the intersections were found to meet or exceed AASHTO minimum guidelines for intersection sight distance except the Hart Mill Drive approach to SR 157. At Hart Mill Drive, the horizontal and vertical roadway curvature combined with limited available right of way limit a driver's sight distance looking south (left) on SR 157 to 200 feet, below the AASHTO-recommended minimum of 385 feet for a 40 mph design speed.

TRAFFIC SAFETY

Descriptive crash statistics were developed from the most recent three years of available crash data (2008 to 2010) and were used to help identify appropriate alternative improvements and treatments to reduce crashes. Methods from AASHTO's *Highway Safety Manual* (HSM) (Reference 3) were used to calculate the change in crashes for each alternative. **Figure 8** displays the SR 157 corridor crash map.

Crashes are rare and random events whose occurrence is influenced foremost by human behavior and secondarily by driver's responding to roadway conditions, other motorists, pedestrians, and bicyclists. As a result, engineering cannot prevent or eliminate crashes altogether; combining engineering with enforcement, education and emergency response services create the potential to reduce crashes the most. This report focuses on engineering solutions; therefore, contributing factors to crashes were summarized and crash trends identified to obtain a sense of the number and nature of crashes that have occurred and may be feasible to mitigate through engineering solutions.

Crash History

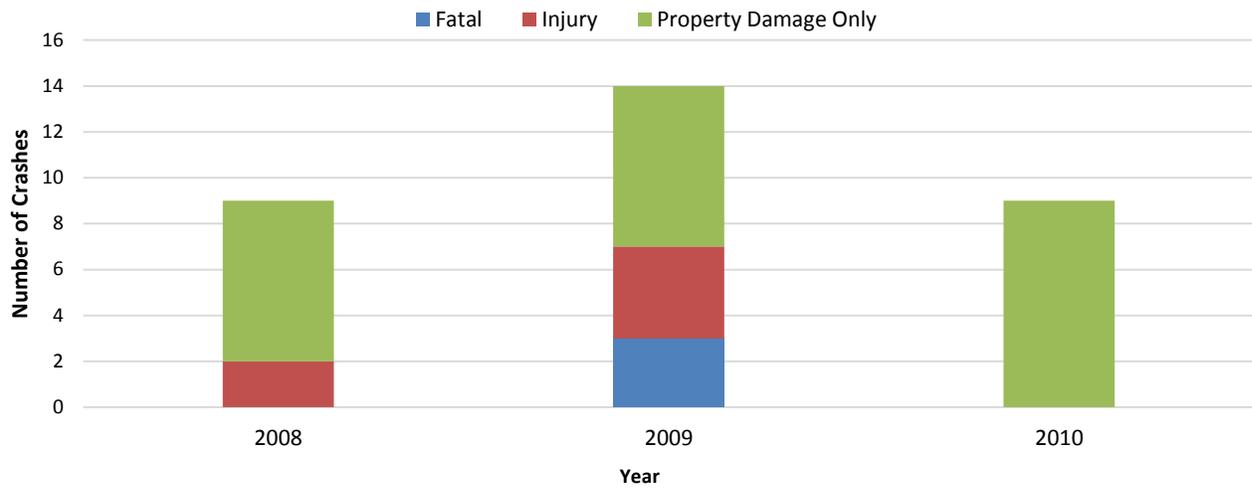
Crash data from 2008 through 2010 for the corridor were provided by VDOT-CRO. During this period 32 reported crashes occurred along the study corridor. Of the 32 total reported crashes, 23 resulted in property damage only (PDO), six involved at least one injury, and three resulted in fatalities. **Figure 9** summarizes the SR 157 crash history by year. **Appendix D** contains the crash data summary sheets.



0 245 490 980 Feet

SPRINGFIELD ROAD (SR 157) CRASH DENSITY, TYPE AND SEVERITY HENRICO COUNTY, VIRGINIA

Figure 9 SR 157 Crash Severity History by Year (Nuckols Road to Staples Mill Road)



As displayed in Figure 9, there were more reported crashes in 2009 than either of the other two years in the study period. In addition, the three recorded fatalities in the study area all occurred in 2009.

When Crashes Occurred

Crash type and severity by month for the years 2008 to 2010 are shown in **Figure 10** and **Figure 11**, respectively.

Figure 10 SR 157 Crash Type by Month (2008-2010)

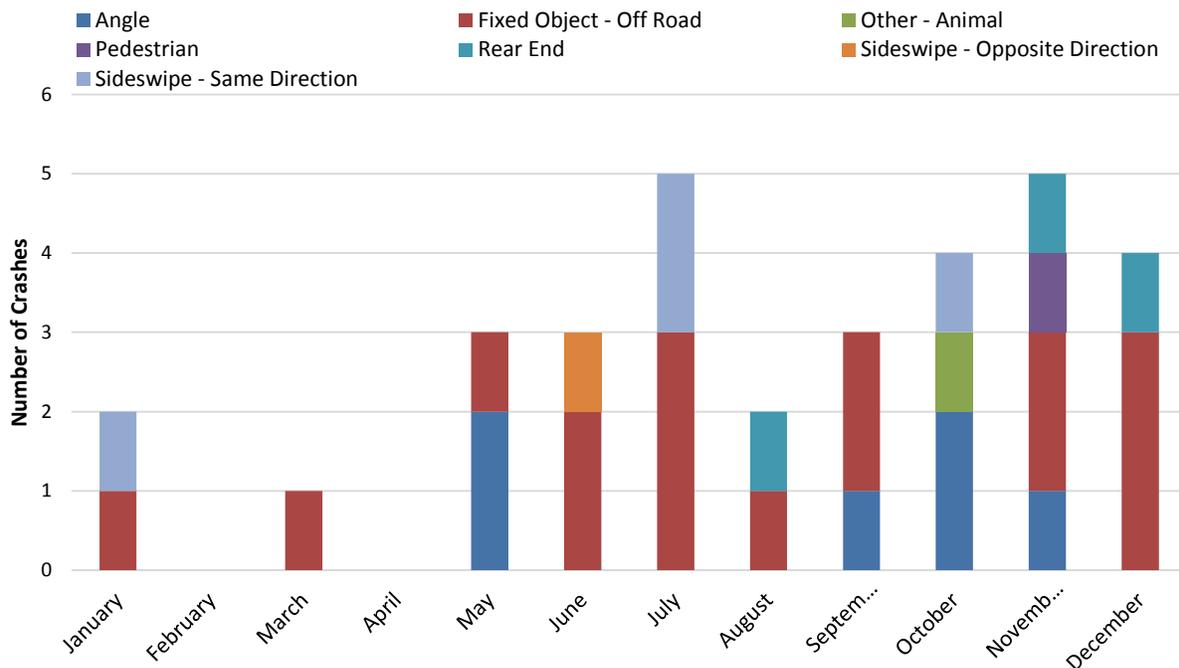


Figure 11 SR 157 Crash Severity by Month (2008-2010)

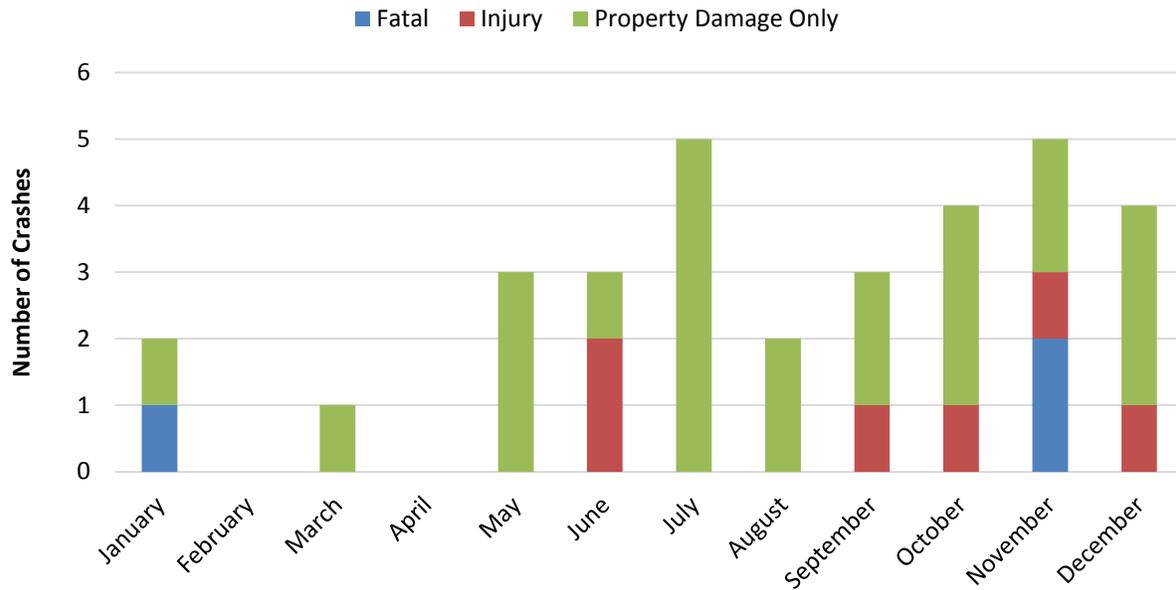
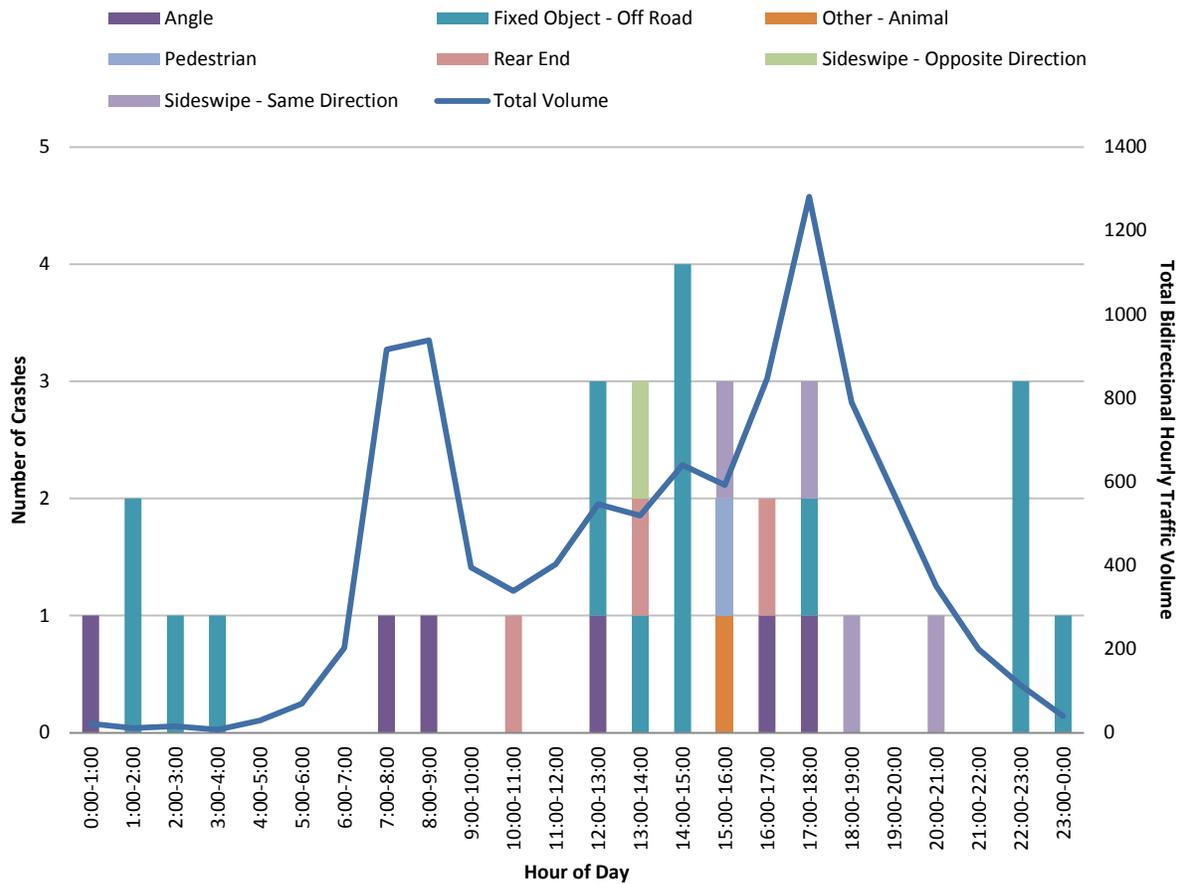


Figure 10 shows how crash types vary month by month. Although there are no distinct patterns, certain crash types could potentially be attributed to seasonal events. For example, both crashes involving an animal occurred in October, a month that historically has higher car-deer incidents³. Figure 10 also shows that nine out of 12 months experienced a “Fixed Object-Off Road” crash. As shown in Figure 11, all three fatal reported crashes occurred between November and January.

The number of crashes by crash type and hourly traffic volumes by time of day for the years 2008 to 2010 are shown in **Figure 12**.

³ Deer Damage Management in the Commonwealth of Virginia
<http://www.aphis.usda.gov/regulations/pdfs/nepa/VAddeer.pdf>

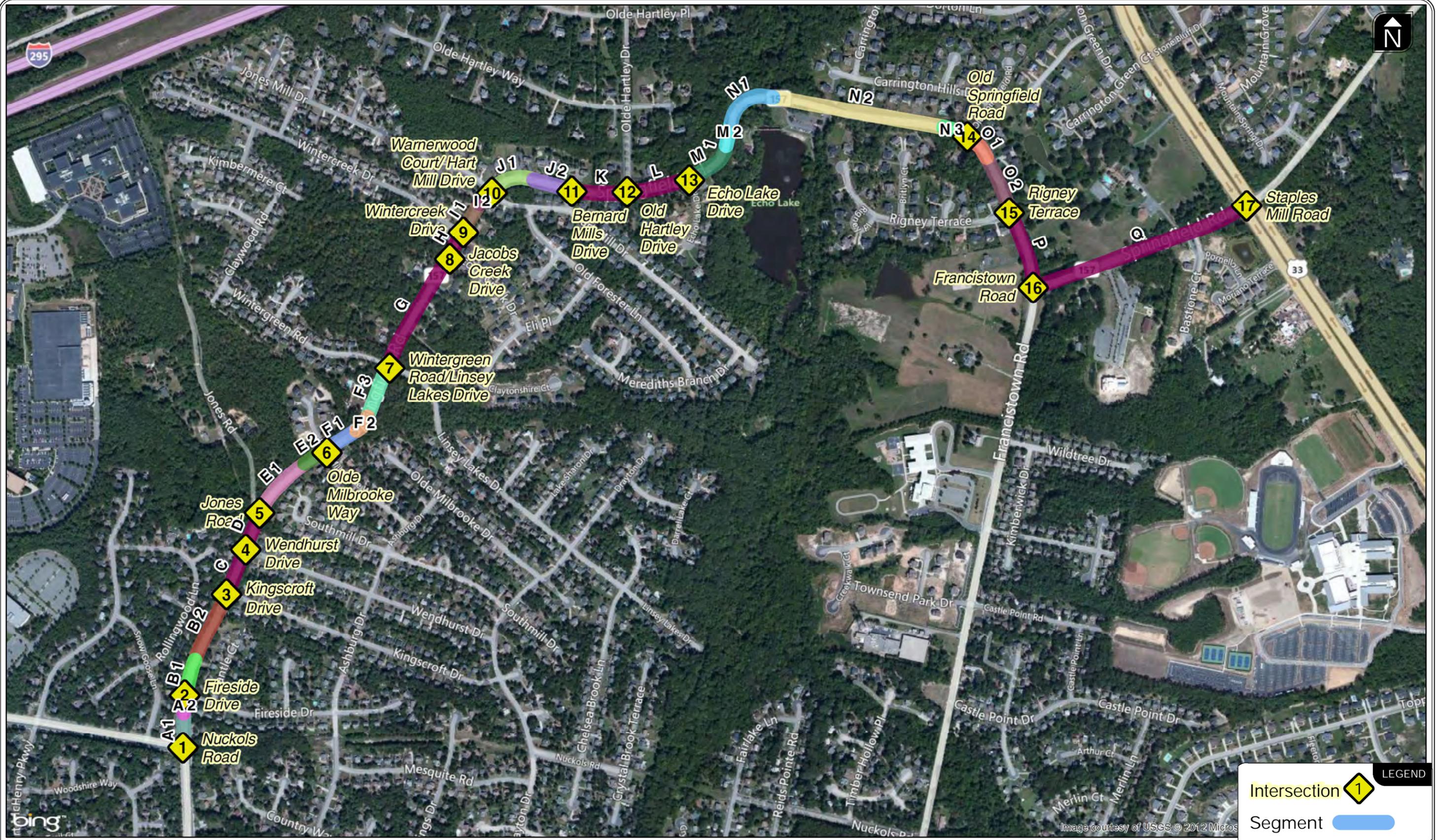
Figure 12 SR 157 Crash Type by Time of Day (2008-2010)



As seen in Figure 12, the number of crashes per hour generally follows the hourly traffic volume profile, with one main exception. Between hours 11:00 p.m. and 4:00 a.m. the crash frequency is as high as or higher than other periods of the day when traffic volumes are noticeably greater. Furthermore, during this same time period, of the nine reported crashes, eight were Fixed Object-Off Road crashes. As discussed in greater detail later in the report, increasing illumination and/or increasing the clear zone may help mitigate some of those fixed object crashes occurring at night. Eighteen of the 32 reported crashes occurred between 12:00 p.m. and 5:00 p.m., which is consistent with the daily afternoon and evening increase in traffic volumes. While the aforementioned trends are indeed present in the data, it is important to note the relatively low sample size.

Crash Locations

As part of the safety analysis, the Springfield Road corridor was divided into segments and intersections. Segments were created based on features factoring into the safety performance of the corridor such as lane width, shoulder width, horizontal and vertical curvature, and illumination. Intersections were organized based on their traffic control (e.g. stop-control vs. signal) and the number of approaches. Roads intersecting SR 157 that exhibited significantly lower volumes were treated as driveways within a roadway segment. **Figure 13** displays and labels the roadway segments and intersections.



K:\H_Reston\profile11764 - Central Region VDOT On-Call\Task Orders\Task 16 (12-023A) - Springfield Road I\GIS\Study\Intersection_Figure.mxd

0 245 490 980 Feet

SPRINGFIELD ROAD (SR 157) SEGMENTS AND STUDY INTERSECTION INVENTORY
HENRICO COUNTY, VIRGINIA

Figure 14 SR 157 Crash Type by Segment (2008-2010)

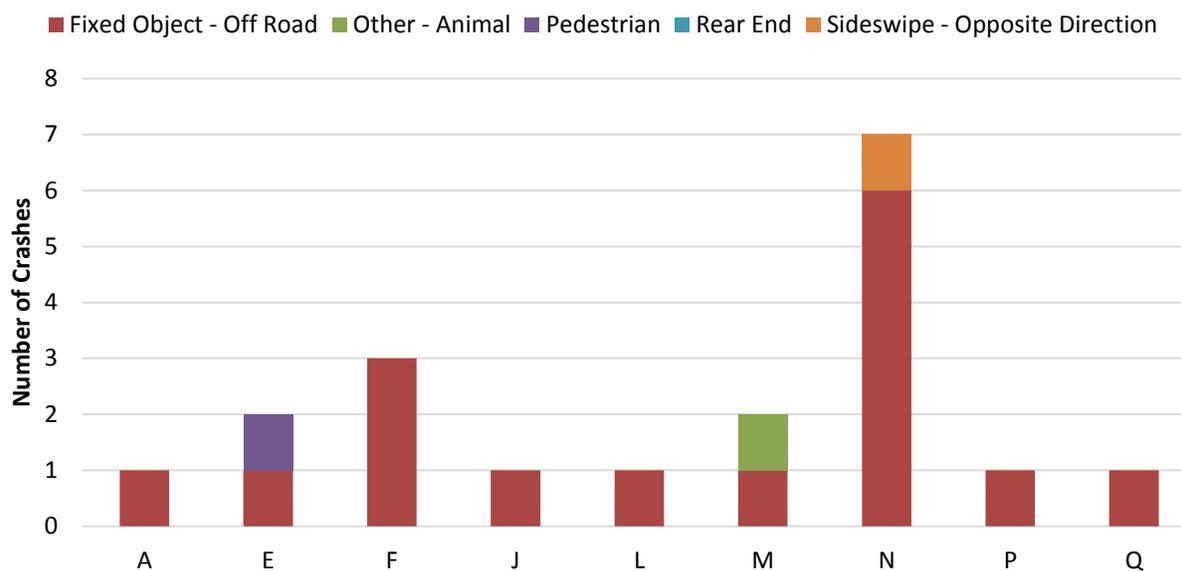
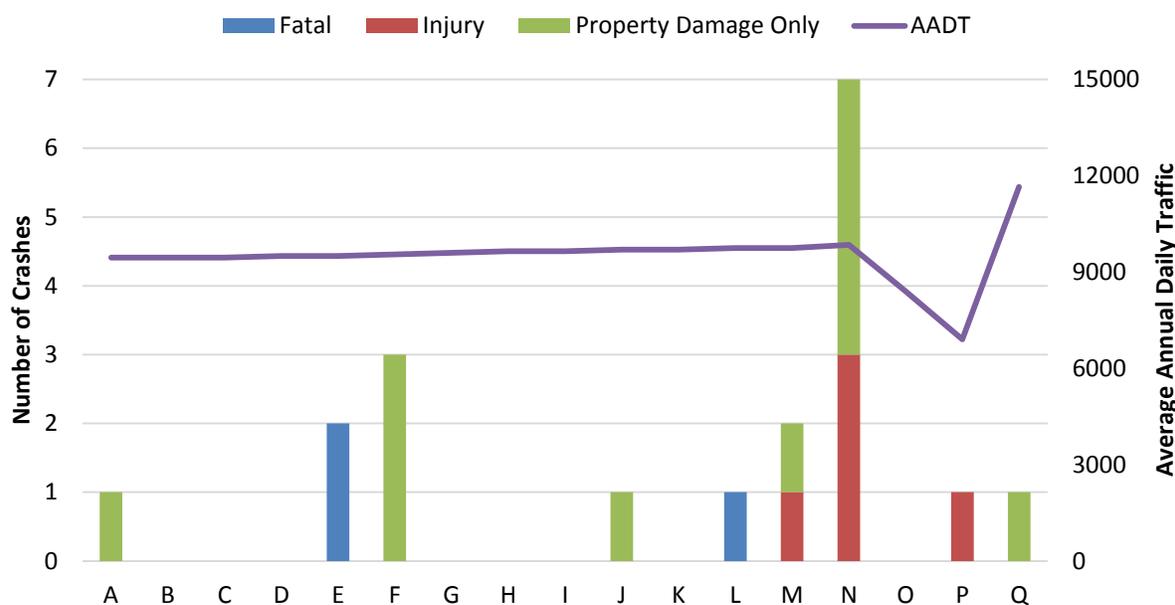


Figure 15 SR 157 Crash Severity by Segment (2008-2010)



As shown in **Figure 14** above, seven of the 19 reported crashes occurred in Segment N, which corresponds to 20.09 crashes per mile. Segment M experienced the highest crashes per mile (23.57), but only two crashes overall. In the westbound direction, Segment N includes a lengthy straight stretch where vehicles can accelerate, leading into a tight curvilinear alignment. As seen in **Figure 15** above, the majority of crashes occurred in the eastern half of the corridor.

Table 5 displays the number of crashes per mile for each Segment by severity. Segment F, M, and N each had more than 20 crashes per mile. It should be noted that Segments F, M, and N each have

horizontal curve radii less than 650 feet. There does not appear to be a trend between number of crashes and average annual daily traffic for each segment. As shown in Table 5, in every segment where a crash occurred there was at least one fixed-object off-road crash. Segment N has the most fixed-object crashes with six, followed by segment F with three.

Table 5 Henrico County SR 157 Crash Severity per mile by Segment (2008-2010)

Section	Severity (crash per mile) for the period 2008 to 2010			Total
	PDO ¹	Injury	Fatality	
A - Nuckols Road to Fireside Drive	15.53	0.00	0.00	15.53
E - Jones Road to Olde Milbrooke Way	0.00	0.00	17.34	17.34
F - Olde Milbrooke Way to Wintergreen Road/Linsey Lakes Drive	21.04	0.00	0.00	21.04
J - Wamerwood Court to Bernard Mills Drive	8.96	0.00	0.00	8.96
L - Olde Hartley Drive to Echo Lake Drive	0.00	0.00	12.31	12.31
M - Echo Lake Drive through End of Horizontal Curve 1	11.79	11.79	0.00	23.57
N - Start of Horizontal Curve 2 to Old Springfield Road	11.48	8.61	0.00	20.09
P - Rigney Terrace to Francistown Road	0.00	9.58	0.00	9.58
Q - Francistown Road to Staples Mill Road	3.51	0.00	0.00	3.51
Crash per mile for whole corridor	0.09	0.35	0.70	0.06

¹ Property Damage Only

Intersection-Related Crashes

The number of intersection versus non-intersection crashes by severity level is displayed in **Table 6**.

Table 6 SR 157 Intersection Crashes by Severity Level (2008-2010)

Location	PDO ¹	Injury	Fatality	Total
Intersection	12	1	0	13
Non-Intersection	11	5	3	19
Total	23	6	3	32

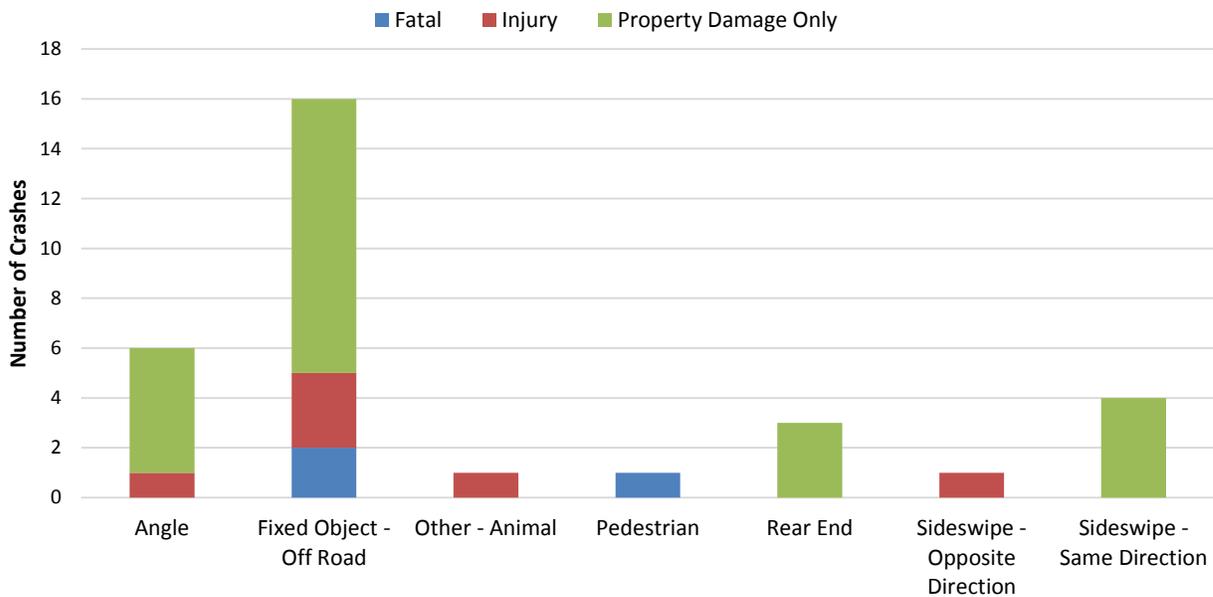
¹ Property Damage Only

As displayed in Table 6, the majority of the crashes (19 of 32) occurred outside of intersections compared to at intersections, and all three reported fatal crashes were also non-intersection related crashes. It should be noted that only crashes related to the operations of the 17 identified intersections were considered intersection crashes (i.e. crashes related to turning movements at the intersections).

Crash Types

As displayed in **Figure 16** below, a majority of crashes were Fixed Object-Off Road crashes. The pedestrian fatality occurred after a driver stopped, exited their vehicle, and then was hit by an oncoming car. The other fatalities both occurred in fixed objects crashes. Fixed object crashes are associated with the majority of recorded injuries.

Figure 16 Crash Severity by Crash Type



Statewide Crash Rate Comparison

As part of the study’s crash evaluation, crash rates on SR 157 were compared to statewide average crash rates. From 2008 to 2010 the SR 157 study area included an annual average of 11 total crashes per 7 million vehicle miles traveled (VMT), for an average of 146 crashes per 100 million vehicle miles traveled. The statewide average during the years of 2008 to 2010 was 150 crashes per 100 million vehicle miles traveled. The total crash rate for SR 157 is slightly less than the statewide average. However, it should be noted that the statewide values are aggregated for all state facilities: the specific statistics for two-lane undivided roads are not available.

HIGHWAY SAFETY MANUAL ANALYSIS

Disclaimer:

Throughout this report, HSM methods were used to calculate expected average annual crashes for existing conditions, future no-build conditions, and alternative improvements. The expected average annual crashes were used in a relative manner to prioritize segments, intersections, and improvements. To the best of our knowledge, VDOT does not have statewide calibration factors to adjust the generic HSM methods to specific VDOT facilities. If calibration factors are developed and applied, the expected average annual crashes would represent the specific (actual) long-term expected average number of crashes for each site and condition. Without

calibration factors, the results can be used for *only* relative comparisons. For more information on calibration factors, see Part C of the HSM. The HSM is not intended to be a substitute for the exercise of sound engineering judgment.

Principles and methods from the HSM were used to quantify the safety performance of alternative treatments to reduce crashes on the Springfield Road corridor. Crash data provided by VDOT, the predictive and Empirical Bayes methods presented in Part C of the HSM, and countermeasures presented in Part D of the HSM were used to calculate the percent change in expected crashes for each alternative treatment(s) relative to existing conditions. For more information about the specific methods and/or procedures, please refer to Part C and Part D of the HSM.

Springfield Road serves an urban/suburban community band was analyzed using Chapter 12 (Urban/Suburban Arterials) of the HSM. The expected average annual crashes for the Springfield Road corridor were calculated using methodologies described in Part C of the HSM.

Safety Analysis Results

Table 7 compares the HSM-calculated expected average annual total crashes to the three-year average of reported crashes from 2008-2010. Again, the HSM-calculated average is not calibrated.

Table 7 Existing Annual Crashes Comparison

HSM-Calculated Expected Total Existing Annual Crashes	Average Annual Reported Crashes
15.43	10.67

Several intersections and segments were identified as having higher crash frequencies than others along the corridor. The intersections and segments are:

- Intersection
 - SR 157/Nuckols Road
 - SR 157/Wintergreen Road/ Linsey Lakes Drive
 - SR 157/Francistown Road
 - SR 157/Staples Mill Road
- Segments:
 - Segment F – Jones Road to Olde Milbrooke Way
 - Segment N - Horizontal Curve 2 to Old Springfield Road
 - Segment Q – Francistown Road to Staple Mills Road

Details regarding the HSM analysis of existing conditions are provided in **Appendix E**.

Section 4
Alternatives Analysis

ALTERNATIVES ANALYSIS

Methodology

Operational and safety improvements were evaluated for three alternatives. Improvements incorporate a design speed of 40 miles per hour (mph) and include the following considerations:

- Sight distance
- Addition of turn lanes
- Cross-sectional elements
- Accommodations for bicyclists and pedestrians
- Estimated percent reduction in crashes

Sight Distance

Existing intersection sight distance was measured at all study intersections and compared against the recommended minimum guidelines for the existing conditions set forth in the standard reference AASHTO's *A Policy on Geometric Design of Highways and Streets*. In instances where existing intersection sight distance was found to be less than the recommended minimums, appropriate improvements/mitigations were considered for all alternatives.

Turn Lanes

Existing right-turn lanes and tapers were evaluated at all study intersections under no-build traffic conditions to assess the appropriateness of each treatment using Figure 3-26 in Appendix F of the VDOT Road Design Manual. In instances where intersections were found to operate at LOS E/F under design year 2036 no-build traffic conditions, the need for new left- and right-turn lanes was evaluated for all alternatives.

Cross-Sectional Elements & Functional Classification

All alternatives generally consider a roadway cross-section (51 feet wide) throughout study limits of SR 157 that includes:

- 11-foot travel lanes
- 3-foot paved shoulder
- 2.5-foot gutter pan and curb (2-foot wide gutter pan, 6-inch wide curb)
- 4-foot buffer
- 5-foot sidewalks

The identified cross-section and 40 mph design speed are consistent with the Urban Minor Arterial functional classifications as noted in Table GS-5 of the VDOT Road Design Manual. The identified cross-sectional features noted above appropriately address the following contextual considerations of the corridor:

- Land uses surrounding the corridor are built out and largely residential in nature, with little potential for future growth
- Projected future ADT volumes are relatively low and do not result in future design year capacity constraints or result in undue delays for end-to-end travel through the corridor
- There is County park with recreational trails within the study area, and an elementary school and high school just outside of the study area with sustained potential for pedestrian and bicycle activity
- Interstate 295 parallels the study corridor, reducing the attractiveness and need for Springfield Road to favor end-to-end travel through the corridor
- Vehicle speed is a contributing factor to the existing crash history; the cross-sectional elements selected for the corridor improve accessibility and mobility for all users, and include traffic calming characteristics which address identified safety concerns

For these reasons, the Urban Minor Arterial designation appears to be the most appropriate functional classification for this roadway.

Bicyclist Accommodations

SR 157 contains limited existing infrastructure to accommodate bicyclists within the study limits. As such, accommodations for bicyclists were considered for both alternatives. Details regarding the consideration of bicycle treatments are provided below.

Bicyclist Facilities

The VDOT Road Design Manual (Reference 4) and AASHTO's Guide for the Development of Bicycle Facilities (Reference 5) were used to determine what accommodations would be appropriate to support cyclists in the study corridor.

Section A of the VDOT Road Design Manual identifies four variables used to determine appropriate bicyclist design treatments:

- Type of bicyclist
- Vehicle operating speed
- Average Annual Daily Traffic (AADT)
- Sight distance

Detailed information on the type of bicyclists in the area is unknown, so both experienced and inexperienced cyclists were considered. As stated previously, all alternatives incorporate a design speed of 40 miles per hour. AADT volumes on SR 157 vary from roughly 8,000 to over 11,000 vehicles depending on the segment. Measured intersection sight distance was also considered.

Considering these variables, appropriate design treatments for advanced bicyclists and less experienced bicyclists were identified using Tables A-5-1 and A-5-4 of the VDOT Road Design Manual, respectively. Table A-5-1 identifies an outside lane width of 14 feet, which represents "usable width" of outside lanes

measured from lane stripe to edge of the gutter pan. Table A-5-4 calls for a five foot bike lane measured from the bike lane/fog stripe to the face of curb.

The AASHTO Bicycle Guide identifies a minimum width of five feet (which can include gutter pan) measured from the face of curb to the fog stripe to accommodate bicyclists on this type of facility.

Based on these design guidelines, the proposed cross-section of 14-foot paved lane width (striped as an 11-foot lane with a 3-foot paved shoulder) plus the two-foot gutter pan is an appropriate design treatment to accommodate bicyclists.

Pedestrian Accommodations

SR 157 contains virtually no existing infrastructure to accommodate pedestrians within the study limits. As such, accommodations for pedestrians were considered for all alternatives. Details regarding the consideration of pedestrian treatments are provided below.

Pedestrian Facilities

Specifications for new sidewalks are also described in the VDOT Road Design Manual. The manual states new sidewalks should be a minimum of 60 inches. The manual also states that wherever possible, buffer strips should be a minimum of 48 inches to accommodate 36"x36" signs when a posted speed limit is greater than 25 miles per hour (mph).

Shared Facilities

As both pedestrians and bicyclists accommodations are considered for this project, shared facilities are an additional option. The AASHTO Guide for the Development of Bicycle Facilities also provides guidelines for the design of shared use paths. According to the guide, the minimum paved width for a two-directional shared use path is ten feet. The guide also states that ideally there should be a graded shoulder area of at least three to five feet on either side of the path.

Based on the character of the roadway, the planned accommodation of bicyclists on the roadway itself, and the surrounding residential land use context, five-foot sidewalks with a four-foot buffer strip are recommended to accommodate pedestrians throughout the Springfield Road corridor. In some cases, it may be appropriate to reduce the buffer areas to avoid unnecessary or unreasonable right-of-way impacts.

HSM Safety Analysis

Principles and information from the HSM were used to identify and estimate safety benefits of potential improvements. In some instances, the HSM did not have the information needed to estimate the potential safety improvements and in those instances FHWA's online *Crash Modification Factor Clearinghouse* (Reference 6) was used. Crash data and contributing factors were analyzed to identify potential countermeasures (see Chapters 5 and 6 of the HSM for more information). The identified countermeasures were then evaluated for feasibility/applicability within the context of the study corridor.

The potential change in crashes associated with each countermeasure was calculated using procedures in the HSM. If a standard error was given, a range of crash reductions is presented. Analyses of future conditions were completed using forecast design year 2036 traffic volumes. Each countermeasure was analyzed independent of the other countermeasures.

YEAR 2036 FUTURE NO-BUILD CONDITIONS

A future no-build scenario was developed and analyzed to forecast how the study area's transportation system would operate in 2036 if the road's existing conditions were unchanged. Both operations and safety were analyzed for this scenario to identify possible deficiencies.

Operations Analysis

The operations analysis for this scenario identifies how the study area's existing transportation system works in the future, planning year 2036. This analysis involves understanding how the traffic flows through the system, how well intersections function, and identifying potential traffic flow issues, such as extensive queues or delays, through the corridor.

Future Traffic Volumes & Background Growth

Future design year 2036 traffic volumes were developed using an annual growth rate of three percent per year as directed by VDOT staff in the study area. This growth rate was applied exclusively to traffic on the corridor identified as through traffic. The procedure used to isolate the percentage of through traffic on the corridor from local traffic is outlined below:

1. Calculate vehicles entering and existing side streets
2. Calculate vehicles entering and exiting corridor
3. Calculate the difference between the total of steps 1 and 2
4. Distribute difference between entering and exiting at each end of the corridor
5. Balance the volumes

This procedure was performed because the vast majority of areas in and around the study area are already built-out with residential land uses in and there is limited space for additional growth.

One background project (Innsbrook Next) in the vicinity of the corridor was specifically identified by VDOT for further consideration. A review of the traffic study for this rezoning project west of the study area confirmed that the three percent annual growth rate assumed in this analysis adequately accounts for this development as well as additional regional background growth.

Right Turn Lane Assessment

Each intersection was evaluated using Figure 3-26 in Appendix F of the VDOT Road Design Manual to determine what, if any, right-turn treatments were appropriate. The highest peak hour volumes were assumed for each evaluation. The results of the evaluations are summarized in **Table 8**.

Table 8 VDOT Right Turn Evaluation Summary

Intersection	Direction	Peak Hour	Turn Lane Required?	Existing	Suggested Action
Fireside Drive/Springfield Road	Northbound	PM	Full-width turn lane and taper required	Two northbound lanes	None
Kingscroft Drive/Springfield Road	Northbound	PM	Full-width turn lane and taper required	Full-width turn lane and taper	None
Wendhurst Drive/Springfield Road	Northbound	PM	Full-width turn lane and taper required	Two northbound lanes	None
Jones Road/Springfield Road	Southbound	AM	No turn lanes or tapers required	No turn lane or taper	None
Olde Milbrooke Way/Springfield Road	Northbound	PM	No turn lanes or tapers required	Full-width turn lane and taper	Remove turn lane and taper
Olde Milbrooke Way/Springfield Road	Southbound	AM	No turn lanes or tapers required	No turn lanes or tapers	None
Wintergreen Road/Springfield Road	Southbound	AM	Taper required	No turn lanes or tapers	Add taper
Linsey Lakes Drive/Springfield Road	Northbound	PM	No turn lanes or tapers required	Full-width turn lane and taper	Remove turn lane and taper
Jacobs Creek Drive/Springfield Road	Northbound	PM	Full-width turn lane and taper required	Taper	Add full-width turn lane
Wintercreek Drive/Springfield Road	Southbound	AM	No turn lanes or tapers required	Taper	Remove taper
Warnerwood Court/Springfield Road	Southbound	AM	No turn lanes or tapers required	Taper	Remove taper
Hart Mill Drive/Springfield Road	Northbound	PM	Taper required	Full-width turn lane and taper	Reduce to taper only
Bernard Mills Drive/Springfield Road	Eastbound	PM	Taper required	Full-width turn lane and taper	Reduce to taper only
Olde Hartley Drive/Springfield Road	Westbound	AM	No turn lanes or tapers required	Full-width turn lane and taper	Remove turn lane and taper
Echo Lake Drive/Springfield Road	Eastbound	PM	Taper required	No turn lane or taper	Add taper
Old Springfield Road/Springfield Road	Westbound	AM	No turn lanes or tapers required	No turn lane or taper	None
Rigney Terrace/Springfield Road	Southbound	PM	Taper required	Full-width turn lane and taper	Reduce to taper only
Francistown Road/Springfield Road	Northbound	AM	Full-width turn lane and taper required	Full-width turn lane and taper	None
Springfield Road/Francistown Road	Westbound	PM	Full-width turn lane and taper required	Full-width turn lane and taper	None

As Table 8 shows, changes to existing right-turn treatments were identified at 11 of the 17 study intersections.

Access Management Analysis

According to the VDOT Road Design Manual, Appendix F, intersections along an urban minor arterial should be spaced at least 660 feet apart measured centerline to centerline. **Table 9** shows the existing intersection spacing between on Springfield Road, if the functional classification spacing standard is met, and notes the number of private driveways between intersections where present.

Table 9 Existing Intersection Spacing

Location	Driveways	Existing	
		Distance Between Intersections(feet):	Acceptable Minimum Distance for Minor Arterial?
Nuckols Road to Fireside Drive	1	340	No
Fireside Drive to Kingscroft Drive	0	774	Yes
Kingscroft Drive to Wendhurst Drive	0	327	No
Wendhurst Drive to Jones Road	0	306	No
Jones Road to Olde Milbrooke Way	0	609	No
Olde Milbrooke Way to Wintergreen Road/Linsey Lakes Drive	2	753	Yes
Wintergreen Road/Linsey Lakes Drive to Jacobs Creek Drive	7	866	Yes
Jacobs Creek Drive to Wintercreek Drive	0	199	No
Wintercreek Drive to Wamerwood Court	2	353	No
Wamerwood Court to Bernard Mills Drive	3	589	No
Bernard Mills Drive to Olde Hartley Drive	3	396	No
Olde Hartley Drive to Echo Lake Drive	2	429	No
Echo Lake Drive to Old Springfield Road	1	2,288	Yes
Old Springfield Road to Rigney Terrace	6	591	No
Rigney Terrace to Francistown Road	3	551	No
Francistown Road to Staples Mill Road	4	1,504	Yes
TOTALS		Minor Arterial Standard Met	5 Segments
		Not Met	11 Segments

As seen in Table 9, five segments currently meet or exceed the minimum minor arterial spacing standard of 660 feet while 11 do not. Intersection spacing and the presence of private driveways between local streets does not appear to be a factor in the reported crashes; as such, no changes to existing intersection spacing are recommended.

Intersection Level of Service (LOS)

Year 2036 weekday a.m. and p.m. peak-hour turning-movement volumes, shown in **Figure 17** and **Figure 18** were used to conduct an operational analysis at each study intersection to evaluate year 2036 no-build traffic operations at the study intersections. This analysis determined that nearly all of the study intersections are forecast to continue to operate at LOS D or better during the weekday a.m. and p.m. peak hours except:

- SR 157/Wintergreen Road/Linsey Lakes Drive: Eastbound approach is forecast to operate at LOS E during the weekday a.m. peak hour.
- SR 157/Francistown Road: Westbound left-turn movement is forecast to operate at LOS F during both peak hours.
- SR 157/Staples Mill Road: Forecast to operate over capacity at LOS F during both peak hours.

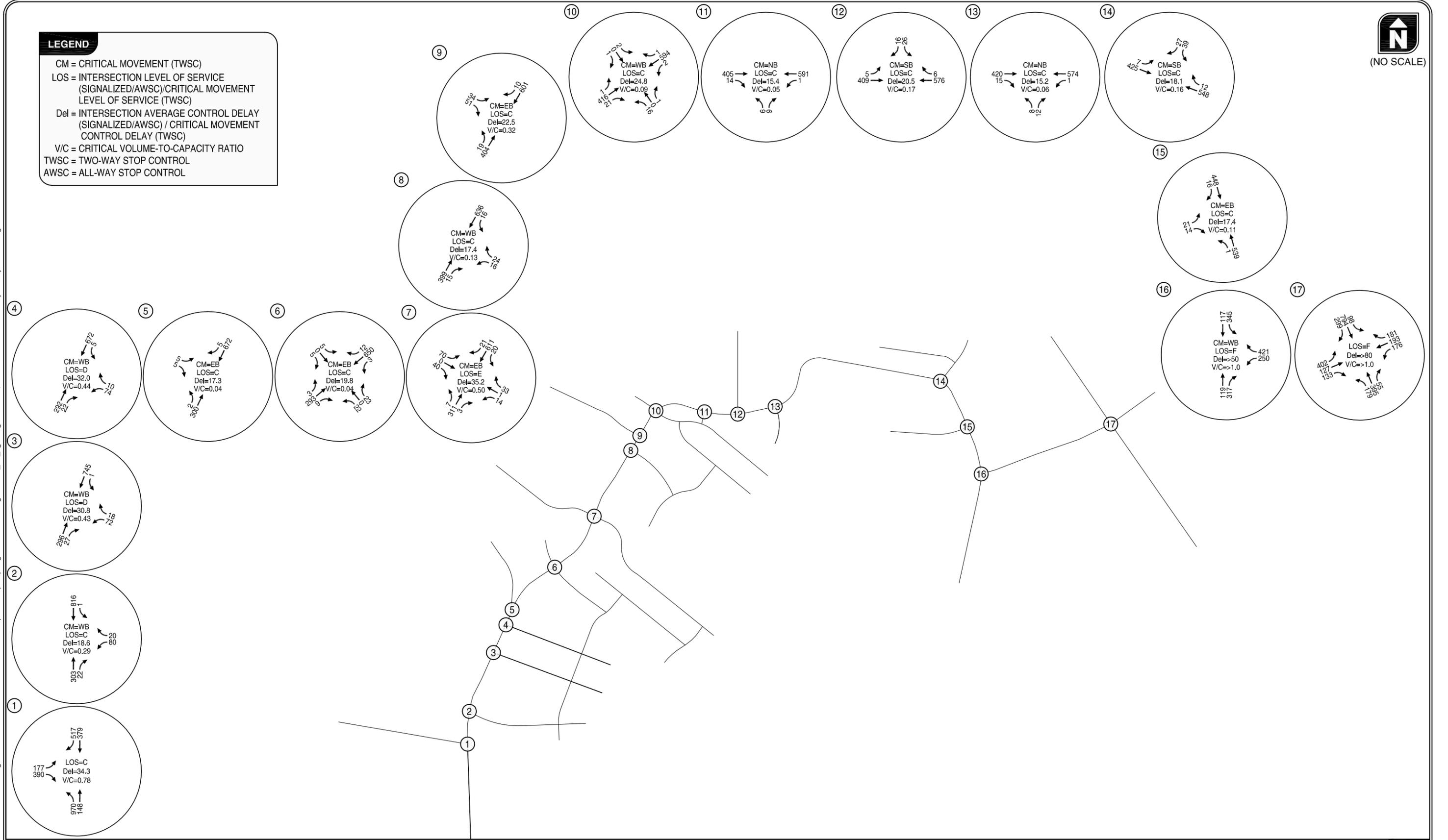
Figure 19 and **Figure 20** illustrate the resultant lane group level of service results. **Table 10** summarizes the operational results for the year 2036 No-Build scenario. **Appendix F** contains the year 2036 No-Build scenario analysis worksheets.



(NO SCALE)

LEGEND

CM = CRITICAL MOVEMENT (TWSC)
 LOS = INTERSECTION LEVEL OF SERVICE (SIGNALIZED/AWSC)/CRITICAL MOVEMENT LEVEL OF SERVICE (TWSC)
 Del = INTERSECTION AVERAGE CONTROL DELAY (SIGNALIZED/AWSC) / CRITICAL MOVEMENT CONTROL DELAY (TWSC)
 V/C = CRITICAL VOLUME-TO-CAPACITY RATIO
 TWSC = TWO-WAY STOP CONTROL
 AWSC = ALL-WAY STOP CONTROL



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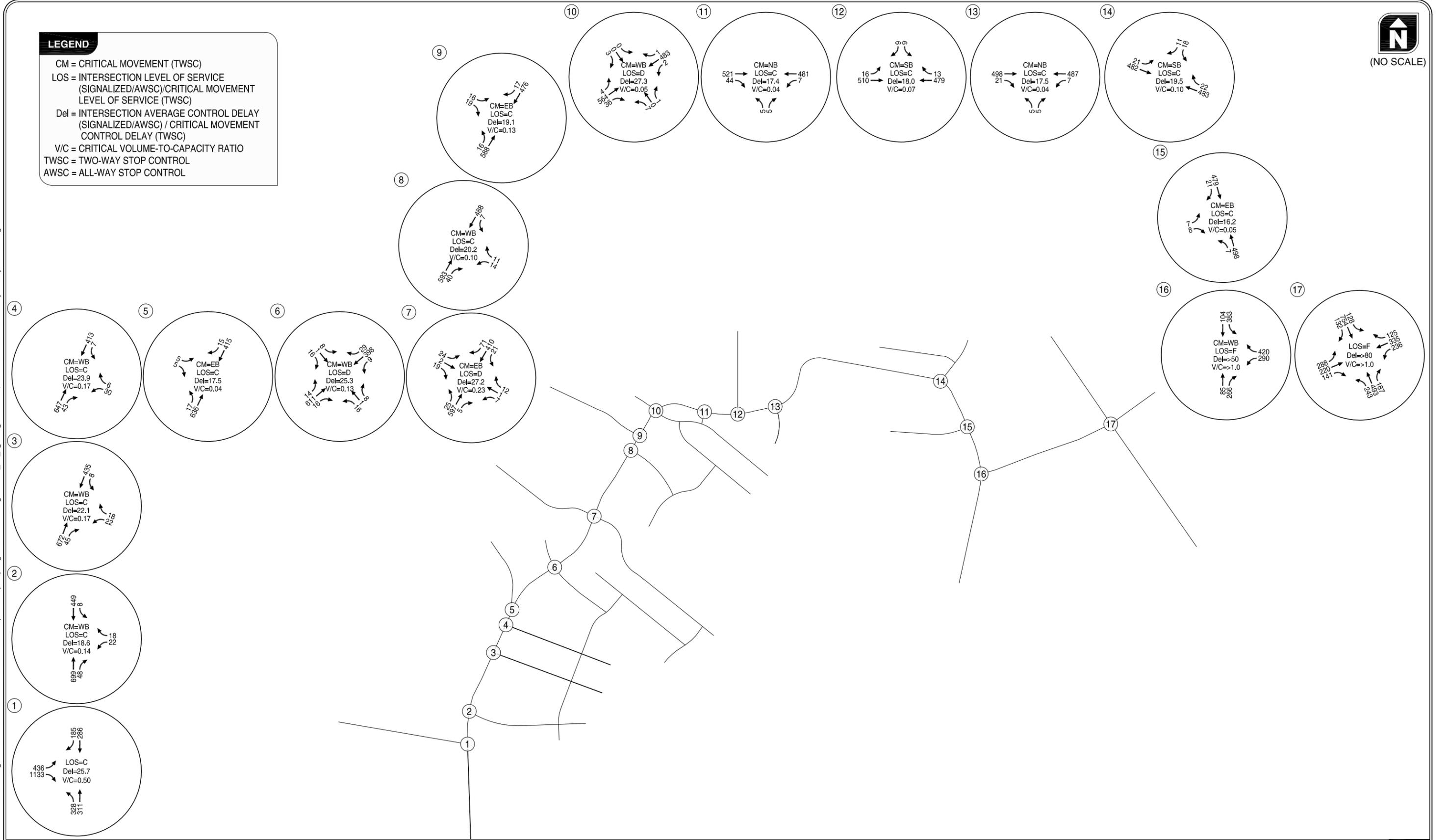
YEAR 2036 FUTURE NO-BUILD TRAFFIC CONDITIONS
WEEKDAY AM PEAK HOUR
HENRICO COUNTY, VIRGINIA



(NO SCALE)

LEGEND

CM = CRITICAL MOVEMENT (TWSC)
 LOS = INTERSECTION LEVEL OF SERVICE (SIGNALIZED/AWSC)/CRITICAL MOVEMENT LEVEL OF SERVICE (TWSC)
 Del = INTERSECTION AVERAGE CONTROL DELAY (SIGNALIZED/AWSC) / CRITICAL MOVEMENT CONTROL DELAY (TWSC)
 V/C = CRITICAL VOLUME-TO-CAPACITY RATIO
 TWSC = TWO-WAY STOP CONTROL
 AWSC = ALL-WAY STOP CONTROL



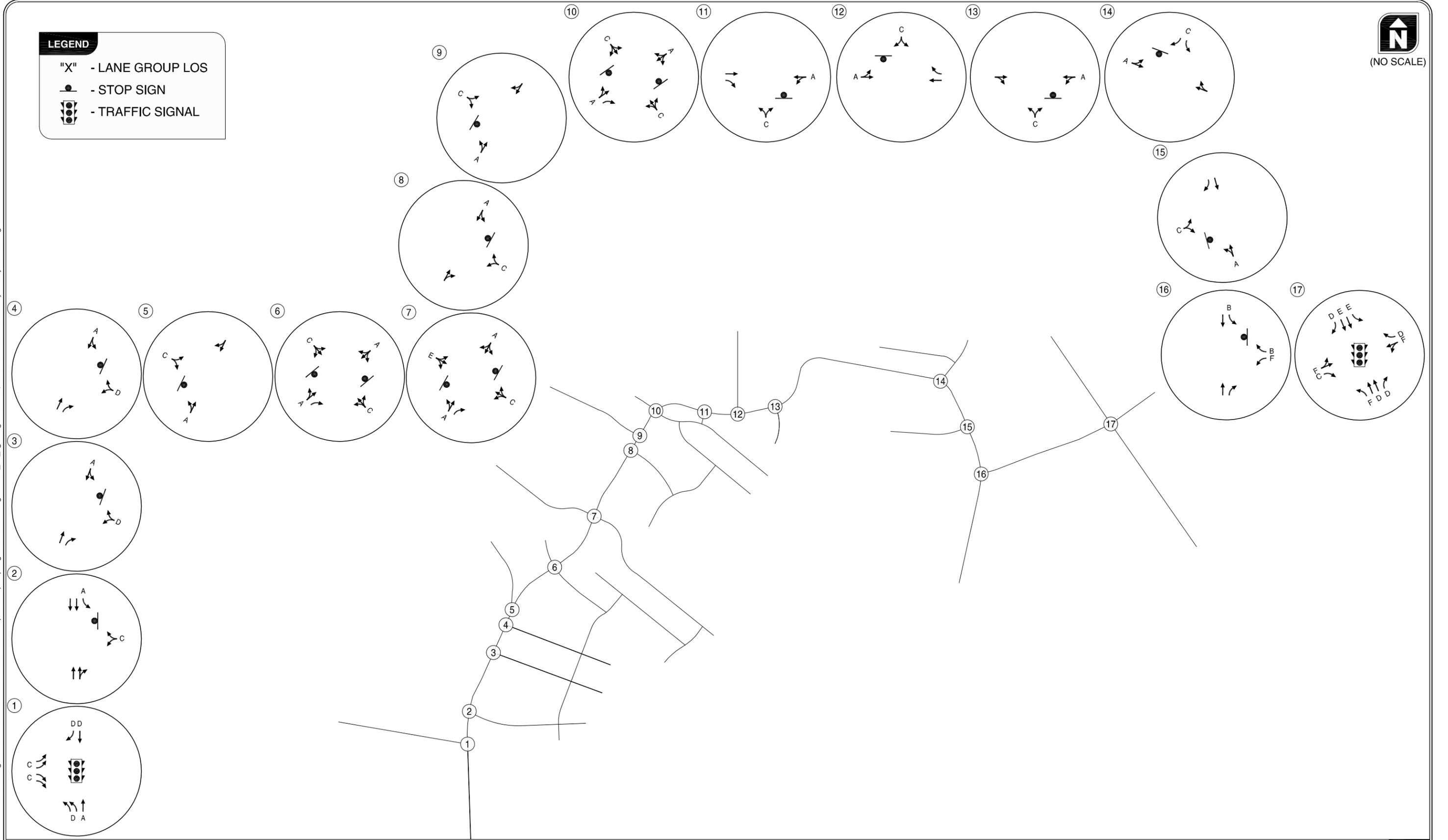
YEAR 2036 FUTURE NO-BUILD TRAFFIC CONDITIONS
WEEKDAY PM PEAK HOUR
HENRICO COUNTY, VIRGINIA

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LEGEND

- "X" - LANE GROUP LOS
- - STOP SIGN
- 🚦 - TRAFFIC SIGNAL

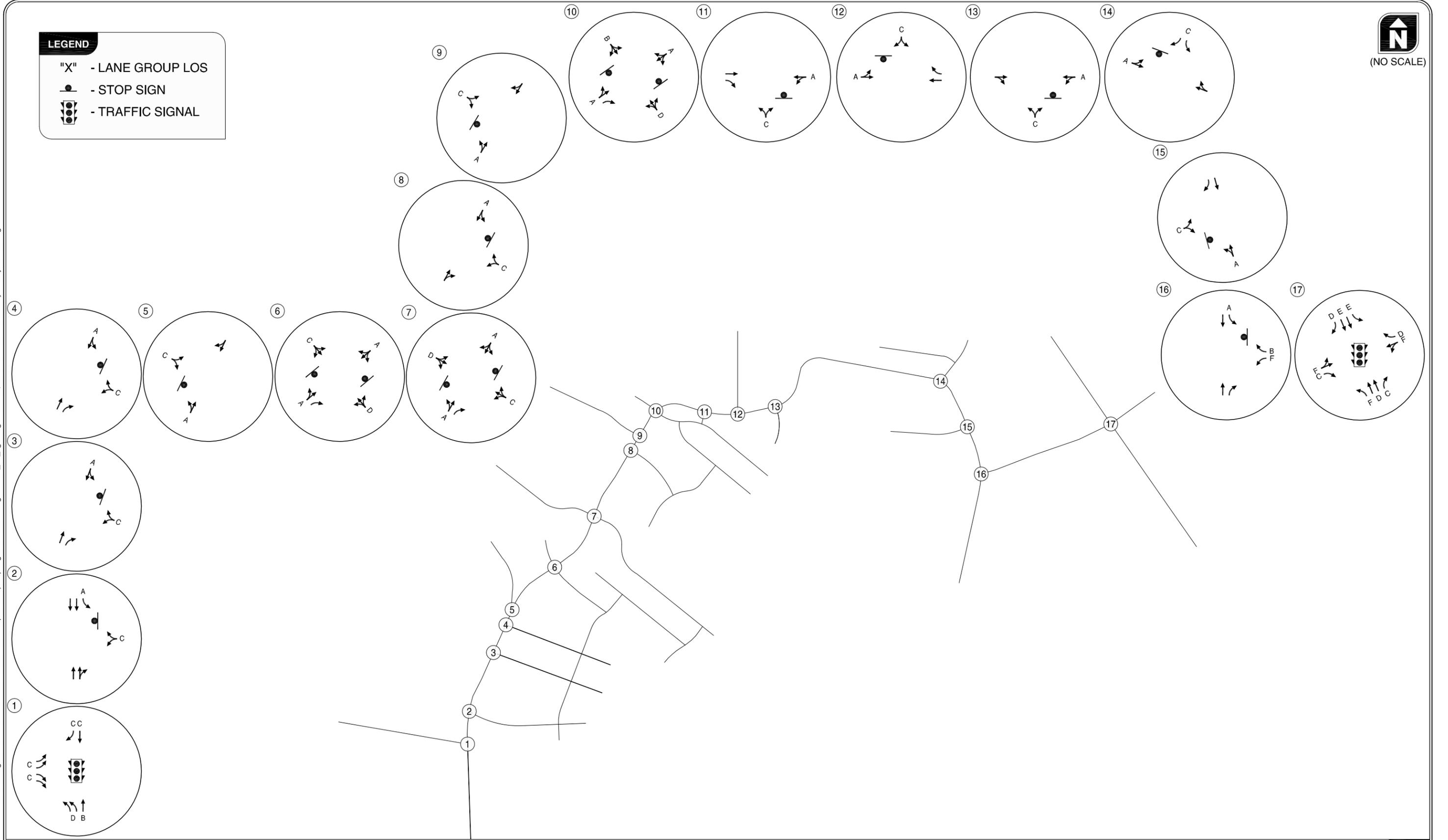


YEAR 2036 FUTURE NO-BUILD LANE GROUP LEVEL OF SERVICE
WEEKDAY AM PEAK HOUR
HENRICO COUNTY, VIRGINIA



LEGEND

- "X" - LANE GROUP LOS
- - STOP SIGN
- 🚦 - TRAFFIC SIGNAL



YEAR 2036 FUTURE NO-BUILD LANE GROUP LEVEL OF SERVICE
WEEKDAY PM PEAK HOUR
HENRICO COUNTY, VIRGINIA

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Table 10 Levels of Service, 95th Percentile Back of Queue and Delay Results - Year 2036 Future No-Build Traffic Conditions

Intersection Information					AM Peak Hour			PM Peak Hour			
Intersection	Traffic Control	Approach	Lane Group	Existing/ Proposed turn-lane lengths	LOS	Back of Queue (feet)	Delay (sec)	LOS	Back of Queue (feet)	Delay (sec)	
Nuckols Road & Springfield Road	Signalized	EB	EBL	275	C	65	28.9	C	159	27	
			EBR	175	C	35	28.1	C	50	26.8	
		EB Approach				C		28.4	C		26.9
		NB	NBL	225	D	#406	38	D	137	37.5	
			NBT		A	66	6.2	B	144	10.2	
		NB Approach				C		33.8	C		24.2
		SB	SBT		D	#430	43.7	C	227	23.8	
			SBR		D	169	35.1	C	48	23.7	
		SB Approach				D		38.7	C		23.8
Overall LOS				C		34.3	C		25.7		
Fireside Drive &	Unsignalized	WB	WBLR		C	30	18.6	C	12	18.6	
			WB Approach			C		18.6	C		18.6
		NB	NBTR				0	0		0	0
			NB Approach					0			0
		SB	SBL		A	0	8	A	1	9.5	
			SBT			0	0		0	0	
SB Approach						0		0.2			
Overall LOS				A		1.5	A		0.7		
Kingscroft Drive & Springfield Road	Unsignalized	WB	WBLR		D	51	30.8	C	15	22.1	
			WB Approach			D		30.8	C		22.1
		NB	NBT			0	0		0	0	
			NBR			0	0		0	0	
		NB Approach						0		0	
		SB	SBLT		A	0	0	A	1	0.3	
SB Approach						0		0.3			
Overall LOS				A		2.4	A		0.8		
Wendhurst Drive & Springfield Road	Unsignalized	WB	WBLR		D	51	32	C	15	23.9	
			WB Approach			D		32	C		23.9
		NB	NBT			0	0		0	0	
			NBR			0	0		0	0	
		NB Approach						0		0	
		SB	SBLT		A	0	0.1	A	1	0.3	
SB Approach						0.1		0.3			
Overall LOS				A		2.6	A		0.8		
Jones Road & Springfield Road	Unsignalized	EB	EBLR		C	3	17.3	C	3	17.5	
			EB Approach			C		17.3	C		17.5
		NB	NBLT		A	0	0.1	A	1	0.5	
			NB Approach					0.1		0.5	
		SB	SBTR			0	0		0	0	
			SB Approach					0		0	
Overall LOS				A		0.2	B		0.4		
Olde Milbrooke Way & Springfield Road	Unsignalized	EB	EBLTR		C	3	19.8	C	7	17.6	
			EB Approach			C		19.8	C		17.6
		WB	WBLTR		C	15	19	D	11	25.3	
			WB Approach			C		19	D		25.3
		NB	NBLT		A	0	0.1	A	1	0.4	
			NBR			0	0		0	0	
		NB Approach						0.1		0.4	
		SB	SBLTR		A	0	0.1	A	1	0.3	
SB Approach						0.1		0.3			
Overall LOS				A		1.1	A		1.3		
Wintergreen Road & Springfield Road	Unsignalized	EB	EBLTR		E	64	35.2	D	22	27.2	
			EB Approach			E		35.2	D		27.2
		WB	WBLTR		C	12	16.6	C	7	21.3	
			WB Approach			C		16.6	C		21.3
		NB	NBLT		A	1	0.3	A	2	0.7	
NBR				0	0		0	0			

Intersection Information					AM Peak Hour			PM Peak Hour		
Intersection	Traffic Control	Approach	Lane Group	Existing/ Proposed turn-lane lengths	LOS	Back of Queue (feet)	Delay (sec)	LOS	Back of Queue (feet)	Delay (sec)
		NB Approach					0.3			0.7
		SB	SBLTR		A	1	0.5	A	2	0.7
		SB Approach					0.5			0.7
		Overall LOS			C		4.5	A		2
Jacobs Creek Drive & Springfield Road	Unsignalized	WB	WBLR		C	11	17.4	C	9	20.2
		WB Approach			C		17.4	C		20.2
		NB	NBTR			0	0		0	0
		NB Approach					0			0
		SB	SBLT		A	1	0.4	A	1	0.2
		SB Approach					0.4			0.2
		Overall LOS			B		0.9	A		0.5
Wintercreek Drive & Springfield Road	Unsignalized	EB	EBLR		C	34	22.5	C	11	19.1
		EB Approach			C		22.5	C		19.1
		NB	NBLT		A	2	0.7	A	1	0.5
		NB Approach					0.7			0.5
		SB	SBTR			0	0		0	0
		SB Approach					0			0
		Overall LOS			A		2	A		0.8
Warnerwood Ct & Springfield Road	Unsignalized	EB	EBLTR		C	1	20.4	B	0	11.8
		EB Approach			C		20.4	B		11.8
		WB	WBLTR		C	7	24.8	D	4	27.3
		WB Approach			C		24.8	D		27.3
		NB	NBLT		A	0	0	A	0	0.1
			NBR			0	0		0	0
		NB Approach					0			0.1
		SB	SBLTR		A	0	0.1	A	0	0.1
		SB Approach					0.1			0.1
		Overall LOS			A		0.5	A		0.3
Springfield Road & Bernard Mills Drive	Unsignalized	EB	EBT			0	0		0	0
			EBR			0	0		0	0
		EB Approach					0			0
		WB	WBLT		A	0	0	A	1	0.2
		WB Approach					0			0.2
		NB	NBLR		C	4	15.4	C	3	17.4
		NB Approach			C		15.4	C		17.4
Overall LOS			A		0.2	A		0.3		
Springfield Road & Olde Hartley Drive	Unsignalized	EB	EBLT		A	0	0.2	A	1	0.5
		EB Approach					0.2			0.5
		WB	WBT			0	0		0	0
			WBR			0	0		0	0
		WB Approach					0			0
		SB	SBLR		C	15	20.5	C	6	18
		SB Approach			C		20.5	C		18
Overall LOS			A		0.9	A		0.6		
Springfield Road & Echo Lake Drive	Unsignalized	EB	EBTR			0	0		0	0
		EB Approach					0			0
		WB	WBLT		A	0	0	A	1	0.2
		WB Approach					0			0.2
		NB	NBLR		C	5	15.2	C	3	17.5
		NB Approach			C		15.2	C		17.5
Overall LOS			A		0.3	A		0.3		
Springfield Road & Old Springfield Road	Unsignalized	EB	EBLT		A	1	0.2	A	2	0.7
		EB Approach					0.2			0.7
		WB	WBTR			0	0		0	0
		WB Approach					0			0
		SB	SBL		C	14	18.1	C	8	19.5
		SB Approach			C		18.1	C		19.5
		Overall LOS			A		1.2	A		0.9
Rigney Terrace & Springfield Road	Unsignalized	EB	EBLR		C	10	17.4	C	4	16.2
		EB Approach			C		17.4	C		16.2
		NB	NBLT		A	0	0	A	1	0.2

Intersection Information					AM Peak Hour			PM Peak Hour			
Intersection	Traffic Control	Approach	Lane Group	Existing/ Proposed turn-lane lengths	LOS	Back of Queue (feet)	Delay (sec)	LOS	Back of Queue (feet)	Delay (sec)	
		NB Approach					0			0.2	
		SB	SBT			0	0		0	0	
			SBR			0	0		0	0	
		SB Approach						0			0
		Overall LOS					A	0.6		A	0.3
Springfield Road & Francistown Road	Unsignalized	WB	WBL		F	447	325.5	F	570	441.9	
			WBR		B	71	12.8	B	63	11.9	
		WB Approach				F		129.3	F		187.5
		NB	NBT				0	0		0	0
			NBR				0	0		0	0
		NB Approach						0			0
		SB	SBL			B	39	10	A	39	9.6
			SBT				0	0		0	0
		SB Approach						7.5			7.6
		Overall LOS					A	57.5		A	88.4
Springfield Road & Staples Mill Road	Signalized	EB	EBLT		F	#756	171	F	#699	138	
			EBR	575	C	51	34.6	C	51	34.6	
		EB Approach				F		143.6	F		115.5
		WB	WBLT			F	#527	113.7	F	#911	403.1
			WBR			D	62	39.6	D	86	41.9
		WB Approach				F		89.3	F		338.3
		NB	NBL	150		F	#327	192.5	F	#438	310.4
			NBT			D	204	41.9	D	243	40.4
			NBR	125		D	36	35.7	C	75	34.9
		NB Approach				F		84.1	F		110.3
		SB	SBL	200		E	136	58.7	E	167	63.5
			SBT			E	#480	74.8	E	#418	57.1
			SBR	75		D	250	48	D	111	37.9
SB Approach				E		66.7	E		55.4		
Overall LOS					F	91.2		F	142.7		

*The '#' indicates 95th percentile volume exceeds capacity queue may be longer and the queue shown is the maximum after two cycles.

Future No-Build HSM Analysis

Table 11 shows the HSM-predicted average annual total crashes for the year 2036 no-build scenario and compares it back to existing conditions. Because VDOT has no available calibration factors, the numbers shown below can only be used in a relative manner. The actual numbers shown below in the predicted ranges are neither accurate nor absolute for either scenario.

Table 11 Total Predicted Annual Crashes: Existing Conditions vs. No-Build Scenario

Alternative	Predicted Total Annual Crashes
Existing Conditions	15.43
Year 2036 No-Build	19.37
Percent Increase	26%

As shown in Table 11, the identified predicted total annual crashes are forecast to increase by 26 percent within the study limits by the design year 2036 if no changes to the study corridor are made.

Appendix G contains the year 2036 No-Build scenario HSM Analysis worksheets.

ALTERNATIVE 1 – EXISTING ALIGNMENT

Alternative 1 would modify the existing cross-section and alignment of SR 157 to address road safety and operational issues. Assumed design changes for Alternative 1 are illustrated in **Figure 21** and include:

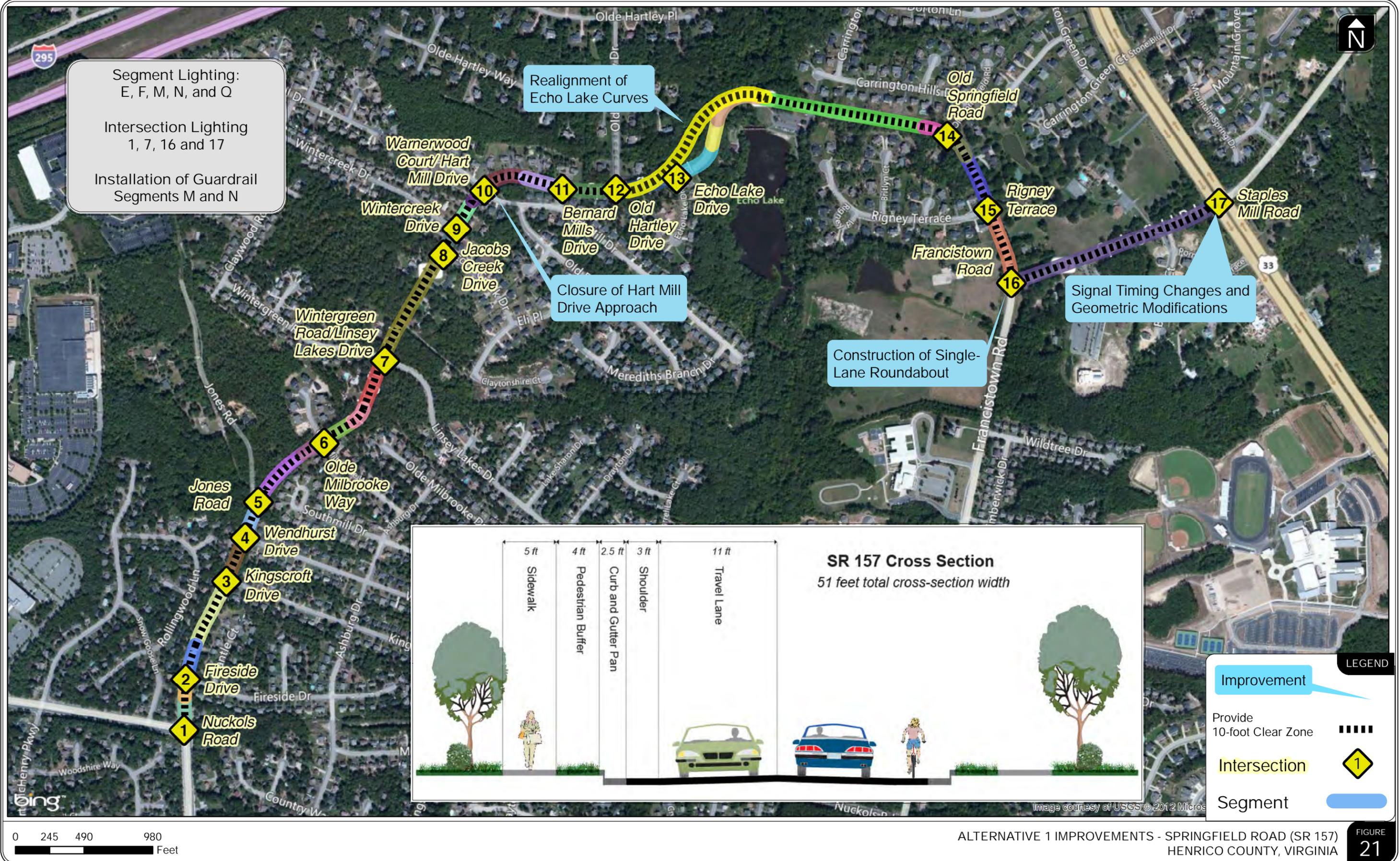
- Construct a roadway cross-section (51 feet wide) throughout study limits of SR 157 that includes:
 - 11-foot travel lanes
 - 3-foot paved shoulders
 - 2.5-foot gutter pan and curb (2-foot wide gutter pan, 6-inch wide curb)
 - 4-foot buffer
 - 5-foot sidewalks
- Provision of segment lighting on the following segments:
 - Wendhurst Drive to Olde Millbrooke Way (Segment E)
 - Olde Millbrook Way to Wintergreen Road/Linsey Lakes Drive (Segment F)
 - Echo Lake Drive to Echo Lake County Park access (Segments M & N)
 - Francistown Road to Staples Mill Road (Segment Q)
- Provision of a 10-foot clear zone throughout the study corridor
- Installation of guardrail on Echo Lake Curves (Segments M.1, M.2, N.1)
- Realignment of Echo Lake Curves (Segments M.1, M.2, N.1)
- Provision of intersection lighting at the following intersections:
 - SR 157/Nuckols Road
 - SR 157/Francistown Road
 - SR 157/Staples Mill Road
- Provision of signal timing changes and geometric modifications at the SR 157/Staples Mill Road intersection
- Closure of the Hart Mill Drive approach to SR 157
- Construction of a single-lane roundabout at the SR 157/Francistown Road intersection

Details regarding the analysis and selection of these improvements are provided below.

Operations Analysis

Alternative 1 assumes the same traffic volumes as the future no-build scenario, but includes recommended improvements throughout the corridor to achieve LOS D or better. Three intersections were found to operate unacceptably under future no-build traffic conditions:

- SR 157/Wintergreen Road/Linsey Lakes Drive
- SR 157/Francistown Road
- SR 157/Staples Mill Road



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SR 157/Wintergreen Road/Linsey Lakes Drive

The eastbound approach is forecast to operate at LOS E during the weekday a.m. peak hour and LOS D during the weekday p.m. peak hour under year 2036 no-build conditions. While this approach may temporarily experience slightly higher delays during the weekday a.m. peak hour, the volume-to-capacity ratio for this approach is 0.50, indicating that the movement still operates well below capacity. Because of this, no improvements are recommended at this intersection.

SR 157/Francistown Road

The westbound left-turn movement is forecast to operate over capacity at LOS F during both peak hours under year 2036 no-build traffic conditions. Three alternative forms of intersection control were considered to achieve the desired level of service:

- All-way stop control
- Roundabout
- Signalized control

An analysis of all three control forms concluded that a single-lane roundabout would provide the best traffic operations, operating at LOS C during both peak hours and minimizing control delay at the intersection. Roundabouts have also been shown to be safer than the other control forms.⁴ As such, a single-lane roundabout was assumed at this intersection in the evaluation.

SR 157/Staples Mill Road

This intersection is forecast to operate over capacity at LOS F during both peak hours under year 2036 no-build traffic conditions. To achieve the desired LOS D, a number of modifications/improvements would be needed, including:

- Eastbound Approach
 - Construct dual eastbound left-turn lanes with 300 feet of storage to accommodate forecast queues
 - Construct separate eastbound through and right-turn lanes
- Westbound Approach
 - Construct separate left, through, and right-turn lanes
 - Operate westbound left-turns with protected phasing
- Northbound Approach
 - Increase the northbound left-turn queue storage from 150 to 350 feet to accommodate forecast queues
- Signal phasing
 - Eliminate split phase EB/WB operation (operate protected) and provide right-turn overlap phasing on all approaches

⁴ Transportation Research Board. *NCHRP Report 672: Roundabouts: An Informational Guide, 2nd Edition*. 2010.

In addition to these intersection improvements, two more general roadway improvements were assumed to correct safety issues identified in the existing and no-build analyses.

Hart Mill Drive Sight Distance

Available intersection sight distance at Hart Mill Drive was measured to be below the AASHTO-recommended minimum of 385 feet based on the assumed design speed of 40 mph. Given the low volume of traffic turning into and out of this location and the presence of a viable alternative access via Bernard Mills Road, Hart Mill Drive was assumed to be closed in Alternative 1.

Echo Lake Curves

Springfield Road has two tight horizontal curves in the vicinity of Echo Lake between Olde Hartley Drive and the Echo Lake County Park parking area. These curves have also been the site of several crashes as documented previously. Plan maps indicate there is a reserved corridor of right-of-way that could accommodate a realignment of Springfield Road in this area to increase the radii of these horizontal curves, which has been previously identified as an appropriate safety countermeasure for this area. As such, this realignment was assumed to be included in Alternative 1.

Figure 22 and **Figure 23** show the year 2036 Alternative 1 operational results for the weekday a.m. and p.m. peak hours, respectively. **Figure 24** and **Figure 25** show the lane group level of service. **Table 12** summarizes the operational results for Alternative 1.

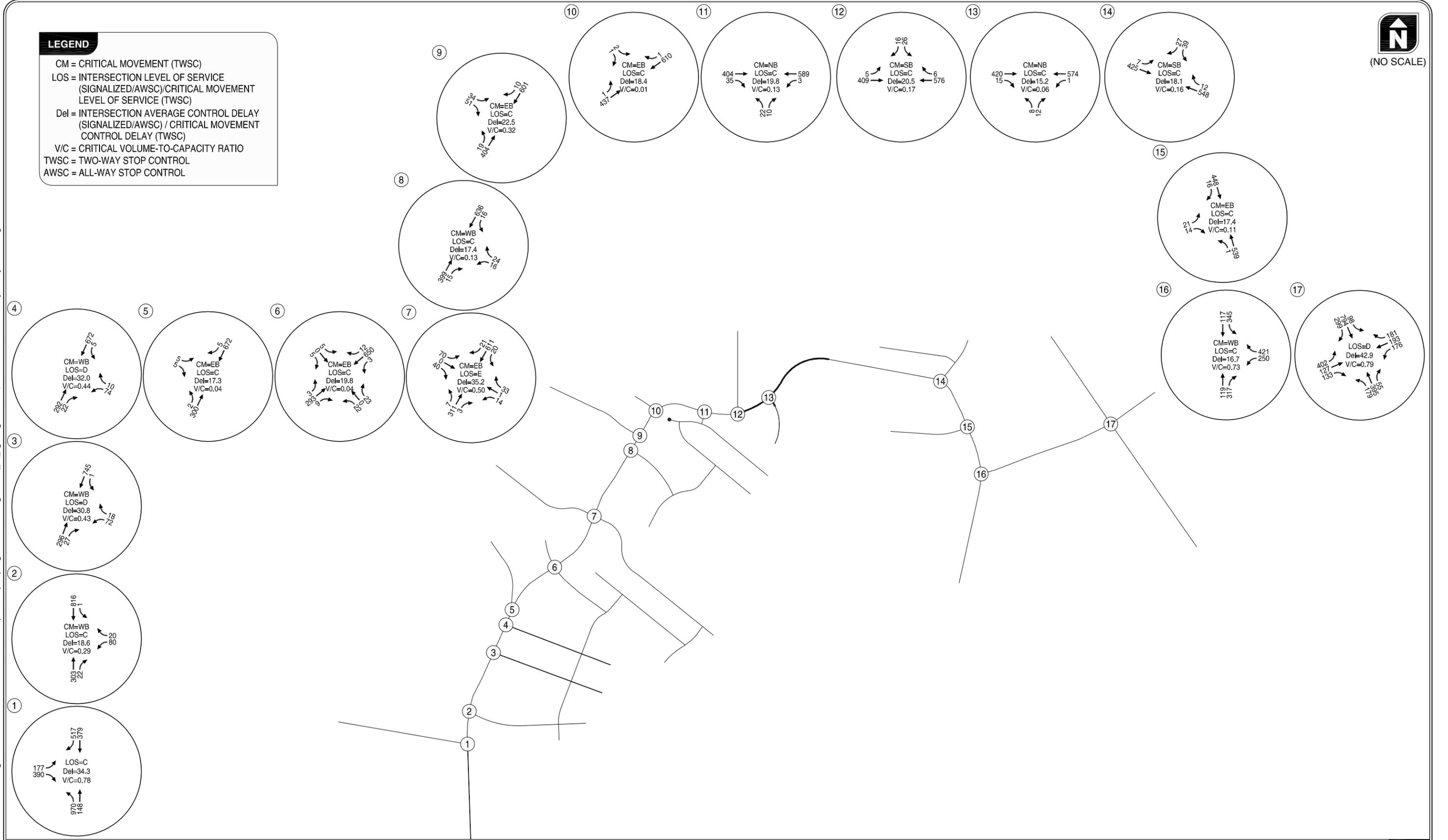
Appendix H contains the Alternative 1 operational analysis worksheets.



(NO SCALE)

LEGEND

CM = CRITICAL MOVEMENT (TWSC)
 LOS = INTERSECTION LEVEL OF SERVICE (SIGNALIZED/AWSC)/CRITICAL MOVEMENT LEVEL OF SERVICE (TWSC)
 Del = INTERSECTION AVERAGE CONTROL DELAY (SIGNALIZED/AWSC) / CRITICAL MOVEMENT CONTROL DELAY (TWSC)
 V/C = CRITICAL VOLUME-TO-CAPACITY RATIO
 TWSC = TWO-WAY STOP CONTROL
 AWSC = ALL-WAY STOP CONTROL



ALTERNATIVE 1 TRAFFIC CONDITIONS
 WEEKDAY AM PEAK HOUR
 HENRICO COUNTY, VIRGINIA

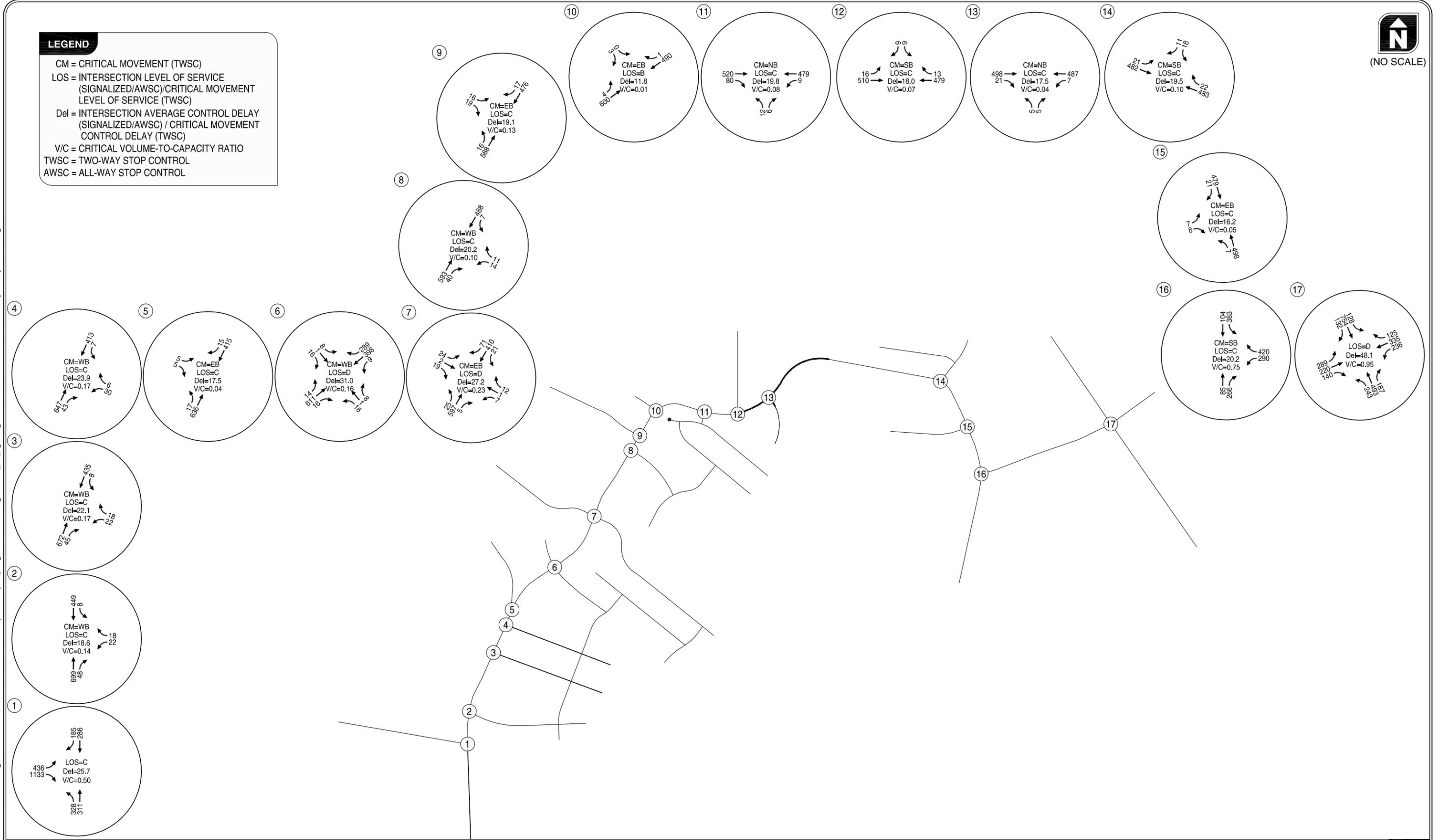
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(NO SCALE)

LEGEND

CM = CRITICAL MOVEMENT (TWSC)
 LOS = INTERSECTION LEVEL OF SERVICE (SIGNALIZED/AWSC)/CRITICAL MOVEMENT LEVEL OF SERVICE (TWSC)
 Del = INTERSECTION AVERAGE CONTROL DELAY (SIGNALIZED/AWSC) / CRITICAL MOVEMENT CONTROL DELAY (TWSC)
 V/C = CRITICAL VOLUME-TO-CAPACITY RATIO
 TWSC = TWO-WAY STOP CONTROL
 AWSC = ALL-WAY STOP CONTROL



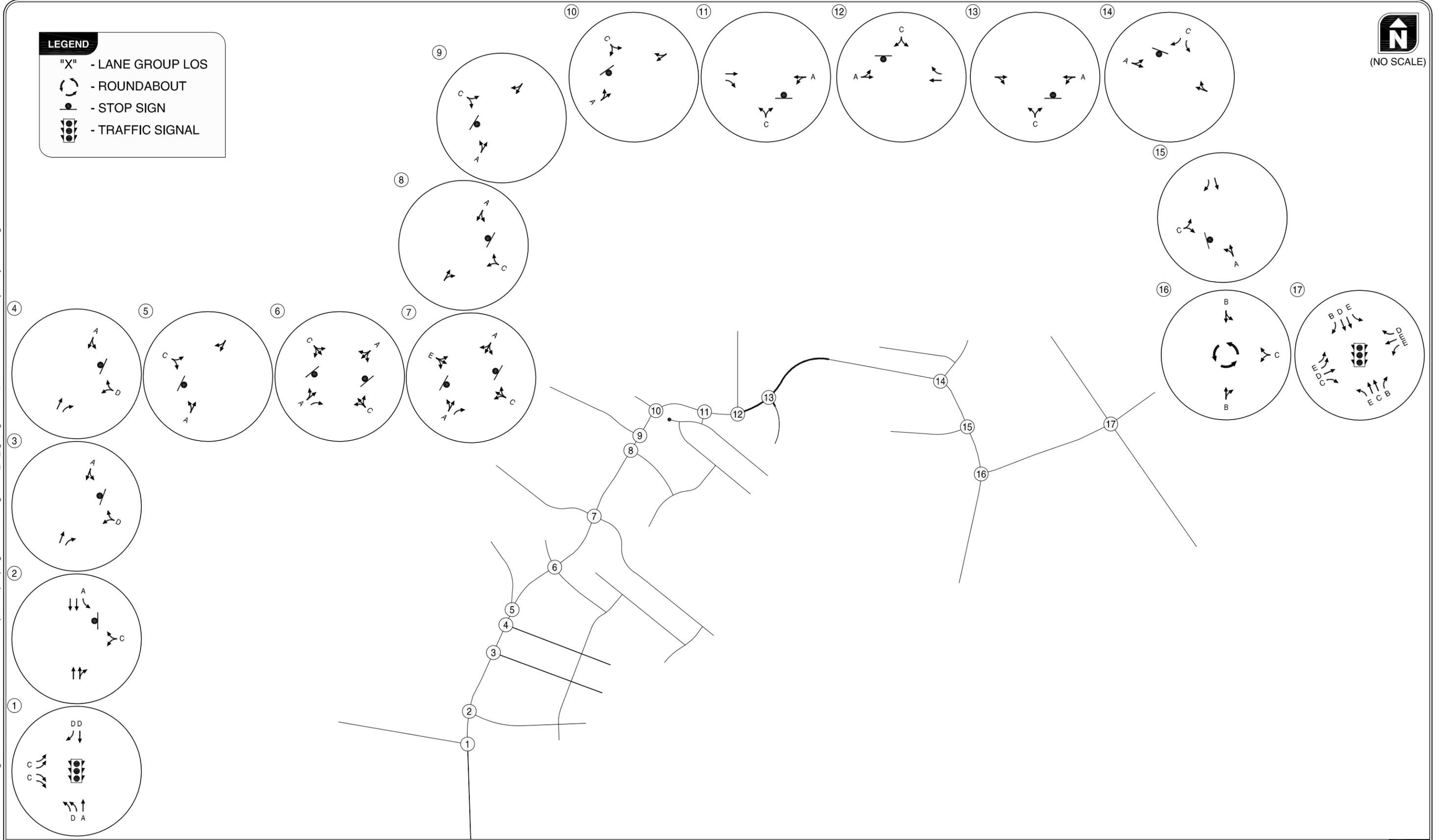
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ALTERNATIVE 1 TRAFFIC CONDITIONS
WEEKDAY PM PEAK HOUR
HENRICO COUNTY, VIRGINIA

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LEGEND

- "X" - LANE GROUP LOS
- - ROUNDABOUT
- - STOP SIGN
- ⬆️⬆️⬆️ - TRAFFIC SIGNAL

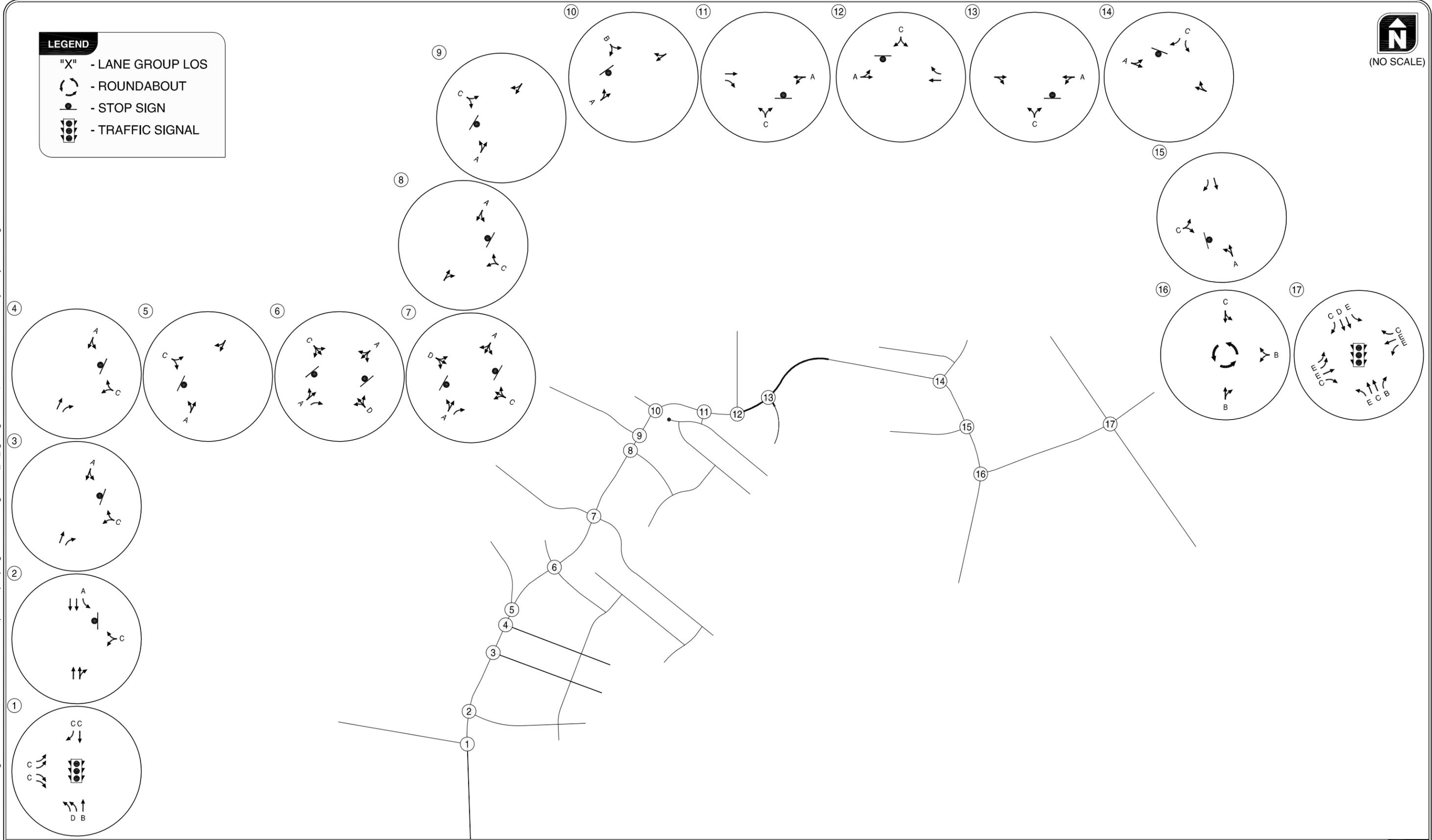


ALTERNATIVE 1 LANE GROUP LEVEL OF SERVICE
WEEKDAY AM PEAK HOUR
HENRICO COUNTY, VIRGINIA

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LEGEND

- "X" - LANE GROUP LOS
- - ROUNDABOUT
- - STOP SIGN
- ⬆️⬆️⬆️ - TRAFFIC SIGNAL



ALTERNATIVE 1 LANE GROUP LEVEL OF SERVICE
WEEKDAY PM PEAK HOUR
HENRICO COUNTY, VIRGINIA

Table 12 Levels of Service, 95th Percentile Back of Queue and Delay Results - Alternative 1 Year 2036 Traffic Conditions

Intersection Information					AM Peak Hour			PM Peak Hour			
Intersection	Traffic Control	Approach	Lane Group	Existing/ Proposed turn-lane lengths	LOS	Back of Queue (feet)	Delay (sec)	LOS	Back of Queue (feet)	Delay (sec)	
Nuckols Road & Springfield Road	Signalized	EB	EBL	275	C	65	28.9	C	159	27	
			EBR	175	C	35	28.1	C	50	26.8	
		EB Approach				C		28.4	C		26.9
		NB	NBL	225	D	#406	38	D	137	37.5	
			NBT		A	66	6.2	B	144	10.2	
		NB Approach				C		33.8	C		24.2
		SB	SBT		D	#430	43.7	C	227	23.8	
			SBR		D	169	35.1	C	48	23.7	
SB Approach				D		38.7	C		23.8		
Overall LOS				C		34.3	C		25.7		
Fireside Drive & Springfield Road	Unsignalized	WB	WBLR		C	30	18.6	C	12	18.6	
			WB Approach			C		18.6	C		18.6
		NB	NBTR			0	0		0	0	
			NB Approach					0			0
		SB	SBL		A	0	8	A	1	9.5	
			SBT			0	0		0	0	
		SB Approach					0			0.2	
Overall LOS			A		1.5	A		0.7			
Kingscroft Drive & Springfield Road	Unsignalized	WB	WBLR		D	51	30.8	C	15	22.1	
			WB Approach			D		30.8	C		22.1
		NB	NBT			0	0		0	0	
			NBR			0	0		0	0	
		NB Approach					0			0	
		SB	SBLT		A	0	0	A	1	0.3	
			SB Approach					0			0.3
Overall LOS			A		2.4	A		0.8			
Wendhurst Drive & Springfield Road	Unsignalized	WB	WBLR		D	51	32	C	15	23.9	
			WB Approach			D		32	C		23.9
		NB	NBT			0	0		0	0	
			NBR			0	0		0	0	
		NB Approach					0			0	
		SB	SBLT		A	0	0.1	A	1	0.3	
			SB Approach					0.1			0.3
Overall LOS			A		2.6	A		0.8			
Jones Road & Springfield Road	Unsignalized	EB	EBLR		C	3	17.3	C	3	17.5	
			EB Approach			C		17.3	C		17.5
		NB	NBLT		A	0	0.1	A	1	0.5	
			NB Approach					0.1			0.5
		SB	SBTR			0	0		0	0	
			SB Approach					0			0
Overall LOS			A		0.2	B		0.4			
Olde Milbrooke Way & Springfield Road	Unsignalized	EB	EBLTR		C	3	19.8	C	9	21	
			EB Approach			C		19.8	C		21
		WB	WBLTR		C	15	19	D	14	31	
			WB Approach			C		19	D		31
		NB	NBLT		A	0	0.1	A	1	0.5	
			NBR			0	0		0	0	
		NB Approach					0.1			0.5	
		SB	SBLTR		A	0	0.1	A	1	0.3	
SB Approach						0.1			0.3		
Overall LOS			A		1.1	B		1.3			
Wintergreen Road/Linsey Lakes & Springfield Road	Unsignalized	EB	EBLTR		E	64	35.2	D	22	27.2	
			EB Approach			E		35.2	D		27.2
		WB	WBLTR		C	12	16.6	C	7	21.3	
			WB Approach			C		16.6	C		21.3
		NB	NBLT		A	1	0.3	A	2	0.7	
			NBR			0	0		0	0	
		NB Approach					0.3			0.7	
SB	SBLTR		A	1	0.5	A	2	0.7			

Intersection Information					AM Peak Hour			PM Peak Hour			
Intersection	Traffic Control	Approach	Lane Group	Existing/ Proposed turn-lane lengths	LOS	Back of Queue (feet)	Delay (sec)	LOS	Back of Queue (feet)	Delay (sec)	
Jacobs Creek Drive & Springfield Road	Unsignalized	SB Approach					0.5			0.7	
		Overall LOS				C		4.5	A		2
		WB	WBLR			C	11	17.4	C	9	20.2
		WB Approach				C		17.4	C		20.2
		NB	NBTR				0	0		0	0
		NB Approach						0			0
		SB	SBLT			A	1	0.4	A	1	0.2
Wintercreek Drive & Springfield Road	Unsignalized	SB Approach					0.4			0.2	
		Overall LOS				B		0.9	A		0.5
		EB	EBLR			C	34	22.5	C	11	19.1
		EB Approach				C		22.5	C		19.1
		NB	NBLT			A	2	0.7	A	1	0.5
		NB Approach						0.7			0.5
		SB	SBTR				0	0		0	0
Warnerwood Ct & Springfield Road	Unsignalized	SB Approach					0			0	
		Overall LOS				A		2	A		0.8
		EB	EBLR			C	1	18.4	B	0	11.8
		EB Approach				C		18.4	B		11.8
		NB	NBLT			A	0	0	A	0	0.1
		NB Approach						0			0.1
		SB	SBTR				0	0		0	0
Springfield Road & Bernard Mills Drive	Unsignalized	SB Approach					0			0	
		Overall LOS				A		0.1	A		0.1
		EB	EBT				0	0		0	0
		EB Approach					0	0		0	0
		WB	WBLT			A	0	0.1	A	1	0.3
		WB Approach						0.1			0.3
		NB	NBLR			C	11	19.8	C	6	19.8
Springfield Road & Olde Hartley Drive	Unsignalized	NB Approach				C	19.8	C		19.8	
		Overall LOS				A		0.6	A		0.5
		EB	EBLT			A	0	0.2	A	1	0.5
		EB Approach						0.2			0.5
		WB	WBT				0	0		0	0
		WB Approach					0	0		0	0
		SB	SBLR			C	15	20.5	C	6	18
Springfield Road & Echo Lake Drive	Unsignalized	SB Approach				C	20.5	C		18	
		Overall LOS				A		0.9	A		0.6
		EB	EBTR				0	0		0	0
		EB Approach						0			0
		WB	WBLT			A	0	0	A	1	0.2
		WB Approach						0			0.2
		NB	NBLR			C	5	15.2	C	3	17.5
Springfield Road & Old Springfield Road	Unsignalized	NB Approach				C	15.2	C		17.5	
		Overall LOS				A		0.3	A		0.3
		EB	EBLT			A	1	0.2	A	2	0.7
		EB Approach						0.2			0.7
		WB	WBTR				0	0		0	0
		WB Approach						0			0
		SB	SBL			C	14	18.1	C	8	19.5
Rigney Terrace & Springfield Road	Unsignalized	SB Approach				C	18.1	C		19.5	
		Overall LOS				A		1.2	A		0.9
		EB	EBLR			C	10	17.4	C	4	16.2
		EB Approach				C		17.4	C		16.2
		NB	NBLT			A	0	0	A	1	0.2
		NB Approach						0			0.2
		SB	SBT				0	0		0	0
Rigney Terrace & Springfield Road	Unsignalized	SB Approach					0			0	
		Overall LOS				A		0.6	A		0.3
		SB	SBR				0	0		0	0

Intersection Information					AM Peak Hour			PM Peak Hour		
Intersection	Traffic Control	Approach	Lane Group	Existing/ Proposed turn-lane lengths	LOS	Back of Queue (feet)	Delay (sec)	LOS	Back of Queue (feet)	Delay (sec)
Francistown Road & Springfield Road	Roundabout	WB	WBLR		C	180	16.7	B	147	13.5
		NB	NBTR		B	104	14.8	B	70	13.1
		SB	SBLT		B	98	12.9	C	185	20.2
		Overall LOS			C		16.7	C		20.2
Springfield Road & Staples Mill Road	Signalized	EB	EBL	200	E	#223	58.8	E	163	55.7
			EBT		D	163	48.4	E	257	55.2
			EBR	575	C	59	32.1	C	85	28.8
		EB Approach			D		51.5	D		49.7
		WB	WBL	350	E	212	58.3	E	#321	71.7
			WBT		E	#237	61.8	E	#434	70.8
			WBR	150	D	70	36.8	C	58	29.5
		WB Approach			D		52.4	E		63.7
		NB	NBL	350	E	#231	65	E	#328	73.2
			NBT		C	167	25.9	C	225	31.9
			NBR	125	B	18	13.3	B	36	16.2
		NB Approach			D		35.9	D		39.6
		SB	SBL	200	E	135	58.7	E	164	59.4
			SBT		D	387	36.7	D	#382	45.5
			SBR	75	C	218	32.6	C	68	22.6
		SB Approach			D		37.5	D		44.2
Overall LOS			D		42.9	D		48.1		

*The '#' indicates 95th percentile volume exceeds capacity queue may be longer and the queue shown is the maximum after two cycles.

Alternative 1 Countermeasure Analysis

Recommendations from VDOT's Road Design Manual and AASHTO's *Policy on Geometric Design of Highways and Streets* were used as a starting point to identify potential improvements in Alternative 1. Potential changes in crashes associated with each countermeasure were calculated using procedures in the HSM. If a standard error was given, a range of crash reductions is shown. This analysis was completed using forecast design year 2036 traffic volumes. Each countermeasure was analyzed independent of the other countermeasures. **Table 13** summarizes the selected Alternative 1 countermeasures, area(s) where the countermeasure were assumed, and the predicted reduction in total average annual crashes.

Table 13 Alternative 1 Intersection Countermeasure Analysis Results

Countermeasure	Applicable Segment/Intersection	Predicted Percent Change ¹		
		Total Crashes by Segment/Intersection		
		Low	High	Expected
<i>Segment</i>				
Install segment lighting	E, F, M, N, Q	N/A ²	N/A	7% Reduction
Provide 10 ft clear zone ³	All (except D, I, and K)	17% Reduction	59% Reduction	N/A
Install guardrail ³	M.1, M.2, N.1	6% Reduction	18% Reduction	N/A
Flatten horizontal curve (minimum radius of 444ft)	M.1, N.1	12% Reduction	17% Reduction	N/A
<i>Intersection</i>				
Install intersection lighting	1, 16, 17	N/A	N/A	9% Reduction
Retime signal change intervals to ITE standards	17	12% Increase ⁴	28% Reduction	N/A
Convert four-leg intersection to three-leg intersection	10	N/A	N/A	60% Reduction
Convert two-way stop-controlled intersection into roundabout	16	29% Reduction	49% Reduction	N/A

¹ Percentages were rounded to the nearest whole number

² N/A – Not Available

³ Development of a 10-foot clear zone and installation of guardrail does are not exclusive countermeasures. Rather, they are two of many treatments used in achieving a roadside hazard rating of 3, which has its own crash modification factor. These two treatments have been broken out individually for clarity.

⁴ The standard error from the clearinghouse for this countermeasure is large enough to result in a calculated potential increase in crashes. Still, applying proper signal timing to an intersection is more likely to reduce crashes than result in an increase.

HSM Analysis Summary

Table 14 compares the HSM-predicted total annual crashes for the no-build scenario and Alternative 1. Because VDOT has yet to develop calibration factors, the numbers shown below can only be used in a relative manner to compare between scenarios. The actual numbers shown below in the predicted ranges are neither accurate nor absolute for either scenario.

Table 14 Total Predicted Annual Crashes: Alternative 1 vs. No-Build Scenario

Alternative	Predicted Total Annual Crashes
No-Build	19.37
Alternative 1	17.82
Percent Reduction	8%

As shown in Table 14, the identified countermeasures implemented in Alternative 1 would result in a predicted reduction of total corridor crashes of eight percent within the study limits as compared to the no-build scenario.

Cost Benefit Analysis

A cost benefit analysis for crashes was conducted to compare Alternative 1 to the no-build scenario using crash-cost values contained in the year 2012 Highway Safety Improvement Program (HSIP) Federal Year (FY) 2012-2013 worksheet published by VDOT. Crash-cost values are based on state and federal statistics estimating total costs of crashes based on the severity of the crash. Other factors such as environmental impacts, right-of-way, and design and construction costs are not included. The analysis results assume a 25-year service life.

Predicted crashes were allocated on the KABCO⁵ scale based on the statewide crash distribution pattern for rural undivided roads year 2008 data (most are 2 lane, some are 4 lane) provided by VDOT. The allocated crashes were multiplied by their respective cost and again by the assumed 25-year service life. The sum of these totals represents the total cost of all predicted crashes for each scenario. Again it is important to note that the dollar values presented here are not accurate or absolute, and are referenced exclusively for relative comparisons between scenarios. **Table 15** summarizes the comparative crash cost results between Alternative 1 and the no-build scenario.

Table 15 Cost Benefit Analysis: Alternative 1 vs. No-Build Scenario

Alternative	Total Cost of Crashes
No-Build	\$73,815,134
Alternative 1	\$67,307,185
Potential Savings	\$6,507,949

As shown in Table 15, Alternative 1 is estimated to save \$6.5 million compared to the no-build scenario over the assumed 25-year service life of the improvements.

⁵ K-Killed; A-Incapacitating Injury; B-Non-Incapacitating Injury; C-Possible Injury; O-No Injury.

Segments affected by the construction of a new alignment (see Alternatives 2 and 3) were isolated to compare the relative cost-benefit of improvements limited only to the sections of SR 157 impacted by the new alignment. Of the total \$6.5 million savings calculated for Alternative 1, roughly \$4.9 million (75 percent) is attributable to improvements to SR 157 between Linsey Lakes Road and Francistown Road.

At the request of VDOT, segments affected by the potential construction of a new alignment (see Alternatives 2 and 3) were isolated to compare the relative cost-benefit of improvements limited to the new alignment only. Of the total \$6.5 million savings, roughly \$4.9 million is attributable to the portion of SR 157 between Linsey Lakes Road and Francistown Road. **Appendix I** contains the Alternative 1 HSM analysis worksheets and analysis details.

Alternative 1 - Preliminary Estimate of Probable Cost

KAI (with support from Timmons Group) prepared preliminary cost estimates of the identified improvements, right-of-way acquisitions, and utility relocations. The cost estimate was conducted without detailed survey or utility information, and therefore is intended for planning purposes only and should not be considered a detailed engineering cost estimate. A preliminary estimate of probable cost indicates Alternative 1 would cost approximately \$12.3 million. **Appendix J** contains the Alternative 1 detailed cost estimate worksheet.

ALTERNATIVE 2 – NEW ALIGNMENT

Alternative 2 involves the partial realignment of SR 157 north Olde Milbrooke Way, creating a new east-west road to connect to the existing SR 157/Francistown Road intersection. Approximately 1.5 miles of new road would need to be constructed for this alternative.

Alternative 2 would change the way forecast future traffic volumes move through the network. The component of through traffic currently traveling along the existing Springfield Road would use the new road alignment, leaving only local residential traffic on SR 157 between the point at which the new alignment begins and the SR 157/Francistown Road intersection.

The following procedure was used to isolate and reassign the percentage of through traffic on the corridor from local traffic:

1. Calculate vehicles entering and existing side streets. These trips are assumed to be local trips.
2. Calculate vehicles entering and exiting corridor.
3. Calculate the difference between the total of steps 1 and 2. This is the number of “through” trips within the study area.
4. Reassign “through” trips to the new alignment.

Alternative 2 can be broken down into four primary sections:

- Existing SR 157 – Nuckols Road to Linsey Lakes Drive (modify cross-section)
- Existing SR 157 – Linsey Lakes Drive to Francistown Road (spot improvements)
- *New SR 157 – Linsey Lakes Drive to Francistown Road (modify cross-section)*
- Existing SR 157 – Francistown Road to Staples Mill Road (modify cross-section)

Three modified cross-section is described in detail below.

Alternative 2 is broken out into two categories: those that apply exclusively to the wholly modified sections, and spot improvements that would still be made to the existing alignment of SR 157 between Linsey Lakes Drive and Francistown Road:

New SR 157 Alignment/Cross-Section

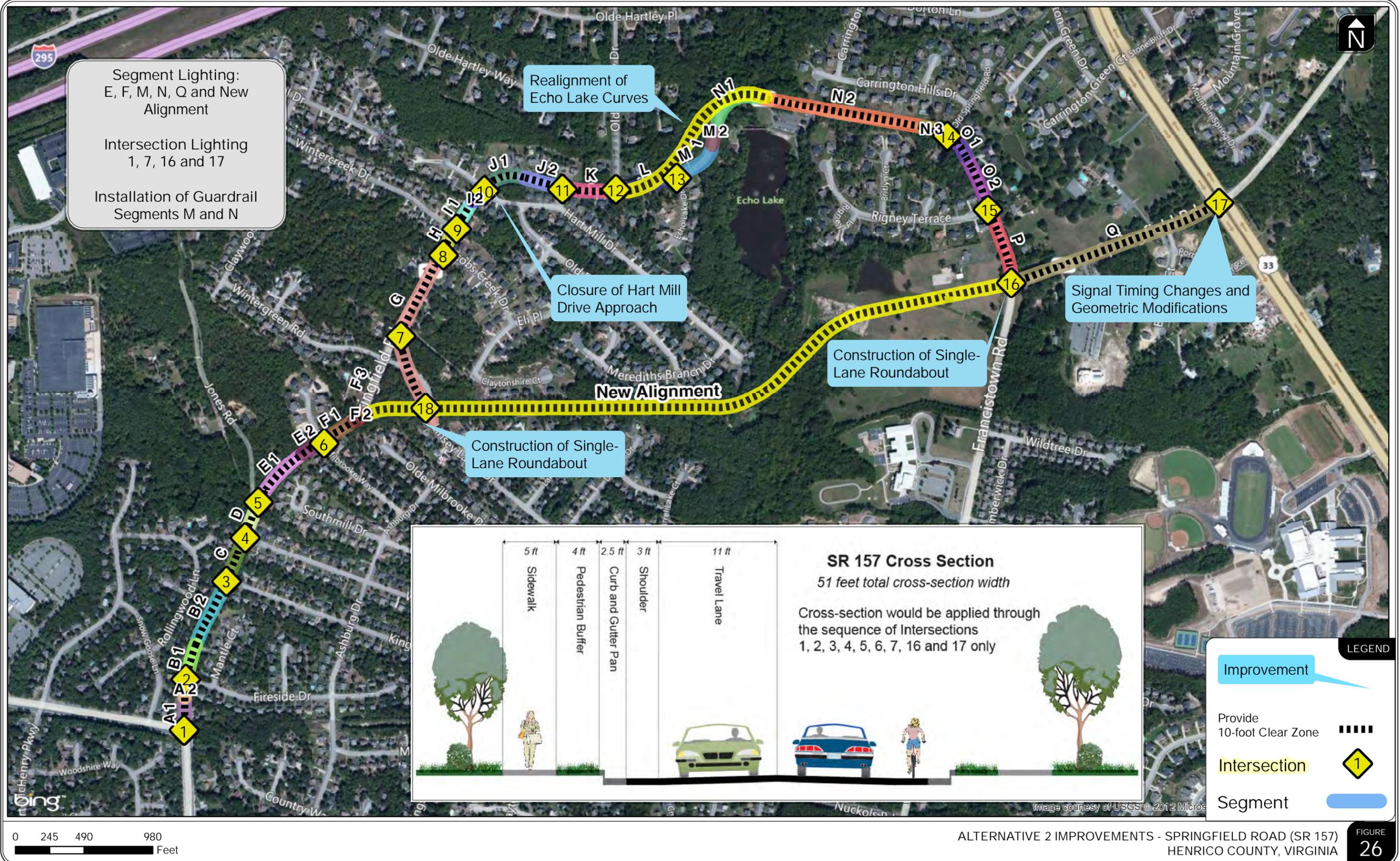
- Construct a roadway cross-section (51 feet wide) along the new alignment of SR 157 that includes:
 - 11-foot travel lanes
 - 3-foot paved shoulders
 - 2.5-foot gutter pan and curb (2-foot wide gutter pan, 6-inch wide curb)
 - 4-foot buffer
 - 5-foot sidewalks
- Provision of a 10-foot clear zone throughout the improved corridor

- Provision of intersection lighting at the following intersections:
 - SR 157/Nuckols Road (existing traffic signal)
 - SR 157/Linsey Lake Drive (new single-lane roundabout)
 - SR 157/Francistown Road (new single-lane roundabout)
 - SR 157/Staples Mill Road (modified traffic signal)
- Provision of segment lighting on the following segments:
 - Wendhurst Drive to Olde Millbrooke Way (Segment E)
 - Olde Millbrook Way to Linsey Lakes Drive (Segment F)
- Provision of signal timing changes and geometric modifications at the SR 157/Staples Mill Road intersection
- Construction of a single-lane roundabout at the SR 157/Linsey Lakes Drive intersection
- Construction of a single-lane roundabout at the SR 157/Francistown Road intersection

Existing SR 157 Alignment (Linsey Lakes Drive to Francistown Road)

- Provision of segment lighting on the following segments:
 - Echo Lake Drive to Echo Lake County Park access (Segments M & N)
 - Francistown Road to Staples Mill Road (Segment Q)
- Installation of guardrail on Echo Lake Curves (Segments M.1, M.2, N.1)
- Realignment of Echo Lake Curves (Segments M.1, M.2, N.1)
- Closure of the Hart Mill Drive approach to SR 157

Assumed improvements for Alternative 2 are illustrated in **Figure 26**. Details regarding the analysis and selection of these improvements are provided below.



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Alternative 2 West-End Intersection Configuration Options

The point at which the new alignment of SR 157 begins has been roughly defined by the preservation of a strip of existing right-of-way to accommodate it. The future intersection configuration of the eastern terminus of the new alignment at the SR 157/Francistown Road is fairly well defined, as the new road will become the fourth leg at that intersection. However, to date there has been no evaluation of various intersection configurations that could be developed at the western end of the new corridor. As such, an operational analysis of three potential alignment options was conducted for the western end of the new SR 157 alignment to determine if any one option was more advantageous than the others from a traffic operations perspective.

Options

Option A would develop the primary through movement along the new alignment of Springfield Road. The northern portion of existing Springfield Road would be realigned to intersect the new alignment directly across from Linsey Lakes Drive. A portion of existing Linsey Lakes Drive would be removed to accommodate the realignment, and Wintergreen Road would also be slightly modified.

Option B would also develop the primary through movement along the new alignment of Springfield Road. However, in this case the northern portion of existing Springfield Road would remain largely untouched, with only a minor realignment at the point at which it would intersect the new alignment. The existing segment of Linsey Lakes Drive between Springfield Road and the new alignment would be removed, forming a T-intersection at the new Springfield Road/Linsey Lakes Drive intersection.

Option C would retain the existing Springfield Road alignment as the primary through movement. The new alignment of Springfield Road would intersect the existing roadway roughly at the point where Wintergreen Road and Linsey Lakes Drive intersect Springfield Road today. Linsey Lakes Drive would then intersect the new alignment to form a T-intersection west of the new intersection.

Operational Analysis Parameters

Four types of intersection control were considered at the west end intersection for all three Options:

- Unsignalized: two-way stop
- Unsignalized: four-way stop
- Signalized (if warranted)
- Roundabout

Intersection control delay was selected as the critical parameter to compare the various intersection control forms for each Option. It is well known that drivers have a tendency to become increasingly impatient the longer they are delayed at an intersection⁶. Minimizing delay benefits the transportation system and reduces instances where long delays promote more aggressive driving behavior.

⁶ Delay Effects on Driver Gap Acceptance Characteristics at Two-Way Stop-Controlled Intersections
http://www.webs1.uidaho.edu/ce572s05/other_links/references/kittelso%20and%20vandehey%20paper.pdf

The process for identifying the most appropriate intersection control form for each option is outlined below:

1. If the two-way stop control was found to operate at LOS B or better for all approaches during all time periods, then other intersection control devices were not evaluated.
2. Preliminary Manual on Uniform Traffic Control Devices (MUTCD – Reference 7) signal warrant analyses were performed for each Option to identify if/when a traffic signal was appropriate for consideration.
3. Operational analyses were performed using HCS 2010 (roundabout) and Synchro 8 (two-way stop, all-way stop, and traffic signal).

The following sections summarize the results of the operational analyses and selected intersection control form for each option considered.

Option A Operational Analysis

Option A consists of three distinct intersections:

- New SR 157/Linsey Lakes Drive/Existing SR 157
- Existing SR 157/Wintergreen Road
- New SR 157/Francistown Road/Existing SR 157

Figure 27 illustrates the west end alignment for Option A. The New SR 157/Linsey Lakes Drive/Existing SR 157 and SR 157/Francistown Road intersections are forecast to meet signal warrants under design year conditions. Signal warrant analyses for Option A are contained in **Appendix K**.

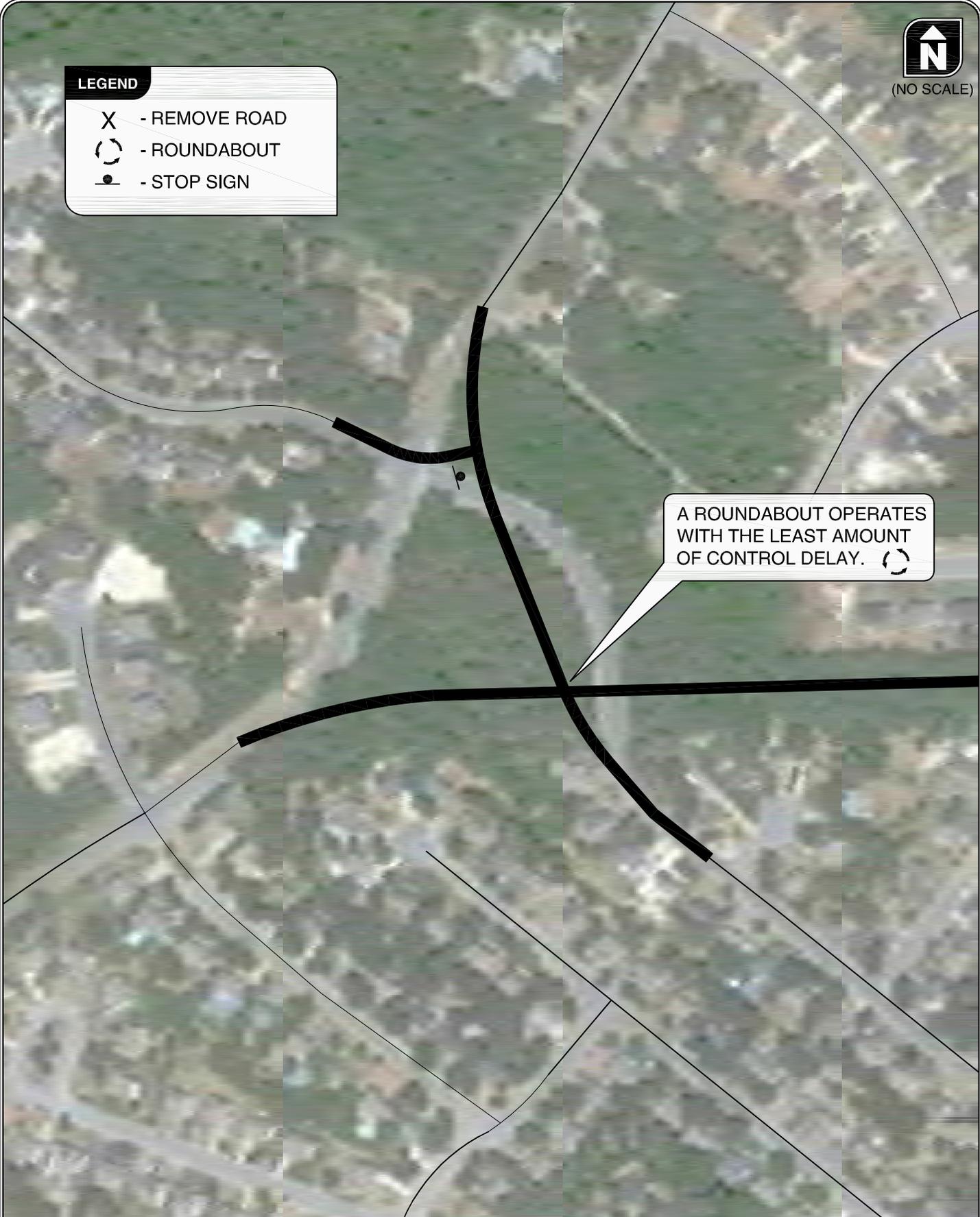
Table 16 summarizes the selected intersection control form chosen for each intersection based on intersection control delay and displays the resultant operations.



(NO SCALE)

LEGEND

- X - REMOVE ROAD
- - ROUNDABOUT
- - STOP SIGN



A ROUNDABOUT OPERATES WITH THE LEAST AMOUNT OF CONTROL DELAY. ○

ALTERNATIVE 2 WEST-END INTERSECTION CONFIGURATION
 OPTION A
 HENRICO COUNTY, VIRGINIA

FIGURE
27

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Table 16 Alternative 2 Option A Intersection Control Form

Intersection	Control Type	Operations			
		Dir	LOS	V/C	Delay (s)
New SR 157/Linsey Lakes Drive/Existing SR 157	Roundabout	NB	A	0.61	6.7
		SB			6.9
		EB			11.2
		WB			9.0
Existing SR 157/ Wintergreen Road	Two-way stop	NB	A	0.15	0.9
		SB	A		0.0
		EB	B		11.7
New SR 157/Francistown Road/Existing SR 157	Roundabout	NB	B	0.77	13.0
		SB			10.2
		EB			11.1
		WB			18.4

Option B Operational Analysis

Option B consists of three distinct intersections:

- New SR 157/Existing SR 157
- New SR 157/Linsey Lakes Drive
- New SR 157/Francistown Road/Existing SR 157

Figure 28 illustrates the west end alignment for Option B. The New SR 157/Francistown Road/Existing SR 157 intersection is forecast to meet signal warrants under design year conditions. Signal warrant analyses for Option B are contained in Appendix K.

Table 17 summarizes the intersections, chosen control types, and operation characteristics for Option B.



(NO SCALE)

LEGEND

- X - REMOVE ROAD
- - ROUNDABOUT
- - STOP SIGN



A ROUNDABOUT OPERATES WITH THE LEAST AMOUNT OF CONTROL DELAY. ○

ALTERNATIVE 2 WEST-END INTERSECTION CONFIGURATION
 OPTION B
 HENRICO COUNTY, VIRGINIA

FIGURE
28

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Table 17 Alternative 2 Option B Intersection Control Form

Intersection	Control Type	Operations			
		Dir	LOS	V/C	Delay (s)
New SR 157/Existing SR 157	Roundabout	NB	B	0.62	--
		SB			9.0
		EB			6.6
		WB			11.8
New SR 157/Linsey Lakes Drive	Two-way stop	NB	B	0.24	12.7
		EB	A		0.0
		WB	A		6.6
New SR 157/Francistown Road/Existing SR 157	Roundabout	NB	B	0.77	13.0
		SB			10.2
		EB			11.1
		WB			18.4

Option C Operational Analysis

Option C consists of three distinct intersections:

- New SR 157/Wintergreen Road/Existing SR 157
- New SR 157 /Linsey Lakes Drive
- New SR 157/Francistown Road/Existing SR 157

Figure 29 illustrates the west end alignment for Option C. The New SR 157/Wintergreen Road/Existing SR 157 and New SR 157/Francistown Road/Existing SR 157 intersections are forecast to meet signal warrants under design year conditions. Signal warrant analyses for Option C are contained in Appendix K.

Table 18 summarizes the intersections, chosen control types, and operational characteristics for Option C.



(NO SCALE)

LEGEND

- X - REMOVE ROAD
- - ROUNDABOUT
- - STOP SIGN

A ROUNDABOUT OPERATES WITH THE LEAST AMOUNT OF CONTROL DELAY. ○

ALTERNATIVE 2 WEST-END INTERSECTION CONFIGURATION
 OPTION C
 HENRICO COUNTY, VIRGINIA

FIGURE
29

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Table 18 Alternative 2 Option C Intersection Control Form

Intersection	Control Type	Operations			
		Dir	LOS	V/C	Delay (s)
New SR 157/Wintergreen Road/Existing SR 157	Roundabout	NB	A	0.61	11.6
		SB			7.8
		EB			5.0
		WB			8.6
New SR 157 /Linsey Lakes Drive	Two-way stop	NB	A	0.24	11.1
		EB	A		0.0
		WB	A		0.6
New SR 157/Francistown Road/Existing SR 157	Roundabout	NB	B	0.77	13.0
		SB			10.2
		EB			11.1
		WB			18.4

Delay Comparison

A quantitative comparison of overall delay was also conducted, recognizing that minimizing delay is another important parameter to consider. Three possible routes through the corridor were identified and the travel time in seconds to progress through the routes in the weekday p.m. peak hour were calculated. The three routes used include:

- Olde Milbrooke Way/Springfield Road intersection to Springfield Road/Francistown Road/SR 157
- Wintergreen Road/Springfield Road intersection to Olde Milbrooke Way
- Springfield Road/Francistown Road/SR 157 to Springfield Road/Jacobs Creek Drive

Travel times for these routes were then weighted by the number of forecast vehicles in the year 2036 weekday p.m. peak hour to determine the overall time for each route.

Based on the results of this analysis, Option A resulted in the least amount of aggregated delay. As such, Option A was selected for the Alternative 2 operations analysis. Complete details regarding this analysis can be found in Appendix K.

Alternative 2 Operations Analysis

Alternative 2 would develop a partial new alignment for SR 157 within the study area. The new alignment would begin just north of Olde Milbrooke Way and extend eastward approximately 1.5 miles to the SR 157/Francistown Road intersection. The Option A intersection configuration is assumed, and roundabouts were selected as the intersection control form at the newly formed SR 157/Linsey Lakes Drive and SR 157/Francistown intersections for both safety and operational reasons. The existing portion of SR 157 between the two endpoints is assumed to be minimally improved to address only those safety and operational issues identified under existing conditions.

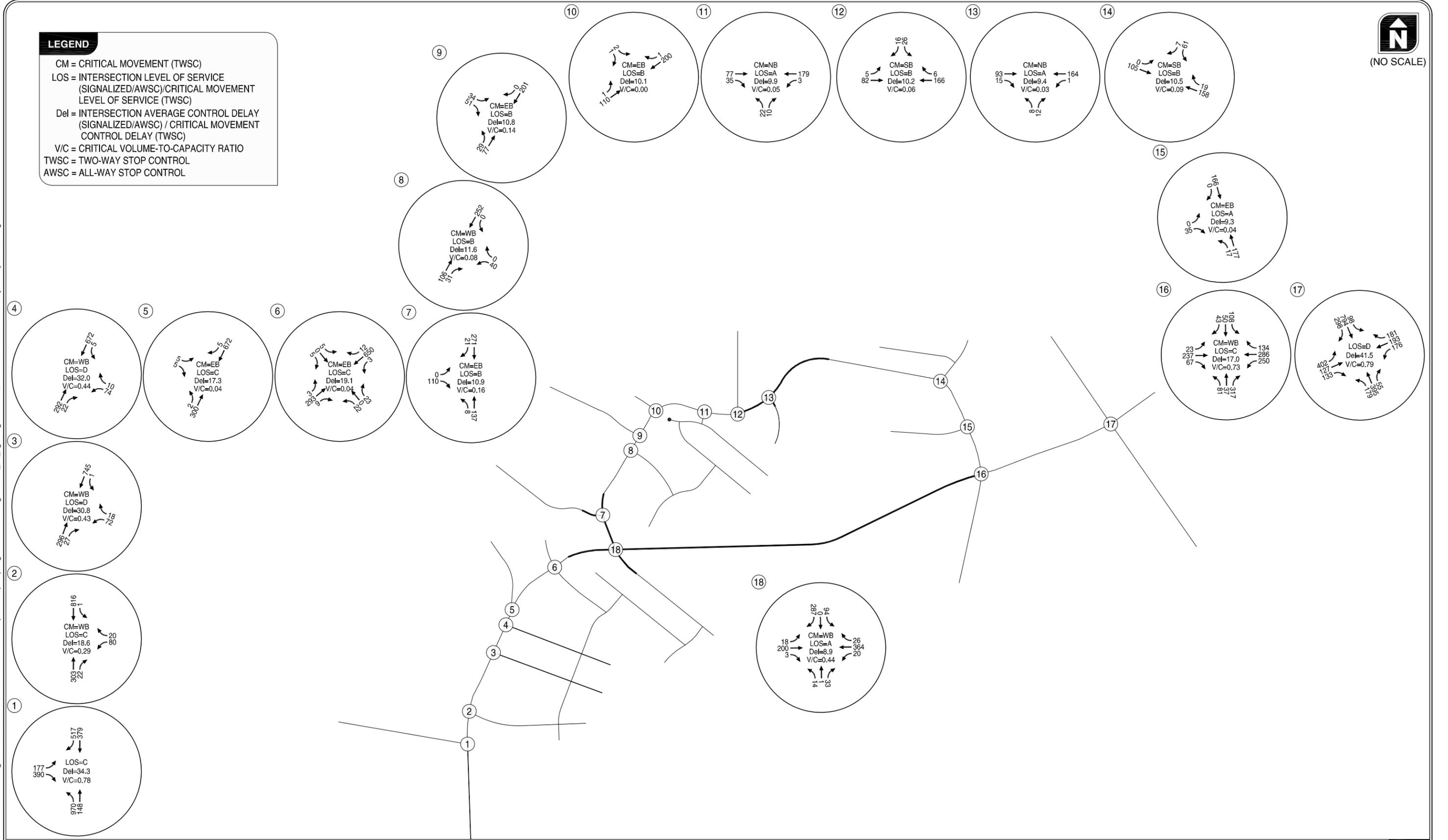
Figure 30 and **Figure 31** show the forecast traffic volumes and traffic operations for the Alternative 2 scenario. **Figure 32** and **Figure 33** show the lane group level of service results. **Table 19** summarizes the operational results. **Appendix L** contains the Alternative 2 operational analysis worksheets.



(NO SCALE)

LEGEND

CM = CRITICAL MOVEMENT (TWSC)
 LOS = INTERSECTION LEVEL OF SERVICE (SIGNALIZED/AWSC)/CRITICAL MOVEMENT LEVEL OF SERVICE (TWSC)
 Del = INTERSECTION AVERAGE CONTROL DELAY (SIGNALIZED/AWSC) / CRITICAL MOVEMENT CONTROL DELAY (TWSC)
 V/C = CRITICAL VOLUME-TO-CAPACITY RATIO
 TWSC = TWO-WAY STOP CONTROL
 AWSC = ALL-WAY STOP CONTROL



ALTERNATIVE 2 TRAFFIC CONDITIONS
 WEEKDAY AM PEAK HOUR
 HENRICO COUNTY, VIRGINIA

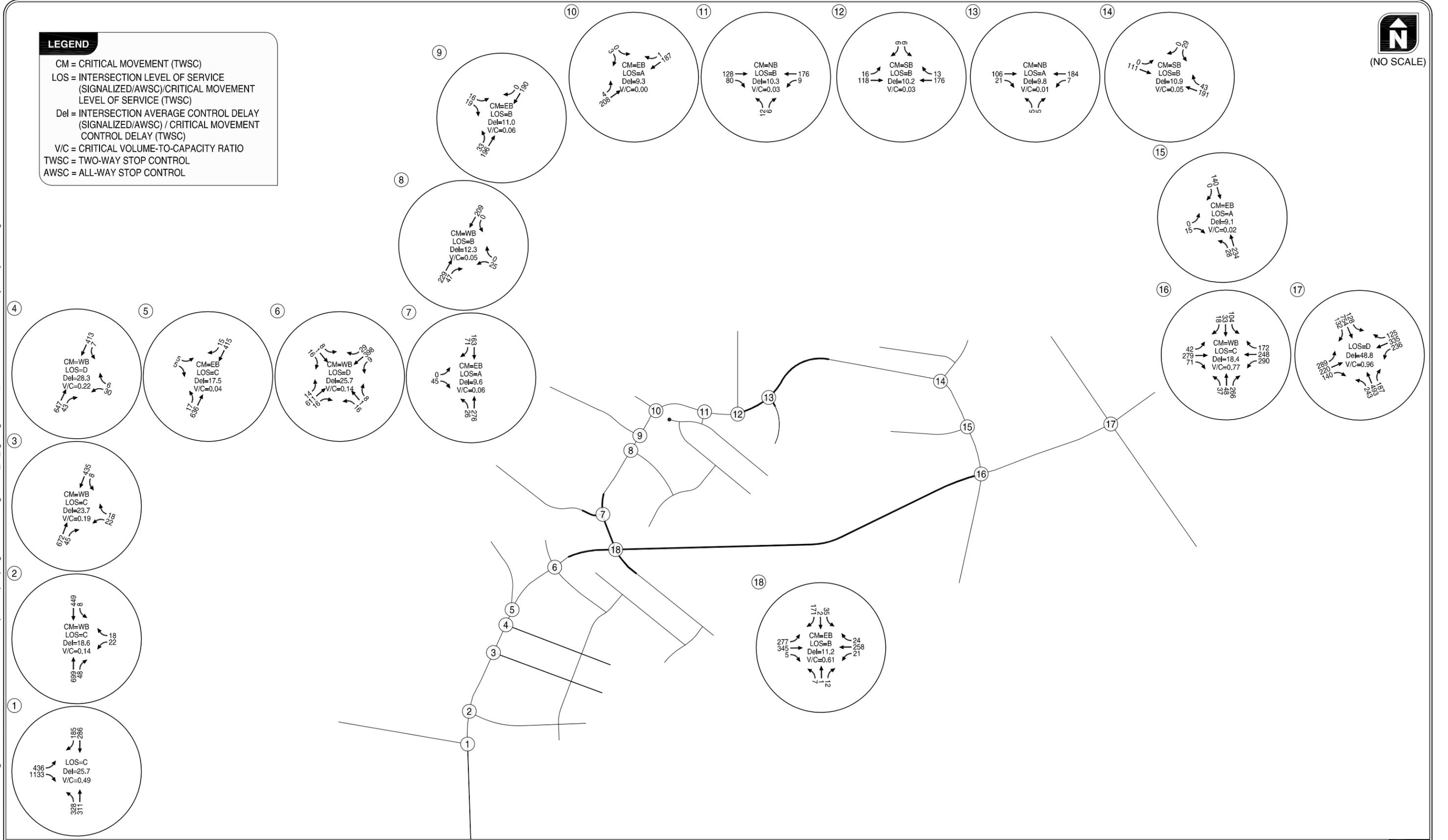
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(NO SCALE)

LEGEND

CM = CRITICAL MOVEMENT (TWSC)
 LOS = INTERSECTION LEVEL OF SERVICE (SIGNALIZED/AWSC)/CRITICAL MOVEMENT LEVEL OF SERVICE (TWSC)
 Del = INTERSECTION AVERAGE CONTROL DELAY (SIGNALIZED/AWSC) / CRITICAL MOVEMENT CONTROL DELAY (TWSC)
 V/C = CRITICAL VOLUME-TO-CAPACITY RATIO
 TWSC = TWO-WAY STOP CONTROL
 AWSC = ALL-WAY STOP CONTROL



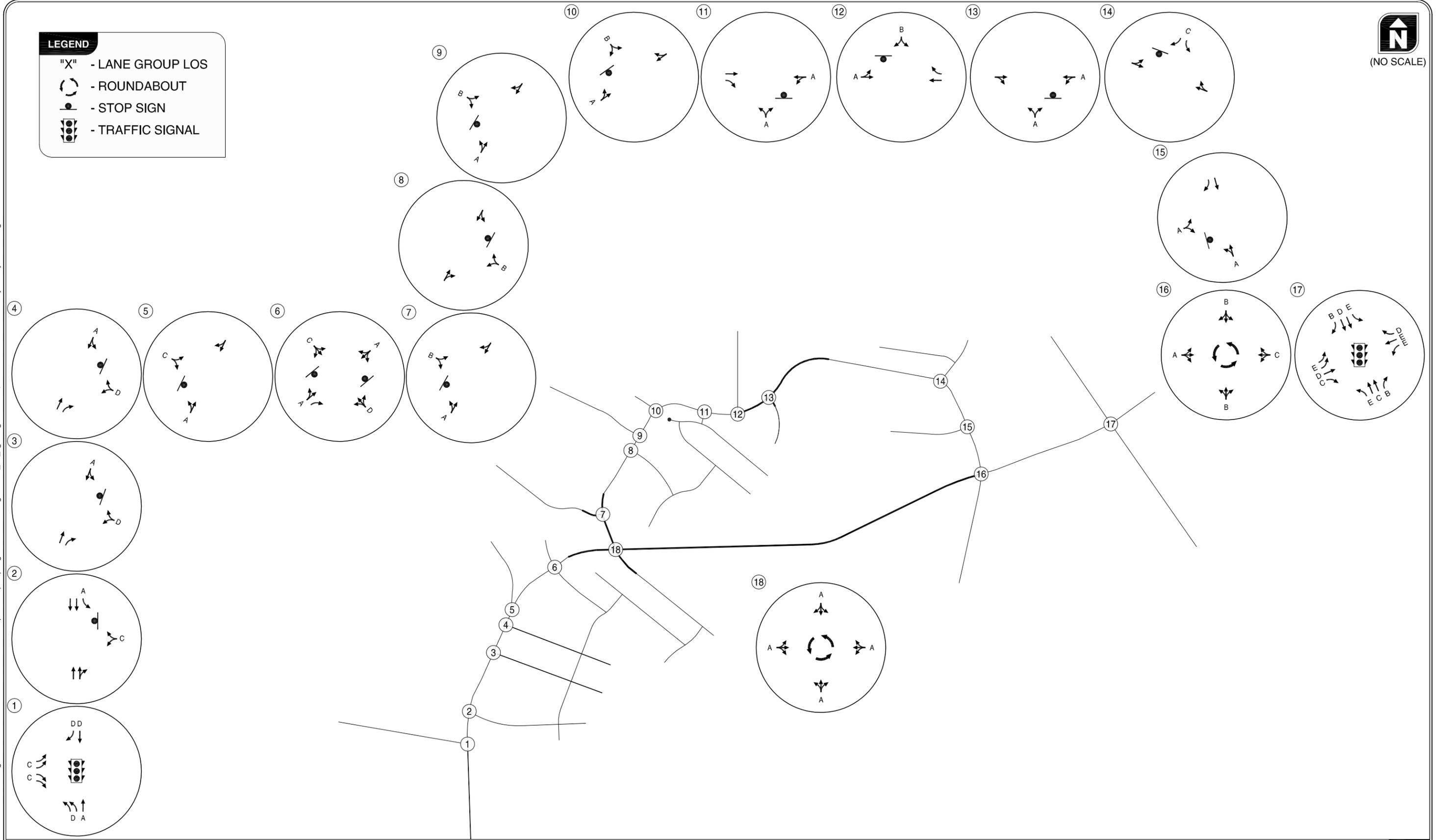
ALTERNATIVE 2 TRAFFIC CONDITIONS
WEEKDAY PM PEAK HOUR
HENRICO COUNTY, VIRGINIA

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LEGEND

- "X" - LANE GROUP LOS
- ⊙ - ROUNDABOUT
- - STOP SIGN
- 🚦 - TRAFFIC SIGNAL



ALTERNATIVE 2 LANE GROUP LEVEL OF SERVICE
WEEKDAY AM PEAK HOUR
HENRICO COUNTY, VIRGINIA

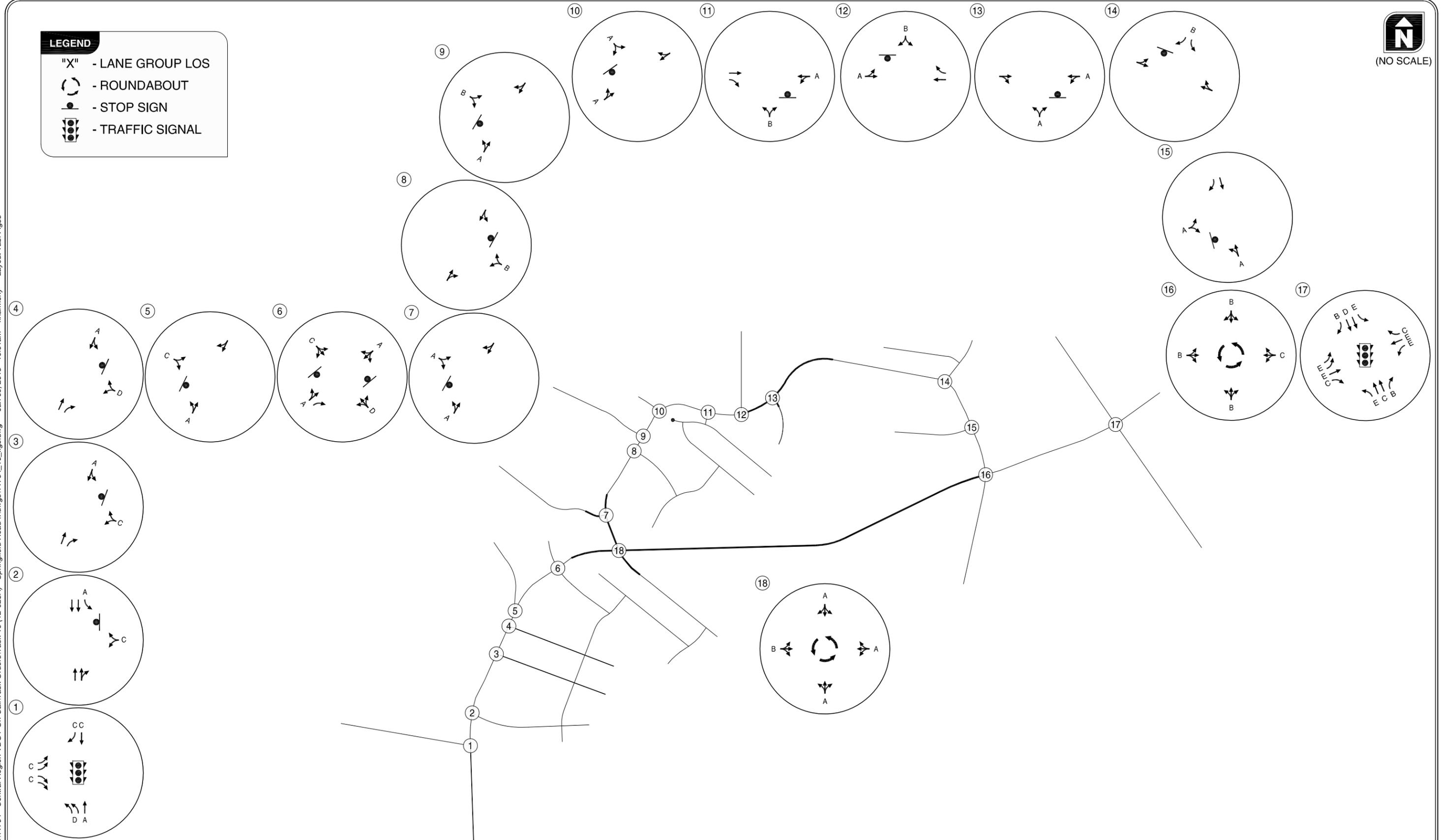
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(NO SCALE)

LEGEND

- "X" - LANE GROUP LOS
- ⊙ - ROUNDABOUT
- - STOP SIGN
- 🚦 - TRAFFIC SIGNAL



ALTERNATIVE 2 LANE GROUP LEVEL OF SERVICE
WEEKDAY PM PEAK HOUR
HENRICO COUNTY, VIRGINIA

FIGURE

33

Table 19 Levels of Service, 95th Percentile Back of Queue and Delay Results - Alternative 2 Year 2036 Traffic Conditions

Intersection Information					AM Peak Hour			PM Peak Hour			
Intersection	Traffic Control	Approach	Lane Group	Existing/ Proposed turn-lane lengths	LOS	Back of Queue (feet)	Delay (sec)	LOS	Back of Queue (feet)	Delay (sec)	
Nuckols Road & Springfield Road	Signalized	EB	EBL	275	C	65	28.9	C	154	27.3	
			EBR	175	C	35	28.1	C	50	27	
		EB Approach				C		28.4	C		27.1
		NB	NBL	225	D	#406	38	D	132	37.6	
			NBT		A	66	6.2	A	137	9.9	
		NB Approach				C		33.8	C		24.1
		SB	SBT		D	#430	43.7	C	217	22.9	
			SBR		D	169	35.1	C	47	23.9	
SB Approach				D		38.7	C		23.3		
Overall LOS				C		34.3	C		25.7		
Fireside Drive & Springfield Road	Unsignalized	WB	WBLR		C	30	18.6	C	12	18.6	
			WB Approach			C		18.6	C		18.6
		NB	NBTR			0	0		0	0	
			NB Approach					0			0
		SB	SBL		A	0	8	A	1	9.5	
			SBT			0	0		0	0	
		SB Approach					0			0.2	
Overall LOS				A		1.5	A		0.7		
Kingscroft Drive & Springfield Road	Unsignalized	WB	WBLR		D	51	30.8	C	17	23.7	
			WB Approach			D		30.8	C		23.7
		NB	NBT			0	0		0	0	
			NBR			0	0		0	0	
		NB Approach					0			0	
		SB	SBLT		A	0	0	A	1	0.3	
			SB Approach					0			0.3
Overall LOS				A		2.4	A		0.9		
Wendhurst Drive & Springfield Road	Unsignalized	WB	WBLR		D	51	32	D	20	28.3	
			WB Approach			D		32	D		28.3
		NB	NBT			0	0		0	0	
			NBR			0	0		0	0	
		NB Approach					0			0	
		SB	SBLT		A	0	0.1	A	1	0.3	
SB Approach						0.1			0.3		
Overall LOS				A		2.6	A		1		
Jones Road & Springfield Road	Unsignalized	EB	EBLR		C	3	17.3	C	3	17.5	
			EB Approach			C		17.3	C		17.5
		NB	NBLT		A	0	0.1	A	1	0.5	
			NB Approach					0.1			0.5
		SB	SBTR			0	0		0	0	
			SB Approach					0			0
Overall LOS				A		0.2	B		0.4		
Olde Milbrooke Way & Springfield Road	Unsignalized	EB	EBLTR		C	3	19.1	C	7	17.6	
			EB Approach			C		19.1	C		17.6
		WB	WBLTR		C	14	18.4	D	12	25.7	
			WB Approach			C		18.4	D		25.7
		NB	NBLT		A	0	0.1	A	1	0.4	
			NBR			0	0		0	0	
		NB Approach					0.1			0.4	
		SB	SBLTR		A	0	0.1	A	1	0.3	
SB Approach						0.1			0.3		
Overall LOS				A		1.1	A		1.3		
Wintergreen Road & Springfield Road	Unsignalized	EB	EBLR		B	14	10.9	A	5	9.6	
			EB Approach			B		10.9	A		9.6
		NB	NBLT		A	1	0.5	A	2	0.9	
			NB Approach					0.5			0.9
		SB	SBTR			0	0		0	0	
			SB Approach					0			0
Overall LOS				A		2.3	A		1.2		
Jacobs Creek	Unsignalized	WB	WBLR		B	6	11.6	B	4	12.3	

Intersection Information					AM Peak Hour			PM Peak Hour			
Intersection	Traffic Control	Approach	Lane Group	Existing/ Proposed turn-lane lengths	LOS	Back of Queue (feet)	Delay (sec)	LOS	Back of Queue (feet)	Delay (sec)	
Drive & Springfield Road		WB Approach			B		11.6	B		12.3	
		NB	NBTR			0	0		0	0	
		NB Approach					0			0	0
		SB	SBLT			0	0		0	0	
		SB Approach					0			0	0
Overall LOS					A		1.1	A		0.6	
Wintercreek Drive & Springfield Road	Unsignalized	EB	EBLR		B	12	10.8	B	5	11	
		EB Approach			B		10.8	B		11	
		NB	NBLT		A	2	2.3	A	2	1.3	
		NB Approach					2.3			1.3	1.3
		SB	SBTR			0	0		0	0	
		SB Approach					0			0	0
Overall LOS					A		3	A		1.5	
Warnerwood Ct & Springfield Road	Unsignalized	EB	EBLR		B	0	10.1	A	0	9.3	
		EB Approach			B		10.1	A		9.3	
		NB	NBLT		A	0	0.1	A	0	0.2	
		NB Approach					0.1			0.2	0.2
		SB	SBTR			0	0		0	0	
		SB Approach					0			0	0
Overall LOS					A		0.1	A		0.2	
Springfield Road & Bernard Mills Drive	Unsignalized	EB	EBT			0	0		0	0	
			EBR			0	0		0	0	
		EB Approach					0			0	0
		WB	WBLT		A	0	0.1	A	1	0.4	
		WB Approach					0.1			0.4	0.4
		NB	NBLR		A	4	9.9	B	2	10.3	
		NB Approach			A		9.9	B		10.3	10.3
Overall LOS					A		1.1	A		0.6	
Springfield Road & Olde Hartley Drive	Unsignalized	EB	EBLT		A	0	0.5	A	1	1	
		EB Approach					0.5			1	
		WB	WBT			0	0		0	0	
			WBR			0	0		0	0	
		WB Approach					0			0	0
		SB	SBLR		B	5	10.2	B	2	10.2	
SB Approach			B		10.2	B		10.2	10.2		
Overall LOS					A		1.6	A		0.9	
Springfield Road & Echo Lake Drive	Unsignalized	EB	EBTR			0	0		0	0	
		EB Approach					0			0	
		WB	WBLT		A	0	0.1	A	0	0.3	
		WB Approach					0.1			0.3	0.3
		NB	NBLR		A	2	9.4	A	1	9.8	
		NB Approach			A		9.4	A		9.8	9.8
Overall LOS					A		0.7	A		0.5	
Springfield Road & Old Springfield Road	Unsignalized	EB	EBLT			0	0		0	0	
		EB Approach					0			0	
		WB	WBTR			0	0		0	0	
		WB Approach					0			0	0
		SB	SBL		B	8	10.5	B	4	10.9	
		SB Approach			B		10.5	B		10.9	10.9
Overall LOS					A		2	A		0.8	
Rigney Terrace & Springfield Road	Unsignalized	EB	EBLR		A	3	9.3	A	1	9.1	
		EB Approach			A		9.3	A		9.1	
		NB	NBLT		A	1	0.8	A	2	1	
		NB Approach					0.8			1	1
		SB	SBT			0	0		0	0	
			SBR			0	0		0	0	
		SB Approach					0			0	0
Overall LOS					A		1.2	A		0.9	
Francistown Road & Springfield Road	Roundabout	EB	EBLTR		A	38	9.5	B	50	11.1	
		WB	WBLTR		C	185	17	C	213	18.4	
		NB	NBLTR		B	102	14.9	B	73	13	

Intersection Information					AM Peak Hour			PM Peak Hour		
Intersection	Traffic Control	Approach	Lane Group	Existing/ Proposed turn-lane lengths	LOS	Back of Queue (feet)	Delay (sec)	LOS	Back of Queue (feet)	Delay (sec)
Springfield Road & Staples Mill Road	Signalized	SB	SBLTR		B	38	11.6	B	30	10.2
		Overall LOS			C		17	C		18.4
		EB	EBL	200	E	#223	58.8	E	165	56.3
			EBT		D	163	48.4	E	#285	57.8
			EBR	575	C	59	32.3	C	84	29
		EB Approach			D		51.5	D		50.9
		WB	WBL	350	E	212	58.3	E	#316	69.1
			WBT		E	#237	61.8	E	#445	73
			WBR	150	D	70	36.8	C	62	29.3
		WB Approach			D		52.4	E		63.8
		NB	NBL	350	E	#231	67.1	E	#334	74.5
			NBT		C	167	25.9	C	230	32.3
			NBR	125	B	18	13.3	B	36	16.1
		NB Approach			D		36.5	D		40.1
		SB	SBL	200	E	135	58.7	E	165	59.1
SBT			D	387	36.4	D	#393	46.4		
SBR	75		B	113	17.8	C	68	22.8		
SB Approach			C		33.6	D		45		
Overall LOS			D		41.5	D		48.8		
Springfield Road & Linsey Lakes Drive	Roundabout	EB	EBLTR		A	28	6.9	B	86	11.2
		WB	WBLTR		A	60	8.9	A	44	9
		NB	NBLTR		A	6	5.7	A	3	6.7
		SB	SBLTR		A	42	9.8	A	23	6.9
		Overall LOS			A		9.8	B		11.2

*The '#' indicates 95th percentile volume exceeds capacity queue may be longer and the queue shown is the maximum after two cycles.

Alternative 2 Countermeasure Analysis

Recommendations from VDOT's Roadside Design Manual and AASHTO's *Policy on Geometric Design of Highways and Streets* were used as a starting point to identify potential improvements in Alternative 2. Potential changes in crashes associated with each countermeasure were calculated using procedures in the HSM. If a standard error was given, a range of crash reductions is shown. This analysis was completed using forecast design year 2036 traffic volumes. Each countermeasure was analyzed independent of the other countermeasures. **Table 20** summarizes the selected Alternative 2 countermeasures, area(s) where the countermeasure were assumed, and the predicted reduction in total average annual crashes.

Table 20 Alternative 2 Intersection Countermeasure Analysis Results

Countermeasure	Applicable Segment/Intersection	Predicted Percent Change ¹		
		Total Crashes by Segment/Intersection		
		Low	High	Expected
<i>Segment</i>				
Install segment lighting	E, F, M, N, Q	N/A ²	N/A	7% Reduction
Create 10ft clear zone ³	All	6% Reduction	18% Reduction	N/A
Install guardrail ³	M.1, M.2, N.1	6% Reduction	18% Reduction	N/A
Flatten horizontal curve (minimum radius of 500ft)	M.1 & N.1	12% Reduction	17% Reduction	N/A
Reduce AADT on segment ⁴	G, H, I, J, K, L, M, N, O, P	N/A	N/A	58-70% Reduction
<i>Intersection</i>				
Lighting in intersection	1, 7, 16, 17	N/A	N/A	9% Reduction
Retime signal and change intervals to ITE standards	17	10% Increase ⁵	34% Reduction	N/A
Covert four-leg intersection to three-leg intersection	10	N/A	N/A	60% Reduction
Convert two-way stop-controlled intersection into roundabout	7, 16	29% Reduction	49% Reduction	N/A
Reduce AADT at intersection on major road segment ⁴	8, 9, 10, 11, 12, 13, 14, 15, 16	N/A	N/A	6-61% Reduction

¹ Percentages were rounded to the nearest whole number

² N/A - Not Available

³ Development of a 10-foot clear zone and installation of guardrail does are not exclusive countermeasures. Rather, they are two of many treatments used in achieving a roadside hazard rating of 3, which has its own crash modification factor. These two treatments have been broken out individually for clarity.

⁴ Magnitude of reduction depends on the magnitude of the reduction in AADT. See Appendix M for details regarding each segment and intersection.

⁵ The standard error from the clearinghouse for this countermeasure is large enough to result in a calculated potential increase in crashes. Still, applying proper signal timing to an intersection is more likely to reduce crashes than result in an increase.

HSM Analysis Summary

Table 21 compares the HSM-predicted total average annual crashes for the no-build scenario and Alternative 2. Because VDOT has no available calibration factors, the numbers shown below can only be used in a relative manner to compare between scenarios. The actual numbers shown below in the predicted ranges are neither accurate nor absolute for either scenario.

Table 21 Total Predicted Annual Crashes: Alternative 2 vs. No-Build Scenario

Alternative	Total Predicted Annual Crashes
No-Build	19.37
Alternative 2	15.04
Percent Reduction	22%

As shown in Table 21, the identified countermeasures implemented in Alternative 2 would result in a predicted reduction of 22 percent within the study limits as compared to the no-build scenario.

Cost Benefit Analysis

A cost benefit analysis for crashes was conducted to compare Alternative 2 to the no-build scenario using crash-cost values contained in the year 2012 Highway Safety Improvement Program (HSIP) Federal Year (FY) 2012-2013 worksheet published by VDOT. Other factors such as environmental impacts, right-of-way, and design and construction costs are not included. The analysis results assume a 25-year service life.

Predicted crashes were allocated on the KABCO scale based on the statewide crash distribution pattern for rural undivided roads year 2008 data (most are 2 lane, some are 4 lane) provided by VDOT. The allocated crashes were multiplied by their respective cost and again by the assumed 25-year service life. The sum of these totals represents the total cost of all predicted crashes for each scenario. Again it is important to note that the dollar values presented here are not accurate or absolute, and are referenced exclusively for relative comparisons between scenarios. **Table 22** summarizes the comparative crash cost results between Alternative 2 and the no-build scenario.

Table 22 Cost Benefit Analysis: Alternative 2 vs. No-Build Scenario

Alternative	Total Cost of Crashes
No-Build	\$73,815,134
Alternative 2	\$57,258,589
Potential Savings	\$16,556,545

As shown in Table 22, Alternative 2 is estimated to save \$16.5 million compared to the no-build scenario over the assumed 25-year service life of the improvements.

Segments affected by the construction of a new alignment were isolated to compare the relative cost-benefit of improvements limited only to the sections of SR 157 impacted by the new alignment. Of the total \$16.5 million savings calculated for Alternative 2, roughly \$14.2 million (86 percent) is attributable to improvements to SR 157 between Linsey Lakes Road and Francistown Road. **Appendix M** contains the Alternative 2 HSM analysis worksheets and analysis details.

Alternative 2 - Preliminary Estimate of Probable Cost

A preliminary estimate of probable cost indicates Alternative 2 would cost approximately \$18.3 million. **Appendix N** contains the Alternative 2 detailed cost estimate worksheet.

ALTERNATIVE 3 – NEW ALIGNMENT + CUL-DE-SAC

Alternative 3 also involves the partial realignment of SR 157 north of SR 157/Linsey Lake Drive, creating a new east-west road to connect to the existing SR 157/Francistown Road intersection. Approximately 1.5 miles of new road would be constructed. In addition, existing Springfield Road would be severed in the vicinity of Echo Lake Park, essentially creating two cul-de-sacs at Echo Lake Drive on the west side, and Echo Lake Park on the east side. A service road connection would still be maintained through the abandoned horizontal curve section of road between these two endpoints, allowing for pedestrian, bicycle, and emergency vehicle movements.

Alternative 3 also changes how forecast future traffic volumes move through the network. In addition to the reassignment of through traffic to the new road alignment (see Alternative 2), a portion of local residential traffic traveling to/from existing SR 157 must also be reassigned due to the disconnection of SR 157 at Echo Lake. Local trips (originating from local side streets) within the affected section of Springfield Road were reassigned to the new alignment accordingly.

Alternative 3 can be broken down into five primary sections:

- Existing SR 157 – Nuckols Road to Linsey Lakes Drive (modify cross-section)
- Existing SR 157 – Linsey Lakes Drive to Echo Lake Drive (spot improvements)
- Existing SR 157 – Echo Lake Park to Francistown Road (spot improvements)
- *New SR 157 – Linsey Lakes Drive to Francistown Road (modify cross-section)*
- Existing SR 157 – Francistown Road to Staples Mill Road (modify cross-section)

Three modified cross-section is described in detail below.

Alternative 3 is broken out into two categories: those that apply exclusively to the wholly modified sections, and spot improvements that would still be made to the alignment of SR 157 between Linsey Lakes Drive and Francistown Road:

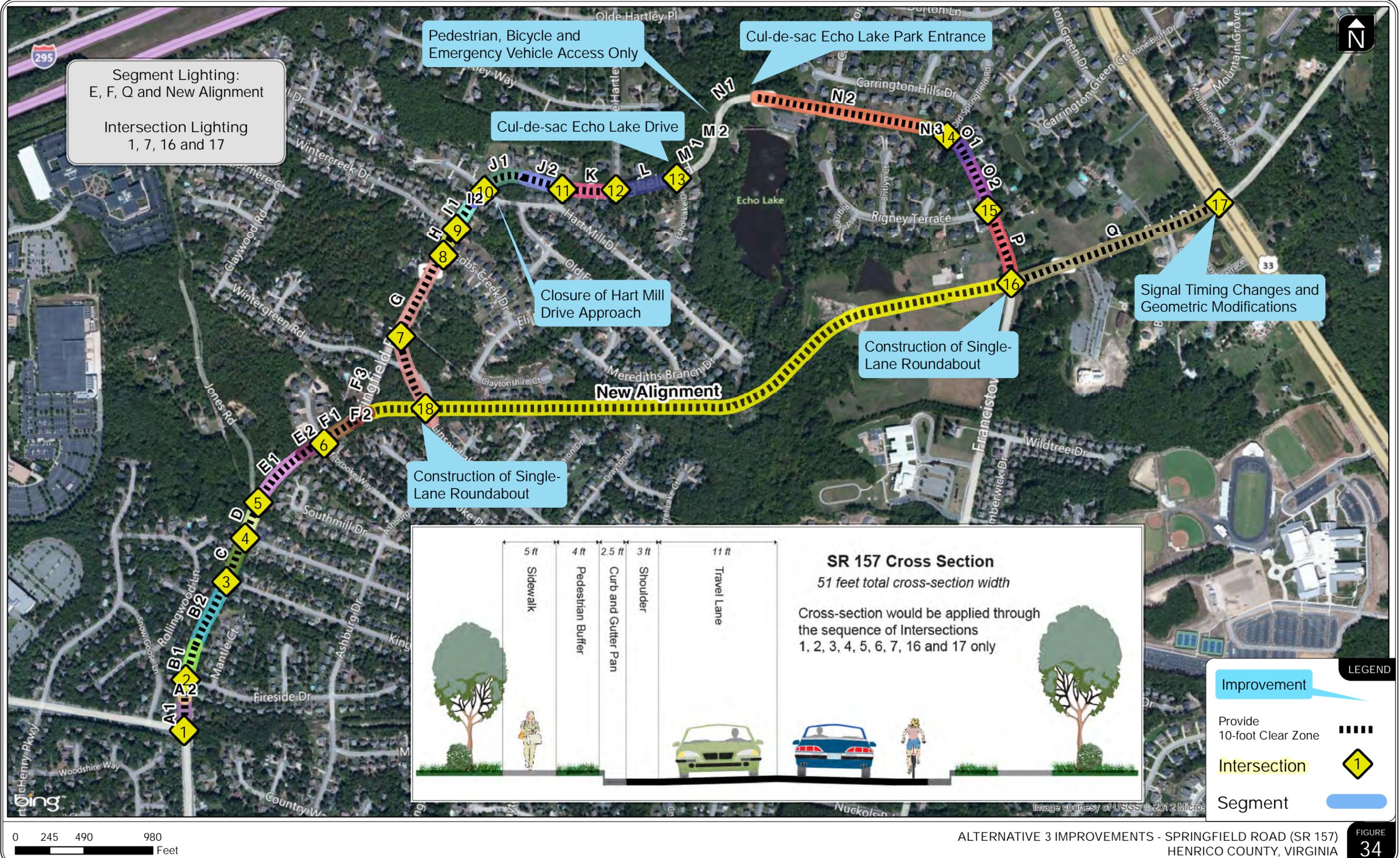
New SR 157 Alignment/Cross-Section

- Construct a roadway cross-section (51 feet wide) along the new alignment of SR 157 that includes:
 - 11-foot travel lanes
 - 3-foot paved shoulders
 - 2.5-foot gutter pan and curb (2-foot wide gutter pan, 6-inch wide curb)
 - 4-foot buffer
 - 5-foot sidewalks
- Provision of a 10-foot clear zone throughout the improved corridor
- Provision of intersection lighting at the following intersections:
 - SR 157/Nuckols Road (existing traffic signal)
 - SR 157/Linsey Lake Drive (new single-lane roundabout)
 - SR 157/Francistown Road (new single-lane roundabout)
 - SR 157/Staples Mill Road (modified traffic signal)
- Provision of segment lighting on the following segments:
 - Wendhurst Drive to Olde Millbrooke Way (Segment E)
 - Olde Millbrook Way to Linsey Lakes Drive (Segment F)
- Provision of signal timing changes and geometric modifications at the SR 157/Staples Mill Road intersection
- Construction of a single-lane roundabout at the SR 157/Linsey Lakes Drive intersection
- Construction of a single-lane roundabout at the SR 157/Francistown Road intersection

Existing SR 157 Alignment (Linsey Lakes Drive to Echo Lake Drive & Echo Lake Park to Francistown Road)

- Provision of segment lighting on the following segments:
 - Francistown Road to Staples Mill Road (Segment Q)
- Closure of the Hart Mill Drive approach to SR 157
- Eliminate through traffic on SR 157 between Echo Lake Drive and Echo Lake Park (Segments M, N) while continuing to provide for pedestrian, bicycle, and emergency vehicle access.

Assumed improvements for Alternative 3 are illustrated in **Figure 34**. Details regarding the analysis and selection of these improvements are provided below.



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Alternative 3 West-End Intersection Configuration Options

While cul-de-sacing existing Springfield Road at Echo Lake will result in some localized trip rerouting, the overall operational impact of this rerouting at the endpoints of the new alignment is negligible. As such, the overall intersection configuration (Option A) and assumed roundabout control identified in Alternative 2 at the newly formed SR 157/Linsey Lakes Drive and SR 157/Francistown Road intersections are also assumed for Alternative 3.

Alternative 3 Operations Analysis

Alternative 3 would develop a partial new alignment for SR 157 within the study area. The new alignment would begin just north of Olde Milbrooke Way and extend eastward approximately 1.5 miles to the SR 157/Francistown Road intersection. In addition, existing Springfield Road would be severed in the vicinity of Echo Lake Park, essentially creating two cul-de-sacs at Echo Lake Drive on the west side, and Echo Lake Park on the east side.

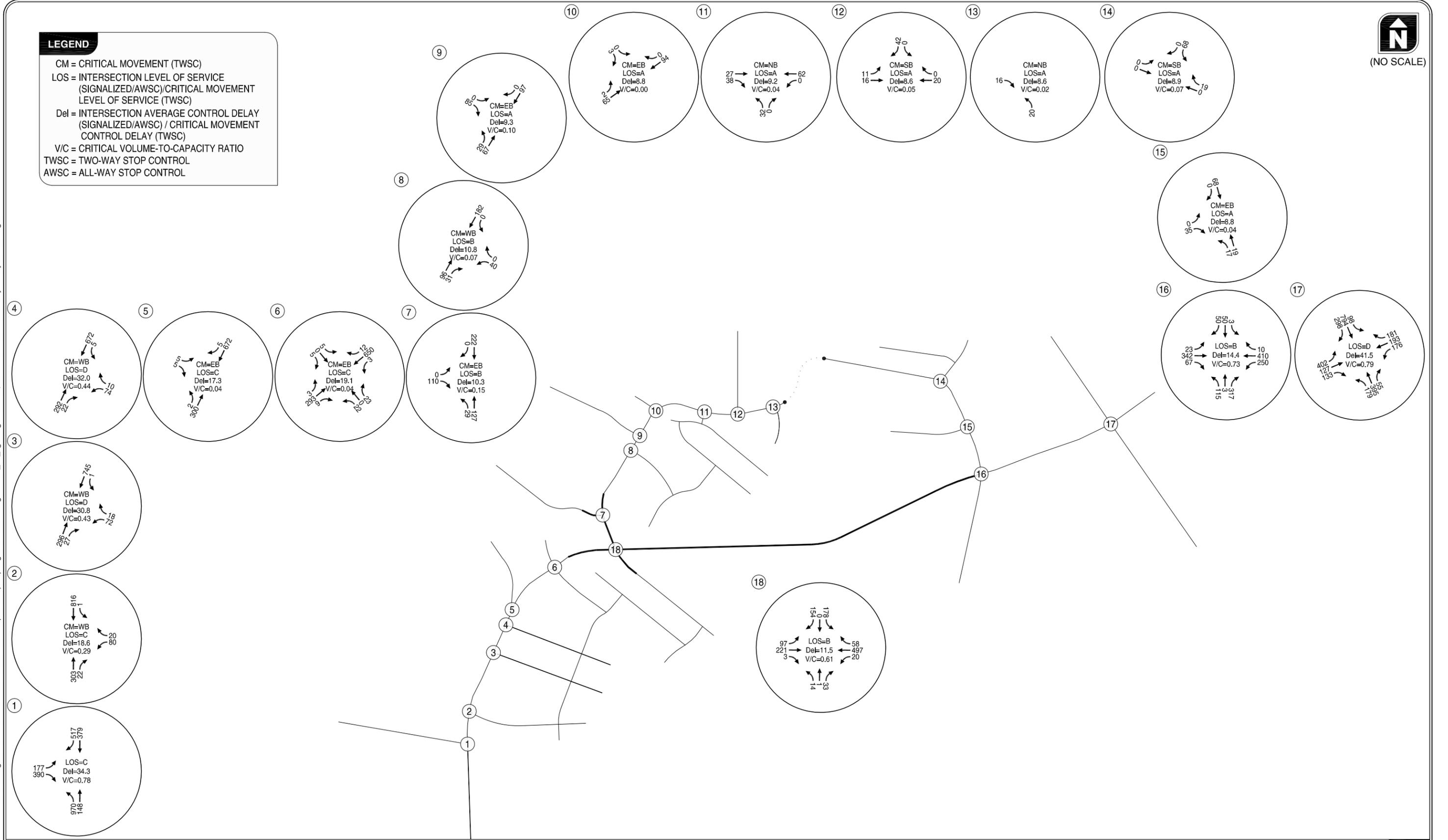
Figure 35 and **Figure 36** show the forecast traffic volumes and traffic operations for the Alternative 3 scenario. **Figure 37** and **Figure 38** show the lane group level of service results. **Table 23** summarizes the operational results. **Appendix O** contains the Alternative 3 operational analysis worksheets.



(NO SCALE)

LEGEND

CM = CRITICAL MOVEMENT (TWSC)
 LOS = INTERSECTION LEVEL OF SERVICE (SIGNALIZED/AWSC)/CRITICAL MOVEMENT LEVEL OF SERVICE (TWSC)
 Del = INTERSECTION AVERAGE CONTROL DELAY (SIGNALIZED/AWSC) / CRITICAL MOVEMENT CONTROL DELAY (TWSC)
 V/C = CRITICAL VOLUME-TO-CAPACITY RATIO
 TWSC = TWO-WAY STOP CONTROL
 AWSC = ALL-WAY STOP CONTROL



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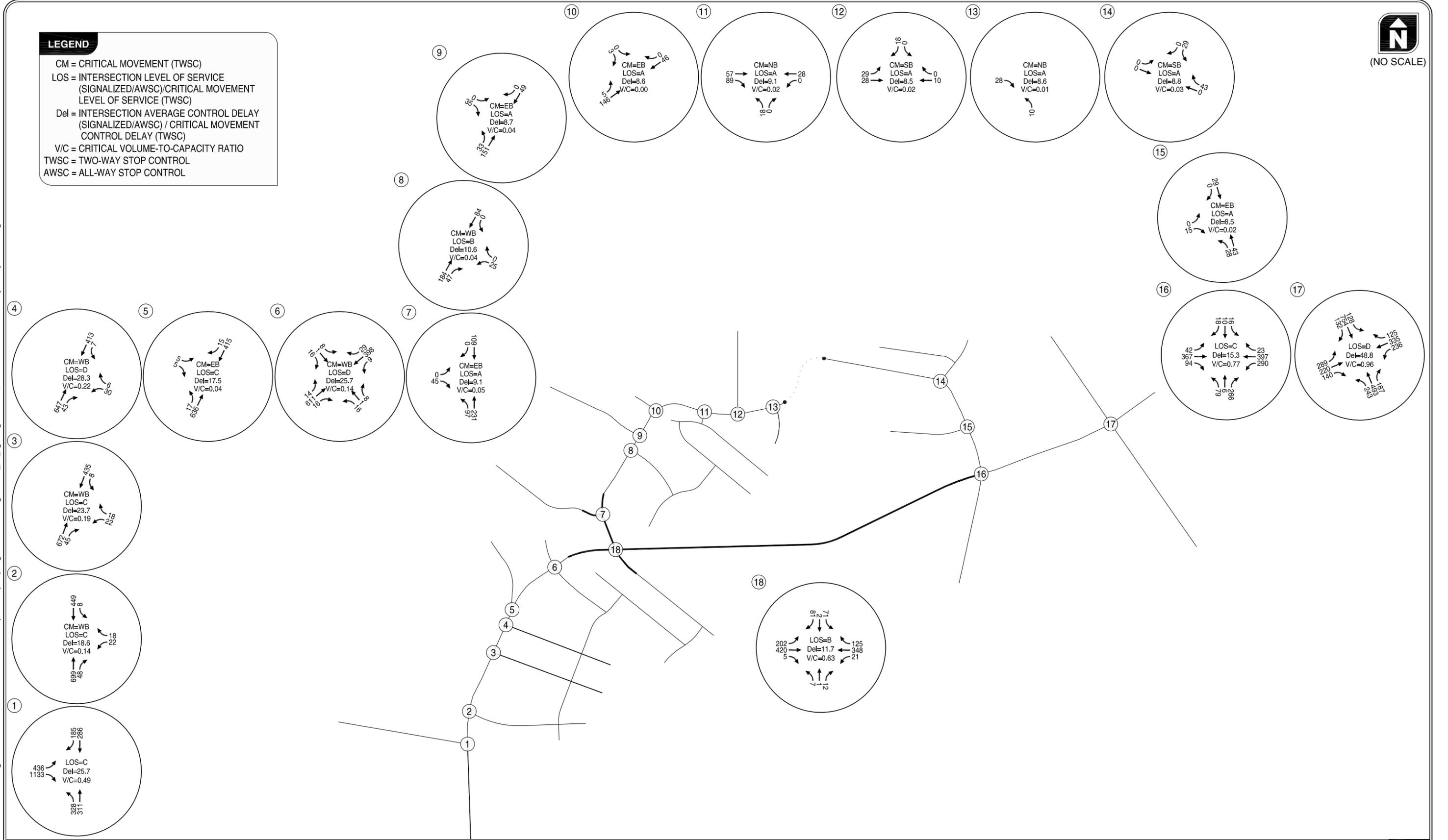
ALTERNATIVE 3 TRAFFIC CONDITIONS
WEEKDAY AM PEAK HOUR
HENRICO COUNTY, VIRGINIA



(NO SCALE)

LEGEND

CM = CRITICAL MOVEMENT (TWSC)
 LOS = INTERSECTION LEVEL OF SERVICE (SIGNALIZED/AWSC)/CRITICAL MOVEMENT LEVEL OF SERVICE (TWSC)
 Del = INTERSECTION AVERAGE CONTROL DELAY (SIGNALIZED/AWSC) / CRITICAL MOVEMENT CONTROL DELAY (TWSC)
 V/C = CRITICAL VOLUME-TO-CAPACITY RATIO
 TWSC = TWO-WAY STOP CONTROL
 AWSC = ALL-WAY STOP CONTROL



ALTERNATIVE 3 TRAFFIC CONDITIONS
WEEKDAY PM PEAK HOUR
HENRICO COUNTY, VIRGINIA

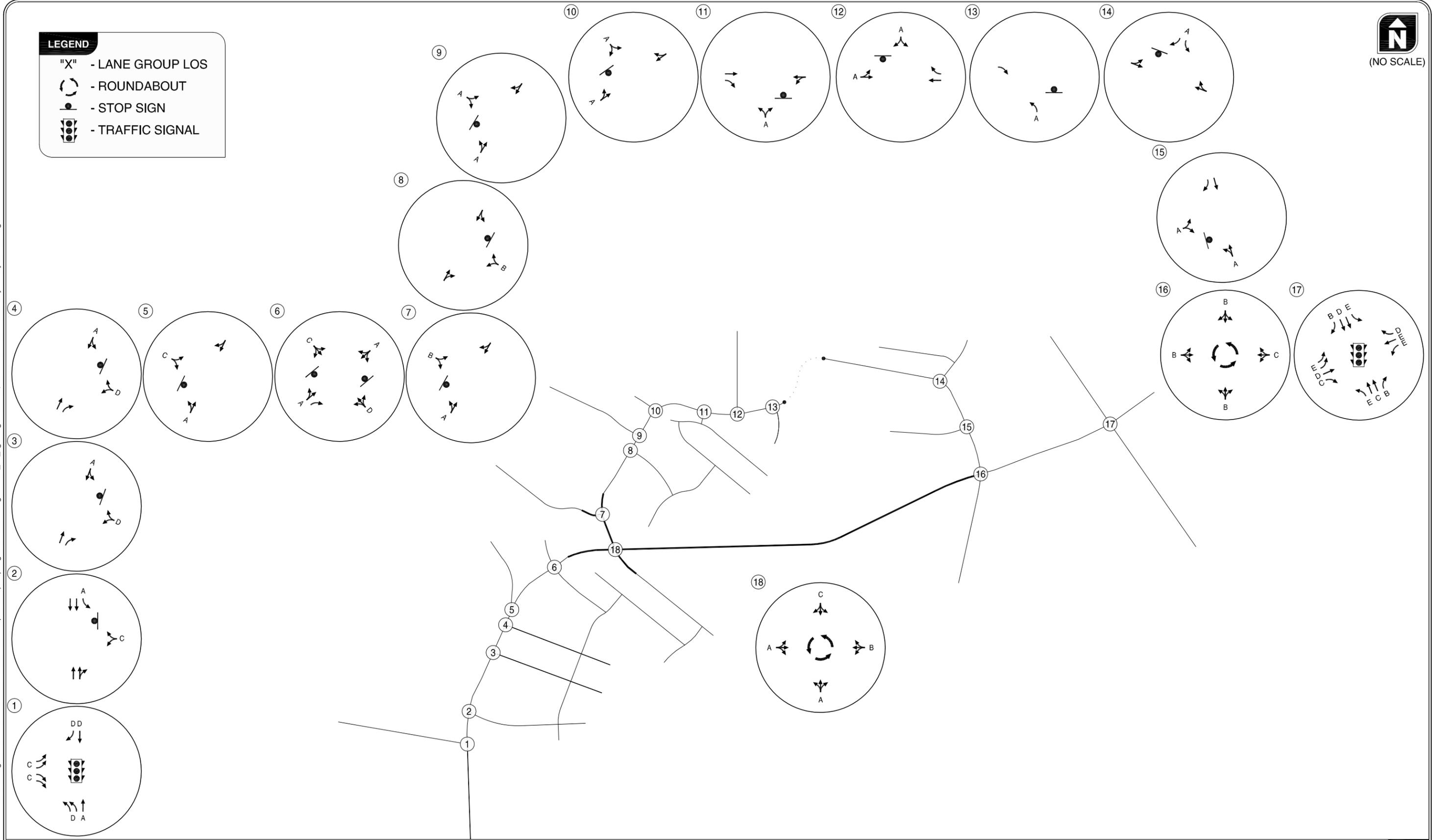
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LEGEND

- "X" - LANE GROUP LOS
- - ROUNDABOUT
- - STOP SIGN
- ⬆️⬆️⬆️ - TRAFFIC SIGNAL

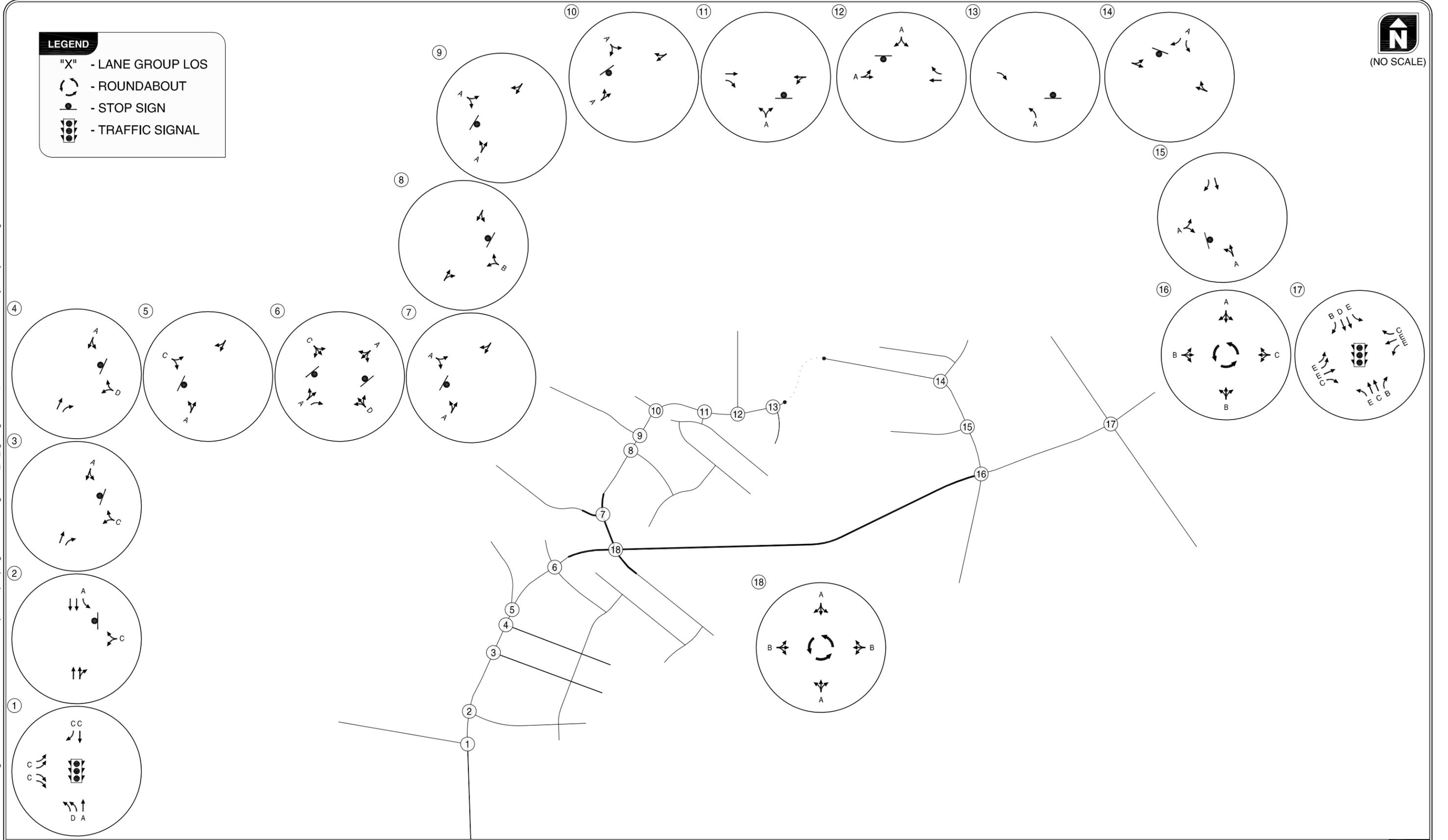


ALTERNATIVE 3 LANE GROUP LEVEL OF SERVICE
WEEKDAY AM PEAK HOUR
HENRICO COUNTY, VIRGINIA

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LEGEND

- "X" - LANE GROUP LOS
- ⊙ - ROUNDABOUT
- - STOP SIGN
- 🚦 - TRAFFIC SIGNAL



ALTERNATIVE 3 LANE GROUP LEVEL OF SERVICE
WEEKDAY PM PEAK HOUR
HENRICO COUNTY, VIRGINIA

Table 23 Levels of Service, 95th Percentile Back of Queue and Delay Results - Alternative 3 Year 2036 Traffic Conditions

Intersection Information					AM Peak Hour			PM Peak Hour			
Intersection	Traffic Control	Approach	Lane Group	Existing/ Proposed turn-lane lengths	LOS	Back of Queue (feet)	Delay (sec)	LOS	Back of Queue (feet)	Delay (sec)	
Nuckols Road & Springfield Road	Signalized	EB	EBL	275	C	65	28.9	C	154	27.3	
			EBR	175	C	35	28.1	C	50	27	
		EB Approach				C		28.4	C		27.1
		NB	NBL	225	D	#406	38		D	132	37.6
			NBT		A	66	6.2		A	137	9.9
		NB Approach				C		33.8	C		24.1
		SB	SBT		D	#430	43.7		C	217	22.9
			SBR		D	169	35.1		C	47	23.9
		SB Approach				D		38.7	C		23.3
Overall LOS				C		34.3	C		25.7		
Fireside Drive & Springfield Road	Unsignalized	WB	WBLR		C	30	18.6	C	12	18.6	
			WB Approach			C		18.6	C		18.6
		NB	NBTR				0	0		0	0
			NB Approach						0		0
		SB	SBL		A	0	8		A	1	9.5
			SBT				0	0		0	0
		SB Approach						0			0.2
Overall LOS				A		1.5	A		0.7		
Kingscroft Drive & Springfield Road	Unsignalized	WB	WBLR		D	51	30.8	C	17	23.7	
			WB Approach			D		30.8	C		23.7
		NB	NBT				0	0		0	0
			NBR				0	0		0	0
		NB Approach						0			0
		SB	SBLT		A	0	0		A	1	0.3
			SB Approach						0		0.3
Overall LOS				A		2.4	A		0.9		
Wendhurst Drive & Springfield Road	Unsignalized	WB	WBLR		D	51	32	D	20	28.3	
			WB Approach			D		32	D		28.3
		NB	NBT				0	0		0	0
			NBR				0	0		0	0
		NB Approach						0			0
		SB	SBLT		A	0	0.1		A	1	0.3
			SB Approach					0.1			0.3
Overall LOS				A		2.6	A		1		
Jones Road & Springfield Road	Unsignalized	EB	EBLR		C	3	17.3	C	3	17.5	
			EB Approach			C		17.3	C		17.5
		NB	NBLT		A	0	0.1		A	1	0.5
			NB Approach					0.1			0.5
		SB	SBTR				0	0		0	0
			SB Approach					0			0
Overall LOS				A		0.2	B		0.4		
Olde Milbrooke Way & Springfield Road	Unsignalized	EB	EBLTR		C	3	19.1	C	7	17.6	
			EB Approach			C		19.1	C		17.6
		WB	WBLTR		C	14	18.4		D	12	25.7
			WB Approach			C		18.4	D		25.7
		NB	NBLT		A	0	0.1		A	1	0.4
			NBR				0	0		0	0
		NB Approach						0.1			0.4
		SB	SBLTR		A	0	0.1		A	1	0.3
SB Approach						0.1			0.3		
Overall LOS				A		1.1	A		1.3		
Wintergreen Road &	Unsignalized	EB	EBLR		B	13	10.3	A	4	9.1	
			EB Approach			B		10.3	A		9.1

Intersection Information					AM Peak Hour			PM Peak Hour		
Intersection	Traffic Control	Approach	Lane Group	Existing/ Proposed turn-lane lengths	LOS	Back of Queue (feet)	Delay (sec)	LOS	Back of Queue (feet)	Delay (sec)
Springfield Road		NB	NBLT		A	2	1.6	A	6	2.7
		NB Approach					1.6			2.7
		SB	SBTR			0	0		0	0
		SB Approach					0			0
		Overall LOS				A		2.8	A	
Jacobs Creek Drive & Springfield Road	Unsignalized	WB	WBLR		B	5	10.8	B	3	10.6
		WB Approach			B		10.8	B		10.6
		NB	NBTR			0	0		0	0
		NB Approach					0			0
		SB	SBLT			0	0		0	0
		SB Approach					0			0
		Overall LOS				A		1.2	A	
Wintercreek Drive & Springfield Road	Unsignalized	EB	EBLR		A	9	9.3	A	3	8.7
		EB Approach			A		9.3	A		8.7
		NB	NBLT		A	2	2.4	A	2	1.5
		NB Approach					2.4			1.5
		SB	SBTR			0	0		0	0
		SB Approach					0			0
Warnerwood Ct & Springfield Road	Unsignalized	EB	EBLR		A	0	8.8	A	0	8.6
		EB Approach			A		8.8	A		8.6
		NB	NBLT		A	0	0.2	A	0	0.3
		NB Approach					0.2			0.3
		SB	SBTR			0	0		0	0
		SB Approach					0			0
Springfield Road & Bernard Mills Drive	Unsignalized	EB	EBT			0	0		0	0
			EBR			0	0		0	0
		EB Approach					0			0
		WB	WBLT			0	0		0	0
		WB Approach					0			0
		NB	NBLR		A	3	9.2	A	2	9.1
Springfield Road & Olde Hartley Drive	Unsignalized	NB Approach			A		9.2	A		9.1
		Overall LOS			A		1.8	A		0.8
		EB	EBLT		A	1	3	A	2	3.8
		EB Approach					3			3.8
		WB	WBT			0	0		0	0
			WBR			0	0		0	0
Springfield Road & Echo Lake Drive	Unsignalized	WB Approach				0			0	
		SB	SBLR		A	4	8.6	A	1	8.5
		SB Approach			A		8.6	A		8.5
		Overall LOS			A		5	A		4.3
		EB	EBTR			0	0		0	0
		EB Approach					0			0
Springfield Road & Old Springfield Road	Unsignalized	WB	WBLT			0	0		0	0
		WB Approach					0			0
		NB	NBLR		A	2	8.6	A	1	8.6
		NB Approach			A		8.6	A		8.6
		Overall LOS			A		4.8	A		2.3
		EB	EBLT			0	0		0	0
EB Approach					0			0		
Springfield Road & Old Springfield Road	Unsignalized	WB	WBTR			0	0		0	0
		WB Approach					0			0
		SB	SBL		A	6	8.9	A	2	8.8
		SB Approach			A		8.9	A		8.8

Intersection Information					AM Peak Hour			PM Peak Hour			
Intersection	Traffic Control	Approach	Lane Group	Existing/ Proposed turn-lane lengths	LOS	Back of Queue (feet)	Delay (sec)	LOS	Back of Queue (feet)	Delay (sec)	
		Overall LOS			A		6.9	A		3.6	
Rigney Terrace & Springfield Road	Unsignalized	EB	EBLR		A	3	8.8	A	1	8.5	
		EB Approach			A		8.8	A		8.5	
		NB	NBLT		A	1	3.5	A	1	3	
		NB Approach					3.5			3	
		SB	SBT				0	0		0	0
			SBR				0	0		0	0
		SB Approach						0			0
Overall LOS					A		3.1	A		2.9	
Springfield Road & Francistown Road	Roundabout	EB	EBLTR		B	55.5	10.7	B	78.7	12.9	
		WB	WBLTR		C	185.5	17.0	C	214.3	18.4	
		NB	NBLTR		B	102.2	15.0	B	72.7	13.1	
		SB	SBLTR		B	19.3	10.7	A	7.7	8.6	
		Overall LOS					B		14.4	C	
Springfield Road & Staples Mill Road	Signalized	EB	EBL	200	E	#223	58.8	E	165	56.3	
			EBT		D	163	48.4	E	#285	57.8	
			EBR	575	C	59	32.3	C	84	29	
		EB Approach				D		51.5	D		50.9
		WB	WBL	350	E	212	58.3	E	#316	69.1	
			WBT		E	#237	61.8	E	#445	73	
			WBR	150	D	70	36.8	C	62	29.3	
		WB Approach				D		52.4	E		63.8
		NB	NBL	350	E	#231	67.1	E	#334	74.5	
			NBT		C	167	25.9	C	230	32.3	
			NBR	125	B	18	13.3	B	36	16.1	
		NB Approach				D		36.5	D		40.1
		SB	SBL	200	E	135	58.7	E	165	59.1	
			SBT		D	387	36.4	D	#393	46.4	
			SBR	75	B	113	17.8	C	68	22.8	
SB Approach				C		33.6	D		45		
Overall LOS					D			D			
Springfield Road & Linsey Lakes Drive	Roundabout	EB	EBLTR		A	29.9	7.5	B	90.3	12.4	
		WB	WBLTR		B	109.5	12.2	B	96.8	12.4	
		NB	NBLTR		A	6.5	6.3	A	3.2	7.2	
		SB	SBLTR		C	77.1	15.1	A	20.6	7.2	
		Overall LOS					B		11.5	B	

*The '#' indicates 95th percentile volume exceeds capacity queue may be longer and the queue shown is the maximum after two cycles.

Alternative 3 Countermeasure Analysis

Recommendations from VDOT's Roadside Design Manual and AASHTO's *Policy on Geometric Design of Highways and Streets* were used as a starting point to identify potential improvements in Alternative 3. Potential changes in crashes associated with each countermeasure were calculated using procedures in the HSM. If a standard error was given, a range of crash reductions is shown. This analysis was completed using forecast design year 2036 traffic volumes. Each countermeasure was analyzed independent of the other countermeasures. **Table 24** summarizes the selected Alternative 3 countermeasures, area(s) where the countermeasure were assumed, and the predicted reduction in total average annual crashes.

Table 24 Alternative 3 Intersection Countermeasure Analysis Results

Countermeasure	Applicable Segment/Intersection	Predicted Percent Change ¹		
		Total Crashes by Segment/Intersection		
		Low	High	Expected
<i>Segment</i>				
Install segment lighting	E, F, Q	N/A ²	N/A	7% Reduction
Create 10ft clear zone ³	All (except M, N)	6% Reduction	18% Reduction	N/A
Reduce AADT on segment ⁴	G, H, I, J, K, L, M, N, O, P	N/A	N/A	72-100% Reduction
<i>Intersection</i>				
Lighting in intersection	1, 7, 16, 17	N/A	N/A	9% Reduction
Retime signal and change intervals to ITE standards	17	10% Increase ⁵	34% Reduction	N/A
Covert four-leg intersection to three-leg intersection	10	N/A	N/A	60% Reduction
Convert two-way stop-controlled intersection into roundabout	7, 16	29% Reduction	49% Reduction	N/A
Reduce AADT at intersection on major road segment	8, 9, 10, 11, 12, 13, 14, 15, 16	N/A	N/A	39% Increase ⁶ -95% Reduction

¹ Percentages were rounded to the nearest whole number

² N/A - Not Available

³ Development of a 10-foot clear zone does are not exclusive countermeasures. Rather, it is one of many treatments used in achieving a roadside hazard rating of 3, which has its own crash modification factor. This treatment has been broken out individually for clarity.

⁴ Magnitude of reduction depends on the magnitude of the reduction in AADT. See Appendix P for details regarding each segment and intersection.

⁵ The standard error from the clearinghouse for this countermeasure is large enough to result in a calculated potential increase in crashes. Still, applying proper signal timing to an intersection is more likely to reduce crashes than result in an increase.

⁶ Alternative 3 results in additional traffic volumes at intersection 16, which actually increase the theoretical expected crash potential at this one location.

HSM Analysis Summary

Table 25 compares the HSM-predicted total average annual crashes for the no-build scenario and Alternative 3. Because VDOT has no available calibration factors, the numbers shown below can only be used in a relative manner to compare between scenarios. The actual numbers shown below in the predicted ranges are neither accurate nor absolute for either scenario.

Table 25 Total Predicted Annual Crashes: Alternative 3 vs. No-Build Scenario

Alternative	Total Predicted Annual Crashes
No-Build	19.37
Alternative 3	15.40
Percent Reduction	20%

As shown in Table 25, the identified countermeasures implemented in Alternative 3 would result in a predicted reduction of 20 percent within the study limits as compared to the no-build scenario.

Alternative 3 is predicted to be slightly less successful in reducing crashes as compared to Alternative 2, though both alternatives are estimated to substantially reduce crashes relative to the no-build scenario. Disconnecting the existing SR 157 alignment at Echo Lake through the construction of cul-de-sacs reduce traffic volumes on remaining portions of the alignment between Linsey Lakes Drive and Francistown Road and has a beneficial effect. However, the resultant rerouting of local trips to the new alignment disproportionately increases the potential for crashes on the new SR 157 alignment, thus resulting in a small increase in predicted crashes (0.36 crashes per year).

Cost Benefit Analysis

A cost benefit analysis for crashes was conducted to compare Alternative 3 to the no-build scenario using crash-cost values contained in the year 2012 Highway Safety Improvement Program (HSIP) Federal Year (FY) 2012-2013 worksheet published by VDOT. Other factors such as environmental impacts, right-of-way, and design and construction costs are not included. The analysis results assume a 25-year service life.

Predicted crashes were allocated on the KABCO scale based on the statewide crash distribution pattern for rural undivided roads year 2008 data (most are 2 lane, some are 4 lane) provided by VDOT. The allocated crashes were multiplied by their respective cost and again by the assumed 25-year service life. The sum of these totals represents the total cost of all predicted crashes for each scenario. Again it is important to note that the dollar values presented here are not accurate or absolute, and are referenced exclusively for relative comparisons between scenarios. **Table 26** summarizes the comparative crash cost results between Alternative 3 and the no-build scenario.

Table 26 Cost Benefit Analysis: Alternative 3 vs. No-Build Scenario

Alternative	Total Cost of Crashes
No-Build	\$73,815,134
Alternative 3	\$59,121,295
Potential Savings	\$14,693,839

As shown in Table 26, Alternative 3 is estimated to save \$14.7 million compared to the no-build scenario over the assumed 25-year service life of the improvements.

Segments affected by the construction of a new alignment were isolated to compare the relative cost-benefit of improvements limited only to the sections of SR 157 impacted by the new alignment. Of the total \$14.7 million savings calculated for Alternative 2, roughly \$13.1 million (89 percent) is attributable to improvements to SR 157 between Linsey Lakes Road and Francistown Road. **Appendix P** contains the Alternative 3 HSM analysis worksheets and analysis details.

Alternative 3 - Preliminary Estimate of Probable Cost

A preliminary estimate of probable cost indicates Alternative 3 would cost approximately \$17.4 million. **Appendix Q** contains the Alternative 3 detailed cost estimate worksheet.

Section 5
Findings, Summary & Conclusion

FINDINGS

The following findings have been determined through our field evaluation and analysis of existing and future operational and safety performance of the Springfield Road (SR 157) corridor between Nuckols Road and Staples Mill Road.

EXISTING CONDITIONS

- All study intersections currently operate at VDOT standards (LOS D for signalized intersections/LOS E for unsignalized) or better during the weekday a.m. and p.m. peak hours except the following:
 - SR 157/Francistown Road: The critical westbound left-turn movement operates at LOS F during the weekday a.m. peak hour.
 - SR 157/Staples Mill Road: The intersection operates at capacity at LOS E during the weekday a.m. peak hour and LOS F during the weekday p.m. peak hour.
- All study intersections were found to meet or exceed AASHTO minimum guidelines for intersection sight distance except the Hart Mill Drive approach to SR 157.
- There are currently no bicycle facilities and virtually no pedestrian facilities within the study area, which is predominately residential in nature. There is a County park with recreational trails within the study area, and two nearby schools.
- Of the 17 basic study segments formed by local street intersections, five study segments currently meet or exceed both the minimum minor arterial spacing standard of 660 feet, four segments meet or exceed only the collector minimum spacing standard of 440 feet, and seven segments meet neither. Intersection spacing and the presence of private driveways between local streets does not appear to be a factor in the reported crashes; as such, no changes to existing intersection spacing are recommended.

Existing Safety Statistics

- Thirty-two crashes were reported within the study limits for the three-year period between 2008 and 2010.
- Of the 32 reported crashes:
 - 18 occurred between 12:00 p.m. and 5:00 p.m., consistent with higher vehicle volumes during the same time periods
 - 23 were Property Damage Only (PDO), 6 resulted in injury, and 3 fatalities were recorded
 - 16 were fixed-object crashes
 - 19 occurred outside of intersections

- The calculated crash rate on SR 157 (146 crashes per 100 million vehicle miles traveled) is slightly lower than the reported statewide average (150 crashes per 100 million vehicle miles traveled); however, the statewide average aggregates all state facilities. Specific statistics for two-lane undivided facilities are not available.

Existing Conditions Highway Safety Manual (HSM) Analysis

- Intersections and segments were evaluated using Chapter 12 (Urban/Suburban Arterial) procedures in the HSM. The existing corridor also exhibits some roadway characteristics consistent with that of a rural road; as such, certain countermeasures from Chapter 10 (Rural Two Lane Roadways) were also considered.
- The following intersections and segments along the SR 157 study corridor were identified as having high crash frequencies:
 - Intersection
 - Nuckols Road
 - Wintergreen Road/ Linsey Lakes Drive
 - Francistown Road
 - Staples Mill Road
 - Segments:
 - Jones Road to Olde Milbrooke Way
 - Echo Lake Drive to Old Springfield Road
 - Francistown Road to Staple Mills Road
- The uncalibrated HSM analysis estimates 15.43 expected average annual crashes under existing conditions.

FUTURE NO-BUILD CONDITIONS

Year 2036 No-Build Operations

- All of the study intersections are forecast to continue to operate at LOS D or better during the weekday a.m. and p.m. peak hours except:
 - SR 157/Wintergreen Road/Linsey Lakes Drive: Eastbound approach is forecast to operate at LOS E during the weekday a.m. peak hour.
 - SR 157/Francistown Road: Westbound left-turn movement is forecast to operate at LOS F during both peak hours.
 - SR 157/Staples Mill Road: Operates over capacity at LOS F during both peak hours.
- Changes to existing right-turn treatments were identified at 11 of the 17 study intersections per Figure 3-26 in Appendix F of the VDOT Road Design Manual.

Right-Turn Treatment	SR 157 Cross-Street
Remove existing turn lane and taper	- Olde Milbrooke Way - Linsey Lakes Drive - Olde Hartley Drive
Remove existing taper	- Wintercreek Drive - Warnerwood Court
Reduce existing full turn lane to taper only	- Hart Mill Drive - Bernard Mills Drive - Rigney Terrace
Add a taper	- Wintergreen Road - Echo Lake Drive
Add a full turn lane and taper	- Jacobs Creek Drive

No-Build HSM Analysis

- The uncalibrated HSM analysis predicts 19.37 average annual crashes assuming no changes to the study corridor under design year 2036 no-build traffic conditions.

ALTERNATIVE 1

Alternative 1 Design Changes

Alternative 1 would modify the existing alignment of SR 157 to improve road safety and operations. A summary of improvements is listed below:

- Construct a roadway cross-section (51 feet wide) throughout study limits of SR 157 that includes:
 - 11-foot travel lanes
 - 3-foot paved shoulder
 - 2.5-foot gutter pan and curb (2-foot wide gutter pan, 6-inch wide curb)
 - 4-foot buffer
 - 5-foot sidewalks
- Install a single-lane roundabout at the SR 157/Francistown Road intersection
- Modify the SR 157/Staples Mill Road intersection as follows:
 - Eastbound Approach
 - Construct dual eastbound left-turn lanes with 300 feet of storage to accommodate forecast queues
 - Construct separate eastbound through and right-turn lanes
 - Westbound Approach
 - Construct separate left, through, and right-turn lanes
 - Operate westbound left-turns with protected phasing
 - Northbound Approach
 - Increase the northbound left-turn queue storage from 150 to 350 feet to accommodate forecast queues

- Signal phasing
 - Replace split phase EB/WB operation with protected left-turn phasing and provide right-turn overlap phasing on all approaches
- Eliminate the Hart Mill Drive approach to SR 157 (use adjacent Bernard Mills Drive access) due to sight distance limitations.
- Realign SR 157 between Olde Hartley Drive and the Echo Lake County Park parking area to increase horizontal curve radii in this segment

Alternative 1 Operations

- All of the study intersections are forecast to operate at LOS D or better during the future year 2036 weekday a.m. and p.m. peak hours assuming provision of the Alternative 1 improvements.

Alternative 1 HSM Safety Analysis

- Alternative 1 was evaluated using Chapter 12 (Urban/Suburban Arterial) procedures in the HSM.
- Alternative 1 is anticipated to result in an eight percent reduction in crashes relative to the no-build scenario.
- Alternative 1 is estimated to save \$6.5 million compared to the no-build scenario over the assumed 25-year service life of the improvements.
 - Roughly 75 percent of the cost savings (\$4.9M) is attributable to improvements to SR 157 between Linsey Lakes Road and Francistown Road.

Alternative 1 Cost Estimate

- A preliminary estimate of probable cost indicates Alternative 1 would cost approximately \$12.3 million to design and construct.

ALTERNATIVE 2

Alternative 2 Design Changes

Alternative 2 involves the partial realignment of SR 157 north of SR 157/Linsey Lake Drive, creating a new east-west road to connect to the existing SR 157/Francistown Road intersection. Approximately 1.5 miles of new road would be constructed.

Alternative 2 would result in a change in traffic patterns through the network. The component of through traffic currently traveling along the existing Springfield Road alignment would use the new road alignment, leaving only local residential traffic on SR 157 between the point at which the new alignment begins and the SR 157/Francistown Road intersection. A summary of improvements is listed below:

- Realign the northern portion of existing Springfield Road at the western end of the new alignment to intersect the new alignment directly across from Linsey Lakes Drive. A portion of existing Linsey Lakes Drive would be removed to accommodate the realignment, and Wintergreen Road would also be slightly modified.
 - Construct a roadway cross-section (51 feet wide) throughout study limits **except** on the existing section of SR 157 that would serve only local residential traffic (between Linsey Lake Drive and Francistown Road). The cross-section would include:
 - 11-foot travel lanes
 - 3-foot paved shoulder (bike lane)
 - 2.5-foot gutter pan and curb (2-foot wide gutter pan, 6-inch wide curb)
 - 4-foot buffer
 - 5-foot sidewalks
 - The portion of existing Springfield Road between Linsey Lake Drive and Francistown Road does not include wholesale cross-sectional improvements but does include strategic spot improvements.
- Install single-lane roundabouts at the SR 157/Wintergreen Road/Linsey Lakes Drive and SR 157/Francistown Road intersections.
- Modify the SR 157/Staples Mill Road intersection as described in Alternative 1.
- Eliminate the Hart Mill Drive approach to SR 157 (use adjacent Bernard Mills Drive access) due to sight distance limitations.
- Realign SR 157 between Olde Hartley Drive and the Echo Lake County Park parking area to increase horizontal curve radii in this segment.

Alternative 2 Operations

- Of the roughly 10,000 Average Daily Traffic (ADT) volumes forecast to be using the Springfield Road corridor in year 2036, approximately 60 percent are anticipated to divert to the new alignment of SR 157.
- All of the study intersections are forecast to operate at LOS D or better during the future year 2036 weekday a.m. and p.m. peak hours assuming provision of the Alternative 2 improvements.

Alternative 2 HSM Safety Analysis

- Alternative 2 was also evaluated using Chapter 12 (Urban/Suburban Arterial) procedures in the HSM.
- Alternative 2 is anticipated to result in an 22 percent reduction in crashes relative to the no-build scenario.
- Alternative 2 is estimated to save \$16.5 million compared to the no-build scenario over the assumed 25-year service life of the improvements.

- Roughly 86 percent of the cost savings (\$14.2M) is attributable to improvements to SR 157 between Linsey Lakes Road and Francistown Road.

Alternative 2 Cost Estimate

- A preliminary estimate of probable cost indicates Alternative 2 would cost approximately \$18.3 million to design and construct.

ALTERNATIVE 3

Alternative 3 Design Changes

Alternative 3 also involves the partial realignment of SR 157 north of SR 157/Linsey Lake Drive, creating a new east-west road to connect to the existing SR 157/Francistown Road intersection. Approximately 1.5 miles of new road would be constructed. In addition, existing Springfield Road would be severed in the vicinity of Echo Lake Park, essentially creating two cul-de-sacs at Echo Lake Drive on the west side, and Echo Lake Park on the east side. A service road connection would still be maintained through the abandoned horizontal curve section of road between these two endpoints, still allowing for pedestrian, bicycle, and emergency vehicle movements.

A summary of improvements is listed below:

- Realign the northern portion of existing Springfield Road at the western end of the new alignment to intersect the new alignment directly across from Linsey Lakes Drive. A portion of existing Linsey Lakes Drive would be removed to accommodate the realignment, and Wintergreen Road would also be slightly modified.
- Abandon the section of Springfield Road between Echo Lake Drive and Echo Lake Park, effectively creating two cul-de-sacs. A service road connection would still be maintained through the abandoned sections, allowing for pedestrian, bicycle, and emergency vehicle movements.
 - Construct a roadway cross-section (51 feet wide) throughout study limits **except** on the existing section of SR 157 that would serve only local residential traffic (between Linsey Lake Drive and Francistown Road). The cross-section would include:
 - 11-foot travel lanes
 - 3-foot paved shoulder (bike lane)
 - 2.5-foot gutter pan and curb (2-foot wide gutter pan, 6-inch wide curb)
 - 4-foot buffer
 - 5-foot sidewalks
 - The portion of existing Springfield Road between Linsey Lake Drive and Francistown Road does not include wholesale cross-sectional improvements but does include strategic spot improvements.

- Install single-lane roundabouts at the SR 157/Wintergreen Road/Linsey Lakes Drive and SR 157/Francistown Road intersections.
- Modify the SR 157/Staples Mill Road intersection as described in Alternative 1.
- Eliminate the Hart Mill Drive approach to SR 157 (use adjacent Bernard Mills Drive access) due to sight distance limitations.
- Disconnect SR 157 between Echo Lake Drive and the Echo Lake County Park parking area to provide only pedestrian, bicycle, and emergency vehicle access.

Alternative 3 Operations

- Of the roughly 10,000 Average Daily Traffic (ADT) volumes forecast to be using the Springfield Road corridor in year 2036, approximately 75 percent are anticipated to divert to the new alignment of SR 157 under Alternative 3.
 - Disconnecting the existing Springfield Road alignment between Echo Lake Drive and Echo Lake Park will also introduce localized travel pattern changes for residents along Springfield Road, adding an additional 1,500 ADT to the new alignment of SR 157.
- All of the study intersections are forecast to operate at LOS D or better during the future year 2036 weekday a.m. and p.m. peak hours assuming provision of the Alternative 3 improvements.

Alternative 3 HSM Safety Analysis

- Alternative 3 was also evaluated using Chapter 12 (Urban/Suburban Arterial) procedures in the HSM.
- Alternative 3 is anticipated to result in a 20 percent reduction in crashes relative to the no-build scenario.
- Alternative 3 is estimated to save \$14.7 million compared to the no-build scenario over the assumed 25-year service life of the improvements.
 - Roughly 89 percent of the cost savings (\$13.1M) is attributable to improvements to SR 157 between Linsey Lakes Road and Francistown Road.

Alternative 3 Cost Estimate

- A preliminary estimate of probable cost indicates Alternative 3 would cost approximately \$17.4 million to design and construct.

SUMMARY

Generalized findings are summarized below based on the analyses contained in this report.

- A majority of study intersections operate at LOS D or better today, and are forecast to continue to do so under design year 2036 traffic conditions.

- Single-lane roundabouts are the preferred intersection control form (operations and safety) at the SR 157/Linsey Lakes Drive and SR 157/Francistown Road intersections for all Alternatives as compared to all-way stop control and traffic signal control.
- The identified corridor cross-section and 40 mph design speed are consistent with Urban Minor Arterial functional classifications as noted in Table GS-5 of the VDOT Road Design Manual.
- The following design changes should be considered under all alternatives (unless otherwise noted) to address identified operational and safety issues:
 - Construct turn lane improvements and make signal timing modifications at the SR 157/Staples Mill Road intersection to allow the intersection to operate at LOS D or better under design year 2036 traffic conditions
 - Eliminate the Hart Mill Drive approach to SR 157 (use adjacent Bernard Mills Drive access) due to sight distance limitations
 - Realign SR 157 between Olde Hartley Drive and the Echo Lake County Park parking area to increase horizontal curve radii in this segment (Alternative 1 & 2 only)
- Alternatives 2 and 3 both involve the construction of a new 1.5-mile two-lane roadway between Lindsey Lakes Drive and Francistown Road.
 - Under Alternative 2, the new roadway connection is anticipated to carry approximately 6,000 vehicles per day in the design year 2036, shifting 60 percent of traffic off of the existing SF 157 alignment between the two endpoints of the new alignment.
 - Under Alternative 3, local trip rerouting due to the closure of the existing SR 157 alignment to through traffic at Echo Lake will shift even more vehicles to the new alignment – approximately 7,500 vehicles per day in the design year 2036.
- Alternative 2 is estimated to result in the greatest reduction of average annual crashes (22 percent reduction) within the SR 157 study corridor as compared to the no-build condition.
 - Alternative 3 is estimated to result in a 20 percent reduction
 - Alternative 1 is estimated to result in an eight percent reduction
- Alternative 2 is estimated to result in the greatest overall cost benefit (\$16.5M) compared to the no-build scenario over the assumed 25-year service life of the improvements.
 - Alternative 3 results in a \$14.7M cost benefit
 - Alternative 1 results in a \$6.5M cost benefit
- Alternative 3 results in the greatest cost-benefit percentage (89 percent) when isolating improvements attributable to segments of SR 157 between Linsey Lakes Road and Francistown Road as compared to Alternative 2 (86 percent) and Alternative 1 (75 percent).
- Alternative 1 is the least expensive alternative, estimated to cost \$12.3M for design and construction.

The higher costs of Alternatives 2 and 3 (\$18.3M and \$17.4M, respectively) are primarily related to the costs of constructing a new 1.5-mile two-lane roadway between Lindsey Lakes Drive and Francistown Road.

CONCLUSION

The selected cross-sectional elements, intersection and segment treatments, and safety countermeasures for the corridor were selected with several factors in mind:

- Address anticipated future vehicular demand
- Accommodate bicyclists and pedestrians
- Address identified safety/operational issues
- Consider the current and future land use context of the corridor

The findings contained in this report allow for a relative comparison of predicted study corridor crashes between identified Alternatives and the no-build condition assuming provision of the identified treatments and safety countermeasures from both a safety and traffic operations perspective. Preliminary estimates of probable cost are also provided for comparative purposes.

HSM methods were applied to calculate the number of expected average annual crashes for existing and future scenarios. The expected average annual crashes are used in a relative manner to prioritize segments, intersections, and improvements. A relative cost benefit calculation for study alternatives has also been prepared focused exclusively on crashes; environmental impacts, right-of-way, and design and construction costs were not included. VDOT has not yet developed statewide calibration factors to adjust the generic HSM methods to specific VDOT facilities. If calibration factors were developed and applied, the expected average annual crashes could be calibrated to represent the specific long-term expected average number of crashes for each site and condition. Those specific crash estimate values could then be used more extensively in activities such as benefit/cost analysis. Without calibration factors, the HSM analysis results reported herein can be used *only* for relative comparisons.

We trust this report adequately documents an evaluation of alternative safety and operational improvements to Springfield Road (SR 157) between Nuckols Road and Staples Mill Road. Please contact us with any questions at (703) 885-8970.

Section 6
References

REFERENCES

1. Transportation Research Board. Highway Capacity Manual. 2000.
2. American Association of State Highway Transportation Officials (AASHTO). *A Policy on Geometric Design of Highways and Streets, 6th Edition*. 2010.
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www.cmfclearinghouse.org
7. Federal Highway Administration. *Manual on Uniform Traffic Control Devices (MUTCD)*. 2009.

Appendix A
Traffic Movement Counts

Davenport Transportation Consulting

305 West Fourth Street
Winston-Salem, NC 27101
(336) 744-1636

Counted By: R. Slade, M. Davenport

File Name : Nuckols Rd at Springfield Rd

Site Code : 00012317

Start Date : 3/27/2012

Page No : 1

Weather: Clear

Groups Printed- Cars - Trucks

Start Time	Springfield Rd Southbound					N/A Westbound					Springfield Rd Northbound					Nuckols Rd Eastbound					Exclu. Total	Inclu. Total	Int. Total
	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total			
07:00 AM	0	45	42	0	87	0	0	0	0	0	88	14	0	0	102	11	0	45	0	56	0	245	245
07:15 AM	0	67	74	0	141	0	0	0	0	0	145	20	0	0	165	16	0	69	0	85	0	391	391
07:30 AM	0	60	82	0	142	0	0	0	0	0	196	16	0	0	212	34	0	91	0	125	0	479	479
07:45 AM	0	51	101	0	152	0	0	0	0	0	280	31	0	0	311	34	0	87	0	121	0	584	584
Total	0	223	299	0	522	0	0	0	0	0	709	81	0	0	790	95	0	292	0	387	0	1699	1699
08:00 AM	0	64	92	0	156	0	0	0	0	0	273	24	0	0	297	24	0	96	1	120	1	573	574
08:15 AM	0	85	82	0	167	0	0	0	0	0	219	38	0	0	257	34	0	116	0	150	0	574	574
08:30 AM	0	60	56	0	116	0	0	0	0	0	194	22	0	0	216	30	0	95	0	125	0	457	457
08:45 AM	0	48	26	0	74	0	0	0	0	0	221	17	0	0	238	13	0	80	0	93	0	405	405
Total	0	257	256	0	513	0	0	0	0	0	907	101	0	0	1008	101	0	387	1	488	1	2009	2010
09:00 AM	0	38	49	0	87	0	0	0	0	0	147	17	0	0	164	12	0	68	0	80	0	331	331
09:15 AM	0	30	53	0	83	0	0	0	0	0	119	14	0	0	133	12	0	72	0	84	0	300	300
09:30 AM	0	32	29	0	61	0	0	0	0	0	114	18	0	0	132	13	0	62	0	75	0	268	268
09:45 AM	0	34	36	0	70	0	0	0	0	0	93	17	0	0	110	7	0	67	0	74	0	254	254
Total	0	134	167	0	301	0	0	0	0	0	473	66	0	0	539	44	0	269	0	313	0	1153	1153
10:00 AM	0	21	25	0	46	0	0	0	0	0	76	21	0	0	97	17	0	86	0	103	0	246	246
10:15 AM	0	27	27	0	54	0	0	0	0	0	63	26	0	0	89	14	0	73	0	87	0	230	230
10:30 AM	0	32	13	0	45	0	0	0	0	0	72	16	0	0	88	24	0	75	0	99	0	232	232
10:45 AM	0	25	19	0	44	0	0	0	0	0	96	18	0	0	114	15	0	74	0	89	0	247	247
Total	0	105	84	0	189	0	0	0	0	0	307	81	0	0	388	70	0	308	0	378	0	955	955
11:00 AM	0	32	22	0	54	0	0	0	0	0	90	22	0	0	112	15	0	101	0	116	0	282	282
11:15 AM	0	27	27	0	54	0	0	0	0	0	77	22	0	0	99	21	0	85	0	106	0	259	259
11:30 AM	0	42	28	0	70	0	0	0	0	0	90	23	0	0	113	27	0	137	0	164	0	347	347
11:45 AM	0	18	29	0	47	0	0	0	0	0	97	27	0	0	124	39	0	148	0	187	0	358	358
Total	0	119	106	0	225	0	0	0	0	0	354	94	0	0	448	102	0	471	0	573	0	1246	1246
12:00 PM	0	30	22	0	52	0	0	0	0	0	116	35	0	0	151	38	0	186	0	224	0	427	427
12:15 PM	0	32	31	0	63	0	0	0	0	0	102	31	0	0	133	61	0	183	0	244	0	440	440
12:30 PM	0	31	31	0	62	0	0	0	0	0	139	30	0	0	169	44	0	145	0	189	0	420	420
12:45 PM	0	32	42	0	74	0	0	0	0	0	180	34	0	0	214	31	0	128	0	159	0	447	447
Total	0	125	126	0	251	0	0	0	0	0	537	130	0	0	667	174	0	642	0	816	0	1734	1734
01:00 PM	0	22	39	0	61	0	0	0	0	0	148	33	0	0	181	28	0	109	0	137	0	379	379
01:15 PM	0	32	38	0	70	0	0	0	0	0	134	29	0	0	163	38	0	102	0	140	0	373	373
01:30 PM	0	37	37	0	74	0	0	0	0	0	139	40	0	0	179	28	0	104	0	132	0	385	385
01:45 PM	0	21	42	0	63	0	0	0	0	0	142	41	0	0	183	24	0	92	0	116	0	362	362
Total	0	112	156	0	268	0	0	0	0	0	563	143	0	0	706	118	0	407	0	525	0	1499	1499
02:00 PM	0	22	35	0	57	0	0	0	0	0	110	48	0	0	158	51	0	107	0	158	0	373	373
02:15 PM	0	34	38	0	72	0	0	0	0	0	116	43	0	0	159	53	0	99	0	152	0	383	383
02:30 PM	0	26	31	0	57	0	0	0	0	0	105	30	0	0	135	26	0	105	0	131	0	323	323
02:45 PM	0	36	33	0	69	0	0	0	0	0	120	27	0	0	147	29	0	79	0	108	0	324	324
Total	0	118	137	0	255	0	0	0	0	0	451	148	0	0	599	159	0	390	0	549	0	1403	1403
03:00 PM	0	31	27	0	58	0	0	0	0	0	116	48	0	0	164	35	0	121	0	156	0	378	378
03:15 PM	0	32	30	0	62	0	0	0	0	0	66	37	0	0	103	42	0	114	0	156	0	321	321
03:30 PM	0	21	32	0	53	0	0	0	0	0	79	43	0	0	122	43	0	113	1	156	1	331	332
03:45 PM	0	37	31	0	68	0	0	0	0	0	112	59	0	0	171	37	0	113	0	150	0	389	389
Total	0	121	120	0	241	0	0	0	0	0	373	187	0	0	560	157	0	461	1	618	1	1419	1420

Davenport Transportation Consulting

305 West Fourth Street
Winston-Salem, NC 27101
(336) 744-1636

Counted By: R. Slade, M. Davenport

File Name : Nuckols Rd at Springfield Rd
Site Code : 00012317
Start Date : 3/27/2012
Page No : 2

Weather: Clear

Groups Printed- Cars - Trucks

Start Time	Springfield Rd Southbound					N/A Westbound					Springfield Rd Northbound					Nuckols Rd Eastbound					Exclu. Total	Inclu. Total	Int. Total
	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total			
04:00 PM	0	37	46	0	83	0	0	0	0	0	104	61	0	0	165	69	0	149	0	218	0	466	466
04:15 PM	0	31	35	0	66	0	0	0	0	0	82	43	0	0	125	25	0	151	0	176	0	367	367
04:30 PM	0	36	38	0	74	0	0	0	0	0	84	38	0	0	122	62	0	208	0	270	0	466	466
04:45 PM	0	38	36	0	74	0	0	0	0	0	83	36	0	0	119	62	0	263	0	325	0	518	518
Total	0	142	155	0	297	0	0	0	0	0	353	178	0	0	531	218	0	771	0	989	0	1817	1817
05:00 PM	0	37	42	0	79	0	0	0	0	0	81	33	0	0	114	79	0	351	0	430	0	623	623
05:15 PM	0	52	34	0	86	0	0	0	0	0	85	44	0	0	129	82	0	306	0	388	0	603	603
05:30 PM	0	59	21	0	80	0	0	0	0	0	78	62	0	0	140	58	0	241	0	299	0	519	519
05:45 PM	0	50	32	0	82	0	0	0	0	0	84	37	0	0	121	85	0	235	0	320	0	523	523
Total	0	198	129	0	327	0	0	0	0	0	328	176	0	0	504	304	0	1133	0	1437	0	2268	2268
06:00 PM	0	43	52	0	95	0	0	0	0	0	99	59	0	0	158	72	0	190	0	262	0	515	515
06:15 PM	0	38	38	0	76	0	0	0	0	0	99	58	0	0	157	40	0	151	0	191	0	424	424
06:30 PM	0	42	43	0	85	0	0	0	0	0	75	41	0	0	116	40	0	153	0	193	0	394	394
06:45 PM	0	39	30	0	69	0	0	0	0	0	104	41	0	0	145	35	0	110	0	145	0	359	359
Total	0	162	163	0	325	0	0	0	0	0	377	199	0	0	576	187	0	604	0	791	0	1692	1692
Grand Total	0	1816	1898	0	3714	0	0	0	0	0	5732	1584	0	0	7316	1729	0	6135	2	7864	2	18894	18896
Apprch %	0	48.9	51.1			0	0	0			78.3	21.7	0			22	0	78					
Total %	0	9.6	10		19.7	0	0	0		0	30.3	8.4	0		38.7	9.2	0	32.5		41.6	0	100	
Cars	0	1781	1864		3645	0	0	0		0	5660	1539	0		7199	1698	0	6070		7770	0	0	18614
% Cars	0	98.1	98.2	0	98.1	0	0	0	0	0	98.7	97.2	0	0	98.4	98.2	0	98.9	100	98.8	0	0	98.5
Trucks	0	35	34		69	0	0	0		0	72	45	0		117	31	0	65		96	0	0	282
% Trucks	0	1.9	1.8	0	1.9	0	0	0	0	0	1.3	2.8	0	0	1.6	1.8	0	1.1	0	1.2	0	0	1.5

Davenport Transportation Consulting

305 West Fourth Street
Winston-Salem, NC 27101

(336) 744-1636

Counted By: R. Slade, M. Davenport

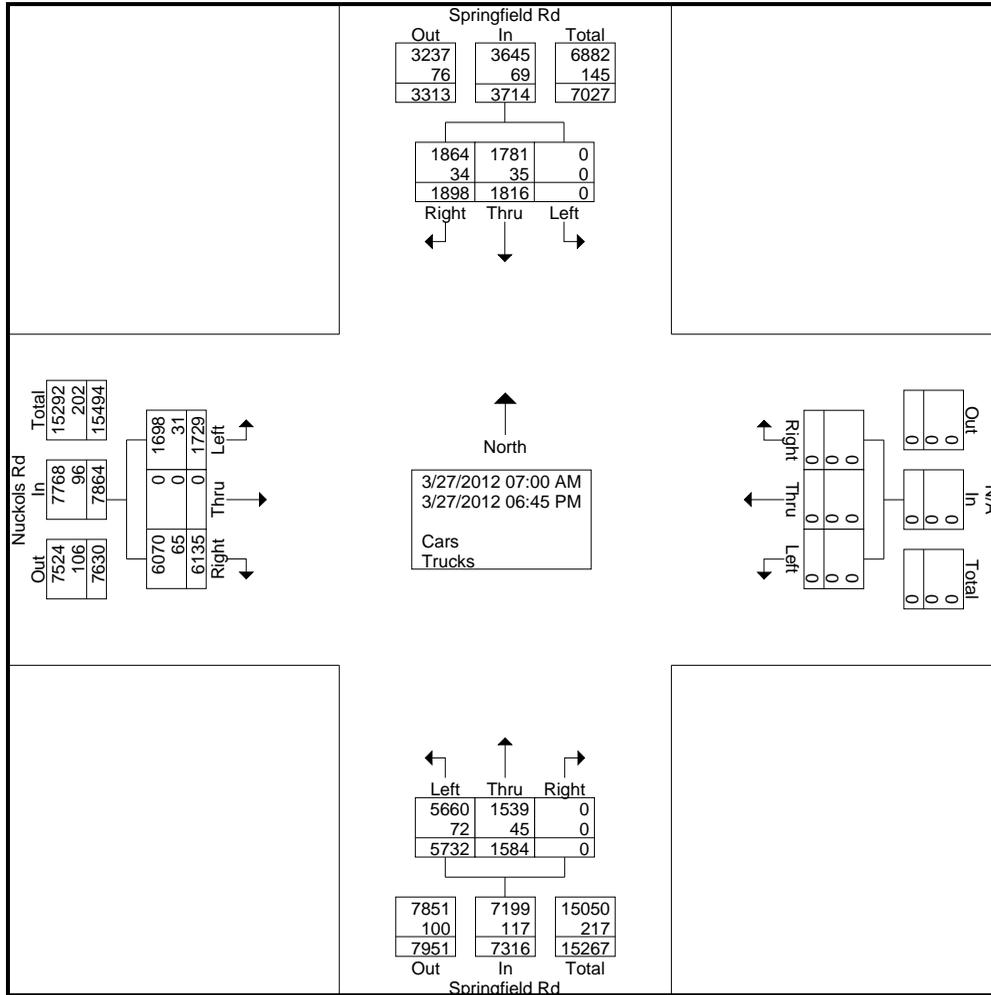
File Name : Nuckols Rd at Springfield Rd

Site Code : 00012317

Start Date : 3/27/2012

Page No : 3

Weather: Clear



Davenport Transportation Consulting

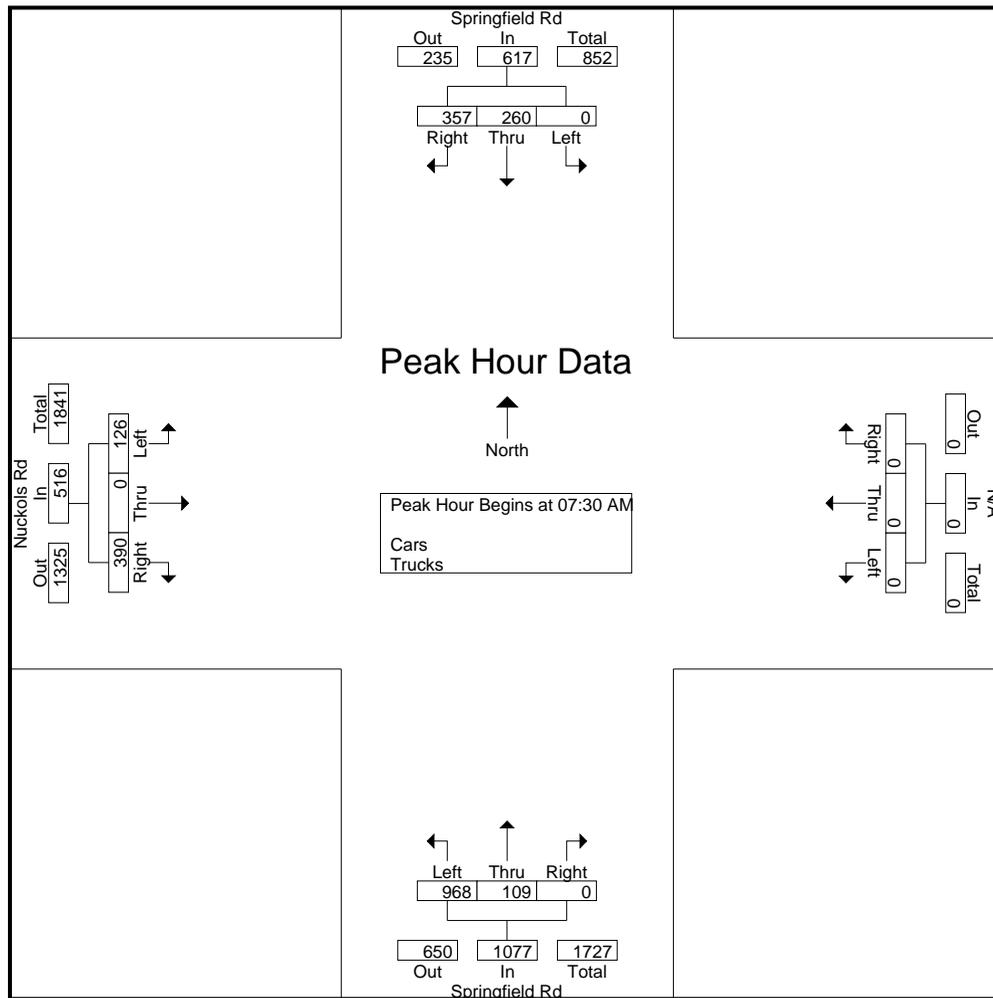
305 West Fourth Street
Winston-Salem, NC 27101
(336) 744-1636

Counted By: R. Slade, M. Davenport

File Name : Nuckols Rd at Springfield Rd
Site Code : 00012317
Start Date : 3/27/2012
Page No : 4

Weather: Clear

Start Time	Springfield Rd Southbound				N/A Westbound				Springfield Rd Northbound				Nuckols Rd Eastbound				Int. Total
	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 07:30 AM																	
07:30 AM	0	60	82	142	0	0	0	0	196	16	0	212	34	0	91	125	479
07:45 AM	0	51	101	152	0	0	0	0	280	31	0	311	34	0	87	121	584
08:00 AM	0	64	92	156	0	0	0	0	273	24	0	297	24	0	96	120	573
08:15 AM	0	85	82	167	0	0	0	0	219	38	0	257	34	0	116	150	574
Total Volume	0	260	357	617	0	0	0	0	968	109	0	1077	126	0	390	516	2210
% App. Total	0	42.1	57.9		0	0	0		89.9	10.1	0		24.4	0	75.6		
PHF	.000	.765	.884	.924	.000	.000	.000	.000	.864	.717	.000	.866	.926	.000	.841	.860	.946



Davenport Transportation Consulting

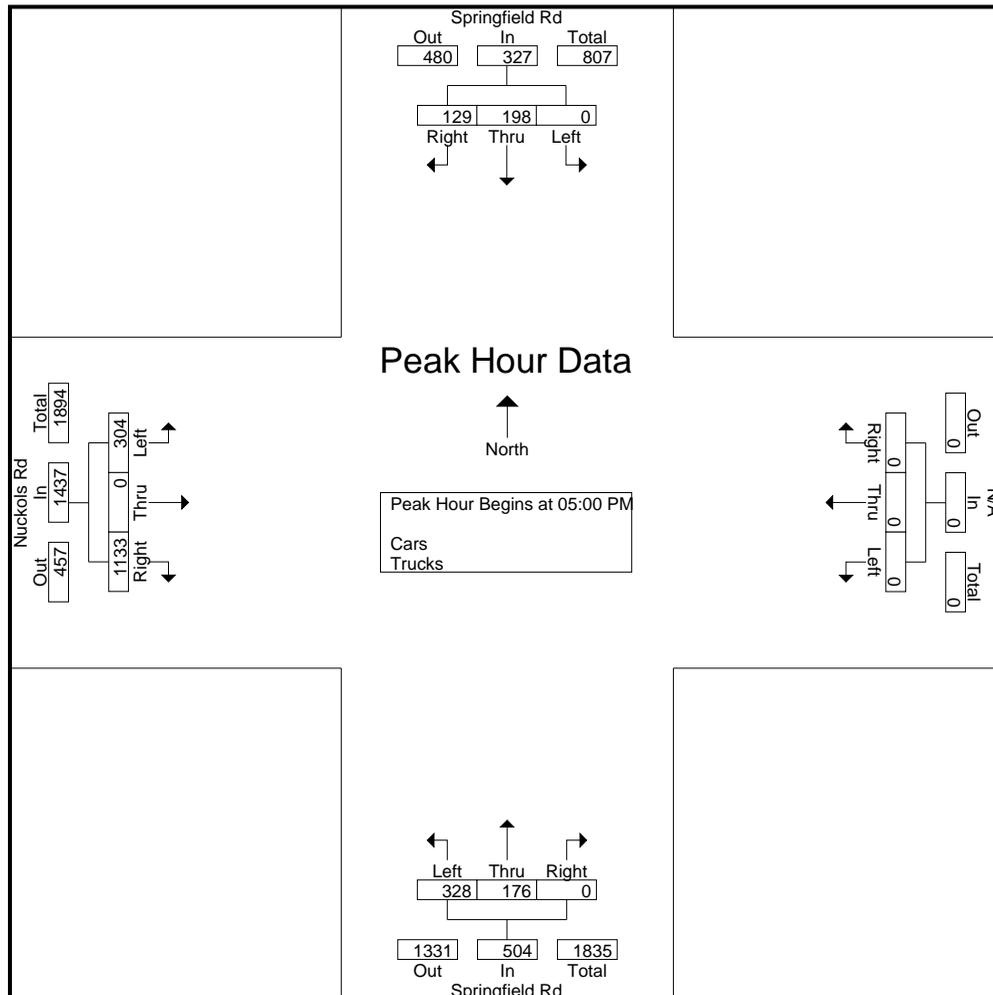
305 West Fourth Street
Winston-Salem, NC 27101
(336) 744-1636

Counted By: R. Slade, M. Davenport

File Name : Nuckols Rd at Springfield Rd
Site Code : 00012317
Start Date : 3/27/2012
Page No : 5

Weather: Clear

Start Time	Springfield Rd Southbound				N/A Westbound				Springfield Rd Northbound				Nuckols Rd Eastbound				Int. Total
	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	
Peak Hour Analysis From 04:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 05:00 PM																	
05:00 PM	0	37	42	79	0	0	0	0	81	33	0	114	79	0	351	430	623
05:15 PM	0	52	34	86	0	0	0	0	85	44	0	129	82	0	306	388	603
05:30 PM	0	59	21	80	0	0	0	0	78	62	0	140	58	0	241	299	519
05:45 PM	0	50	32	82	0	0	0	0	84	37	0	121	85	0	235	320	523
Total Volume	0	198	129	327	0	0	0	0	328	176	0	504	304	0	1133	1437	2268
% App. Total	0	60.6	39.4		0	0	0		65.1	34.9	0		21.2	0	78.8		
PHF	.000	.839	.768	.951	.000	.000	.000	.000	.965	.710	.000	.900	.894	.000	.807	.835	.910



Davenport Transportation Consulting

305 West Fourth Street
Winston-Salem, NC 27101
(336) 744-1636

Counted By: R. Slade

File Name : Wendhurst Dr at Springfield Rd
Site Code : 00012317
Start Date : 3/27/2012
Page No : 1

Weather: Clear

Groups Printed- Cars

Start Time	Springfield Rd Southbound					Wendhurst Dr Westbound					Springfield Rd Northbound					N/A Eastbound					Exclu. Total	Inclu. Total	Int. Total
	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total			
07:00 AM	1	56	0	0	57	5	0	2	0	7	0	23	0	0	23	0	0	0	0	0	0	87	87
07:15 AM	0	90	0	0	90	13	0	1	0	14	0	55	0	0	55	0	0	0	0	0	0	159	159
07:30 AM	0	100	0	0	100	21	0	2	0	23	0	33	4	0	37	0	0	0	0	0	0	160	160
07:45 AM	1	110	0	0	111	26	0	2	0	28	0	48	7	0	55	0	0	0	0	0	0	194	194
Total	2	356	0	0	358	65	0	7	0	72	0	159	11	0	170	0	0	0	0	0	0	600	600
08:00 AM	0	120	0	0	120	12	0	4	0	16	0	45	5	0	50	0	0	0	0	0	0	186	186
08:15 AM	0	142	0	0	142	15	0	2	0	17	0	68	5	0	73	0	0	0	0	0	0	232	232
08:30 AM	0	126	0	0	126	14	0	5	0	19	0	53	1	0	54	0	0	0	0	0	0	199	199
08:45 AM	2	80	0	0	82	5	0	0	0	5	0	19	2	0	21	0	0	0	0	0	0	108	108
Total	2	468	0	0	470	46	0	11	0	57	0	185	13	0	198	0	0	0	0	0	0	725	725
04:00 PM	1	58	0	0	59	2	0	1	0	3	0	92	17	0	109	0	0	0	0	0	0	171	171
04:15 PM	0	63	0	0	63	1	0	0	0	1	0	60	10	0	70	0	0	0	0	0	0	134	134
04:30 PM	1	59	0	0	60	7	0	1	0	8	0	70	9	0	79	0	0	0	0	0	0	147	147
04:45 PM	1	65	0	0	66	4	0	1	0	5	0	75	7	0	82	0	0	0	0	0	0	153	153
Total	3	245	0	0	248	14	0	3	0	17	0	297	43	0	340	0	0	0	0	0	0	605	605
05:00 PM	1	61	0	0	62	9	0	0	0	9	0	92	10	0	102	0	0	0	0	0	0	173	173
05:15 PM	0	80	0	0	80	9	0	1	0	10	0	100	10	0	110	0	0	0	0	0	0	200	200
05:30 PM	4	85	0	0	89	6	0	2	0	8	0	102	13	0	115	0	0	0	0	0	0	212	212
05:45 PM	2	65	0	0	67	6	0	3	0	9	0	97	10	0	107	0	0	0	0	0	0	183	183
Total	7	291	0	0	298	30	0	6	0	36	0	391	43	0	434	0	0	0	0	0	0	768	768
Grand Total	14	1360	0	0	1374	155	0	27	0	182	0	1032	110	0	1142	0	0	0	0	0	0	2698	2698
Apprch %	1	99	0			85.2	0	14.8			0	90.4	9.6			0	0	0					
Total %	0.5	50.4	0		50.9	5.7	0	1		6.7	0	38.3	4.1		42.3	0	0	0			0	100	

Davenport Transportation Consulting

305 West Fourth Street
Winston-Salem, NC 27101

(336) 744-1636

Counted By: R. Slade

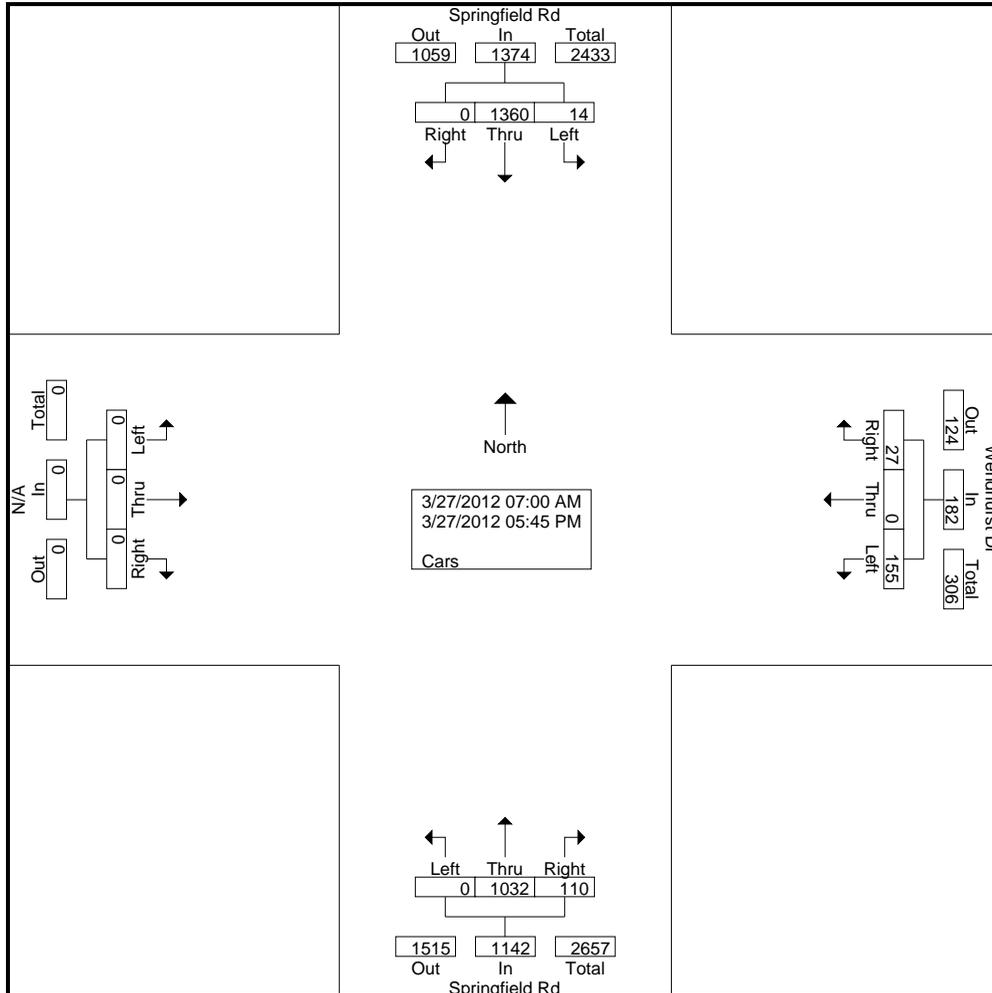
Weather: Clear

File Name : Wendhurst Dr at Springfield Rd

Site Code : 00012317

Start Date : 3/27/2012

Page No : 2



Davenport Transportation Consulting

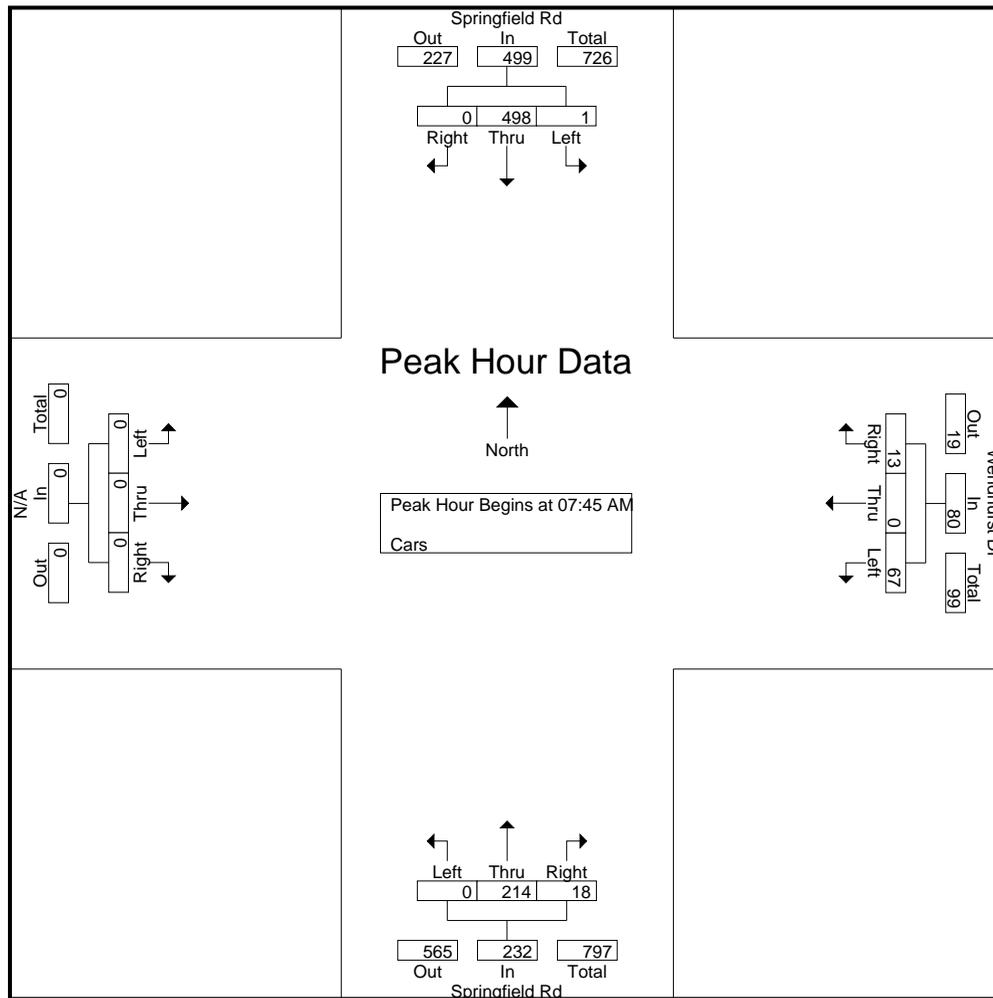
305 West Fourth Street
Winston-Salem, NC 27101
(336) 744-1636

Counted By: R. Slade

File Name : Wendhurst Dr at Springfield Rd
Site Code : 00012317
Start Date : 3/27/2012
Page No : 3

Weather: Clear

Start Time	Springfield Rd Southbound				Wendhurst Dr Westbound				Springfield Rd Northbound				N/A Eastbound				Int. Total
	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 07:45 AM																	
07:45 AM	1	110	0	111	26	0	2	28	0	48	7	55	0	0	0	0	194
08:00 AM	0	120	0	120	12	0	4	16	0	45	5	50	0	0	0	0	186
08:15 AM	0	142	0	142	15	0	2	17	0	68	5	73	0	0	0	0	232
08:30 AM	0	126	0	126	14	0	5	19	0	53	1	54	0	0	0	0	199
Total Volume	1	498	0	499	67	0	13	80	0	214	18	232	0	0	0	0	811
% App. Total	0.2	99.8	0		83.8	0	16.2		0	92.2	7.8		0	0	0		
PHF	.250	.877	.000	.879	.644	.000	.650	.714	.000	.787	.643	.795	.000	.000	.000	.000	.874



Davenport Transportation Consulting

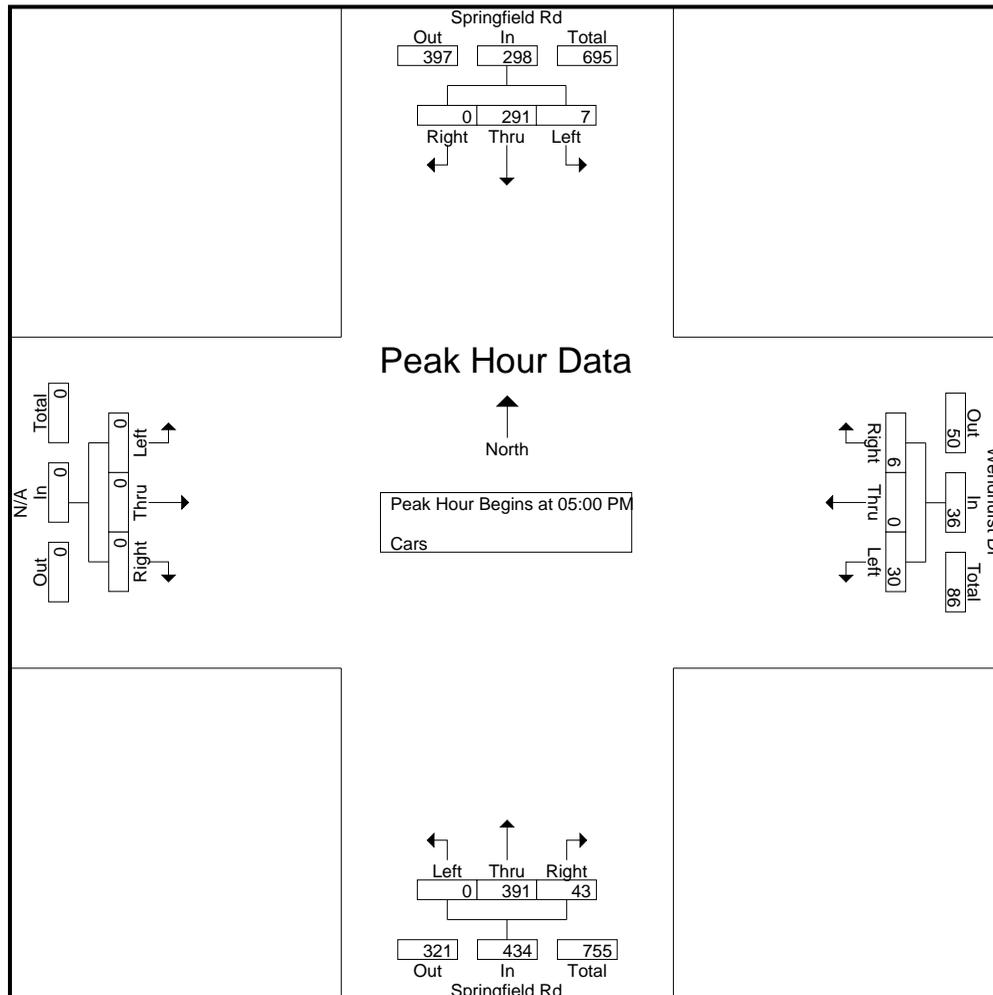
305 West Fourth Street
Winston-Salem, NC 27101
(336) 744-1636

Counted By: R. Slade

File Name : Wendhurst Dr at Springfield Rd
Site Code : 00012317
Start Date : 3/27/2012
Page No : 4

Weather: Clear

Start Time	Springfield Rd Southbound				Wendhurst Dr Westbound				Springfield Rd Northbound				N/A Eastbound				Int. Total
	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	
Peak Hour Analysis From 04:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 05:00 PM																	
05:00 PM	1	61	0	62	9	0	0	9	0	92	10	102	0	0	0	0	173
05:15 PM	0	80	0	80	9	0	1	10	0	100	10	110	0	0	0	0	200
05:30 PM	4	85	0	89	6	0	2	8	0	102	13	115	0	0	0	0	212
05:45 PM	2	65	0	67	6	0	3	9	0	97	10	107	0	0	0	0	183
Total Volume	7	291	0	298	30	0	6	36	0	391	43	434	0	0	0	0	768
% App. Total	2.3	97.7	0		83.3	0	16.7		0	90.1	9.9		0	0	0		
PHF	.438	.856	.000	.837	.833	.000	.500	.900	.000	.958	.827	.943	.000	.000	.000	.000	.906



Davenport Transportation Consulting

305 West Fourth Street
Winston-Salem, NC 27101
(336) 744-1636

Counted By: R. Slade

File Name : Springfield Rd at Wintergreen Rd & Linsey Lake Dr
Site Code : 00012317
Start Date : 3/27/2012
Page No : 1

Weather: Clear

Groups Printed- Cars - Trucks

Start Time	Springfield Rd Southbound					Linsey Lake Dr Westbound					Springfield Rd Northbound					Wintergreen Rd Eastbound					Exclu. Total	Inclu. Total	Int. Total
	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total			
07:00 AM	0	40	4	0	44	3	0	1	0	4	1	31	1	0	33	14	0	5	0	19	0	100	100
07:15 AM	0	63	0	0	63	6	0	6	0	12	1	63	2	0	66	14	0	12	0	26	0	167	167
07:30 AM	0	99	3	0	102	2	1	7	0	10	2	45	1	0	48	21	0	10	0	31	0	191	191
07:45 AM	1	108	9	0	118	0	0	8	0	8	1	43	1	0	45	24	0	13	0	37	0	208	208
Total	1	310	16	0	327	11	1	22	0	34	5	182	5	0	192	73	0	40	0	113	0	666	666
08:00 AM	3	112	4	0	119	4	0	9	0	13	3	62	0	0	65	12	0	10	0	22	0	219	219
08:15 AM	2	123	5	0	130	8	0	9	0	17	1	56	1	0	58	13	0	7	0	20	0	225	225
08:30 AM	2	93	1	0	96	4	0	4	0	8	0	67	1	0	68	4	0	12	0	16	0	188	188
08:45 AM	0	67	0	0	67	1	0	3	0	4	1	30	1	0	32	3	0	5	0	8	0	111	111
Total	7	395	10	0	412	17	0	25	0	42	5	215	3	0	223	32	0	34	0	66	0	743	743
04:00 PM	8	84	10	0	102	1	1	5	0	7	8	69	2	0	79	7	0	2	0	9	0	197	197
04:15 PM	6	42	13	0	61	2	0	4	0	6	3	44	2	0	49	4	0	2	0	6	0	122	122
04:30 PM	7	52	9	0	68	1	0	4	0	5	1	62	2	0	65	3	0	4	0	7	0	145	145
04:45 PM	7	64	8	0	79	2	0	4	0	6	6	64	0	0	70	2	0	5	0	7	0	162	162
Total	28	242	40	0	310	6	1	17	0	24	18	239	6	0	263	16	0	13	0	29	0	626	626
05:00 PM	0	65	13	0	78	1	1	2	0	4	7	85	0	0	92	3	0	1	0	4	0	178	178
05:15 PM	8	50	16	0	74	3	0	3	0	6	4	95	1	0	100	4	1	9	0	14	0	194	194
05:30 PM	5	65	18	0	88	3	0	5	0	8	6	100	2	0	108	8	1	4	0	13	0	217	217
05:45 PM	8	60	24	0	92	0	0	2	0	2	8	90	2	0	100	9	0	5	0	14	0	208	208
Total	21	240	71	0	332	7	1	12	0	20	25	370	5	0	400	24	2	19	0	45	0	797	797
Grand Total	57	1187	137	0	1381	41	3	76	0	120	53	1006	19	0	1078	145	2	106	0	253	0	2832	2832
Apprch %	4.1	86	9.9			34.2	2.5	63.3			4.9	93.3	1.8			57.3	0.8	41.9					
Total %	2	41.9	4.8		48.8	1.4	0.1	2.7		4.2	1.9	35.5	0.7		38.1	5.1	0.1	3.7		8.9	0	100	
Cars	57	1166	135		1358	36	3	74		113	51	990	19		1060	144	2	102		248	0	0	2779
% Cars	100	98.2	98.5	0	98.3	87.8	100	97.4	0	94.2	96.2	98.4	100	0	98.3	99.3	100	96.2	0	98	0	0	98.1
Trucks	0	21	2		23	5	0	2		7	2	16	0		18	1	0	4		5	0	0	53
% Trucks	0	1.8	1.5	0	1.7	12.2	0	2.6	0	5.8	3.8	1.6	0	0	1.7	0.7	0	3.8	0	2	0	0	1.9

Davenport Transportation Consulting

305 West Fourth Street
Winston-Salem, NC 27101

(336) 744-1636

Counted By: R. Slade

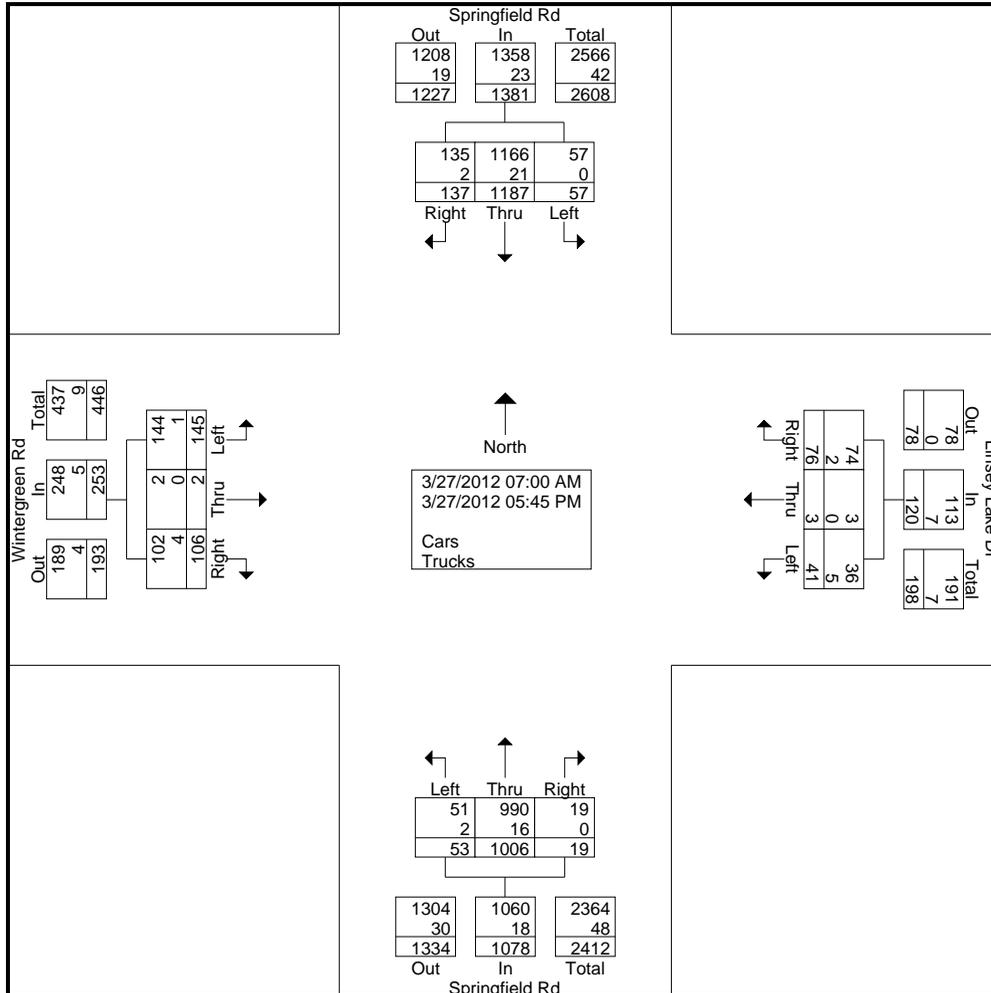
File Name : Springfield Rd at Wintergreen Rd & Linsey Lake Dr

Site Code : 00012317

Start Date : 3/27/2012

Page No : 2

Weather: Clear



Davenport Transportation Consulting

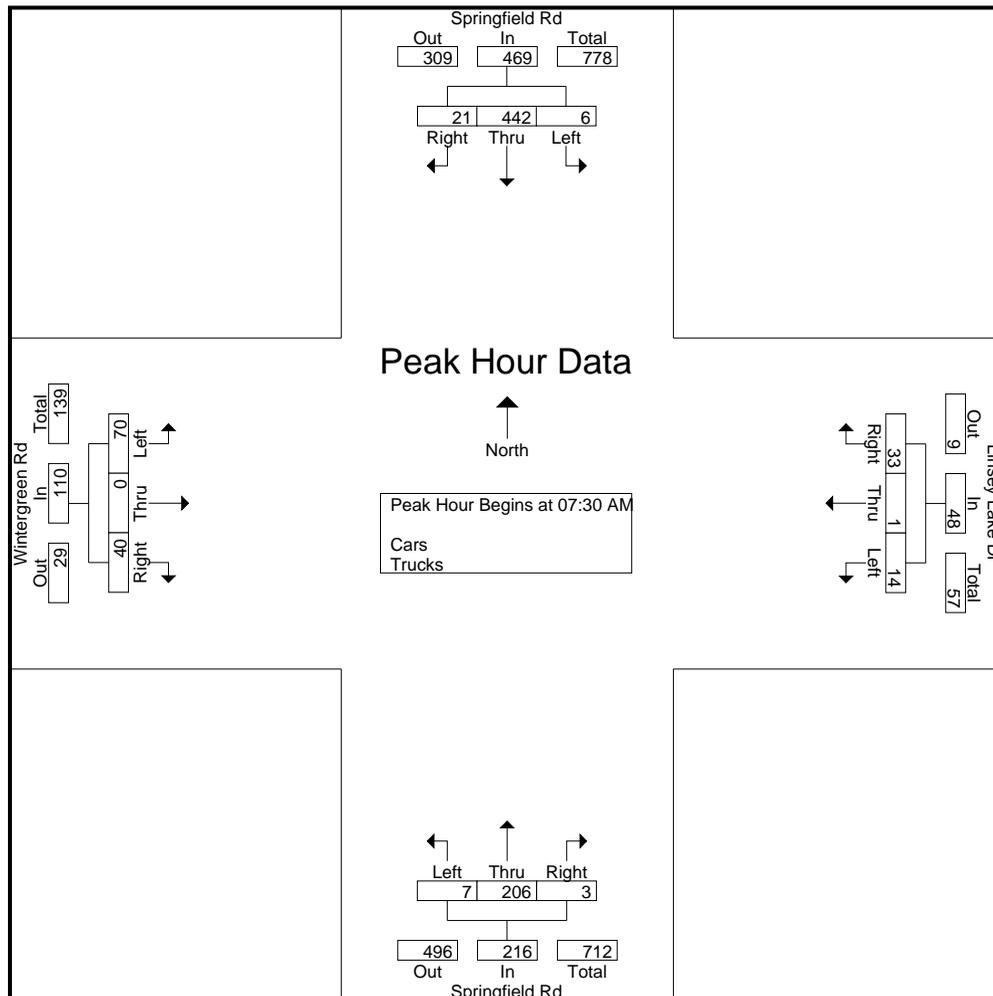
305 West Fourth Street
Winston-Salem, NC 27101
(336) 744-1636

Counted By: R. Slade

File Name : Springfield Rd at Wintergreen Rd & Linsey Lake Dr
Site Code : 00012317
Start Date : 3/27/2012
Page No : 3

Weather: Clear

Start Time	Springfield Rd Southbound				Linsey Lake Dr Westbound				Springfield Rd Northbound				Wintergreen Rd Eastbound				Int. Total
	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 07:30 AM																	
07:30 AM	0	99	3	102	2	1	7	10	2	45	1	48	21	0	10	31	191
07:45 AM	1	108	9	118	0	0	8	8	1	43	1	45	24	0	13	37	208
08:00 AM	3	112	4	119	4	0	9	13	3	62	0	65	12	0	10	22	219
08:15 AM	2	123	5	130	8	0	9	17	1	56	1	58	13	0	7	20	225
Total Volume	6	442	21	469	14	1	33	48	7	206	3	216	70	0	40	110	843
% App. Total	1.3	94.2	4.5		29.2	2.1	68.8		3.2	95.4	1.4		63.6	0	36.4		
PHF	.500	.898	.583	.902	.438	.250	.917	.706	.583	.831	.750	.831	.729	.000	.769	.743	.937



Davenport Transportation Consulting

305 West Fourth Street
Winston-Salem, NC 27101
(336) 744-1636

Counted By: R. Slade

File Name : Springfield Rd at Wintergreen Rd & Linsey Lake Dr

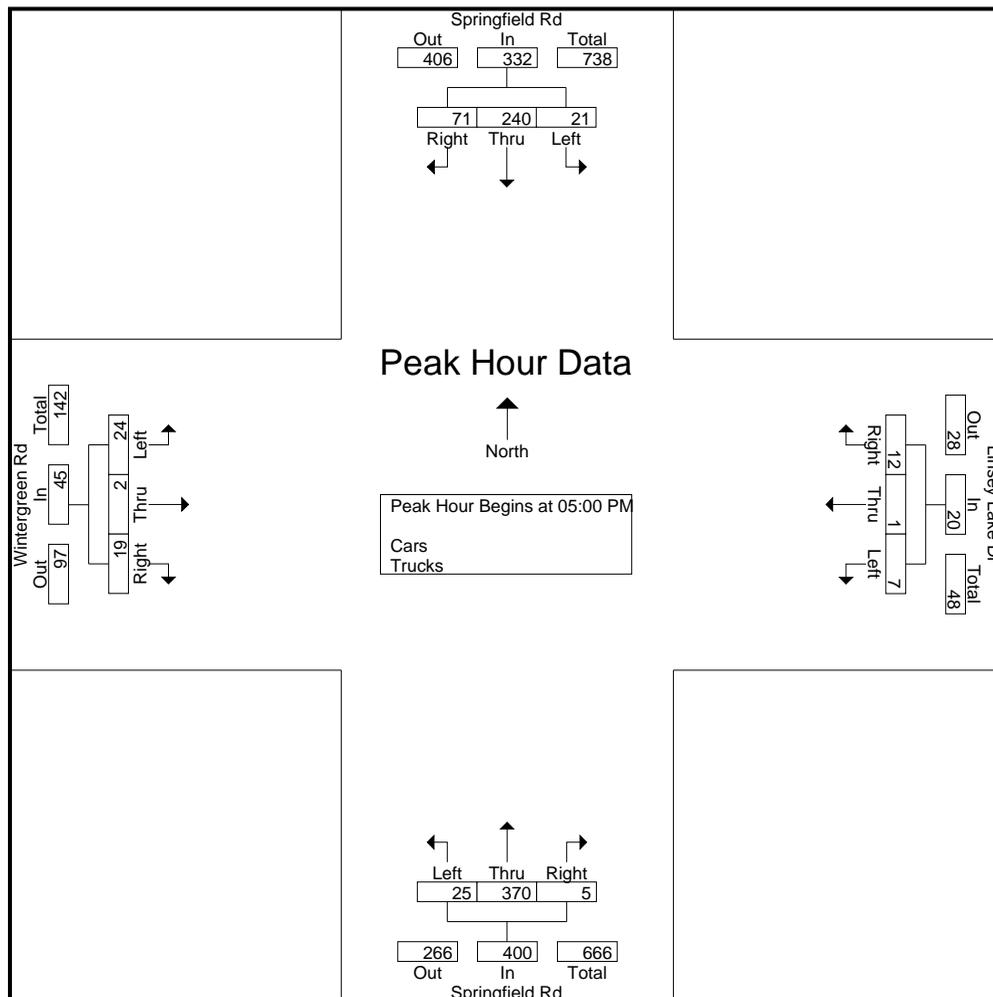
Site Code : 00012317

Start Date : 3/27/2012

Page No : 4

Weather: Clear

Start Time	Springfield Rd Southbound				Linsey Lake Dr Westbound				Springfield Rd Northbound				Wintergreen Rd Eastbound				Int. Total
	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	
Peak Hour Analysis From 04:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 05:00 PM																	
05:00 PM	0	65	13	78	1	1	2	4	7	85	0	92	3	0	1	4	178
05:15 PM	8	50	16	74	3	0	3	6	4	95	1	100	4	1	9	14	194
05:30 PM	5	65	18	88	3	0	5	8	6	100	2	108	8	1	4	13	217
05:45 PM	8	60	24	92	0	0	2	2	8	90	2	100	9	0	5	14	208
Total Volume	21	240	71	332	7	1	12	20	25	370	5	400	24	2	19	45	797
% App. Total	6.3	72.3	21.4		35	5	60		6.2	92.5	1.2		53.3	4.4	42.2		
PHF	.656	.923	.740	.902	.583	.250	.600	.625	.781	.925	.625	.926	.667	.500	.528	.804	.918



Davenport Transportation Consulting

305 West Fourth Street
Winston-Salem, NC 27101
(336) 744-1636

Counted By: R. Slade

File Name : Springfield Rd at Hart Mill Dr & Warnerwood Court
Site Code : 00012317
Start Date : 3/27/2012
Page No : 1

Weather: Clear

Groups Printed- Cars - Trucks

Start Time	Springfield Rd Southbound					Hart Mill Dr Westbound					Springfield Rd Northbound					Warnerwood Court Eastbound					Exclu. Total	Inclu. Total	Int. Total
	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total			
07:00 AM	1	40	0	0	41	2	0	1	0	3	0	43	3	0	46	1	0	1	0	2	0	92	92
07:15 AM	2	61	0	0	63	1	0	0	0	1	0	81	0	0	81	1	0	3	0	4	0	149	149
07:30 AM	1	93	1	0	95	7	0	1	0	8	0	72	2	0	74	1	0	0	0	1	0	178	178
07:45 AM	1	116	0	0	117	1	0	0	0	1	1	69	5	0	75	0	0	0	0	0	0	193	193
Total	5	310	1	0	316	11	0	2	0	13	1	265	10	0	276	3	0	4	0	7	0	612	612
08:00 AM	0	122	0	0	122	4	0	0	0	4	0	67	6	0	73	1	0	0	0	1	0	200	200
08:15 AM	0	129	0	0	129	4	0	0	0	4	0	70	8	0	78	0	0	1	0	1	0	212	212
08:30 AM	0	91	0	0	91	3	0	0	0	3	1	76	3	0	80	0	0	0	0	0	0	174	174
08:45 AM	0	61	0	0	61	2	0	0	0	2	0	22	0	0	22	0	0	1	0	1	0	86	86
Total	0	403	0	0	403	13	0	0	0	13	1	235	17	0	253	1	0	2	0	3	0	672	672
04:00 PM	0	79	2	0	81	2	0	0	0	2	1	66	6	0	73	0	0	0	0	0	0	156	156
04:15 PM	0	43	0	0	43	0	0	0	0	0	0	68	3	0	71	0	0	2	0	2	0	116	116
04:30 PM	0	57	1	0	58	0	0	0	0	0	1	77	7	0	85	0	0	2	0	2	0	145	145
04:45 PM	0	66	0	0	66	1	0	0	0	1	0	83	8	0	91	0	0	0	0	0	0	158	158
Total	0	245	3	0	248	3	0	0	0	3	2	294	24	0	320	0	0	4	0	4	0	575	575
05:00 PM	1	67	1	0	69	1	0	1	0	2	2	96	6	0	104	0	0	2	0	2	0	177	177
05:15 PM	0	59	0	0	59	5	0	0	0	5	1	116	13	0	130	0	0	0	0	0	0	194	194
05:30 PM	0	80	0	0	80	1	0	0	0	1	0	134	11	0	145	0	0	1	0	1	0	227	227
05:45 PM	1	82	0	0	83	0	0	0	0	0	1	100	6	0	107	0	0	0	0	0	0	190	190
Total	2	288	1	0	291	7	0	1	0	8	4	446	36	0	486	0	0	3	0	3	0	788	788
Grand Total	7	1246	5	0	1258	34	0	3	0	37	8	1240	87	0	1335	4	0	13	0	17	0	2647	2647
Apprch %	0.6	99	0.4			91.9	0	8.1			0.6	92.9	6.5			23.5	0	76.5					
Total %	0.3	47.1	0.2		47.5	1.3	0	0.1		1.4	0.3	46.8	3.3		50.4	0.2	0	0.5		0.6	0	100	
Cars	5	1230	5		1240	34	0	3		37	8	1220	80		1308	4	0	13		17	0	0	2602
% Cars	71.4	98.7	100		98.6	100	0	100		100	100	98.4	92		98	100	0	100		100	0	0	98.3
Trucks	2	16	0		18	0	0	0		0	0	20	7		27	0	0	0		0	0	0	45
% Trucks	28.6	1.3	0		1.4	0	0	0		0	0	1.6	8		2	0	0	0		0	0	0	1.7

Davenport Transportation Consulting

305 West Fourth Street
Winston-Salem, NC 27101

(336) 744-1636

Counted By: R. Slade

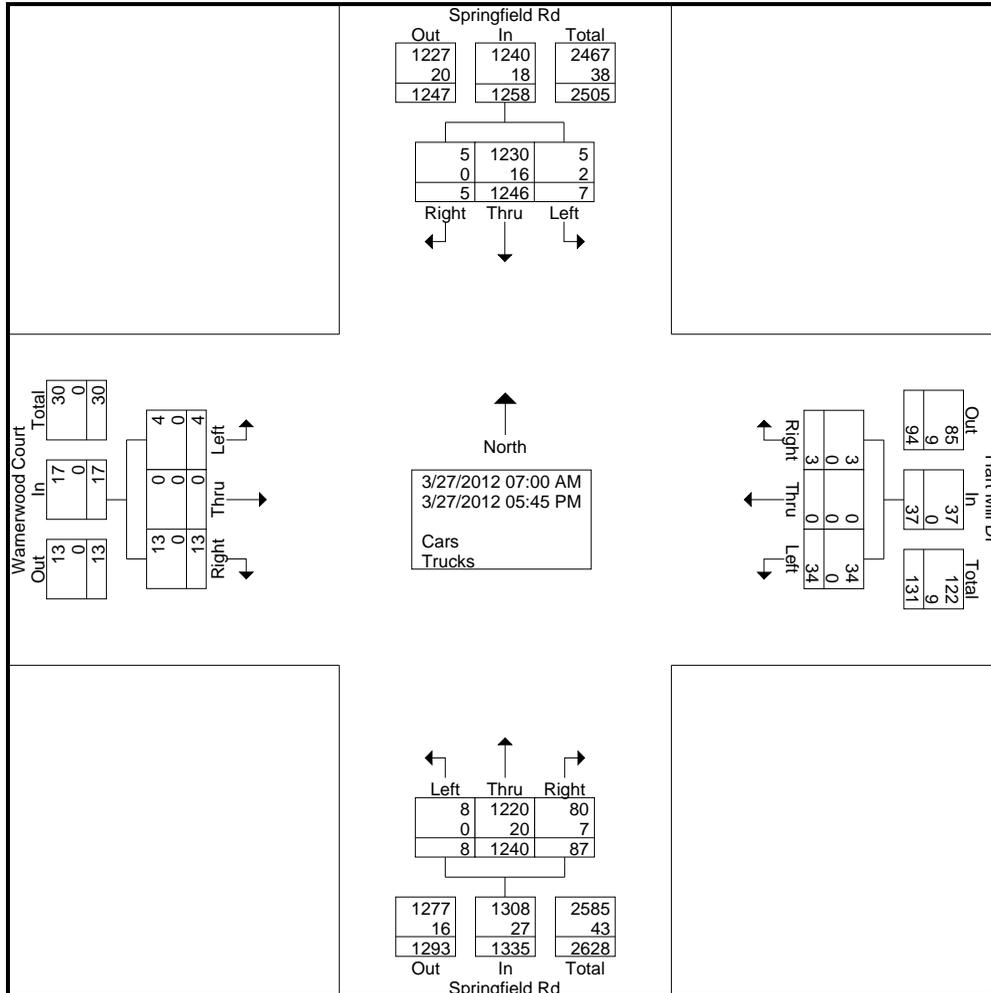
File Name : Springfield Rd at Hart Mill Dr & Warnerwood Court

Site Code : 00012317

Start Date : 3/27/2012

Page No : 2

Weather: Clear



Springfield Rd		
Out	In	Total
1227	1240	2467
20	18	38
1247	1258	2505

5	1230	5
0	16	2
5	1246	7
Right	Thru	Left

Warnerwood Court		
Out	In	Total
13	17	30
0	0	0
13	17	30

13	0	4
0	0	0
13	0	4
Right	Thru	Left

Hart Mill Dr		
Out	In	Total
85	37	122
94	0	94
3	0	3
0	0	0
3	0	3
0	0	0
34	0	34
Right	Thru	Left

Left	Thru	Right
8	1220	80
0	20	7
8	1240	87

Springfield Rd		
Out	In	Total
1277	1308	2585
16	27	43
1293	1335	2628

Davenport Transportation Consulting

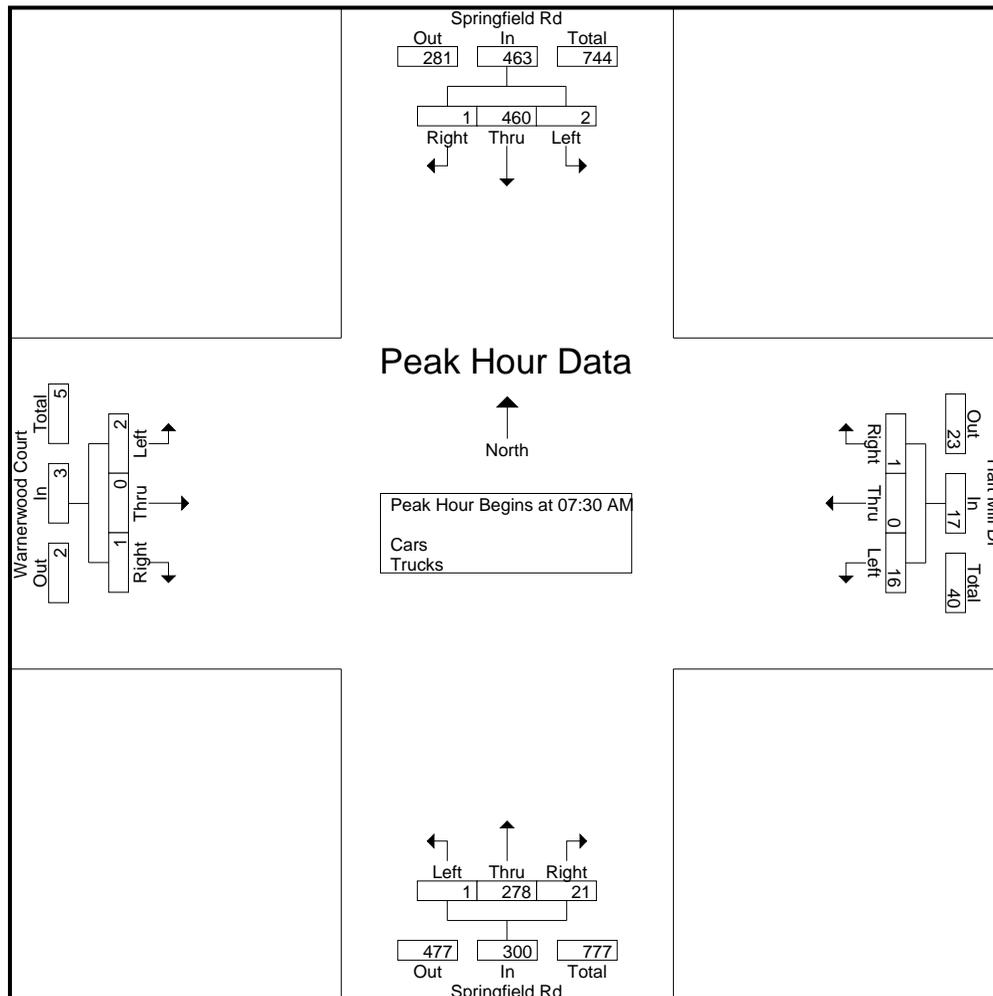
305 West Fourth Street
Winston-Salem, NC 27101
(336) 744-1636

Counted By: R. Slade

File Name : Springfield Rd at Hart Mill Dr & Warnerwood Court
Site Code : 00012317
Start Date : 3/27/2012
Page No : 3

Weather: Clear

Start Time	Springfield Rd Southbound				Hart Mill Dr Westbound				Springfield Rd Northbound				Warnerwood Court Eastbound				Int. Total
	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 07:30 AM																	
07:30 AM	1	93	1	95	7	0	1	8	0	72	2	74	1	0	0	1	178
07:45 AM	1	116	0	117	1	0	0	1	1	69	5	75	0	0	0	0	193
08:00 AM	0	122	0	122	4	0	0	4	0	67	6	73	1	0	0	1	200
08:15 AM	0	129	0	129	4	0	0	4	0	70	8	78	0	0	1	1	212
Total Volume	2	460	1	463	16	0	1	17	1	278	21	300	2	0	1	3	783
% App. Total	0.4	99.4	0.2		94.1	0	5.9		0.3	92.7	7		66.7	0	33.3		
PHF	.500	.891	.250	.897	.571	.000	.250	.531	.250	.965	.656	.962	.500	.000	.250	.750	.923



Davenport Transportation Consulting

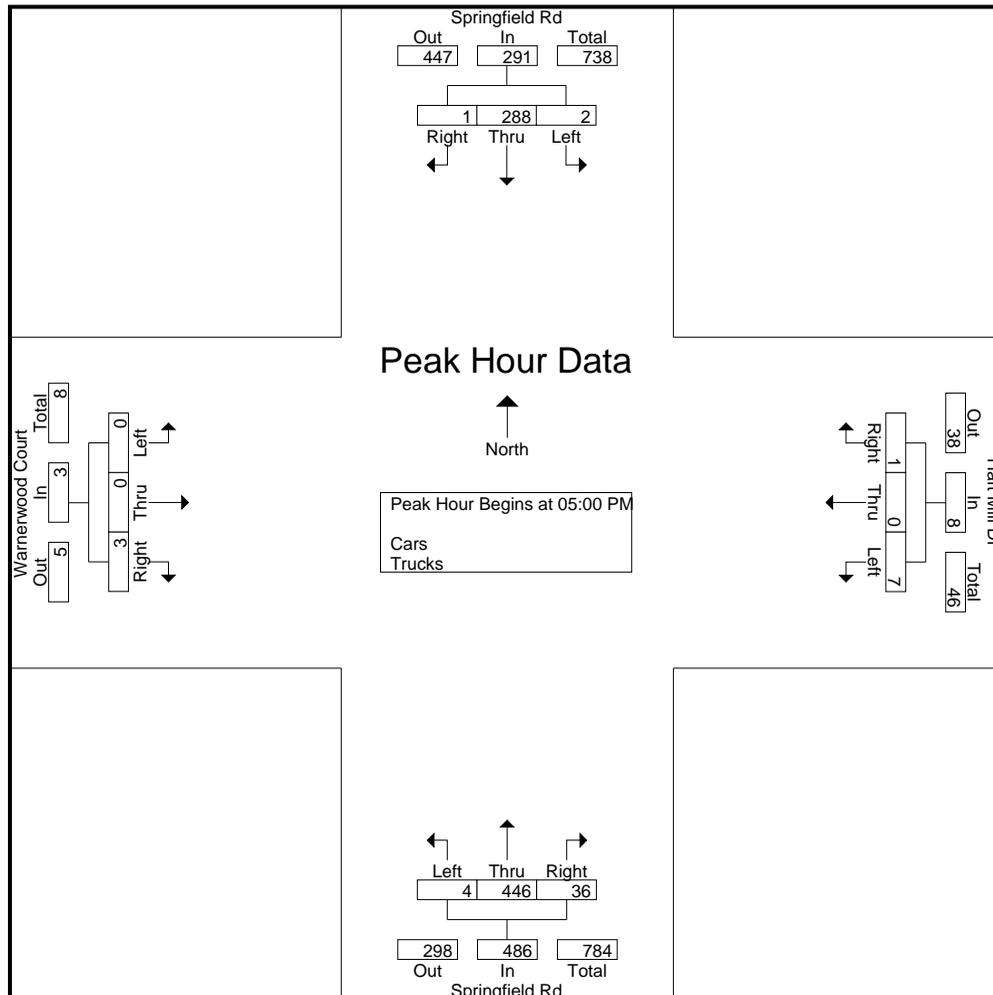
305 West Fourth Street
Winston-Salem, NC 27101
(336) 744-1636

Counted By: R. Slade

File Name : Springfield Rd at Hart Mill Dr & Warnerwood Court
Site Code : 00012317
Start Date : 3/27/2012
Page No : 4

Weather: Clear

Start Time	Springfield Rd Southbound				Hart Mill Dr Westbound				Springfield Rd Northbound				Warnerwood Court Eastbound				Int. Total
	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	
Peak Hour Analysis From 04:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 05:00 PM																	
05:00 PM	1	67	1	69	1	0	1	2	2	96	6	104	0	0	2	2	177
05:15 PM	0	59	0	59	5	0	0	5	1	116	13	130	0	0	0	0	194
05:30 PM	0	80	0	80	1	0	0	1	0	134	11	145	0	0	1	1	227
05:45 PM	1	82	0	83	0	0	0	0	1	100	6	107	0	0	0	0	190
Total Volume	2	288	1	291	7	0	1	8	4	446	36	486	0	0	3	3	788
% App. Total	0.7	99	0.3		87.5	0	12.5		0.8	91.8	7.4		0	0	100		
PHF	.500	.878	.250	.877	.350	.000	.250	.400	.500	.832	.692	.838	.000	.000	.375	.375	.868



Davenport Transportation Consulting

305 West Fourth Street
Winston-Salem, NC 27101
(336) 744-1636

Counted By: R. Slade

File Name : Springfield Rd at Old Hartley Dr
Site Code : 00012317
Start Date : 3/27/2012
Page No : 1

Weather: Clear

Groups Printed- Cars - Trucks

Start Time	Springfield Rd Southbound					N/A Westbound					Springfield Rd Northbound					Old Hartley Dr Eastbound					Exclu. Total	Inclu. Total	Int. Total
	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total			
07:00 AM	0	29	1	0	30	0	0	0	0	0	1	42	0	0	43	2	0	10	1	12	1	85	86
07:15 AM	0	61	1	0	62	0	0	0	0	0	3	81	0	0	84	4	0	1	0	5	0	151	151
07:30 AM	0	91	2	0	93	0	0	0	0	0	0	74	0	0	74	9	0	4	0	13	0	180	180
07:45 AM	0	115	1	0	116	0	0	0	0	0	1	67	0	0	68	8	0	2	0	10	0	194	194
Total	0	296	5	0	301	0	0	0	0	0	5	264	0	0	269	23	0	17	1	40	1	610	611
08:00 AM	0	114	0	0	114	0	0	0	0	0	2	66	0	0	68	2	0	6	0	8	0	190	190
08:15 AM	0	126	3	0	129	0	0	0	0	0	2	76	0	0	78	7	0	4	0	11	0	218	218
08:30 AM	0	86	2	0	88	0	0	0	0	0	5	72	0	0	77	4	0	1	0	5	0	170	170
08:45 AM	0	54	0	0	54	0	0	0	0	0	0	26	0	0	26	3	0	7	0	10	0	90	90
Total	0	380	5	0	385	0	0	0	0	0	9	240	0	0	249	16	0	18	0	34	0	668	668
04:00 PM	0	82	4	0	86	0	0	0	0	0	6	60	0	0	66	1	0	6	0	7	0	159	159
04:15 PM	0	48	3	0	51	0	0	0	0	0	6	59	0	0	65	0	0	1	0	1	0	117	117
04:30 PM	0	56	4	0	60	0	0	0	0	0	2	76	0	0	78	1	0	4	0	5	0	143	143
04:45 PM	0	63	4	0	67	0	0	0	0	0	3	80	0	0	83	1	0	2	0	3	0	153	153
Total	0	249	15	0	264	0	0	0	0	0	17	275	0	0	292	3	0	13	0	16	0	572	572
05:00 PM	0	65	1	0	66	0	0	0	0	0	3	95	0	0	98	5	0	2	0	7	0	171	171
05:15 PM	0	55	2	0	57	0	0	0	0	0	3	113	0	0	116	0	0	4	0	4	0	177	177
05:30 PM	0	82	7	0	89	0	0	0	0	0	5	122	0	0	127	2	0	2	0	4	0	220	220
05:45 PM	0	81	3	0	84	0	0	0	0	0	5	97	0	0	102	2	0	1	0	3	0	189	189
Total	0	283	13	0	296	0	0	0	0	0	16	427	0	0	443	9	0	9	0	18	0	757	757
Grand Total	0	1208	38	0	1246	0	0	0	0	0	47	1206	0	0	1253	51	0	57	1	108	1	2607	2608
Apprch %	0	97	3			0	0	0			3.8	96.2	0			47.2	0	52.8					
Total %	0	46.3	1.5		47.8	0	0	0		0	1.8	46.3	0		48.1	2	0	2.2		4.1	0	100	
Cars	0	1197	36		1233	0	0	0		0	45	1179	0		1224	50	0	53		104	0	0	2561
% Cars	0	99.1	94.7	0	99	0	0	0	0	0	95.7	97.8	0	0	97.7	98	0	93	100	95.4	0	0	98.2
Trucks	0	11	2		13	0	0	0		0	2	27	0		29	1	0	4		5	0	0	47
% Trucks	0	0.9	5.3	0	1	0	0	0	0	0	4.3	2.2	0	0	2.3	2	0	7	0	4.6	0	0	1.8

Davenport Transportation Consulting

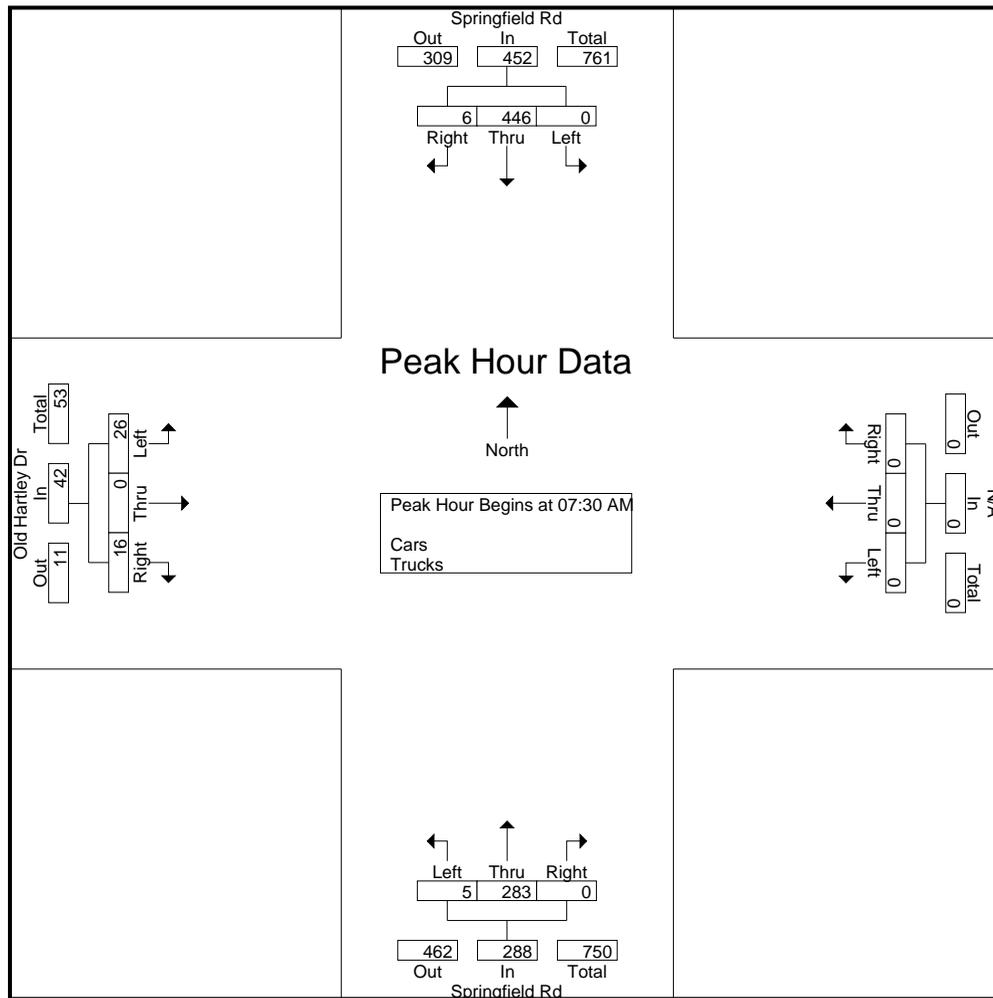
305 West Fourth Street
Winston-Salem, NC 27101
(336) 744-1636

Counted By: R. Slade

File Name : Springfield Rd at Old Hartley Dr
Site Code : 00012317
Start Date : 3/27/2012
Page No : 3

Weather: Clear

Start Time	Springfield Rd Southbound				N/A Westbound				Springfield Rd Northbound				Old Hartley Dr Eastbound				Int. Total
	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 07:30 AM																	
07:30 AM	0	91	2	93	0	0	0	0	0	74	0	74	9	0	4	13	180
07:45 AM	0	115	1	116	0	0	0	0	1	67	0	68	8	0	2	10	194
08:00 AM	0	114	0	114	0	0	0	0	2	66	0	68	2	0	6	8	190
08:15 AM	0	126	3	129	0	0	0	0	2	76	0	78	7	0	4	11	218
Total Volume	0	446	6	452	0	0	0	0	5	283	0	288	26	0	16	42	782
% App. Total	0	98.7	1.3		0	0	0		1.7	98.3	0		61.9	0	38.1		
PHF	.000	.885	.500	.876	.000	.000	.000	.000	.625	.931	.000	.923	.722	.000	.667	.808	.897



Davenport Transportation Consulting

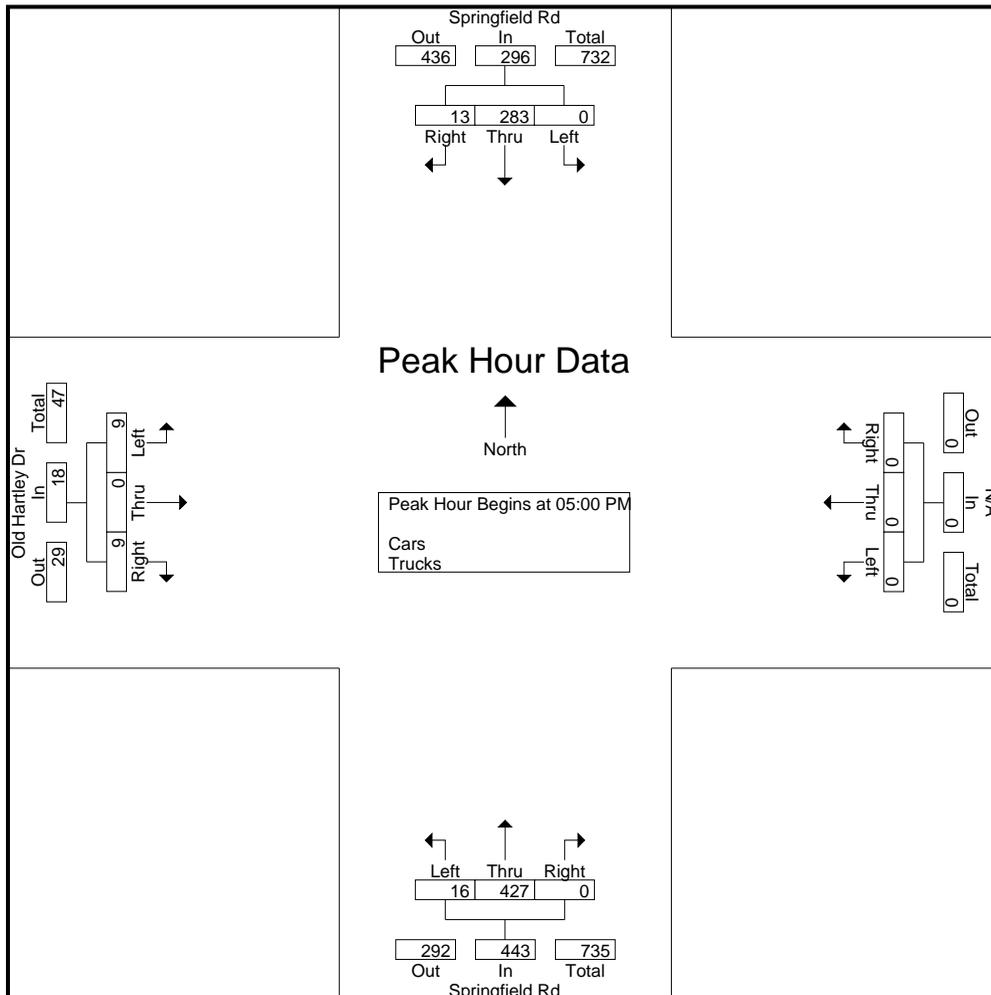
305 West Fourth Street
Winston-Salem, NC 27101
(336) 744-1636

Counted By: R. Slade

File Name : Springfield Rd at Old Hartley Dr
Site Code : 00012317
Start Date : 3/27/2012
Page No : 4

Weather: Clear

Start Time	Springfield Rd Southbound				N/A Westbound				Springfield Rd Northbound				Old Hartley Dr Eastbound				Int. Total
	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	
Peak Hour Analysis From 04:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 05:00 PM																	
05:00 PM	0	65	1	66	0	0	0	0	3	95	0	98	5	0	2	7	171
05:15 PM	0	55	2	57	0	0	0	0	3	113	0	116	0	0	4	4	177
05:30 PM	0	82	7	89	0	0	0	0	5	122	0	127	2	0	2	4	220
05:45 PM	0	81	3	84	0	0	0	0	5	97	0	102	2	0	1	3	189
Total Volume	0	283	13	296	0	0	0	0	16	427	0	443	9	0	9	18	757
% App. Total	0	95.6	4.4		0	0	0		3.6	96.4	0		50	0	50		
PHF	.000	.863	.464	.831	.000	.000	.000	.000	.800	.875	.000	.872	.450	.000	.563	.643	.860



Davenport Transportation Consulting

305 West Fourth Street
Winston-Salem, NC 27101
(336) 744-1636

Counted By: M. Davenport

File Name : Springfield Rd at Old Springfield Rd
Site Code : 00012317
Start Date : 3/27/2012
Page No : 1

Weather: Clear

Groups Printed- Cars - Trucks

Start Time	Springfield Rd Southbound					Old Springfield Rd Westbound					Springfield Rd Northbound					N/A Eastbound					Exclu. Total	Inclu. Total	Int. Total
	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total			
07:00 AM	1	42	0	0	43	1	0	4	0	5	0	30	0	0	30	0	0	0	0	0	0	78	78
07:15 AM	0	81	0	0	81	7	0	4	0	11	0	60	2	0	62	0	0	0	0	0	0	154	154
07:30 AM	1	86	0	0	87	12	0	7	0	19	0	86	5	0	91	0	0	0	0	0	0	197	197
07:45 AM	0	65	0	0	65	15	0	11	0	26	0	106	2	0	108	0	0	0	0	0	0	199	199
Total	2	274	0	0	276	35	0	26	0	61	0	282	9	0	291	0	0	0	0	0	0	628	628
08:00 AM	1	61	0	0	62	6	0	7	0	13	0	98	4	0	102	0	0	0	0	0	0	177	177
08:15 AM	5	69	0	0	74	6	0	2	0	8	0	121	1	0	122	0	0	0	0	0	0	204	204
08:30 AM	2	62	0	0	64	5	0	4	0	9	0	78	3	0	81	0	0	0	0	0	0	154	154
08:45 AM	1	28	0	0	29	5	0	2	0	7	0	51	0	0	51	0	0	0	0	0	0	87	87
Total	9	220	0	0	229	22	0	15	0	37	0	348	8	0	356	0	0	0	0	0	0	622	622
04:00 PM	2	62	0	0	64	4	0	3	0	7	0	82	2	0	84	0	0	0	0	0	0	155	155
04:15 PM	3	63	0	0	66	2	0	2	0	4	0	46	3	0	49	0	0	0	0	0	0	119	119
04:30 PM	8	74	0	0	82	0	0	1	0	1	0	57	4	0	61	0	0	0	0	0	0	144	144
04:45 PM	5	76	0	0	81	1	0	3	0	4	0	64	0	0	64	0	0	0	0	0	0	149	149
Total	18	275	0	0	293	7	0	9	0	16	0	249	9	0	258	0	0	0	0	0	0	567	567
05:00 PM	2	97	0	0	99	1	0	3	0	4	0	58	4	0	62	0	0	0	0	0	0	165	165
05:15 PM	4	109	0	0	113	9	0	2	0	11	0	55	5	0	60	0	0	0	0	0	0	184	184
05:30 PM	5	116	0	0	121	3	0	3	0	6	0	88	6	0	94	0	0	0	0	0	0	221	221
05:45 PM	10	93	0	0	103	5	0	3	0	8	0	81	7	0	88	0	0	0	0	0	0	199	199
Total	21	415	0	0	436	18	0	11	0	29	0	282	22	0	304	0	0	0	0	0	0	769	769
Grand Total	50	1184	0	0	1234	82	0	61	0	143	0	1161	48	0	1209	0	0	0	0	0	0	2586	2586
Apprch %	4.1	95.9	0			57.3	0	42.7			0	96	4			0	0	0					
Total %	1.9	45.8	0		47.7	3.2	0	2.4		5.5	0	44.9	1.9		46.8	0	0	0		0	0	100	
Cars	50	1161	0		1211	80	0	59		139	0	1146	43		1189	0	0	0		0	0	0	2539
% Cars	100	98.1	0	0	98.1	97.6	0	96.7	0	97.2	0	98.7	89.6	0	98.3	0	0	0	0	0	0	0	98.2
Trucks	0	23	0		23	2	0	2		4	0	15	5		20	0	0	0		0	0	0	47
% Trucks	0	1.9	0	0	1.9	2.4	0	3.3	0	2.8	0	1.3	10.4	0	1.7	0	0	0	0	0	0	0	1.8

Davenport Transportation Consulting

305 West Fourth Street
Winston-Salem, NC 27101

(336) 744-1636

Counted By: M. Davenport

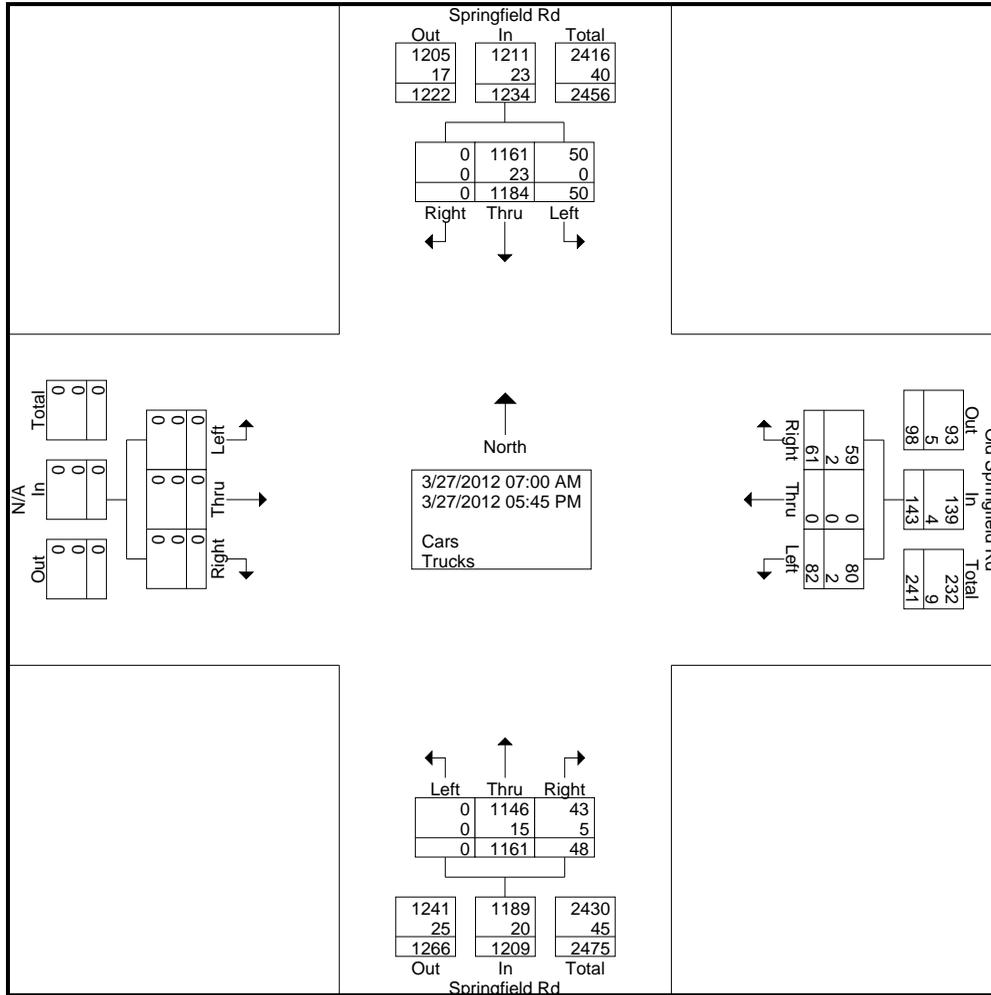
Weather: Clear

File Name : Springfield Rd at Old Springfield Rd

Site Code : 00012317

Start Date : 3/27/2012

Page No : 2



Davenport Transportation Consulting

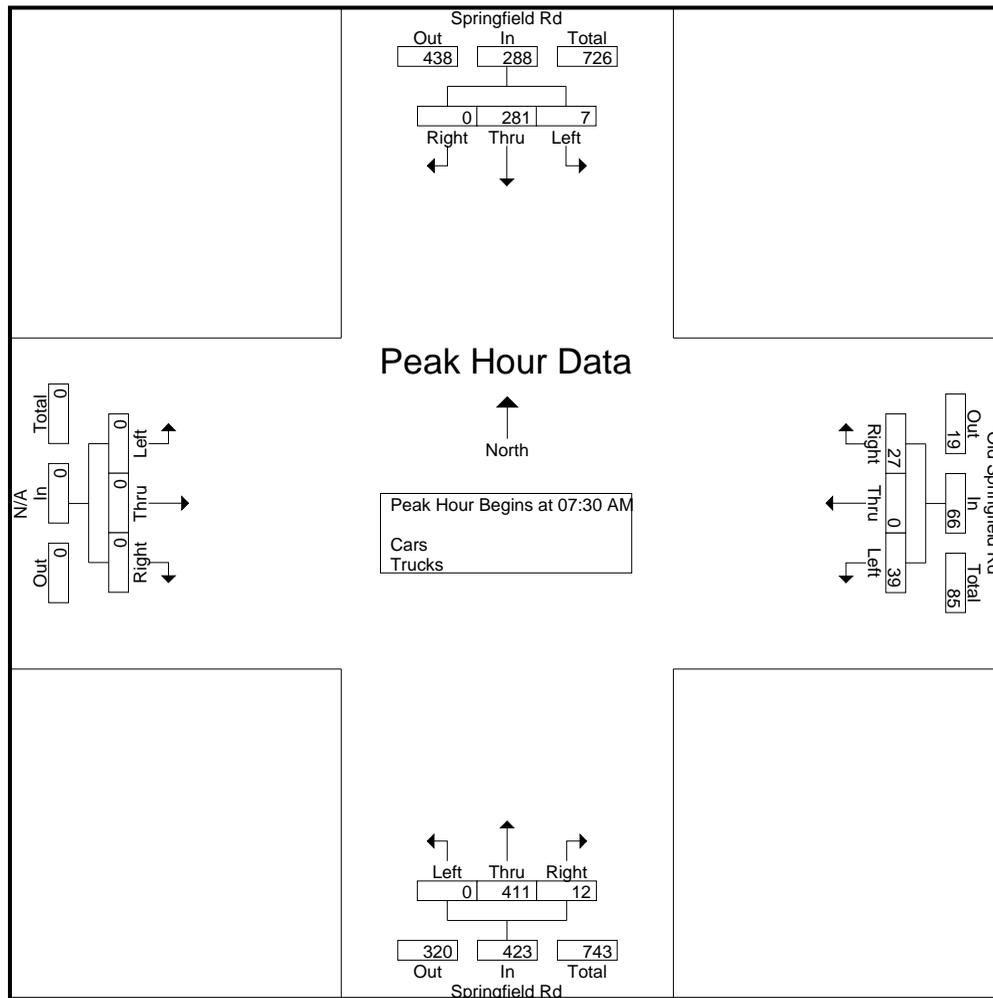
305 West Fourth Street
Winston-Salem, NC 27101
(336) 744-1636

Counted By: M. Davenport

File Name : Springfield Rd at Old Springfield Rd
Site Code : 00012317
Start Date : 3/27/2012
Page No : 3

Weather: Clear

Start Time	Springfield Rd Southbound				Old Springfield Rd Westbound				Springfield Rd Northbound				N/A Eastbound				Int. Total
	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 07:30 AM																	
07:30 AM	1	86	0	87	12	0	7	19	0	86	5	91	0	0	0	0	197
07:45 AM	0	65	0	65	15	0	11	26	0	106	2	108	0	0	0	0	199
08:00 AM	1	61	0	62	6	0	7	13	0	98	4	102	0	0	0	0	177
08:15 AM	5	69	0	74	6	0	2	8	0	121	1	122	0	0	0	0	204
Total Volume	7	281	0	288	39	0	27	66	0	411	12	423	0	0	0	0	777
% App. Total	2.4	97.6	0		59.1	0	40.9		0	97.2	2.8		0	0	0		
PHF	.350	.817	.000	.828	.650	.000	.614	.635	.000	.849	.600	.867	.000	.000	.000	.000	.952



Davenport Transportation Consulting

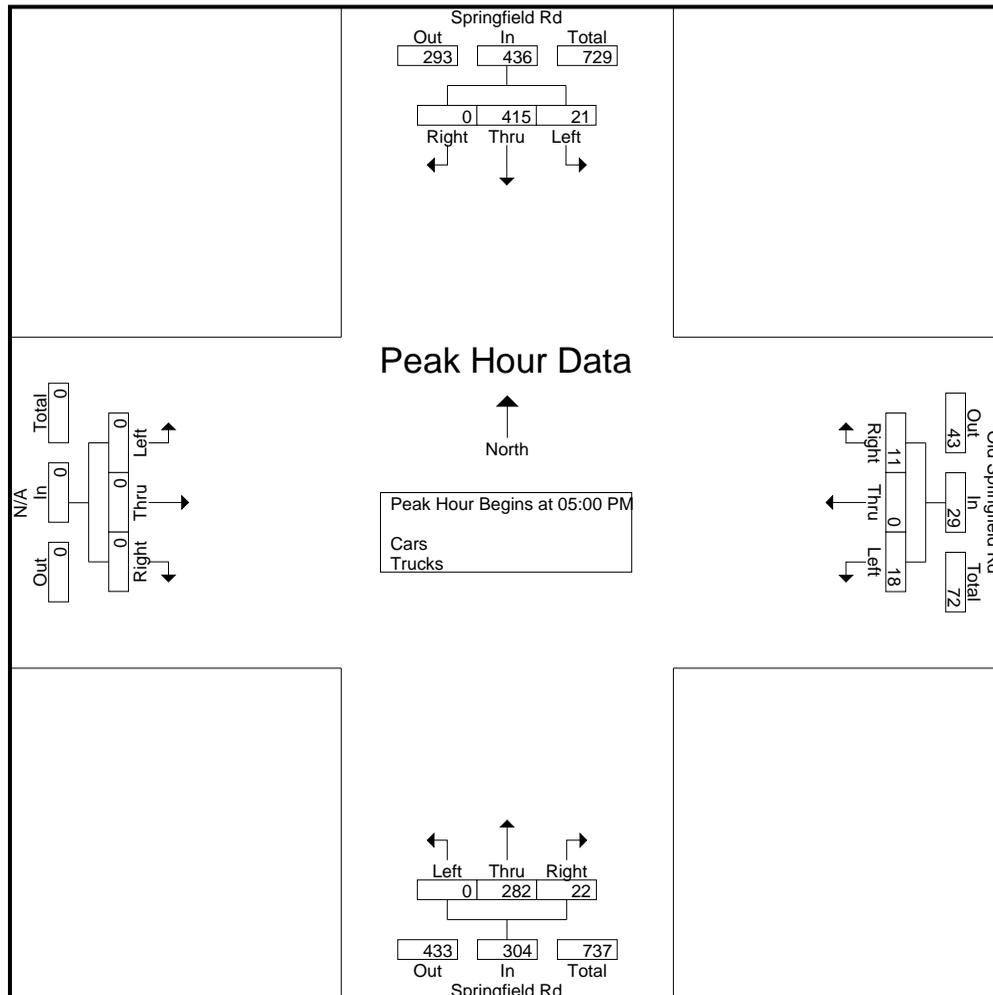
305 West Fourth Street
Winston-Salem, NC 27101
(336) 744-1636

Counted By: M. Davenport

File Name : Springfield Rd at Old Springfield Rd
Site Code : 00012317
Start Date : 3/27/2012
Page No : 4

Weather: Clear

Start Time	Springfield Rd Southbound				Old Springfield Rd Westbound				Springfield Rd Northbound				N/A Eastbound				Int. Total
	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	
Peak Hour Analysis From 04:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 05:00 PM																	
05:00 PM	2	97	0	99	1	0	3	4	0	58	4	62	0	0	0	0	165
05:15 PM	4	109	0	113	9	0	2	11	0	55	5	60	0	0	0	0	184
05:30 PM	5	116	0	121	3	0	3	6	0	88	6	94	0	0	0	0	221
05:45 PM	10	93	0	103	5	0	3	8	0	81	7	88	0	0	0	0	199
Total Volume	21	415	0	436	18	0	11	29	0	282	22	304	0	0	0	0	769
% App. Total	4.8	95.2	0		62.1	0	37.9		0	92.8	7.2		0	0	0		
PHF	.525	.894	.000	.901	.500	.000	.917	.659	.000	.801	.786	.809	.000	.000	.000	.000	.870



Davenport Transportation Consulting

305 West Fourth Street
Winston-Salem, NC 27101
(336) 744-1636

Counted By: M. Davenport

File Name : Springfield Rd at Francistown Rd
Site Code : 00012317
Start Date : 3/28/2012
Page No : 1

Weather: Clear

Groups Printed- Cars - Trucks

Start Time	Springfield Rd Southbound					Springfield Rd Westbound					Francistown Rd Northbound					N/A Eastbound					Exclu. Total	Inclu. Total	Int. Total
	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total			
07:00 AM	38	5	0	0	43	36	0	21	0	57	0	5	57	0	62	0	0	0	0	0	0	162	162
07:15 AM	38	36	0	0	74	57	0	39	0	96	0	18	54	0	72	0	0	0	0	0	0	242	242
07:30 AM	63	46	0	0	109	70	0	46	0	116	0	27	80	0	107	0	0	0	0	0	0	332	332
07:45 AM	78	22	0	0	100	67	0	87	0	154	0	29	72	0	101	0	0	0	0	0	0	355	355
Total	217	109	0	0	326	230	0	193	0	423	0	79	263	0	342	0	0	0	0	0	0	1091	1091
08:00 AM	67	13	0	0	80	60	0	83	0	143	0	17	78	0	95	0	0	0	0	0	0	318	318
08:15 AM	66	12	0	0	78	54	0	80	0	134	0	10	83	0	93	0	0	0	0	0	0	305	305
08:30 AM	74	4	0	0	78	49	0	59	0	108	0	7	68	0	75	0	0	0	0	0	0	261	261
08:45 AM	33	10	0	0	43	55	0	42	0	97	0	7	43	1	50	0	0	0	0	0	1	190	191
Total	240	39	0	0	279	218	0	264	0	482	0	41	272	1	313	0	0	0	0	0	1	1074	1075
09:00 AM	36	4	0	0	40	46	0	50	0	96	0	3	32	0	35	0	0	0	0	0	0	171	171
09:15 AM	23	4	0	0	27	35	0	43	0	78	0	9	32	0	41	0	0	0	0	0	0	146	146
09:30 AM	28	3	0	0	31	40	0	28	0	68	0	5	32	0	37	0	0	0	0	0	0	136	136
09:45 AM	38	4	0	0	42	36	0	28	0	64	0	5	27	0	32	0	0	0	0	0	0	138	138
Total	125	15	0	0	140	157	0	149	0	306	0	22	123	0	145	0	0	0	0	0	0	591	591
10:00 AM	20	6	0	0	26	28	0	32	0	60	0	4	35	0	39	0	0	0	0	0	0	125	125
10:15 AM	23	3	0	0	26	29	0	20	0	49	0	9	28	0	37	0	0	0	0	0	0	112	112
10:30 AM	33	3	0	0	36	30	0	29	2	59	0	1	25	0	26	0	0	0	0	0	2	121	123
10:45 AM	22	1	0	0	23	40	0	20	0	60	0	2	30	0	32	0	0	0	0	0	0	115	115
Total	98	13	0	0	111	127	0	101	2	228	0	16	118	0	134	0	0	0	0	0	2	473	475
11:00 AM	20	7	0	0	27	31	0	23	0	54	0	3	45	0	48	0	0	0	0	0	0	129	129
11:15 AM	22	5	0	3	27	20	0	20	2	40	0	6	39	2	45	0	0	0	0	0	7	112	119
11:30 AM	26	2	0	0	28	29	0	28	0	57	0	3	23	3	26	0	0	0	0	0	3	111	114
11:45 AM	19	3	0	0	22	38	0	36	0	74	0	4	22	0	26	0	0	0	0	0	0	122	122
Total	87	17	0	3	104	118	0	107	2	225	0	16	129	5	145	0	0	0	0	0	10	474	484
12:00 PM	37	7	0	0	44	33	0	37	1	70	0	6	32	0	38	0	0	0	0	0	1	152	153
12:15 PM	38	7	0	0	45	32	0	37	0	69	0	13	53	0	66	0	0	0	0	0	0	180	180
12:30 PM	36	8	0	0	44	29	0	40	0	69	0	4	35	0	39	0	0	0	0	0	0	152	152
12:45 PM	47	9	0	0	56	33	0	33	0	66	0	9	36	0	45	0	0	0	0	0	0	167	167
Total	158	31	0	0	189	127	0	147	1	274	0	32	156	0	188	0	0	0	0	0	1	651	652
01:00 PM	29	8	0	0	37	24	0	35	0	59	0	6	32	0	38	0	0	0	0	0	0	134	134
01:15 PM	37	9	0	0	46	39	0	44	0	83	0	7	48	0	55	0	0	0	0	0	0	184	184
01:30 PM	35	9	0	0	44	46	0	43	0	89	0	6	35	0	41	0	0	0	0	0	0	174	174
01:45 PM	37	8	0	1	45	40	0	46	1	86	0	6	35	1	41	0	0	0	0	0	3	172	175
Total	138	34	0	1	172	149	0	168	1	317	0	25	150	1	175	0	0	0	0	0	3	664	667
02:00 PM	48	12	0	1	60	35	0	46	0	81	0	9	52	0	61	0	0	0	0	0	1	202	203
02:15 PM	34	15	0	0	49	38	0	24	0	62	0	15	57	0	72	0	0	0	0	0	0	183	183
02:30 PM	42	12	0	0	54	48	0	31	0	79	0	9	43	0	52	0	0	0	0	0	0	185	185
02:45 PM	46	9	0	0	55	43	0	40	0	83	0	8	42	0	50	0	0	0	0	0	0	188	188
Total	170	48	0	1	218	164	0	141	0	305	0	41	194	0	235	0	0	0	0	0	1	758	759
03:00 PM	32	13	0	0	45	31	0	20	0	51	0	11	44	0	55	0	0	0	0	0	0	151	151
03:15 PM	63	3	0	0	66	45	0	31	0	76	0	8	71	0	79	0	0	0	0	0	0	221	221
03:30 PM	46	11	0	0	57	48	0	35	0	83	0	3	63	0	66	0	0	0	0	0	0	206	206
03:45 PM	46	6	0	0	52	79	0	43	0	122	0	8	60	0	68	0	0	0	0	0	0	242	242
Total	187	33	0	0	220	203	0	129	0	332	0	30	238	0	268	0	0	0	0	0	0	820	820

Davenport Transportation Consulting

305 West Fourth Street
Winston-Salem, NC 27101

(336) 744-1636

Counted By: M. Davenport

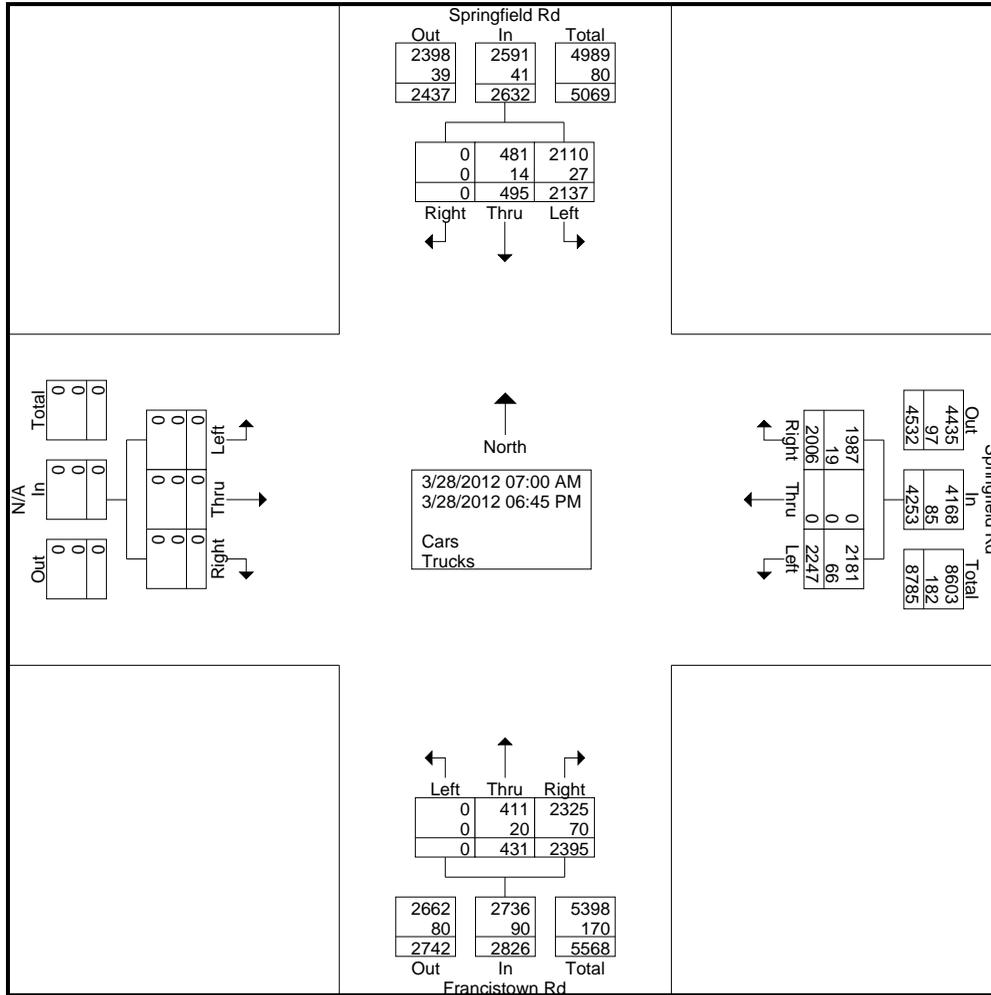
File Name : Springfield Rd at Francistown Rd

Site Code : 00012317

Start Date : 3/28/2012

Page No : 3

Weather: Clear



Davenport Transportation Consulting

305 West Fourth Street
Winston-Salem, NC 27101
(336) 744-1636

Counted By: M. Davenport

File Name : Springfield Rd at Francistown Rd

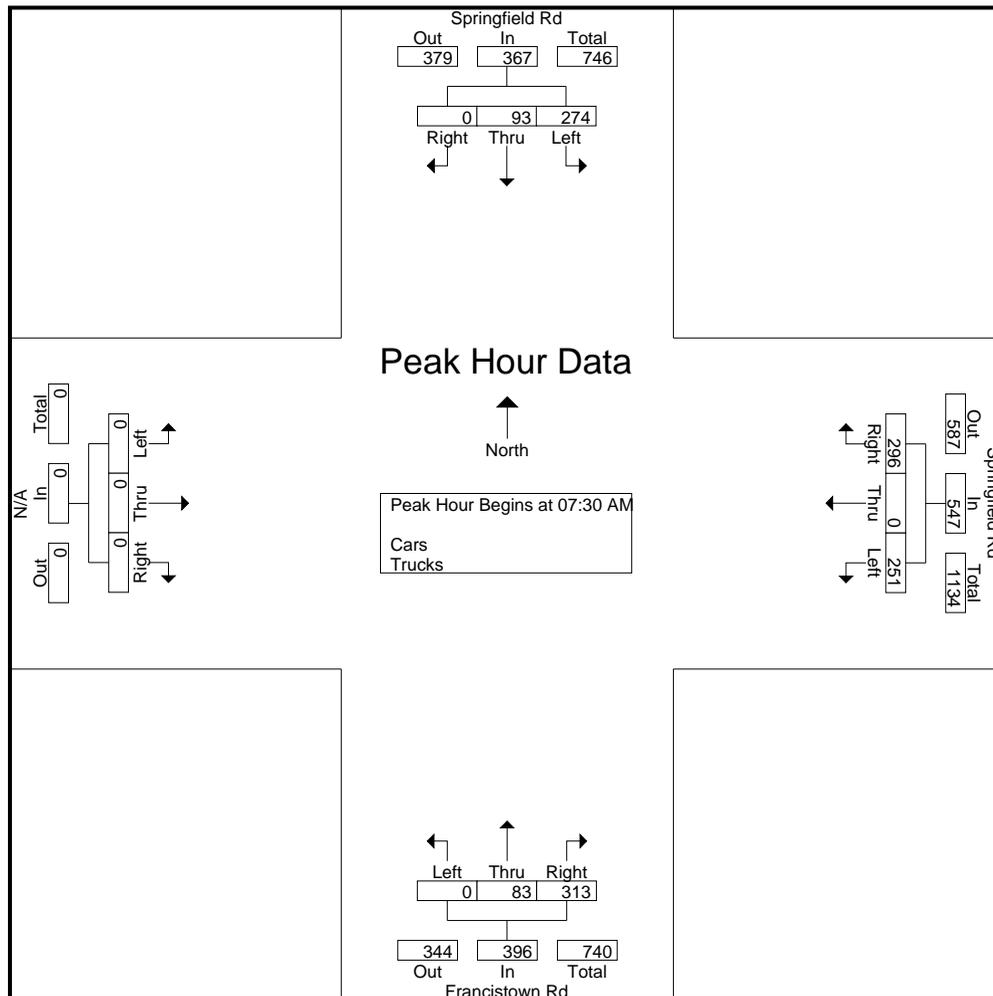
Site Code : 00012317

Start Date : 3/28/2012

Page No : 4

Weather: Clear

Start Time	Springfield Rd Southbound				Springfield Rd Westbound				Francistown Rd Northbound				N/A Eastbound				Int. Total
	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 07:30 AM																	
07:30 AM	63	46	0	109	70	0	46	116	0	27	80	107	0	0	0	0	332
07:45 AM	78	22	0	100	67	0	87	154	0	29	72	101	0	0	0	0	355
08:00 AM	67	13	0	80	60	0	83	143	0	17	78	95	0	0	0	0	318
08:15 AM	66	12	0	78	54	0	80	134	0	10	83	93	0	0	0	0	305
Total Volume	274	93	0	367	251	0	296	547	0	83	313	396	0	0	0	0	1310
% App. Total	74.7	25.3	0		45.9	0	54.1		0	21	79		0	0	0		
PHF	.878	.505	.000	.842	.896	.000	.851	.888	.000	.716	.943	.925	.000	.000	.000	.000	.923



Davenport Transportation Consulting

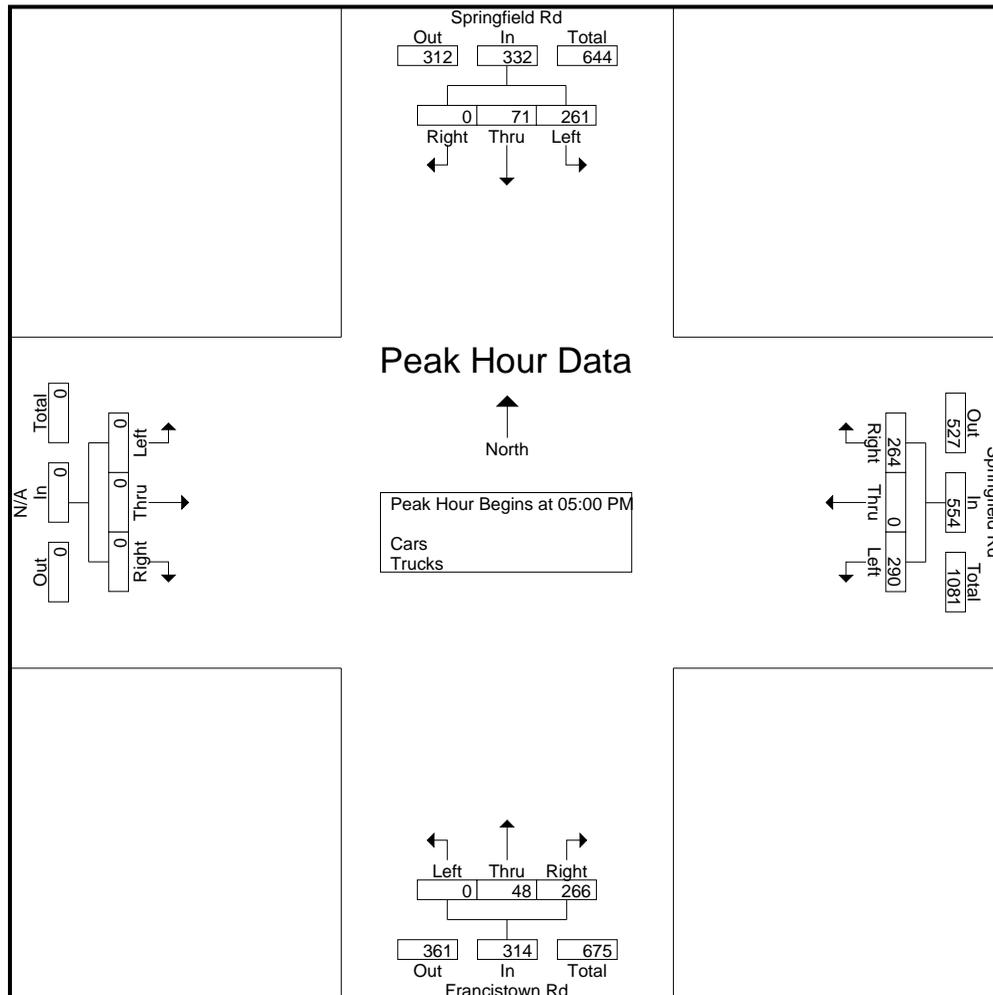
305 West Fourth Street
Winston-Salem, NC 27101
(336) 744-1636

Counted By: M. Davenport

File Name : Springfield Rd at Francistown Rd
Site Code : 00012317
Start Date : 3/28/2012
Page No : 5

Weather: Clear

Start Time	Springfield Rd Southbound				Springfield Rd Westbound				Francistown Rd Northbound				N/A Eastbound				Int. Total
	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	
Peak Hour Analysis From 04:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 05:00 PM																	
05:00 PM	89	21	0	110	71	0	55	126	0	17	70	87	0	0	0	0	323
05:15 PM	63	21	0	84	53	0	73	126	0	6	71	77	0	0	0	0	287
05:30 PM	38	13	0	51	85	0	77	162	0	12	53	65	0	0	0	0	278
05:45 PM	71	16	0	87	81	0	59	140	0	13	72	85	0	0	0	0	312
Total Volume	261	71	0	332	290	0	264	554	0	48	266	314	0	0	0	0	1200
% App. Total	78.6	21.4	0		52.3	0	47.7		0	15.3	84.7		0	0	0		
PHF	.733	.845	.000	.755	.853	.000	.857	.855	.000	.706	.924	.902	.000	.000	.000	.000	.929



Davenport Transportation Consulting

305 West Fourth Street
Winston-Salem, NC 27101
(336) 744-1636

Counted By: J. Williams, L. Reid

File Name : Staples Mill Rd at Mountain Rd & Springfield Rd

Site Code : 00012317

Start Date : 3/28/2012

Page No : 1

Weather: Clear

Groups Printed- Cars - Trucks

Start Time	Staples Mill Rd Southbound					Mountain Rd Westbound					Staples Mill Rd Northbound					Springfield Rd Eastbound					Exclu. Total	Inclu. Total	Int. Total
	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total			
07:00 AM	13	122	27	0	162	23	11	23	3	57	14	96	11	0	121	65	12	26	0	103	3	443	446
07:15 AM	20	145	37	0	202	34	26	42	1	102	23	73	12	1	108	62	24	11	1	97	3	509	512
07:30 AM	36	218	56	2	310	44	32	51	1	127	35	101	15	1	151	95	27	31	1	153	5	741	746
07:45 AM	27	196	74	0	297	44	39	58	0	141	35	89	12	0	136	87	36	27	1	150	1	724	725
Total	96	681	194	2	971	145	108	174	5	427	107	359	50	2	516	309	99	95	3	503	12	2417	2429
08:00 AM	18	214	55	3	287	38	47	38	0	123	36	101	14	0	151	94	25	21	0	140	3	701	704
08:15 AM	17	166	57	0	240	50	37	34	0	121	37	104	14	0	155	83	23	41	0	147	0	663	663
08:30 AM	32	219	45	0	296	46	30	27	0	103	32	107	10	0	149	67	19	52	0	138	0	686	686
08:45 AM	17	133	28	0	178	21	18	25	0	64	51	102	12	0	165	56	12	11	0	79	0	486	486
Total	84	732	185	3	1001	155	132	124	0	411	156	414	50	0	620	300	79	125	0	504	3	2536	2539
09:00 AM	10	108	47	0	165	26	27	25	0	78	19	54	16	0	89	45	11	13	0	69	0	401	401
09:15 AM	18	98	28	0	144	17	37	26	0	80	14	87	10	0	111	22	11	14	0	47	0	382	382
09:30 AM	7	95	30	0	132	19	21	19	0	59	19	63	14	0	96	35	10	16	0	61	0	348	348
09:45 AM	11	81	29	0	121	15	16	16	0	47	16	61	8	0	85	35	13	15	0	63	0	316	316
Total	46	382	134	0	562	77	101	86	0	264	68	265	48	0	381	137	45	58	0	240	0	1447	1447
10:00 AM	21	76	29	0	126	19	15	13	0	47	15	62	12	0	89	26	15	17	0	58	0	320	320
10:15 AM	16	85	26	0	127	11	13	16	0	40	12	82	10	0	104	24	10	11	0	45	0	316	316
10:30 AM	10	72	27	0	109	10	14	15	0	39	18	59	9	0	86	29	15	12	0	56	0	290	290
10:45 AM	7	80	22	0	109	10	16	17	0	43	22	78	14	0	114	27	12	12	0	51	0	317	317
Total	54	313	104	0	471	50	58	61	0	169	67	281	45	0	393	106	52	52	0	210	0	1243	1243
11:00 AM	11	67	18	0	96	12	16	12	0	40	16	70	12	0	98	45	10	12	0	67	0	301	301
11:15 AM	19	83	18	0	120	14	12	13	0	39	11	46	9	0	66	40	15	4	0	59	0	284	284
11:30 AM	25	63	27	0	115	20	16	14	0	50	16	72	6	0	94	31	11	7	0	49	0	308	308
11:45 AM	23	90	34	0	147	12	22	16	0	50	18	69	11	0	98	23	11	8	1	42	1	337	338
Total	78	303	97	0	478	58	66	55	0	179	61	257	38	0	356	139	47	31	1	217	1	1230	1231
12:00 PM	11	99	29	0	139	16	20	11	0	47	21	102	13	0	136	33	19	14	1	66	1	388	389
12:15 PM	36	89	20	0	145	13	14	13	0	40	33	96	13	0	142	41	27	18	1	86	1	413	414
12:30 PM	12	90	21	0	123	14	25	16	0	55	24	78	14	0	116	45	17	14	0	76	0	370	370
12:45 PM	22	71	23	0	116	10	13	20	0	43	28	89	13	1	130	43	27	14	0	84	1	373	374
Total	81	349	93	0	523	53	72	60	0	185	106	365	53	1	524	162	90	60	2	312	3	1544	1547
01:00 PM	15	68	20	0	103	10	19	26	1	55	18	78	23	0	119	32	16	15	0	63	1	340	341
01:15 PM	19	63	24	0	106	10	22	18	0	50	29	74	19	0	122	41	25	19	0	85	0	363	363
01:30 PM	11	69	31	0	111	28	22	17	0	67	39	84	14	0	137	31	20	19	0	70	0	385	385
01:45 PM	17	69	35	0	121	20	22	14	0	56	24	60	21	0	105	35	19	16	0	70	0	352	352
Total	62	269	110	0	441	68	85	75	1	228	110	296	77	0	483	139	80	69	0	288	1	1440	1441
02:00 PM	15	64	26	0	105	13	17	12	0	42	31	72	20	0	123	45	25	25	0	95	0	365	365
02:15 PM	33	59	22	0	114	15	21	23	0	59	20	75	19	1	114	38	27	21	0	86	1	373	374
02:30 PM	18	63	31	0	112	15	25	19	0	59	23	77	21	0	121	36	21	22	0	79	0	371	371
02:45 PM	15	64	32	0	111	13	16	22	0	51	26	72	27	0	125	38	33	15	0	86	0	373	373
Total	81	250	111	0	442	56	79	76	0	211	100	296	87	1	483	157	106	83	0	346	1	1482	1483
03:00 PM	20	104	12	0	136	38	23	16	0	77	14	67	33	0	114	35	25	19	0	79	0	406	406
03:15 PM	17	80	16	0	113	50	46	26	0	122	22	84	39	0	145	48	42	27	0	117	0	497	497
03:30 PM	22	102	26	0	150	40	32	28	0	100	28	90	30	0	148	44	23	36	0	103	0	501	501
03:45 PM	43	112	43	0	198	43	39	24	0	106	46	85	44	0	175	46	30	27	0	103	0	582	582
Total	102	398	97	0	597	171	140	94	0	405	110	326	146	0	582	173	120	109	0	402	0	1986	1986

Davenport Transportation Consulting

305 West Fourth Street
Winston-Salem, NC 27101
(336) 744-1636

Counted By: J. Williams, L. Reid

File Name : Staples Mill Rd at Mountain Rd & Springfield Rd
Site Code : 00012317
Start Date : 3/28/2012
Page No : 2

Weather: Clear

Groups Printed- Cars - Trucks

Start Time	Staples Mill Rd Southbound					Mountain Rd Westbound					Staples Mill Rd Northbound					Springfield Rd Eastbound					Exclu. Total	Inclu. Total	Int. Total
	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total			
04:00 PM	24	121	28	0	173	43	28	28	0	99	33	98	42	0	173	54	35	32	0	121	0	566	566
04:15 PM	40	135	32	0	207	55	35	22	0	112	44	109	45	0	198	63	26	27	0	116	0	633	633
04:30 PM	25	144	29	0	198	48	27	33	0	108	40	112	56	0	208	57	27	28	0	112	0	626	626
04:45 PM	38	163	25	0	226	67	33	24	0	124	44	135	49	0	228	63	51	39	0	153	0	731	731
Total	127	563	114	0	804	213	123	107	0	443	161	454	192	0	807	237	139	126	0	502	0	2556	2556
05:00 PM	33	175	20	0	228	73	49	27	1	149	57	106	43	0	206	65	50	41	1	156	2	739	741
05:15 PM	33	208	31	1	272	58	58	40	2	156	37	138	44	0	219	60	50	23	0	133	3	780	783
05:30 PM	24	170	41	0	235	72	65	40	0	177	57	120	54	0	231	45	28	18	0	91	0	734	734
05:45 PM	38	201	28	0	267	33	45	18	0	96	70	129	46	1	245	60	51	32	0	143	1	751	752
Total	128	754	120	1	1002	236	217	125	3	578	221	493	187	1	901	230	179	114	1	523	6	3004	3010
06:00 PM	60	134	24	0	218	48	55	33	0	136	54	97	44	0	195	54	51	30	0	135	0	684	684
06:15 PM	40	161	32	0	233	55	39	28	0	122	41	81	29	0	151	59	21	28	0	108	0	614	614
06:30 PM	43	131	18	0	192	38	49	16	0	103	40	104	23	0	167	48	28	16	0	92	0	554	554
06:45 PM	46	124	22	0	192	36	16	17	0	69	25	100	28	1	153	42	29	18	0	89	1	503	504
Total	189	550	96	0	835	177	159	94	0	430	160	382	124	1	666	203	129	92	0	424	1	2355	2356
Grand Total	1128	5544	1455	6	8127	1459	1340	1131	9	3930	1427	4188	1097	6	6712	2292	1165	1014	7	4471	28	23240	23268
Apprch %	13.9	68.2	17.9			37.1	34.1	28.8			21.3	62.4	16.3			51.3	26.1	22.7					
Total %	4.9	23.9	6.3		35	6.3	5.8	4.9		16.9	6.1	18	4.7		28.9	9.9	5	4.4		19.2	0.1	99.9	
Cars	1109	5490	1443		8048	1443	1313	1103		3868	1410	4132	1079		6627	2271	1153	996		4427	0	0	22970
% Cars	98.3	99	99.2	100	99	98.9	98	97.5	100	98.2	98.8	98.7	98.4	100	98.6	99.1	99	98.2	100	98.9	0	0	98.7
Trucks	19	54	12		85	16	27	28		71	17	56	18		91	21	12	18		51	0	0	298
% Trucks	1.7	1	0.8	0	1	1.1	2	2.5	0	1.8	1.2	1.3	1.6	0	1.4	0.9	1	1.8	0	1.1	0	0	1.3

Davenport Transportation Consulting

305 West Fourth Street
Winston-Salem, NC 27101

(336) 744-1636

Counted By: J. Williams, L. Reid

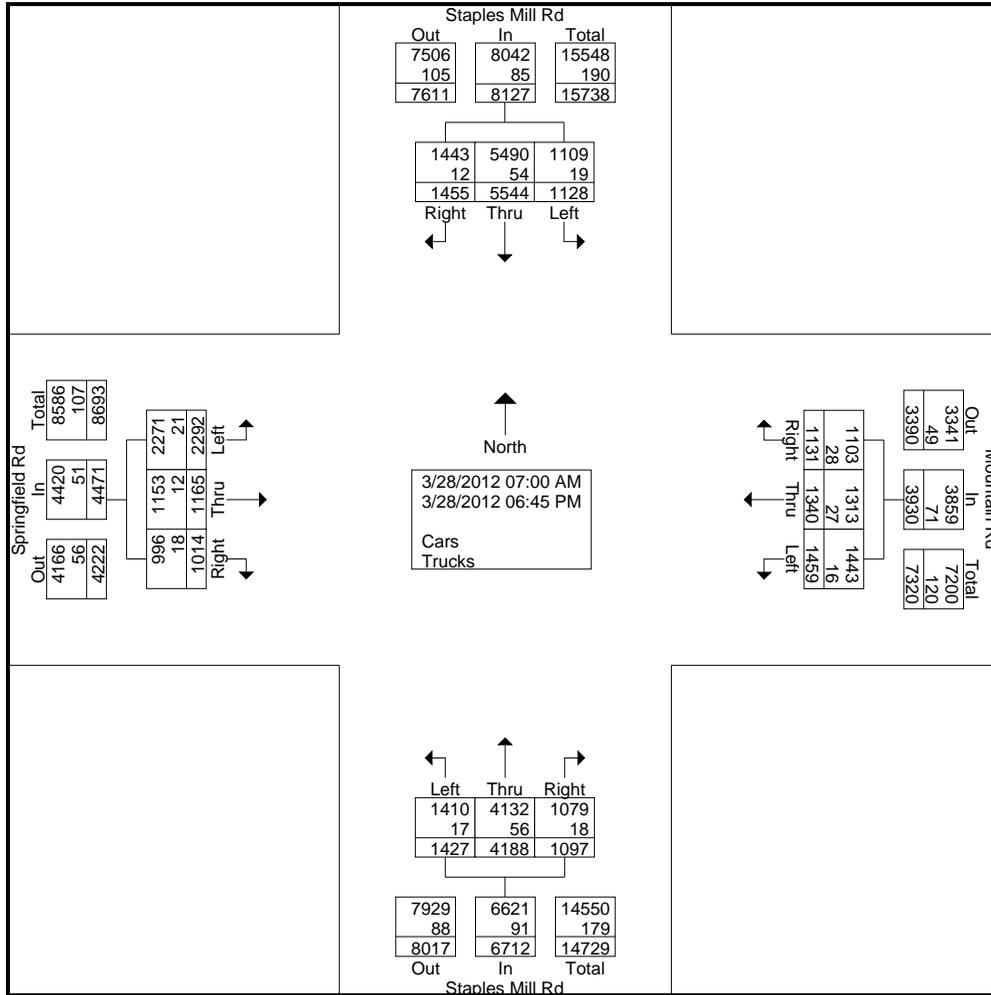
File Name : Staples Mill Rd at Mountain Rd & Springfield Rd

Site Code : 00012317

Start Date : 3/28/2012

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Weather: Clear



Davenport Transportation Consulting

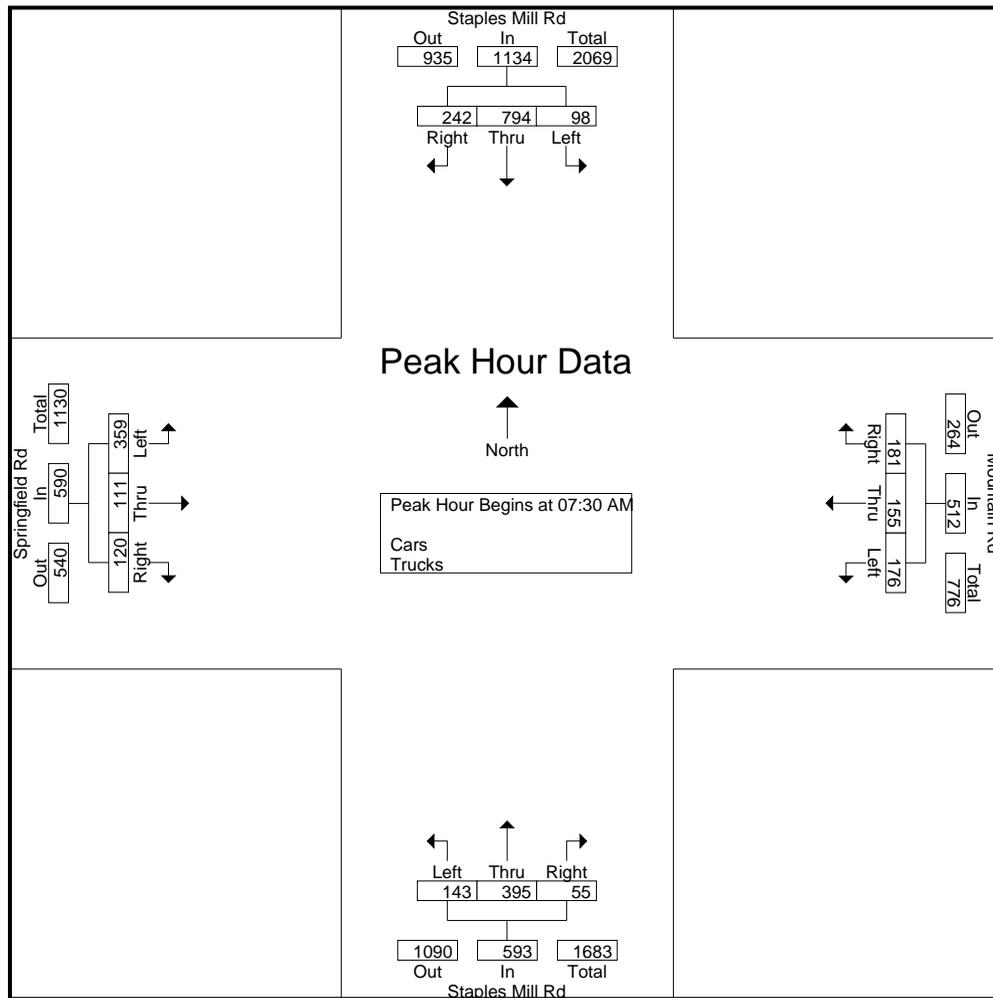
305 West Fourth Street
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Counted By: J. Williams, L. Reid

File Name : Staples Mill Rd at Mountain Rd & Springfield Rd
Site Code : 00012317
Start Date : 3/28/2012
Page No : 4

Weather: Clear

Start Time	Staples Mill Rd Southbound				Mountain Rd Westbound				Staples Mill Rd Northbound				Springfield Rd Eastbound				Int. Total
	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 07:30 AM																	
07:30 AM	36	218	56	310	44	32	51	127	35	101	15	151	95	27	31	153	741
07:45 AM	27	196	74	297	44	39	58	141	35	89	12	136	87	36	27	150	724
08:00 AM	18	214	55	287	38	47	38	123	36	101	14	151	94	25	21	140	701
08:15 AM	17	166	57	240	50	37	34	121	37	104	14	155	83	23	41	147	663
Total Volume	98	794	242	1134	176	155	181	512	143	395	55	593	359	111	120	590	2829
% App. Total	8.6	70	21.3		34.4	30.3	35.4		24.1	66.6	9.3		60.8	18.8	20.3		
PHF	.681	.911	.818	.915	.880	.824	.780	.908	.966	.950	.917	.956	.945	.771	.732	.964	.954



Davenport Transportation Consulting

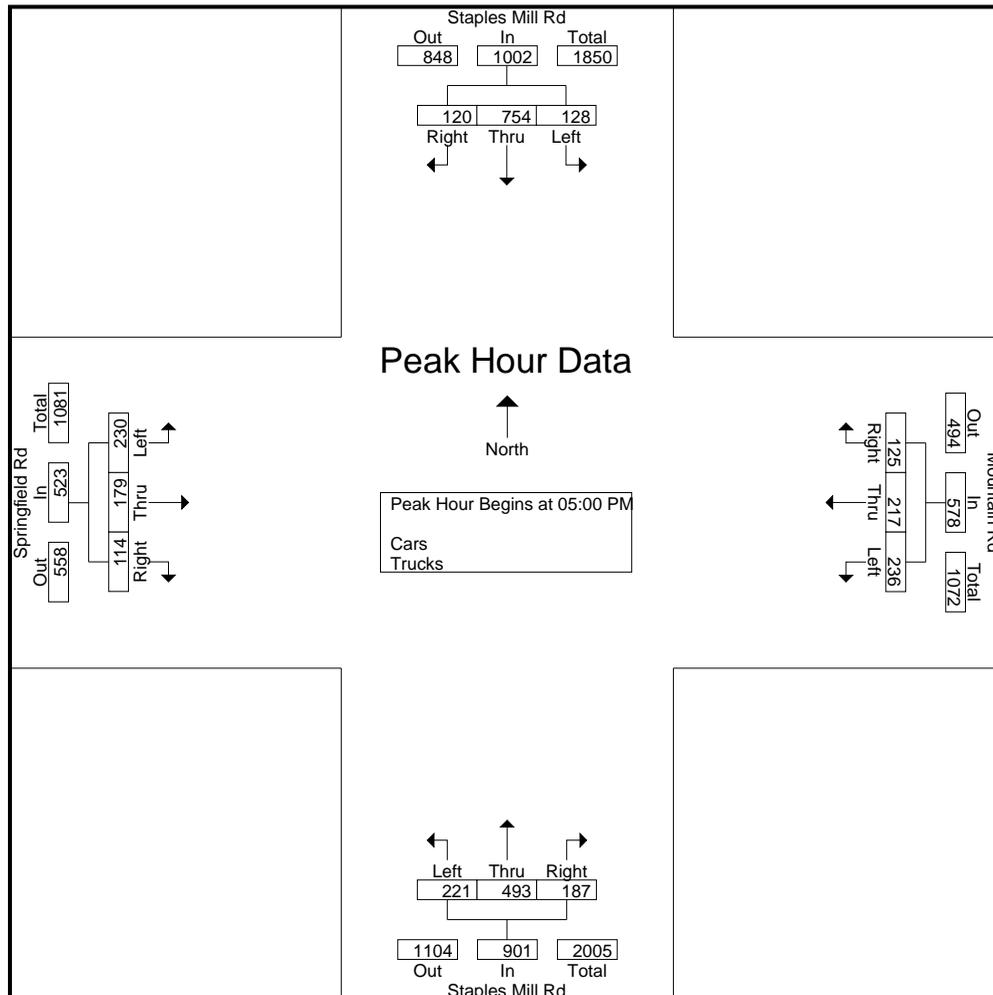
305 West Fourth Street
Winston-Salem, NC 27101
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Counted By: J. Williams, L. Reid

File Name : Staples Mill Rd at Mountain Rd & Springfield Rd
Site Code : 00012317
Start Date : 3/28/2012
Page No : 5

Weather: Clear

Start Time	Staples Mill Rd Southbound				Mountain Rd Westbound				Staples Mill Rd Northbound				Springfield Rd Eastbound				Int. Total
	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	
Peak Hour Analysis From 04:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 05:00 PM																	
05:00 PM	33	175	20	228	73	49	27	149	57	106	43	206	65	50	41	156	739
05:15 PM	33	208	31	272	58	58	40	156	37	138	44	219	60	50	23	133	780
05:30 PM	24	170	41	235	72	65	40	177	57	120	54	231	45	28	18	91	734
05:45 PM	38	201	28	267	33	45	18	96	70	129	46	245	60	51	32	143	751
Total Volume	128	754	120	1002	236	217	125	578	221	493	187	901	230	179	114	523	3004
% App. Total	12.8	75.2	12		40.8	37.5	21.6		24.5	54.7	20.8		44	34.2	21.8		
PHF	.842	.906	.732	.921	.808	.835	.781	.816	.789	.893	.866	.919	.885	.877	.695	.838	.963



SR 157 ADT SUMMARY

Intersection	Count	Street Name	Dir 1	27-Mar-12	28-Mar-12	Average	Dir 2	27-Mar-12	28-Mar-12	Average	ADT	ph ADT	K factor	Weighted Avg	ADT
2	1	Fireside Drive	Entering	370	361	365.5	Exiting	380	375	377.5	743.00				743 vehicles
	2	Springfield N O Fireside	NB	4615	4609	4612	SB	4826	4859	4842.5	9,455.00	1,075.00	0.1137	0.0311	9455 vehicles
3	3	Kingscroft Drive	Entering	357	364	360.5	Exiting	458	478	468	829.00				829 vehicles
4	4	Wendhurst	Entering	386	421	403.5	Exiting	507	460	483.5	887.00				887 vehicles
6	5	Olde Milbrooke Way	Entering	239	259	249	Exiting	265	276	270.5	520.00				520 vehicles
7	6	Lindsey Lakes	Entering	595	618	606.5	Exiting	595	607	601	1,208.00				1208 vehicles
7	7	Wintergreen	Entering	331	371	351	Exiting	639	689	664	1,015.00				1015 vehicles
9	8	Wintercreek	Entering	488	468	478	Exiting	479	450	464.5	943.00				943 vehicles
8	9	Jacob Creek Drive	Entering	142	151	146.5	Exiting	221	264	242.5	389.00				389 vehicles
10	10	Hart Mill Drive	Entering	42	34	38	Exiting	276	171	223.5	262.00				262 vehicles
	11	Old Forester Lane/Bernard Mills Dr	Entering	335	334	334.5	Exiting	141	130	135.5	470.00				470 vehicles
12	12	Old Hartley Drive	Entering	289	296	292.5	Exiting	294	297	295.5	588.00				588 vehicles
	13	Springfield S O Carrington	NB	3308	3174	3241	SB	3383	3336	3359.5	6,601.00	1,020.00	0.1545	0.0295	6601 vehicles
15	14	Old Springfield Road	Entering	322	330	326	Exiting	374	391	382.5	709.00				709 vehicles
16	15	Rigney Terrace	Entering	161	167	164	Exiting	171	168	169.5	334.00				334 vehicles
	16	Springfield btw Rigney and Springfield	NB	3417	3337	3377	SB	3519	3520	3519.5	6,897.00	995.00	0.1443	0.0288	6897 vehicles
17	17	Francistown Road	NB	3516	3562	3539	SB	3927	4043	3985	7,524.00				7524 vehicles
	18	Springfield btw Springfield and Staples Mill	EB	5693	5638	5665.5	WB	6039	5931	5985	11,651.00	1,355.00	0.1163	0.0392	11651 vehicles
											34,604.00	4,445.00			0.13 K-factor

Appendix B
Description of Level-of-Service
Methods and Criteria

APPENDIX B LEVEL-OF-SERVICE CONCEPT

Level of service (LOS) is a concept developed to quantify the degree of comfort (including such elements as travel time, number of stops, total amount of stopped delay, and impediments caused by other vehicles) afforded to drivers as they travel through an intersection or roadway segment. Six grades are used to denote the various level of service from “A” to “F”.⁷

Signalized Intersections

The six level-of-service grades are described qualitatively for signalized intersections in Table B1. Additionally, Table B2 identifies the relationship between level of service and average control delay per vehicle. Control delay is defined to include initial deceleration delay, queue move-up time, stopped delay, and final acceleration delay. Using this definition, Level of Service “D” is generally considered to represent the minimum acceptable design standard.

Table B1 Level-of-Service Definitions (Signalized Intersections)

Level of Service	Average Delay per Vehicle
A	Very low average control delay, less than 10 seconds per vehicle. This occurs when progression is extremely favorable, and most vehicles arrive during the green phase. Most vehicles do not stop at all. Short cycle lengths may also contribute to low delay.
B	Average control delay is greater than 10 seconds per vehicle and less than or equal to 20 seconds per vehicle. This generally occurs with good progression and/or short cycle lengths. More vehicles stop than for a level of service A, causing higher levels of average delay.
C	Average control delay is greater than 20 seconds per vehicle and less than or equal to 35 seconds per vehicle. These higher delays may result from fair progression and/or longer cycle lengths. Individual cycle failures may begin to appear at this level. The number of vehicles stopping is significant at this level, although many still pass through the intersection without stopping.
D	Average control delay is greater than 35 seconds per vehicle and less than or equal to 55 seconds per vehicle. The influence of congestion becomes more noticeable. Longer delays may result from some combination of unfavorable progression, long cycle length, or high volume/capacity ratios. Many vehicles stop, and the proportion of vehicles not stopping declines. Individual cycle failures are noticeable.
E	Average control delay is greater than 55 seconds per vehicle and less than or equal to 80 seconds per vehicle. This is usually considered to be the limit of acceptable delay. These high delay values generally (but not always) indicate poor progression, long cycle lengths, and high volume/capacity ratios. Individual cycle failures are frequent occurrences.
F	Average control delay is in excess of 80 seconds per vehicle. This is considered to be unacceptable to most drivers. This condition often occurs with oversaturation. It may also occur at high volume/capacity ratios below 1.0 with many individual cycle failures. Poor progression and long cycle lengths may also contribute to such high delay values.

Most of the material in this Appendix is adapted from the Transportation Research Board, Highway Capacity Manual, (2000).

⁷ Most of the material in this Appendix is adapted from the Transportation Research Board, Highway Capacity Manual, (2000).

Table B2 Level-of-Service Criteria for Signalized Intersections

Level of Service	Average Control Delay per Vehicle (Seconds)
A	<10.0
B	>10 and (20
C	>20 and (35
D	>35 and (55
E	>55 and (80
F	>80

Unsignalized Intersections

Unsignalized intersections include two-way stop-controlled (TWSC) and all-way stop-controlled (AWSC) intersections. The 2000 Highway Capacity Manual (HCM) provides models for estimating control delay at both TWSC and AWSC intersections. A qualitative description of the various service levels associated with an unsignalized intersection is presented in Table B3. A quantitative definition of level of service for unsignalized intersections is presented in Table B4. Using this definition, Level of Service “E” is generally considered to represent the minimum acceptable design standard.

Table B3 Level-of-Service Criteria for Unsignalized Intersections

Level of Service	Average Delay per Vehicle to Minor Street
A	<ul style="list-style-type: none"> Nearly all drivers find freedom of operation. Very seldom is there more than one vehicle in queue.
B	<ul style="list-style-type: none"> Some drivers begin to consider the delay an inconvenience. Occasionally there is more than one vehicle in queue.
C	<ul style="list-style-type: none"> Many times there is more than one vehicle in queue. Most drivers feel restricted, but not objectionably so.
D	<ul style="list-style-type: none"> Often there is more than one vehicle in queue. Drivers feel quite restricted.
E	<ul style="list-style-type: none"> Represents a condition in which the demand is near or equal to the probable maximum number of vehicles that can be accommodated by the movement. There is almost always more than one vehicle in queue. Drivers find the delays approaching intolerable levels.
F	<ul style="list-style-type: none"> Forced flow. Represents an intersection failure condition that is caused by geometric and/or operational constraints external to the intersection.

Table B4 Level-of-Service Criteria for Unsignalized Intersections

Level of Service	Average Control Delay per Vehicle (Seconds)
A	<10.0
B	>10.0 and (15.0
C	>15.0 and (25.0
D	>25.0 and (35.0
E	>35.0 and (50.0
F	>50.0

It should be noted that the level-of-service criteria for unsignalized intersections are somewhat different than the criteria used for signalized intersections. The primary reason for this difference is that drivers expect different levels of performance from different kinds of transportation facilities. The expectation is that a signalized intersection is designed to carry higher traffic volumes than an unsignalized intersection. Additionally, there are a number of driver behavior considerations that combine to make delays at signalized intersections less galling than at unsignalized intersections. For example, drivers at signalized intersections are able to relax during the red interval, while drivers on the minor street approaches to TWSC intersections must remain attentive to the task of identifying acceptable gaps and vehicle conflicts. Also, there is often much more variability in the amount of delay experienced by individual drivers at unsignalized intersections than signalized intersections. For these reasons, it is considered that the control delay threshold for any given level of service is less for an unsignalized intersection than for a signalized intersection. While overall intersection level of service is calculated for AWSC intersections, level of service is only calculated for the minor approaches and the major street left turn movements at TWSC intersections. No delay is assumed to the major street through movements. For TWSC intersections, the overall intersection level of service remains undefined: level of service is only calculated for each minor street lane.

In the performance evaluation of TWSC intersections, it is important to consider other measures of effectiveness (MOEs) in addition to delay, such as v/c ratios for individual movements, average queue lengths, and 95th-percentile queue lengths. By focusing on a single MOE for the worst movement only, such as delay for the minor-street left turn, users may make inappropriate traffic control decisions. The potential for making such inappropriate decisions is likely to be particularly pronounced when the HCM level-of-service thresholds are adopted as legal standards, as is the case in many public agencies.

Appendix C
Existing Conditions
Level of Service Worksheets

Queues
1: Nuckols Road & Springfield Road

Existing Conditions
Weekday AM



Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Group Flow (vph)	132	411	1021	116	325	446
v/c Ratio	0.13	0.23	0.92	0.11	0.86	0.94
Control Delay	23.4	5.9	44.4	8.9	58.6	60.8
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	23.4	5.9	44.4	8.9	58.6	60.8
Queue Length 50th (ft)	28	44	285	27	180	246
Queue Length 95th (ft)	50	64	#406	51	#330	#432
Internal Link Dist (ft)	362			346	244	
Turn Bay Length (ft)	275	175	225			
Base Capacity (vph)	995	1818	1127	1097	376	479
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.13	0.23	0.91	0.11	0.86	0.93

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

HCM Signalized Intersection Capacity Analysis
1: Nuckols Road & Springfield Road

Existing Conditions
Weekday AM



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	125	390	970	110	309	424
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	11	11	12	12	12	12
Total Lost time (s)	5.0	5.0	5.0	6.0	6.0	5.0
Lane Util. Factor	0.97	0.88	0.97	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	3286	2668	3467	1881	1863	1583
Flt Permitted	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (perm)	3286	2668	3467	1881	1863	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	132	411	1021	116	325	446
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	132	411	1021	116	325	446
Heavy Vehicles (%)	3%	3%	1%	1%	2%	2%
Turn Type		pm+ov	Prot			Over
Protected Phases	3	5	5	2	6	3
Permitted Phases		3				
Actuated Green, G (s)	26.8	55.2	28.4	51.4	18.0	26.8
Effective Green, g (s)	26.8	55.2	28.4	51.4	18.0	26.8
Actuated g/C Ratio	0.30	0.62	0.32	0.58	0.20	0.30
Clearance Time (s)	5.0	5.0	5.0	6.0	6.0	5.0
Vehicle Extension (s)	5.0	3.0	3.0	6.0	6.0	5.0
Lane Grp Cap (vph)	987	1801	1104	1084	376	476
v/s Ratio Prot	0.04	0.07	c0.29	0.06	c0.17	c0.28
v/s Ratio Perm		0.08				
v/c Ratio	0.13	0.23	0.92	0.11	0.86	0.94
Uniform Delay, d1	22.7	7.5	29.4	8.5	34.4	30.4
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.1	0.1	12.7	0.1	20.4	26.9
Delay (s)	22.9	7.6	42.1	8.7	54.8	57.2
Level of Service	C	A	D	A	D	E
Approach Delay (s)	11.3			38.7	56.2	
Approach LOS	B			D	E	

Intersection Summary			
HCM Average Control Delay		38.1	HCM Level of Service D
HCM Volume to Capacity ratio		0.91	
Actuated Cycle Length (s)		89.2	Sum of lost time (s) 16.0
Intersection Capacity Utilization		62.3%	ICU Level of Service B
Analysis Period (min)		15	
c Critical Lane Group			

HCM Unsignalized Intersection Capacity Analysis

2: Fireside Drive &

Existing Conditions
Weekday AM



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	80	20	213	22	1	653
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91
Hourly flow rate (vph)	88	22	234	24	1	718
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage (veh)						
Upstream signal (ft)			377			
pX, platoon unblocked						
vC, conflicting volume	607	129			258	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	607	129			258	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	80	98			100	
cM capacity (veh/h)	432	903			1303	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	110	156	102	1	359	359
Volume Left	88	0	0	1	0	0
Volume Right	22	0	24	0	0	0
cSH	483	1700	1700	1303	1700	1700
Volume to Capacity	0.23	0.09	0.06	0.00	0.21	0.21
Queue Length 95th (ft)	22	0	0	0	0	0
Control Delay (s)	14.6	0.0	0.0	7.8	0.0	0.0
Lane LOS	B			A		
Approach Delay (s)	14.6	0.0		0.0		
Approach LOS	B					

Intersection Summary						
Average Delay			1.5			
Intersection Capacity Utilization			30.4%	ICU Level of Service		A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis

3: Kingscroft Drive & Springfield Road

Existing Conditions
Weekday AM



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↙		↑	↘		↘
Volume (veh/h)	72	18	206	27	1	582
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	83	21	237	31	1	669
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage (veh)						
Upstream signal (ft)			1118			
pX, platoon unblocked						
vC, conflicting volume	908	237			268	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	908	237			268	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	73	97			100	
cM capacity (veh/h)	308	807			1296	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1
Volume Total	103	237	31	670
Volume Left	83	0	0	1
Volume Right	21	0	31	0
cSH	351	1700	1700	1296
Volume to Capacity	0.29	0.14	0.02	0.00
Queue Length 95th (ft)	30	0	0	0
Control Delay (s)	19.5	0.0	0.0	0.0
Lane LOS	C			A
Approach Delay (s)	19.5	0.0		0.0
Approach LOS	C			

Intersection Summary			
Average Delay		1.9	
Intersection Capacity Utilization		43.2%	ICU Level of Service A
Analysis Period (min)		15	

HCM Unsignalized Intersection Capacity Analysis

4: Wendhurst Drive & Springfield Road

Existing Conditions

Weekday AM



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	74	10	202	22	5	509
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.83	0.83	0.83	0.83	0.83	0.83
Hourly flow rate (vph)	89	12	243	27	6	613
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	869	243			270	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	869	243			270	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	72	98			100	
cM capacity (veh/h)	324	800			1299	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1
Volume Total	101	243	27	619
Volume Left	89	0	0	6
Volume Right	12	0	27	0
cSH	348	1700	1700	1299
Volume to Capacity	0.29	0.14	0.02	0.00
Queue Length 95th (ft)	30	0	0	0
Control Delay (s)	19.5	0.0	0.0	0.1
Lane LOS	C			A
Approach Delay (s)	19.5	0.0		0.1
Approach LOS	C			

Intersection Summary			
Average Delay		2.1	
Intersection Capacity Utilization		42.1%	ICU Level of Service
Analysis Period (min)		15	A

HCM Unsignalized Intersection Capacity Analysis

5: Jones Road & Springfield Road

Existing Conditions
Weekday AM



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	5	5	2	210	509	5
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Hourly flow rate (vph)	6	6	2	233	566	6
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	806	568	571			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	806	568	571			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	98	99	100			
cM capacity (veh/h)	353	526	1002			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	11	236	571			
Volume Left	6	2	0			
Volume Right	6	0	6			
cSH	423	1002	1700			
Volume to Capacity	0.03	0.00	0.34			
Queue Length 95th (ft)	2	0	0			
Control Delay (s)	13.7	0.1	0.0			
Lane LOS	B	A				
Approach Delay (s)	13.7	0.1	0.0			
Approach LOS	B					
Intersection Summary						
Average Delay			0.2			
Intersection Capacity Utilization			37.1%		ICU Level of Service	A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis

6: Olde Milbrooke Way & Springfield Road

Existing Conditions
Weekday AM



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔			↔			↑	↗		↔	
Volume (veh/h)	5	0	5	22	0	23	3	203	9	3	487	12
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	6	0	6	25	0	26	3	228	10	3	547	13
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage (veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	821	806	554	801	802	228	561			238		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	821	806	554	801	802	228	561			238		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	100	99	92	100	97	100			100		
cM capacity (veh/h)	285	316	536	300	318	816	1010			1329		

Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1
Volume Total	11	51	231	10	564
Volume Left	6	25	3	0	3
Volume Right	6	26	0	10	13
cSH	372	444	1010	1700	1329
Volume to Capacity	0.03	0.11	0.00	0.01	0.00
Queue Length 95th (ft)	2	10	0	0	0
Control Delay (s)	15.0	14.2	0.2	0.0	0.1
Lane LOS	B	B	A		A
Approach Delay (s)	15.0	14.2	0.2		0.1
Approach LOS	B	B			

Intersection Summary		
Average Delay		1.1
Intersection Capacity Utilization	43.2%	ICU Level of Service
Analysis Period (min)		15
		A

HCM Unsignalized Intersection Capacity Analysis

7: Wintergreen Road & Springfield Road

Existing Conditions
Weekday AM

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	70	0	40	14	1	33	7	221	3	20	448	21
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	74	0	43	15	1	35	7	235	3	21	477	22
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage (veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	816	784	488	823	791	235	499			238		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	816	784	488	823	791	235	499			238		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	73	100	93	94	100	96	99			98		
cM capacity (veh/h)	278	319	582	266	314	804	1055			1329		
Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1							
Volume Total	117	51	243	3	520							
Volume Left	74	15	7	0	21							
Volume Right	43	35	0	3	22							
cSH	343	496	1055	1700	1329							
Volume to Capacity	0.34	0.10	0.01	0.00	0.02							
Queue Length 95th (ft)	37	9	1	0	1							
Control Delay (s)	20.8	13.1	0.3	0.0	0.5							
Lane LOS	C	B	A		A							
Approach Delay (s)	20.8	13.1	0.3		0.5							
Approach LOS	C	B										
Intersection Summary												
Average Delay			3.7									
Intersection Capacity Utilization			60.5%		ICU Level of Service					B		
Analysis Period (min)			15									

HCM Unsignalized Intersection Capacity Analysis
 8: Jacobs Creek Drive & Springfield Road

Existing Conditions
 Weekday AM



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	16	24	309	15	16	473
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	18	27	347	17	18	531
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	923	356			364	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	923	356			364	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	94	96			98	
cM capacity (veh/h)	297	693			1195	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	45	364	549
Volume Left	18	0	18
Volume Right	27	17	0
cSH	452	1700	1195
Volume to Capacity	0.10	0.21	0.02
Queue Length 95th (ft)	8	0	1
Control Delay (s)	13.8	0.0	0.4
Lane LOS	B		A
Approach Delay (s)	13.8	0.0	0.4
Approach LOS	B		

Intersection Summary			
Average Delay		0.9	
Intersection Capacity Utilization		47.8%	ICU Level of Service A
Analysis Period (min)		15	

HCM Unsignalized Intersection Capacity Analysis

9: Wintercreek Drive & Springfield Road

Existing Conditions
Weekday AM



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	34	51	19	314	438	10
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	39	58	22	357	498	11
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	903	503	509			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	903	503	509			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	87	90	98			
cM capacity (veh/h)	301	568	1056			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	97	378	509			
Volume Left	39	22	0			
Volume Right	58	0	11			
cSH	420	1056	1700			
Volume to Capacity	0.23	0.02	0.30			
Queue Length 95th (ft)	22	2	0			
Control Delay (s)	16.1	0.7	0.0			
Lane LOS	C	A				
Approach Delay (s)	16.1	0.7	0.0			
Approach LOS	C					
Intersection Summary						
Average Delay			1.8			
Intersection Capacity Utilization		43.8%		ICU Level of Service		A
Analysis Period (min)			15			

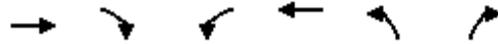
HCM Unsignalized Intersection Capacity Analysis
 10: Warnerwood Ct & Springfield Road

Existing Conditions
 Weekday AM

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	2	0	1	16	0	1	1	326	21	2	431	1
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Hourly flow rate (vph)	2	0	1	17	0	1	1	351	23	2	463	1
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage (veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	822	844	464	822	822	351	465			373		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	822	844	464	822	822	351	465			373		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	99	100	100	94	100	100	100			100		
cM capacity (veh/h)	291	298	596	294	311	697	1092			1191		
Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1							
Volume Total	3	18	352	23	467							
Volume Left	2	17	1	0	2							
Volume Right	1	1	0	23	1							
cSH	351	304	1092	1700	1191							
Volume to Capacity	0.01	0.06	0.00	0.01	0.00							
Queue Length 95th (ft)	1	5	0	0	0							
Control Delay (s)	15.4	17.6	0.0	0.0	0.1							
Lane LOS	C	C	A		A							
Approach Delay (s)	15.4	17.6	0.0		0.1							
Approach LOS	C	C										
Intersection Summary												
Average Delay			0.5									
Intersection Capacity Utilization			39.5%		ICU Level of Service				A			
Analysis Period (min)			15									

HCM Unsignalized Intersection Capacity Analysis
 11: Springfield Road & Bernard Mills Drive

Existing Conditions
 Weekday AM



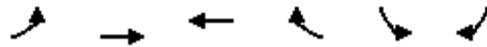
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑	↑		↑	↑	
Volume (veh/h)	315	14	1	428	6	9
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	358	16	1	486	7	10
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			374		847	358
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			374		847	358
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		98	99
cM capacity (veh/h)			1185		335	691

Direction, Lane #	EB 1	EB 2	WB 1	NB 1
Volume Total	358	16	488	17
Volume Left	0	0	1	7
Volume Right	0	16	0	10
cSH	1700	1700	1185	485
Volume to Capacity	0.21	0.01	0.00	0.04
Queue Length 95th (ft)	0	0	0	3
Control Delay (s)	0.0	0.0	0.0	12.7
Lane LOS			A	B
Approach Delay (s)	0.0		0.0	12.7
Approach LOS				B

Intersection Summary			
Average Delay		0.3	
Intersection Capacity Utilization		33.3%	ICU Level of Service
Analysis Period (min)		15	A

HCM Unsignalized Intersection Capacity Analysis
 12: Springfield Road & Olde Hartley Drive

Existing Conditions
 Weekday AM



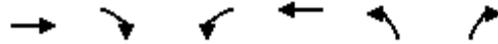
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↕	↕	↕	↕	
Volume (veh/h)	5	319	413	6	26	16
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	6	358	464	7	29	18
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	471				834	464
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	471				834	464
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	99				91	97
cM capacity (veh/h)	1091				333	592

Direction, Lane #	EB 1	WB 1	WB 2	SB 1
Volume Total	364	464	7	47
Volume Left	6	0	0	29
Volume Right	0	0	7	18
cSH	1091	1700	1700	399
Volume to Capacity	0.01	0.27	0.00	0.12
Queue Length 95th (ft)	0	0	0	10
Control Delay (s)	0.2	0.0	0.0	15.2
Lane LOS	A			C
Approach Delay (s)	0.2	0.0		15.2
Approach LOS				C

Intersection Summary			
Average Delay		0.9	
Intersection Capacity Utilization		31.7%	ICU Level of Service A
Analysis Period (min)		15	

HCM Unsignalized Intersection Capacity Analysis
 13: Springfield Road & Echo Lake Drive

Existing Conditions
 Weekday AM



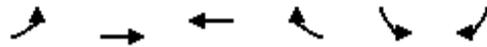
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	→			←	←	↘
Volume (veh/h)	330	15	1	411	8	12
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	359	16	1	447	9	13
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None		None			
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			375		816	367
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			375		816	367
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %						
cM capacity (veh/h)			1183		349	683

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	375	448	22
Volume Left	0	1	9
Volume Right	16	0	13
cSH	1700	1183	494
Volume to Capacity	0.22	0.00	0.04
Queue Length 95th (ft)	0	0	3
Control Delay (s)	0.0	0.0	12.6
Lane LOS		A	B
Approach Delay (s)	0.0	0.0	12.6
Approach LOS			B

Intersection Summary			
Average Delay		0.3	
Intersection Capacity Utilization	32.4%	ICU Level of Service	A
Analysis Period (min)		15	

HCM Unsignalized Intersection Capacity Analysis
 14: Springfield Road & Old Springfield Road

Existing Conditions
 Weekday AM



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↔	↔		↔	↔
Volume (veh/h)	7	335	385	12	39	27
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	7	353	405	13	41	28
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						2
Median type		None	None			
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	418				779	412
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	418				779	412
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	99				89	96
cM capacity (veh/h)	1147				362	640

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	360	418	69
Volume Left	7	0	41
Volume Right	0	13	28
cSH	1147	1700	613
Volume to Capacity	0.01	0.25	0.11
Queue Length 95th (ft)	0	0	10
Control Delay (s)	0.2	0.0	14.0
Lane LOS	A		B
Approach Delay (s)	0.2	0.0	14.0
Approach LOS			B

Intersection Summary			
Average Delay		1.2	
Intersection Capacity Utilization		33.2%	ICU Level of Service A
Analysis Period (min)		15	

HCM Unsignalized Intersection Capacity Analysis
 15: Rigney Terrace & Springfield Road

Existing Conditions
 Weekday AM



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	21	14	1	376	358	16
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	22	15	1	400	381	17
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	783	381	398			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	783	381	398			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	94	98	100			
cM capacity (veh/h)	365	671	1161			

Direction, Lane #	EB 1	NB 1	SB 1	SB 2
Volume Total	37	401	381	17
Volume Left	22	1	0	0
Volume Right	15	0	0	17
cSH	446	1161	1700	1700
Volume to Capacity	0.08	0.00	0.22	0.01
Queue Length 95th (ft)	7	0	0	0
Control Delay (s)	13.8	0.0	0.0	0.0
Lane LOS	B	A		
Approach Delay (s)	13.8	0.0	0.0	
Approach LOS	B			

Intersection Summary			
Average Delay		0.6	
Intersection Capacity Utilization		30.6%	ICU Level of Service A
Analysis Period (min)		15	

HCM Unsignalized Intersection Capacity Analysis
 16: Springfield Road & Francistown Road

Existing Conditions
 Weekday AM

						
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	250	294	83	317	278	94
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	272	320	90	345	302	102
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	797	90			435	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	797	90			435	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	0	67			73	
cM capacity (veh/h)	259	965			1125	
Direction, Lane #	WB 1	WB 2	NB 1	NB 2	SB 1	SB 2
Volume Total	272	320	90	345	302	102
Volume Left	272	0	0	0	302	0
Volume Right	0	320	0	345	0	0
cSH	259	965	1700	1700	1125	1700
Volume to Capacity	1.05	0.33	0.05	0.20	0.27	0.06
Queue Length 95th (ft)	273	36	0	0	27	0
Control Delay (s)	111.5	10.6	0.0	0.0	9.4	0.0
Lane LOS	F	B			A	
Approach Delay (s)	57.0		0.0		7.0	
Approach LOS	F					
Intersection Summary						
Average Delay			25.5			
Intersection Capacity Utilization			42.6%		ICU Level of Service	A
Analysis Period (min)			15			

Queues
17: Springfield Road & Staples Mill Road

Existing Conditions
Weekday AM



Lane Group	EBT	EBR	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Group Flow (vph)	499	127	349	191	152	416	58	103	836	257
v/c Ratio	1.11	0.26	1.05	0.43	0.90	0.47	0.13	0.61	0.95	0.52
Control Delay	118.4	7.4	110.0	9.1	102.4	41.0	10.2	67.0	65.4	21.5
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	118.4	7.4	110.0	9.1	102.4	41.0	10.2	67.0	65.4	21.5
Queue Length 50th (ft)	~443	0	~295	0	119	145	0	78	337	76
Queue Length 95th (ft)	#654	49	#482	63	#246	203	35	134	#464	161
Internal Link Dist (ft)	1531		132			423			575	
Turn Bay Length (ft)		575			150		125	200		125
Base Capacity (vph)	449	491	333	446	168	889	441	216	879	498
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	1.11	0.26	1.05	0.43	0.90	0.47	0.13	0.48	0.95	0.52

Intersection Summary

- ~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
- # 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

HCM Signalized Intersection Capacity Analysis
 17: Springfield Road & Staples Mill Road

Existing Conditions
 Weekday AM

													
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	
Lane Configurations													
Volume (vph)	362	112	121	176	156	181	144	395	55	98	794	244	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	
Total Lost time (s)		7.0	7.0		7.0	7.0	6.5	6.3	6.3	6.5	6.7	6.7	
Lane Util. Factor		1.00	1.00		1.00	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Frt		1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	
Flt Protected		0.96	1.00		0.97	1.00	0.95	1.00	1.00	0.95	1.00	1.00	
Satd. Flow (prot)		1794	1583		1815	1583	1787	3574	1599	1787	3574	1599	
Flt Permitted		0.96	1.00		0.97	1.00	0.95	1.00	1.00	0.95	1.00	1.00	
Satd. Flow (perm)		1794	1583		1815	1583	1787	3574	1599	1787	3574	1599	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	
Adj. Flow (vph)	381	118	127	185	164	191	152	416	58	103	836	257	
RTOR Reduction (vph)	0	0	95	0	0	156	0	0	44	0	0	105	
Lane Group Flow (vph)	0	499	32	0	349	35	152	416	14	103	836	152	
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	1%	1%	1%	1%	1%	1%	
Turn Type	Split		Perm	Split		Perm	Prot		Perm	Prot		Perm	
Protected Phases	3	3		4	4		1	6		5	2		
Permitted Phases			3			4			6			2	
Actuated Green, G (s)		30.0	30.0		22.0	22.0	11.3	29.9	29.9	11.3	29.5	29.5	
Effective Green, g (s)		30.0	30.0		22.0	22.0	11.3	29.9	29.9	11.3	29.5	29.5	
Actuated g/C Ratio		0.25	0.25		0.18	0.18	0.09	0.25	0.25	0.09	0.25	0.25	
Clearance Time (s)		7.0	7.0		7.0	7.0	6.5	6.3	6.3	6.5	6.7	6.7	
Vehicle Extension (s)		3.5	3.5		3.5	3.5	2.5	6.0	6.0	2.5	6.0	6.0	
Lane Grp Cap (vph)		449	396		333	290	168	891	398	168	879	393	
v/s Ratio Prot		c0.28			c0.19		c0.09	0.12		0.06	c0.23		
v/s Ratio Perm			0.02			0.02			0.01			0.10	
v/c Ratio		1.11	0.08		1.05	0.12	0.90	0.47	0.04	0.61	0.95	0.39	
Uniform Delay, d1		45.0	34.4		49.0	40.9	53.8	38.3	34.1	52.2	44.5	37.7	
Progression Factor		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2		76.4	0.1		62.4	0.2	42.8	1.8	0.2	5.6	20.2	1.8	
Delay (s)		121.4	34.5		111.4	41.1	96.6	40.0	34.3	57.8	64.7	39.5	
Level of Service		F	C		F	D	F	D	C	E	E	D	
Approach Delay (s)		103.8			86.6			53.2			58.7		
Approach LOS		F			F			D			E		
Intersection Summary													
HCM Average Control Delay			72.0									HCM Level of Service	E
HCM Volume to Capacity ratio			1.02										
Actuated Cycle Length (s)			120.0									Sum of lost time (s)	27.2
Intersection Capacity Utilization			96.5%									ICU Level of Service	F
Analysis Period (min)			15										

c Critical Lane Group

Queues
1: Nuckols Road & Springfield Road

Existing Conditions
Weekday PM



Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Group Flow (vph)	413	1245	360	238	232	152
v/c Ratio	0.42	0.74	0.64	0.22	0.34	0.26
Control Delay	26.8	4.6	40.2	9.8	23.8	5.4
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	26.8	4.6	40.2	9.8	23.8	5.4
Queue Length 50th (ft)	93	0	99	63	98	0
Queue Length 95th (ft)	137	50	137	99	167	42
Internal Link Dist (ft)	362			346	244	
Turn Bay Length (ft)	275	175	225			
Base Capacity (vph)	1038	1706	1117	1112	688	596
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.40	0.73	0.32	0.21	0.34	0.26

Intersection Summary

HCM Signalized Intersection Capacity Analysis
1: Nuckols Road & Springfield Road

Existing Conditions
Weekday PM



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	376	1133	328	217	211	138
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	11	11	12	12	12	12
Total Lost time (s)	5.0	5.0	5.0	6.0	6.0	5.0
Lane Util. Factor	0.97	0.88	0.97	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	3385	2748	3467	1881	1881	1599
Flt Permitted	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (perm)	3385	2748	3467	1881	1881	1599
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	413	1245	360	238	232	152
RTOR Reduction (vph)	0	880	0	0	0	107
Lane Group Flow (vph)	413	365	360	238	232	45
Heavy Vehicles (%)	0%	0%	1%	1%	1%	1%
Turn Type		custom	Prot			Over
Protected Phases	3	3	5	2	6	3
Permitted Phases		3				
Actuated Green, G (s)	26.4	26.4	14.7	52.6	32.9	26.4
Effective Green, g (s)	26.4	26.4	14.7	52.6	32.9	26.4
Actuated g/C Ratio	0.29	0.29	0.16	0.58	0.37	0.29
Clearance Time (s)	5.0	5.0	5.0	6.0	6.0	5.0
Vehicle Extension (s)	5.0	5.0	3.0	6.0	6.0	5.0
Lane Grp Cap (vph)	993	806	566	1099	688	469
v/s Ratio Prot	0.12	c0.13	c0.10	0.13	c0.12	0.03
v/s Ratio Perm						
v/c Ratio	0.42	0.45	0.64	0.22	0.34	0.10
Uniform Delay, d1	25.6	25.9	35.2	8.9	20.7	23.1
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.6	0.8	2.3	0.5	1.3	0.2
Delay (s)	26.2	26.8	37.5	9.3	22.0	23.3
Level of Service	C	C	D	A	C	C
Approach Delay (s)	26.6			26.3	22.5	
Approach LOS	C			C	C	

Intersection Summary			
HCM Average Control Delay	25.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.44		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	59.9%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

HCM Unsignalized Intersection Capacity Analysis

2: Fireside Drive &

Existing Conditions

Weekday PM



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	22	18	545	48	8	327
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91
Hourly flow rate (vph)	24	20	599	53	9	359
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage (veh)						
Upstream signal (ft)			377			
pX, platoon unblocked						
vC, conflicting volume	823	326			652	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	823	326			652	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	92	97			99	
cM capacity (veh/h)	313	676			938	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	44	399	252	9	180	180
Volume Left	24	0	0	9	0	0
Volume Right	20	0	53	0	0	0
cSH	413	1700	1700	938	1700	1700
Volume to Capacity	0.11	0.23	0.15	0.01	0.11	0.11
Queue Length 95th (ft)	9	0	0	1	0	0
Control Delay (s)	14.8	0.0	0.0	8.9	0.0	0.0
Lane LOS	B			A		
Approach Delay (s)	14.8	0.0		0.2		
Approach LOS	B					

Intersection Summary						
Average Delay			0.7			
Intersection Capacity Utilization			26.6%		ICU Level of Service	A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis

3: Kingscroft Drive & Springfield Road

Existing Conditions
Weekday PM



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↙		↑	↗		↘
Volume (veh/h)	22	18	518	45	8	313
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91
Hourly flow rate (vph)	24	20	569	49	9	344
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage (veh)						
Upstream signal (ft)			1118			
pX, platoon unblocked						
vC, conflicting volume	931	569			619	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	931	569			619	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	92	96			99	
cM capacity (veh/h)	296	525			966	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1
Volume Total	44	569	49	353
Volume Left	24	0	0	9
Volume Right	20	0	49	0
cSH	368	1700	1700	966
Volume to Capacity	0.12	0.33	0.03	0.01
Queue Length 95th (ft)	10	0	0	1
Control Delay (s)	16.1	0.0	0.0	0.3
Lane LOS	C			A
Approach Delay (s)	16.1	0.0		0.3
Approach LOS	C			

Intersection Summary			
Average Delay		0.8	
Intersection Capacity Utilization		37.3%	ICU Level of Service A
Analysis Period (min)		15	

HCM Unsignalized Intersection Capacity Analysis

4: Wendhurst Drive & Springfield Road

Existing Conditions
Weekday PM



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	W		T	R	L	T
Volume (veh/h)	30	6	493	43	7	291
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91
Hourly flow rate (vph)	33	7	542	47	8	320
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	877	542			589	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	877	542			589	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	90	99			99	
cM capacity (veh/h)	319	544			991	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1
Volume Total	40	542	47	327
Volume Left	33	0	0	8
Volume Right	7	0	47	0
cSH	343	1700	1700	991
Volume to Capacity	0.12	0.32	0.03	0.01
Queue Length 95th (ft)	10	0	0	1
Control Delay (s)	16.9	0.0	0.0	0.3
Lane LOS	C			A
Approach Delay (s)	16.9	0.0		0.3
Approach LOS	C			

Intersection Summary			
Average Delay		0.8	
Intersection Capacity Utilization		35.9%	ICU Level of Service A
Analysis Period (min)		15	

HCM Unsignalized Intersection Capacity Analysis

5: Jones Road & Springfield Road

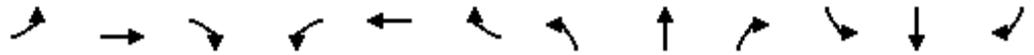
Existing Conditions
Weekday PM



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	5	5	17	482	293	15
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Hourly flow rate (vph)	6	6	19	536	326	17
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	907	334	342			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	907	334	342			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	98	99	98			
cM capacity (veh/h)	304	713	1222			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	11	554	342			
Volume Left	6	19	0			
Volume Right	6	0	17			
cSH	426	1222	1700			
Volume to Capacity	0.03	0.02	0.20			
Queue Length 95th (ft)	2	1	0			
Control Delay (s)	13.7	0.4	0.0			
Lane LOS	B	A				
Approach Delay (s)	13.7	0.4	0.0			
Approach LOS	B					
Intersection Summary						
Average Delay			0.4			
Intersection Capacity Utilization			49.1%		ICU Level of Service	A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
6: Olde Milbrooke Way & Springfield Road

Existing Conditions
Weekday PM



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕	↕		↕	
Volume (veh/h)	8	1	16	16	1	8	14	457	16	9	276	29
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	9	1	17	17	1	9	15	497	17	10	300	32
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage (veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	872	880	316	880	878	497	332			514		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	872	880	316	880	878	497	332			514		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	97	100	98	93	100	98	99			99		
cM capacity (veh/h)	264	282	729	258	282	577	1234			1057		
Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1							
Volume Total	27	27	512	17	341							
Volume Left	9	17	15	0	10							
Volume Right	17	9	0	17	32							
cSH	448	315	1234	1700	1057							
Volume to Capacity	0.06	0.09	0.01	0.01	0.01							
Queue Length 95th (ft)	5	7	1	0	1							
Control Delay (s)	13.6	17.5	0.4	0.0	0.3							
Lane LOS	B	C	A		A							
Approach Delay (s)	13.6	17.5	0.4		0.3							
Approach LOS	B	C										
Intersection Summary												
Average Delay			1.2									
Intersection Capacity Utilization			40.2%		ICU Level of Service				A			
Analysis Period (min)			15									

HCM Unsignalized Intersection Capacity Analysis

7: Wintergreen Road & Springfield Road

Existing Conditions
Weekday PM



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔			↔			↑	↗		↔	
Volume (veh/h)	24	2	19	7	1	12	25	443	5	21	288	71
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	26	2	21	8	1	13	27	482	5	23	313	77
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type												
Median storage (veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	947	939	352	955	972	482	390			487		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	947	939	352	955	972	482	390			487		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	89	99	97	97	100	98	98			98		
cM capacity (veh/h)	229	255	696	224	243	589	1174			1081		
Direction, Lane #												
	EB 1	WB 1	NB 1	NB 2	SB 1							
Volume Total	49	22	509	5	413							
Volume Left	26	8	27	0	23							
Volume Right	21	13	0	5	77							
cSH	322	359	1174	1700	1081							
Volume to Capacity	0.15	0.06	0.02	0.00	0.02							
Queue Length 95th (ft)	13	5	2	0	2							
Control Delay (s)	18.2	15.7	0.7	0.0	0.7							
Lane LOS	C	C	A		A							
Approach Delay (s)	18.2	15.7	0.7		0.7							
Approach LOS	C	C										
Intersection Summary												
Average Delay			1.9									
Intersection Capacity Utilization			47.9%	ICU Level of Service		A						
Analysis Period (min)			15									

HCM Unsignalized Intersection Capacity Analysis

8: Jacobs Creek Drive & Springfield Road

Existing Conditions
Weekday PM



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	14	11	439	40	7	366
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91
Hourly flow rate (vph)	15	12	482	44	8	402
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	922	504			526	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	922	504			526	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	95	98			99	
cM capacity (veh/h)	300	572			1046	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	27	526	410
Volume Left	15	0	8
Volume Right	12	44	0
cSH	379	1700	1046
Volume to Capacity	0.07	0.31	0.01
Queue Length 95th (ft)	6	0	1
Control Delay (s)	15.2	0.0	0.2
Lane LOS	C		A
Approach Delay (s)	15.2	0.0	0.2
Approach LOS	C		

Intersection Summary			
Average Delay		0.5	
Intersection Capacity Utilization		35.5%	ICU Level of Service
Analysis Period (min)		15	A

HCM Unsignalized Intersection Capacity Analysis

9: Wintercreek Drive & Springfield Road

Existing Conditions
Weekday PM



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	16	19	16	434	354	17
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	18	21	18	488	398	19
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	931	407	417			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	931	407	417			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	94	97	98			
cM capacity (veh/h)	294	648	1148			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	39	506	417			
Volume Left	18	18	0			
Volume Right	21	0	19			
cSH	418	1148	1700			
Volume to Capacity	0.09	0.02	0.25			
Queue Length 95th (ft)	8	1	0			
Control Delay (s)	14.5	0.5	0.0			
Lane LOS	B	A				
Approach Delay (s)	14.5	0.5	0.0			
Approach LOS	B					
Intersection Summary						
Average Delay			0.8			
Intersection Capacity Utilization		45.8%		ICU Level of Service		A
Analysis Period (min)			15			

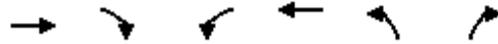
HCM Unsignalized Intersection Capacity Analysis
 10: Warnerwood Ct & Springfield Road

Existing Conditions
 Weekday PM

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	3	7	0	1	4	410	36	2	361	1
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	0	0	3	8	0	1	5	471	41	2	415	1
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage (veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	902	942	416	904	901	471	416			513		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	902	942	416	904	901	471	416			513		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	99	97	100	100	100			100		
cM capacity (veh/h)	259	263	641	257	278	597	1148			1058		
Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1							
Volume Total	3	9	476	41	418							
Volume Left	0	8	5	0	2							
Volume Right	3	1	0	41	1							
cSH	641	277	1148	1700	1058							
Volume to Capacity	0.01	0.03	0.00	0.02	0.00							
Queue Length 95th (ft)	0	3	0	0	0							
Control Delay (s)	10.6	18.4	0.1	0.0	0.1							
Lane LOS	B	C	A		A							
Approach Delay (s)	10.6	18.4	0.1		0.1							
Approach LOS	B	C										
Intersection Summary												
Average Delay			0.3									
Intersection Capacity Utilization			37.1%		ICU Level of Service				A			
Analysis Period (min)			15									

HCM Unsignalized Intersection Capacity Analysis
 11: Springfield Road & Bernard Mills Drive

Existing Conditions
 Weekday PM



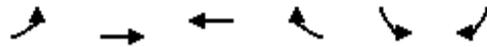
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑	↑		↑	↑	
Volume (veh/h)	367	44	7	359	5	5
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	422	51	8	413	6	6
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			472		851	422
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			472		851	422
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			99		98	99
cM capacity (veh/h)			1095		331	636

Direction, Lane #	EB 1	EB 2	WB 1	NB 1
Volume Total	422	51	421	11
Volume Left	0	0	8	6
Volume Right	0	51	0	6
cSH	1700	1700	1095	435
Volume to Capacity	0.25	0.03	0.01	0.03
Queue Length 95th (ft)	0	0	1	2
Control Delay (s)	0.0	0.0	0.2	13.5
Lane LOS			A	B
Approach Delay (s)	0.0		0.2	13.5
Approach LOS				B

Intersection Summary			
Average Delay		0.3	
Intersection Capacity Utilization		34.5%	ICU Level of Service A
Analysis Period (min)		15	

HCM Unsignalized Intersection Capacity Analysis
 12: Springfield Road & Olde Hartley Drive

Existing Conditions
 Weekday PM



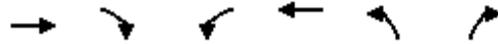
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↕	↕	↗	↘	↘
Volume (veh/h)	16	356	357	13	9	9
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.86	0.86	0.86	0.86	0.86	0.86
Hourly flow rate (vph)	19	414	415	15	10	10
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	430				866	415
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	430				866	415
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	98				97	98
cM capacity (veh/h)	1135				321	642

Direction, Lane #	EB 1	WB 1	WB 2	SB 1
Volume Total	433	415	15	21
Volume Left	19	0	0	10
Volume Right	0	0	15	10
cSH	1135	1700	1700	428
Volume to Capacity	0.02	0.24	0.01	0.05
Queue Length 95th (ft)	1	0	0	4
Control Delay (s)	0.5	0.0	0.0	13.8
Lane LOS	A			B
Approach Delay (s)	0.5	0.0		13.8
Approach LOS				B

Intersection Summary			
Average Delay		0.6	
Intersection Capacity Utilization		41.7%	ICU Level of Service
Analysis Period (min)		15	A

HCM Unsignalized Intersection Capacity Analysis
 13: Springfield Road & Echo Lake Drive

Existing Conditions
 Weekday PM



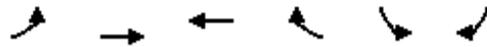
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	→			←	←	↘
Volume (veh/h)	344	21	7	365	5	5
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.86	0.86	0.86	0.86	0.86	0.86
Hourly flow rate (vph)	400	24	8	424	6	6
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			424		853	412
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			424		853	412
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			99		98	99
cM capacity (veh/h)			1140		330	644

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	424	433	12
Volume Left	0	8	6
Volume Right	24	0	6
cSH	1700	1140	436
Volume to Capacity	0.25	0.01	0.03
Queue Length 95th (ft)	0	1	2
Control Delay (s)	0.0	0.2	13.5
Lane LOS		A	B
Approach Delay (s)	0.0	0.2	13.5
Approach LOS			B

Intersection Summary			
Average Delay		0.3	
Intersection Capacity Utilization	34.8%		ICU Level of Service A
Analysis Period (min)		15	

HCM Unsignalized Intersection Capacity Analysis
 14: Springfield Road & Old Springfield Road

Existing Conditions
 Weekday PM



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↔	↔		↔	↔
Volume (veh/h)	21	328	361	22	18	11
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	24	377	415	25	21	13
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						2
Median type		None	None			
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	440				853	428
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	440				853	428
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	98				94	98
cM capacity (veh/h)	1125				325	631

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	401	440	33
Volume Left	24	0	21
Volume Right	0	25	13
cSH	1125	1700	524
Volume to Capacity	0.02	0.26	0.06
Queue Length 95th (ft)	2	0	5
Control Delay (s)	0.7	0.0	14.5
Lane LOS	A		B
Approach Delay (s)	0.7	0.0	14.5
Approach LOS			B

Intersection Summary			
Average Delay		0.9	
Intersection Capacity Utilization		44.5%	ICU Level of Service
Analysis Period (min)		15	A

HCM Unsignalized Intersection Capacity Analysis
 15: Rigney Terrace & Springfield Road

Existing Conditions
 Weekday PM



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	7	8	7	376	325	21
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Hourly flow rate (vph)	8	9	8	418	361	23
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	794	361	384			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	794	361	384			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	98	99	99			
cM capacity (veh/h)	357	688	1180			

Direction, Lane #	EB 1	NB 1	SB 1	SB 2
Volume Total	17	426	361	23
Volume Left	8	8	0	0
Volume Right	9	0	0	23
cSH	480	1180	1700	1700
Volume to Capacity	0.03	0.01	0.21	0.01
Queue Length 95th (ft)	3	0	0	0
Control Delay (s)	12.8	0.2	0.0	0.0
Lane LOS	B	A		
Approach Delay (s)	12.8	0.2	0.0	
Approach LOS	B			

Intersection Summary			
Average Delay		0.4	
Intersection Capacity Utilization		35.4%	ICU Level of Service
Analysis Period (min)		15	A

HCM Unsignalized Intersection Capacity Analysis
 16: Springfield Road & Francistown Road

Existing Conditions
 Weekday PM

						
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	290	324	59	266	262	71
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93
Hourly flow rate (vph)	312	348	63	286	282	76
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	703	63			349	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	703	63			349	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	0	65			77	
cM capacity (veh/h)	311	1004			1215	
Direction, Lane #	WB 1	WB 2	NB 1	NB 2	SB 1	SB 2
Volume Total	312	348	63	286	282	76
Volume Left	312	0	0	0	282	0
Volume Right	0	348	0	286	0	0
cSH	311	1004	1700	1700	1215	1700
Volume to Capacity	1.00	0.35	0.04	0.17	0.23	0.04
Queue Length 95th (ft)	271	39	0	0	22	0
Control Delay (s)	89.2	10.5	0.0	0.0	8.9	0.0
Lane LOS	F	B			A	
Approach Delay (s)	47.7		0.0		7.0	
Approach LOS	E					
Intersection Summary						
Average Delay			24.8			
Intersection Capacity Utilization			43.9%		ICU Level of Service	A
Analysis Period (min)			15			

Queues
17: Springfield Road & Staples Mill Road

Existing Conditions
Weekday PM



Lane Group	EBT	EBR	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Group Flow (vph)	431	120	495	130	253	514	195	133	785	138
v/c Ratio	0.95	0.25	1.45	0.34	1.51	0.60	0.38	0.72	0.89	0.32
Control Delay	76.8	7.6	252.9	14.4	293.4	44.5	11.0	72.6	57.5	24.8
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	76.8	7.6	252.9	14.4	293.4	44.5	11.0	72.6	57.5	24.8
Queue Length 50th (ft)	329	0	-527	16	-272	190	17	100	310	53
Queue Length 95th (ft)	#528	47	#738	71	#438	251	82	167	#418	111
Internal Link Dist (ft)	1523		132			549			509	
Turn Bay Length (ft)		575			150		125	200		75
Base Capacity (vph)	458	490	342	384	168	854	509	216	879	433
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.94	0.24	1.45	0.34	1.51	0.60	0.38	0.62	0.89	0.32

Intersection Summary

- ~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
- # 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

HCM Signalized Intersection Capacity Analysis
 17: Springfield Road & Staples Mill Road

Existing Conditions
 Weekday PM

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	233	180	115	236	239	125	243	493	187	128	754	132
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		7.0	7.0		7.0	7.0	6.5	6.3	6.3	6.5	6.7	6.7
Lane Util. Factor		1.00	1.00		1.00	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Frt		1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		0.97	1.00		0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		1830	1599		1836	1599	1787	3574	1599	1787	3574	1599
Flt Permitted		0.97	1.00		0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)		1830	1599		1836	1599	1787	3574	1599	1787	3574	1599
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	243	188	120	246	249	130	253	514	195	133	785	138
RTOR Reduction (vph)	0	0	90	0	0	86	0	0	127	0	0	40
Lane Group Flow (vph)	0	431	30	0	495	44	253	514	68	133	785	98
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Split		Perm	Split		Perm	Prot		Perm	Prot		Perm
Protected Phases	3	3		4	4		1	6		5	2	
Permitted Phases			3			4			6			2
Actuated Green, G (s)		29.7	29.7		22.3	22.3	11.3	28.7	28.7	12.5	29.5	29.5
Effective Green, g (s)		29.7	29.7		22.3	22.3	11.3	28.7	28.7	12.5	29.5	29.5
Actuated g/C Ratio		0.25	0.25		0.19	0.19	0.09	0.24	0.24	0.10	0.25	0.25
Clearance Time (s)		7.0	7.0		7.0	7.0	6.5	6.3	6.3	6.5	6.7	6.7
Vehicle Extension (s)		3.5	3.5		3.5	3.5	2.5	6.0	6.0	2.5	6.0	6.0
Lane Grp Cap (vph)		453	396		341	297	168	855	382	186	879	393
v/s Ratio Prot		c0.24			c0.27		c0.14	0.14		0.07	c0.22	
v/s Ratio Perm			0.02			0.03			0.04			0.06
v/c Ratio		0.95	0.08		1.45	0.15	1.51	0.60	0.18	0.72	0.89	0.25
Uniform Delay, d1		44.4	34.6		48.8	40.9	54.4	40.6	36.3	52.0	43.7	36.4
Progression Factor		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		30.3	0.1		219.0	0.3	256.0	3.1	1.0	11.5	13.4	1.5
Delay (s)		74.8	34.7		267.8	41.2	310.4	43.7	37.3	63.5	57.1	37.9
Level of Service		E	C		F	D	F	D	D	E	E	D
Approach Delay (s)		66.0			220.7			112.5			55.4	
Approach LOS		E			F			F			E	
Intersection Summary												
HCM Average Control Delay			106.8									F
HCM Volume to Capacity ratio			1.04									
Actuated Cycle Length (s)			120.0								20.5	
Intersection Capacity Utilization			105.0%									G
Analysis Period (min)			15									
c Critical Lane Group												

Appendix D
Crash Data Summary

Document Number	Intersection	Collision Type	Crash Date	Day of Week	Crash Severity	Time	Crash Type	Direction	First Harmful Event	First Harmful Event Location
93550354	No	Fixed Object - Off Road	11/21/2009	Saturday	Fatal	11:32 PM	Fatal	East	28. Ran Off Road	1. On Roadway
100250628	No	Pedestrian	11/28/2009	Saturday	Fatal	3:39 PM	Fatal	North	19. Ped	1. On Roadway
100341304	Yes	Angle	11/30/2009	Monday	Injury	8:05 AM	General	Not Provided	20. Motor Vehicle In Transport	1. On Roadway
92900610	No	Fixed Object - Off Road	6/26/2009	Friday	Injury	2:13 PM	General	North	2. Trees	8. Off Roadway, Location Unknown
102640028	Yes	Rear End	8/15/2010	Sunday	Property Damage Only	1:00 PM	General	Not Provided	20. Motor Vehicle In Transport	1. On Roadway
110870965	Yes	Angle	10/17/2010	Sunday	Property Damage Only	12:48 PM	General	West	20. Motor Vehicle In Transport	1. On Roadway
101540902	Yes	Angle	5/3/2010	Monday	Property Damage Only	7:26 AM	General	Not Provided	20. Motor Vehicle In Transport	1. On Roadway
93070385	Yes	Fixed Object - Off Road	7/20/2009	Monday	Property Damage Only	2:03 PM	General	Not Provided	2. Trees	2. Shoulder
110120101	Yes	Angle	9/27/2010	Monday	Property Damage Only	4:13 PM	General	Not Provided	20. Motor Vehicle In Transport	1. On Roadway
92300464	No	Fixed Object - Off Road	3/17/2009	Tuesday	Property Damage Only	2:00 PM	General	South	2. Trees	4. Roadside
103370446	Yes	Angle	10/7/2010	Thursday	Property Damage Only	5:35 PM	General	Not Provided	20. Motor Vehicle In Transport	1. On Roadway
100110613	Yes	Rear End	11/19/2009	Thursday	Property Damage Only	4:45 PM	General	Not Provided	20. Motor Vehicle In Transport	1. On Roadway
103505043	Yes	Rear End	12/16/2010	Thursday	Property Damage Only	10:00 AM	General	North	20. Motor Vehicle In Transport	1. On Roadway
100480902	No	Fixed Object - Off Road	9/25/2009	Friday	Property Damage Only	1:38 AM	General	East	42. Other Non-Collision	1. On Roadway
93210000	No	Fixed Object - Off Road	8/8/2009	Saturday	Property Damage Only	3:23 AM	General	South	4. Fence Or Post	1. On Roadway
110460845	Yes	Fixed Object - Off Road	12/18/2010	Saturday	Property Damage Only	2:22 AM	General	Not Provided	28. Ran Off Road	4. Roadside
90295097	No	Fixed Object - Off Road	1/10/2009	Saturday	Fatal	10:37 PM	Not Provided	East	2. Trees	2. Shoulder
91320910	Unknown	Sideswipe - Same Direction	10/13/2008	Monday	Property Damage Only	3:06 PM	Unknown	Unknown	Unknown	Unknown
80655622	Unknown	Sideswipe - Same Direction	1/15/2008	Tuesday	Property Damage Only	8:03 PM	Unknown	Unknown	Unknown	Unknown
90685188	Unknown	Sideswipe - Same Direction	7/1/2008	Tuesday	Property Damage Only	6:13 PM	Unknown	Unknown	Unknown	Unknown
90425419	Unknown	Sideswipe - Same Direction	7/8/2008	Tuesday	Property Damage Only	5:02 PM	Unknown	Unknown	Unknown	Unknown
91590939	Unknown	Fixed Object - Off Road	11/28/2008	Friday	Property Damage Only	5:58 PM	Unknown	Unknown	Unknown	Unknown
100490364	No	Fixed Object - Off Road	9/25/2009	Friday	Injury	2:54 PM	General	North	1. Bank Or Ledge	4. Roadside
101820904	No	Fixed Object - Off Road	5/17/2010	Monday	Property Damage Only	12:30 PM	General	North	5. Guard Rail	2. Shoulder
93140364	No	Fixed Object - Off Road	7/31/2009	Friday	Property Damage Only	12:27 PM	General	East	4. Fence Or Post	1. On Roadway
102980200	No	Fixed Object - Off Road	7/16/2010	Friday	Property Damage Only	1:34 AM	General	East	4. Fence Or Post	2. Shoulder
92600852	Yes	Angle	5/9/2009	Saturday	Property Damage Only	12:56 AM	General	Not Provided	15. Other Fixed Object	2. Shoulder
93490957	No	Other - Animal	10/15/2009	Thursday	Injury	3:20 PM	General	East	2. Trees	1. On Roadway
91700840	Unknown	Fixed Object - Off Road	12/24/2008	Wednesday	Injury	10:52 PM	Unknown	Unknown	Unknown	Unknown
90095104	Unknown	Sideswipe - Opposite Direction	6/19/2008	Thursday	Injury	1:53 PM	Unknown	Unknown	Unknown	Unknown
90055325	Unknown	Fixed Object - Off Road	6/1/2008	Sunday	Property Damage Only	1:06 PM	Unknown	Unknown	Unknown	Unknown
91670252	Unknown	Fixed Object - Off Road	12/12/2008	Friday	Property Damage Only	10:10 PM	Unknown	Unknown	Unknown	Unknown

Document Number	Light Condition	Non Pedestrian Fatality Count	Non Pedestrian Injury Count	Pedestrian Fatality Count	Pedestrian Injury Cnt	Rec Src	Reported Vehicle Number	Roadway Alignment Type	Roadway Defect Type
93550354	5. Darkness - Road Not Lighted	1	0	0	0	V	1	2. Curve - Level	1. No Defects
100250628	2. Daylight	0	0	1	1	V	3	2. Curve - Level	1. No Defects
100341304	2. Daylight	0	2	0	0	V	2	1. Straight - Level	1. No Defects
92900610	2. Daylight	0	1	0	0	V	1	2. Curve - Level	1. No Defects
102640028	2. Daylight	0	0	0	0	V	2	1. Straight - Level	1. No Defects
110870965	2. Daylight	0	0	0	0	V	2	1. Straight - Level	1. No Defects
101540902	2. Daylight	0	0	0	0	V	2	1. Straight - Level	1. No Defects
93070385	2. Daylight	0	0	0	0	V	1	4. Grade - Curve	1. No Defects
110120101	2. Daylight	0	0	0	0	V	3	1. Straight - Level	1. No Defects
92300464	2. Daylight	0	0	0	0	V	1	2. Curve - Level	1. No Defects
103370446	2. Daylight	0	0	0	0	V	2	1. Straight - Level	1. No Defects
100110613	3. Dusk	0	0	0	0	T	3	3. Grade - Straight	1. No Defects
103505043	2. Daylight	0	0	0	0	V	2	1. Straight - Level	1. No Defects
100480902	5. Darkness - Road Not Lighted	0	0	0	0	V	1	4. Grade - Curve	1. No Defects
93210000	5. Darkness - Road Not Lighted	0	0	0	0	V	1	2. Curve - Level	1. No Defects
110460845	5. Darkness - Road Not Lighted	0	0	0	0	V	1	1. Straight - Level	1. No Defects
90295097	5. Darkness - Road Not Lighted	1	0	0	0	V	1	4. Grade - Curve	1. No Defects
91320910	2. Daylight	0	0	0	0	T	2	1. Straight - Level	1. No Defects
80655622	5. Darkness - Road Not Lighted	0	0	0	0	T	2	1. Straight - Level	1. No Defects
90685188	2. Daylight	0	0	0	0	T	2	1. Straight - Level	1. No Defects
90425419	2. Daylight	0	0	0	0	T	2	1. Straight - Level	1. No Defects
91590939	5. Darkness - Road Not Lighted	0	0	0	0	T	1	1. Straight - Level	1. No Defects
100490364	2. Daylight	0	1	0	0	V	1	1. Straight - Level	1. No Defects
101820904	2. Daylight	0	0	0	0	V	1	4. Grade - Curve	1. No Defects
93140364	2. Daylight	0	0	0	0	V	1	2. Curve - Level	1. No Defects
102980200	2. Daylight	0	0	0	0	V	1	1. Straight - Level	1. No Defects
92600852	5. Darkness - Road Not Lighted	0	0	0	0	V	1	2. Curve - Level	1. No Defects
93490957	Not Provided	0	1	0	0	T	1	10. On/Off Ramp	1. No Defects
91700840	5. Darkness - Road Not Lighted	0	1	0	0	T	1	2. Curve - Level	1. No Defects
90095104	2. Daylight	0	1	0	0	T	2	6. Hillcrest - Curve	1. No Defects
90055325	2. Daylight	0	0	0	0	T	1	1. Straight - Level	1. No Defects
91670252	5. Darkness - Road Not Lighted	0	0	0	0	T	1	4. Grade - Curve	1. No Defects

Document Number	Roadway Surface Cond Type	Roadway Surface Type	Roadway Type	School Zone Type	Secondary Location	Traffic Control Status Type
93550354	1. Dry	2. Blacktop, Asphalt, Bituminous	1. Two-Way, Not Divided	3. No	JONES ROAD	1. Yes - Working
100250628	1. Dry	2. Blacktop, Asphalt, Bituminous	1. Two-Way, Not Divided	3. No	JONES RD	1. Yes - Working
100341304	1. Dry	2. Blacktop, Asphalt, Bituminous	1. Two-Way, Not Divided	3. No	KINGSCROFT DR	1. Yes - Working
92900610	1. Dry	2. Blacktop, Asphalt, Bituminous	1. Two-Way, Not Divided	3. No	ECHO LAKE DR	1. Yes - Working
102640028	1. Dry	2. Blacktop, Asphalt, Bituminous	1. Two-Way, Not Divided	3. No	NUCKOLS RD	1. Yes - Working
110870965	1. Dry	2. Blacktop, Asphalt, Bituminous	1. Two-Way, Not Divided	3. No	STAPLES MILL RD	1. Yes - Working
101540902	1. Dry	2. Blacktop, Asphalt, Bituminous	1. Two-Way, Not Divided	3. No	FRANCISTOWN RD	1. Yes - Working
93070385	2. Wet	2. Blacktop, Asphalt, Bituminous	1. Two-Way, Not Divided	3. No	ECHO LAKE DR	1. Yes - Working
110120101	2. Wet	2. Blacktop, Asphalt, Bituminous	2. Two-Way, Divided, Unprotected Median	3. No	FRANCISTOWN ROAD	1. Yes - Working
92300464	1. Dry	2. Blacktop, Asphalt, Bituminous	2. Two-Way, Divided, Unprotected Median	3. No	LINDSEY LAKES DR	1. Yes - Working
103370446	1. Dry	2. Blacktop, Asphalt, Bituminous	2. Two-Way, Divided, Unprotected Median	3. No	francistown rd	1. Yes - Working
100110613	2. Wet	2. Blacktop, Asphalt, Bituminous	1. Two-Way, Not Divided	3. No	OLDE HARTLEY DRIVE	1. Yes - Working
103505043	3. Snowy	2. Blacktop, Asphalt, Bituminous	2. Two-Way, Divided, Unprotected Median	3. No	ROUTE 33STAPLES MILL ROAD	1. Yes - Working
100480902	2. Wet	2. Blacktop, Asphalt, Bituminous	2. Two-Way, Divided, Unprotected Median	3. No	OLD HARTLEY DR	1. Yes - Working
93210000	1. Dry	2. Blacktop, Asphalt, Bituminous	2. Two-Way, Divided, Unprotected Median	3. No	BERNARD MILL DR	1. Yes - Working
110460845	1. Dry	1. Concrete	1. Two-Way, Not Divided	3. No	OLDE MILBROOKE WAY	1. Yes - Working
90295097	2. Wet	2. Blacktop, Asphalt, Bituminous	2. Two-Way, Divided, Unprotected Median	3. No	ECHO LAKE DR	1. Yes - Working
91320910	1. Dry	2. Blacktop, Asphalt, Bituminous	Unknown	Unknown	Unknown	1. Yes - Working
80655622	1. Dry	2. Blacktop, Asphalt, Bituminous	Unknown	Unknown	Unknown	1. Yes - Working
90685188	1. Dry	2. Blacktop, Asphalt, Bituminous	Unknown	Unknown	Unknown	1. Yes - Working
90425419	1. Dry	2. Blacktop, Asphalt, Bituminous	Unknown	Unknown	Unknown	1. Yes - Working
91590939	1. Dry	2. Blacktop, Asphalt, Bituminous	Unknown	Unknown	Unknown	1. Yes - Working
100490364	1. Dry	2. Blacktop, Asphalt, Bituminous	1. Two-Way, Not Divided	3. No	echo lake dr	6. No Traffic Control Device Present
101820904	2. Wet	2. Blacktop, Asphalt, Bituminous	1. Two-Way, Not Divided	3. No	ECHL LAKE DR	6. No Traffic Control Device Present
93140364	1. Dry	2. Blacktop, Asphalt, Bituminous	1. Two-Way, Not Divided	3. No	At Olde Milbrooke Way	6. No Traffic Control Device Present
102980200	1. Dry	2. Blacktop, Asphalt, Bituminous	1. Two-Way, Not Divided	3. No	francistown rd	6. No Traffic Control Device Present
92600852	2. Wet	2. Blacktop, Asphalt, Bituminous	1. Two-Way, Not Divided	3. No	WENDHURST DR	6. No Traffic Control Device Present
93490957	10. Slush	Not Provided	1. Two-Way, Not Divided	2. Yes - With School Activity	ECHO LAKE DRIVE	Not Provided
91700840	2. Wet	2. Blacktop, Asphalt, Bituminous	Unknown	Unknown	Unknown	Unknown
90095104	1. Dry	2. Blacktop, Asphalt, Bituminous	Unknown	Unknown	Unknown	Unknown
90055325	1. Dry	1. Concrete	Unknown	Unknown	Unknown	Unknown
91670252	1. Dry	2. Blacktop, Asphalt, Bituminous	Unknown	Unknown	Unknown	Unknown

Document Number	Traffic Control Type	Weather Condition Type	Work Zone Location Type	Work Zone Related	Work Zone Type	Work Zone Workers Present
93550354	6. Traffic Lanes Marked	1. No Adverse Condition (Clear/Cloudy)	Not Provided	2. No	Not Provided	Not Provided
100250628	6. Traffic Lanes Marked	1. No Adverse Condition (Clear/Cloudy)	Not Provided	2. No	Not Provided	Not Provided
100341304	4. Stop Sign	1. No Adverse Condition (Clear/Cloudy)	Not Provided	Not Applicable	Not Provided	3. No Workers Present
92900610	6. Traffic Lanes Marked	1. No Adverse Condition (Clear/Cloudy)	Not Provided	2. No	Not Provided	Not Provided
102640028	3. Traffic Signal	1. No Adverse Condition (Clear/Cloudy)	Not Provided	2. No	Not Provided	Not Provided
110870965	6. Traffic Lanes Marked	1. No Adverse Condition (Clear/Cloudy)	Not Provided	2. No	Not Provided	Not Provided
101540902	4. Stop Sign	1. No Adverse Condition (Clear/Cloudy)	Not Provided	2. No	Not Provided	Not Provided
93070385	5. Slow or Warning Sign	5. Rain	Not Provided	2. No	Not Provided	Not Provided
110120101	4. Stop Sign	5. Rain	Not Provided	2. No	Not Provided	Not Provided
92300464	6. Traffic Lanes Marked	1. No Adverse Condition (Clear/Cloudy)	Not Provided	2. No	Not Provided	Not Provided
103370446	4. Stop Sign	1. No Adverse Condition (Clear/Cloudy)	Not Provided	2. No	Not Provided	Not Provided
100110613	6. Traffic Lanes Marked	5. Rain	Not Provided	2. No	Not Provided	Not Provided
103505043	3. Traffic Signal	6. Snow	Not Provided	2. No	Not Provided	Not Provided
100480902	6. Traffic Lanes Marked	5. Rain	Not Provided	2. No	Not Provided	Not Provided
93210000	6. Traffic Lanes Marked	1. No Adverse Condition (Clear/Cloudy)	Not Provided	2. No	Not Provided	Not Provided
110460845	6. Traffic Lanes Marked	1. No Adverse Condition (Clear/Cloudy)	Not Provided	2. No	Not Provided	Not Provided
90295097	6. Traffic Lanes Marked	5. Rain	Not Provided	2. No	Not Provided	Not Provided
91320910	3. Traffic Signal	1. No Adverse Condition (Clear/Cloudy)		2. No		3. No Workers Present
80655622	6. Traffic Lanes Marked	1. No Adverse Condition (Clear/Cloudy)		2. No		3. No Workers Present
90685188	3. Traffic Signal	1. No Adverse Condition (Clear/Cloudy)		2. No		3. No Workers Present
90425419	3. Traffic Signal	1. No Adverse Condition (Clear/Cloudy)		2. No		3. No Workers Present
91590939	3. Traffic Signal	1. No Adverse Condition (Clear/Cloudy)		2. No		3. No Workers Present
100490364	1. No Traffic Control	1. No Adverse Condition (Clear/Cloudy)	Not Provided	2. No	Not Provided	Not Provided
101820904	6. Traffic Lanes Marked	5. Rain	Not Provided	2. No	Not Provided	Not Provided
93140364	1. No Traffic Control	1. No Adverse Condition (Clear/Cloudy)	Not Provided	2. No	Not Provided	Not Provided
102980200	1. No Traffic Control	1. No Adverse Condition (Clear/Cloudy)	Not Provided	2. No	Not Provided	Not Provided
92600852	6. Traffic Lanes Marked	5. Rain	Not Provided	2. No	Not Provided	Not Provided
93490957	1. No Traffic Control	4. Mist	1. Advance Warning Area	1. Yes	5. Other	1. With Law Enforcement
91700840	6. Traffic Lanes Marked	5. Rain		2. No		3. No Workers Present
90095104	1. No Traffic Control	1. No Adverse Condition (Clear/Cloudy)		2. No		3. No Workers Present
90055325	1. No Traffic Control	1. No Adverse Condition (Clear/Cloudy)		2. No		3. No Workers Present
91670252	1. No Traffic Control	1. No Adverse Condition (Clear/Cloudy)		2. No		3. No Workers Present

Appendix E
HSM Crash Prediction Methods
& Existing Conditions Analysis

HSM Expected Crash Analysis – Existing Conditions

Disclaimer:

HSM methods were used to calculate expected average annual crashes for existing conditions, future no-build conditions, and alternative improvements. The expected average annual crashes were used in a relative manner to prioritize segments, intersections, and improvements. VDOT has not yet developed statewide calibration factors to adjust the generic HSM methods to specific VDOT facilities. If calibration factors are developed and applied, the expected average annual crashes would represent the specific (actual) long-term expected average number of crashes for each site and condition. Without calibration factors, the results can be used for *only* relative comparisons. For more information on calibration factors, see Part C of the HSM. The HSM is not intended to be a substitute for the exercise of sound engineering judgment.

The areas surrounding the existing Springfield Road can be considered primarily suburban in nature. However, the study corridor contains roadway characteristics that are also consistent with a rural road. As such, both Chapter 10 (Rural Two Lane Roadways) and Chapter 12 (Urban/Suburban Arterials) of the HSM were initially evaluated to identify those issues and potential countermeasures that would be most applicable to the study corridor.

Chapter 10 – Rural Two-Lane Roads

Tables E1 and E2 summarize the total calculated expected average annual crashes for the study intersections and segments considering the study corridor in a rural context.

Table E1 Springfield Road Total Segment Crash Estimates for Existing Conditions

Segment number	Segment Length (miles)	Expected Average Annual Crashes ¹		
		Fatal/Injury	PDO	Total
A.1 ²	0.03	0.02	0.26	0.29
A.2	0.04	0.03	0.04	0.05
B.1	0.05	0.04	0.05	0.05
B.2	0.10	0.06	0.08	0.10
C	0.06	0.04	0.06	0.06
D	0.06	0.03	0.05	0.06
E.1	0.08	0.43	0.09	0.62
E.2	0.03	0.02	0.03	0.03
F.1	0.05	0.03	0.47	0.53
F.2	0.06	0.05	0.33	0.35
F.3	0.03	0.03	0.04	0.04
G	0.16	0.15	0.19	0.20
H	0.04	0.02	0.03	0.04
I.1	0.05	0.04	0.05	0.06
I.2	0.01	0.01	0.01	0.02
J.1	0.06	0.06	0.07	0.07
J.2	0.06	0.03	0.26	0.29
K	0.08	0.06	0.08	0.09
L	0.08	0.27	0.09	0.37
M.1	0.07	0.27	0.33	0.64
M.2	0.03	0.01	0.02	0.02
N.1	0.06	0.48	0.33	0.92
N.2	0.23	0.28	0.60	0.92
N.3	0.05	0.04	0.31	0.33
O.1	0.03	0.03	0.04	0.04
O.2	0.08	0.06	0.08	0.09
P	0.10	0.25	0.10	0.37
Q	0.28	0.21	0.51	0.56
Total Springfield Road Segments Expected		3.05	4.60	7.21

¹ Calibration factors for Virginia were not available. Expected crash frequency does not accurately represent the number of crashes expected for the area. These numbers were used purely for comparative purposes between segments. The numbers are not the true expected crashes for the site and should be used exclusively for relative comparison purposes.

² Segments had to be further divided for the Chapter 10 analysis based on horizontal curvature. Each curve became its own segment.

Table E2 Springfield Road Total Intersection Crash Estimates for Existing Conditions

Intersection number	Cross Street	Intersection Type	Expected Average Annual Crashes ¹		
			Fatal/Injury	PDO	Total
1	Nuckols Road	3SG ²	1.42	2.97	3.39
2	Fireside Drive	3ST ³	0.26	0.31	0.39
3	Kingscroft Drive	3ST	0.53	0.40	0.72
4	Wendhurst Drive	3ST	0.36	0.62	0.73
5	Jones Road	3ST	0.30	0.35	0.43
6	Olde Milbrooke Way	4ST ⁴	0.47	0.56	0.76
7	Wintergreen Road/Linsey Lakes Drive	4ST	0.60	0.70	0.89
8	Jacobs Creek Drive	3ST	0.46	0.55	0.75
9	Wintercreek Drive	3ST	0.63	0.73	0.92
10	Wamerwood Court/Hart Mill Drive	4ST	0.34	0.41	0.59
11	Bernard Mills Drive	3ST	0.26	0.31	0.39
12	Olde Hartley Drive	3ST	0.28	0.51	0.63
13	Echo Lake Drive	3ST	0.27	0.33	0.40
14	Old Springfield Road	3ST	0.29	0.35	0.42
15	Rigney Terrace	3ST	0.22	0.27	0.36
16	Francistown Road	3ST	0.29	0.89	1.10
17	Staples Mill Road	4SG ⁵	1.23	2.11	2.47
Total Springfield Road Corridor Intersection Expected Annual Crashes			8.21	12.37	15.34

¹ Calibration factors for Virginia were not available. Expected crash frequency does not accurately represent the number of crashes expected for the area. These numbers were used purely for comparative purposes between intersections. The numbers are not the true expected crashes for the site and should be used exclusively for relative comparison purposes.

² Signalized intersection with three approaches

³ Minor street stop controlled intersection with three approaches

⁴ Minor street stop controlled intersection with four approaches

⁵ Signalized intersection with four approaches

Chapter 12 – Urban/Suburban Arterials

Tables E3 and E4 summarize the total calculated expected average annual crashes for the study intersections and segments considering the study corridor in a urban/suburban context.

Table E3 Springfield Road Total Segment Crash Estimates for Existing Conditions

Intersection number	Segment Length (miles)	Expected Average Annual Crashes ¹		
		F/I	PDO	Total
A	0.06	0.04	0.04	0.04
B	0.15	0.09	0.09	0.09
C	0.06	0.04	0.04	0.04
D	0.06	0.03	0.03	0.03
E	0.12	0.09	0.09	0.09
F	0.14	0.08	0.08	0.08
G	0.16	0.11	0.11	0.11
H	0.04	0.02	0.02	0.02
I	0.07	0.04	0.04	0.04
J	0.11	0.07	0.07	0.07
K	0.08	0.04	0.04	0.04
L	0.08	0.05	0.05	0.05
M	0.09	0.05	0.05	0.05
N	0.34	0.29	0.29	0.29
O	0.11	0.07	0.07	0.07
P	0.10	0.06	0.06	0.06
Q	0.28	0.24	0.24	0.24
Total Springfield Road Segments Expected		1.41	3.52	5.15

¹ Calibration factors for Virginia were not available. Expected crash frequency does not accurately represent the number of crashes expected for the area. These numbers were used purely for comparative purposes between segments. The numbers are not the true expected crashes for the site and should be used exclusively for relative comparison purposes.

Table E4 Springfield Road Total Intersection Crash Estimates for Existing Conditions

Intersection number	Cross Street	Intersection Type	Expected Average Annual Crashes ¹		
			F/I	PDO	Total
1	Nuckols Road	3SG ²	0.50	1.65	1.97
2	Fireside Drive	3ST ³	0.14	0.21	0.30
3	Kingscroft Drive	3ST	0.28	0.25	0.54
4	Wendhurst Drive	3ST	0.18	0.40	0.54
5	Jones Road	3ST	0.14	0.18	0.28
6	Olde Milbrooke Way	4ST ⁴	0.27	0.46	0.62
7	Wintergreen Road/Linsey Lakes Drive	4ST	0.30	0.50	0.67
8	Jacobs Creek Drive	3ST	0.15	0.20	0.30
9	Wintercreek Drive	3ST	0.18	0.27	0.37
10	Wamerwood Court/Hart Mill Drive	4ST	0.22	0.40	0.55
11	Bernard Mills Drive	3ST	0.13	0.19	0.28
12	Olde Hartley Drive	3ST	0.14	0.31	0.45
13	Echo Lake Drive	3ST	0.14	0.20	0.29
14	Old Springfield Road	3ST	0.14	0.22	0.31
15	Rigney Terrace	3ST	0.11	0.15	0.24
16	Francistown Road	3ST	0.21	0.96	1.15
17	Staples Mill Road	4SG ⁵	0.62	1.19	1.43
Total Springfield Road Corridor Intersection Expected Annual Crashes			3.85	7.74	10.29

¹ Calibration factors for Virginia were not available. Expected crash frequency does not accurately represent the number of crashes expected for the area. These numbers were used purely for comparative purposes between intersections. The numbers are not the true expected crashes for the site and should be used exclusively for relative comparison purposes.

² Signalized intersection with three approaches

³ Minor street stop controlled intersection with three approaches

⁴ Minor street stop controlled intersection with four approaches

⁵ Signalized intersection with four approaches

Table E5 compares the HSM-calculated range of expected total annual crashes to the actual three-year average of reported crashes from 2008-2010.

Table E5 Existing Annual Crashes Comparison

HSM-Calculated Expected Total Existing Annual Crashes	Average Annual Reported Crashes
15.43 – 22.52	10.67

Table E6 summarizes the selected countermeasures for both the rural and urban/suburban analyses using Chapters 10 and 12 of the HSM.

Table E6 Crash Modification Factors

Countermeasure	Source	CMF	SE	Star Rating
Chapter 10 – Rural Two-Lane Roads				
Segment Lighting	HSM			
Install Shoulder Rumble Strips	NCHRP Report 641: Guidance for the Design and Application of Shoulder and Centerline Rumble Strips via CMF clearing house	0.76	0.861	4
Reduce roadside hazard rating to 3 (10 ft clear zone & guardrail)	HSM			
Install 8ft shoulder	HSM			
Increase Lane width from 11ft to 12 ft	HSM			
Increase Lane width from 11.5ft to 12 ft	HSM			
Flatten horizontal curve (minimum radius 500ft)	HSM			
Lighting in Intersection	HSM			
Retiming signal change intervals to ITE standards (All)	Older Drivers at a Crossroads via CMF clearing house	0.92	0.1	3
Retiming signal change intervals to ITE standards (Injury)	Older Drivers at a Crossroads via CMF clearing house	0.88	0.11	3
Installation of left-turn lanes on both major road approaches	HSM			
Convert four-leg intersection to three-leg intersection	HSM			
Conversion of two-way stop-controlled intersection into roundabout	HSM			
Convert two-way to all-way stop control	HSM			
Convert four-way stop to roundabout	HSM			
Reduce AADT	HSM			
Chapter 12 – Urban/Suburban Arterials				
Lighting	HSM			
Remove or Relocate fixed objects outside of clear zone	Development of Crash Reduction Factors	0.62	0.102	3
Remove or Relocate fixed objects outside of clear zone	Development of Crash Reduction Factors via CMF clearing house	0.62	0.134	3
Lighting in Intersection	HSM			

Retiming signal change intervals to ITE standards (All)	Older Drivers at a Crossroads via CMF clearing house	0.92	0.1	3
Retiming signal change intervals to ITE standards (Injury)	Older Drivers at a Crossroads via CMF clearing house	0.88	0.11	3
Add left-turn lanes to major road approaches at intersection	HSM			
Convert four-leg intersection to three-leg intersection	HSM			
Convert two-way stop-controlled intersection into roundabout	HSM			
Convert two-way to all-way stop control	HSM			
Install traffic Signal	HSM			
Reduce AADT	HSM			

HSM Analysis Findings

Four intersections were identified as having higher expected crash frequencies under both: Nuckols Road, Wintergreen Road/Linsey Lakes Drive, Wintercreek Drive, Francistown Road, and Staples Mill Road. The following intersections were identified in the urban/suburban analysis as having higher expected crash frequencies: Nuckols Road, Olde Milbrooke Way, Wintergreen Road/Linsey Lakes Drive, Francistown Road, and Staples Mill Road. Four intersections were common to both; and therefore given priority within this evaluation:

- Nuckols Road
- Wintergreen Road/Linsey Lakes Drive
- Francistown Road
- Staples Mill Road

Improvements at these four intersections have a higher probability of decreasing crash frequency along the Springfield Road Corridor.

Segments E.1, F.1, M.1, N.1, N.2, and Q were identified in the rural analysis as having higher expected crash frequencies. Segments F, N, and Q were identified in the rural analysis as having higher expected crash frequencies. Improvements made to F, N and Q, priority segments identified in both analyses, have a higher probability of reducing crash frequency along the Springfield Road corridor.

Rural Corridor Analysis Results (Chapter 10)

Table E7 displays corridor’s segments ranked by expected number of crashes.

Table E7 Springfield Road Segment Prioritization – Rural Analysis

Priority Number	Segment
1	N.1
	N.2
3	M.1
4	E.1
5	Q
6	F.1
7	L
	P
9	F.2
10	N.3
11	A.1
	J.2
13	G
14	B.2
15	K
	O.2
17	J.1
18	C
	D
	I.1
21	A.2
	B.1
23	F.3
	H
	O.1
26	E.2
27	M.2
28	B.2

*Segment N had to be divided for the Chapter 10 analysis based on horizontal curvature. N.1 ends and N.2 begins at the first driveway in segment N.

Segments E.1, F.1, M.1, N.1, N.2, and Q were identified as priority segments when considered in a rural context. These six segments comprise 38 percent of the corridor’s length but 58 percent of the corridor’s expected segment crashes and 56 percent of the corridor’s expected segment fatal and/or serious injury crashes. Similarly, these six segments account for 19 percent of the corridor’s expected crashes and 15 percent of the corridor’s expected fatal and/or serious injury crashes. Consequently,

crash-related countermeasures targeted toward crashes at these segments are likely to have substantial impact on the corridor’s total expected crashes. It should be noted that segment E.1 has a curve radii of 750 feet and segments M.1 and N.1 have curve radii less than 400 feet. Roadway geometry is likely a contributing factor to crash frequency.

Table E8 displays the corridor’s intersection ranked by expected number of crashes.

Table E8 Springfield Road Intersection Prioritization – Rural Analysis

Priority Number	Intersection Cross Street	Intersection Type
1	Nuckols Road	3SG ¹
2	Staples Mill Road	4SG ²
3	Francistown Road	3ST
4	Wintercreek Drive	3ST
5	Wintergreen Road/Linsey Lakes Drive	4ST
6	Wendhurst Drive	3ST
7	Olde Milbrooke Way	4ST ³
8	Jacobs Creek Drive	3ST
9	Olde Hartley Drive	3ST
10	Wamerwood Court/Hart Mill Drive	3ST
11	Kingscroft Drive	4ST
12	Old Springfield Road	3ST
	Jones Road	3ST
14	Echo Lake Drive	3ST
15	Bernard Mills Drive	3ST
	Fireside Drive	3ST ⁴
17	Rigney Terrace	3ST

¹ Signalized intersection with three approaches
² Signalized intersections with four approaches
³ Minor street stop controlled intersection with three approaches
⁴ Minor street stop controlled intersection with four approaches

The following intersections should receive priority for improvements when considered in an rural context:

- Nuckols Road
- Staples Mill Road

- Francistown Road
- Wintercreek Drive
- Wintergreen Road/Linsey Lakes Drive

These five intersections account for 57 percent of the total expected intersection crashes and 47 percent of the total expected intersection fatal and/or serious injury crashes. Similarly, these five intersections account for 68 percent of the corridor’s total expected crashes and 16 percent of the corridor’s total expected fatal and/or serious injury crashes. Consequently, crash-related countermeasures at these intersections are likely to have a substantial impact in the corridor’s total expected crashes; particularly on the total expected fatal and/or serious injury crashes.

Urban/Suburban Corridor Analysis Results (Chapter 12)

Table E9 displays corridor’s segments ranked by expected number of crashes.

Table E9 Springfield Road Segment Prioritization – Urban/Suburban Analysis

Priority Number	Segment
1	N
2	Q
3	F
4	E
5	G
6	J
7	B
8	P
9	M
10	O
11	L
	A
13	K
	I
15	C
16	D
17	H

Segments F, N, and Q were identified as priority segments when considered in an urban/suburban context. These three segments comprise 37 percent of the corridor's length but 43 percent of the corridor's expected segment crashes and 46 percent of the corridor's expected segment fatal and/or serious injury crashes. Similarly, these three segments account for 16 percent of the corridor's expected crashes and 12 percent of the corridor's expected fatal and/or serious injury crashes. Consequently, crash-related countermeasures targeted toward crashes at these segments are likely to have substantial impact on the corridor's total expected crashes. It should be noted that segments F and N have curve radii less than 650 feet. Roadway geometry is likely a contributing factor to crash frequency.

HSM Analysis Summary

The following priority intersections and segments were common to both rural and urban/suburban analyses:

- Intersections:
 - SR 157/Nuckols Road
 - SR 157/Wintergreen Road/Linsey Lakes Drive
 - SR 157/Francistown Road
 - SR 157/Staples Mill Road
- Segments:
 - Jones Road to Olde Milbrooke Way
 - Echo Lake Drive to Old Springfield Road
 - Francistown Road to Staple Mills Road

Improvements at these four intersections and three segments have a higher probability of decreasing crash frequency along the Springfield Road Corridor because they are common to both analyses.

Table E10 displays the corridor's intersection ranked by expected number of crashes.

Table E10 Springfield Road Intersection Prioritization – Urban/Suburban Analysis

Priority Number	Intersection Cross Street	Intersection Type
1	Nuckols Road	3SG ¹
2	Staples Mill Road	4SG ²
3	Francistown Road	3ST
4	Wintergreen Road/Linsey Lakes Drive	4ST
5	Olde Milbrooke Way	4ST ³
6	Wamerwood Court/Hart Mill Drive	4ST
7	Wendhurst Drive	3ST
	Kingscroft Drive	3ST
9	Olde Hartley Drive	3ST
10	Wintercreek Drive	3ST
11	Old Springfield Road	3ST
12	Fireside Drive	3ST
	Jacobs Creek Drive	3ST
14	Echo Lake Drive	3ST ⁴
15	Bernard Mills Drive	3ST
	Jones Road	3ST
17	Rigney Terrace	3ST

¹ Signalized intersection with three approaches
² Signalized intersections with four approaches
³ Minor street stop controlled intersection with four approaches
⁴ Minor street stop controlled intersection with three approaches

The following intersections should receive priority for improvements when considered in an urban/suburban context:

- Nuckols Road
- Staples Mill Road
- Francistown Road
- Wintergreen Road/Linsey Lakes Drive
- Olde Milbrooke Way

These five intersections account for 57 percent of the total expected intersection crashes and 49 percent of the total expected intersection fatal and/or serious injury crashes. Similarly, these five intersections account for 38 percent of the corridor’s total expected crashes and 36 percent of the corridor’s total expected fatal and/or serious injury crashes. Consequently, crash-related countermeasures at these intersections are likely to have a substantial impact in the corridor’s total expected crashes; particularly on the total expected fatal and/or serious injury crashes. Table E10 displays annual crashes for the roadways segments.

Table E11 summarizes reported crash type and severity along the Springfield Road corridor.

Table E11 Springfield Road Total Reported Crash Type by Severity for Existing Conditions

Crash Type	Fatal/Injury	PDO	Total
Angle	1	5	6
Fixed Object - Off Road	5	11	16
Other - Animal	1	0	1
Pedestrian	1	0	1
Rear End	3	3	3
Sideswipe - Opposite Direction	1	0	1
Sideswipe - Same Direction	0	4	4
Total	9	23	32

As seen in Table E11, Fixed Object-Off Road crashes represent 50 percent of the total reported crashes including two of the three reported fatal crashes and three of the six reported injury crashes. The second highest reported crash frequency are angle crashes with six reported crashes, 19 percent of total reported crashes. Ten of the 32 reported crashes, including eight of the 16 reported fixed object crashes, occurred at night, and there is no lighting along the corridor study area.

Segment N.1 and N.2 have the highest reported crash frequency of any segment with three crashes each. The lengths of these segments represent seven percent of the total corridor length, but 19 percent of all reported crashes occurred in these two segments. Segment N.1 has the second smallest horizontal curve along the corridor, which is a radius of approximately 330 feet. Segment E.1, F.1, and M.1 have the second highest crash frequency was with two reported crashes each. The high percentage of fixed object crashes, the effects of horizontal curvature, and the prevalence of reported crashes occurring outside of intersections (60 percent) are characteristics consistent with the operations of a rural road. This is consistent with the results of expected annual crashes calculated for existing conditions.

General Information

Analyst	JXP	Analysis Name	Existing-Chapter12	Date of Analysis	5/28/2012
Agency/Company	Kittelsohn & Associates, Inc.	Project Number/PIN #	11764.4	Comments	
State	Virginia	Site(s)	Springfield Road		
Region/Area/City/County	Glen Allen/Henrico County	Jurisdiction	Henrico County		

Analysis Summary Results

Crash Severity Distribution	Crash Frequency		
	Fatal and Injury (FI)	Property Damage Only (PDO)	Total
Total Predicted Crashes (entire study period)	22.32	41.37	63.69
Total Predicted Crashes (crashes/year)	7.44	13.79	21.23
Total Expected Crashes (entire study period)	15.85	33.76	46.28
Total Expected Crashes (crashes/year)	5.28	11.25	15.43
Nuckols Road to Fireside Drive	0.05	0.12	0.16
Additional Year - 2009	0.05	0.12	0.16
Additional Year - 2010	0.05	0.12	0.16
Total Predicted Crashes (crashes/year)	0.05	0.12	0.16
Total Expected Crashes (crashes/year)	0.04	0.14	0.18
Fireside Drive to Kingscroft Drive	0.10	0.25	0.35
Additional Year - 2009	0.10	0.25	0.35
Additional Year - 2010	0.10	0.25	0.35
Total Predicted Crashes (crashes/year)	0.10	0.25	0.35
Total Expected Crashes (crashes/year)	0.09	0.19	0.24
Kingscroft Drive to Wendhurst Drive	0.04	0.11	0.15
Additional Year - 2009	0.04	0.11	0.15
Additional Year - 2010	0.04	0.11	0.15
Total Predicted Crashes (crashes/year)	0.04	0.11	0.15

Analysis Summary Results

Crash Severity Distribution	Crash Frequency		
	Fatal and Injury (FI)	Property Damage Only (PDO)	Total
Total Expected Crashes (crashes/year)	0.04	0.10	0.13
Wendhurst Drive to Jones Road	0.03	0.09	0.12
Additional Year - 2009	0.03	0.09	0.12
Additional Year - 2010	0.03	0.09	0.12
Total Predicted Crashes (crashes/year)	0.03	0.09	0.12
Total Expected Crashes (crashes/year)	0.03	0.08	0.11
Jones Road to Olde Milbrooke Way	0.07	0.19	0.26
Additional Year - 2009	0.07	0.19	0.26
Additional Year - 2010	0.07	0.19	0.26
Total Predicted Crashes (crashes/year)	0.07	0.19	0.26
Total Expected Crashes (crashes/year)	0.09	0.15	0.32
Olde Milbrooke way to Wintergreen Road/ Linsey L:	0.08	0.21	0.30
Additional Year - 2009	0.08	0.21	0.30
Additional Year - 2010	0.08	0.21	0.30
Total Predicted Crashes (crashes/year)	0.08	0.21	0.30
Total Expected Crashes (crashes/year)	0.08	0.35	0.44
Wintergreen Roal/Linsey Lakes Drive to Jacobs Cre	0.12	0.30	0.42
Additional Year - 2009	0.12	0.30	0.42
Additional Year - 2010	0.12	0.30	0.42
Total Predicted Crashes (crashes/year)	0.12	0.30	0.42
Total Expected Crashes (crashes/year)	0.11	0.23	0.30
Jacobs Creek Drive to Wintercreek Drive	0.02	0.05	0.07

Analysis Summary Results

Crash Severity Distribution	Crash Frequency		
	Fatal and Injury (FI)	Property Damage Only (PDO)	Total
Additional Year - 2009	0.02	0.05	0.07
Additional Year - 2010	0.02	0.05	0.07
Total Predicted Crashes (crashes/year)	0.02	0.05	0.07
Total Expected Crashes (crashes/year)	0.02	0.05	0.07
Wintercreek Drive to Hart Mill Drive	0.04	0.10	0.14
Additional Year - 2009	0.04	0.10	0.14
Additional Year - 2010	0.04	0.10	0.14
Total Predicted Crashes (crashes/year)	0.04	0.10	0.14
Total Expected Crashes (crashes/year)	0.04	0.09	0.13
Wamerwood Court to Bernard Mills Drive	0.07	0.17	0.24
Additional Year - 2009	0.07	0.17	0.24
Additional Year - 2010	0.07	0.17	0.24
Total Predicted Crashes (crashes/year)	0.07	0.17	0.24
Total Expected Crashes (crashes/year)	0.07	0.20	0.25
Bernard Mills Drive to Olde Hartley Drive	0.05	0.11	0.16
Additional Year - 2009	0.05	0.11	0.16
Additional Year - 2010	0.05	0.11	0.16
Total Predicted Crashes (crashes/year)	0.05	0.11	0.16
Total Expected Crashes (crashes/year)	0.04	0.10	0.14
Olde Hartley Drive to Echo Lake Drive	0.05	0.12	0.16
Additional Year - 2009	0.05	0.12	0.16
Additional Year - 2010	0.05	0.12	0.16
Total Predicted Crashes (crashes/year)	0.05	0.12	0.16

Analysis Summary Results

Crash Severity Distribution	Crash Frequency		
	Fatal and Injury (FI)	Property Damage Only (PDO)	Total
Total Expected Crashes (crashes/year)	0.05	0.10	0.18
Echo Lake Drive through End of Horizontal Curve 1	0.04	0.10	0.14
Additional Year - 2009	0.04	0.10	0.14
Additional Year - 2010	0.04	0.10	0.14
Total Predicted Crashes (crashes/year)	0.04	0.10	0.14
Total Expected Crashes (crashes/year)	0.05	0.13	0.21
Start of Horizontal Curve 2 to Old Springfield Rd	0.20	0.48	0.67
Additional Year - 2009	0.20	0.48	0.67
Additional Year - 2010	0.20	0.48	0.67
Total Predicted Crashes (crashes/year)	0.20	0.48	0.67
Total Expected Crashes (crashes/year)	0.29	0.78	1.35
Old Springfield Road to Rigney Terrace	0.07	0.17	0.25
Additional Year - 2009	0.07	0.17	0.25
Additional Year - 2010	0.07	0.17	0.25
Total Predicted Crashes (crashes/year)	0.07	0.17	0.25
Total Expected Crashes (crashes/year)	0.07	0.15	0.20
Rigney Terrace to Francistown Road	0.06	0.14	0.20
Additional Year - 2009	0.06	0.14	0.20
Additional Year - 2010	0.06	0.14	0.20
Total Predicted Crashes (crashes/year)	0.06	0.14	0.20
Total Expected Crashes (crashes/year)	0.06	0.12	0.22
Francistown Road to Staples Mill Road	0.30	0.73	1.02

Analysis Summary Results

Crash Severity Distribution	Crash Frequency		
	Fatal and Injury (FI)	Property Damage Only (PDO)	Total
Additional Year - 2009	0.30	0.73	1.02
Additional Year - 2010	0.30	0.73	1.02
Total Predicted Crashes (crashes/year)	0.30	0.73	1.02
Total Expected Crashes (crashes/year)	0.24	0.55	0.67
Nuckols Road/Springfield Road	0.76	1.49	2.25
Additional Year - 2009	0.76	1.49	2.25
Additional Year - 2010	0.76	1.49	2.25
Total Predicted Crashes (crashes/year)	0.76	1.49	2.25
Total Expected Crashes (crashes/year)	0.50	1.65	1.97
Springfield Road/Fireside Drive	0.21	0.31	0.52
Additional Year - 2009	0.21	0.31	0.52
Additional Year - 2010	0.21	0.31	0.52
Total Predicted Crashes (crashes/year)	0.21	0.31	0.52
Total Expected Crashes (crashes/year)	0.14	0.21	0.30
Springfield Road/Kingscroft Drive	0.28	0.42	0.70
Additional Year - 2009	0.28	0.41	0.70
Additional Year - 2010	0.28	0.42	0.70
Total Predicted Crashes (crashes/year)	0.28	0.42	0.70
Total Expected Crashes (crashes/year)	0.28	0.25	0.54
Springfield Road/Wendhurst Drive	0.29	0.43	0.71
Additional Year - 2009	0.29	0.43	0.71
Additional Year - 2010	0.29	0.43	0.71
Total Predicted Crashes (crashes/year)	0.29	0.43	0.71

Analysis Summary Results

Crash Severity Distribution	Crash Frequency		
	Fatal and Injury (FI)	Property Damage Only (PDO)	Total
Total Expected Crashes (crashes/year)	0.18	0.40	0.54
Springfield Road/Jones Road	0.21	0.26	0.47
Additional Year - 2009	0.21	0.26	0.47
Additional Year - 2010	0.21	0.26	0.47
Total Predicted Crashes (crashes/year)	0.21	0.26	0.47
Total Expected Crashes (crashes/year)	0.14	0.18	0.28
Springfield Road/Olde Milbrooke Way	0.43	0.75	1.18
Additional Year - 2009	0.43	0.75	1.18
Additional Year - 2010	0.43	0.75	1.18
Total Predicted Crashes (crashes/year)	0.43	0.75	1.18
Total Expected Crashes (crashes/year)	0.27	0.46	0.62
Springfield Road/Wintergreen Roal/Linsey Lakes Dri	0.50	0.85	1.35
Additional Year - 2009	0.50	0.85	1.35
Additional Year - 2010	0.50	0.85	1.35
Total Predicted Crashes (crashes/year)	0.50	0.85	1.35
Total Expected Crashes (crashes/year)	0.30	0.50	0.67
Springfield Road/Jacobs Creek Drive	0.23	0.30	0.53
Additional Year - 2009	0.23	0.30	0.53
Additional Year - 2010	0.23	0.30	0.53
Total Predicted Crashes (crashes/year)	0.23	0.30	0.53
Total Expected Crashes (crashes/year)	0.15	0.20	0.30
Springfield Road/Wintercreek Drive	0.30	0.45	0.75

Analysis Summary Results

Crash Severity Distribution	Crash Frequency		
	Fatal and Injury (FI)	Property Damage Only (PDO)	Total
Additional Year - 2009	0.30	0.45	0.75
Additional Year - 2010	0.30	0.45	0.75
Total Predicted Crashes (crashes/year)	0.30	0.45	0.75
Total Expected Crashes (crashes/year)	0.18	0.27	0.37
Springfield Road/Hart Mill Drive	0.33	0.60	0.92
Additional Year - 2009	0.33	0.60	0.92
Additional Year - 2010	0.33	0.60	0.92
Total Predicted Crashes (crashes/year)	0.33	0.60	0.92
Total Expected Crashes (crashes/year)	0.22	0.40	0.55
Springfield Road/Bernard Mills Drive	0.22	0.29	0.50
Additional Year - 2009	0.19	0.26	0.45
Additional Year - 2010	0.19	0.26	0.45
Total Predicted Crashes (crashes/year)	0.20	0.27	0.47
Total Expected Crashes (crashes/year)	0.13	0.19	0.28
Springfield Road/Olde Hartley Drive	0.21	0.29	0.49
Additional Year - 2009	0.21	0.29	0.49
Additional Year - 2010	0.21	0.29	0.49
Total Predicted Crashes (crashes/year)	0.21	0.29	0.49
Total Expected Crashes (crashes/year)	0.14	0.31	0.45
Springfield Road/Echo Lake Drive	0.21	0.28	0.50
Additional Year - 2009	0.21	0.28	0.50
Additional Year - 2010	0.21	0.28	0.50
Total Predicted Crashes (crashes/year)	0.21	0.28	0.50

Analysis Summary Results

Crash Severity Distribution	Crash Frequency		
	Fatal and Injury (FI)	Property Damage Only (PDO)	Total
Total Expected Crashes (crashes/year)	0.14	0.20	0.29
Springfield Road/Old Springfield Rd	0.23	0.33	0.56
Additional Year - 2009	0.23	0.33	0.56
Additional Year - 2010	0.23	0.33	0.56
Total Predicted Crashes (crashes/year)	0.23	0.33	0.56
Total Expected Crashes (crashes/year)	0.14	0.22	0.31
Springfield Road/Rigney Terrace	0.16	0.20	0.36
Additional Year - 2009	0.16	0.20	0.36
Additional Year - 2010	0.16	0.20	0.36
Total Predicted Crashes (crashes/year)	0.16	0.20	0.36
Total Expected Crashes (crashes/year)	0.11	0.15	0.24
Springfield Road/Francistown Road	0.39	0.81	1.20
Additional Year - 2009	0.39	0.81	1.20
Additional Year - 2010	0.39	0.81	1.20
Total Predicted Crashes (crashes/year)	0.39	0.81	1.20
Total Expected Crashes (crashes/year)	0.21	0.96	1.15
Staples Mill Road/Springfield Road	1.13	2.32	3.45
Additional Year - 2009	1.13	2.32	3.45
Additional Year - 2010	1.13	2.32	3.45
Total Predicted Crashes (crashes/year)	1.13	2.32	3.45
Total Expected Crashes (crashes/year)	0.62	1.19	1.43

Appendix F
Year 2036 Future No-Build
Level of Service Worksheets

Queues
1: Nuckols Road & Springfield Road

Year 2036 No-Build Conditions
Weekday AM



Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Group Flow (vph)	186	411	1021	156	399	544
v/c Ratio	0.25	0.45	0.90	0.13	0.80	0.79
Control Delay	27.7	4.2	40.6	7.6	48.1	16.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	27.7	4.2	40.6	7.6	48.1	16.0
Queue Length 50th (ft)	44	0	267	31	226	55
Queue Length 95th (ft)	65	35	#406	66	#430	169
Internal Link Dist (ft)	362			346	244	
Turn Bay Length (ft)	275	175	225			
Base Capacity (vph)	986	1088	1155	1225	498	774
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.19	0.38	0.88	0.13	0.80	0.70

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

HCM Signalized Intersection Capacity Analysis
1: Nuckols Road & Springfield Road

Year 2036 No-Build Conditions

Weekday AM



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	177	390	970	148	379	517
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	11	11	12	12	12	12
Total Lost time (s)	5.0	5.0	5.0	6.0	6.0	5.0
Lane Util. Factor	0.97	0.88	0.97	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	3286	2668	3467	1881	1863	1583
Flt Permitted	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (perm)	3286	2668	3467	1881	1863	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	186	411	1021	156	399	544
RTOR Reduction (vph)	0	318	0	0	0	330
Lane Group Flow (vph)	186	93	1021	156	399	214
Heavy Vehicles (%)	3%	3%	1%	1%	2%	2%
Turn Type	custom		Prot	Over		
Protected Phases	3	3	5	2	6	3
Permitted Phases	3					
Actuated Green, G (s)	20.4	20.4	29.6	58.6	24.0	20.4
Effective Green, g (s)	20.4	20.4	29.6	58.6	24.0	20.4
Actuated g/C Ratio	0.23	0.23	0.33	0.65	0.27	0.23
Clearance Time (s)	5.0	5.0	5.0	6.0	6.0	5.0
Vehicle Extension (s)	5.0	5.0	3.0	6.0	6.0	5.0
Lane Grp Cap (vph)	745	605	1140	1225	497	359
v/s Ratio Prot	0.06	0.03	c0.29	0.08	c0.21	c0.14
v/s Ratio Perm						
v/c Ratio	0.25	0.15	0.90	0.13	0.80	0.60
Uniform Delay, d1	28.5	27.9	28.7	6.0	30.8	31.1
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.4	0.2	9.3	0.2	12.9	4.0
Delay (s)	28.9	28.1	38.0	6.2	43.7	35.1
Level of Service	C	C	D	A	D	D
Approach Delay (s)	28.4			33.8	38.7	
Approach LOS	C			C	D	

Intersection Summary			
HCM Average Control Delay	34.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	68.0%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

HCM Unsignalized Intersection Capacity Analysis

2: Fireside Drive &

Year 2036 No-Build Conditions
Weekday AM



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	80	20	303	22	1	816
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91
Hourly flow rate (vph)	88	22	333	24	1	897
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage (veh)						
Upstream signal (ft)			377			
pX, platoon unblocked						
vC, conflicting volume	796	179			357	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	796	179			357	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	73	97			100	
cM capacity (veh/h)	328	840			1198	
Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	110	222	135	1	448	448
Volume Left	88	0	0	1	0	0
Volume Right	22	0	24	0	0	0
cSH	374	1700	1700	1198	1700	1700
Volume to Capacity	0.29	0.13	0.08	0.00	0.26	0.26
Queue Length 95th (ft)	30	0	0	0	0	0
Control Delay (s)	18.6	0.0	0.0	8.0	0.0	0.0
Lane LOS	C			A		
Approach Delay (s)	18.6	0.0		0.0		
Approach LOS	C					
Intersection Summary						
Average Delay			1.5			
Intersection Capacity Utilization			34.9%		ICU Level of Service	A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
 3: Kingscroft Drive & Springfield Road

Year 2036 No-Build Conditions

Weekday AM



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	72	18	296	27	1	745
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	83	21	340	31	1	856
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage (veh)						
Upstream signal (ft)			1118			
pX, platoon unblocked						
vC, conflicting volume	1199	340			371	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1199	340			371	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	60	97			100	
cM capacity (veh/h)	207	707			1187	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1
Volume Total	103	340	31	857
Volume Left	83	0	0	1
Volume Right	21	0	31	0
cSH	241	1700	1700	1187
Volume to Capacity	0.43	0.20	0.02	0.00
Queue Length 95th (ft)	51	0	0	0
Control Delay (s)	30.8	0.0	0.0	0.0
Lane LOS	D			A
Approach Delay (s)	30.8	0.0		0.0
Approach LOS	D			

Intersection Summary			
Average Delay		2.4	
Intersection Capacity Utilization		51.8%	ICU Level of Service A
Analysis Period (min)		15	

HCM Unsignalized Intersection Capacity Analysis

4: Wendhurst Drive & Springfield Road

Year 2036 No-Build Conditions
Weekday AM



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↙		↑	↗		↓
Volume (veh/h)	74	10	292	22	5	672
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.83	0.83	0.83	0.83	0.83	0.83
Hourly flow rate (vph)	89	12	352	27	6	810
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1173	352			378	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1173	352			378	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	58	98			99	
cM capacity (veh/h)	213	696			1186	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1
Volume Total	101	352	27	816
Volume Left	89	0	0	6
Volume Right	12	0	27	0
cSH	232	1700	1700	1186
Volume to Capacity	0.44	0.21	0.02	0.01
Queue Length 95th (ft)	51	0	0	0
Control Delay (s)	32.0	0.0	0.0	0.1
Lane LOS	D			A
Approach Delay (s)	32.0	0.0		0.1
Approach LOS	D			

Intersection Summary			
Average Delay		2.6	
Intersection Capacity Utilization		50.7%	ICU Level of Service A
Analysis Period (min)		15	

HCM Unsignalized Intersection Capacity Analysis
5: Jones Road & Springfield Road

Year 2036 No-Build Conditions
Weekday AM



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	5	5	2	300	672	5
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Hourly flow rate (vph)	6	6	2	333	747	6
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1087	749	752			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1087	749	752			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	98	99	100			
cM capacity (veh/h)	241	415	857			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	11	336	752			
Volume Left	6	2	0			
Volume Right	6	0	6			
cSH	305	857	1700			
Volume to Capacity	0.04	0.00	0.44			
Queue Length 95th (ft)	3	0	0			
Control Delay (s)	17.3	0.1	0.0			
Lane LOS	C	A				
Approach Delay (s)	17.3	0.1	0.0			
Approach LOS	C					
Intersection Summary						
Average Delay			0.2			
Intersection Capacity Utilization		45.7%		ICU Level of Service		A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
6: Olde Milbrooke Way & Springfield Road

Year 2036 No-Build Conditions
Weekday AM



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔			↔			↑	↗		↔	
Volume (veh/h)	5	0	5	22	0	23	3	293	9	3	650	12
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	6	0	6	25	0	26	3	329	10	3	730	13
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage (veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1106	1090	737	1085	1087	329	744			339		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1106	1090	737	1085	1087	329	744			339		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	97	100	99	87	100	96	100			100		
cM capacity (veh/h)	182	216	422	192	216	717	864			1220		

Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1
Volume Total	11	51	333	10	747
Volume Left	6	25	3	0	3
Volume Right	6	26	0	10	13
cSH	254	307	864	1700	1220
Volume to Capacity	0.04	0.16	0.00	0.01	0.00
Queue Length 95th (ft)	3	15	0	0	0
Control Delay (s)	19.8	19.0	0.1	0.0	0.1
Lane LOS	C	C	A		A
Approach Delay (s)	19.8	19.0	0.1		0.1
Approach LOS	C	C			

Intersection Summary		
Average Delay		1.1
Intersection Capacity Utilization	51.8%	ICU Level of Service
Analysis Period (min)		15
		A

HCM Unsignalized Intersection Capacity Analysis
7: Wintergreen Road & Springfield Road

Year 2036 No-Build Conditions

Weekday AM

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	70	0	40	14	1	33	7	311	3	20	611	21
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	74	0	43	15	1	35	7	331	3	21	650	22
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage (veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1085	1053	661	1092	1061	331	672			334		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1085	1053	661	1092	1061	331	672			334		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	59	100	91	91	100	95	99			98		
cM capacity (veh/h)	181	221	464	171	218	711	909			1225		
Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1							
Volume Total	117	51	338	3	694							
Volume Left	74	15	7	0	21							
Volume Right	43	35	0	3	22							
cSH	233	361	909	1700	1225							
Volume to Capacity	0.50	0.14	0.01	0.00	0.02							
Queue Length 95th (ft)	64	12	1	0	1							
Control Delay (s)	35.2	16.6	0.3	0.0	0.5							
Lane LOS	E	C	A		A							
Approach Delay (s)	35.2	16.6	0.3		0.5							
Approach LOS	E	C										
Intersection Summary												
Average Delay			4.5									
Intersection Capacity Utilization			68.9%		ICU Level of Service					C		
Analysis Period (min)			15									

HCM Unsignalized Intersection Capacity Analysis
8: Jacobs Creek Drive & Springfield Road

Year 2036 No-Build Conditions
Weekday AM



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	16	24	399	15	16	636
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	18	27	448	17	18	715
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1207	457			465	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1207	457			465	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	91	96			98	
cM capacity (veh/h)	201	608			1096	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	45	465	733
Volume Left	18	0	18
Volume Right	27	17	0
cSH	336	1700	1096
Volume to Capacity	0.13	0.27	0.02
Queue Length 95th (ft)	11	0	1
Control Delay (s)	17.4	0.0	0.4
Lane LOS	C		A
Approach Delay (s)	17.4	0.0	0.4
Approach LOS	C		

Intersection Summary			
Average Delay		0.9	
Intersection Capacity Utilization		56.3%	ICU Level of Service
Analysis Period (min)		15	B

HCM Unsignalized Intersection Capacity Analysis
 9: Wintercreek Drive & Springfield Road

Year 2036 No-Build Conditions
 Weekday AM



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	34	51	19	404	601	10
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	39	58	22	459	683	11
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1191	689	694			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1191	689	694			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	81	87	98			
cM capacity (veh/h)	202	446	901			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	97	481	694			
Volume Left	39	22	0			
Volume Right	58	0	11			
cSH	301	901	1700			
Volume to Capacity	0.32	0.02	0.41			
Queue Length 95th (ft)	34	2	0			
Control Delay (s)	22.5	0.7	0.0			
Lane LOS	C	A				
Approach Delay (s)	22.5	0.7	0.0			
Approach LOS	C					
Intersection Summary						
Average Delay			2.0			
Intersection Capacity Utilization			48.4%		ICU Level of Service	A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
 10: Warnerwood Ct & Springfield Road

Year 2036 No-Build Conditions

Weekday AM

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	2	0	1	16	0	1	1	416	21	2	594	1
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Hourly flow rate (vph)	2	0	1	17	0	1	1	447	23	2	639	1
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage (veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1094	1116	639	1094	1094	447	640			470		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1094	1116	639	1094	1094	447	640			470		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	99	100	100	91	100	100	100			100		
cM capacity (veh/h)	190	206	474	192	215	615	940			1097		
Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1							
Volume Total	3	18	448	23	642							
Volume Left	2	17	1	0	2							
Volume Right	1	1	0	23	1							
cSH	237	200	940	1700	1097							
Volume to Capacity	0.01	0.09	0.00	0.01	0.00							
Queue Length 95th (ft)	1	7	0	0	0							
Control Delay (s)	20.4	24.8	0.0	0.0	0.1							
Lane LOS	C	C	A		A							
Approach Delay (s)	20.4	24.8	0.0		0.1							
Approach LOS	C	C										
Intersection Summary												
Average Delay			0.5									
Intersection Capacity Utilization			48.1%		ICU Level of Service				A			
Analysis Period (min)			15									

HCM Unsignalized Intersection Capacity Analysis
 11: Springfield Road & Bernard Mills Drive

Year 2036 No-Build Conditions
 Weekday AM



Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑	↗		↑	↘	
Volume (veh/h)	405	14	1	591	6	9
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	460	16	1	672	7	10
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			476		1134	460
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			476		1134	460
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		97	98
cM capacity (veh/h)			1086		226	605

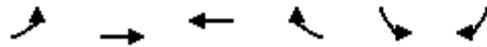
Direction, Lane #	EB 1	EB 2	WB 1	NB 1
Volume Total	460	16	673	17
Volume Left	0	0	1	7
Volume Right	0	16	0	10
cSH	1700	1700	1086	362
Volume to Capacity	0.27	0.01	0.00	0.05
Queue Length 95th (ft)	0	0	0	4
Control Delay (s)	0.0	0.0	0.0	15.4
Lane LOS			A	C
Approach Delay (s)	0.0		0.0	15.4
Approach LOS				C

Intersection Summary			
Average Delay		0.2	
Intersection Capacity Utilization		41.9%	ICU Level of Service A
Analysis Period (min)		15	

HCM Unsignalized Intersection Capacity Analysis
 12: Springfield Road & Olde Hartley Drive

Year 2036 No-Build Conditions

Weekday AM



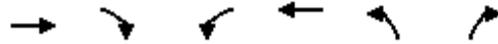
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↶	↶	↷	↷	
Volume (veh/h)	5	409	576	6	26	16
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	6	460	647	7	29	18
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	654				1118	647
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	654				1118	647
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	99				87	96
cM capacity (veh/h)	933				225	466

Direction, Lane #	EB 1	WB 1	WB 2	SB 1
Volume Total	465	647	7	47
Volume Left	6	0	0	29
Volume Right	0	0	7	18
cSH	933	1700	1700	280
Volume to Capacity	0.01	0.38	0.00	0.17
Queue Length 95th (ft)	0	0	0	15
Control Delay (s)	0.2	0.0	0.0	20.5
Lane LOS	A			C
Approach Delay (s)	0.2	0.0		20.5
Approach LOS				C

Intersection Summary			
Average Delay		0.9	
Intersection Capacity Utilization		40.3%	ICU Level of Service A
Analysis Period (min)		15	

HCM Unsignalized Intersection Capacity Analysis
 13: Springfield Road & Echo Lake Drive

Year 2036 No-Build Conditions
 Weekday AM



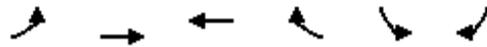
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	→			←	←	↘
Volume (veh/h)	420	15	1	574	8	12
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	457	16	1	624	9	13
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			473		1091	465
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			473		1091	465
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		96	98
cM capacity (veh/h)			1089		240	602

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	473	625	22
Volume Left	0	1	9
Volume Right	16	0	13
cSH	1700	1089	375
Volume to Capacity	0.28	0.00	0.06
Queue Length 95th (ft)	0	0	5
Control Delay (s)	0.0	0.0	15.2
Lane LOS		A	C
Approach Delay (s)	0.0	0.0	15.2
Approach LOS			C

Intersection Summary			
Average Delay		0.3	
Intersection Capacity Utilization	41.0%		ICU Level of Service A
Analysis Period (min)		15	

HCM Unsignalized Intersection Capacity Analysis
 14: Springfield Road & Old Springfield Road

Year 2036 No-Build Conditions
 Weekday AM



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↔	↔		↔	↔
Volume (veh/h)	7	425	548	12	39	27
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	7	447	577	13	41	28
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						2
Median type		None	None			
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	589				1045	583
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	589				1045	583
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	99				84	94
cM capacity (veh/h)	991				251	512

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	455	589	69
Volume Left	7	0	41
Volume Right	0	13	28
cSH	991	1700	425
Volume to Capacity	0.01	0.35	0.16
Queue Length 95th (ft)	1	0	14
Control Delay (s)	0.2	0.0	18.1
Lane LOS	A		C
Approach Delay (s)	0.2	0.0	18.1
Approach LOS			C

Intersection Summary			
Average Delay		1.2	
Intersection Capacity Utilization		39.6%	ICU Level of Service A
Analysis Period (min)		15	

HCM Unsignalized Intersection Capacity Analysis
 15: Rigney Terrace & Springfield Road

Year 2036 No-Build Conditions
 Weekday AM



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	21	14	1	539	448	16
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	22	15	1	573	477	17
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1052	477	494			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1052	477	494			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	91	97	100			
cM capacity (veh/h)	253	593	1070			

Direction, Lane #	EB 1	NB 1	SB 1	SB 2
Volume Total	37	574	477	17
Volume Left	22	1	0	0
Volume Right	15	0	0	17
cSH	328	1070	1700	1700
Volume to Capacity	0.11	0.00	0.28	0.01
Queue Length 95th (ft)	10	0	0	0
Control Delay (s)	17.4	0.0	0.0	0.0
Lane LOS	C	A		
Approach Delay (s)	17.4	0.0	0.0	
Approach LOS	C			

Intersection Summary			
Average Delay		0.6	
Intersection Capacity Utilization		39.2%	ICU Level of Service A
Analysis Period (min)		15	

HCM Unsignalized Intersection Capacity Analysis
 16: Springfield Road & Francistown Road

Year 2036 No-Build Conditions

Weekday AM

						
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	250	421	119	317	345	117
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	272	458	129	345	375	127
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1007	129			474	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1007	129			474	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	0	50			66	
cM capacity (veh/h)	174	918			1088	
Direction, Lane #	WB 1	WB 2	NB 1	NB 2	SB 1	SB 2
Volume Total	272	458	129	345	375	127
Volume Left	272	0	0	0	375	0
Volume Right	0	458	0	345	0	0
cSH	174	918	1700	1700	1088	1700
Volume to Capacity	1.56	0.50	0.08	0.20	0.34	0.07
Queue Length 95th (ft)	447	71	0	0	39	0
Control Delay (s)	325.5	12.8	0.0	0.0	10.0	0.0
Lane LOS	F	B			B	
Approach Delay (s)	129.3		0.0		7.5	
Approach LOS	F					
Intersection Summary						
Average Delay			57.5			
Intersection Capacity Utilization			46.3%		ICU Level of Service	A
Analysis Period (min)			15			

Queues
17: Springfield Road & Staples Mill Road

Year 2036 No-Build Conditions
Weekday AM



Lane Group	EBT	EBR	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Group Flow (vph)	557	140	388	191	188	416	58	103	836	315
v/c Ratio	1.24	0.28	1.07	0.41	1.21	0.50	0.14	0.62	0.99	0.68
Control Delay	164.7	7.3	111.7	8.5	184.0	42.8	10.5	68.6	75.0	34.8
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	164.7	7.3	111.7	8.5	184.0	42.8	10.5	68.6	75.0	34.8
Queue Length 50th (ft)	~536	0	~332	0	~177	148	0	78	341	145
Queue Length 95th (ft)	#756	51	#527	62	#327	204	36	136	#480	250
Internal Link Dist (ft)	1531		132			545			464	
Turn Bay Length (ft)		575			150		125	200		75
Base Capacity (vph)	449	501	364	469	156	837	419	200	843	463
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	1.24	0.28	1.07	0.41	1.21	0.50	0.14	0.52	0.99	0.68

Intersection Summary

- ~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
- # 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

HCM Signalized Intersection Capacity Analysis
17: Springfield Road & Staples Mill Road

Year 2036 No-Build Conditions

Weekday AM

													
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	
Lane Configurations													
Volume (vph)	402	127	133	176	193	181	179	395	55	98	794	299	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	
Total Lost time (s)		7.0	7.0		7.0	7.0	6.5	6.3	6.3	6.5	6.7	6.7	
Lane Util. Factor		1.00	1.00		1.00	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Frt		1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	
Flt Protected		0.96	1.00		0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00	
Satd. Flow (prot)		1795	1583		1819	1583	1787	3574	1599	1787	3574	1599	
Flt Permitted		0.96	1.00		0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00	
Satd. Flow (perm)		1795	1583		1819	1583	1787	3574	1599	1787	3574	1599	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	
Adj. Flow (vph)	423	134	140	185	203	191	188	416	58	103	836	315	
RTOR Reduction (vph)	0	0	105	0	0	153	0	0	44	0	0	86	
Lane Group Flow (vph)	0	557	35	0	388	38	188	416	14	103	836	229	
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	1%	1%	1%	1%	1%	1%	
Turn Type	Split		Perm	Split		Perm	Prot		Perm	Prot		Perm	
Protected Phases	3	3		4	4		1	6		5	2		
Permitted Phases			3			4			6			2	
Actuated Green, G (s)		30.0	30.0		24.0	24.0	10.5	28.1	28.1	11.1	28.3	28.3	
Effective Green, g (s)		30.0	30.0		24.0	24.0	10.5	28.1	28.1	11.1	28.3	28.3	
Actuated g/C Ratio		0.25	0.25		0.20	0.20	0.09	0.23	0.23	0.09	0.24	0.24	
Clearance Time (s)		7.0	7.0		7.0	7.0	6.5	6.3	6.3	6.5	6.7	6.7	
Vehicle Extension (s)		3.5	3.5		3.5	3.5	2.5	6.0	6.0	2.5	6.0	6.0	
Lane Grp Cap (vph)		449	396		364	317	156	837	374	165	843	377	
v/s Ratio Prot		c0.31			c0.21		c0.11	0.12		0.06	c0.23		
v/s Ratio Perm			0.02			0.02			0.01			0.14	
v/c Ratio		1.24	0.09		1.07	0.12	1.21	0.50	0.04	0.62	0.99	0.61	
Uniform Delay, d1		45.0	34.5		48.0	39.3	54.8	39.8	35.5	52.4	45.7	40.9	
Progression Factor		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2		126.0	0.1		65.7	0.2	137.7	2.1	0.2	6.2	29.1	7.1	
Delay (s)		171.0	34.6		113.7	39.6	192.5	41.9	35.7	58.7	74.8	48.0	
Level of Service		F	C		F	D	F	D	D	E	E	D	
Approach Delay (s)		143.6			89.3			84.1			66.7		
Approach LOS		F			F			F			E		
Intersection Summary													
HCM Average Control Delay			91.2									HCM Level of Service	F
HCM Volume to Capacity ratio			1.04										
Actuated Cycle Length (s)			120.0									Sum of lost time (s)	20.5
Intersection Capacity Utilization			103.4%									ICU Level of Service	G
Analysis Period (min)			15										
c Critical Lane Group													

Queues
1: Nuckols Road & Springfield Road

Year 2036 No-Build Conditions
Weekday PM



Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Group Flow (vph)	479	1245	360	342	314	203
v/c Ratio	0.48	0.74	0.64	0.31	0.45	0.33
Control Delay	28.1	4.7	40.2	10.6	25.4	5.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	28.1	4.7	40.2	10.6	25.4	5.3
Queue Length 50th (ft)	113	0	99	93	135	0
Queue Length 95th (ft)	159	50	137	144	227	48
Internal Link Dist (ft)	967			491	244	
Turn Bay Length (ft)	275	175	225			
Base Capacity (vph)	1016	1696	1117	1102	691	622
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.47	0.73	0.32	0.31	0.45	0.33
Intersection Summary						

HCM Signalized Intersection Capacity Analysis
1: Nuckols Road & Springfield Road

Year 2036 No-Build Conditions

Weekday PM



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	436	1133	328	311	286	185
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	11	11	12	12	12	12
Total Lost time (s)	5.0	5.0	5.0	6.0	6.0	5.0
Lane Util. Factor	0.97	0.88	0.97	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	3385	2748	3467	1881	1881	1599
Flt Permitted	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (perm)	3385	2748	3467	1881	1881	1599
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	479	1245	360	342	314	203
RTOR Reduction (vph)	0	881	0	0	0	144
Lane Group Flow (vph)	479	364	360	342	314	59
Heavy Vehicles (%)	0%	0%	1%	1%	1%	1%
Turn Type	custom		Prot			Over
Protected Phases	3	3	5	2	6	3
Permitted Phases	3					
Actuated Green, G (s)	26.3	26.3	14.7	52.7	33.0	26.3
Effective Green, g (s)	26.3	26.3	14.7	52.7	33.0	26.3
Actuated g/C Ratio	0.29	0.29	0.16	0.59	0.37	0.29
Clearance Time (s)	5.0	5.0	5.0	6.0	6.0	5.0
Vehicle Extension (s)	5.0	5.0	3.0	6.0	6.0	5.0
Lane Grp Cap (vph)	989	803	566	1101	690	467
v/s Ratio Prot	c0.14	0.13	c0.10	0.18	c0.17	0.04
v/s Ratio Perm						
v/c Ratio	0.48	0.45	0.64	0.31	0.46	0.13
Uniform Delay, d1	26.3	26.0	35.2	9.4	21.7	23.4
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.8	0.9	2.3	0.7	2.2	0.3
Delay (s)	27.0	26.8	37.5	10.2	23.8	23.7
Level of Service	C	C	D	B	C	C
Approach Delay (s)	26.9			24.2	23.8	
Approach LOS	C			C	C	

Intersection Summary			
HCM Average Control Delay	25.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.50		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	63.9%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

HCM Unsignalized Intersection Capacity Analysis

2: Fireside Drive &

Year 2036 No-Build Conditions
Weekday PM



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	22	18	699	48	8	449
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91
Hourly flow rate (vph)	24	20	768	53	9	493
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage (veh)						
Upstream signal (ft)			377			
pX, platoon unblocked						
vC, conflicting volume	1059	410			821	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1059	410			821	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	89	97			99	
cM capacity (veh/h)	221	596			811	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	44	512	309	9	247	247
Volume Left	24	0	0	9	0	0
Volume Right	20	0	53	0	0	0
cSH	308	1700	1700	811	1700	1700
Volume to Capacity	0.14	0.30	0.18	0.01	0.15	0.15
Queue Length 95th (ft)	12	0	0	1	0	0
Control Delay (s)	18.6	0.0	0.0	9.5	0.0	0.0
Lane LOS	C			A		
Approach Delay (s)	18.6	0.0		0.2		
Approach LOS	C					

Intersection Summary						
Average Delay			0.7			
Intersection Capacity Utilization			30.9%		ICU Level of Service	A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis

3: Kingscroft Drive & Springfield Road

Year 2036 No-Build Conditions
Weekday PM



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	22	18	672	45	8	435
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91
Hourly flow rate (vph)	24	20	738	49	9	478
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage (veh)						
Upstream signal (ft)			1118			
pX, platoon unblocked	0.98	0.98			0.98	
vC, conflicting volume	1234	738			788	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1229	725			775	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	87	95			99	
cM capacity (veh/h)	193	421			830	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1
Volume Total	44	738	49	487
Volume Left	24	0	0	9
Volume Right	20	0	49	0
cSH	255	1700	1700	830
Volume to Capacity	0.17	0.43	0.03	0.01
Queue Length 95th (ft)	15	0	0	1
Control Delay (s)	22.1	0.0	0.0	0.3
Lane LOS	C			A
Approach Delay (s)	22.1	0.0		0.3
Approach LOS	C			

Intersection Summary			
Average Delay		0.8	
Intersection Capacity Utilization		45.4%	ICU Level of Service A
Analysis Period (min)		15	

HCM Unsignalized Intersection Capacity Analysis
4: Wendhurst Drive & Springfield Road

Year 2036 No-Build Conditions

Weekday PM



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↙		↑	↘		↘
Volume (veh/h)	30	6	647	43	7	413
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91
Hourly flow rate (vph)	33	7	711	47	8	454
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1180	711			758	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1180	711			758	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	84	98			99	
cM capacity (veh/h)	210	436			858	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1
Volume Total	40	711	47	462
Volume Left	33	0	0	8
Volume Right	7	0	47	0
cSH	230	1700	1700	858
Volume to Capacity	0.17	0.42	0.03	0.01
Queue Length 95th (ft)	15	0	0	1
Control Delay (s)	23.9	0.0	0.0	0.3
Lane LOS	C			A
Approach Delay (s)	23.9	0.0		0.3
Approach LOS	C			

Intersection Summary			
Average Delay		0.8	
Intersection Capacity Utilization		44.1%	ICU Level of Service A
Analysis Period (min)		15	

HCM Unsignalized Intersection Capacity Analysis
5: Jones Road & Springfield Road

Year 2036 No-Build Conditions
Weekday PM



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	5	5	17	636	415	15
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Hourly flow rate (vph)	6	6	19	707	461	17
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1214	469	478			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1214	469	478			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	97	99	98			
cM capacity (veh/h)	199	598	1090			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	11	726	478			
Volume Left	6	19	0			
Volume Right	6	0	17			
cSH	299	1090	1700			
Volume to Capacity	0.04	0.02	0.28			
Queue Length 95th (ft)	3	1	0			
Control Delay (s)	17.5	0.5	0.0			
Lane LOS	C	A				
Approach Delay (s)	17.5	0.5	0.0			
Approach LOS	C					
Intersection Summary						
Average Delay			0.4			
Intersection Capacity Utilization			57.2%		ICU Level of Service	B
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
6: Olde Milbrooke Way & Springfield Road

Year 2036 No-Build Conditions
Weekday PM



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔			↔			↑	↗		↔	
Volume (veh/h)	8	1	16	16	1	8	14	611	16	9	398	29
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	9	1	17	17	1	9	15	664	17	10	433	32
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage (veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1172	1180	448	1180	1178	664	464			682		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1172	1180	448	1180	1178	664	464			682		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	95	99	97	89	99	98	99			99		
cM capacity (veh/h)	164	187	615	160	188	464	1102			916		

Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1
Volume Total	27	27	679	17	474
Volume Left	9	17	15	0	10
Volume Right	17	9	0	17	32
cSH	312	204	1102	1700	916
Volume to Capacity	0.09	0.13	0.01	0.01	0.01
Queue Length 95th (ft)	7	11	1	0	1
Control Delay (s)	17.6	25.3	0.4	0.0	0.3
Lane LOS	C	D	A		A
Approach Delay (s)	17.6	25.3	0.4		0.3
Approach LOS	C	D			

Intersection Summary		
Average Delay		1.3
Intersection Capacity Utilization	49.2%	ICU Level of Service
Analysis Period (min)		15
		A

HCM Unsignalized Intersection Capacity Analysis

7: Wintergreen Road & Springfield Road

Year 2036 No-Build Conditions
Weekday PM



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔			↔			↑	↗		↔	
Volume (veh/h)	24	2	19	7	1	12	25	597	5	21	410	71
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	26	2	21	8	1	13	27	649	5	23	446	77
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage (veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1247	1239	484	1255	1272	649	523			654		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1247	1239	484	1255	1272	649	523			654		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	82	99	96	94	99	97	97			98		
cM capacity (veh/h)	141	168	587	138	161	473	1049			937		
Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1							
Volume Total	49	22	676	5	546							
Volume Left	26	8	27	0	23							
Volume Right	21	13	0	5	77							
cSH	210	243	1049	1700	937							
Volume to Capacity	0.23	0.09	0.03	0.00	0.02							
Queue Length 95th (ft)	22	7	2	0	2							
Control Delay (s)	27.2	21.3	0.7	0.0	0.7							
Lane LOS	D	C	A		A							
Approach Delay (s)	27.2	21.3	0.7		0.7							
Approach LOS	D	C										
Intersection Summary												
Average Delay			2.0									
Intersection Capacity Utilization			54.1%		ICU Level of Service					A		
Analysis Period (min)			15									

HCM Unsignalized Intersection Capacity Analysis
8: Jacobs Creek Drive & Springfield Road

Year 2036 No-Build Conditions
Weekday PM



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	14	11	593	40	7	488
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91
Hourly flow rate (vph)	15	12	652	44	8	536
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1225	674			696	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1225	674			696	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	92	97			99	
cM capacity (veh/h)	198	458			905	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	27	696	544
Volume Left	15	0	8
Volume Right	12	44	0
cSH	264	1700	905
Volume to Capacity	0.10	0.41	0.01
Queue Length 95th (ft)	9	0	1
Control Delay (s)	20.2	0.0	0.2
Lane LOS	C		A
Approach Delay (s)	20.2	0.0	0.2
Approach LOS	C		

Intersection Summary			
Average Delay		0.5	
Intersection Capacity Utilization		43.6%	ICU Level of Service A
Analysis Period (min)		15	

HCM Unsignalized Intersection Capacity Analysis
 9: Wintercreek Drive & Springfield Road

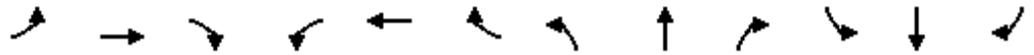
Year 2036 No-Build Conditions
 Weekday PM



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	16	19	16	588	476	17
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	18	21	18	661	535	19
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1241	544	554			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1241	544	554			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	91	96	98			
cM capacity (veh/h)	192	543	1021			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	39	679	554			
Volume Left	18	18	0			
Volume Right	21	0	19			
cSH	295	1021	1700			
Volume to Capacity	0.13	0.02	0.33			
Queue Length 95th (ft)	11	1	0			
Control Delay (s)	19.1	0.5	0.0			
Lane LOS	C	A				
Approach Delay (s)	19.1	0.5	0.0			
Approach LOS	C					
Intersection Summary						
Average Delay			0.8			
Intersection Capacity Utilization			53.8%	ICU Level of Service		A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
 10: Warnerwood Ct & Springfield Road

Year 2036 No-Build Conditions
 Weekday PM



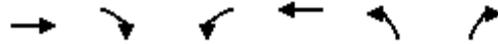
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔			↔			↑	↗		↔	
Volume (veh/h)	0	0	3	7	0	1	4	564	36	2	483	1
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	0	0	3	8	0	1	5	648	41	2	555	1
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage (veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1219	1259	556	1221	1218	648	556			690		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1219	1259	556	1221	1218	648	556			690		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	99	95	100	100	100			100		
cM capacity (veh/h)	157	171	535	156	181	474	1019			910		

Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1
Volume Total	3	9	653	41	559
Volume Left	0	8	5	0	2
Volume Right	3	1	0	41	1
cSH	535	170	1019	1700	910
Volume to Capacity	0.01	0.05	0.00	0.02	0.00
Queue Length 95th (ft)	0	4	0	0	0
Control Delay (s)	11.8	27.3	0.1	0.0	0.1
Lane LOS	B	D	A		A
Approach Delay (s)	11.8	27.3	0.1		0.1
Approach LOS	B	D			

Intersection Summary		
Average Delay		0.3
Intersection Capacity Utilization	45.3%	ICU Level of Service
Analysis Period (min)		15
		A

HCM Unsignalized Intersection Capacity Analysis
 11: Springfield Road & Bernard Mills Drive

Year 2036 No-Build Conditions
 Weekday PM



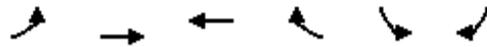
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑	↗		↑	↘	
Volume (veh/h)	521	44	7	481	5	5
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	599	51	8	553	6	6
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			649		1168	599
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			649		1168	599
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			99		97	99
cM capacity (veh/h)			941		214	505

Direction, Lane #	EB 1	EB 2	WB 1	NB 1
Volume Total	599	51	561	11
Volume Left	0	0	8	6
Volume Right	0	51	0	6
cSH	1700	1700	941	301
Volume to Capacity	0.35	0.03	0.01	0.04
Queue Length 95th (ft)	0	0	1	3
Control Delay (s)	0.0	0.0	0.2	17.4
Lane LOS			A	C
Approach Delay (s)	0.0		0.2	17.4
Approach LOS				C

Intersection Summary			
Average Delay		0.3	
Intersection Capacity Utilization	40.9%		ICU Level of Service A
Analysis Period (min)		15	

HCM Unsignalized Intersection Capacity Analysis
 12: Springfield Road & Olde Hartley Drive

Year 2036 No-Build Conditions
 Weekday PM



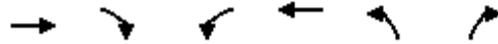
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↕	↕	↗	↘	↘
Volume (veh/h)	16	510	479	13	9	9
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.86	0.86	0.86	0.86	0.86	0.86
Hourly flow rate (vph)	19	593	557	15	10	10
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	572				1187	557
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	572				1187	557
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	98				95	98
cM capacity (veh/h)	1006				206	534

Direction, Lane #	EB 1	WB 1	WB 2	SB 1
Volume Total	612	557	15	21
Volume Left	19	0	0	10
Volume Right	0	0	15	10
cSH	1006	1700	1700	297
Volume to Capacity	0.02	0.33	0.01	0.07
Queue Length 95th (ft)	1	0	0	6
Control Delay (s)	0.5	0.0	0.0	18.0
Lane LOS	A			C
Approach Delay (s)	0.5	0.0		18.0
Approach LOS				C

Intersection Summary			
Average Delay		0.6	
Intersection Capacity Utilization		49.8%	ICU Level of Service
Analysis Period (min)		15	A

HCM Unsignalized Intersection Capacity Analysis
 13: Springfield Road & Echo Lake Drive

Year 2036 No-Build Conditions
 Weekday PM



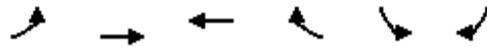
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	→			←	↙	↘
Volume (veh/h)	498	21	7	487	5	5
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.86	0.86	0.86	0.86	0.86	0.86
Hourly flow rate (vph)	579	24	8	566	6	6
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			603		1174	591
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			603		1174	591
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			99		97	99
cM capacity (veh/h)			979		212	510

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	603	574	12
Volume Left	0	8	6
Volume Right	24	0	6
cSH	1700	979	300
Volume to Capacity	0.35	0.01	0.04
Queue Length 95th (ft)	0	1	3
Control Delay (s)	0.0	0.2	17.5
Lane LOS		A	C
Approach Delay (s)	0.0	0.2	17.5
Approach LOS			C

Intersection Summary			
Average Delay		0.3	
Intersection Capacity Utilization	41.2%		ICU Level of Service A
Analysis Period (min)		15	

HCM Unsignalized Intersection Capacity Analysis
 14: Springfield Road & Old Springfield Road

Year 2036 No-Build Conditions
 Weekday PM



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↔	↔		↔	↔
Volume (veh/h)	21	482	483	22	18	11
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	24	554	555	25	21	13
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						2
Median type		None	None			
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	580				1170	568
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	580				1170	568
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	98				90	98
cM capacity (veh/h)	999				210	526

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	578	580	33
Volume Left	24	0	21
Volume Right	0	25	13
cSH	999	1700	338
Volume to Capacity	0.02	0.34	0.10
Queue Length 95th (ft)	2	0	8
Control Delay (s)	0.7	0.0	19.5
Lane LOS	A		C
Approach Delay (s)	0.7	0.0	19.5
Approach LOS			C

Intersection Summary			
Average Delay		0.9	
Intersection Capacity Utilization		52.4%	ICU Level of Service
Analysis Period (min)		15	A

HCM Unsignalized Intersection Capacity Analysis
 15: Rigney Terrace & Springfield Road

Year 2036 No-Build Conditions
 Weekday PM



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	7	8	7	498	479	21
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Hourly flow rate (vph)	8	9	8	553	532	23
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1101	532	556			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1101	532	556			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	97	98	99			
cM capacity (veh/h)	235	551	1020			

Direction, Lane #	EB 1	NB 1	SB 1	SB 2
Volume Total	17	561	532	23
Volume Left	8	8	0	0
Volume Right	9	0	0	23
cSH	338	1020	1700	1700
Volume to Capacity	0.05	0.01	0.31	0.01
Queue Length 95th (ft)	4	1	0	0
Control Delay (s)	16.2	0.2	0.0	0.0
Lane LOS	C	A		
Approach Delay (s)	16.2	0.2	0.0	
Approach LOS	C			

Intersection Summary			
Average Delay		0.3	
Intersection Capacity Utilization	41.8%		ICU Level of Service A
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
 16: Springfield Road & Francistown Road

Year 2036 No-Build Conditions

Weekday PM

						
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	290	420	85	266	383	104
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93
Hourly flow rate (vph)	312	452	91	286	412	112
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1027	91			377	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1027	91			377	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	0	53			65	
cM capacity (veh/h)	170	969			1187	
Direction, Lane #	WB 1	WB 2	NB 1	NB 2	SB 1	SB 2
Volume Total	312	452	91	286	412	112
Volume Left	312	0	0	0	412	0
Volume Right	0	452	0	286	0	0
cSH	170	969	1700	1700	1187	1700
Volume to Capacity	1.83	0.47	0.05	0.17	0.35	0.07
Queue Length 95th (ft)	570	63	0	0	39	0
Control Delay (s)	441.9	11.9	0.0	0.0	9.6	0.0
Lane LOS	F	B			A	
Approach Delay (s)	187.5		0.0		7.6	
Approach LOS	F					
Intersection Summary						
Average Delay			88.4			
Intersection Capacity Utilization			50.6%		ICU Level of Service	A
Analysis Period (min)			15			

Queues
17: Springfield Road & Staples Mill Road

Year 2036 No-Build Conditions

Weekday PM



Lane Group	EBT	EBR	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Group Flow (vph)	529	147	595	130	253	514	195	133	785	138
v/c Ratio	1.16	0.29	1.76	0.36	1.51	0.55	0.36	0.72	0.89	0.32
Control Delay	133.7	7.2	384.6	18.9	293.4	41.2	9.6	72.6	57.5	24.8
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	133.7	7.2	384.6	18.9	293.4	41.2	9.6	72.6	57.5	24.8
Queue Length 50th (ft)	~484	0	~687	28	~272	183	14	100	310	53
Queue Length 95th (ft)	#699	51	#911	86	#438	243	75	167	#418	111
Internal Link Dist (ft)	1523		281			1215			1242	
Turn Bay Length (ft)		575			150		125	200		75
Base Capacity (vph)	457	510	338	365	168	938	546	216	879	433
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	1.16	0.29	1.76	0.36	1.51	0.55	0.36	0.62	0.89	0.32

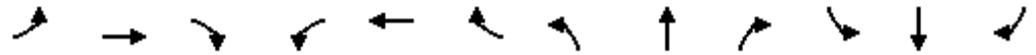
Intersection Summary

- ~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
- # 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

HCM Signalized Intersection Capacity Analysis
17: Springfield Road & Staples Mill Road

Year 2036 No-Build Conditions

Weekday PM



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕	↗		↕	↗	↘	↕↕	↗	↘	↕↕	↗
Volume (vph)	288	220	141	236	335	125	243	493	187	128	754	132
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		7.0	7.0		7.0	7.0	6.5	3.5	3.5	6.5	6.7	6.7
Lane Util. Factor		1.00	1.00		1.00	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Frt		1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		0.97	1.00		0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		1829	1599		1843	1599	1787	3574	1599	1787	3574	1599
Flt Permitted		0.97	1.00		0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)		1829	1599		1843	1599	1787	3574	1599	1787	3574	1599
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	300	229	147	246	349	130	253	514	195	133	785	138
RTOR Reduction (vph)	0	0	110	0	0	72	0	0	127	0	0	40
Lane Group Flow (vph)	0	529	37	0	595	58	253	514	68	133	785	98
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Split		Perm	Split		Perm	Prot		Perm	Prot		Perm
Protected Phases	3	3		4	4		1	6		5	2	
Permitted Phases			3			4			6			2
Actuated Green, G (s)		30.0	30.0		22.0	22.0	11.3	31.5	31.5	12.5	29.5	29.5
Effective Green, g (s)		30.0	30.0		22.0	22.0	11.3	31.5	31.5	12.5	29.5	29.5
Actuated g/C Ratio		0.25	0.25		0.18	0.18	0.09	0.26	0.26	0.10	0.25	0.25
Clearance Time (s)		7.0	7.0		7.0	7.0	6.5	3.5	3.5	6.5	6.7	6.7
Vehicle Extension (s)		0.5	0.5		3.5	3.5	2.5	6.0	6.0	2.5	6.0	6.0
Lane Grp Cap (vph)		457	400		338	293	168	938	420	186	879	393
v/s Ratio Prot		c0.29			c0.32		c0.14	0.14		0.07	c0.22	
v/s Ratio Perm			0.02			0.04			0.04			0.06
v/c Ratio		1.16	0.09		1.76	0.20	1.51	0.55	0.16	0.72	0.89	0.25
Uniform Delay, d1		45.0	34.5		49.0	41.5	54.4	38.1	34.1	52.0	43.7	36.4
Progression Factor		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		93.0	0.0		354.1	0.4	256.0	2.3	0.8	11.5	13.4	1.5
Delay (s)		138.0	34.6		403.1	41.9	310.4	40.4	34.9	63.5	57.1	37.9
Level of Service		F	C		F	D	F	D	C	E	E	D
Approach Delay (s)		115.5			338.3			110.3			55.4	
Approach LOS		F			F			F			E	

Intersection Summary

HCM Average Control Delay	142.7	HCM Level of Service	F
HCM Volume to Capacity ratio	1.17		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	20.5
Intersection Capacity Utilization	113.3%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Appendix G
2036 Future No-Build
HSM Analysis

General Information

Analyst	JXP	Analysis Name	No Build-Chapter12	Date of Analysis	5/28/2012
Agency/Company	Kittelson & Associates, Inc.	Project Number/PIN #	11764.4	Comments	
State	Virginia	Site(s)	Springfield Road		
Region/Area/City/County	Glen Allen/Henrico County	Jurisdiction	Henrico County		

Analysis Summary Results

Crash Severity Distribution	Crash Frequency		
	Fatal and Injury (FI)	Property Damage Only (PDO)	Total
Total Predicted Crashes (entire study period)	6.71	12.66	19.37
Total Predicted Crashes (crashes/year)	6.71	12.66	19.37
Total Expected Crashes (entire study period)	0.44	0.00	0.44
Total Expected Crashes (crashes/year)	0.44	0.00	0.44
Nuckols Road to Firsedide Drive	0.05	0.12	0.16
Total Predicted Crashes (crashes/year)	0.05	0.12	0.16
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
Firsedide Drive to Kingscroft Drive	0.09	0.24	0.33
Total Predicted Crashes (crashes/year)	0.09	0.24	0.33
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
Kingscroft Drive to Wendhurst Drive	0.04	0.10	0.14
Total Predicted Crashes (crashes/year)	0.04	0.10	0.14
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
Wendhurst Drive to Jones Road	0.03	0.08	0.11
Total Predicted Crashes (crashes/year)	0.03	0.08	0.11
Total Expected Crashes (crashes/year)	0.00	0.00	0.00

Analysis Summary Results

Crash Severity Distribution	Crash Frequency		
	Fatal and Injury (FI)	Property Damage Only (PDO)	Total
Jones Road to Olde Millbrooke Way	0.06	0.17	0.23
Total Predicted Crashes (crashes/year)	0.06	0.17	0.23
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
Olde Millbrooke way to Wintergreen Road/ Linsey L	0.08	0.19	0.27
Total Predicted Crashes (crashes/year)	0.08	0.19	0.27
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
Wintergreen Roal/Linsey Lakes Drive to Jacobs Cre	0.12	0.31	0.43
Total Predicted Crashes (crashes/year)	0.12	0.31	0.43
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
Jacobs Creek Drive to Wintercreek Drive	0.02	0.06	0.08
Total Predicted Crashes (crashes/year)	0.02	0.06	0.08
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
Wintercreek Drive to Hart Mill Drive	0.04	0.11	0.15
Total Predicted Crashes (crashes/year)	0.04	0.11	0.15
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
Wamerwood Court to Bernard Mills Drive	0.07	0.19	0.26
Total Predicted Crashes (crashes/year)	0.07	0.19	0.26
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
Bernard Mills Drive to Olde Hartley Drive	0.05	0.12	0.16
Total Predicted Crashes (crashes/year)	0.05	0.12	0.16
Total Expected Crashes (crashes/year)	0.00	0.00	0.00

Analysis Summary Results

Crash Severity Distribution	Crash Frequency		
	Fatal and Injury (FI)	Property Damage Only (PDO)	Total
Olde Hartley Drive to Echo Lake Drive	0.05	0.12	0.17
Total Predicted Crashes (crashes/year)	0.05	0.12	0.17
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
Echo Lake Drive through End of Horizontal Curve 1	0.04	0.11	0.15
Total Predicted Crashes (crashes/year)	0.04	0.11	0.15
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
Start of Horizontal Curve 2 to Old Springfield Rd	0.23	0.57	0.80
Total Predicted Crashes (crashes/year)	0.23	0.57	0.80
Total Expected Crashes (crashes/year)	0.01	0.00	0.01
Old Springfield Road to Rigney Terrace	0.08	0.20	0.29
Total Predicted Crashes (crashes/year)	0.08	0.20	0.29
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
Rigney Terrace to Francistown Road	0.06	0.16	0.22
Total Predicted Crashes (crashes/year)	0.06	0.16	0.22
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
Francistown Road to Staples Mill Road	0.26	0.64	0.90
Total Predicted Crashes (crashes/year)	0.26	0.64	0.90
Total Expected Crashes (crashes/year)	0.01	0.00	0.01
Nuckols Road/Springfield Road	0.86	1.72	2.58
Total Predicted Crashes (crashes/year)	0.86	1.72	2.58

Analysis Summary Results

Crash Severity Distribution	Crash Frequency		
	Fatal and Injury (FI)	Property Damage Only (PDO)	Total
Total Expected Crashes (crashes/year)	0.03	0.00	0.03
Springfield Road/Fireside Drive	0.10	0.15	0.25
Total Predicted Crashes (crashes/year)	0.10	0.15	0.25
Total Expected Crashes (crashes/year)	0.01	0.00	0.01
Springfield Road/Kingscroft Drive	0.10	0.14	0.24
Total Predicted Crashes (crashes/year)	0.10	0.14	0.24
Total Expected Crashes (crashes/year)	0.01	0.00	0.01
Springfield Road/Wendhurst Drive	0.09	0.13	0.21
Total Predicted Crashes (crashes/year)	0.09	0.13	0.21
Total Expected Crashes (crashes/year)	0.01	0.00	0.01
Springfield Road/Jones Road	0.07	0.09	0.16
Total Predicted Crashes (crashes/year)	0.07	0.09	0.16
Total Expected Crashes (crashes/year)	0.01	0.00	0.01
Springfield Road/Olde Milbrooke Way	0.39	0.70	1.09
Total Predicted Crashes (crashes/year)	0.39	0.70	1.09
Total Expected Crashes (crashes/year)	0.04	0.00	0.04
Springfield Road/Wintergreen Roal/Linsey Lakes Dri	0.46	0.79	1.25
Total Predicted Crashes (crashes/year)	0.46	0.79	1.25
Total Expected Crashes (crashes/year)	0.05	0.00	0.05
Springfield Road/Jacobs Creek Drive	0.26	0.36	0.63

Analysis Summary Results

Crash Severity Distribution	Crash Frequency		
	Fatal and Injury (FI)	Property Damage Only (PDO)	Total
Total Predicted Crashes (crashes/year)	0.26	0.36	0.63
Total Expected Crashes (crashes/year)	0.02	0.00	0.02
Springfield Road/Wintercreek Drive	0.25	0.34	0.59
Total Predicted Crashes (crashes/year)	0.25	0.34	0.59
Total Expected Crashes (crashes/year)	0.02	0.00	0.02
Springfield Road/Hart Mill Drive	0.40	0.71	1.11
Total Predicted Crashes (crashes/year)	0.40	0.71	1.11
Total Expected Crashes (crashes/year)	0.04	0.00	0.04
Springfield Road/Bernard Mills Drive	0.21	0.28	0.49
Total Predicted Crashes (crashes/year)	0.21	0.28	0.49
Total Expected Crashes (crashes/year)	0.02	0.00	0.02
Springfield Road/Olde Hartley Drive	0.18	0.23	0.41
Total Predicted Crashes (crashes/year)	0.18	0.23	0.41
Total Expected Crashes (crashes/year)	0.01	0.00	0.01
Springfield Road/Echo Lake Drive	0.18	0.23	0.41
Total Predicted Crashes (crashes/year)	0.18	0.23	0.41
Total Expected Crashes (crashes/year)	0.01	0.00	0.01
Springfield Road/Old Springfield Rd	0.24	0.33	0.57
Total Predicted Crashes (crashes/year)	0.24	0.33	0.57
Total Expected Crashes (crashes/year)	0.02	0.00	0.02

Analysis Summary Results

Crash Severity Distribution	Crash Frequency		
	Fatal and Injury (FI)	Property Damage Only (PDO)	Total
Springfield Road/Rigney Terrace	0.18	0.23	0.40
Total Predicted Crashes (crashes/year)	0.18	0.23	0.40
Total Expected Crashes (crashes/year)	0.01	0.00	0.01
Springfield Road/Francistown Road	0.35	0.70	1.04
Total Predicted Crashes (crashes/year)	0.35	0.70	1.04
Total Expected Crashes (crashes/year)	0.04	0.00	0.04
Staples Mill Road/Springfield Road	1.01	2.09	3.10
Total Predicted Crashes (crashes/year)	1.01	2.09	3.10
Total Expected Crashes (crashes/year)	0.05	0.00	0.05

Appendix H
Alternative 1
Level of Service Worksheets

Queues
1: Nuckols Road & Springfield Road

Year 2036 Alternative 1
Weekday AM



Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Group Flow (vph)	186	411	1021	156	399	544
v/c Ratio	0.25	0.45	0.90	0.13	0.80	0.79
Control Delay	27.7	4.2	40.6	7.6	48.1	16.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	27.7	4.2	40.6	7.6	48.1	16.0
Queue Length 50th (ft)	44	0	267	31	226	55
Queue Length 95th (ft)	65	35	#406	66	#430	169
Internal Link Dist (ft)	362			346	244	
Turn Bay Length (ft)	275	175	225			
Base Capacity (vph)	986	1088	1155	1225	498	774
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.19	0.38	0.88	0.13	0.80	0.70

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

HCM Signalized Intersection Capacity Analysis
1: Nuckols Road & Springfield Road

Year 2036 Alternative 1
Weekday AM



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	177	390	970	148	379	517
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	11	11	12	12	12	12
Total Lost time (s)	5.0	5.0	5.0	6.0	6.0	5.0
Lane Util. Factor	0.97	0.88	0.97	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	3286	2668	3467	1881	1863	1583
Flt Permitted	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (perm)	3286	2668	3467	1881	1863	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	186	411	1021	156	399	544
RTOR Reduction (vph)	0	318	0	0	0	330
Lane Group Flow (vph)	186	93	1021	156	399	214
Heavy Vehicles (%)	3%	3%	1%	1%	2%	2%
Turn Type		custom	Prot			Over
Protected Phases	3	3	5	2	6	3
Permitted Phases		3				
Actuated Green, G (s)	20.4	20.4	29.6	58.6	24.0	20.4
Effective Green, g (s)	20.4	20.4	29.6	58.6	24.0	20.4
Actuated g/C Ratio	0.23	0.23	0.33	0.65	0.27	0.23
Clearance Time (s)	5.0	5.0	5.0	6.0	6.0	5.0
Vehicle Extension (s)	5.0	5.0	3.0	6.0	6.0	5.0
Lane Grp Cap (vph)	745	605	1140	1225	497	359
v/s Ratio Prot	0.06	0.03	c0.29	0.08	c0.21	c0.14
v/s Ratio Perm						
v/c Ratio	0.25	0.15	0.90	0.13	0.80	0.60
Uniform Delay, d1	28.5	27.9	28.7	6.0	30.8	31.1
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.4	0.2	9.3	0.2	12.9	4.0
Delay (s)	28.9	28.1	38.0	6.2	43.7	35.1
Level of Service	C	C	D	A	D	D
Approach Delay (s)	28.4			33.8	38.7	
Approach LOS	C			C	D	

Intersection Summary			
HCM Average Control Delay	34.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	68.0%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

HCM Unsignalized Intersection Capacity Analysis

2: Fireside Drive & Springfield Road

Year 2036 Alternative 1
Weekday AM



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↵		↕↵		↵	↕↕
Volume (veh/h)	80	20	303	22	1	816
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91
Hourly flow rate (vph)	88	22	333	24	1	897
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage (veh)						
Upstream signal (ft)			377			
pX, platoon unblocked						
vC, conflicting volume	796	179			357	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	796	179			357	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	73	97			100	
cM capacity (veh/h)	328	840			1198	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	110	222	135	1	448	448
Volume Left	88	0	0	1	0	0
Volume Right	22	0	24	0	0	0
cSH	374	1700	1700	1198	1700	1700
Volume to Capacity	0.29	0.13	0.08	0.00	0.26	0.26
Queue Length 95th (ft)	30	0	0	0	0	0
Control Delay (s)	18.6	0.0	0.0	8.0	0.0	0.0
Lane LOS	C			A		
Approach Delay (s)	18.6	0.0		0.0		
Approach LOS	C					

Intersection Summary						
Average Delay			1.5			
Intersection Capacity Utilization			34.9%		ICU Level of Service	A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
 3: Kingscroft Drive & Springfield Road

Year 2036 Alternative 1
 Weekday AM



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	72	18	296	27	1	745
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	83	21	340	31	1	856
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage (veh)						
Upstream signal (ft)			1118			
pX, platoon unblocked						
vC, conflicting volume	1199	340			371	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1199	340			371	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	60	97			100	
cM capacity (veh/h)	207	707			1187	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1
Volume Total	103	340	31	857
Volume Left	83	0	0	1
Volume Right	21	0	31	0
cSH	241	1700	1700	1187
Volume to Capacity	0.43	0.20	0.02	0.00
Queue Length 95th (ft)	51	0	0	0
Control Delay (s)	30.8	0.0	0.0	0.0
Lane LOS	D			A
Approach Delay (s)	30.8	0.0		0.0
Approach LOS	D			

Intersection Summary			
Average Delay		2.4	
Intersection Capacity Utilization		51.8%	ICU Level of Service A
Analysis Period (min)		15	

HCM Unsignalized Intersection Capacity Analysis

4: Wendhurst Drive & Springfield Road

Year 2036 Alternative 1
Weekday AM



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↶		↑	↷		↵
Volume (veh/h)	74	10	292	22	5	672
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.83	0.83	0.83	0.83	0.83	0.83
Hourly flow rate (vph)	89	12	352	27	6	810
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1173	352			378	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1173	352			378	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	58	98			99	
cM capacity (veh/h)	213	696			1186	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1
Volume Total	101	352	27	816
Volume Left	89	0	0	6
Volume Right	12	0	27	0
cSH	232	1700	1700	1186
Volume to Capacity	0.44	0.21	0.02	0.01
Queue Length 95th (ft)	51	0	0	0
Control Delay (s)	32.0	0.0	0.0	0.1
Lane LOS	D			A
Approach Delay (s)	32.0	0.0		0.1
Approach LOS	D			

Intersection Summary			
Average Delay		2.6	
Intersection Capacity Utilization		50.7%	ICU Level of Service A
Analysis Period (min)		15	

HCM Unsignalized Intersection Capacity Analysis
5: Jones Road & Springfield Road

Year 2036 Alternative 1
Weekday AM



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	5	5	2	300	672	5
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Hourly flow rate (vph)	6	6	2	333	747	6
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1087	749	752			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1087	749	752			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	98	99	100			
cM capacity (veh/h)	241	415	857			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	11	336	752			
Volume Left	6	2	0			
Volume Right	6	0	6			
cSH	305	857	1700			
Volume to Capacity	0.04	0.00	0.44			
Queue Length 95th (ft)	3	0	0			
Control Delay (s)	17.3	0.1	0.0			
Lane LOS	C	A				
Approach Delay (s)	17.3	0.1	0.0			
Approach LOS	C					
Intersection Summary						
Average Delay			0.2			
Intersection Capacity Utilization		45.7%		ICU Level of Service		A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
6: Olde Milbrooke Way & Springfield Road

Year 2036 Alternative 1
Weekday AM



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔			↔			↑	↗		↔	
Volume (veh/h)	5	0	5	22	0	23	3	293	9	3	650	12
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	6	0	6	25	0	26	3	329	10	3	730	13
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage (veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1106	1090	737	1085	1087	329	744			339		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1106	1090	737	1085	1087	329	744			339		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	97	100	99	87	100	96	100			100		
cM capacity (veh/h)	182	216	422	192	216	717	864			1220		

Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1
Volume Total	11	51	333	10	747
Volume Left	6	25	3	0	3
Volume Right	6	26	0	10	13
cSH	254	307	864	1700	1220
Volume to Capacity	0.04	0.16	0.00	0.01	0.00
Queue Length 95th (ft)	3	15	0	0	0
Control Delay (s)	19.8	19.0	0.1	0.0	0.1
Lane LOS	C	C	A		A
Approach Delay (s)	19.8	19.0	0.1		0.1
Approach LOS	C	C			

Intersection Summary		
Average Delay		1.1
Intersection Capacity Utilization	51.8%	ICU Level of Service
Analysis Period (min)		15
		A

HCM Unsignalized Intersection Capacity Analysis
7: Wintergreen Road & Springfield Road

Year 2036 Alternative 1
Weekday AM



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕	↕		↕	
Volume (veh/h)	70	0	40	14	1	33	7	311	3	20	611	21
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	74	0	43	15	1	35	7	331	3	21	650	22
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage (veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1085	1053	661	1092	1061	331	672			334		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1085	1053	661	1092	1061	331	672			334		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	59	100	91	91	100	95	99			98		
cM capacity (veh/h)	181	221	464	171	218	711	909			1225		

Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1
Volume Total	117	51	338	3	694
Volume Left	74	15	7	0	21
Volume Right	43	35	0	3	22
cSH	233	361	909	1700	1225
Volume to Capacity	0.50	0.14	0.01	0.00	0.02
Queue Length 95th (ft)	64	12	1	0	1
Control Delay (s)	35.2	16.6	0.3	0.0	0.5
Lane LOS	E	C	A		A
Approach Delay (s)	35.2	16.6	0.3		0.5
Approach LOS	E	C			

Intersection Summary		
Average Delay		4.5
Intersection Capacity Utilization	68.9%	ICU Level of Service C
Analysis Period (min)		15

HCM Unsignalized Intersection Capacity Analysis
 8: Jacobs Creek Drive & Springfield Road

Year 2036 Alternative 1
 Weekday AM



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	16	24	399	15	16	636
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	18	27	448	17	18	715
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1207	457			465	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1207	457			465	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	91	96			98	
cM capacity (veh/h)	201	608			1096	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	45	465	733
Volume Left	18	0	18
Volume Right	27	17	0
cSH	336	1700	1096
Volume to Capacity	0.13	0.27	0.02
Queue Length 95th (ft)	11	0	1
Control Delay (s)	17.4	0.0	0.4
Lane LOS	C		A
Approach Delay (s)	17.4	0.0	0.4
Approach LOS	C		

Intersection Summary			
Average Delay		0.9	
Intersection Capacity Utilization		56.3%	ICU Level of Service
Analysis Period (min)		15	B

HCM Unsignalized Intersection Capacity Analysis
9: Wintercreek Drive & Springfield Road

Year 2036 Alternative 1
Weekday AM



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	34	51	19	404	601	10
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	39	58	22	459	683	11
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1191	689	694			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1191	689	694			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	81	87	98			
cM capacity (veh/h)	202	446	901			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	97	481	694			
Volume Left	39	22	0			
Volume Right	58	0	11			
cSH	301	901	1700			
Volume to Capacity	0.32	0.02	0.41			
Queue Length 95th (ft)	34	2	0			
Control Delay (s)	22.5	0.7	0.0			
Lane LOS	C	A				
Approach Delay (s)	22.5	0.7	0.0			
Approach LOS	C					
Intersection Summary						
Average Delay			2.0			
Intersection Capacity Utilization			48.4%		ICU Level of Service	A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
 10: Warnerwood Ct & Springfield Road

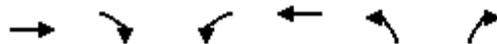
Year 2036 Alternative 1
 Weekday AM



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	2	1	1	437	610	1
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93
Hourly flow rate (vph)	2	1	1	470	656	1
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1128	656	657			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1128	656	657			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	99	100	100			
cM capacity (veh/h)	224	463	926			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	3	471	657			
Volume Left	2	1	0			
Volume Right	1	0	1			
cSH	271	926	1700			
Volume to Capacity	0.01	0.00	0.39			
Queue Length 95th (ft)	1	0	0			
Control Delay (s)	18.4	0.0	0.0			
Lane LOS	C	A				
Approach Delay (s)	18.4	0.0	0.0			
Approach LOS	C					
Intersection Summary						
Average Delay			0.1			
Intersection Capacity Utilization		42.2%		ICU Level of Service		A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
 11: Springfield Road & Bernard Mills Drive

Year 2036 Alternative 1
 Weekday AM



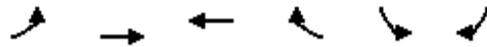
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑	↗		↖	↖	↗
Volume (veh/h)	404	35	3	589	22	10
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	459	40	3	669	25	11
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			499	1135		459
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			499	1135		459
tC, single (s)			4.1	6.4		6.2
tC, 2 stage (s)						
tF (s)			2.2	3.5		3.3
p0 queue free %			100	89		98
cM capacity (veh/h)			1065	225		606

Direction, Lane #	EB 1	EB 2	WB 1	NB 1
Volume Total	459	40	673	36
Volume Left	0	0	3	25
Volume Right	0	40	0	11
cSH	1700	1700	1065	280
Volume to Capacity	0.27	0.02	0.00	0.13
Queue Length 95th (ft)	0	0	0	11
Control Delay (s)	0.0	0.0	0.1	19.8
Lane LOS			A	C
Approach Delay (s)	0.0	0.1		19.8
Approach LOS			C	

Intersection Summary				
Average Delay			0.6	
Intersection Capacity Utilization	43.4%		ICU Level of Service	A
Analysis Period (min)	15			

HCM Unsignalized Intersection Capacity Analysis
 12: Springfield Road & Olde Hartley Drive

Year 2036 Alternative 1
 Weekday AM



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↕	↕	↗	↘	↘
Volume (veh/h)	5	409	576	6	26	16
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	6	460	647	7	29	18
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	654				1118	647
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	654				1118	647
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	99				87	96
cM capacity (veh/h)	933				225	466

Direction, Lane #	EB 1	WB 1	WB 2	SB 1
Volume Total	465	647	7	47
Volume Left	6	0	0	29
Volume Right	0	0	7	18
cSH	933	1700	1700	280
Volume to Capacity	0.01	0.38	0.00	0.17
Queue Length 95th (ft)	0	0	0	15
Control Delay (s)	0.2	0.0	0.0	20.5
Lane LOS	A			C
Approach Delay (s)	0.2	0.0		20.5
Approach LOS				C

Intersection Summary			
Average Delay		0.9	
Intersection Capacity Utilization		40.3%	ICU Level of Service A
Analysis Period (min)		15	

HCM Unsignalized Intersection Capacity Analysis
 13: Springfield Road & Echo Lake Drive

Year 2036 Alternative 1
 Weekday AM



Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	→			←	←	↘
Volume (veh/h)	420	15	1	574	8	12
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	457	16	1	624	9	13
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			473		1091	465
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			473		1091	465
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		96	98
cM capacity (veh/h)			1089		240	602

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	473	625	22
Volume Left	0	1	9
Volume Right	16	0	13
cSH	1700	1089	375
Volume to Capacity	0.28	0.00	0.06
Queue Length 95th (ft)	0	0	5
Control Delay (s)	0.0	0.0	15.2
Lane LOS		A	C
Approach Delay (s)	0.0	0.0	15.2
Approach LOS			C

Intersection Summary			
Average Delay		0.3	
Intersection Capacity Utilization	41.0%		ICU Level of Service A
Analysis Period (min)		15	

HCM Unsignalized Intersection Capacity Analysis
 14: Springfield Road & Old Springfield Road

Year 2036 Alternative 1
 Weekday AM



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↔	↔		↔	↔
Volume (veh/h)	7	425	548	12	39	27
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	7	447	577	13	41	28
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						2
Median type		None	None			
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	589				1045	583
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	589				1045	583
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	99				84	94
cM capacity (veh/h)	991				251	512

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	455	589	69
Volume Left	7	0	41
Volume Right	0	13	28
cSH	991	1700	425
Volume to Capacity	0.01	0.35	0.16
Queue Length 95th (ft)	1	0	14
Control Delay (s)	0.2	0.0	18.1
Lane LOS	A		C
Approach Delay (s)	0.2	0.0	18.1
Approach LOS			C

Intersection Summary			
Average Delay		1.2	
Intersection Capacity Utilization		39.6%	ICU Level of Service A
Analysis Period (min)		15	

HCM Unsignalized Intersection Capacity Analysis
 15: Rigney Terrace & Springfield Road

Year 2036 Alternative 1
 Weekday AM



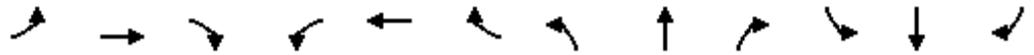
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	21	14	1	539	448	16
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	22	15	1	573	477	17
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1052	477	494			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1052	477	494			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	91	97	100			
cM capacity (veh/h)	253	593	1070			

Direction, Lane #	EB 1	NB 1	SB 1	SB 2
Volume Total	37	574	477	17
Volume Left	22	1	0	0
Volume Right	15	0	0	17
cSH	328	1070	1700	1700
Volume to Capacity	0.11	0.00	0.28	0.01
Queue Length 95th (ft)	10	0	0	0
Control Delay (s)	17.4	0.0	0.0	0.0
Lane LOS	C	A		
Approach Delay (s)	17.4	0.0	0.0	
Approach LOS	C			

Intersection Summary			
Average Delay		0.6	
Intersection Capacity Utilization		39.2%	ICU Level of Service A
Analysis Period (min)		15	

Queues
17: Springfield Road & Staples Mill Road

Year 2036 Alternative 1
Weekday AM



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Group Flow (vph)	423	134	140	185	203	191	188	416	58	103	836	315
v/c Ratio	0.81	0.48	0.23	0.72	0.76	0.33	0.78	0.30	0.06	0.62	0.68	0.50
Control Delay	62.2	53.4	8.4	64.4	68.2	8.6	72.2	27.2	3.0	68.4	38.3	22.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	62.2	53.4	8.4	64.4	68.2	8.6	72.2	27.2	3.0	68.4	38.3	22.9
Queue Length 50th (ft)	163	95	14	137	151	17	141	121	0	78	305	121
Queue Length 95th (ft)	#223	163	59	212	#237	70	#231	167	18	135	387	218
Internal Link Dist (ft)		1531			132			545			464	
Turn Bay Length (ft)	200		575	350		150	350		125	200		75
Base Capacity (vph)	544	280	644	310	295	606	275	1392	1009	201	1231	631
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.78	0.48	0.22	0.60	0.69	0.32	0.68	0.30	0.06	0.51	0.68	0.50

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

HCM Signalized Intersection Capacity Analysis
17: Springfield Road & Staples Mill Road

Year 2036 Alternative 1
Weekday AM

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	402	127	133	176	193	181	179	395	55	98	794	299
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	7.0	7.0	6.5	7.0	7.0	6.5	6.5	6.3	7.0	6.5	6.7	6.7
Lane Util. Factor	0.97	1.00	1.00	1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	1863	1583	1770	1863	1583	1787	3574	1599	1787	3574	1599
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	1863	1583	1770	1863	1583	1787	3574	1599	1787	3574	1599
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	423	134	140	185	203	191	188	416	58	103	836	315
RTOR Reduction (vph)	0	0	80	0	0	122	0	0	27	0	0	81
Lane Group Flow (vph)	423	134	60	185	203	69	188	416	31	103	836	234
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	1%	1%	1%	1%	1%	1%
Turn Type	Prot		pm+ov	Prot		pm+ov	Prot		pm+ov	Prot		Perm
Protected Phases	7	4	1	3	8	5	1	6	3	5	2	
Permitted Phases			4			8			6			2
Actuated Green, G (s)	18.2	17.9	34.0	17.5	17.2	28.3	16.1	46.7	64.2	11.1	41.3	41.3
Effective Green, g (s)	18.2	17.9	34.0	17.5	17.2	28.3	16.1	46.7	64.2	11.1	41.3	41.3
Actuated g/C Ratio	0.15	0.15	0.28	0.15	0.14	0.24	0.13	0.39	0.54	0.09	0.34	0.34
Clearance Time (s)	7.0	7.0	6.5	7.0	7.0	6.5	6.5	6.3	7.0	6.5	6.7	6.7
Vehicle Extension (s)	3.5	3.5	2.5	3.5	3.5	2.5	2.5	6.0	3.5	2.5	6.0	6.0
Lane Grp Cap (vph)	521	278	449	258	267	373	240	1391	855	165	1230	550
v/s Ratio Prot	c0.12	0.07	0.02	0.10	c0.11	0.02	c0.11	c0.12	0.01	0.06	c0.23	
v/s Ratio Perm			0.02			0.03			0.01			0.15
v/c Ratio	0.81	0.48	0.13	0.72	0.76	0.18	0.78	0.30	0.04	0.62	0.68	0.43
Uniform Delay, d1	49.2	46.8	32.0	48.9	49.4	36.6	50.3	25.3	13.2	52.4	33.7	30.2
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	9.6	1.6	0.1	9.4	12.4	0.2	14.8	0.6	0.0	6.2	3.0	2.4
Delay (s)	58.8	48.4	32.1	58.3	61.8	36.8	65.0	25.9	13.3	58.7	36.7	32.6
Level of Service	E	D	C	E	E	D	E	C	B	E	D	C
Approach Delay (s)		51.5			52.4			35.9			37.5	
Approach LOS		D			D			D			D	
Intersection Summary												
HCM Average Control Delay			42.9				HCM Level of Service				D	
HCM Volume to Capacity ratio			0.79									
Actuated Cycle Length (s)			120.0				Sum of lost time (s)			33.5		
Intersection Capacity Utilization			76.2%				ICU Level of Service			D		
Analysis Period (min)			15									

c Critical Lane Group

Queues
1: Nuckols Road & Springfield Road

Year 2036 Alternative 1
Weekday PM



Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Group Flow (vph)	479	1245	360	342	314	203
v/c Ratio	0.48	0.74	0.64	0.31	0.45	0.33
Control Delay	28.1	4.7	40.2	10.6	25.4	5.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	28.1	4.7	40.2	10.6	25.4	5.3
Queue Length 50th (ft)	113	0	99	93	135	0
Queue Length 95th (ft)	159	50	137	144	227	48
Internal Link Dist (ft)	967			491	244	
Turn Bay Length (ft)	275	175	225			
Base Capacity (vph)	1016	1696	1117	1102	691	622
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.47	0.73	0.32	0.31	0.45	0.33
Intersection Summary						

HCM Signalized Intersection Capacity Analysis
1: Nuckols Road & Springfield Road

Year 2036 Alternative 1
Weekday PM



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	436	1133	328	311	286	185
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	11	11	12	12	12	12
Total Lost time (s)	5.0	5.0	5.0	6.0	6.0	5.0
Lane Util. Factor	0.97	0.88	0.97	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	3385	2748	3467	1881	1881	1599
Flt Permitted	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (perm)	3385	2748	3467	1881	1881	1599
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	479	1245	360	342	314	203
RTOR Reduction (vph)	0	881	0	0	0	144
Lane Group Flow (vph)	479	364	360	342	314	59
Heavy Vehicles (%)	0%	0%	1%	1%	1%	1%
Turn Type		custom	Prot			Over
Protected Phases	3	3	5	2	6	3
Permitted Phases		3				
Actuated Green, G (s)	26.3	26.3	14.7	52.7	33.0	26.3
Effective Green, g (s)	26.3	26.3	14.7	52.7	33.0	26.3
Actuated g/C Ratio	0.29	0.29	0.16	0.59	0.37	0.29
Clearance Time (s)	5.0	5.0	5.0	6.0	6.0	5.0
Vehicle Extension (s)	5.0	5.0	3.0	6.0	6.0	5.0
Lane Grp Cap (vph)	989	803	566	1101	690	467
v/s Ratio Prot	c0.14	0.13	c0.10	0.18	c0.17	0.04
v/s Ratio Perm						
v/c Ratio	0.48	0.45	0.64	0.31	0.46	0.13
Uniform Delay, d1	26.3	26.0	35.2	9.4	21.7	23.4
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.8	0.9	2.3	0.7	2.2	0.3
Delay (s)	27.0	26.8	37.5	10.2	23.8	23.7
Level of Service	C	C	D	B	C	C
Approach Delay (s)	26.9			24.2	23.8	
Approach LOS	C			C	C	

Intersection Summary			
HCM Average Control Delay	25.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.50		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	63.9%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

HCM Unsignalized Intersection Capacity Analysis
2: Fireside Drive & Springfield Road

Year 2036 Alternative 1
Weekday PM



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	22	18	699	48	8	449
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91
Hourly flow rate (vph)	24	20	768	53	9	493
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage (veh)						
Upstream signal (ft)			377			
pX, platoon unblocked						
vC, conflicting volume	1059	410			821	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1059	410			821	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	89	97			99	
cM capacity (veh/h)	221	596			811	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	44	512	309	9	247	247
Volume Left	24	0	0	9	0	0
Volume Right	20	0	53	0	0	0
cSH	308	1700	1700	811	1700	1700
Volume to Capacity	0.14	0.30	0.18	0.01	0.15	0.15
Queue Length 95th (ft)	12	0	0	1	0	0
Control Delay (s)	18.6	0.0	0.0	9.5	0.0	0.0
Lane LOS	C			A		
Approach Delay (s)	18.6	0.0		0.2		
Approach LOS	C					

Intersection Summary						
Average Delay			0.7			
Intersection Capacity Utilization			30.9%	ICU Level of Service		A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
3: Kingscroft Drive & Springfield Road

Year 2036 Alternative 1
Weekday PM



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↙		↑	↗		↗
Volume (veh/h)	22	18	672	45	8	435
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91
Hourly flow rate (vph)	24	20	738	49	9	478
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage (veh)						
Upstream signal (ft)			1118			
pX, platoon unblocked	0.98	0.98			0.98	
vC, conflicting volume	1234	738			788	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1229	725			775	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	87	95			99	
cM capacity (veh/h)	193	421			830	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1
Volume Total	44	738	49	487
Volume Left	24	0	0	9
Volume Right	20	0	49	0
cSH	255	1700	1700	830
Volume to Capacity	0.17	0.43	0.03	0.01
Queue Length 95th (ft)	15	0	0	1
Control Delay (s)	22.1	0.0	0.0	0.3
Lane LOS	C			A
Approach Delay (s)	22.1	0.0		0.3
Approach LOS	C			

Intersection Summary			
Average Delay		0.8	
Intersection Capacity Utilization	45.4%		ICU Level of Service A
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
4: Wendhurst Drive & Springfield Road

Year 2036 Alternative 1
Weekday PM

						
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	30	6	647	43	7	413
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91
Hourly flow rate (vph)	33	7	711	47	8	454
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1180	711			758	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1180	711			758	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	84	98			99	
cM capacity (veh/h)	210	436			858	
Direction, Lane #	WB 1	NB 1	NB 2	SB 1		
Volume Total	40	711	47	462		
Volume Left	33	0	0	8		
Volume Right	7	0	47	0		
cSH	230	1700	1700	858		
Volume to Capacity	0.17	0.42	0.03	0.01		
Queue Length 95th (ft)	15	0	0	1		
Control Delay (s)	23.9	0.0	0.0	0.3		
Lane LOS	C			A		
Approach Delay (s)	23.9	0.0		0.3		
Approach LOS	C					
Intersection Summary						
Average Delay			0.8			
Intersection Capacity Utilization			44.1%		ICU Level of Service	A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
5: Jones Road & Springfield Road

Year 2036 Alternative 1
Weekday PM



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	5	5	17	636	415	15
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Hourly flow rate (vph)	6	6	19	707	461	17
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1214	469	478			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1214	469	478			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	97	99	98			
cM capacity (veh/h)	199	598	1090			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	11	726	478			
Volume Left	6	19	0			
Volume Right	6	0	17			
cSH	299	1090	1700			
Volume to Capacity	0.04	0.02	0.28			
Queue Length 95th (ft)	3	1	0			
Control Delay (s)	17.5	0.5	0.0			
Lane LOS	C	A				
Approach Delay (s)	17.5	0.5	0.0			
Approach LOS	C					
Intersection Summary						
Average Delay			0.4			
Intersection Capacity Utilization			57.2%	ICU Level of Service		B
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
6: Olde Milbrooke Way & Springfield Road

Year 2036 Alternative 1
Weekday PM



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔			↔			↑	↗		↔	
Volume (veh/h)	8	1	16	16	1	8	14	611	16	9	398	289
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	9	1	17	17	1	9	15	664	17	10	433	314
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage (veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1313	1321	590	1322	1461	664	747			682		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1313	1321	590	1322	1461	664	747			682		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	93	99	97	86	99	98	98			99		
cM capacity (veh/h)	130	154	511	127	127	464	866			916		

Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1
Volume Total	27	27	679	17	757
Volume Left	9	17	15	0	10
Volume Right	17	9	0	17	314
cSH	252	165	866	1700	916
Volume to Capacity	0.11	0.16	0.02	0.01	0.01
Queue Length 95th (ft)	9	14	1	0	1
Control Delay (s)	21.0	31.0	0.5	0.0	0.3
Lane LOS	C	D	A		A
Approach Delay (s)	21.0	31.0	0.5		0.3
Approach LOS	C	D			

Intersection Summary		
Average Delay		1.3
Intersection Capacity Utilization	56.2%	ICU Level of Service
Analysis Period (min)		15
		B

HCM Unsignalized Intersection Capacity Analysis
7: Wintergreen Road & Springfield Road

Year 2036 Alternative 1
Weekday PM

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	24	2	19	7	1	12	25	597	5	21	410	71
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	26	2	21	8	1	13	27	649	5	23	446	77
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage (veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1247	1239	484	1255	1272	649	523			654		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1247	1239	484	1255	1272	649	523			654		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	82	99	96	94	99	97	97			98		
cM capacity (veh/h)	141	168	587	138	161	473	1049			937		
Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1							
Volume Total	49	22	676	5	546							
Volume Left	26	8	27	0	23							
Volume Right	21	13	0	5	77							
cSH	210	243	1049	1700	937							
Volume to Capacity	0.23	0.09	0.03	0.00	0.02							
Queue Length 95th (ft)	22	7	2	0	2							
Control Delay (s)	27.2	21.3	0.7	0.0	0.7							
Lane LOS	D	C	A		A							
Approach Delay (s)	27.2	21.3	0.7		0.7							
Approach LOS	D	C										
Intersection Summary												
Average Delay			2.0									
Intersection Capacity Utilization			54.1%		ICU Level of Service					A		
Analysis Period (min)			15									

HCM Unsignalized Intersection Capacity Analysis
8: Jacobs Creek Drive & Springfield Road

Year 2036 Alternative 1
Weekday PM



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	14	11	593	40	7	488
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91
Hourly flow rate (vph)	15	12	652	44	8	536
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1225	674			696	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1225	674			696	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	92	97			99	
cM capacity (veh/h)	198	458			905	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	27	696	544
Volume Left	15	0	8
Volume Right	12	44	0
cSH	264	1700	905
Volume to Capacity	0.10	0.41	0.01
Queue Length 95th (ft)	9	0	1
Control Delay (s)	20.2	0.0	0.2
Lane LOS	C		A
Approach Delay (s)	20.2	0.0	0.2
Approach LOS	C		

Intersection Summary			
Average Delay		0.5	
Intersection Capacity Utilization		43.6%	ICU Level of Service
Analysis Period (min)		15	A

HCM Unsignalized Intersection Capacity Analysis
 9: Wintercreek Drive & Springfield Road

Year 2036 Alternative 1
 Weekday PM



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	16	19	16	588	476	17
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	18	21	18	661	535	19
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1241	544	554			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1241	544	554			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	91	96	98			
cM capacity (veh/h)	192	543	1021			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	39	679	554			
Volume Left	18	18	0			
Volume Right	21	0	19			
cSH	295	1021	1700			
Volume to Capacity	0.13	0.02	0.33			
Queue Length 95th (ft)	11	1	0			
Control Delay (s)	19.1	0.5	0.0			
Lane LOS	C	A				
Approach Delay (s)	19.1	0.5	0.0			
Approach LOS	C					
Intersection Summary						
Average Delay			0.8			
Intersection Capacity Utilization			53.8%	ICU Level of Service		A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
 10: Warnerwood Ct & Springfield Road

Year 2036 Alternative 1
 Weekday PM



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	0	3	4	600	490	1
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	0	3	5	690	563	1
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1263	564	564			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1263	564	564			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	99	100			
cM capacity (veh/h)	188	529	1012			
Direction, Lane #						
	EB 1	NB 1	SB 1			
Volume Total	3	694	564			
Volume Left	0	5	0			
Volume Right	3	0	1			
cSH	529	1012	1700			
Volume to Capacity	0.01	0.00	0.33			
Queue Length 95th (ft)	0	0	0			
Control Delay (s)	11.8	0.1	0.0			
Lane LOS	B	A				
Approach Delay (s)	11.8	0.1	0.0			
Approach LOS	B					
Intersection Summary						
Average Delay			0.1			
Intersection Capacity Utilization		44.8%		ICU Level of Service		A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
 11: Springfield Road & Bernard Mills Drive

Year 2036 Alternative 1
 Weekday PM



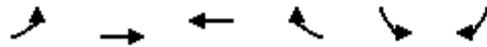
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑	↑		↑	↑	
Volume (veh/h)	520	80	9	479	12	6
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	598	92	10	551	14	7
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			690		1169	598
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			690		1169	598
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			99		94	99
cM capacity (veh/h)			910		213	506

Direction, Lane #	EB 1	EB 2	WB 1	NB 1
Volume Total	598	92	561	21
Volume Left	0	0	10	14
Volume Right	0	92	0	7
cSH	1700	1700	910	264
Volume to Capacity	0.35	0.05	0.01	0.08
Queue Length 95th (ft)	0	0	1	6
Control Delay (s)	0.0	0.0	0.3	19.8
Lane LOS			A	C
Approach Delay (s)	0.0		0.3	19.8
Approach LOS				C

Intersection Summary			
Average Delay		0.5	
Intersection Capacity Utilization		42.4%	ICU Level of Service A
Analysis Period (min)		15	

HCM Unsignalized Intersection Capacity Analysis
 12: Springfield Road & Olde Hartley Drive

Year 2036 Alternative 1
 Weekday PM



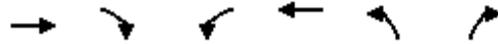
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↕	↕	↕	↕	
Volume (veh/h)	16	510	479	13	9	9
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.86	0.86	0.86	0.86	0.86	0.86
Hourly flow rate (vph)	19	593	557	15	10	10
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	572				1187	557
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	572				1187	557
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	98				95	98
cM capacity (veh/h)	1006				206	534

Direction, Lane #	EB 1	WB 1	WB 2	SB 1
Volume Total	612	557	15	21
Volume Left	19	0	0	10
Volume Right	0	0	15	10
cSH	1006	1700	1700	297
Volume to Capacity	0.02	0.33	0.01	0.07
Queue Length 95th (ft)	1	0	0	6
Control Delay (s)	0.5	0.0	0.0	18.0
Lane LOS	A			C
Approach Delay (s)	0.5	0.0		18.0
Approach LOS				C

Intersection Summary			
Average Delay		0.6	
Intersection Capacity Utilization		49.8%	ICU Level of Service A
Analysis Period (min)		15	

HCM Unsignalized Intersection Capacity Analysis
 13: Springfield Road & Echo Lake Drive

Year 2036 Alternative 1
 Weekday PM



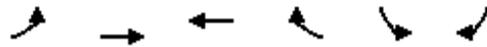
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	498	21	7	487	5	5
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.86	0.86	0.86	0.86	0.86	0.86
Hourly flow rate (vph)	579	24	8	566	6	6
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			603		1174	591
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			603		1174	591
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			99		97	99
cM capacity (veh/h)			979		212	510

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	603	574	12
Volume Left	0	8	6
Volume Right	24	0	6
cSH	1700	979	300
Volume to Capacity	0.35	0.01	0.04
Queue Length 95th (ft)	0	1	3
Control Delay (s)	0.0	0.2	17.5
Lane LOS		A	C
Approach Delay (s)	0.0	0.2	17.5
Approach LOS			C

Intersection Summary			
Average Delay		0.3	
Intersection Capacity Utilization		41.2%	ICU Level of Service
Analysis Period (min)		15	A

HCM Unsignalized Intersection Capacity Analysis
 14: Springfield Road & Old Springfield Road

Year 2036 Alternative 1
 Weekday PM



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↔	↔		↔	↔
Volume (veh/h)	21	482	483	22	18	11
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	24	554	555	25	21	13
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						2
Median type		None	None			
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	580				1170	568
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	580				1170	568
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	98				90	98
cM capacity (veh/h)	999				210	526

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	578	580	33
Volume Left	24	0	21
Volume Right	0	25	13
cSH	999	1700	338
Volume to Capacity	0.02	0.34	0.10
Queue Length 95th (ft)	2	0	8
Control Delay (s)	0.7	0.0	19.5
Lane LOS	A		C
Approach Delay (s)	0.7	0.0	19.5
Approach LOS			C

Intersection Summary			
Average Delay		0.9	
Intersection Capacity Utilization		52.4%	ICU Level of Service
Analysis Period (min)		15	A

HCM Unsignalized Intersection Capacity Analysis
 15: Rigney Terrace & Springfield Road

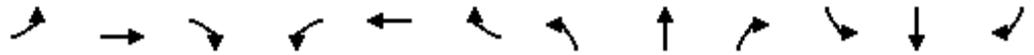
Year 2036 Alternative 1
 Weekday PM



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	7	8	7	498	479	21
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Hourly flow rate (vph)	8	9	8	553	532	23
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1101	532	556			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1101	532	556			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	97	98	99			
cM capacity (veh/h)	235	551	1020			
Direction, Lane #	EB 1	NB 1	SB 1	SB 2		
Volume Total	17	561	532	23		
Volume Left	8	8	0	0		
Volume Right	9	0	0	23		
cSH	338	1020	1700	1700		
Volume to Capacity	0.05	0.01	0.31	0.01		
Queue Length 95th (ft)	4	1	0	0		
Control Delay (s)	16.2	0.2	0.0	0.0		
Lane LOS	C	A				
Approach Delay (s)	16.2	0.2	0.0			
Approach LOS	C					
Intersection Summary						
Average Delay			0.3			
Intersection Capacity Utilization		41.8%		ICU Level of Service		A
Analysis Period (min)		15				

Queues
17: Springfield Road & Staples Mill Road

Year 2036 Alternative 1
Weekday PM



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Group Flow (vph)	301	229	146	246	349	130	253	514	195	133	785	138
v/c Ratio	0.70	0.72	0.22	0.86	0.91	0.20	0.88	0.43	0.20	0.68	0.78	0.18
Control Delay	59.6	60.9	13.8	76.5	74.3	8.9	78.7	33.1	2.6	68.2	46.5	10.2
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	59.6	60.9	13.8	76.5	74.3	8.9	78.7	33.1	2.6	68.2	46.5	10.2
Queue Length 50th (ft)	115	169	39	186	265	18	191	165	0	100	304	28
Queue Length 95th (ft)	163	257	85	#321	#434	58	#328	225	36	164	#382	68
Internal Link Dist (ft)		1523			281			1215			1242	
Turn Bay Length (ft)	200		575	350		150	350		125	200		75
Base Capacity (vph)	462	329	676	298	396	695	305	1208	977	244	1012	794
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.65	0.70	0.22	0.83	0.88	0.19	0.83	0.43	0.20	0.55	0.78	0.17

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

HCM Signalized Intersection Capacity Analysis
17: Springfield Road & Staples Mill Road

Year 2036 Alternative 1
Weekday PM

													
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	
Lane Configurations	 		 	 		 	 	 	 	 			
Volume (vph)	289	220	140	236	335	125	243	493	187	128	754	132	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	
Total Lost time (s)	7.0	7.0	6.5	7.0	7.0	6.5	6.5	6.3	7.0	6.5	6.7	7.0	
Lane Util. Factor	0.97	1.00	1.00	1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	
Satd. Flow (prot)	3467	1881	1599	1787	1881	1599	1787	3574	1599	1787	3574	1599	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	
Satd. Flow (perm)	3467	1881	1599	1787	1881	1599	1787	3574	1599	1787	3574	1599	
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	
Adj. Flow (vph)	301	229	146	246	349	130	253	514	195	133	785	138	
RTOR Reduction (vph)	0	0	43	0	0	63	0	0	98	0	0	43	
Lane Group Flow (vph)	301	229	103	246	349	67	253	514	97	133	785	95	
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	
Turn Type	Prot		pm+ov	Prot		pm+ov	Prot		pm+ov	Prot		pm+ov	
Protected Phases	7	4	1	3	8	5	1	6	3	5	2	7	
Permitted Phases			4			8			6			2	
Actuated Green, G (s)	14.9	20.3	39.7	19.2	24.6	37.8	19.4	40.5	59.7	13.2	33.9	48.8	
Effective Green, g (s)	14.9	20.3	39.7	19.2	24.6	37.8	19.4	40.5	59.7	13.2	33.9	48.8	
Actuated g/C Ratio	0.12	0.17	0.33	0.16	0.20	0.32	0.16	0.34	0.50	0.11	0.28	0.41	
Clearance Time (s)	7.0	7.0	6.5	7.0	7.0	6.5	6.5	6.3	7.0	6.5	6.7	7.0	
Vehicle Extension (s)	3.5	3.5	2.5	3.5	3.5	2.5	2.5	6.0	3.5	2.5	6.0	3.5	
Lane Grp Cap (vph)	430	318	529	286	386	504	289	1206	796	197	1010	650	
v/s Ratio Prot	0.09	0.12	0.03	c0.14	c0.19	0.01	c0.14	c0.14	0.02	0.07	c0.22	0.02	
v/s Ratio Perm			0.03			0.03			0.04			0.04	
v/c Ratio	0.70	0.72	0.19	0.86	0.90	0.13	0.88	0.43	0.12	0.68	0.78	0.15	
Uniform Delay, d1	50.4	47.2	28.7	49.1	46.5	29.4	49.1	30.8	16.1	51.3	39.6	22.5	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	5.3	8.0	0.1	22.7	24.2	0.1	24.1	1.1	0.1	8.0	5.9	0.1	
Delay (s)	55.7	55.2	28.8	71.7	70.8	29.5	73.2	31.9	16.2	59.4	45.5	22.6	
Level of Service	E	E	C	E	E	C	E	C	B	E	D	C	
Approach Delay (s)		49.7			63.7			39.6			44.2		
Approach LOS		D			E			D			D		
Intersection Summary													
HCM Average Control Delay			48.1									HCM Level of Service	D
HCM Volume to Capacity ratio			0.95										
Actuated Cycle Length (s)			120.0									Sum of lost time (s)	33.5
Intersection Capacity Utilization			83.8%									ICU Level of Service	E
Analysis Period (min)			15										

c Critical Lane Group

Appendix I
Alternative 1
HSM Analysis

Alternative 1 Countermeasure Analysis Details

The potential change in crashes associated with each countermeasure deemed feasible and appropriate were calculated using Chapter 12 (Urban/Suburban Arterials) procedures in the HSM. If a standard error was given, a range of crash reductions is shown. This analysis was completed using forecast design year 2036 traffic volumes. Each countermeasure was analyzed independent of the other countermeasures.

Table I1 summarizes the roadway segments for Alternative 1. The urban/suburban arterial analysis (Chapter 12 of the HSM) results follow and are displayed Table I2 and Table I3.

Table I1 Alternative 1 List of Segments

Segments
A. Nuckols Road to Fireside Drive
A.1 Straight
A.2 Curve
B. Fireside Drive to Kingscroft Drive
B.1 Curve
B.2 Straight
C. Kingscroft Drive to Wendhurst Drive
D. Wendhurst Drive to Jones Road
E. Jones Road to Olde Milbrooke Way
E.1 Curve
E.2 Curve
F. Olde Milbrooke Way to Wintergreen Road/Linsey Lakes Drive
F.1 Straight
F.2 Curve
F.3 Straight
G. Wintergreen Road/Linsey Lakes Drive to Jacobs Creek Drive
H. Jacobs Creek Drive to Wintercreek Drive
I. Wintercreek Drive to Warnerwood Court
I.1 Straight
I.2 Curve
J. Warnerwood Court to Bernard Mills Drive

J.1 Curve
J.2 Straight
K. Bernard Mills Drive to Olde Hartley Drive
L. Olde Hartley Drive to Echo Lake Drive
M. Echo Lake Drive through End of Horizontal Curve 1
M.1 Curve
M.2 Straight
N. Start of Horizontal Curve to Old Springfield Road
N.1. Curve
N.2 Straight
N.3 Curve
O. Old Springfield Road to Rigney Terrace
O.1 Curve
O.2 Straight
P. Rigney Terrace to Francistown Road
Q. Francistown Road to Staples Mill Road

Chapter 12 – Urban/Suburban Arterial Analysis

Alternative 1 Segments

Table I2 displays segment countermeasures for the Chapter 12 urban/suburban arterial analysis that were determined feasible and provide the greatest potential for crash reduction. Source information for the countermeasures can be found in Appendix E.

Table I2 Alternative 1 Segment Countermeasure Analysis Results (Chapter 12)

Countermeasure	Applicable Segment	Predicted Percent Change ¹					
		Total Crashes			Fatal and/or Injury Crashes		
		Low	High	Expected	Low	High	Expected
Install lighting	E, F, M, N, Q	N/A	N/A	7% Reduction	N/A	N/A	10% Reduction
Remove or relocate fixed objects outside of clear zone	All	17% Reduction	59% Reduction	N/A	11% Reduction	65% Reduction	N/A

¹ Percentages were rounded to the nearest whole number

² N/A – Not Available

³ The standard error from the clearinghouse for this countermeasure is large enough to result in a calculated potential increase in crashes. Still, applying centerline rumble strips is more likely to reduce crashes than result in an increase.

Alternative 1 Intersections

Table I3 displays intersection countermeasures for the Chapter 12 urban/suburban arterial analysis that were determined feasible and provide the greatest potential for crash reduction. Source information for the countermeasures can be found in Appendix E.

Table I3 Alternative 1 Intersection Countermeasure Analysis Results (Chapter 12)

Countermeasure	Applicable Intersection	Predicted Percent Change ¹					
		Total Crashes			Fatal and/or Injury Crashes		
		Low	High	Expected	Low	High	Expected
Lighting in intersection	1, 16, 17	N/A ²	N/A	9% Reduction	N/A	N/A	9% Reduction
Retiming signal change intervals to ITE standards	17	12% Increase ³	28% Reduction	N/A	10% Increase	34% Reduction	N/A
Convert four-leg intersection to three-leg intersection	10	N/A	N/A	60% Reduction	N/A	N/A	49% Reduction
Convert two-way stop-controlled intersection into roundabout	16	29% Reduction	49% Reduction	N/A	68% Reduction	88% Reduction	N/A
Convert two-way to all-way stop control	16	N/A	N/A	N/A	58% Reduction	82% Reduction	N/A
Install a traffic signal	16	13% Increase	23% Reduction	N/A	N/A	N/A	N/A

¹ Percentages were rounded to the nearest whole number

² N/A – Not Available

³ The standard error from the clearinghouse for this countermeasure is large enough to result in a calculated potential increase in crashes. Still, applying proper signal timing to an intersection is more likely to reduce crashes than result in an increase.

Alternative 1 Suggested Countermeasures (Chapter 12)

Segment lighting

Lighting can reduce the total number of crashes by seven percent and 10 percent for fatal/injury crashes on urban/suburban facilities. Alternative 1 assumes segment lighting is installed on segments E, F, M, N, and Q, as these segments experienced a higher frequency of crashes.

Ten foot clear zone

Provision of a 10 foot clear zone would help achieve a roadside hazard rating of three, and is expected to reduce total crashes by 17 to 59 percent and fatal crashes by 11 to 65 percent for urban/suburban facilities. Alternative 1 assumes a ten foot clear zone is provided on all segments except D, I, and K as part of the design changes to the SR 157 study corridor. Segments D, I, and K already have a minimum clear zone of 10 feet.

Lighting in intersections

Lighting individual intersections can reduce the total number of crashes by nine percent as well as fatal/injury crashes on urban/suburban facilities. Intersections lighting includes installing luminaires at the intersection proper and on the approaches. Alternative 1 assumes that the following major intersections within the study limits are lighted:

- SR 157/Nuckols Road (existing traffic signal)
- SR 157/Francistown Road (new single-lane roundabout)
- SR 157/Staples Mill Road (modified traffic signal)

Retiming signal change intervals to ITE standards

The standard error from the clearinghouse for this countermeasure is large enough to result in a calculated potential increase in crashes. Still, applying proper signal timing to an intersection is more likely to reduce crashes than result in an increase. Alternative 1 assumes that the signal timing at the SR 157/Staples Mill Road intersection is updated to ITE standards when improved to the future Alternative 1 configuration.

Convert four-leg intersection to three-leg intersection

This conversion can reduce total crashes by 19 percent and fatal/injury crashes by 22 percent for urban/suburban facilities. Available intersection sight distance at Hart Mill Drive was measured to be below AASHTO-recommended minimums. Alternative 1 assumes this approach is closed given the low volume of traffic turning into and out of this location and the presence of a viable alternative access via Bernard Mills Road.

Conversion of two-way stop-controlled intersections into roundabout

Replacing a two-way stop-controlled intersection with a single-lane roundabout can reduce total crashes by 29 to 49 percent and injury crashes by 68 to 88 percent for urban/suburban facilities. An operational analysis of various intersection control forms (all-way stop, roundabout, and traffic signal) at the SR 157/Francistown Road intersection determined that a single-lane roundabout would perform the best. Alternative 1 assumes that the SR 157/Francistown Road intersection is converted to a single-lane roundabout.

Additional Recommended Countermeasures

As noted previously, the study corridor contains roadway characteristics that are also consistent with a rural road. As such, Chapter 10 (Rural Two Lane Roadways) countermeasures applicable to the study corridor were also included.

Achieve roadside hazard rating of 3

Provision of a 10 foot clear zone and guardrail would help achieve a roadside hazard rating of three, and is expected to reduce total crashes by 6 to 18 percent and fatal crashes by 9 to 19 percent on rural two-lane facilities. Alternative 1 assumes a ten foot clear zone is provided on all segments in the study corridor except D, I, and K as part of the design changes to the SR 157 study corridor. Segments D, I, and K already provide a minimum clear zone of 10 feet. Alternative 1 also assumes guardrail is installed on segments M.1, M.2, and N.1 to address the high frequency of crashes in this location.

Flatten horizontal curve

AASHTO identifies a minimum horizontal curve radius of 444 feet for roadways with a design speed of 40 mph and maximum eight percent superelevation. Flattening horizontal curves to achieve the 44-foot

minimum can reduce total crashes by 12 to 17 percent and fatal/injury crashes by nine to 10 percent on rural two-lane facilities. The probability of crashes decreases with longer curve radii and length. Plan maps indicate there is a reserved corridor of right-of-way that could accommodate a realignment of Springfield Road in this area to increase the radii of these horizontal curves. Alternative 1 assumes that horizontal curves on segments M.1 and N.1 are increased to at least 444 feet through this assumed realignment.

Alternative 1 Safety Summary

Table I4 compares predicted crashes for a no-build scenario to Alternative 1. It is important to note that because VDOT has no available calibration factor, the numbers shown below can only be used in a relative manner to compare between scenarios. The reported number of predicted crashes itself is neither accurate nor absolute.

Table I4 Alternative 1 Total Predicted Crashes (Chapter 12)

Alternative	Predicted Annual Crashes		
	Fatal/Injury	Property Damage Only	Total
No-Build	6.71	12.66	19.37
Alternative 1	6.21	11.61	17.82
Percent Change	-7%	-8%	8%

As shown in Table I4, the identified countermeasures implemented in Alternative 1 would result in an eight percent reduction in total crashes within the study limits as compared to the no-build scenario. The identified countermeasures are discussed in detail below.

Benefit/Cost Analysis Methodology

Disclaimer:

VDOT does not have statewide calibration factors to adjust the generic HSM methods to specific VDOT facilities. As such, calculating an **absolute** dollar value benefit for the predicted reduction in crashes for Alternative 1 compared to the no-build condition is not possible. In this case, the calculated cost benefit of alternatives compared to the no-build condition is valid only for relative comparison between alternatives. If calibration factors are developed by VDOT in the future, it would be possible to calculate the actual expected average number of crashes for the no-build and Alternative 1 conditions and calculate an absolute dollar value benefit of Alternative 1 relative to the no-build scenario.

A benefit-cost (B/C) analysis for crashes was conducted for Alternative 1 using crash-cost values contained in the year 2012 Highway Safety Improvement Program (HSIP) Federal Year (FY) 2012-2013

worksheet published by VDOT. A dollar value benefit of the calculated reduction in total expected annual crashes was calculated for an assumed service life of the project of 25 years.

Predicted crashes were allocated on the KABCO scale based on the statewide crash distribution pattern for rural undivided roads year 2008 data (most are 2 lane, some are 4 lane) provided by VDOT. The allocated crashes were multiplied by their respective cost and again by the assumed 25-year service life. The sum of these totals represents the total cost of all predicted crashes for each scenario. Because the calculated cost benefit is only relative, results from the Chapter 12 (Table J7) analysis were used exclusively for the cost benefit comparison. Table I5 summarizes the cost benefit calculations.

Table I5 Cost Benefit Calculations – Alternative 1

Total Predicted Annual Crashes	Crash Severity	VDOT Distribution by Severity	Cost per Crash	Predicted Annual Crashes by Severity Type	25-Year Service Life Cost of Crashes
No-Build					
19.37	K – Killed	1.6%	\$5,038,456	0.31	\$39,048,034
	A – Incapacitating Injury	17.9%	\$275,161	3.46	\$23,801,426
	B – Non-incapacitating Injury	10.1%	\$98,140	1.95	\$4,784,325
	C – Possible Injury	13.8%	\$55,474	2.67	\$3,702,889
	O – No Injury	56.7%	\$9,029	10.98	\$2,478,460
TOTAL					\$73,815,134
Alternative 1					
17.82	K – Killed	1.6%	\$5,038,456	0.28	\$35,269,192
	A – Incapacitating Injury	17.9%	\$275,161	3.19	\$21,944,089
	B – Non-incapacitating Injury	10.1%	\$98,140	1.80	\$4,416,300
	C – Possible Injury	13.8%	\$55,474	2.45	\$3,397,782
	O – No Injury	56.7%	\$9,029	10.10	\$2,279,822
TOTAL					\$67,307,185
Cost Benefit of Alternative 1 compared to No-Build Scenario					\$6,507,949

As shown in Table I5, Alternative 1 is calculated to result in an uncalibrated overall cost benefit of \$6,507,949 compared to the no-build scenario.

At the request of VDOT, segments affected by the potential construction of a new alignment (see Alternatives 2 and 3) were separated out to isolate the relative cost-benefit of identified improvements. Table I6 isolates the total predicted annual crashes of existing SR 157 for just those segments affected by the proposed new alignment in Alternatives 2 and 3 for both the no-build and Alternative 1 scenarios.

Table I6 Cost Benefit Calculations – Alternative 1 (Portion of SR 157 Affected by New Alignment)

Total Predicted Annual Crashes	Crash Severity	VDOT Distribution by Severity	Cost per Crash	Predicted Annual Crashes by Severity Type	25-Year Service Life Cost of Crashes
No-Build					
9.61	K – Killed	1.6%	\$5,038,456	0.15	\$19,367,825
	A – Incapacitating Injury	17.9%	\$275,161	1.72	\$11,833,230
	B – Non-incapacitating Injury	10.1%	\$98,140	0.97	\$2,381,392
	C – Possible Injury	13.8%	\$55,474	1.33	\$1,839,213
	O – No Injury	56.7%	\$9,029	5.44	\$1,227,689
TOTAL					\$36,649,348
Alternative 1					
8.65	K – Killed	1.6%	\$5,038,456	0.13	\$16,173,444
	A – Incapacitating Injury	17.9%	\$275,161	1.55	\$10,651,138
	B – Non-incapacitating Injury	10.1%	\$98,140	0.87	\$2,143,500
	C – Possible Injury	13.8%	\$55,474	1.19	\$1,655,483
	O – No Injury	56.7%	\$9,029	4.9	\$1,107,080
TOTAL					\$31,730,645
Cost Benefit of Alternative 1 compared to No-Build Scenario (Portion of SR 157 Affected by New Alignment)					\$4,918,703

Segments affected by the construction of a new alignment were isolated to compare the relative cost-benefit of improvements limited only to the sections of SR 157 impacted by the new alignment. As shown in Table I6, Alternative 1 is calculated to result in an uncalibrated cost benefit of \$4,918,703 compared to the no-build scenario on just the portion of SR 157 affected by the new alignment. Of the total \$6.5 million savings calculated for Alternative 1, roughly 75 percent (\$4.9M) is attributable to improvements to SR 157 between Linsey Lakes Road and Francistown Road.

General Information

Analyst	ACJ	Analysis Name	Alternative1-Chapter12	Date of Analysis	12/18/2012
Agency/Company	Kittelson & Associates, Inc.	Project Number/PIN #	11764.16	Comments	
State	Virginia	Site(s)	Springfield Road		
Region/Area/City/County	Glen Allen/Henrico County	Jurisdiction	Henrico County		

Analysis Summary Results

Crash Severity Distribution	Crash Frequency		
	Fatal and Injury (FI)	Property Damage Only (PDO)	Total
Total Predicted Crashes (entire study period)	6.21	11.61	17.82
Total Predicted Crashes (crashes/year)	6.21	11.61	17.82
Total Expected Crashes (entire study period)	0.40	0.00	0.40
Total Expected Crashes (crashes/year)	0.40	0.00	0.40
1 - Nuckols Road/Springfield Road	0.78	1.57	2.35
Total Predicted Crashes (crashes/year)	0.78	1.57	2.35
Total Expected Crashes (crashes/year)	0.03	0.00	0.03
A - Nuckols Road to Fireside Drive	0.05	0.12	0.16
Total Predicted Crashes (crashes/year)	0.05	0.12	0.16
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
2 - Springfield Road/Fireside Drive	0.10	0.15	0.25
Total Predicted Crashes (crashes/year)	0.10	0.15	0.25
Total Expected Crashes (crashes/year)	0.01	0.00	0.01
B - Fireside Drive to Kingscroft Drive	0.09	0.24	0.33
Total Predicted Crashes (crashes/year)	0.09	0.24	0.33
Total Expected Crashes (crashes/year)	0.00	0.00	0.00

Analysis Summary Results

Crash Severity Distribution	Crash Frequency		
	Fatal and Injury (FI)	Property Damage Only (PDO)	Total
3 - Springfield Road/Kingscroft Drive	0.10	0.14	0.24
Total Predicted Crashes (crashes/year)	0.10	0.14	0.24
Total Expected Crashes (crashes/year)	0.01	0.00	0.01
C - Kingscroft Drive to Wendhurst Drive	0.04	0.10	0.14
Total Predicted Crashes (crashes/year)	0.04	0.10	0.14
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
4 - Springfield Road/Wendhurst Drive	0.09	0.13	0.21
Total Predicted Crashes (crashes/year)	0.09	0.13	0.21
Total Expected Crashes (crashes/year)	0.01	0.00	0.01
D - Wendhurst Drive to Jones Road	0.03	0.08	0.11
Total Predicted Crashes (crashes/year)	0.03	0.08	0.11
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
5 - Springfield Road/Jones Road	0.07	0.09	0.16
Total Predicted Crashes (crashes/year)	0.07	0.09	0.16
Total Expected Crashes (crashes/year)	0.01	0.00	0.01
E - Jones Road to Olde Milbrooke Way	0.06	0.15	0.21
Total Predicted Crashes (crashes/year)	0.06	0.15	0.21
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
6 - Springfield Road/Olde Milbrooke Way	0.39	0.70	1.09
Total Predicted Crashes (crashes/year)	0.39	0.70	1.09
Total Expected Crashes (crashes/year)	0.04	0.00	0.04

Analysis Summary Results

Crash Severity Distribution	Crash Frequency		
	Fatal and Injury (FI)	Property Damage Only (PDO)	Total
F - Olde Milbrooke way to Wintergreen Road/ Linsey Lakes Drive	0.07	0.18	0.25
Total Predicted Crashes (crashes/year)	0.07	0.18	0.25
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
7 - Springfield Road/Wintergreen Road/Linsey Lakes Drive	0.46	0.79	1.25
Total Predicted Crashes (crashes/year)	0.46	0.79	1.25
Total Expected Crashes (crashes/year)	0.05	0.00	0.05
G - Wintergreen Road/Linsey Lakes Drive to Jacobs Creek Drive	0.12	0.31	0.43
Total Predicted Crashes (crashes/year)	0.12	0.31	0.43
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
8 - Springfield Road/Jacobs Creek Drive	0.26	0.36	0.63
Total Predicted Crashes (crashes/year)	0.26	0.36	0.63
Total Expected Crashes (crashes/year)	0.02	0.00	0.02
H - Jacobs Creek Drive to Wintercreek Drive	0.02	0.06	0.08
Total Predicted Crashes (crashes/year)	0.02	0.06	0.08
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
9 - Springfield Road/Wintercreek Drive	0.25	0.34	0.59
Total Predicted Crashes (crashes/year)	0.25	0.34	0.59
Total Expected Crashes (crashes/year)	0.02	0.00	0.02
I - Wintercreek Drive to Wamerwood Court	0.04	0.11	0.15
Total Predicted Crashes (crashes/year)	0.04	0.11	0.15

Analysis Summary Results

Crash Severity Distribution	Crash Frequency		
	Fatal and Injury (FI)	Property Damage Only (PDO)	Total
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
10 - Springfield Road/Wamerwood Court	0.11	0.10	0.20
Total Predicted Crashes (crashes/year)	0.11	0.10	0.20
Total Expected Crashes (crashes/year)	0.01	0.00	0.01
J - Wamerwood Court to Bernard Mills Drive	0.07	0.19	0.26
Total Predicted Crashes (crashes/year)	0.07	0.19	0.26
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
11 - Springfield Road/Bernard Mills Drive	0.24	0.36	0.60
Total Predicted Crashes (crashes/year)	0.24	0.36	0.60
Total Expected Crashes (crashes/year)	0.02	0.00	0.02
K - Bernard Mills Drive to Olde Hartley Drive	0.05	0.12	0.16
Total Predicted Crashes (crashes/year)	0.05	0.12	0.16
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
12 - Springfield Road/Olde Hartley Drive	0.18	0.23	0.41
Total Predicted Crashes (crashes/year)	0.18	0.23	0.41
Total Expected Crashes (crashes/year)	0.01	0.00	0.01
L - Olde Hartley Drive to Echo Lake Drive	0.05	0.12	0.17
Total Predicted Crashes (crashes/year)	0.05	0.12	0.17
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
13 - Springfield Road/Echo Lake Drive	0.18	0.23	0.41

Analysis Summary Results

Crash Severity Distribution	Crash Frequency		
	Fatal and Injury (FI)	Property Damage Only (PDO)	Total
Total Predicted Crashes (crashes/year)	0.18	0.23	0.41
Total Expected Crashes (crashes/year)	0.01	0.00	0.01
M - Echo Lake Drive through End of Horizontal Curve 1	0.04	0.10	0.14
Total Predicted Crashes (crashes/year)	0.04	0.10	0.14
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
N - Start of Horizontal Curve 2 to Old Springfield Rd	0.21	0.53	0.74
Total Predicted Crashes (crashes/year)	0.21	0.53	0.74
Total Expected Crashes (crashes/year)	0.01	0.00	0.01
14 - Springfield Road/Old Springfield Rd	0.24	0.33	0.57
Total Predicted Crashes (crashes/year)	0.24	0.33	0.57
Total Expected Crashes (crashes/year)	0.02	0.00	0.02
O - Old Springfield Road to Rigney Terrace	0.08	0.20	0.29
Total Predicted Crashes (crashes/year)	0.08	0.20	0.29
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
15 - Springfield Road/Rigney Terrace	0.18	0.23	0.40
Total Predicted Crashes (crashes/year)	0.18	0.23	0.40
Total Expected Crashes (crashes/year)	0.01	0.00	0.01
P - Rigney Terrace to Francistown Road	0.06	0.16	0.22
Total Predicted Crashes (crashes/year)	0.06	0.16	0.22
Total Expected Crashes (crashes/year)	0.00	0.00	0.00

Analysis Summary Results

Crash Severity Distribution	Crash Frequency		
	Fatal and Injury (FI)	Property Damage Only (PDO)	Total
16 - Springfield Road/Francistown Road	0.32	0.63	0.95
Total Predicted Crashes (crashes/year)	0.32	0.63	0.95
Total Expected Crashes (crashes/year)	0.03	0.00	0.03
Q - Francistown Road to Staples Mill Road	0.24	0.59	0.84
Total Predicted Crashes (crashes/year)	0.24	0.59	0.84
Total Expected Crashes (crashes/year)	0.01	0.00	0.01
17 - Staples Mill Road/Springfield Road	0.92	1.90	2.82
Total Predicted Crashes (crashes/year)	0.92	1.90	2.82
Total Expected Crashes (crashes/year)	0.04	0.00	0.04

Appendix J
Alternative 1 Preliminary
Estimate of Probable Cost

SPRINGFIELD ROAD - ALTERNATE 1
 HENRICO, VA
ENGINEER'S OPINION OF PROBABLE COSTS
01-06-13 (STUDY STAGE)

VDOT ITEM #	ITEM	Quantity	UNIT	UNIT PRICE	COST
	RECONSTRUCT MAINLINE	10,500	LF	\$532.84	\$5,594,851.15
	RECONSTRUCT LOCAL ROAD	0	LF	\$518.14	\$0.00
	NEW CONSTRUCTION MAINLINE	1,000	LF	\$625.49	\$625,493.82
	NEW CONSTRUCTION LOCAL ROAD	0	LF	\$656.59	\$0.00
	CUL-DE-SAC	0	EA	\$20,000.00	\$0.00
	STAPLES MILL INTERSECTION IMPROVEMENTS	1	LS	\$2,306,500.00	\$2,306,500.00
	GUARDRAIL	1,500	LF	\$22.00	\$33,000.00
	ROUNDABOUTS	1	EA	\$500,000.00	\$500,000.00
	INTERSECTION LIGHTING	4	EA	\$3,000.00	\$12,000.00
	CORRIDOR LIGHTING	5,500	LF	\$32.53	\$178,933.33
	CLOSE HART MILL ROAD	1	LS	\$20,000.00	\$20,000.00
	MAJOR DRAINAGE	0.00	LS	\$1,100,000.00	\$0.00
	WETLANDS MITIGATION	1	AC	\$50,000.00	\$50,000.00
	STREAM MITIGATION	25	LF	\$300.00	\$7,500.00
	BICYCLE/PEDESTRIAN PATH	0	LF	\$35.00	\$0.00
	WATER QUALITY (BASINS)	0	EA	\$15,000.00	\$0.00
	WATER QUALITY (FILTERRAS)	25	EA	\$10,000.00	\$250,000.00
					\$9,578,278.30

Sub Total from above	\$9,578,278.30
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CEI	\$1,436,741.75
PE	\$1,245,176.18

Total Section Cost	\$12,260,196.22
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Appendix K
Alternative 2
Signal Warrants &
West End Intersection Configuration
Analysis Method/Worksheets

Alternative 2 West End Alignment Options – Operational Analysis

Table K1 summarizes the intersection operations for each intersection control form for Option A.

Table K1 Alternative 2 Option A Intersection Operations Summary

Intersection	Two-way Stop*				Four-way Stop				Signalized			Roundabout		
	Dir	LOS	V/C	Delay (s)	Dir	LOS	V/C	Delay (s)	LOS	V/C	Delay (s)	LOS	V/C	Delay (s)
New SR 157/ Linsey Lakes Drive/ Existing SR 157	NB	E	0.16	35.9	NB	B	0.04	10.2	C	0.5	27.0	A	0.61	6.7
	SB	D	0.64	31.5	SB	B	0.38	12.7			26.9			6.9
	EB	A	0.24	5.4	EB	F	1.02	61.6			17.5			9.0
	WB	A	0.02	0.7	WB	B	0.52	14.6			23.3			11.2
Existing SR 157/ Wintergreen Road	NB	A	0.02	0.9	NB				N/A	N/A	N/A			
	SB	A	0.15	0.0	SB									
	EB	A	0.06	9.6	EB									
	WB				WB									
New SR 157/ Francistown Road/ Existing SR 157	NB	F	7.74	405.4	NB	D	1.61	33.8	C	0.57	24.3	B	0.77	13.0
	SB	F		Err**	SB	C		18.1			19.4			10.2
	EB	A		1.3	EB	E		46.1			35.5			11.1
	WB	A		5.8	WB	F		303.0			22.2			18.4

*If the two-way stop control is operating with a maximum LOS B in all approaches, then other intersection control devices were not deemed necessary for consideration.

**Err – occurs when delay is too large to accurately measure

Table K2 summarizes the intersection operations for each intersection control form for Option B.

Table K2 Alternative 2 Option B Intersection Operations Summary

Intersection	Two-way Stop*				Four-way Stop				Signalized			Roundabout		
	Dir	LOS	V/C	Delay (s)	Dir	LOS	V/C	Delay (s)	LOS	V/C	Delay (s)	LOS	V/C	Delay (s)
New SR 157/ Existing SR 157	NB		0.53		NB		0.60		N/A	N/A	N/A	B	0.62	
	SB	C		22.8	SB	B		11.7						9.0
	EB	A		3.9	EB	B		15.0						6.6
	WB	A		0.0	WB	B		13.1						11.8
New SR 157/ Linsey Lakes Drive	NB	B	0.04	12.7	NB				N/A	N/A	N/A			
	SB				SB									
	EB	A	0.24	0.0	EB									
	WB	A	0.18	0.6	WB									
New SR 157/ Francistown Road/ Existing SR 157	NB	F	7.74	405.4	NB	D	1.61	33.8	C	0.57	24.3	B	0.77	13.0
	SB	F		Err**	SB	C		18.1			19.4			10.2
	EB	A		1.3	EB	E		46.1			35.5			11.1
	WB	A		5.8	WB	F		303.0			22.2			18.4

*If the two-way stop control is operating with a maximum LOS B in all approaches, then other intersection control devices were not deemed necessary for consideration.

**Err – occurs when delay is too large to accurately measure

Table K3 summarizes the intersection operations for each intersection control form for Option C.

Table K3 Alternative 2 Option C Intersection Operations Summary

Intersection	Two-way Stop*				Four-way Stop				Signalized			Roundabout		
	Dir	LOS	V/C	Delay (s)	Dir	LOS	V/C	Delay (s)	LOS	V/C	Delay (s)	LOS	V/C	Delay (s)
New SR 157/ Wintergreen Road/ Existing SR 157	NB	A	0.79	0.4	NB	B	0.56	14.1	C	0.64	28.3	A	0.61	11.6
	SB	A		0.5	SB	B		13.0			39.7			7.8
	EB	C		16.1	EB	B		10.2			44.1			5.0
	WB	E		41.1	WB	C		16.3			36.1			8.6
New SR 157/ Linsey Lakes Drive	NB	A	0.24	11.1	NB				N/A	N/A	N/A			
	SB				SB									
	EB	A		0.0	EB									
	WB	A		0.6	WB									
New SR 157/ Francistown Road/ Existing SR 157	NB	F	7.74	405.4	NB	D	1.61	33.8 18.1 46.1 303.0	C	0.57	24.3	B	0.77	13.0
	SB	F		Err**	SB	C	0.42				19.4			10.2
	EB	A		1.3	EB	E	0.89				35.5			11.1
	WB	A		5.8	WB	F	1.61				22.2			18.4

*If the two-way stop control is operating with a maximum LOS B in all approaches, then other intersection control devices were not deemed necessary for consideration.

**Err – occurs when delay is too large to accurately measure

Alternative 2 West End Alignment Options – Delay Comparison

A quantitative comparison of overall delay was also conducted, recognizing that minimizing delay is another important parameter to consider. Three possible routes through the corridor were identified and the travel time in seconds to progress through the routes in the weekday p.m. peak hour were calculated. The three routes used include:

- Olde Millbrooke Way/Springfield Road intersection to Springfield Road/Francistown Road/SR 157
- Wintergreen Road/Springfield Road intersection to Olde Millbrooke Way
- Springfield Road/Francistown Road/SR 157 to Springfield Road/Jacobs Creek Drive

Travel times for these routes were then weighted by the number of forecast vehicles in the year 2036 weekday p.m. peak hour to determine the overall time for each route. Table K4 summarizes the delay calculations.

Table K4 Alternative 2 Option Delay Calculations

Route	Directions	Option A				Option B				Option C					
		Distance (ft)	Time (s)	Volume	Total time (s)	Distance (ft)	Time (s)	Volume	Total time (s)	Distance (ft)	Time (s)	Volume	Total time (s)		
Olde Millbrooke Way to Francistown Road	Opt A Route	Olde Millbrooke to Linsey Lakes	777	11.8	345	4071.0									
		Through - Linsey Lakes intersection delay		11.2	345	3864.0									
		Linsey Lakes to Francistown	4331	65.6	345	22632.0									
	Opt B Route	Olde Millbrooke to Springfield Rd					746	11.3	345	3898.5					
		Through - Springfield intersection delay						6.6	345	2277.0					
		Springfield to Linsey Lakes					464	7.0	345	2415.0					
		Through - Linsey Lakes delay						0.0	345	0.0					
		Linsey Lakes to Francistown					4331	65.6	345	22632.0					
	Opt C Route	Olde Millbrooke to Wintergreen/Linsey									746	11.3	345	3898.5	
		Right Turn - Wintergreen/Linsey delay										11.6	345	4002.0	
		Wintergreen/Linsey to Lindsey Lakes									447	6.8	345	2346.0	
		Through - Linsey Lakes delay										0.0	345	0.0	
		Linsey Lakes to Francistown									4343	65.8	345	22701.0	
		Sub Total		88.6		30567.0		90.5		31222.5		95.5		32947.5	

Table K4 (cont.)

Route		Directions	Option A				Option B				Option C			
			Distance (ft)	Time (s)	Volume	Total time (s)	Distance (ft)	Time (s)	Volume	Total time (s)	Distance (ft)	Time (s)	Volume	Total time (s)
Wintergreen Road to Olde Milbrooke Way	Opt A Route	Right Turn - Wintergreen/Springfield delay		11.7	19	222.3								
		Wintergreen to SR 157	400	6.1	19	115.9								
		Right turn - SR 157/Lindsey Lakes delay		6.9	19	131.1								
		Linsey Lakes to Olde Milbrooke Way	777	11.8	19	224.2								
	Opt B Route	Right Turn - Wintergreen/Springfield delay						9.4	19	178.6				
		Wintergreen to Springfield Road					449	6.8	19	129.2				
		Right turn - SR 157/Springfield road delay						9.0	19	171.0				
		Springfield road to Olde Milbrooke Way					746	11.3	19	214.7				
	Opt C Route	Right Turn - Wintergreen/Springfield delay										5.0	19	95.0
		Wintergreen to Olde Milbrooke Way									746	11.3	19	214.7
		Sub Total		36.5		693.5		36.5		693.5		16.3		309.7

Table K4 (cont.)

Route		Directions	Option A				Option B				Option C				
			Distance (ft)	Time (s)	Volume	Total time (s)	Distance (ft)	Time (s)	Volume	Total time (s)	Distance (ft)	Time (s)	Volume	Total time (s)	
Francistown Road to Jacobs Creek Drive	Opt A Route	Francistown to Linsey Lakes	4331	65.6	40	2624.0									
		Right turn - Linsey Lakes delay		9.0	40	360.0									
		Linsey Lakes to Wintergreen	400	6.1	40	244.0									
		Through - Wintergreen delay		0.9	40	36.0									
		Wintergreen to Jacobs Creek	854	12.9	40	516.0									
	Opt B Route	Francistown to Linsey Lakes					4331	65.6	40	2624.0					
		Through - Linsey Lakes delay						6.6	40	264.0					
		Linsey Lakes to Springfield Road					464	7.0	40	280.0					
		Right Turn - Springfield Road/SR 157 delay						11.8	40	472.0					
		SR 157 to Wintergreen					449	6.8	40	272.0					
		Through - Wintergreen delay						0.7	40	28.0					
		Wintergreen to Jacobs Creek					883	13.4	40	536.0					
	Opt C Route	Francistown to Linsey Lakes									4343	65.8	40	2632.0	
		Through - Linsey Lakes delay										0.0	40	0.0	
		Linsey Lakes to Wintergreen									447	6.8	40	272.0	
		Right Turn - Wintergreen delay										8.6	40	344.0	
		Wintergreen to Jacobs Creek									890	13.5	40	540.0	
			Sub Total		94.5		3780.0		111.9		4476.0		94.7		3788.0
			Total		219.6		35,040.5		238.9		36,392.0		206.5		37,045.2

The process in Table K4 shows the road configuration that provides the least aggregated delay for the three routes Option A.



KITTELSON & ASSOCIATES, INC.

1850 Centennial Park Drive, Suite 130
 Reston, Virginia 20191
 (703) 885 - 8970

Project #: 11764.4
Project Name: Springfield Road Alternatives
Analyst: XJH
Date: 7/24/2012
File: H:\profile\11764 - Central Region VDOT On-Call\Task Orders\Task 04 (12-023)
 - Springfield Road Route 157 Alt Analysis\excel\Signal Warrants\Signal
 Warrants Francistown Alt 1.xls\Warrant Summary
Intersection: Springfield Road/Francistown Road
Scenario: Alternative 1

Adjusted Traffic Volumes

Hour		Major Street		Minor Street	
Begin	End	NB	SB	EB	WB
12:00 AM	1:00 AM	16	21	0	19
1:00 AM	2:00 AM	7	9	0	9
2:00 AM	3:00 AM	0	7	0	7
3:00 AM	4:00 AM	21	9	0	8
4:00 AM	5:00 AM	13	12	0	16
5:00 AM	6:00 AM	19	45	0	41
6:00 AM	7:00 AM	86	134	0	135
7:00 AM	8:00 AM	232	462	0	528
8:00 AM	9:00 AM	200	363	0	528
9:00 AM	10:00 AM	128	190	0	233
10:00 AM	11:00 AM	103	156	0	199
11:00 AM	12:00 PM	116	167	0	232
12:00 PM	1:00 PM	166	217	0	307
1:00 PM	2:00 PM	135	206	0	290
2:00 PM	3:00 PM	161	257	0	343
3:00 PM	4:00 PM	179	272	0	318
4:00 PM	5:00 PM	338	364	0	469
5:00 PM	6:00 PM	351	487	0	710
6:00 PM	7:00 PM	271	359	0	460
7:00 PM	8:00 PM	288	285	0	334
8:00 PM	9:00 PM	174	200	0	211
9:00 PM	10:00 PM	124	127	0	117
10:00 PM	11:00 PM	64	62	0	71
11:00 PM	12:00 AM	47	27	0	25

Warrant Summary

Warrant	Name	Analyzed?	Met?
#1	Eight-Hour Vehicular Volume	Yes	Yes
#2	Four-Hour Vehicular volume	Yes	Yes
#3	Peak Hour	Yes	Yes
#4	Pedestrian Volume	No	-
#5	School Crossing	No	-
#6	Coordinated Signal System	No	-
#7	Crash Experience	No	-
#8	Roadway Network	No	-

Input Parameters

Volume Adjustment Factor =	1.0
North-South Approach =	Major
East-West Approach =	Minor
Major Street Thru Lanes =	1
Minor Street Thru Lanes =	0
Speed > 40 mph?	Yes
Population < 10,000?	No
Warrant Factor	70%
Peak Hour or Daily Count?	Daily

Warrant #1 Eight-Hour Analysis Summary

Warrant Factor	Condition	Major Street Requirement	Minor Street Requirement	Hours That Condition Is Met	Threshold	Condition for Warrant Factor Met?
100%	A	500	200	6	8	No
	B	750	100	1	8	No
80%	A	400	160	8	8	Yes
	B	600	80	4	8	No
70%	A	350	140	10	8	Yes
	B	525	70	6	8	No



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Date: 7/24/2012
File: H:\profile\11764 - Central Region VDOT On-Call\Task Orders\Task 04 (12-023)
 - Springfield Road Route 157 Alt Analysis\excel\Signal Warrants\Option
 A\Signal Warrants New Road Alt 2 Opt A Int 2.xls\Data Input
Intersection: New SR 157/Linsey Lakes Drive/Existing SR 157
Scenario: Alternative 2

Adjusted Traffic Volumes

Hour		Major Street		Minor Street	
Begin	End	EB	WB	NB	SB
12:00 AM	1:00 AM	1	9	19	8
1:00 AM	2:00 AM	0	4	10	4
2:00 AM	3:00 AM	0	3	7	3
3:00 AM	4:00 AM	1	4	6	4
4:00 AM	5:00 AM	1	5	6	7
5:00 AM	6:00 AM	1	19	25	18
6:00 AM	7:00 AM	5	57	102	57
7:00 AM	8:00 AM	13	197	395	225
8:00 AM	9:00 AM	11	155	486	225
9:00 AM	10:00 AM	7	81	230	99
10:00 AM	11:00 AM	6	66	186	85
11:00 AM	12:00 PM	7	71	225	99
12:00 PM	1:00 PM	9	93	299	131
1:00 PM	2:00 PM	8	88	289	124
2:00 PM	3:00 PM	9	110	332	146
3:00 PM	4:00 PM	10	116	334	136
4:00 PM	5:00 PM	19	155	484	200
5:00 PM	6:00 PM	20	208	627	303
6:00 PM	7:00 PM	15	153	460	196
7:00 PM	8:00 PM	16	122	377	143
8:00 PM	9:00 PM	10	85	267	90
9:00 PM	10:00 PM	7	54	170	50
10:00 PM	11:00 PM	4	26	74	30
11:00 PM	12:00 AM	3	11	34	11

Warrant Summary

Warrant	Name	Analyzed?	Met?
#1	Eight-Hour Vehicular Volume	Yes	No
#2	Four-Hour Vehicular volume	Yes	Yes
#3	Peak Hour	Yes	Yes
#4	Pedestrian Volume	No	-
#5	School Crossing	No	-
#6	Coordinated Signal System	No	-
#7	Crash Experience	No	-
#8	Roadway Network	No	-

Input Parameters

Volume Adjustment Factor =	1.0
North-South Approach =	Minor
East-West Approach =	Major
Major Street Thru Lanes =	1
Minor Street Thru Lanes =	1
Speed > 40 mph?	Yes
Population < 10,000?	No
Warrant Factor	70%
Peak Hour or Daily Count?	Daily

Warrant #1 Eight-Hour Analysis Summary

Warrant Factor	Condition	Major Street Requirement	Minor Street Requirement	Hours That Condition Is Met	Threshold	Condition for Warrant Factor Met?
100%	A	500	150	0	8	No
	B	750	75	0	8	No
80%	A	400	120	0	8	No
	B	600	60	0	8	No
70%	A	350	105	0	8	No
	B	525	53	0	8	No



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Date: 7/24/2012
File: H:\profile\11764 - Central Region VDOT On-Call\Task Orders\Task 04 (12-023)
 - Springfield Road Route 157 Alt Analysis\excel\Signal Warrants\Option
 A\Signal Warrants New Road Alt 2 Opt A Int 2.xls\Warrant Summary
Intersection: New SR 157/Linsey Lakes Drive/Existing SR 157
Scenario: Alternative 2
 Opt A

Adjusted Traffic Volumes

Hour		Major Street		Minor Street	
Begin	End	EB	WB	NB	SB
12:00 AM	1:00 AM	1	9	19	8
1:00 AM	2:00 AM	0	4	10	4
2:00 AM	3:00 AM	0	3	7	3
3:00 AM	4:00 AM	1	4	6	4
4:00 AM	5:00 AM	1	5	6	7
5:00 AM	6:00 AM	1	19	25	18
6:00 AM	7:00 AM	5	57	102	57
7:00 AM	8:00 AM	13	197	395	225
8:00 AM	9:00 AM	11	155	486	225
9:00 AM	10:00 AM	7	81	230	99
10:00 AM	11:00 AM	6	66	186	85
11:00 AM	12:00 PM	7	71	225	99
12:00 PM	1:00 PM	9	93	299	131
1:00 PM	2:00 PM	8	88	289	124
2:00 PM	3:00 PM	9	110	332	146
3:00 PM	4:00 PM	10	116	334	136
4:00 PM	5:00 PM	19	155	484	200
5:00 PM	6:00 PM	20	208	627	303
6:00 PM	7:00 PM	15	153	460	196
7:00 PM	8:00 PM	16	122	377	143
8:00 PM	9:00 PM	10	85	267	90
9:00 PM	10:00 PM	7	54	170	50
10:00 PM	11:00 PM	4	26	74	30
11:00 PM	12:00 AM	3	11	34	11

Warrant Summary

Warrant	Name	Analyzed?	Met?
#1	Eight-Hour Vehicular Volume	Yes	No
#2	Four-Hour Vehicular volume	Yes	Yes
#3	Peak Hour	Yes	Yes
#4	Pedestrian Volume	No	-
#5	School Crossing	No	-
#6	Coordinated Signal System	No	-
#7	Crash Experience	No	-
#8	Roadway Network	No	-

Input Parameters

Volume Adjustment Factor =	1.0
North-South Approach =	Minor
East-West Approach =	Major
Major Street Thru Lanes =	1
Minor Street Thru Lanes =	1
Speed > 40 mph?	Yes
Population < 10,000?	No
Warrant Factor	70%
Peak Hour or Daily Count?	Daily

Warrant #1 Eight-Hour Analysis Summary

Warrant Factor	Condition	Major Street Requirement	Minor Street Requirement	Hours That Condition Is Met	Threshold	Condition for Warrant Factor Met?
100%	A	500	150	0	8	No
	B	750	75	0	8	No
80%	A	400	120	0	8	No
	B	600	60	0	8	No
70%	A	350	105	0	8	No
	B	525	53	0	8	No



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Date: 7/24/2012
File: H:\profile\11764 - Central Region VDOT On-Call\Task Orders\Task 04 (12-023)
 - Springfield Road Route 157 Alt Analysis\excel\Signal Warrants\Option
 A\Signal Warrants New Road Alt 2 Opt A Int 3.xls\Warrant Summary
Intersection: New SR 157/Francisstown Road/Existing SR 157
Scenario: Alternative 2
 Opt A, Opt B, Opt C

Adjusted Traffic Volumes

Hour		Major Street		Minor Street	
Begin	End	EB	WB	NB	SB
12:00 AM	1:00 AM	16	7	12	19
1:00 AM	2:00 AM	7	3	7	9
2:00 AM	3:00 AM	0	2	4	7
3:00 AM	4:00 AM	21	3	4	8
4:00 AM	5:00 AM	13	4	4	16
5:00 AM	6:00 AM	19	14	15	41
6:00 AM	7:00 AM	86	43	64	135
7:00 AM	8:00 AM	232	147	247	528
8:00 AM	9:00 AM	200	115	304	528
9:00 AM	10:00 AM	128	61	144	233
10:00 AM	11:00 AM	103	50	116	199
11:00 AM	12:00 PM	116	53	141	232
12:00 PM	1:00 PM	166	69	187	307
1:00 PM	2:00 PM	135	66	181	290
2:00 PM	3:00 PM	161	82	208	343
3:00 PM	4:00 PM	179	86	209	318
4:00 PM	5:00 PM	338	116	303	469
5:00 PM	6:00 PM	351	155	392	710
6:00 PM	7:00 PM	271	114	287	460
7:00 PM	8:00 PM	288	91	236	334
8:00 PM	9:00 PM	174	64	167	211
9:00 PM	10:00 PM	124	40	106	117
10:00 PM	11:00 PM	64	20	46	71
11:00 PM	12:00 AM	47	9	22	25

Warrant Summary

Warrant	Name	Analyzed?	Met?
#1	Eight-Hour Vehicular Volume	Yes	No
#2	Four-Hour Vehicular volume	Yes	Yes
#3	Peak Hour	Yes	Yes
#4	Pedestrian Volume	No	-
#5	School Crossing	No	-
#6	Coordinated Signal System	No	-
#7	Crash Experience	No	-
#8	Roadway Network	No	-

Input Parameters

Volume Adjustment Factor =	1.0
North-South Approach =	Minor
East-West Approach =	Major
Major Street Thru Lanes =	1
Minor Street Thru Lanes =	1
Speed > 40 mph?	Yes
Population < 10,000?	No
Warrant Factor	70%
Peak Hour or Daily Count?	Daily

Warrant #1 Eight-Hour Analysis Summary

Warrant Factor	Condition	Major Street Requirement	Minor Street Requirement	Hours That Condition Is Met	Threshold	Condition for Warrant Factor Met?
100%	A	500	150	1	8	No
	B	750	75	0	8	No
80%	A	400	120	2	8	No
	B	600	60	0	8	No
70%	A	350	105	5	8	No
	B	525	53	0	8	No



KITTELSON & ASSOCIATES, INC.

1850 Centennial Park Drive, Suite 130
 Reston, Virginia 20191
 (703) 885 - 8970

Project #: 11764.4
Project Name: Springfield Road Alternatives
Analyst: XJH
Date: 7/24/2012
File: H:\profile\11764 - Central Region VDOT On-Call\Task Orders\Task 04 (12-023)
 - Springfield Road Route 157 Alt Analysis\excel\Signal Warrants\Option
 A\Signal Warrants New Road Alt 2 Opt A Int 3.xls\Warrant Summary
Intersection: New SR 157/Linsey Lakes Drive
Scenario: Alternative 2
 Opt B

Adjusted Traffic Volumes

Hour		Major Street		Minor Street	
Begin	End	EB	WB	NB	SB
12:00 AM	1:00 AM	1	0	12	8
1:00 AM	2:00 AM	0	0	6	4
2:00 AM	3:00 AM	0	0	4	3
3:00 AM	4:00 AM	0	0	4	4
4:00 AM	5:00 AM	0	0	4	7
5:00 AM	6:00 AM	2	0	15	18
6:00 AM	7:00 AM	6	0	63	57
7:00 AM	8:00 AM	19	0	244	225
8:00 AM	9:00 AM	15	0	300	225
9:00 AM	10:00 AM	8	0	142	99
10:00 AM	11:00 AM	6	0	115	85
11:00 AM	12:00 PM	7	0	139	99
12:00 PM	1:00 PM	9	0	184	131
1:00 PM	2:00 PM	8	0	179	124
2:00 PM	3:00 PM	11	0	205	146
3:00 PM	4:00 PM	11	0	206	136
4:00 PM	5:00 PM	15	0	299	200
5:00 PM	6:00 PM	20	0	387	303
6:00 PM	7:00 PM	15	0	284	196
7:00 PM	8:00 PM	12	0	233	143
8:00 PM	9:00 PM	8	0	165	90
9:00 PM	10:00 PM	5	0	105	50
10:00 PM	11:00 PM	3	0	46	30
11:00 PM	12:00 AM	1	0	21	11

Warrant Summary

Warrant	Name	Analyzed?	Met?
#1	Eight-Hour Vehicular Volume	Yes	No
#2	Four-Hour Vehicular volume	Yes	No
#3	Peak Hour	Yes	No
#4	Pedestrian Volume	No	-
#5	School Crossing	No	-
#6	Coordinated Signal System	No	-
#7	Crash Experience	No	-
#8	Roadway Network	No	-

Input Parameters

Volume Adjustment Factor =	1.0
North-South Approach =	Minor
East-West Approach =	Major
Major Street Thru Lanes =	1
Minor Street Thru Lanes =	0
Speed > 40 mph?	Yes
Population < 10,000?	No
Warrant Factor	70%
Peak Hour or Daily Count?	Daily

Warrant #1 Eight-Hour Analysis Summary

Warrant Factor	Condition	Major Street Requirement	Minor Street Requirement	Hours That Condition Is Met	Threshold	Condition for Warrant Factor Met?
100%	A	500	200	0	8	No
	B	750	100	0	8	No
80%	A	400	160	0	8	No
	B	600	80	0	8	No
70%	A	350	140	0	8	No
	B	525	70	0	8	No



KITTELSON & ASSOCIATES, INC.

1850 Centennial Park Drive, Suite 130
 Reston, Virginia 20191
 (703) 885 - 8970

Project #: 11764.4
Project Name: Springfield Road Alternatives
Analyst: XJH
Date: 7/24/2012
File: H:\profile\11764 - Central Region VDOT On-Call\Task Orders\Task 04 (12-023)
 - Springfield Road Route 157 Alt Analysis\excel\Signal Warrants\Option
 B\Signal Warrants New Road Alt 2 Opt B Int 2.xls\Data Input
Intersection: New SR 157/Existing SR 157
Scenario: Alternative 2
 Opt B

Adjusted Traffic Volumes

Hour		Major Street		Minor Street	
Begin	End	EB	WB	NB	SB
12:00 AM	1:00 AM	0	9	19	8
1:00 AM	2:00 AM	0	4	10	4
2:00 AM	3:00 AM	0	3	7	3
3:00 AM	4:00 AM	0	4	6	3
4:00 AM	5:00 AM	0	5	6	6
5:00 AM	6:00 AM	0	19	25	17
6:00 AM	7:00 AM	0	57	102	55
7:00 AM	8:00 AM	0	197	395	216
8:00 AM	9:00 AM	0	155	486	216
9:00 AM	10:00 AM	0	81	230	95
10:00 AM	11:00 AM	0	66	186	81
11:00 AM	12:00 PM	0	71	225	95
12:00 PM	1:00 PM	0	93	299	125
1:00 PM	2:00 PM	0	88	289	119
2:00 PM	3:00 PM	0	110	332	140
3:00 PM	4:00 PM	0	116	334	130
4:00 PM	5:00 PM	0	155	484	191
5:00 PM	6:00 PM	0	208	627	290
6:00 PM	7:00 PM	0	153	460	188
7:00 PM	8:00 PM	0	122	377	137
8:00 PM	9:00 PM	0	85	267	86
9:00 PM	10:00 PM	0	54	170	48
10:00 PM	11:00 PM	0	26	74	29
11:00 PM	12:00 AM	0	11	34	10

Warrant Summary

Warrant	Name	Analyzed?	Met?
#1	Eight-Hour Vehicular Volume	Yes	No
#2	Four-Hour Vehicular volume	Yes	No
#3	Peak Hour	Yes	Yes
#4	Pedestrian Volume	No	-
#5	School Crossing	No	-
#6	Coordinated Signal System	No	-
#7	Crash Experience	No	-
#8	Roadway Network	No	-

Input Parameters

Volume Adjustment Factor =	1.0
North-South Approach =	Minor
East-West Approach =	Major
Major Street Thru Lanes =	1
Minor Street Thru Lanes =	0
Speed > 40 mph?	Yes
Population < 10,000?	No
Warrant Factor	70%
Peak Hour or Daily Count?	Daily

Warrant #1 Eight-Hour Analysis Summary

Warrant Factor	Condition	Major Street Requirement	Minor Street Requirement	Hours That Condition Is Met	Threshold	Condition for Warrant Factor Met?
100%	A	500	200	0	8	No
	B	750	100	0	8	No
80%	A	400	160	0	8	No
	B	600	80	0	8	No
70%	A	350	140	0	8	No
	B	525	70	0	8	No



KITTELSON & ASSOCIATES, INC.

1850 Centennial Park Drive, Suite 130
 Reston, Virginia 20191
 (703) 885 - 8970

Project #: 11764.4
Project Name: Springfield Road Alternatives
Analyst: XJH
Date: 7/24/2012
File: H:\profile\11764 - Central Region VDOT On-Call\Task Orders\Task 04 (12-023)
 - Springfield Road Route 157 Alt Analysis\excel\Signal Warrants\Option
 C:\Signal Warrants New Road Alt 2 Opt C Int 1.xls\Warrant Summary
Intersection: New SR 157/Wintergreen Road/Existing SR 157
Scenario: Alternative 2
 Opt C

Adjusted Traffic Volumes

Hour		Major Street		Minor Street	
Begin	End	NB	SB	EB	WB
12:00 AM	1:00 AM	19	7	1	8
1:00 AM	2:00 AM	10	4	1	4
2:00 AM	3:00 AM	7	3	0	3
3:00 AM	4:00 AM	6	2	0	3
4:00 AM	5:00 AM	6	2	0	6
5:00 AM	6:00 AM	25	9	2	17
6:00 AM	7:00 AM	102	38	7	55
7:00 AM	8:00 AM	395	147	28	216
8:00 AM	9:00 AM	486	181	35	216
9:00 AM	10:00 AM	230	86	17	95
10:00 AM	11:00 AM	186	69	13	81
11:00 AM	12:00 PM	225	84	16	95
12:00 PM	1:00 PM	299	111	21	125
1:00 PM	2:00 PM	289	108	21	119
2:00 PM	3:00 PM	332	124	24	140
3:00 PM	4:00 PM	334	125	24	130
4:00 PM	5:00 PM	484	181	35	191
5:00 PM	6:00 PM	627	234	45	290
6:00 PM	7:00 PM	460	172	33	188
7:00 PM	8:00 PM	377	141	27	137
8:00 PM	9:00 PM	267	100	19	86
9:00 PM	10:00 PM	170	63	12	48
10:00 PM	11:00 PM	74	28	5	29
11:00 PM	12:00 AM	34	13	2	10

Warrant Summary

Warrant	Name	Analyzed?	Met?
#1	Eight-Hour Vehicular Volume	Yes	No
#2	Four-Hour Vehicular volume	Yes	Yes
#3	Peak Hour	Yes	Yes
#4	Pedestrian Volume	No	-
#5	School Crossing	No	-
#6	Coordinated Signal System	No	-
#7	Crash Experience	No	-
#8	Roadway Network	No	-

Input Parameters

Volume Adjustment Factor =	1.0
North-South Approach =	Major
East-West Approach =	Minor
Major Street Thru Lanes =	1
Minor Street Thru Lanes =	0
Speed > 40 mph?	Yes
Population < 10,000?	No
Warrant Factor	70%
Peak Hour or Daily Count?	Daily

Warrant #1 Eight-Hour Analysis Summary

Warrant Factor	Condition	Major Street Requirement	Minor Street Requirement	Hours That Condition Is Met	Threshold	Condition for Warrant Factor Met?
100%	A	500	200	3	8	No
	B	750	100	1	8	No
80%	A	400	160	5	8	No
	B	600	80	4	8	No
70%	A	350	140	6	8	No
	B	525	70	5	8	No



KITTELSON & ASSOCIATES, INC.

610 SW Alder, Suite 700
 Portland, Oregon 97205
 (503) 228-5230
 Fax: (503) 273-8169

Project #: 11764.4
Project Name: Springfield Road Alternatives
Analyst: XJH
Date: 7/24/2012
File: H:\profile\11764 - Central Region VDOT On-Call\Task Orders\Task 04 (12-023)
 - Springfield Road Route 157 Alt Analysis\excel\Signal Warrants\Option
 C:\Signal Warrants New Road Alt 2 Opt C Int 2.xls\Warrant Summary
Intersection: New SR 157 /Linsey Lakes Drive
Scenario: Alternative 2
 Opt C

Adjusted Traffic Volumes

Hour		Major Street		Minor Street	
Begin	End	EB	WB	NB	SB
12:00 AM	1:00 AM	1	0	12	8
1:00 AM	2:00 AM	0	0	6	4
2:00 AM	3:00 AM	0	0	4	3
3:00 AM	4:00 AM	0	0	4	4
4:00 AM	5:00 AM	0	0	4	7
5:00 AM	6:00 AM	2	0	15	18
6:00 AM	7:00 AM	6	0	63	57
7:00 AM	8:00 AM	19	0	244	225
8:00 AM	9:00 AM	15	0	300	225
9:00 AM	10:00 AM	8	0	142	99
10:00 AM	11:00 AM	6	0	115	85
11:00 AM	12:00 PM	7	0	139	99
12:00 PM	1:00 PM	9	0	184	131
1:00 PM	2:00 PM	8	0	179	124
2:00 PM	3:00 PM	11	0	205	146
3:00 PM	4:00 PM	11	0	206	136
4:00 PM	5:00 PM	15	0	299	200
5:00 PM	6:00 PM	20	0	387	303
6:00 PM	7:00 PM	15	0	284	196
7:00 PM	8:00 PM	12	0	233	143
8:00 PM	9:00 PM	8	0	165	90
9:00 PM	10:00 PM	5	0	105	50
10:00 PM	11:00 PM	3	0	46	30
11:00 PM	12:00 AM	1	0	21	11

Warrant Summary

Warrant	Name	Analyzed?	Met?
#1	Eight-Hour Vehicular Volume	Yes	No
#2	Four-Hour Vehicular volume	Yes	No
#3	Peak Hour	Yes	No
#4	Pedestrian Volume	No	-
#5	School Crossing	No	-
#6	Coordinated Signal System	No	-
#7	Crash Experience	No	-
#8	Roadway Network	No	-

Input Parameters

Volume Adjustment Factor =	1.0
North-South Approach =	Minor
East-West Approach =	Major
Major Street Thru Lanes =	1
Minor Street Thru Lanes =	0
Speed > 40 mph?	Yes
Population < 10,000?	No
Warrant Factor	70%
Peak Hour or Daily Count?	Daily

Warrant #1 Eight-Hour Analysis Summary

Warrant Factor	Condition	Major Street Requirement	Minor Street Requirement	Hours That Condition Is Met	Threshold	Condition for Warrant Factor Met?
100%	A	500	200	0	8	No
	B	750	100	0	8	No
80%	A	400	160	0	8	No
	B	600	80	0	8	No
70%	A	350	140	0	8	No
	B	525	70	0	8	No

HCM Unsignalized Intersection Capacity Analysis
 16: Francistown Road & SR157 & Springfield Road

Year 2036 Alternative 2
 Weekday PM

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	42	279	71	290	248	172	37	48	266	104	33	18
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	46	303	77	315	270	187	40	52	289	113	36	20
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage (veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	457			380			1464	1520	342	1742	1465	363
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	457			380			1464	1520	342	1742	1465	363
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	96			73			28	36	58	0	60	97
cM capacity (veh/h)	1104			1173			56	82	694	15	90	682
Direction, Lane #	EB 1	WB 1	NB 1	SB 1								
Volume Total	426	772	382	168								
Volume Left	46	315	40	113								
Volume Right	77	187	289	20								
cSH	1104	1173	215	22								
Volume to Capacity	0.04	0.27	1.78	7.74								
Queue Length 95th (ft)	3	27	657	Err								
Control Delay (s)	1.3	5.8	405.4	Err								
Lane LOS	A	A	F	F								
Approach Delay (s)	1.3	5.8	405.4	Err								
Approach LOS			F	F								
Intersection Summary												
Average Delay			1055.2									
Intersection Capacity Utilization			103.8%		ICU Level of Service				G			
Analysis Period (min)			15									

HCM Unsignalized Intersection Capacity Analysis
 16: Francistown Road & SR157 & Springfield Road

Year 2036 Alternative 2
 Weekday PM

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	42	279	71	290	248	172	37	48	266	104	33	18
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	46	303	77	315	270	187	40	52	289	113	36	20
Direction, Lane #	EB 1	WB 1	NB 1	SB 1								
Volume Total (vph)	426	772	382	168								
Volume Left (vph)	46	315	40	113								
Volume Right (vph)	77	187	289	20								
Hadj (s)	-0.05	-0.02	-0.35	0.10								
Departure Headway (s)	7.5	7.5	7.5	8.9								
Degree Utilization, x	0.89	1.61	0.80	0.42								
Capacity (veh/h)	461	482	466	366								
Control Delay (s)	46.1	303.0	33.8	18.1								
Approach Delay (s)	46.1	303.0	33.8	18.1								
Approach LOS	E	F	D	C								
Intersection Summary												
Delay			154.1									
HCM Level of Service			F									
Intersection Capacity Utilization			103.8%	ICU Level of Service	G							
Analysis Period (min)			15									

Queues
16: Francistown Road & SR157 & Springfield Road

Year 2036 Alternative 2
Weekday PM

								
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	46	380	315	457	40	341	113	56
v/c Ratio	0.15	0.82	0.75	0.60	0.07	0.47	0.33	0.08
Control Delay	13.6	44.9	27.5	21.1	18.1	8.2	20.9	17.6
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	13.6	44.9	27.5	21.1	18.1	8.2	20.9	17.6
Queue Length 50th (ft)	13	194	108	181	13	22	38	14
Queue Length 95th (ft)	26	284	166	248	36	99	82	45
Internal Link Dist (ft)		4251		1531		547		478
Turn Bay Length (ft)	150		150					
Base Capacity (vph)	309	553	467	841	550	727	343	673
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.15	0.69	0.67	0.54	0.07	0.47	0.33	0.08
Intersection Summary								

HCM Signalized Intersection Capacity Analysis
 16: Francistown Road & SR157 & Springfield Road

Year 2036 Alternative 2

Weekday PM

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	42	279	71	290	248	172	37	48	266	104	33	18
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Fr _t	1.00	0.97		1.00	0.94		1.00	0.87		1.00	0.95	
Fl _t Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1806		1752	1741		1770	1579		1770	1763	
Fl _t Permitted	0.49	1.00		0.20	1.00		0.72	1.00		0.32	1.00	
Satd. Flow (perm)	919	1806		372	1741		1342	1579		599	1763	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	46	303	77	315	270	187	40	52	289	113	36	20
RTOR Reduction (vph)	0	11	0	0	30	0	0	199	0	0	13	0
Lane Group Flow (vph)	46	369	0	315	427	0	40	142	0	113	43	0
Heavy Vehicles (%)	2%	2%	2%	3%	2%	3%	2%	5%	5%	2%	2%	2%
Turn Type	pm+pt	NA		pm+pt	NA		pm+pt	NA		pm+pt	NA	
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	26.6	24.2		44.1	37.7		31.5	28.1		36.3	30.5	
Effective Green, g (s)	26.6	24.2		44.1	37.7		31.5	28.1		36.3	30.5	
Actuated g/C Ratio	0.30	0.27		0.49	0.42		0.35	0.31		0.40	0.34	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	294	486		426	729		486	493		317	597	
v/s Ratio Prot	0.00	0.20		c0.13	0.25		0.00	0.09		c0.02	0.02	
v/s Ratio Perm	0.04			c0.23			0.03			c0.12		
v/c Ratio	0.16	0.76		0.74	0.59		0.08	0.29		0.36	0.07	
Uniform Delay, d ₁	22.9	30.2		16.8	20.1		19.5	23.4		18.1	20.2	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d ₂	0.2	6.7		6.6	1.2		0.1	1.5		0.7	0.2	
Delay (s)	23.2	36.9		23.4	21.3		19.5	24.9		18.8	20.4	
Level of Service	C	D		C	C		B	C		B	C	
Approach Delay (s)		35.5			22.2			24.3			19.4	
Approach LOS		D			C			C			B	

Intersection Summary

HCM Average Control Delay	25.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.57		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	73.1%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

HCM Unsignalized Intersection Capacity Analysis
 18: Linsey Lakes Drive & Springfield Road & SR157

Year 2036 Alternative 2
 Weekday PM

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	277	345	5	21	258	24	7	1	12	35	2	171
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	301	375	5	23	280	26	8	1	13	38	2	186
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage (veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	307			380			1506	1332	378	1333	1322	293
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	307			380			1506	1332	378	1333	1322	293
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	76			98			87	99	98	63	98	75
cM capacity (veh/h)	1254			1178			59	115	669	103	117	746
Direction, Lane #	EB 1	WB 1	NB 1	SB 1								
Volume Total	682	329	22	226								
Volume Left	301	23	8	38								
Volume Right	5	26	13	186								
cSH	1254	1178	138	354								
Volume to Capacity	0.24	0.02	0.16	0.64								
Queue Length 95th (ft)	24	1	14	105								
Control Delay (s)	5.4	0.7	35.9	31.5								
Lane LOS	A	A	E	D								
Approach Delay (s)	5.4	0.7	35.9	31.5								
Approach LOS			E	D								
Intersection Summary												
Average Delay			9.4									
Intersection Capacity Utilization			73.9%		ICU Level of Service					D		
Analysis Period (min)			15									

HCM Unsignalized Intersection Capacity Analysis
 18: Linsey Lakes Drive & Springfield Road & SR157

Year 2036 Alternative 2
 Weekday PM

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	277	345	5	21	258	24	7	1	12	35	2	171
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	301	375	5	23	280	26	8	1	13	38	2	186
Direction, Lane #	EB 1	WB 1	NB 1	SB 1								
Volume Total (vph)	682	329	22	226								
Volume Left (vph)	301	23	8	38								
Volume Right (vph)	5	26	13	186								
Hadj (s)	0.12	0.00	-0.26	-0.43								
Departure Headway (s)	5.4	5.7	6.9	6.1								
Degree Utilization, x	1.02	0.52	0.04	0.38								
Capacity (veh/h)	666	621	460	568								
Control Delay (s)	61.6	14.6	10.2	12.7								
Approach Delay (s)	61.6	14.6	10.2	12.7								
Approach LOS	F	B	B	B								
Intersection Summary												
Delay			39.6									
HCM Level of Service			E									
Intersection Capacity Utilization			73.9%	ICU Level of Service	D							
Analysis Period (min)			15									

Queues
 18: Linsey Lakes Drive & Springfield Road & SR157

Year 2036 Alternative 2
 Weekday PM

						
Lane Group	EBL	EBT	WBL	WBT	NBT	SBT
Lane Group Flow (vph)	301	380	23	306	22	226
v/c Ratio	0.66	0.39	0.16	0.67	0.12	0.60
Control Delay	30.3	11.8	36.9	30.7	23.9	15.5
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	30.3	11.8	36.9	30.7	23.9	15.5
Queue Length 50th (ft)	97	63	8	97	3	14
Queue Length 95th (ft)	224	192	37	230	27	84
Internal Link Dist (ft)		697		4251	393	320
Turn Bay Length (ft)	200		200			
Base Capacity (vph)	733	1324	147	704	317	548
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.41	0.29	0.16	0.43	0.07	0.41
Intersection Summary						

HCM Signalized Intersection Capacity Analysis
 18: Linsey Lakes Drive & Springfield Road & SR157

Year 2036 Alternative 2
 Weekday PM

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	277	345	5	21	258	24	7	1	12	35	2	171
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00			1.00			1.00	
Fr _t	1.00	1.00		1.00	0.99			0.92			0.89	
Fl _t Protected	0.95	1.00		0.95	1.00			0.98			0.99	
Satd. Flow (prot)	1770	1859		1770	1839			1684			1642	
Fl _t Permitted	0.95	1.00		0.95	1.00			0.98			0.99	
Satd. Flow (perm)	1770	1859		1770	1839			1684			1642	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	301	375	5	23	280	26	8	1	13	38	2	186
RTOR Reduction (vph)	0	0	0	0	4	0	0	12	0	0	162	0
Lane Group Flow (vph)	301	380	0	23	302	0	0	10	0	0	64	0
Turn Type	Prot	NA		Prot	NA		Split	NA		Split	NA	
Protected Phases	7	4		3	8		2	2		6	6	
Permitted Phases												
Actuated Green, G (s)	16.3	33.3		1.6	18.6			6.4			8.3	
Effective Green, g (s)	16.3	33.3		1.6	18.6			6.4			8.3	
Actuated g/C Ratio	0.25	0.51		0.02	0.28			0.10			0.13	
Clearance Time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0			3.0			3.0	
Lane Grp Cap (vph)	440	944		43	521			164			208	
v/s Ratio Prot	c0.17	0.20		0.01	c0.16			c0.01			c0.04	
v/s Ratio Perm												
v/c Ratio	0.68	0.40		0.53	0.58			0.06			0.31	
Uniform Delay, d ₁	22.3	10.0		31.6	20.2			26.9			26.0	
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	
Incremental Delay, d ₂	4.4	0.3		12.2	1.6			0.2			0.8	
Delay (s)	26.7	10.3		43.8	21.8			27.0			26.9	
Level of Service	C	B		D	C			C			C	
Approach Delay (s)		17.5			23.3			27.0			26.9	
Approach LOS		B			C			C			C	
Intersection Summary												
HCM Average Control Delay			20.9			HCM Level of Service				C		
HCM Volume to Capacity ratio			0.50									
Actuated Cycle Length (s)			65.6			Sum of lost time (s)			16.0			
Intersection Capacity Utilization			54.3%			ICU Level of Service			A			
Analysis Period (min)			15									
c Critical Lane Group												

HCM Unsignalized Intersection Capacity Analysis
7: Springfield Road & Wintergreen Road

Year 2036 Alternative 2
Weekday PM

						
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	0	45	26	276	163	71
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	49	28	300	177	77
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	572	216	254			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	572	216	254			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	94	98			
cM capacity (veh/h)	471	824	1311			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	49	328	254			
Volume Left	0	28	0			
Volume Right	49	0	77			
cSH	824	1311	1700			
Volume to Capacity	0.06	0.02	0.15			
Queue Length 95th (ft)	5	2	0			
Control Delay (s)	9.6	0.9	0.0			
Lane LOS	A	A				
Approach Delay (s)	9.6	0.9	0.0			
Approach LOS	A					
Intersection Summary						
Average Delay			1.2			
Intersection Capacity Utilization		42.2%		ICU Level of Service		A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
 20: Linsey Lakes Drive & SR157

Year 2036 Alternative 2 - Option B
 Weekday PM



Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑	↑	↑	↑	↑	↑
Volume (veh/h)	380	7	21	282	8	12
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	413	8	23	307	9	13
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None		None			
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			421		765	413
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			421		765	413
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			98		98	98
cM capacity (veh/h)			1138		364	639
Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	
Volume Total	413	8	23	307	22	
Volume Left	0	0	23	0	9	
Volume Right	0	8	0	0	13	
cSH	1700	1700	1138	1700	491	
Volume to Capacity	0.24	0.00	0.02	0.18	0.04	
Queue Length 95th (ft)	0	0	2	0	3	
Control Delay (s)	0.0	0.0	8.2	0.0	12.7	
Lane LOS			A			B
Approach Delay (s)	0.0		0.6			12.7
Approach LOS						B
Intersection Summary						
Average Delay			0.6			
Intersection Capacity Utilization			30.0%	ICU Level of Service	A	
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
 29: SR157 & Springfield Rd

Year 2036 Alternative 2 - Option B
 Weekday PM



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations	↶	↷	↷	↶	↶	↶
Volume (veh/h)	277	350	265	25	37	171
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	301	380	288	27	40	186
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	315				1271	288
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	315				1271	288
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	76				71	75
cM capacity (veh/h)	1245				141	751
Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1	
Volume Total	301	380	288	27	226	
Volume Left	301	0	0	0	40	
Volume Right	0	0	0	27	186	
cSH	1245	1700	1700	1700	424	
Volume to Capacity	0.24	0.22	0.17	0.02	0.53	
Queue Length 95th (ft)	24	0	0	0	76	
Control Delay (s)	8.8	0.0	0.0	0.0	22.8	
Lane LOS	A				C	
Approach Delay (s)	3.9		0.0		22.8	
Approach LOS					C	
Intersection Summary						
Average Delay			6.4			
Intersection Capacity Utilization			51.9%		ICU Level of Service	A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
 29: SR157 & Springfield Rd

Year 2036 Alternative 2 - Option B
 Weekday PM



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations	↵	↑	↑	↵	↵	
Sign Control		Stop	Stop		Stop	
Volume (vph)	277	350	265	25	37	171
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	301	380	288	27	40	186
Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1	
Volume Total (vph)	301	380	288	27	226	
Volume Left (vph)	301	0	0	0	40	
Volume Right (vph)	0	0	0	27	186	
Hadj (s)	0.53	0.03	0.03	-0.67	-0.42	
Departure Headway (s)	6.2	5.7	6.1	5.4	5.6	
Degree Utilization, x	0.52	0.60	0.49	0.04	0.35	
Capacity (veh/h)	569	625	568	630	587	
Control Delay (s)	14.3	15.5	13.7	7.4	11.7	
Approach Delay (s)	15.0		13.1		11.7	
Approach LOS	B		B		B	
Intersection Summary						
Delay			13.9			
HCM Level of Service			B			
Intersection Capacity Utilization			51.9%	ICU Level of Service	A	
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
 20: Linsey Lakes Drive & SR157

Year 2036 Alternative 2 - Option C
 Weekday PM



Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑	↗	↖	↑	↖	↗
Volume (veh/h)	380	7	21	282	8	12
Sign Control	Free		Free		Stop	
Grade	0%		0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	413	8	23	307	9	13
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	TWLTL		None			
Median storage (veh)	2					
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			421		765	413
vC1, stage 1 conf vol					413	
vC2, stage 2 conf vol					352	
vCu, unblocked vol			421		765	413
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)					5.4	
tF (s)			2.2		3.5	3.3
p0 queue free %			98		98	98
cM capacity (veh/h)			1138		562	639
Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2
Volume Total	413	8	23	307	9	13
Volume Left	0	0	23	0	9	0
Volume Right	0	8	0	0	0	13
cSH	1700	1700	1138	1700	562	639
Volume to Capacity	0.24	0.00	0.02	0.18	0.02	0.02
Queue Length 95th (ft)	0	0	2	0	1	2
Control Delay (s)	0.0	0.0	8.2	0.0	11.5	10.8
Lane LOS			A		B	B
Approach Delay (s)	0.0		0.6		11.1	
Approach LOS					B	
Intersection Summary						
Average Delay			0.6			
Intersection Capacity Utilization			30.0%	ICU Level of Service	A	
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
7: Springfield Road & Wintergreen Road/SR157

Year 2036 Alternative 2 - Option C
Weekday PM

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	26	19	265	1	24	25	252	350	11	152	71
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	0	28	20	282	1	26	27	268	372	12	162	76
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage (veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	570	916	199	578	582	268	237			640		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	570	916	199	578	582	268	237			640		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	90	98	25	100	97	98			99		
cM capacity (veh/h)	408	264	844	374	411	771	1318			944		
Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1							
Volume Total	48	309	295	372	249							
Volume Left	0	282	27	0	12							
Volume Right	20	26	0	372	76							
cSH	372	391	1318	1700	944							
Volume to Capacity	0.13	0.79	0.02	0.22	0.01							
Queue Length 95th (ft)	11	170	2	0	1							
Control Delay (s)	16.1	41.1	0.9	0.0	0.5							
Lane LOS	C	E	A		A							
Approach Delay (s)	16.1	41.1	0.4		0.5							
Approach LOS	C	E										
Intersection Summary												
Average Delay				10.9								
Intersection Capacity Utilization			51.9%		ICU Level of Service					A		
Analysis Period (min)			15									

HCM Unsignalized Intersection Capacity Analysis
 7: Springfield Road & Wintergreen Road/SR157

Year 2036 Alternative 2 - Option C
 Weekday PM

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	0	26	19	265	1	24	25	252	350	11	152	71
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	0	28	20	282	1	26	27	268	372	12	162	76
Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1							
Volume Total (vph)	48	309	295	372	249							
Volume Left (vph)	0	282	27	0	12							
Volume Right (vph)	20	26	0	372	76							
Hadj (s)	-0.24	0.17	0.11	-0.63	-0.14							
Departure Headway (s)	6.6	6.3	6.2	5.4	5.9							
Degree Utilization, x	0.09	0.54	0.51	0.56	0.41							
Capacity (veh/h)	450	543	557	643	572							
Control Delay (s)	10.2	16.3	14.2	14.0	13.0							
Approach Delay (s)	10.2	16.3	14.1		13.0							
Approach LOS	B	C	B		B							
Intersection Summary												
Delay			14.2									
HCM Level of Service			B									
Intersection Capacity Utilization			51.9%	ICU Level of Service	A							
Analysis Period (min)			15									

Queues
7: Springfield Road & Wintergreen Road/SR157

Year 2036 Alternative 2 - Option C
Weekday PM

	→	←	↑	↘	↓
Lane Group	EBT	WBT	NBT	NBR	SBT
Lane Group Flow (vph)	48	309	295	372	250
v/c Ratio	0.33	0.64	0.56	0.52	0.63
Control Delay	33.5	36.3	32.1	5.7	37.6
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	33.5	36.3	32.1	5.7	37.6
Queue Length 50th (ft)	15	154	142	0	119
Queue Length 95th (ft)	50	243	225	64	199
Internal Link Dist (ft)	116	367	666		810
Turn Bay Length (ft)				325	
Base Capacity (vph)	145	484	525	713	394
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.33	0.64	0.56	0.52	0.63
Intersection Summary					

HCM Signalized Intersection Capacity Analysis
7: Springfield Road & Wintergreen Road/SR157

Year 2036 Alternative 2 - Option C
Weekday PM

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	26	19	265	1	24	25	252	350	11	152	71
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	12	14	12	12	14	12	12	12	12	12	12	12
Total Lost time (s)		4.0			4.0			4.0	4.0		4.0	
Lane Util. Factor		1.00			1.00			1.00	1.00		1.00	
Flt		0.94			0.99			1.00	0.85		0.96	
Flt Protected		1.00			0.96			1.00	1.00		1.00	
Satd. Flow (prot)		1894			1879			1819	1553		1782	
Flt Permitted		1.00			0.96			1.00	1.00		1.00	
Satd. Flow (perm)		1894			1879			1819	1553		1782	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	28	20	282	1	26	27	268	372	12	162	76
RTOR Reduction (vph)	0	19	0	0	4	0	0	0	265	0	17	0
Lane Group Flow (vph)	0	29	0	0	305	0	0	295	107	0	233	0
Heavy Vehicles (%)	1%	1%	1%	2%	2%	2%	4%	4%	4%	2%	2%	2%
Turn Type	Split	NA		Split	NA		Split	NA	Perm	Split	NA	
Protected Phases	4	4		8	8		2	2		6	6	
Permitted Phases									2			
Actuated Green, G (s)		6.0			23.0			26.0	26.0		19.0	
Effective Green, g (s)		6.0			23.0			26.0	26.0		19.0	
Actuated g/C Ratio		0.07			0.26			0.29	0.29		0.21	
Clearance Time (s)		4.0			4.0			4.0	4.0		4.0	
Lane Grp Cap (vph)		126			480			525	449		376	
v/s Ratio Prot		c0.02			c0.16			c0.16			c0.13	
v/s Ratio Perm									0.07			
v/c Ratio		0.23			0.64			0.56	0.24		0.62	
Uniform Delay, d1		39.8			29.8			27.2	24.4		32.2	
Progression Factor		1.00			1.00			1.00	1.00		1.00	
Incremental Delay, d2		4.3			6.3			4.3	1.3		7.4	
Delay (s)		44.1			36.1			31.5	25.7		39.7	
Level of Service		D			D			C	C		D	
Approach Delay (s)		44.1			36.1			28.3			39.7	
Approach LOS		D			D			C			D	
Intersection Summary												
HCM Average Control Delay			33.0			HCM Level of Service			C			
HCM Volume to Capacity ratio			0.57									
Actuated Cycle Length (s)			90.0			Sum of lost time (s)			16.0			
Intersection Capacity Utilization			51.9%			ICU Level of Service			A			
Analysis Period (min)			15									

c Critical Lane Group

MOVEMENT SUMMARY

Site: 2036 Alt 1 AM Francistown

Springfield Road/Francistown Road
 Year 2036 Alternative 1
 Weekday PM Peak Hour
 Roundabout

Movement Performance - Vehicles											
Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance ft	Prop. Queued	Effective Stop Rate per veh	Average Speed mph
South: Francistown Road (Northbound)											
8	T	128	1.0	0.609	14.8	LOS B	4.1	104.0	0.69	0.87	25.1
18	R	341	1.0	0.609	14.8	LOS B	4.1	104.0	0.69	0.90	24.9
Approach		469	1.0	0.609	14.8	LOS B	4.1	104.0	0.69	0.89	25.0
East: Springfield Road (Westbound)											
1	L	269	1.0	0.734	16.7	LOS C	7.2	180.5	0.64	0.74	22.6
16	R	453	1.0	0.734	16.7	LOS C	7.2	180.5	0.64	0.62	23.8
Approach		722	1.0	0.734	16.7	LOS C	7.2	180.5	0.64	0.67	23.3
North: Springfield Road (Southbound)											
7	L	371	1.0	0.583	12.9	LOS B	3.9	97.5	0.61	0.87	24.0
4	T	126	1.0	0.583	12.9	LOS B	3.9	97.5	0.61	0.71	25.7
Approach		497	1.0	0.583	12.9	LOS B	3.9	97.5	0.61	0.83	24.4
All Vehicles		1687	1.0	0.734	15.0	LOS C	7.2	180.5	0.64	0.78	24.1

Level of Service (LOS) Method: Delay & v/c (HCM 2010).

Roundabout LOS Method: Same as Sign Control.

Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement

LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).

Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 2010).

Roundabout Capacity Model: US HCM 2010.

HCM Delay Model used.

Processed: Thursday, July 12, 2012 3:29:57 PM

SIDRA INTERSECTION 5.1.5.2006

Project: H:\profile\11764 - Central Region VDOT On-Call\Task Orders\Task 04 (12-023) - Springfield Road Route

157 Alt Analysis\sidra\11764 4 Roundabout Analysis.sjp

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MOVEMENT SUMMARY

Site: 2036 Alt 1 PM Francistown

Springfield Road/Francistown Road
 Year 2036 Alternative 1
 Weekday PM Peak Hour
 Roundabout

Movement Performance - Vehicles											
Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Queue Distance ft	Prop. Queued	Effective Stop Rate per veh	Average Speed mph
South: Francistown Road (Northbound)											
8	T	70	1.0	0.511	13.1	LOS B	2.8	69.7	0.66	0.84	25.9
18	R	285	1.0	0.511	13.1	LOS B	2.8	69.7	0.66	0.88	25.7
Approach		355	1.0	0.511	13.1	LOS B	2.8	69.7	0.66	0.87	25.7
East: Springfield Road (Westbound)											
1	L	312	1.0	0.670	13.5	LOS B	5.8	147.1	0.43	0.69	23.7
16	R	387	1.0	0.670	13.5	LOS B	5.8	147.1	0.43	0.51	25.3
Approach		699	1.0	0.670	13.5	LOS B	5.8	147.1	0.43	0.59	24.5
North: Springfield Road (Southbound)											
7	L	473	1.0	0.751	20.2	LOS C	7.3	185.1	0.81	1.02	21.4
4	T	140	1.0	0.751	20.2	LOS C	7.3	185.1	0.81	0.94	22.5
Approach		613	1.0	0.751	20.2	LOS C	7.3	185.1	0.81	1.00	21.7
All Vehicles		1667	1.0	0.751	15.9	LOS C	7.3	185.1	0.62	0.80	23.6

Level of Service (LOS) Method: Delay & v/c (HCM 2010).

Roundabout LOS Method: Same as Sign Control.

Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement

LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).

Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 2010).

Roundabout Capacity Model: US HCM 2010.

HCM Delay Model used.

Processed: Thursday, July 12, 2012 11:57:54 AM

SIDRA INTERSECTION 5.1.5.2006

Project: H:\profile\11764 - Central Region VDOT On-Call\Task Orders\Task 04 (12-023) - Springfield Road Route

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MOVEMENT SUMMARY

Site: 2036 Alt 2 AM Francistown

Springfield Road/Francistown Road
 Year 2036 Alternative 2
 Weekday PM Peak Hour
 Roundabout

Movement Performance - Vehicles											
Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance ft	Prop. Queued	Effective Stop Rate per veh	Average Speed mph
South: Francistown Road (Northbound)											
3	L	85	3.0	0.607	14.9	LOS B	4.0	102.0	0.69	1.01	23.4
8	T	39	1.0	0.607	14.9	LOS B	4.0	102.0	0.69	0.87	24.9
18	R	334	1.0	0.607	14.9	LOS B	4.0	102.0	0.69	0.90	24.7
Approach		458	1.4	0.607	14.9	LOS B	4.0	102.0	0.69	0.92	24.4
East: Springfield Road (Westbound)											
1	L	263	1.0	0.734	17.0	LOS C	7.3	184.9	0.67	0.80	22.6
6	T	301	1.0	0.734	17.0	LOS C	7.3	184.9	0.67	0.64	24.0
16	R	141	1.0	0.734	17.0	LOS C	7.3	184.9	0.67	0.68	23.8
Approach		705	1.0	0.734	17.0	LOS C	7.3	184.9	0.67	0.71	23.4
North: Springfield Road (Southbound)											
7	L	114	1.0	0.367	11.6	LOS B	1.5	38.1	0.64	0.95	24.5
4	T	53	1.0	0.367	11.6	LOS B	1.5	38.1	0.64	0.80	26.4
14	R	45	3.0	0.367	11.6	LOS B	1.5	38.1	0.64	0.84	26.1
Approach		212	1.4	0.367	11.6	LOS B	1.5	38.1	0.64	0.89	25.3
West: RoadName											
5	L	24	1.0	0.417	9.5	LOS A	1.5	38.1	0.46	0.98	25.6
2	T	249	1.0	0.417	9.5	LOS A	1.5	38.1	0.46	0.70	27.9
12	R	71	1.0	0.417	9.5	LOS A	1.5	38.1	0.46	0.76	27.6
Approach		344	1.0	0.417	9.5	LOS A	1.5	38.1	0.46	0.73	27.7
All Vehicles		1719	1.2	0.734	14.3	LOS B	7.3	184.9	0.63	0.79	24.7

Level of Service (LOS) Method: Delay & v/c (HCM 2010).

Roundabout LOS Method: Same as Sign Control.

Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement

LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).

Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 2010).

Roundabout Capacity Model: US HCM 2010.

HCM Delay Model used.

MOVEMENT SUMMARY

Site: 2036 Alt 2 OptA AM Linsey Lakes

SR157/Linsey Lakes Dr
 Year 2036 Alternative 2 Option A
 Weekday PM Peak Hour
 Roundabout

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance ft	Prop. Queued	Effective Stop Rate per veh	Average Speed mph	
South: Linsey Lakes (Northbound)												
3	L	15	1.0	0.070	5.7	LOS A	0.2	6.0	0.45	0.83	27.2	
8	T	1	1.0	0.070	5.7	LOS A	0.2	6.0	0.45	0.59	30.0	
18	R	35	1.0	0.070	5.7	LOS A	0.2	6.0	0.45	0.65	29.6	
Approach		51	1.0	0.070	5.7	LOS A	0.2	6.0	0.45	0.70	28.8	
East: SR 157 (Westbound)												
1	L	21	1.0	0.444	8.9	LOS A	2.4	59.9	0.39	0.86	25.8	
6	T	383	1.0	0.444	8.9	LOS A	2.4	59.9	0.39	0.52	28.4	
16	R	27	1.0	0.444	8.9	LOS A	2.4	59.9	0.39	0.59	28.0	
Approach		432	1.0	0.444	8.9	LOS A	2.4	59.9	0.39	0.55	28.2	
North: Springfield Road (Southbound)												
7	L	99	1.0	0.382	9.8	LOS A	1.7	42.3	0.57	0.92	25.3	
4	T	1	1.0	0.382	9.8	LOS A	1.7	42.3	0.57	0.73	27.4	
14	R	180	1.0	0.382	9.8	LOS A	1.7	42.3	0.57	0.77	27.1	
Approach		280	1.0	0.382	9.8	LOS A	1.7	42.3	0.57	0.83	26.4	
West: SR 157 (Eastbound)												
5	L	124	1.0	0.329	6.9	LOS A	1.1	27.9	0.23	0.82	26.5	
2	T	211	1.0	0.329	6.9	LOS A	1.1	27.9	0.23	0.45	29.5	
12	R	3	1.0	0.329	6.9	LOS A	1.1	27.9	0.23	0.53	29.0	
Approach		338	1.0	0.329	6.9	LOS A	1.1	27.9	0.23	0.59	28.3	
All Vehicles		1100	1.0	0.444	8.3	LOS A	2.4	59.9	0.39	0.64	27.8	

Level of Service (LOS) Method: Delay & v/c (HCM 2010).

Roundabout LOS Method: Same as Sign Control.

Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement

LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).

Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 2010).

Roundabout Capacity Model: US HCM 2010.

HCM Delay Model used.

MOVEMENT SUMMARY

Site: 2036 Alt 2 PM Francistown

Springfield Road/Francistown Road
 Year 2036 Alternative 2
 Weekday PM Peak Hour
 Roundabout

Movement Performance - Vehicles											
Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance ft	Prop. Queued	Effective Stop Rate per veh	Average Speed mph
South: Francistown Road (Northbound)											
3	L	39	3.0	0.521	13.0	LOS B	2.9	72.6	0.65	1.00	24.1
8	T	51	1.0	0.521	13.0	LOS B	2.9	72.6	0.65	0.84	25.8
18	R	280	1.0	0.521	13.0	LOS B	2.9	72.6	0.65	0.87	25.6
Approach		369	1.2	0.521	13.0	LOS B	2.9	72.6	0.65	0.88	25.5
East: Springfield Road (Westbound)											
1	L	305	1.0	0.765	18.4	LOS C	8.5	213.3	0.70	0.77	22.1
6	T	261	1.0	0.765	18.4	LOS C	8.5	213.3	0.70	0.63	23.4
16	R	181	1.0	0.765	18.4	LOS C	8.5	213.3	0.70	0.66	23.2
Approach		747	1.0	0.765	18.4	LOS C	8.5	213.3	0.70	0.69	22.8
North: Springfield Road (Southbound)											
7	L	129	1.0	0.311	10.2	LOS B	1.2	30.1	0.60	0.92	25.1
4	T	40	1.0	0.311	10.2	LOS B	1.2	30.1	0.60	0.76	27.1
14	R	19	3.0	0.311	10.2	LOS B	1.2	30.1	0.60	0.80	26.8
Approach		188	1.2	0.311	10.2	LOS B	1.2	30.1	0.60	0.87	25.6
West: RoadName											
5	L	44	1.0	0.484	11.1	LOS B	2.0	49.6	0.51	1.00	24.9
2	T	275	1.0	0.484	11.1	LOS B	2.0	49.6	0.51	0.74	27.0
12	R	68	1.0	0.484	11.1	LOS B	2.0	49.6	0.51	0.80	26.7
Approach		387	1.0	0.484	11.1	LOS B	2.0	49.6	0.51	0.78	26.7
All Vehicles		1693	1.1	0.765	14.6	LOS B	8.5	213.3	0.64	0.77	24.5

Level of Service (LOS) Method: Delay & v/c (HCM 2010).

Roundabout LOS Method: Same as Sign Control.

Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement

LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).

Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 2010).

Roundabout Capacity Model: US HCM 2010.

HCM Delay Model used.

MOVEMENT SUMMARY

Site: 2036 Alt 2 OptA PM Linsey Lakes

SR157/Linsey Lakes Dr
 Year 2036 Alternative 2 Option A
 Weekday PM Peak Hour
 Roundabout

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance ft	Prop. Queued	Effective Stop Rate per veh	Average Speed mph	
South: Linsey Lakes (Northbound)												
3	L	7	1.0	0.037	6.7	LOS A	0.1	3.0	0.53	0.87	26.7	
8	T	1	1.0	0.037	6.7	LOS A	0.1	3.0	0.53	0.66	29.3	
18	R	13	1.0	0.037	6.7	LOS A	0.1	3.0	0.53	0.71	28.9	
Approach		21	1.0	0.037	6.7	LOS A	0.1	3.0	0.53	0.76	28.1	
East: SR 157 (Westbound)												
1	L	22	1.0	0.386	9.0	LOS A	1.8	44.2	0.51	0.92	25.9	
6	T	272	1.0	0.386	9.0	LOS A	1.8	44.2	0.51	0.65	28.3	
16	R	25	1.0	0.386	9.0	LOS A	1.8	44.2	0.51	0.71	27.9	
Approach		319	1.0	0.386	9.0	LOS A	1.8	44.2	0.51	0.68	28.0	
North: Springfield Road (Southbound)												
7	L	12	1.0	0.235	6.9	LOS A	0.9	23.3	0.44	0.85	26.6	
4	T	2	1.0	0.235	6.9	LOS A	0.9	23.3	0.44	0.59	29.4	
14	R	180	1.0	0.235	6.9	LOS A	0.9	23.3	0.44	0.65	28.9	
Approach		194	1.0	0.235	6.9	LOS A	0.9	23.3	0.44	0.66	28.8	
West: SR 157 (Eastbound)												
5	L	292	1.0	0.605	11.2	LOS B	3.4	85.9	0.19	0.78	24.6	
2	T	363	1.0	0.605	11.2	LOS B	3.4	85.9	0.19	0.40	27.0	
12	R	5	1.0	0.605	11.2	LOS B	3.4	85.9	0.19	0.48	26.5	
Approach		660	1.0	0.605	11.2	LOS B	3.4	85.9	0.19	0.57	25.8	
All Vehicles		1194	1.0	0.605	9.9	LOS A	3.4	85.9	0.32	0.62	26.9	

Level of Service (LOS) Method: Delay & v/c (HCM 2010).

Roundabout LOS Method: Same as Sign Control.

Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement

LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).

Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 2010).

Roundabout Capacity Model: US HCM 2010.

HCM Delay Model used.

Appendix L
Alternative 2
Level of Service Worksheets

Queues
1: Nuckols Road & Springfield Road

Year 2036 Alternative 2
Weekday AM



Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Group Flow (vph)	186	411	1021	156	399	544
v/c Ratio	0.25	0.45	0.90	0.13	0.80	0.79
Control Delay	27.7	4.2	40.6	7.6	48.1	16.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	27.7	4.2	40.6	7.6	48.1	16.0
Queue Length 50th (ft)	44	0	267	31	226	55
Queue Length 95th (ft)	65	35	#406	66	#430	169
Internal Link Dist (ft)	362			346	244	
Turn Bay Length (ft)	275	175	225			
Base Capacity (vph)	986	1088	1155	1225	498	774
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.19	0.38	0.88	0.13	0.80	0.70

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

HCM Signalized Intersection Capacity Analysis
1: Nuckols Road & Springfield Road

Year 2036 Alternative 2
Weekday AM



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	177	390	970	148	379	517
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	11	11	12	12	12	12
Total Lost time (s)	5.0	5.0	5.0	6.0	6.0	5.0
Lane Util. Factor	0.97	0.88	0.97	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	3286	2668	3467	1881	1863	1583
Flt Permitted	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (perm)	3286	2668	3467	1881	1863	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	186	411	1021	156	399	544
RTOR Reduction (vph)	0	318	0	0	0	330
Lane Group Flow (vph)	186	93	1021	156	399	214
Heavy Vehicles (%)	3%	3%	1%	1%	2%	2%
Turn Type		custom	Prot			Over
Protected Phases	3	3	5	2	6	3
Permitted Phases		3				
Actuated Green, G (s)	20.4	20.4	29.6	58.6	24.0	20.4
Effective Green, g (s)	20.4	20.4	29.6	58.6	24.0	20.4
Actuated g/C Ratio	0.23	0.23	0.33	0.65	0.27	0.23
Clearance Time (s)	5.0	5.0	5.0	6.0	6.0	5.0
Vehicle Extension (s)	5.0	5.0	3.0	6.0	6.0	5.0
Lane Grp Cap (vph)	745	605	1140	1225	497	359
v/s Ratio Prot	0.06	0.03	c0.29	0.08	c0.21	c0.14
v/s Ratio Perm						
v/c Ratio	0.25	0.15	0.90	0.13	0.80	0.60
Uniform Delay, d1	28.5	27.9	28.7	6.0	30.8	31.1
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.4	0.2	9.3	0.2	12.9	4.0
Delay (s)	28.9	28.1	38.0	6.2	43.7	35.1
Level of Service	C	C	D	A	D	D
Approach Delay (s)	28.4			33.8	38.7	
Approach LOS	C			C	D	

Intersection Summary			
HCM Average Control Delay	34.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	68.0%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

HCM Unsignalized Intersection Capacity Analysis
2: Fireside Drive & Springfield Road

Year 2036 Alternative 2

Weekday AM



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	80	20	303	22	1	816
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91
Hourly flow rate (vph)	88	22	333	24	1	897
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage (veh)						
Upstream signal (ft)			377			
pX, platoon unblocked						
vC, conflicting volume	796	179			357	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	796	179			357	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	73	97			100	
cM capacity (veh/h)	328	840			1198	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	110	222	135	1	448	448
Volume Left	88	0	0	1	0	0
Volume Right	22	0	24	0	0	0
cSH	374	1700	1700	1198	1700	1700
Volume to Capacity	0.29	0.13	0.08	0.00	0.26	0.26
Queue Length 95th (ft)	30	0	0	0	0	0
Control Delay (s)	18.6	0.0	0.0	8.0	0.0	0.0
Lane LOS	C			A		
Approach Delay (s)	18.6	0.0		0.0		
Approach LOS	C					

Intersection Summary						
Average Delay			1.5			
Intersection Capacity Utilization			34.9%		ICU Level of Service	A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
 3: Kingscroft Drive & Springfield Road

Year 2036 Alternative 2

Weekday AM



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↙		↑	↘		↘
Volume (veh/h)	72	18	296	27	1	745
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	83	21	340	31	1	856
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage (veh)						
Upstream signal (ft)			1118			
pX, platoon unblocked						
vC, conflicting volume	1199	340			371	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1199	340			371	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	60	97			100	
cM capacity (veh/h)	207	707			1187	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1
Volume Total	103	340	31	857
Volume Left	83	0	0	1
Volume Right	21	0	31	0
cSH	241	1700	1700	1187
Volume to Capacity	0.43	0.20	0.02	0.00
Queue Length 95th (ft)	51	0	0	0
Control Delay (s)	30.8	0.0	0.0	0.0
Lane LOS	D			A
Approach Delay (s)	30.8	0.0		0.0
Approach LOS	D			

Intersection Summary			
Average Delay		2.4	
Intersection Capacity Utilization		51.8%	ICU Level of Service A
Analysis Period (min)		15	

HCM Unsignalized Intersection Capacity Analysis

4: Wendhurst Drive & Springfield Road

Year 2036 Alternative 2
Weekday AM



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↶		↷	↷		↷
Volume (veh/h)	74	10	292	22	5	672
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.83	0.83	0.83	0.83	0.83	0.83
Hourly flow rate (vph)	89	12	352	27	6	810
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1173	352			378	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1173	352			378	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	58	98			99	
cM capacity (veh/h)	213	696			1186	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1
Volume Total	101	352	27	816
Volume Left	89	0	0	6
Volume Right	12	0	27	0
cSH	232	1700	1700	1186
Volume to Capacity	0.44	0.21	0.02	0.01
Queue Length 95th (ft)	51	0	0	0
Control Delay (s)	32.0	0.0	0.0	0.1
Lane LOS	D			A
Approach Delay (s)	32.0	0.0		0.1
Approach LOS	D			

Intersection Summary			
Average Delay		2.6	
Intersection Capacity Utilization		50.7%	ICU Level of Service A
Analysis Period (min)		15	

HCM Unsignalized Intersection Capacity Analysis
5: Jones Road & Springfield Road

Year 2036 Alternative 2
Weekday AM



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	5	5	2	300	672	5
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Hourly flow rate (vph)	6	6	2	333	747	6
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1087	749	752			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1087	749	752			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	98	99	100			
cM capacity (veh/h)	241	415	857			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	11	336	752			
Volume Left	6	2	0			
Volume Right	6	0	6			
cSH	305	857	1700			
Volume to Capacity	0.04	0.00	0.44			
Queue Length 95th (ft)	3	0	0			
Control Delay (s)	17.3	0.1	0.0			
Lane LOS	C	A				
Approach Delay (s)	17.3	0.1	0.0			
Approach LOS	C					
Intersection Summary						
Average Delay			0.2			
Intersection Capacity Utilization		45.7%		ICU Level of Service		A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
6: Olde Milbrooke Way & Springfield Road

Year 2036 Alternative 2

Weekday AM

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	5	0	5	22	0	23	3	293	9	3	650	12
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.89	0.89	0.89	0.89	0.92	0.89	0.92	0.89	0.92	0.92	0.92
Hourly flow rate (vph)	5	0	6	25	0	25	3	318	10	3	707	13
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage (veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1070	1055	713	1050	1051	318	720			329		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1070	1055	713	1050	1051	318	720			329		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	97	100	99	88	100	97	100			100		
cM capacity (veh/h)	191	226	435	203	227	722	882			1231		
Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1							
Volume Total	11	50	322	10	723							
Volume Left	5	25	3	0	3							
Volume Right	6	25	0	10	13							
cSH	267	318	882	1700	1231							
Volume to Capacity	0.04	0.16	0.00	0.01	0.00							
Queue Length 95th (ft)	3	14	0	0	0							
Control Delay (s)	19.1	18.4	0.1	0.0	0.1							
Lane LOS	C	C	A		A							
Approach Delay (s)	19.1	18.4	0.1		0.1							
Approach LOS	C	C										
Intersection Summary												
Average Delay			1.1									
Intersection Capacity Utilization			51.8%		ICU Level of Service				A			
Analysis Period (min)			15									

HCM Unsignalized Intersection Capacity Analysis
7: Wintergreen Road & Springfield Road

Year 2036 Alternative 2
Weekday AM



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	0	110	8	137	271	21
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	120	9	149	295	23
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	472	306	317			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	472	306	317			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	84	99			
cM capacity (veh/h)	546	734	1243			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	120	158	317			
Volume Left	0	9	0			
Volume Right	120	0	23			
cSH	734	1243	1700			
Volume to Capacity	0.16	0.01	0.19			
Queue Length 95th (ft)	14	1	0			
Control Delay (s)	10.9	0.5	0.0			
Lane LOS	B	A				
Approach Delay (s)	10.9	0.5	0.0			
Approach LOS	B					
Intersection Summary						
Average Delay			2.3			
Intersection Capacity Utilization		29.0%		ICU Level of Service		A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
8: Jacobs Creek Drive & Springfield Road

Year 2036 Alternative 2
Weekday AM



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	40	0	106	31	0	252
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	45	0	119	35	0	283
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	420	137			154	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	420	137			154	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	92	100			100	
cM capacity (veh/h)	594	917			1426	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	45	154	283
Volume Left	45	0	0
Volume Right	0	35	0
cSH	594	1700	1426
Volume to Capacity	0.08	0.09	0.00
Queue Length 95th (ft)	6	0	0
Control Delay (s)	11.6	0.0	0.0
Lane LOS	B		
Approach Delay (s)	11.6	0.0	0.0
Approach LOS	B		

Intersection Summary			
Average Delay		1.1	
Intersection Capacity Utilization		23.3%	ICU Level of Service A
Analysis Period (min)		15	

HCM Unsignalized Intersection Capacity Analysis
9: Wintercreek Drive & Springfield Road

Year 2036 Alternative 2
Weekday AM



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	34	51	29	77	201	0
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	39	58	33	88	228	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	382	228	228			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	382	228	228			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	94	93	98			
cM capacity (veh/h)	605	811	1340			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	97	120	228			
Volume Left	39	33	0			
Volume Right	58	0	0			
cSH	714	1340	1700			
Volume to Capacity	0.14	0.02	0.13			
Queue Length 95th (ft)	12	2	0			
Control Delay (s)	10.8	2.3	0.0			
Lane LOS	B	A				
Approach Delay (s)	10.8	2.3	0.0			
Approach LOS	B					
Intersection Summary						
Average Delay			3.0			
Intersection Capacity Utilization			31.3%		ICU Level of Service	A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
 10: Warnerwood Ct & Springfield Road

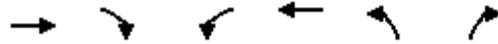
Year 2036 Alternative 2
 Weekday AM



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	2	1	1	110	200	1
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93
Hourly flow rate (vph)	2	1	1	118	215	1
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	336	216	216			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	336	216	216			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	100	100			
cM capacity (veh/h)	657	822	1348			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	3	119	216			
Volume Left	2	1	0			
Volume Right	1	0	1			
cSH	704	1348	1700			
Volume to Capacity	0.00	0.00	0.13			
Queue Length 95th (ft)	0	0	0			
Control Delay (s)	10.1	0.1	0.0			
Lane LOS	B	A				
Approach Delay (s)	10.1	0.1	0.0			
Approach LOS	B					
Intersection Summary						
Average Delay			0.1			
Intersection Capacity Utilization		20.6%		ICU Level of Service		A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
 11: Springfield Road & Bernard Mills Drive

Year 2036 Alternative 2
 Weekday AM



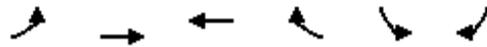
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑	↑		↑	↑	
Volume (veh/h)	77	35	3	179	22	10
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	88	40	3	203	25	11
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			127		298	88
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			127		298	88
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		96	99
cM capacity (veh/h)			1459		696	976

Direction, Lane #	EB 1	EB 2	WB 1	NB 1
Volume Total	88	40	207	36
Volume Left	0	0	3	25
Volume Right	0	40	0	11
cSH	1700	1700	1459	765
Volume to Capacity	0.05	0.02	0.00	0.05
Queue Length 95th (ft)	0	0	0	4
Control Delay (s)	0.0	0.0	0.1	9.9
Lane LOS			A	A
Approach Delay (s)	0.0		0.1	9.9
Approach LOS				A

Intersection Summary			
Average Delay			1.1
Intersection Capacity Utilization	21.8%		ICU Level of Service
Analysis Period (min)	15		A

HCM Unsignalized Intersection Capacity Analysis
 12: Springfield Road & Olde Hartley Drive

Year 2036 Alternative 2
 Weekday AM



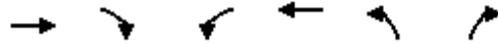
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↕	↕	↕	↕	
Volume (veh/h)	5	82	166	6	26	16
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	6	92	187	7	29	18
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	193				290	187
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	193				290	187
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				96	98
cM capacity (veh/h)	1380				692	848

Direction, Lane #	EB 1	WB 1	WB 2	SB 1
Volume Total	98	187	7	47
Volume Left	6	0	0	29
Volume Right	0	0	7	18
cSH	1380	1700	1700	744
Volume to Capacity	0.00	0.11	0.00	0.06
Queue Length 95th (ft)	0	0	0	5
Control Delay (s)	0.5	0.0	0.0	10.2
Lane LOS	A			B
Approach Delay (s)	0.5	0.0		10.2
Approach LOS				B

Intersection Summary			
Average Delay		1.6	
Intersection Capacity Utilization		18.7%	ICU Level of Service A
Analysis Period (min)		15	

HCM Unsignalized Intersection Capacity Analysis
 13: Springfield Road & Echo Lake Drive

Year 2036 Alternative 2
 Weekday AM



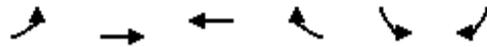
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	→			←	←	←
Volume (veh/h)	93	15	1	164	8	12
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	101	16	1	178	9	13
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			117		290	109
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			117		290	109
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		99	99
cM capacity (veh/h)			1471		705	950

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	117	179	22
Volume Left	0	1	9
Volume Right	16	0	13
cSH	1700	1471	834
Volume to Capacity	0.07	0.00	0.03
Queue Length 95th (ft)	0	0	2
Control Delay (s)	0.0	0.1	9.4
Lane LOS		A	A
Approach Delay (s)	0.0	0.1	9.4
Approach LOS			A

Intersection Summary			
Average Delay		0.7	
Intersection Capacity Utilization		19.4%	ICU Level of Service A
Analysis Period (min)		15	

HCM Unsignalized Intersection Capacity Analysis
 14: Springfield Road & Old Springfield Road

Year 2036 Alternative 2
 Weekday AM



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↔	↔		↔	↔
Volume (veh/h)	0	105	158	19	61	7
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	0	111	166	20	64	7
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						2
Median type		None	None			
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	186				287	176
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	186				287	176
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				91	99
cM capacity (veh/h)	1394				704	867

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	111	186	72
Volume Left	0	0	64
Volume Right	0	20	7
cSH	1394	1700	784
Volume to Capacity	0.00	0.11	0.09
Queue Length 95th (ft)	0	0	8
Control Delay (s)	0.0	0.0	10.5
Lane LOS			B
Approach Delay (s)	0.0	0.0	10.5
Approach LOS			B

Intersection Summary			
Average Delay		2.0	
Intersection Capacity Utilization		19.5%	ICU Level of Service A
Analysis Period (min)		15	

HCM Unsignalized Intersection Capacity Analysis
 15: Rigney Terrace & Springfield Road

Year 2036 Alternative 2
 Weekday AM



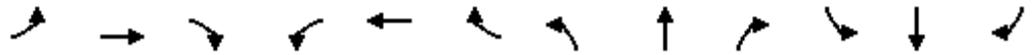
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	0	35	17	177	166	0
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	0	37	18	188	177	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	401	177	177			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	401	177	177			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	96	99			
cM capacity (veh/h)	601	872	1400			

Direction, Lane #	EB 1	NB 1	SB 1	SB 2
Volume Total	37	206	177	0
Volume Left	0	18	0	0
Volume Right	37	0	0	0
cSH	872	1400	1700	1700
Volume to Capacity	0.04	0.01	0.10	0.00
Queue Length 95th (ft)	3	1	0	0
Control Delay (s)	9.3	0.8	0.0	0.0
Lane LOS	A	A		
Approach Delay (s)	9.3	0.8	0.0	
Approach LOS	A			

Intersection Summary			
Average Delay		1.2	
Intersection Capacity Utilization		32.3%	ICU Level of Service A
Analysis Period (min)		15	

Queues
17: Springfield Road & Staples Mill Road

Year 2036 Alternative 2
Weekday AM



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Group Flow (vph)	423	134	140	185	203	191	188	416	58	103	836	314
v/c Ratio	0.81	0.48	0.23	0.72	0.76	0.33	0.80	0.30	0.06	0.62	0.67	0.33
Control Delay	62.2	53.4	8.4	64.4	68.2	8.6	74.2	27.2	3.0	68.4	38.0	7.7
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	62.2	53.4	8.4	64.4	68.2	8.6	74.2	27.2	3.0	68.4	38.0	7.7
Queue Length 50th (ft)	163	95	14	137	151	17	142	121	0	78	303	52
Queue Length 95th (ft)	#223	163	59	212	#237	70	#231	167	18	135	387	113
Internal Link Dist (ft)		1531			132			545			464	
Turn Bay Length (ft)	200		575	350		150	350		125	200		75
Base Capacity (vph)	544	280	644	310	295	606	275	1392	1009	201	1240	975
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.78	0.48	0.22	0.60	0.69	0.32	0.68	0.30	0.06	0.51	0.67	0.32

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

HCM Signalized Intersection Capacity Analysis
17: Springfield Road & Staples Mill Road

Year 2036 Alternative 2

Weekday AM

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	 							 			 	
Volume (vph)	402	127	133	176	193	181	179	395	55	98	794	298
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	7.0	7.0	6.5	7.0	7.0	6.5	6.5	6.3	7.0	6.5	6.7	7.0
Lane Util. Factor	0.97	1.00	1.00	1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	1863	1583	1770	1863	1583	1787	3574	1599	1787	3574	1599
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	1863	1583	1770	1863	1583	1787	3574	1599	1787	3574	1599
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	423	134	140	185	203	191	188	416	58	103	836	314
RTOR Reduction (vph)	0	0	81	0	0	122	0	0	27	0	0	89
Lane Group Flow (vph)	423	134	59	185	203	69	188	416	31	103	836	225
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	1%	1%	1%	1%	1%	1%
Turn Type	Prot		pm+ov	Prot		pm+ov	Prot		pm+ov	Prot		pm+ov
Protected Phases	7	4	1	3	8	5	1	6	3	5	2	7
Permitted Phases			4			8			6			2
Actuated Green, G (s)	18.2	17.9	33.7	17.5	17.2	28.3	15.8	46.7	64.2	11.1	41.6	59.8
Effective Green, g (s)	18.2	17.9	33.7	17.5	17.2	28.3	15.8	46.7	64.2	11.1	41.6	59.8
Actuated g/C Ratio	0.15	0.15	0.28	0.15	0.14	0.24	0.13	0.39	0.54	0.09	0.35	0.50
Clearance Time (s)	7.0	7.0	6.5	7.0	7.0	6.5	6.5	6.3	7.0	6.5	6.7	7.0
Vehicle Extension (s)	3.5	3.5	2.0	3.5	3.5	2.5	2.0	6.0	3.5	2.5	6.0	3.5
Lane Grp Cap (vph)	521	278	445	258	267	373	235	1391	855	165	1239	797
v/s Ratio Prot	c0.12	0.07	0.02	0.10	c0.11	0.02	c0.11	c0.12	0.01	0.06	c0.23	0.04
v/s Ratio Perm			0.02			0.03			0.01			0.10
v/c Ratio	0.81	0.48	0.13	0.72	0.76	0.18	0.80	0.30	0.04	0.62	0.67	0.28
Uniform Delay, d1	49.2	46.8	32.2	48.9	49.4	36.6	50.6	25.3	13.2	52.4	33.4	17.6
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	9.6	1.6	0.0	9.4	12.4	0.2	16.6	0.6	0.0	6.2	3.0	0.2
Delay (s)	58.8	48.4	32.3	58.3	61.8	36.8	67.1	25.9	13.3	58.7	36.4	17.8
Level of Service	E	D	C	E	E	D	E	C	B	E	D	B
Approach Delay (s)		51.5			52.4			36.5			33.6	
Approach LOS		D			D			D			C	
Intersection Summary												
HCM Average Control Delay			41.5				HCM Level of Service				D	
HCM Volume to Capacity ratio			0.79									
Actuated Cycle Length (s)			120.0				Sum of lost time (s)			33.5		
Intersection Capacity Utilization			76.2%				ICU Level of Service			D		
Analysis Period (min)			15									

c Critical Lane Group

Queues
1: Nuckols Road & Springfield Road

Year 2036 Alternative 2
Weekday PM



Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Group Flow (vph)	459	1193	345	327	301	195
v/c Ratio	0.48	0.74	0.63	0.30	0.43	0.33
Control Delay	28.2	4.8	40.2	10.4	24.7	5.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	28.2	4.8	40.2	10.4	24.7	5.3
Queue Length 50th (ft)	108	0	95	88	128	0
Queue Length 95th (ft)	154	50	132	137	217	47
Internal Link Dist (ft)	362			346	244	
Turn Bay Length (ft)	275	175	225			
Base Capacity (vph)	986	1636	1117	1107	697	611
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.47	0.73	0.31	0.30	0.43	0.32

Intersection Summary

HCM Signalized Intersection Capacity Analysis
1: Nuckols Road & Springfield Road

Year 2036 Alternative 2
Weekday PM



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	436	1133	328	311	286	185
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	11	11	12	12	12	12
Total Lost time (s)	5.0	5.0	5.0	6.0	6.0	5.0
Lane Util. Factor	0.97	0.88	0.97	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	3286	2668	3467	1881	1863	1583
Flt Permitted	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (perm)	3286	2668	3467	1881	1863	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	459	1193	345	327	301	195
RTOR Reduction (vph)	0	848	0	0	0	139
Lane Group Flow (vph)	459	345	345	327	301	56
Heavy Vehicles (%)	3%	3%	1%	1%	2%	2%
Turn Type		custom	Prot			Over
Protected Phases	3	3	5	2	6	3
Permitted Phases		3				
Actuated Green, G (s)	26.0	26.0	14.3	53.0	33.7	26.0
Effective Green, g (s)	26.0	26.0	14.3	53.0	33.7	26.0
Actuated g/C Ratio	0.29	0.29	0.16	0.59	0.37	0.29
Clearance Time (s)	5.0	5.0	5.0	6.0	6.0	5.0
Vehicle Extension (s)	5.0	5.0	3.0	6.0	6.0	5.0
Lane Grp Cap (vph)	949	771	551	1108	698	457
v/s Ratio Prot	c0.14	0.13	c0.10	0.17	c0.16	0.04
v/s Ratio Perm						
v/c Ratio	0.48	0.45	0.63	0.30	0.43	0.12
Uniform Delay, d1	26.5	26.1	35.4	9.2	21.0	23.6
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.8	0.9	2.2	0.7	1.9	0.3
Delay (s)	27.3	27.0	37.6	9.9	22.9	23.9
Level of Service	C	C	D	A	C	C
Approach Delay (s)	27.1			24.1	23.3	
Approach LOS	C			C	C	

Intersection Summary			
HCM Average Control Delay	25.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.49		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	63.9%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

HCM Unsignalized Intersection Capacity Analysis
2: Fireside Drive & Springfield Road

Year 2036 Alternative 2

Weekday PM



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	22	18	699	48	8	449
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91
Hourly flow rate (vph)	24	20	768	53	9	493
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage (veh)						
Upstream signal (ft)			377			
pX, platoon unblocked						
vC, conflicting volume	1059	410			821	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1059	410			821	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	89	97			99	
cM capacity (veh/h)	221	596			804	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	44	512	309	9	247	247
Volume Left	24	0	0	9	0	0
Volume Right	20	0	53	0	0	0
cSH	308	1700	1700	804	1700	1700
Volume to Capacity	0.14	0.30	0.18	0.01	0.15	0.15
Queue Length 95th (ft)	12	0	0	1	0	0
Control Delay (s)	18.6	0.0	0.0	9.5	0.0	0.0
Lane LOS	C			A		
Approach Delay (s)	18.6	0.0		0.2		
Approach LOS	C					

Intersection Summary						
Average Delay			0.7			
Intersection Capacity Utilization			30.9%		ICU Level of Service	A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis

3: Kingscroft Drive & Springfield Road

Year 2036 Alternative 2
Weekday PM



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↙		↑	↗		↘
Volume (veh/h)	22	18	672	45	8	435
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	25	21	772	52	9	500
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage (veh)						
Upstream signal (ft)			1118			
pX, platoon unblocked	0.99	0.99			0.99	
vC, conflicting volume	1291	772			824	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1289	767			819	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	86	95			99	
cM capacity (veh/h)	179	402			803	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1
Volume Total	46	772	52	509
Volume Left	25	0	0	9
Volume Right	21	0	52	0
cSH	239	1700	1700	803
Volume to Capacity	0.19	0.45	0.03	0.01
Queue Length 95th (ft)	17	0	0	1
Control Delay (s)	23.7	0.0	0.0	0.3
Lane LOS	C			A
Approach Delay (s)	23.7	0.0		0.3
Approach LOS	C			

Intersection Summary			
Average Delay		0.9	
Intersection Capacity Utilization		45.4%	ICU Level of Service A
Analysis Period (min)		15	

HCM Unsignalized Intersection Capacity Analysis
4: Wendhurst Drive & Springfield Road

Year 2036 Alternative 2
Weekday PM



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	30	6	647	43	7	413
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.83	0.83	0.83	0.83	0.83	0.83
Hourly flow rate (vph)	36	7	780	52	8	498
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1294	780			831	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1294	780			831	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	80	98			99	
cM capacity (veh/h)	179	399			805	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1
Volume Total	43	780	52	506
Volume Left	36	0	0	8
Volume Right	7	0	52	0
cSH	197	1700	1700	805
Volume to Capacity	0.22	0.46	0.03	0.01
Queue Length 95th (ft)	20	0	0	1
Control Delay (s)	28.3	0.0	0.0	0.3
Lane LOS	D			A
Approach Delay (s)	28.3	0.0		0.3
Approach LOS	D			

Intersection Summary			
Average Delay		1.0	
Intersection Capacity Utilization		44.1%	ICU Level of Service A
Analysis Period (min)		15	

HCM Unsignalized Intersection Capacity Analysis

5: Jones Road & Springfield Road

Year 2036 Alternative 2
Weekday PM



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	5	5	17	636	415	15
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Hourly flow rate (vph)	6	6	19	707	461	17
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1214	469	478			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1214	469	478			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	97	99	98			
cM capacity (veh/h)	199	598	1084			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	11	726	478			
Volume Left	6	19	0			
Volume Right	6	0	17			
cSH	299	1084	1700			
Volume to Capacity	0.04	0.02	0.28			
Queue Length 95th (ft)	3	1	0			
Control Delay (s)	17.5	0.5	0.0			
Lane LOS	C	A				
Approach Delay (s)	17.5	0.5	0.0			
Approach LOS	C					
Intersection Summary						
Average Delay			0.4			
Intersection Capacity Utilization		57.2%		ICU Level of Service		B
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
6: Olde Milbrooke Way & Springfield Road

Year 2036 Alternative 2
Weekday PM

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	8	1	16	16	1	8	14	611	16	9	398	29
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.89	0.89	0.89	0.89	0.92	0.89	0.92	0.89	0.92	0.92	0.92
Hourly flow rate (vph)	9	1	18	18	1	9	16	664	18	10	433	32
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage (veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1173	1182	448	1182	1179	664	464			682		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1173	1182	448	1182	1179	664	464			682		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	95	99	97	89	99	98	99			99		
cM capacity (veh/h)	162	187	615	159	187	461	1097			911		
Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1							
Volume Total	28	28	680	18	474							
Volume Left	9	18	16	0	10							
Volume Right	18	9	0	18	32							
cSH	312	202	1097	1700	911							
Volume to Capacity	0.09	0.14	0.01	0.01	0.01							
Queue Length 95th (ft)	7	12	1	0	1							
Control Delay (s)	17.6	25.7	0.4	0.0	0.3							
Lane LOS	C	D	A		A							
Approach Delay (s)	17.6	25.7	0.4		0.3							
Approach LOS	C	D										
Intersection Summary												
Average Delay			1.3									
Intersection Capacity Utilization			49.2%		ICU Level of Service				A			
Analysis Period (min)			15									

HCM Unsignalized Intersection Capacity Analysis
7: Wintergreen Road & Springfield Road

Year 2036 Alternative 2
Weekday PM



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	0	45	26	276	163	71
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	49	28	300	177	77
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	572	216	254			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	572	216	254			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	94	98			
cM capacity (veh/h)	471	824	1311			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	49	328	254			
Volume Left	0	28	0			
Volume Right	49	0	77			
cSH	824	1311	1700			
Volume to Capacity	0.06	0.02	0.15			
Queue Length 95th (ft)	5	2	0			
Control Delay (s)	9.6	0.9	0.0			
Lane LOS	A	A				
Approach Delay (s)	9.6	0.9	0.0			
Approach LOS	A					
Intersection Summary						
Average Delay			1.2			
Intersection Capacity Utilization		42.2%		ICU Level of Service		A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
 8: Jacobs Creek Drive & Springfield Road

Year 2036 Alternative 2
 Weekday PM



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	25	0	229	47	0	209
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	28	0	257	53	0	235
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	519	284			310	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	519	284			310	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	95	100			100	
cM capacity (veh/h)	521	760			1250	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	28	310	235
Volume Left	28	0	0
Volume Right	0	53	0
cSH	521	1700	1250
Volume to Capacity	0.05	0.18	0.00
Queue Length 95th (ft)	4	0	0
Control Delay (s)	12.3	0.0	0.0
Lane LOS	B		
Approach Delay (s)	12.3	0.0	0.0
Approach LOS	B		

Intersection Summary			
Average Delay		0.6	
Intersection Capacity Utilization	24.9%		ICU Level of Service A
Analysis Period (min)		15	

HCM Unsignalized Intersection Capacity Analysis
 9: Wintercreek Drive & Springfield Road

Year 2036 Alternative 2
 Weekday PM



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	16	19	33	196	190	0
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	18	22	38	223	216	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	514	216	216			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	514	216	216			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	96	97	97			
cM capacity (veh/h)	506	824	1354			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	40	260	216			
Volume Left	18	38	0			
Volume Right	22	0	0			
cSH	640	1354	1700			
Volume to Capacity	0.06	0.03	0.13			
Queue Length 95th (ft)	5	2	0			
Control Delay (s)	11.0	1.3	0.0			
Lane LOS	B	A				
Approach Delay (s)	11.0	1.3	0.0			
Approach LOS	B					
Intersection Summary						
Average Delay			1.5			
Intersection Capacity Utilization			35.5%	ICU Level of Service		A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
 10: Warnerwood Ct & Springfield Road

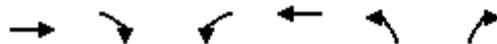
Year 2036 Alternative 2
 Weekday PM



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	0	3	4	208	187	1
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93
Hourly flow rate (vph)	0	3	4	224	201	1
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	434	202	202			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	434	202	202			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	100	100			
cM capacity (veh/h)	575	837	1364			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	3	228	202			
Volume Left	0	4	0			
Volume Right	3	0	1			
cSH	837	1364	1700			
Volume to Capacity	0.00	0.00	0.12			
Queue Length 95th (ft)	0	0	0			
Control Delay (s)	9.3	0.2	0.0			
Lane LOS	A	A				
Approach Delay (s)	9.3	0.2	0.0			
Approach LOS	A					
Intersection Summary						
Average Delay			0.2			
Intersection Capacity Utilization			24.2%		ICU Level of Service	A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
 11: Springfield Road & Bernard Mills Drive

Year 2036 Alternative 2
 Weekday PM



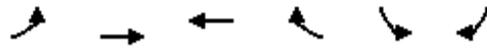
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑	↑		↑	↑	
Volume (veh/h)	128	80	9	176	12	6
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	145	91	10	200	14	7
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			236		366	145
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			236		366	145
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			99		98	99
cM capacity (veh/h)			1331		633	907

Direction, Lane #	EB 1	EB 2	WB 1	NB 1
Volume Total	145	91	210	20
Volume Left	0	0	10	14
Volume Right	0	91	0	7
cSH	1700	1700	1331	704
Volume to Capacity	0.09	0.05	0.01	0.03
Queue Length 95th (ft)	0	0	1	2
Control Delay (s)	0.0	0.0	0.4	10.3
Lane LOS			A	B
Approach Delay (s)	0.0		0.4	10.3
Approach LOS				B

Intersection Summary			
Average Delay		0.6	
Intersection Capacity Utilization	26.6%		ICU Level of Service A
Analysis Period (min)		15	

HCM Unsignalized Intersection Capacity Analysis
 12: Springfield Road & Olde Hartley Drive

Year 2036 Alternative 2
 Weekday PM



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↕	↕	↗	↘	↘
Volume (veh/h)	16	118	176	13	9	9
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	18	133	198	15	10	10
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	212				366	198
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	212				366	198
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	99				98	99
cM capacity (veh/h)	1358				619	836

Direction, Lane #	EB 1	WB 1	WB 2	SB 1
Volume Total	151	198	15	20
Volume Left	18	0	0	10
Volume Right	0	0	15	10
cSH	1358	1700	1700	711
Volume to Capacity	0.01	0.12	0.01	0.03
Queue Length 95th (ft)	1	0	0	2
Control Delay (s)	1.0	0.0	0.0	10.2
Lane LOS	A			B
Approach Delay (s)	1.0	0.0		10.2
Approach LOS				B

Intersection Summary			
Average Delay		0.9	
Intersection Capacity Utilization		29.7%	ICU Level of Service A
Analysis Period (min)		15	

HCM Unsignalized Intersection Capacity Analysis
 13: Springfield Road & Echo Lake Drive

Year 2036 Alternative 2
 Weekday PM



Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	→			←	↙	↘
Volume (veh/h)	106	21	7	184	5	5
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	115	23	8	200	5	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			138		342	127
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			138		342	127
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			99		99	99
cM capacity (veh/h)			1446		655	929

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	138	208	11
Volume Left	0	8	5
Volume Right	23	0	5
cSH	1700	1446	768
Volume to Capacity	0.08	0.01	0.01
Queue Length 95th (ft)	0	0	1
Control Delay (s)	0.0	0.3	9.8
Lane LOS		A	A
Approach Delay (s)	0.0	0.3	9.8
Approach LOS			A

Intersection Summary			
Average Delay		0.5	
Intersection Capacity Utilization	25.4%		ICU Level of Service A
Analysis Period (min)		15	

HCM Unsignalized Intersection Capacity Analysis
 14: Springfield Road & Old Springfield Road

Year 2036 Alternative 2
 Weekday PM



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↔	↔		↔	↔
Volume (veh/h)	0	111	191	43	29	0
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	0	117	201	45	31	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						2
Median type		None	None			
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	246				341	224
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	246				341	224
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				95	100
cM capacity (veh/h)	1326				655	816

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	117	246	31
Volume Left	0	0	31
Volume Right	0	45	0
cSH	1326	1700	640
Volume to Capacity	0.00	0.14	0.05
Queue Length 95th (ft)	0	0	4
Control Delay (s)	0.0	0.0	10.9
Lane LOS			B
Approach Delay (s)	0.0	0.0	10.9
Approach LOS			B

Intersection Summary			
Average Delay		0.8	
Intersection Capacity Utilization		22.7%	ICU Level of Service A
Analysis Period (min)		15	

HCM Unsignalized Intersection Capacity Analysis
 15: Rigney Terrace & Springfield Road

Year 2036 Alternative 2
 Weekday PM



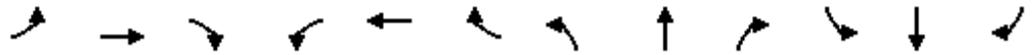
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	0	15	28	234	140	0
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	0	16	30	249	149	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	457	149	149			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	457	149	149			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	98	98			
cM capacity (veh/h)	553	903	1432			

Direction, Lane #	EB 1	NB 1	SB 1	SB 2
Volume Total	16	279	149	0
Volume Left	0	30	0	0
Volume Right	16	0	0	0
cSH	903	1432	1700	1700
Volume to Capacity	0.02	0.02	0.09	0.00
Queue Length 95th (ft)	1	2	0	0
Control Delay (s)	9.1	1.0	0.0	0.0
Lane LOS	A	A		
Approach Delay (s)	9.1	1.0	0.0	
Approach LOS	A			

Intersection Summary			
Average Delay		0.9	
Intersection Capacity Utilization		34.6%	ICU Level of Service A
Analysis Period (min)		15	

Queues
17: Springfield Road & Staples Mill Road

Year 2036 Alternative 2
Weekday PM



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Group Flow (vph)	304	232	147	248	353	132	256	519	197	135	794	139
v/c Ratio	0.71	0.75	0.22	0.85	0.92	0.20	0.88	0.43	0.20	0.68	0.79	0.18
Control Delay	60.1	63.7	13.6	74.1	76.4	9.9	79.3	33.6	2.5	67.5	47.5	10.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	60.1	63.7	13.6	74.1	76.4	9.9	79.3	33.6	2.5	67.5	47.5	10.3
Queue Length 50th (ft)	117	173	38	186	269	22	194	167	0	102	308	29
Queue Length 95th (ft)	165	#285	84	#316	#445	62	#334	230	36	165	#393	68
Internal Link Dist (ft)		1531			132			545			464	
Turn Bay Length (ft)	200		575	350		150	350		125	200		75
Base Capacity (vph)	458	313	667	310	392	697	305	1194	984	256	1001	789
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.66	0.74	0.22	0.80	0.90	0.19	0.84	0.43	0.20	0.53	0.79	0.18

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

HCM Signalized Intersection Capacity Analysis
 17: Springfield Road & Staples Mill Road

Year 2036 Alternative 2
 Weekday PM

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	 							 			 	
Volume (vph)	289	220	140	236	335	125	243	493	187	128	754	132
Ideal Flow (vphp)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	7.0	7.0	6.5	7.0	7.0	6.5	6.5	6.3	7.0	6.5	6.7	7.0
Lane Util. Factor	0.97	1.00	1.00	1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	1863	1583	1770	1863	1583	1787	3574	1599	1787	3574	1599
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	1863	1583	1770	1863	1583	1787	3574	1599	1787	3574	1599
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	304	232	147	248	353	132	256	519	197	135	794	139
RTOR Reduction (vph)	0	0	46	0	0	59	0	0	99	0	0	43
Lane Group Flow (vph)	304	232	101	248	353	73	256	519	98	135	794	96
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	1%	1%	1%	1%	1%	1%
Turn Type	Prot		pm+ov	Prot		pm+ov	Prot		pm+ov	Prot		pm+ov
Protected Phases	7	4	1	3	8	5	1	6	3	5	2	7
Permitted Phases			4			8			6			2
Actuated Green, G (s)	14.9	19.9	39.4	19.8	24.8	38.2	19.5	40.1	59.9	13.4	33.6	48.5
Effective Green, g (s)	14.9	19.9	39.4	19.8	24.8	38.2	19.5	40.1	59.9	13.4	33.6	48.5
Actuated g/C Ratio	0.12	0.17	0.33	0.16	0.21	0.32	0.16	0.33	0.50	0.11	0.28	0.40
Clearance Time (s)	7.0	7.0	6.5	7.0	7.0	6.5	6.5	6.3	7.0	6.5	6.7	7.0
Vehicle Extension (s)	3.5	3.5	2.5	3.5	3.5	2.5	2.5	6.0	3.5	2.5	6.0	3.5
Lane Grp Cap (vph)	426	309	520	292	385	504	290	1194	798	200	1001	646
v/s Ratio Prot	0.09	0.12	0.03	c0.14	c0.19	0.02	c0.14	c0.15	0.02	0.08	c0.22	0.02
v/s Ratio Perm			0.03			0.03			0.04			0.04
v/c Ratio	0.71	0.75	0.19	0.85	0.92	0.15	0.88	0.43	0.12	0.68	0.79	0.15
Uniform Delay, d1	50.5	47.7	28.9	48.7	46.6	29.2	49.1	31.1	16.0	51.2	40.0	22.7
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	5.8	10.1	0.1	20.4	26.4	0.1	25.4	1.2	0.1	7.9	6.5	0.1
Delay (s)	56.3	57.8	29.0	69.1	73.0	29.3	74.5	32.3	16.1	59.1	46.4	22.8
Level of Service	E	E	C	E	E	C	E	C	B	E	D	C
Approach Delay (s)		50.9			63.8			40.1			45.0	
Approach LOS		D			E			D			D	

Intersection Summary		
HCM Average Control Delay	48.8	HCM Level of Service D
HCM Volume to Capacity ratio	0.96	
Actuated Cycle Length (s)	120.0	Sum of lost time (s) 33.5
Intersection Capacity Utilization	83.8%	ICU Level of Service E
Analysis Period (min)	15	

c Critical Lane Group

Appendix M
Alternative 2
HSM Analysis

Alternative 2 Countermeasure Analysis Details

The potential change in crashes associated with each countermeasure deemed feasible and appropriate were calculated using Chapter 12 (Urban/Suburban Arterials) procedures in the HSM. If a standard error was given, a range of crash reductions is shown. This analysis was completed using forecast design year 2036 traffic volumes. Each countermeasure was analyzed independent of the other countermeasures.

The urban/suburban arterial analysis (Chapter 12 of the HSM) results are displayed Table M1 and Table M2.

Chapter 12 – Urban/Suburban Arterial Analysis

Alternative 2 Segments

Table M1 displays countermeasures for the Chapter 12 urban/suburban analysis as well as recommended segments for each. Source information for the countermeasures can be found in Appendix E.

Table M1 Alternative 2 Segment Countermeasure Analysis Results (Chapter 12)

Countermeasure	Applicable Segment	Predicted Percent Change ¹					
		Total Crashes			Fatal and/or Injury Crashes		
		Low	High	Expected	Low	High	Expected
Segment lighting	E, F, M, N, Q	N/A	N/A	7% Reduction	N/A	N/A	10% Reduction
Reduce AADT from 8750 to 3900	G	N/A	N/A	58% Reduction	N/A	N/A	50% Reduction
Reduce AADT from 8450 to 3350	H	N/A	N/A	63% Reduction	N/A	N/A	50% Reduction
Reduce AADT from 8450 to 3100	I	N/A	N/A	67% Reduction	N/A	N/A	50% Reduction
Reduce AADT from 8400 to 3050	J	N/A	N/A	65% Reduction	N/A	N/A	57% Reduction
Reduce AADT from 7800 to 2450	K, L	N/A	N/A	68% Reduction	N/A	N/A	60% Reduction
Reduce AADT from 7650 to 2300	M, N	N/A	N/A	70% Reduction	N/A	N/A	62% Reduction
Reduce AADT from 7750 to 2900	O	N/A	N/A	66% Reduction	N/A	N/A	64% Reduction
Reduce AADT from 7650 to 3200	P	N/A	N/A	59% Reduction	N/A	N/A	50% Reduction

¹ Percentages were rounded to the nearest whole number

² N/A – Not Available

³ The standard error from the clearinghouse for this countermeasure is large enough to result in a calculated potential increase in crashes. Still, applying centerline rumble strips is more likely to reduce crashes than result in an increase.

Alternative 2 Intersections

Table M2 displays countermeasures for the Chapter 12 analysis as well as recommended intersections for each. Source information for the countermeasures can be found in Appendix E.

Table M2 Alternative 2 Intersection Countermeasure Analysis Results (Chapter 12)

Countermeasure	Applicable Intersection	Predicted Percent Change ¹					
		Total Crashes			Fatal and/or Injury Crashes		
		Low	High	Expected	Low	High	Expected
Lighting in intersection	1, 7, 16, 17	N/A ²	N/A	9% Reduction	N/A	N/A	9% Reduction
Retime signal and change intervals to ITE standards	17	12% Increase ³	28% Reduction	N/A	10% Increase	34% Reduction	N/A
Convert four-leg intersection to three-leg intersection	10	N/A	N/A	60% Reduction	N/A	N/A	49% Reduction
Convert two-way stop-controlled intersection into roundabout	7, 16	29% Reduction	49% Reduction	N/A	68% Reduction	88% Reduction	N/A
Reduce AADT on major road from 8600 to 3650	8	N/A	N/A	52% Reduction	N/A	N/A	54% Reduction
Reduce AADT on major road from 8450 to 3200	9	N/A	N/A	56% Reduction	N/A	N/A	56% Reduction
Reduce AADT on major road from 8400 to 3050	10	N/A	N/A	59% Reduction	N/A	N/A	66% Reduction
Reduce AADT on major road from 8100 to 2750	11	N/A	N/A	58% Reduction	N/A	N/A	58% Reduction
Reduce AADT on major road from 7800 to 2450	12	N/A	N/A	61% Reduction	N/A	N/A	61% Reduction
Reduce AADT on major road from 7200 to 2400	13	N/A	N/A	59% Reduction	N/A	N/A	61% Reduction

Reduce AADT on major road from 7700 to 2600	14	N/A	N/A	60% Reduction	N/A	N/A	62% Reduction
Reduce AADT on major road from 7700 to 3050	15	N/A	N/A	55% Reduction	N/A	N/A	56% Reduction
Reduce AADT on major road from 9050 to 7900	16	N/A	N/A	13% Reduction	N/A	N/A	14% Reduction
Reduce AADT on minor road from 5750 to 4450	16	N/A	N/A	6% Reduction	N/A	N/A	7% Reduction

¹ Percentages were rounded to the nearest whole number

² Not Available

³ The standard error from the clearinghouse for this countermeasure is large enough to result in a calculated potential increase in crashes. Still, applying proper signal timing to an intersection is more likely to reduce crashes than result in an increase.

The countermeasures analyzed in table M1 and Table M2 are discussed in greater detail in the subsequent section.

Alternative 2 Suggested Countermeasures (Chapter 12)

Segment lighting

Lighting can reduce the total number of crashes by seven percent and fatal/injury crashes by 10 percent on urban/suburban facilities. Alternative 2 assumes segment lighting is installed on segments E, F, M, N, and Q as these segments experienced a higher frequency of crashes.

Convert four-leg intersection to three-leg intersection

This conversion can reduce total crashes by 60 percent and fatal/injury crashes by 49 percent on urban/suburban facilities. Available intersection sight distance at Hart Mill Drive was measured to be below AASHTO-recommended minimums. Even though this intersection is not assumed to be improved to an Urban Principal Arterial standard, Alternative 2 assumes this approach is closed given the low volume of traffic turning into and out of this location and the presence of a viable alternative access via Bernard Mills Road.

Lighting in intersections

Lighting individual intersections can reduce the total number of crashes by nine percent as well as fatal/injury crashes on rural two-lane facilities. Intersections lighting includes installing luminaires at the intersection proper and on the approaches. Alternative 2 assumes that the following major intersections within the study limits are lighted:

- SR 157/Nuckols Road (existing traffic signal)
- SR 157/Wintergreen Road/Linsey Lakes Drive (new single-lane roundabout)

- SR 157/Francistown Road (new single-lane roundabout)
- SR 157/Staples Mill Road (modified traffic signal)

Retiming signal change intervals to ITE standards

The standard error from the clearinghouse for this countermeasure is large enough to result in a calculated potential increase in crashes. Still, applying proper signal timing to an intersection is more likely to reduce crashes than result in an increase. Alternative 2 assumes that the signal timing at the SR 157/Staples Mill Road intersection is updated to ITE standards when improved to the future Alternative 1 configuration.

Conversion of two-way stop-controlled intersections into roundabout

Replacing a two-way stop-controlled intersection with a single-lane roundabout can reduce total crashes by 29 to 49 percent and injury crashes by 68 to 88 percent on urban/suburban facilities. An operational analysis of various intersection control forms (all-way stop, roundabout, and traffic signal) at the SR 157/Francistown Road intersection determined that a single-lane roundabout would perform the best. Alternative 2 assumes that the SR 157/Linsey Lakes Drive and SR 157/Francistown Road intersections are converted to single-lane roundabouts.

Reduce AADT

Reducing AADT on roadway segments and at intersections can reduce total crashes anywhere from 6 to 70 percent and fatal/injury crashes by 7 to 66 percent on urban/suburban arterial facilities depending on the magnitude of the reduction. Alternative 2 will reduce AADT on the existing portion of Springfield Road between the SR 157/Linsey Lakes Drive and SR 157/Francistown Road intersections due to the diversion of 60 percent of the total corridor traffic to the new alignment.

Additional Recommended Countermeasures

As noted previously, the study corridor contains roadway characteristics that are also consistent with a rural road. As such, Chapter 10 (Rural Two Lane Roadways) countermeasures applicable to the study corridor were also included.

Achieve roadside hazard rating of 3

Provision of a 10 foot clear zone and guardrail would help achieve a roadside hazard rating of three, and is expected to reduce total crashes by 6 to 18 percent and fatal crashes by 9 to 19 percent on rural two-lane facilities. Alternative 2 assumes a ten foot clear zone is provided on all segments A through C, E, and Q as part of the design changes to the SR 157 study corridor. Segment D already provides a minimum clear zone of 10 feet. Alternative 2 also assumes guardrail is still installed on segments M.1, M.2, and N.1 to address the high frequency of crashes in this location though these segments are not assumed to be modified to the new cross-section.

Flatten horizontal curve

AASHTO identifies a minimum horizontal curve radius of 444 feet for roadways with a design speed of 40 mph and maximum eight percent superelevation. Flattening horizontal curves to achieve the 444-

foot minimum can reduce total crashes by 12 to 17 percent and fatal/injury crashes by nine to 10 percent on rural two-lane facilities. The probability of crashes decreases with longer curve radii and length. Plan maps indicate there is a reserved corridor of right-of-way that could accommodate a realignment of Springfield Road in this area to increase the radii of these horizontal curves. Even though these segments are not assumed to be modified to the new cross-section, Alternative 2 assumes guardrail is still installed on segments M.1, M.2, and N.1 to address the high frequency of crashes in this location.

Alternative 2 Safety Summary

Table M3 shows the results of the urban/suburban analysis of Alternative 2 compared with the future no-build.

Table M3 Predicted Annual Crashes for Alternative 2 (Chapter 12)

Alternative	Predicted Annual Crashes		
	Fatal/Injury	Property Damage Only	Total
No-Build	6.71	12.66	19.37
Alternative 2	5.06	9.98	15.04
Percent Change	-25%	-21%	-22%

According to Table M3, Alternative 2 is predicted to reduce the crash frequency along Springfield Road by an average of 22 percent. Fatal/injury crashes are predicted to be reduced by 25 percent and property damage only crashes by 21 percent.

Safety Benefit/Cost Analysis Methodology

Disclaimer:

VDOT does not have statewide calibration factors to adjust the generic HSM methods to specific VDOT facilities. As such, calculating an **absolute** dollar value benefit for the predicted reduction in crashes for Alternative 2 compared to the no-build condition is not possible. In this case, the calculated cost benefit of alternatives compared to the no-build condition is valid only for relative comparison between alternatives. If calibration factors are developed by VDOT in the future, it would be possible to calculate the actual expected average number of crashes for the no-build and Alternative 2 conditions and calculate an absolute dollar value benefit of Alternative 1 relative to the no-build scenario.

A benefit-cost (B/C) analysis was conducted for Alternative 2 using crash-cost values contained in the year 2012 Highway Safety Improvement Program (HSIP) Federal Year (FY) 2012-2013 worksheet published by VDOT. A dollar value benefit of the calculated reduction in total expected annual crashes was calculated for an assumed service life of the project of 25 years.

Predicted crashes were allocated on the KABCO scale based on the statewide crash distribution pattern for rural undivided roads year 2008 data (most are 2 lane, some are 4 lane) provided by VDOT. The allocated crashes were multiplied by their respective cost and again by the assumed 25-year service life. The sum of these totals represents the total cost of all predicted crashes for each scenario. Because the calculated cost benefit is only relative, results from the Chapter 12 (Table M7) analysis were used exclusively for the cost benefit comparison. Table M4 summarizes the cost benefit calculations.

Table M4 Cost Benefit Calculations – Alternative 2

Total Predicted Annual Crashes	Crash Severity	VDOT Distribution by Severity	Cost per Crash	Predicted Annual Crashes by Severity Type	25-Year Service Life Cost of Crashes
No-Build					
19.37	K – Killed	1.6%	\$5,038,456	0.31	\$39,048,034
	A – Incapacitating Injury	17.9%	\$275,161	3.46	\$23,801,426
	B – Non-incapacitating Injury	10.1%	\$98,140	1.95	\$4,784,325
	C – Possible Injury	13.8%	\$55,474	2.67	\$3,702,889
	O – No Injury	56.7%	\$9,029	10.98	\$2,478,460
TOTAL					\$73,815,134
Alternative 2					
15.04	K – Killed	1.6%	\$5,038,456	0.24	\$30,230,736
	A – Incapacitating Injury	17.9%	\$275,161	2.69	\$18,504,577
	B – Non-incapacitating Injury	10.1%	\$98,140	1.52	\$3,729,320
	C – Possible Injury	13.8%	\$55,474	2.07	\$2,870,779
	O – No Injury	56.7%	\$9,029	8.52	\$1,923,177
TOTAL					\$57,258,589
Cost Benefit of Alternative 2 compared to No-Build Scenario					\$16,556,545

As shown in Table M4, Alternative 2 is calculated to result in an uncalibrated overall cost benefit of \$16,556,545 compared to the no-build scenario.

At the request of VDOT, segments affected by the potential construction of a new alignment were separated out to isolate the relative cost-benefit of identified improvements. Table M5 isolates the total predicted annual crashes of existing SR 157 for just those segments affected by the proposed new alignment for both the no-build and Alternative 2 scenarios.

Table M5 Cost Benefit Calculations – Alternative 2 (Portion of SR 157 Affected by New Alignment)

Total Predicted Annual Crashes	Crash Severity	VDOT Distribution by Severity	Cost per Crash	Predicted Annual Crashes by Severity Type	25-Year Service Life Cost of Crashes
No-Build					
9.61	K – Killed	1.6%	\$5,038,456	0.15	\$19,367,825
	A – Incapacitating Injury	17.9%	\$275,161	1.72	\$11,833,230
	B – Non-incapacitating Injury	10.1%	\$98,140	0.97	\$2,381,392
	C – Possible Injury	13.8%	\$55,474	1.33	\$1,839,213
	O – No Injury	56.7%	\$9,029	5.44	\$1,227,689
TOTAL					\$36,649,348
Alternative 2					
5.87	K – Killed	1.6%	\$5,038,456	0.09	\$11,830,295
	A – Incapacitating Injury	17.9%	\$275,161	1.05	\$7,227,998
	B – Non-incapacitating Injury	10.1%	\$98,140	0.59	\$1,454,607
	C – Possible Injury	13.8%	\$55,474	0.81	\$1,123,432
	O – No Injury	56.7%	\$9,029	3.32	\$749,021
TOTAL					\$22,385,352
Cost Benefit of Alternative 2 compared to No-Build Scenario (Portion of SR 157 Affected by New Alignment)					\$14,263,996

Segments affected by the construction of a new alignment were isolated to compare the relative cost-benefit of improvements limited only to the sections of SR 157 impacted by the new alignment. As shown in Table M5, Alternative 2 is calculated to result in an uncalibrated cost benefit of \$14,263,996 compared to the no-build scenario on just the portion of SR 157 affected by the new alignment. Of the total \$16.5 million savings calculated for Alternative 2, roughly 86 percent (\$14.2M) is attributable to improvements to SR 157 between Linsey Lakes Road and Francistown Road.

General Information

Analyst	ACJ	Analysis Name	Alternative2-Chapter12	Date of Analysis	12/18/2012
Agency/Company	Kittelson & Associates, Inc.	Project Number/PIN #	11764.16	Comments	
State	Virginia	Site(s)	Springfield Road		
Region/Area/City/County	Glen Allen/Henrico County	Jurisdiction	Henrico County		

Analysis Summary Results

Crash Severity Distribution	Crash Frequency		
	Fatal and Injury (FI)	Property Damage Only (PDO)	Total
Total Predicted Crashes (entire study period)	4.77	9.27	14.04
Total Predicted Crashes (crashes/year)	4.77	9.27	14.04
Total Expected Crashes (entire study period)	0.28	0.00	0.28
Total Expected Crashes (crashes/year)	0.28	0.00	0.28
1 - Nuckols Road/Springfield Road	0.78	1.57	2.35
Total Predicted Crashes (crashes/year)	0.78	1.57	2.35
Total Expected Crashes (crashes/year)	0.03	0.00	0.03
A - Nuckols Road to Fireside Drive	0.05	0.12	0.16
Total Predicted Crashes (crashes/year)	0.05	0.12	0.16
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
2 - Springfield Road/Fireside Drive	0.10	0.15	0.25
Total Predicted Crashes (crashes/year)	0.10	0.15	0.25
Total Expected Crashes (crashes/year)	0.01	0.00	0.01
B - Fireside Drive to Kingscroft Drive	0.09	0.24	0.33
Total Predicted Crashes (crashes/year)	0.09	0.24	0.33
Total Expected Crashes (crashes/year)	0.00	0.00	0.00

Analysis Summary Results

Crash Severity Distribution	Crash Frequency		
	Fatal and Injury (FI)	Property Damage Only (PDO)	Total
3 - Springfield Road/Kingscroft Drive	0.10	0.14	0.24
Total Predicted Crashes (crashes/year)	0.10	0.14	0.24
Total Expected Crashes (crashes/year)	0.01	0.00	0.01
C - Kingscroft Drive to Wendhurst Drive	0.04	0.10	0.14
Total Predicted Crashes (crashes/year)	0.04	0.10	0.14
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
4 - Springfield Road/Wendhurst Drive	0.09	0.13	0.21
Total Predicted Crashes (crashes/year)	0.09	0.13	0.21
Total Expected Crashes (crashes/year)	0.01	0.00	0.01
D - Wendhurst Drive to Jones Road	0.03	0.08	0.11
Total Predicted Crashes (crashes/year)	0.03	0.08	0.11
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
5 - Springfield Road/Jones Road	0.07	0.09	0.16
Total Predicted Crashes (crashes/year)	0.07	0.09	0.16
Total Expected Crashes (crashes/year)	0.01	0.00	0.01
E - Jones Road to Olde Milbrooke Way	0.06	0.15	0.21
Total Predicted Crashes (crashes/year)	0.06	0.15	0.21
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
6 - Springfield Road/Olde Milbrooke Way	0.38	0.68	1.06
Total Predicted Crashes (crashes/year)	0.38	0.68	1.06
Total Expected Crashes (crashes/year)	0.04	0.00	0.04

Analysis Summary Results

Crash Severity Distribution	Crash Frequency		
	Fatal and Injury (FI)	Property Damage Only (PDO)	Total
F - Olde Milbrooke Way to Linsey Lakes Drive	0.08	0.20	0.28
Total Predicted Crashes (crashes/year)	0.08	0.20	0.28
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
18 - Springfield Road/Linsey Lakes Drive/SR157	0.25	0.49	0.74
Total Predicted Crashes (crashes/year)	0.25	0.49	0.74
Total Expected Crashes (crashes/year)	0.03	0.00	0.03
R - Linsey Lakes Drive to Wintergreen Road	0.03	0.07	0.10
Total Predicted Crashes (crashes/year)	0.03	0.07	0.10
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
7 - Springfield Road/Wintergreen Road	0.06	0.08	0.14
Total Predicted Crashes (crashes/year)	0.06	0.08	0.14
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
G - Wintergreen Road to Jacobs Creek Drive	0.06	0.12	0.18
Total Predicted Crashes (crashes/year)	0.06	0.12	0.18
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
8 - Springfield Road/Jacobs Creek Drive	0.12	0.18	0.30
Total Predicted Crashes (crashes/year)	0.12	0.18	0.30
Total Expected Crashes (crashes/year)	0.01	0.00	0.01
H - Jacobs Creek Drive to Wintercreek Drive	0.01	0.02	0.03
Total Predicted Crashes (crashes/year)	0.01	0.02	0.03

Analysis Summary Results

Crash Severity Distribution	Crash Frequency		
	Fatal and Injury (FI)	Property Damage Only (PDO)	Total
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
9 - Springfield Road/Wintercreek Drive	0.11	0.15	0.26
Total Predicted Crashes (crashes/year)	0.11	0.15	0.26
Total Expected Crashes (crashes/year)	0.01	0.00	0.01
I - Wintercreek Drive to Wamerwood Court	0.02	0.04	0.05
Total Predicted Crashes (crashes/year)	0.02	0.04	0.05
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
10 - Springfield Road/Wamerwood Court	0.04	0.05	0.09
Total Predicted Crashes (crashes/year)	0.04	0.05	0.09
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
J - Wamerwood Court to Bernard Mills Drive	0.03	0.06	0.09
Total Predicted Crashes (crashes/year)	0.03	0.06	0.09
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
11 - Springfield Road/Bernard Mills Drive	0.10	0.15	0.25
Total Predicted Crashes (crashes/year)	0.10	0.15	0.25
Total Expected Crashes (crashes/year)	0.01	0.00	0.01
K - Bernard Mills Drive to Olde Hartley Drive	0.02	0.03	0.05
Total Predicted Crashes (crashes/year)	0.02	0.03	0.05
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
12 - Springfield Road/Olde Hartley Drive	0.07	0.09	0.16

Analysis Summary Results

Crash Severity Distribution	Crash Frequency		
	Fatal and Injury (FI)	Property Damage Only (PDO)	Total
Total Predicted Crashes (crashes/year)	0.07	0.09	0.16
Total Expected Crashes (crashes/year)	0.01	0.00	0.01
L - Olde Hartley Drive to Echo Lake Drive			
Total Predicted Crashes (crashes/year)	0.02	0.03	0.05
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
13 - Springfield Road/Echo Lake Drive			
Total Predicted Crashes (crashes/year)	0.07	0.10	0.17
Total Expected Crashes (crashes/year)	0.01	0.00	0.01
M - Echo Lake Drive through End of Horizontal Curve 1			
Total Predicted Crashes (crashes/year)	0.01	0.03	0.04
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
N - Start of Horizontal Curve 2 to Old Springfield Rd			
Total Predicted Crashes (crashes/year)	0.08	0.15	0.22
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
14 - Springfield Road/Old Springfield Rd			
Total Predicted Crashes (crashes/year)	0.09	0.14	0.23
Total Expected Crashes (crashes/year)	0.01	0.00	0.01
O - Old Springfield Road to Rigney Terrace			
Total Predicted Crashes (crashes/year)	0.03	0.07	0.10
Total Expected Crashes (crashes/year)	0.00	0.00	0.00

Analysis Summary Results

Crash Severity Distribution	Crash Frequency		
	Fatal and Injury (FI)	Property Damage Only (PDO)	Total
15 - Springfield Road/Rigney Terrace	0.08	0.11	0.18
Total Predicted Crashes (crashes/year)	0.08	0.11	0.18
Total Expected Crashes (crashes/year)	0.01	0.00	0.01
P - Rigney Terrace to Francistown Road	0.03	0.06	0.09
Total Predicted Crashes (crashes/year)	0.03	0.06	0.09
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
16 - SR 157/Springfield Road/Springfield Road/Francistown Road	0.42	0.93	1.35
Total Predicted Crashes (crashes/year)	0.42	0.93	1.35
Total Expected Crashes (crashes/year)	0.02	0.00	0.02
Q - Francistown Road to Staples Mill Road	0.24	0.59	0.84
Total Predicted Crashes (crashes/year)	0.24	0.59	0.84
Total Expected Crashes (crashes/year)	0.01	0.00	0.01
17 - Staples Mill Road/Springfield Road	0.92	1.90	2.82
Total Predicted Crashes (crashes/year)	0.92	1.90	2.82
Total Expected Crashes (crashes/year)	0.04	0.00	0.04

General Information

Analyst	ACJ	Analysis Name	Alternative2-Chapter12	Date of Analysis	12/18/2012
Agency/Company	Kittelson & Associates, Inc.	Project Number/PIN #	11764.16	Comments	
State	Virginia	Site(s)	Springfield Road		
Region/Area/City/County	Glen Allen/Henrico County	Jurisdiction	Henrico County		

Input Data

Segment Name	** Linsey Lakes Drive to Francistown Road		
Road Type	Two-lane undivided arterials (2U)		
Length of segment, L (mi)	0.830		
Analysis Year	2036		
AADT (veh/day)	5,350		
Type of on-street parking	None		
Land use	Residential/Other		
Curb length with parking			
Median width (ft)	10-ft (1-ft to 14-ft)		
Lighting	Yes		
Automated speed enforcement	No		
Major commercial driveways	0		
Minor commercial driveways	0		
Major industrial driveways	0		
Minor industrial driveways	0		
Major residential driveways	0		
Minor residential driveways	0		
Other driveways	0		
Speed category	>30mph		
Roadside fixed object density (fixed objects/mi)	75		
Offset to roadside fixed objects (ft)	10		
Calibration Factor, Cr	1.000		
Total Observed Crashes	FI	PDO	Total

Summary Results

	Fatal and Injury (FI)	Property Damage Only (PDO)	Total
Predicted Annual Avg Crash Frequency	0.3	0.7	1.0
Expected Annual Avg Crash Frequency	0.0	0.0	0.0
Roadway segment length, L (mi)	0.83	0.83	0.83
Crash rate (crashes/mi/year)	0.4	0.9	1.2

Crash Severity Distribution

	Fatal and Injury (FI)	Property Damage Only (PDO)	Total
Multiple-Vehicle			
Rear-end collisions	0.100	0.252	0.353
Head-on collisions	0.009	0.001	0.011
Angle collisions	0.012	0.026	0.037
Sideswipe, same direction	0.002	0.010	0.012
Sideswipe, opposite direction	0.010	0.018	0.028
Driveway-related collisions	0.000	0.000	0.000
Other multiple-vehicle collision	0.004	0.017	0.021
Subtotal	0.138	0.324	0.462
Single-Vehicle			
Collision with animal	0.004	0.025	0.029
Collision with fixed object	0.105	0.291	0.396
Collision with other object	0.001	0.005	0.006
Other single-vehicle collision	0.035	0.062	0.097
Collision with pedestrian	0.005		0.005

Appendix N
Alternative 2 Preliminary
Estimate of Probable Cost

SPRINGFIELD ROAD - ALTERNATE 2
 HENRICO, VA
ENGINEER'S OPINION OF PROBABLE COSTS
01-06-13 (STUDY STAGE)

VDOT ITEM #	ITEM	Quantity	UNIT	UNIT PRICE	COST
	RECONSTRUCT MAINLINE	1,500	LF	\$532.84	\$799,264.45
	RECONSTRUCT LOCAL ROAD	8,000	LF	\$518.14	\$4,145,118.67
	NEW CONSTRUCTION MAINLINE	5,000	LF	\$625.49	\$3,127,469.08
	NEW CONSTRUCTION LOCAL ROAD	1,500	LF	\$656.59	\$984,890.73
	CUL-DE-SAC	0	EA	\$20,000.00	\$0.00
	STAPLES MILL INTERSECTION IMPROVEMENTS	1	LS	\$2,306,500.00	\$2,306,500.00
	GUARDRAIL	2,500	LF	\$22.00	\$55,000.00
	ROUNDABOUTS	2	EA	\$500,000.00	\$1,000,000.00
	INTERSECTION LIGHTING	4	EA	\$3,000.00	\$12,000.00
	CORRIDOR LIGHTING	9,500	LF	\$32.53	\$309,066.67
	CLOSE HART MILL ROAD	1	LS	\$20,000.00	\$20,000.00
	MAJOR DRAINAGE	1	LS	\$1,100,000.00	\$1,100,000.00
	WETLANDS MITIGATION	2	AC	\$50,000.00	\$100,000.00
	STREAM MITIGATION	200	LF	\$300.00	\$60,000.00
	BICYCLE/PEDESTRIAN PATH	0	LF	\$35.00	\$0.00
	WATER QUALITY (BASINS)	2	EA	\$15,000.00	\$30,000.00
	WATER QUALITY (FILTERRAS)	25	EA	\$10,000.00	\$250,000.00
					\$14,299,309.59

Sub Total from above	\$14,299,309.59
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CEI	\$2,144,896.44
PE	\$1,858,910.25

Total Section Cost	\$18,303,116.28
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Appendix O
Alternative 3
Level of Service Worksheets

Queues

1: Nuckols Road & Springfield Road

12/6/2012



Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Group Flow (vph)	186	411	1021	156	399	544
v/c Ratio	0.25	0.45	0.90	0.13	0.80	0.79
Control Delay	27.7	4.2	40.6	7.6	48.1	16.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	27.7	4.2	40.6	7.6	48.1	16.0
Queue Length 50th (ft)	44	0	267	31	226	55
Queue Length 95th (ft)	65	35	#406	66	#430	169
Internal Link Dist (ft)	362			346	244	
Turn Bay Length (ft)	275	175	225			
Base Capacity (vph)	986	1088	1155	1225	498	774
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.19	0.38	0.88	0.13	0.80	0.70

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

HCM Signalized Intersection Capacity Analysis

1: Nuckols Road & Springfield Road

12/6/2012

						
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	177	390	970	148	379	517
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	11	11	12	12	12	12
Total Lost time (s)	5.0	5.0	5.0	6.0	6.0	5.0
Lane Util. Factor	0.97	0.88	0.97	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	3286	2668	3467	1881	1863	1583
Flt Permitted	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (perm)	3286	2668	3467	1881	1863	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	186	411	1021	156	399	544
RTOR Reduction (vph)	0	318	0	0	0	330
Lane Group Flow (vph)	186	93	1021	156	399	214
Heavy Vehicles (%)	3%	3%	1%	1%	2%	2%
Turn Type	custom		Prot		Over	
Protected Phases	3	3	5	2	6	3
Permitted Phases	3					
Actuated Green, G (s)	20.4	20.4	29.6	58.6	24.0	20.4
Effective Green, g (s)	20.4	20.4	29.6	58.6	24.0	20.4
Actuated g/C Ratio	0.23	0.23	0.33	0.65	0.27	0.23
Clearance Time (s)	5.0	5.0	5.0	6.0	6.0	5.0
Vehicle Extension (s)	5.0	5.0	3.0	6.0	6.0	5.0
Lane Grp Cap (vph)	745	605	1140	1225	497	359
v/s Ratio Prot	0.06	0.03	c0.29	0.08	c0.21	c0.14
v/s Ratio Perm						
v/c Ratio	0.25	0.15	0.90	0.13	0.80	0.60
Uniform Delay, d1	28.5	27.9	28.7	6.0	30.8	31.1
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.4	0.2	9.3	0.2	12.9	4.0
Delay (s)	28.9	28.1	38.0	6.2	43.7	35.1
Level of Service	C	C	D	A	D	D
Approach Delay (s)	28.4		33.8		38.7	
Approach LOS	C		C		D	
Intersection Summary						
HCM Average Control Delay			34.3	HCM Level of Service		C
HCM Volume to Capacity ratio			0.78			
Actuated Cycle Length (s)			90.0	Sum of lost time (s)		16.0
Intersection Capacity Utilization			68.0%	ICU Level of Service		C
Analysis Period (min)			15			
c Critical Lane Group						

HCM Unsignalized Intersection Capacity Analysis

2: Fireside Drive & Springfield Road

12/6/2012

						
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	80	20	303	22	1	816
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91
Hourly flow rate (vph)	88	22	333	24	1	897
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage (veh)						
Upstream signal (ft)	377					
pX, platoon unblocked						
vC, conflicting volume	796	179	357			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	796	179	357			
tC, single (s)	6.8	6.9	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	73	97	100			
cM capacity (veh/h)	328	840	1198			
Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	110	222	135	1	448	448
Volume Left	88	0	0	1	0	0
Volume Right	22	0	24	0	0	0
cSH	374	1700	1700	1198	1700	1700
Volume to Capacity	0.29	0.13	0.08	0.00	0.26	0.26
Queue Length 95th (ft)	30	0	0	0	0	0
Control Delay (s)	18.6	0.0	0.0	8.0	0.0	0.0
Lane LOS	C			A		
Approach Delay (s)	18.6	0.0		0.0		
Approach LOS	C					
Intersection Summary						
Average Delay			1.5			
Intersection Capacity Utilization			34.9%	ICU Level of Service	A	
Analysis Period (min)	15					

HCM Unsignalized Intersection Capacity Analysis

3: Kingscroft Drive & Springfield Road

12/6/2012



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↙		↑	↗		↓
Volume (veh/h)	72	18	296	27	1	745
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	83	21	340	31	1	856
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage (veh)						
Upstream signal (ft)	1118					
pX, platoon unblocked						
vC, conflicting volume	1199	340			371	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1199	340			371	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	60	97			100	
cM capacity (veh/h)	207	707			1187	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1
Volume Total	103	340	31	857
Volume Left	83	0	0	1
Volume Right	21	0	31	0
cSH	241	1700	1700	1187
Volume to Capacity	0.43	0.20	0.02	0.00
Queue Length 95th (ft)	51	0	0	0
Control Delay (s)	30.8	0.0	0.0	0.0
Lane LOS	D			A
Approach Delay (s)	30.8	0.0		0.0
Approach LOS	D			

Intersection Summary			
Average Delay	2.4		
Intersection Capacity Utilization	51.8%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis

4: Wendhurst Drive & Springfield Road

12/6/2012

						
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	74	10	292	22	5	672
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.83	0.83	0.83	0.83	0.83	0.83
Hourly flow rate (vph)	89	12	352	27	6	810
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1173	352			378	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1173	352			378	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	58	98			99	
cM capacity (veh/h)	213	696			1186	
Direction, Lane #	WB 1	NB 1	NB 2	SB 1		
Volume Total	101	352	27	816		
Volume Left	89	0	0	6		
Volume Right	12	0	27	0		
cSH	232	1700	1700	1186		
Volume to Capacity	0.44	0.21	0.02	0.01		
Queue Length 95th (ft)	51	0	0	0		
Control Delay (s)	32.0	0.0	0.0	0.1		
Lane LOS	D			A		
Approach Delay (s)	32.0	0.0		0.1		
Approach LOS	D					
Intersection Summary						
Average Delay			2.6			
Intersection Capacity Utilization			50.7%	ICU Level of Service	A	
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis

5: Jones Road & Springfield Road

12/6/2012

						
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	5	5	2	300	672	5
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Hourly flow rate (vph)	6	6	2	333	747	6
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1087	749	752			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1087	749	752			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	98	99	100			
cM capacity (veh/h)	241	415	857			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	11	336	752			
Volume Left	6	2	0			
Volume Right	6	0	6			
cSH	305	857	1700			
Volume to Capacity	0.04	0.00	0.44			
Queue Length 95th (ft)	3	0	0			
Control Delay (s)	17.3	0.1	0.0			
Lane LOS	C	A				
Approach Delay (s)	17.3	0.1	0.0			
Approach LOS	C					
Intersection Summary						
Average Delay			0.2			
Intersection Capacity Utilization		45.7%		ICU Level of Service		A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis

6: Olde Milbrooke Way & Springfield Road

12/6/2012

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	5	0	5	22	0	23	3	293	9	3	650	12
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.89	0.89	0.89	0.89	0.92	0.89	0.92	0.89	0.92	0.92	0.92
Hourly flow rate (vph)	5	0	6	25	0	25	3	318	10	3	707	13
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type												
Median storage (veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1070	1055	713	1050	1051	318	720			329		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1070	1055	713	1050	1051	318	720			329		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	97	100	99	88	100	97	100			100		
cM capacity (veh/h)	191	226	435	203	227	722	882			1231		
Direction, Lane #												
	EB 1	WB 1	NB 1	NB 2	SB 1							
Volume Total	11	50	322	10	723							
Volume Left	5	25	3	0	3							
Volume Right	6	25	0	10	13							
cSH	267	318	882	1700	1231							
Volume to Capacity	0.04	0.16	0.00	0.01	0.00							
Queue Length 95th (ft)	3	14	0	0	0							
Control Delay (s)	19.1	18.4	0.1	0.0	0.1							
Lane LOS	C	C	A		A							
Approach Delay (s)	19.1	18.4	0.1		0.1							
Approach LOS	C	C										
Intersection Summary												
Average Delay			1.1									
Intersection Capacity Utilization			51.8%	ICU Level of Service	A							
Analysis Period (min)			15									

HCM Unsignalized Intersection Capacity Analysis

7: Wintergreen Road & Springfield Road

12/6/2012



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	0	110	29	127	222	0
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	120	32	138	241	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	442	241	241			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	442	241	241			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	85	98			
cM capacity (veh/h)	559	798	1325			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	120	170	241			
Volume Left	0	32	0			
Volume Right	120	0	0			
cSH	798	1325	1700			
Volume to Capacity	0.15	0.02	0.14			
Queue Length 95th (ft)	13	2	0			
Control Delay (s)	10.3	1.6	0.0			
Lane LOS	B	A				
Approach Delay (s)	10.3	1.6	0.0			
Approach LOS	B					
Intersection Summary						
Average Delay			2.8			
Intersection Capacity Utilization			36.8%	ICU Level of Service	A	
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis

8: Jacobs Creek Drive & Springfield Road

12/6/2012

						
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	40	0	96	31	0	182
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	45	0	108	35	0	204
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	330	125			143	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	330	125			143	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	93	100			100	
cM capacity (veh/h)	669	931			1440	
Direction, Lane #	WB 1	NB 1	SB 1			
Volume Total	45	143	204			
Volume Left	45	0	0			
Volume Right	0	35	0			
cSH	669	1700	1440			
Volume to Capacity	0.07	0.08	0.00			
Queue Length 95th (ft)	5	0	0			
Control Delay (s)	10.8	0.0	0.0			
Lane LOS	B					
Approach Delay (s)	10.8	0.0	0.0			
Approach LOS	B					
Intersection Summary						
Average Delay			1.2			
Intersection Capacity Utilization			19.6%	ICU Level of Service	A	
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis

9: Wintercreek Drive & Springfield Road

12/6/2012



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	0	85	29	67	97	0
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	0	97	33	76	110	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	252	110	110			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	252	110	110			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	90	98			
cM capacity (veh/h)	720	943	1480			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	97	109	110			
Volume Left	0	33	0			
Volume Right	97	0	0			
cSH	943	1480	1700			
Volume to Capacity	0.10	0.02	0.06			
Queue Length 95th (ft)	9	2	0			
Control Delay (s)	9.3	2.4	0.0			
Lane LOS						
Approach Delay (s)	9.3	2.4	0.0			
Approach LOS	A					
Intersection Summary						
Average Delay			3.7			
Intersection Capacity Utilization		23.7%		ICU Level of Service		A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis

10: Warnerwood Ct & Springfield Road

12/6/2012

						
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	0	3	2	65	94	0
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93
Hourly flow rate (vph)	0	3	2	70	101	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	175	101	101			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	175	101	101			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	100	100			
cM capacity (veh/h)	811	952	1485			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	3	72	101			
Volume Left	0	2	0			
Volume Right	3	0	0			
cSH	952	1485	1700			
Volume to Capacity	0.00	0.00	0.06			
Queue Length 95th (ft)	0	0	0			
Control Delay (s)	8.8	0.2	0.0			
Lane LOS	A	A				
Approach Delay (s)	8.8	0.2	0.0			
Approach LOS	A					
Intersection Summary						
Average Delay			0.3			
Intersection Capacity Utilization		15.0%		ICU Level of Service		A
Analysis Period (min)		15				

HCM Unsignalized Intersection Capacity Analysis

11: Springfield Road & Bernard Mills Drive

12/6/2012

	→	↘	↙	←	↖	↗
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑	↗		↖	↖	↗
Volume (veh/h)	27	38	0	62	32	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	31	43	0	70	36	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None		None			
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			74		101	31
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			74		101	31
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		96	100
cM capacity (veh/h)			1526		902	1049
Direction, Lane #	EB 1	EB 2	WB 1	NB 1		
Volume Total	31	43	70	36		
Volume Left	0	0	0	36		
Volume Right	0	43	0	0		
cSH	1700	1700	1526	902		
Volume to Capacity	0.02	0.03	0.00	0.04		
Queue Length 95th (ft)	0	0	0	3		
Control Delay (s)	0.0	0.0	0.0	9.2		
Lane LOS					A	
Approach Delay (s)	0.0		0.0	9.2		
Approach LOS					A	
Intersection Summary						
Average Delay			1.8			
Intersection Capacity Utilization			13.3%	ICU Level of Service	A	
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis

12: Springfield Road & Olde Hartley Drive

12/6/2012



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↔	↔	↔	↔	↔
Volume (veh/h)	11	16	20	0	0	42
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	12	18	22	0	0	47
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	22				65	22
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	22				65	22
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	99				100	95
cM capacity (veh/h)	1593				926	1046
Direction, Lane #	EB 1	WB 1	WB 2	SB 1		
Volume Total	30	22	0	47		
Volume Left	12	0	0	0		
Volume Right	0	0	0	47		
cSH	1593	1700	1700	1046		
Volume to Capacity	0.01	0.01	0.00	0.05		
Queue Length 95th (ft)	1	0	0	4		
Control Delay (s)	3.0	0.0	0.0	8.6		
Lane LOS	A			A		
Approach Delay (s)	3.0	0.0		8.6		
Approach LOS				A		
Intersection Summary						
Average Delay			5.0			
Intersection Capacity Utilization			18.1%		ICU Level of Service	A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis

13: Springfield Road & Echo Lake Drive

12/6/2012



Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↔			↔	↔	
Volume (veh/h)	0	16	0	0	20	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	17	0	0	22	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None		None			
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			17		9	9
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			17		9	9
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		98	100
cM capacity (veh/h)			1600		1017	1079
Direction, Lane #	EB 1	WB 1	NB 1			
Volume Total	17	0	22			
Volume Left	0	0	22			
Volume Right	17	0	0			
cSH	1700	1700	1017			
Volume to Capacity	0.01	0.00	0.02			
Queue Length 95th (ft)	0	0	2			
Control Delay (s)	0.0	0.0	8.6			
Lane LOS				A		
Approach Delay (s)	0.0	0.0	8.6			
Approach LOS				A		
Intersection Summary						
Average Delay			4.8			
Intersection Capacity Utilization			13.3%	ICU Level of Service	A	
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis

14: Springfield Road & Old Springfield Road

12/6/2012



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↔	↔		↔	↔
Volume (veh/h)	0	0	0	19	68	0
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	0	0	0	20	72	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						2
Median type		None	None			
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	20				10	10
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	20				10	10
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				93	100
cM capacity (veh/h)	1603				1010	1071
Direction, Lane #						
	EB 1	WB 1	SB 1			
Volume Total	0	20	72			
Volume Left	0	0	72			
Volume Right	0	20	0			
cSH	1700	1700	1000			
Volume to Capacity	0.00	0.01	0.07			
Queue Length 95th (ft)	0	0	6			
Control Delay (s)	0.0	0.0	8.9			
Lane LOS			A			
Approach Delay (s)	0.0	0.0	8.9			
Approach LOS			A			
Intersection Summary						
Average Delay			6.9			
Intersection Capacity Utilization			13.8%		ICU Level of Service	A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis

15: Rigney Terrace & Springfield Road

12/6/2012

						
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	0	35	17	19	68	0
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	0	37	18	20	72	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	129	72	72			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	129	72	72			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	96	99			
cM capacity (veh/h)	860	995	1528			
Direction, Lane #	EB 1	NB 1	SB 1	SB 2		
Volume Total	37	38	72	0		
Volume Left	0	18	0	0		
Volume Right	37	0	0	0		
cSH	995	1528	1700	1700		
Volume to Capacity	0.04	0.01	0.04	0.00		
Queue Length 95th (ft)	3	1	0	0		
Control Delay (s)	8.8	3.5	0.0	0.0		
Lane LOS	A	A				
Approach Delay (s)	8.8	3.5	0.0			
Approach LOS	A					
Intersection Summary						
Average Delay			3.1			
Intersection Capacity Utilization		18.6%		ICU Level of Service		A
Analysis Period (min)			15			

Queues

17: Springfield Road & Staples Mill Road

12/6/2012

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Group Flow (vph)	423	134	140	185	203	191	188	416	58	103	836	314
v/c Ratio	0.81	0.48	0.23	0.72	0.76	0.33	0.80	0.30	0.06	0.62	0.67	0.33
Control Delay	62.2	53.4	8.4	64.4	68.2	8.6	74.2	27.2	3.0	68.4	38.0	7.7
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	62.2	53.4	8.4	64.4	68.2	8.6	74.2	27.2	3.0	68.4	38.0	7.7
Queue Length 50th (ft)	163	95	14	137	151	17	142	121	0	78	303	52
Queue Length 95th (ft)	#223	163	59	212	#237	70	#231	167	18	135	387	113
Internal Link Dist (ft)		1531			132			545			464	
Turn Bay Length (ft)	200		575	350		150	350		125	200		75
Base Capacity (vph)	544	280	644	310	295	606	275	1392	1009	201	1240	975
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.78	0.48	0.22	0.60	0.69	0.32	0.68	0.30	0.06	0.51	0.67	0.32

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

HCM Signalized Intersection Capacity Analysis

17: Springfield Road & Staples Mill Road

12/6/2012

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	 							 			 	
Volume (vph)	402	127	133	176	193	181	179	395	55	98	794	298
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	7.0	7.0	6.5	7.0	7.0	6.5	6.5	6.3	7.0	6.5	6.7	7.0
Lane Util. Factor	0.97	1.00	1.00	1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	1863	1583	1770	1863	1583	1787	3574	1599	1787	3574	1599
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	1863	1583	1770	1863	1583	1787	3574	1599	1787	3574	1599
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	423	134	140	185	203	191	188	416	58	103	836	314
RTOR Reduction (vph)	0	0	81	0	0	122	0	0	27	0	0	89
Lane Group Flow (vph)	423	134	59	185	203	69	188	416	31	103	836	225
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	1%	1%	1%	1%	1%	1%
Turn Type	Prot		pm+ov	Prot		pm+ov	Prot		pm+ov	Prot		pm+ov
Protected Phases	7	4	1	3	8	5	1	6	3	5	2	7
Permitted Phases			4			8			6			2
Actuated Green, G (s)	18.2	17.9	33.7	17.5	17.2	28.3	15.8	46.7	64.2	11.1	41.6	59.8
Effective Green, g (s)	18.2	17.9	33.7	17.5	17.2	28.3	15.8	46.7	64.2	11.1	41.6	59.8
Actuated g/C Ratio	0.15	0.15	0.28	0.15	0.14	0.24	0.13	0.39	0.54	0.09	0.35	0.50
Clearance Time (s)	7.0	7.0	6.5	7.0	7.0	6.5	6.5	6.3	7.0	6.5	6.7	7.0
Vehicle Extension (s)	3.5	3.5	2.0	3.5	3.5	2.5	2.0	6.0	3.5	2.5	6.0	3.5
Lane Grp Cap (vph)	521	278	445	258	267	373	235	1391	855	165	1239	797
v/s Ratio Prot	c0.12	0.07	0.02	0.10	c0.11	0.02	c0.11	c0.12	0.01	0.06	c0.23	0.04
v/s Ratio Perm			0.02			0.03			0.01			0.10
v/c Ratio	0.81	0.48	0.13	0.72	0.76	0.18	0.80	0.30	0.04	0.62	0.67	0.28
Uniform Delay, d1	49.2	46.8	32.2	48.9	49.4	36.6	50.6	25.3	13.2	52.4	33.4	17.6
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	9.6	1.6	0.0	9.4	12.4	0.2	16.6	0.6	0.0	6.2	3.0	0.2
Delay (s)	58.8	48.4	32.3	58.3	61.8	36.8	67.1	25.9	13.3	58.7	36.4	17.8
Level of Service	E	D	C	E	E	D	E	C	B	E	D	B
Approach Delay (s)		51.5			52.4			36.5			33.6	
Approach LOS		D			D			D			C	

Intersection Summary

HCM Average Control Delay	41.5	HCM Level of Service	D
HCM Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	33.5
Intersection Capacity Utilization	76.2%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

HCM Unsignalized Intersection Capacity Analysis
 18: Springfield Road & Linsey Lakes Drive

12/6/2012

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Right Turn Channelized												
Volume (veh/h)	97	221	3	20	497	58	14	1	33	178	0	154
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	105	240	3	22	540	63	15	1	36	193	0	167
Approach Volume (veh/h)		349			625			52			361	
Crossing Volume (veh/h)		215			122			539			577	
High Capacity (veh/h)		1170			1259			905			877	
High v/c (veh/h)		0.30			0.50			0.06			0.41	
Low Capacity (veh/h)		966			1047			729			705	
Low v/c (veh/h)		0.36			0.60			0.07			0.51	
Intersection Summary												
Maximum v/c High			0.50									
Maximum v/c Low			0.60									
Intersection Capacity Utilization			83.9%		ICU Level of Service					E		

Queues

1: Nuckols Road & Springfield Road

12/6/2012



Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Group Flow (vph)	459	1193	345	327	301	195
v/c Ratio	0.48	0.74	0.63	0.30	0.43	0.33
Control Delay	28.2	4.8	40.2	10.4	24.7	5.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	28.2	4.8	40.2	10.4	24.7	5.3
Queue Length 50th (ft)	108	0	95	88	128	0
Queue Length 95th (ft)	154	50	132	137	217	47
Internal Link Dist (ft)	362			346	244	
Turn Bay Length (ft)	275	175	225			
Base Capacity (vph)	986	1636	1117	1107	697	611
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.47	0.73	0.31	0.30	0.43	0.32

Intersection Summary

HCM Signalized Intersection Capacity Analysis

1: Nuckols Road & Springfield Road

12/6/2012

						
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	436	1133	328	311	286	185
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	11	11	12	12	12	12
Total Lost time (s)	5.0	5.0	5.0	6.0	6.0	5.0
Lane Util. Factor	0.97	0.88	0.97	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	3286	2668	3467	1881	1863	1583
Flt Permitted	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (perm)	3286	2668	3467	1881	1863	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	459	1193	345	327	301	195
RTOR Reduction (vph)	0	848	0	0	0	139
Lane Group Flow (vph)	459	345	345	327	301	56
Heavy Vehicles (%)	3%	3%	1%	1%	2%	2%
Turn Type	custom		Prot		Over	
Protected Phases	3	3	5	2	6	3
Permitted Phases	3					
Actuated Green, G (s)	26.0	26.0	14.3	53.0	33.7	26.0
Effective Green, g (s)	26.0	26.0	14.3	53.0	33.7	26.0
Actuated g/C Ratio	0.29	0.29	0.16	0.59	0.37	0.29
Clearance Time (s)	5.0	5.0	5.0	6.0	6.0	5.0
Vehicle Extension (s)	5.0	5.0	3.0	6.0	6.0	5.0
Lane Grp Cap (vph)	949	771	551	1108	698	457
v/s Ratio Prot	c0.14	0.13	c0.10	0.17	c0.16	0.04
v/s Ratio Perm						
v/c Ratio	0.48	0.45	0.63	0.30	0.43	0.12
Uniform Delay, d1	26.5	26.1	35.4	9.2	21.0	23.6
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.8	0.9	2.2	0.7	1.9	0.3
Delay (s)	27.3	27.0	37.6	9.9	22.9	23.9
Level of Service	C	C	D	A	C	C
Approach Delay (s)	27.1		24.1		23.3	
Approach LOS	C		C		C	
Intersection Summary						
HCM Average Control Delay			25.7	HCM Level of Service		C
HCM Volume to Capacity ratio			0.49			
Actuated Cycle Length (s)			90.0	Sum of lost time (s)		16.0
Intersection Capacity Utilization			63.9%	ICU Level of Service		B
Analysis Period (min)			15			
c Critical Lane Group						

HCM Unsignalized Intersection Capacity Analysis

2: Fireside Drive & Springfield Road

12/6/2012



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	Y		↑↑		↑	↑↑
Volume (veh/h)	22	18	699	48	8	449
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91
Hourly flow rate (vph)	24	20	768	53	9	493
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage (veh)						
Upstream signal (ft)	377					
pX, platoon unblocked						
vC, conflicting volume	1059	410			821	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1059	410			821	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	89	97			99	
cM capacity (veh/h)	221	596			804	
Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	44	512	309	9	247	247
Volume Left	24	0	0	9	0	0
Volume Right	20	0	53	0	0	0
cSH	308	1700	1700	804	1700	1700
Volume to Capacity	0.14	0.30	0.18	0.01	0.15	0.15
Queue Length 95th (ft)	12	0	0	1	0	0
Control Delay (s)	18.6	0.0	0.0	9.5	0.0	0.0
Lane LOS	C			A		
Approach Delay (s)	18.6	0.0		0.2		
Approach LOS	C					
Intersection Summary						
Average Delay			0.7			
Intersection Capacity Utilization			30.9%	ICU Level of Service	A	
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis

3: Kingscroft Drive & Springfield Road

12/6/2012



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↙		↑	↗		↓
Volume (veh/h)	22	18	672	45	8	435
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	25	21	772	52	9	500
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage (veh)						
Upstream signal (ft)	1118					
pX, platoon unblocked	0.99	0.99			0.99	
vC, conflicting volume	1291	772			824	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1289	767			819	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	86	95			99	
cM capacity (veh/h)	179	402			803	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1
Volume Total	46	772	52	509
Volume Left	25	0	0	9
Volume Right	21	0	52	0
cSH	239	1700	1700	803
Volume to Capacity	0.19	0.45	0.03	0.01
Queue Length 95th (ft)	17	0	0	1
Control Delay (s)	23.7	0.0	0.0	0.3
Lane LOS	C			A
Approach Delay (s)	23.7	0.0		0.3
Approach LOS	C			

Intersection Summary			
Average Delay		0.9	
Intersection Capacity Utilization		45.4%	ICU Level of Service A
Analysis Period (min)		15	

HCM Unsignalized Intersection Capacity Analysis

4: Wendhurst Drive & Springfield Road

12/6/2012

						
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	30	6	647	43	7	413
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.83	0.83	0.83	0.83	0.83	0.83
Hourly flow rate (vph)	36	7	780	52	8	498
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1294	780			831	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1294	780			831	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	80	98			99	
cM capacity (veh/h)	179	399			805	
Direction, Lane #	WB 1	NB 1	NB 2	SB 1		
Volume Total	43	780	52	506		
Volume Left	36	0	0	8		
Volume Right	7	0	52	0		
cSH	197	1700	1700	805		
Volume to Capacity	0.22	0.46	0.03	0.01		
Queue Length 95th (ft)	20	0	0	1		
Control Delay (s)	28.3	0.0	0.0	0.3		
Lane LOS	D			A		
Approach Delay (s)	28.3	0.0		0.3		
Approach LOS	D					
Intersection Summary						
Average Delay			1.0			
Intersection Capacity Utilization			44.1%	ICU Level of Service	A	
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis

5: Jones Road & Springfield Road

12/6/2012

						
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	5	5	17	636	415	15
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Hourly flow rate (vph)	6	6	19	707	461	17
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1214	469	478			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1214	469	478			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	97	99	98			
cM capacity (veh/h)	199	598	1084			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	11	726	478			
Volume Left	6	19	0			
Volume Right	6	0	17			
cSH	299	1084	1700			
Volume to Capacity	0.04	0.02	0.28			
Queue Length 95th (ft)	3	1	0			
Control Delay (s)	17.5	0.5	0.0			
Lane LOS	C	A				
Approach Delay (s)	17.5	0.5	0.0			
Approach LOS	C					
Intersection Summary						
Average Delay			0.4			
Intersection Capacity Utilization		57.2%		ICU Level of Service		B
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis

6: Olde Milbrooke Way & Springfield Road

12/6/2012

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	8	1	16	16	1	8	14	611	16	9	398	29
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.89	0.89	0.89	0.89	0.92	0.89	0.92	0.89	0.92	0.92	0.92
Hourly flow rate (vph)	9	1	18	18	1	9	16	664	18	10	433	32
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type												
Median storage (veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1173	1182	448	1182	1179	664	464			682		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1173	1182	448	1182	1179	664	464			682		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	95	99	97	89	99	98	99			99		
cM capacity (veh/h)	162	187	615	159	187	461	1097			911		
Direction, Lane #												
	EB 1	WB 1	NB 1	NB 2	SB 1							
Volume Total	28	28	680	18	474							
Volume Left	9	18	16	0	10							
Volume Right	18	9	0	18	32							
cSH	312	202	1097	1700	911							
Volume to Capacity	0.09	0.14	0.01	0.01	0.01							
Queue Length 95th (ft)	7	12	1	0	1							
Control Delay (s)	17.6	25.7	0.4	0.0	0.3							
Lane LOS	C	D	A		A							
Approach Delay (s)	17.6	25.7	0.4		0.3							
Approach LOS	C	D										
Intersection Summary												
Average Delay			1.3									
Intersection Capacity Utilization			49.2%	ICU Level of Service	A							
Analysis Period (min)			15									

HCM Unsignalized Intersection Capacity Analysis

7: Wintergreen Road & Springfield Road

12/6/2012



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	0	45	97	231	109	0
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	49	105	251	118	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	580	118	118			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	580	118	118			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	95	93			
cM capacity (veh/h)	442	933	1470			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	49	357	118			
Volume Left	0	105	0			
Volume Right	49	0	0			
cSH	933	1470	1700			
Volume to Capacity	0.05	0.07	0.07			
Queue Length 95th (ft)	4	6	0			
Control Delay (s)	9.1	2.7	0.0			
Lane LOS	A	A				
Approach Delay (s)	9.1	2.7	0.0			
Approach LOS	A					
Intersection Summary						
Average Delay			2.7			
Intersection Capacity Utilization			34.2%	ICU Level of Service	A	
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis

8: Jacobs Creek Drive & Springfield Road

12/6/2012

						
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	25	0	184	47	0	84
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	28	0	207	53	0	94
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	328	233			260	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	328	233			260	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	96	100			100	
cM capacity (veh/h)	671	811			1305	
Direction, Lane #	WB 1	NB 1	SB 1			
Volume Total	28	260	94			
Volume Left	28	0	0			
Volume Right	0	53	0			
cSH	671	1700	1305			
Volume to Capacity	0.04	0.15	0.00			
Queue Length 95th (ft)	3	0	0			
Control Delay (s)	10.6	0.0	0.0			
Lane LOS	B					
Approach Delay (s)	10.6	0.0	0.0			
Approach LOS	B					
Intersection Summary						
Average Delay			0.8			
Intersection Capacity Utilization			22.5%	ICU Level of Service	A	
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis

9: Wintercreek Drive & Springfield Road

12/6/2012



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	0	35	33	151	49	0
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	0	40	38	172	56	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	302	56	56			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	302	56	56			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	96	98			
cM capacity (veh/h)	673	1011	1549			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	40	209	56			
Volume Left	0	38	0			
Volume Right	40	0	0			
cSH	1011	1549	1700			
Volume to Capacity	0.04	0.02	0.03			
Queue Length 95th (ft)	3	2	0			
Control Delay (s)	8.7	1.5	0.0			
Lane LOS	A	A				
Approach Delay (s)	8.7	1.5	0.0			
Approach LOS	A					
Intersection Summary						
Average Delay			2.2			
Intersection Capacity Utilization	26.4%		ICU Level of Service	A		
Analysis Period (min)	15					

HCM Unsignalized Intersection Capacity Analysis

10: Warnerwood Ct & Springfield Road

12/6/2012



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	0	3	5	146	46	0
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93
Hourly flow rate (vph)	0	3	5	157	49	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	217	49	49			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	217	49	49			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	100	100			
cM capacity (veh/h)	766	1016	1551			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	3	162	49			
Volume Left	0	5	0			
Volume Right	3	0	0			
cSH	1016	1551	1700			
Volume to Capacity	0.00	0.00	0.03			
Queue Length 95th (ft)	0	0	0			
Control Delay (s)	8.6	0.3	0.0			
Lane LOS	A	A				
Approach Delay (s)	8.6	0.3	0.0			
Approach LOS	A					
Intersection Summary						
Average Delay			0.3			
Intersection Capacity Utilization	21.7%		ICU Level of Service	A		
Analysis Period (min)	15					

HCM Unsignalized Intersection Capacity Analysis

11: Springfield Road & Bernard Mills Drive

12/6/2012

	→	↘	↙	←	↖	↗
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑	↗		↖	↘	
Volume (veh/h)	57	89	0	28	18	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	65	101	0	32	20	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None		None			
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			166		97	65
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			166		97	65
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		98	100
cM capacity (veh/h)			1412		908	1005
Direction, Lane #	EB 1	EB 2	WB 1	NB 1		
Volume Total	65	101	32	20		
Volume Left	0	0	0	20		
Volume Right	0	101	0	0		
cSH	1700	1700	1412	908		
Volume to Capacity	0.04	0.06	0.00	0.02		
Queue Length 95th (ft)	0	0	0	2		
Control Delay (s)	0.0	0.0	0.0	9.1		
Lane LOS					A	
Approach Delay (s)	0.0		0.0	9.1		
Approach LOS					A	
Intersection Summary						
Average Delay			0.8			
Intersection Capacity Utilization			15.5%	ICU Level of Service	A	
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis

12: Springfield Road & Olde Hartley Drive

12/6/2012



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↔	↔	↔	↔	↔
Volume (veh/h)	29	28	10	0	0	18
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	33	31	11	0	0	20
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	11				108	11
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	11				108	11
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	98				100	98
cM capacity (veh/h)	1608				864	1061
Direction, Lane #	EB 1	WB 1	WB 2	SB 1		
Volume Total	64	11	0	20		
Volume Left	33	0	0	0		
Volume Right	0	0	0	20		
cSH	1608	1700	1700	1061		
Volume to Capacity	0.02	0.01	0.00	0.02		
Queue Length 95th (ft)	2	0	0	1		
Control Delay (s)	3.8	0.0	0.0	8.5		
Lane LOS	A			A		
Approach Delay (s)	3.8	0.0		8.5		
Approach LOS				A		
Intersection Summary						
Average Delay			4.3			
Intersection Capacity Utilization			19.7%		ICU Level of Service	A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis

13: Springfield Road & Echo Lake Drive

12/6/2012

	→	↘	↙	←	↖	↗
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↗			↖	↗	
Volume (veh/h)	0	28	0	0	10	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	30	0	0	11	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None		None			
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			30		15	15
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			30		15	15
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		99	100
cM capacity (veh/h)			1582		1009	1070
Direction, Lane #	EB 1	WB 1	NB 1			
Volume Total	30	0	11			
Volume Left	0	0	11			
Volume Right	30	0	0			
cSH	1700	1700	1009			
Volume to Capacity	0.02	0.00	0.01			
Queue Length 95th (ft)	0	0	1			
Control Delay (s)	0.0	0.0	8.6			
Lane LOS				A		
Approach Delay (s)	0.0	0.0	8.6			
Approach LOS				A		
Intersection Summary						
Average Delay			2.3			
Intersection Capacity Utilization			13.3%	ICU Level of Service	A	
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis

14: Springfield Road & Old Springfield Road

12/6/2012



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↔	↔		↔	↔
Volume (veh/h)	0	0	0	43	29	0
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	0	0	0	45	31	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						2
Median type		None	None			
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	45				23	23
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	45				23	23
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				97	100
cM capacity (veh/h)	1569				994	1054
Direction, Lane #	EB 1	WB 1	SB 1			
Volume Total	0	45	31			
Volume Left	0	0	31			
Volume Right	0	45	0			
cSH	1700	1700	971			
Volume to Capacity	0.00	0.03	0.03			
Queue Length 95th (ft)	0	0	2			
Control Delay (s)	0.0	0.0	8.8			
Lane LOS			A			
Approach Delay (s)	0.0	0.0	8.8			
Approach LOS			A			
Intersection Summary						
Average Delay			3.6			
Intersection Capacity Utilization		13.3%		ICU Level of Service		A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis

15: Rigney Terrace & Springfield Road

12/6/2012

						
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	0	15	28	43	29	0
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	0	16	30	46	31	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	136	31	31			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	136	31	31			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	98	98			
cM capacity (veh/h)	846	1049	1582			
Direction, Lane #	EB 1	NB 1	SB 1	SB 2		
Volume Total	16	76	31	0		
Volume Left	0	30	0	0		
Volume Right	16	0	0	0		
cSH	1049	1582	1700	1700		
Volume to Capacity	0.02	0.02	0.02	0.00		
Queue Length 95th (ft)	1	1	0	0		
Control Delay (s)	8.5	3.0	0.0	0.0		
Lane LOS	A	A				
Approach Delay (s)	8.5	3.0	0.0			
Approach LOS	A					
Intersection Summary						
Average Delay			2.9			
Intersection Capacity Utilization		20.5%		ICU Level of Service		A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
 16: SR157 & Springfield Road

12/6/2012

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Right Turn Channelized												
Volume (veh/h)	42	367	94	290	397	23	79	6	266	16	10	18
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	46	399	102	315	432	25	86	7	289	17	11	20
Approach Volume (veh/h)		547			772			382			48	
Crossing Volume (veh/h)		343			138			462			833	
High Capacity (veh/h)		1057			1243			962			714	
High v/c (veh/h)		0.52			0.62			0.40			0.07	
Low Capacity (veh/h)		865			1033			780			561	
Low v/c (veh/h)		0.63			0.75			0.49			0.09	
Intersection Summary												
Maximum v/c High			0.62									
Maximum v/c Low			0.75									
Intersection Capacity Utilization			99.8%		ICU Level of Service					F		

Queues

17: Springfield Road & Staples Mill Road

12/6/2012

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Group Flow (vph)	304	232	147	248	353	132	256	519	197	135	794	139
v/c Ratio	0.71	0.75	0.22	0.85	0.92	0.20	0.88	0.43	0.20	0.68	0.79	0.18
Control Delay	60.1	63.7	13.6	74.1	76.4	9.9	79.3	33.6	2.5	67.5	47.5	10.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	60.1	63.7	13.6	74.1	76.4	9.9	79.3	33.6	2.5	67.5	47.5	10.3
Queue Length 50th (ft)	117	173	38	186	269	22	194	167	0	102	308	29
Queue Length 95th (ft)	165	#285	84	#316	#445	62	#334	230	36	165	#393	68
Internal Link Dist (ft)		1531			132			545			464	
Turn Bay Length (ft)	200		575	350		150	350		125	200		75
Base Capacity (vph)	458	313	667	310	392	697	305	1194	984	256	1001	789
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.66	0.74	0.22	0.80	0.90	0.19	0.84	0.43	0.20	0.53	0.79	0.18

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

HCM Signalized Intersection Capacity Analysis

17: Springfield Road & Staples Mill Road

12/6/2012

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	 							 			 	
Volume (vph)	289	220	140	236	335	125	243	493	187	128	754	132
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	7.0	7.0	6.5	7.0	7.0	6.5	6.5	6.3	7.0	6.5	6.7	7.0
Lane Util. Factor	0.97	1.00	1.00	1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	1863	1583	1770	1863	1583	1787	3574	1599	1787	3574	1599
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	1863	1583	1770	1863	1583	1787	3574	1599	1787	3574	1599
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	304	232	147	248	353	132	256	519	197	135	794	139
RTOR Reduction (vph)	0	0	46	0	0	59	0	0	99	0	0	43
Lane Group Flow (vph)	304	232	101	248	353	73	256	519	98	135	794	96
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	1%	1%	1%	1%	1%	1%
Turn Type	Prot		pm+ov	Prot		pm+ov	Prot		pm+ov	Prot		pm+ov
Protected Phases	7	4	1	3	8	5	1	6	3	5	2	7
Permitted Phases			4			8			6			2
Actuated Green, G (s)	14.9	19.9	39.4	19.8	24.8	38.2	19.5	40.1	59.9	13.4	33.6	48.5
Effective Green, g (s)	14.9	19.9	39.4	19.8	24.8	38.2	19.5	40.1	59.9	13.4	33.6	48.5
Actuated g/C Ratio	0.12	0.17	0.33	0.17	0.21	0.32	0.16	0.33	0.50	0.11	0.28	0.40
Clearance Time (s)	7.0	7.0	6.5	7.0	7.0	6.5	6.5	6.3	7.0	6.5	6.7	7.0
Vehicle Extension (s)	3.5	3.5	2.5	3.5	3.5	2.5	2.5	6.0	3.5	2.5	6.0	3.5
Lane Grp Cap (vph)	426	309	520	292	385	504	290	1194	798	200	1001	646
v/s Ratio Prot	0.09	0.12	0.03	c0.14	c0.19	0.02	c0.14	c0.15	0.02	0.08	c0.22	0.02
v/s Ratio Perm			0.03			0.03			0.04			0.04
v/c Ratio	0.71	0.75	0.19	0.85	0.92	0.15	0.88	0.43	0.12	0.68	0.79	0.15
Uniform Delay, d1	50.5	47.7	28.9	48.7	46.6	29.2	49.1	31.1	16.0	51.2	40.0	22.7
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	5.8	10.1	0.1	20.4	26.4	0.1	25.4	1.2	0.1	7.9	6.5	0.1
Delay (s)	56.3	57.8	29.0	69.1	73.0	29.3	74.5	32.3	16.1	59.1	46.4	22.8
Level of Service	E	E	C	E	E	C	E	C	B	E	D	C
Approach Delay (s)		50.9			63.8			40.1			45.0	
Approach LOS		D			E			D			D	

Intersection Summary

HCM Average Control Delay	48.8	HCM Level of Service	D
HCM Volume to Capacity ratio	0.96		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	33.5
Intersection Capacity Utilization	83.8%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

HCM Unsignalized Intersection Capacity Analysis
 18: Springfield Road & SR157

12/6/2012

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Right Turn Channelized												
Volume (veh/h)	202	420	5	21	348	125	7	1	12	71	2	81
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	220	457	5	23	378	136	8	1	13	77	2	88
Approach Volume (veh/h)	682		537				22		167			
Crossing Volume (veh/h)	102		228				753		409			
High Capacity (veh/h)	1279		1158				761		1004			
High v/c (veh/h)	0.53		0.46				0.03		0.17			
Low Capacity (veh/h)	1065		956				603		817			
Low v/c (veh/h)	0.64		0.56				0.04		0.20			
Intersection Summary												
Maximum v/c High			0.53									
Maximum v/c Low			0.64									
Intersection Capacity Utilization			83.9%				ICU Level of Service		E			

Appendix P
Alternative 3
HSM Analysis

Alternative 3 Countermeasure Analysis Details

The potential change in crashes associated with each countermeasure deemed feasible and appropriate were calculated using Chapter 12 (Urban/Suburban Arterials) procedures in the HSM. If a standard error was given, a range of crash reductions is shown. This analysis was completed using forecast design year 2036 traffic volumes. Each countermeasure was analyzed independent of the other countermeasures.

The urban/suburban arterial analysis (Chapter 12 of the HSM) results are displayed Table P1 and Table P2.

Chapter 12 – Urban/Suburban Arterial Analysis

Alternative 3 Segments

Table P1 displays countermeasures for the Chapter 12 urban/suburban analysis as well as recommended segments for each. Source information for the countermeasures can be found in Appendix E.

Table P1 Alternative 3 Segment Countermeasure Analysis Results (Chapter 12)

Countermeasure	Applicable Segment	Predicted Percent Change ¹					
		Total Crashes			Fatal and/or Injury Crashes		
		Low	High	Expected	Low	High	Expected
Segment lighting	E, F, Q	N/A	N/A	7% Reduction	N/A	N/A	7% Reduction
Reduce AADT from 8750 to 2600	G	N/A	N/A	72% Reduction	N/A	N/A	67% Reduction
Reduce AADT from 8450 to 2050	H	N/A	N/A	75% Reduction	N/A	N/A	50% Reduction
Reduce AADT from 8450 to 1550	I	N/A	N/A	80% Reduction	N/A	N/A	75% Reduction
Reduce AADT from 8400 to 1500	J	N/A	N/A	81% Reduction	N/A	N/A	71% Reduction
Reduce AADT from 7800 to 650	K, L	N/A	N/A	91% Reduction	N/A	N/A	86% Reduction
Reduce AADT from 7650 to 0	M, N	N/A	N/A	100% Reduction	N/A	N/A	100% Reduction
Reduce AADT from 7750 to 550	O	N/A	N/A	90% Reduction	N/A	N/A	85% Reduction
Reduce AADT from 7650 to 900	P	N/A	N/A	86% Reduction	N/A	N/A	83% Reduction

¹ Percentages were rounded to the nearest whole number

² N/A – Not Available

³ The standard error from the clearinghouse for this countermeasure is large enough to result in a calculated potential increase in crashes. Still, applying centerline rumble strips is more likely to reduce crashes than result in an increase.

Alternative 3 Intersections

Table P2 displays countermeasures for the Chapter 12 analysis as well as recommended intersections for each. Source information for the countermeasures can be found in Appendix E.

Table P2 Alternative 3 Intersection Countermeasure Analysis Results (Chapter 12)

Countermeasure	Applicable Intersection	Predicted Percent Change ¹					
		Total Crashes			Fatal and/or Injury Crashes		
		Low	High	Expected	Low	High	Expected
Lighting in intersection	1, 7, 16, 17	N/A ²	N/A	9% Reduction	N/A	N/A	9% Reduction
Retime signal and change intervals to ITE standards	17	12% Increase ³	28% Reduction	N/A	10% Increase	34% Reduction	N/A
Convert four-leg intersection to three-leg intersection	10	N/A	N/A	60% Reduction	N/A	N/A	49% Reduction
Convert two-way stop-controlled intersection into roundabout	7, 16	29% Reduction	49% Reduction	N/A	68% Reduction	88% Reduction	N/A
Reduce AADT on major road from 8600 to 2350	8	N/A	N/A	65% Reduction	N/A	N/A	65% Reduction
Reduce AADT on major road from 8450 to 1800	9	N/A	N/A	69% Reduction	N/A	N/A	72% Reduction
Reduce AADT on major road from 8400 to 1550	10	N/A	N/A	95% Reduction	N/A	N/A	94% Reduction
Reduce AADT on major road from 8100 to 1100	11	N/A	N/A	71% Reduction	N/A	N/A	75% Reduction
Reduce AADT on major road from 7800 to 500	12	N/A	N/A	83% Reduction	N/A	N/A	83% Reduction
Reduce AADT on major road from 7200 to 300	13	N/A	N/A	85% Reduction	N/A	N/A	89% Reduction

Reduce AADT on major road from 7700 to 550	14	N/A	N/A	82% Reduction	N/A	N/A	84% Reduction
Reduce AADT on major road from 7700 to 750	15	N/A	N/A	80% Reduction	N/A	N/A	83% Reduction
Increase AADT on major road from 7,900 to 9050	16	N/A	N/A	39% Increase	N/A	N/A	33% Increase
Reduce AADT on minor road from 5750 to 3300	16	N/A	N/A	12% Reduction	N/A	N/A	12% Reduction

¹ Percentages were rounded to the nearest whole number

² Not Available

³ The standard error from the clearinghouse for this countermeasure is large enough to result in a calculated potential increase in crashes. Still, applying proper signal timing to an intersection is more likely to reduce crashes than result in an increase.

The countermeasures analyzed in table P1 and Table P2 are discussed in greater detail in the subsequent section.

Alternative 3 Suggested Countermeasures (Chapter 12)

Segment lighting

Lighting can reduce the total number of crashes by seven percent and fatal/injury crashes by 10 percent on urban/suburban facilities. Alternative 3 assumes segment lighting is installed on segments E, F, and Q as these segments experienced a higher frequency of crashes.

Convert four-leg intersection to three-leg intersection

This conversion can reduce total crashes by 60 percent and fatal/injury crashes by 49 percent on urban/suburban facilities. Available intersection sight distance at Hart Mill Drive was measured to be below AASHTO-recommended minimums. Even though this intersection is not assumed to be improved to an Urban Principal Arterial standard, Alternative 3 assumes this approach is closed given the low volume of traffic turning into and out of this location and the presence of a viable alternative access via Bernard Mills Road.

Lighting in intersections

Lighting individual intersections can reduce the total number of crashes by nine percent as well as fatal/injury crashes on rural two-lane facilities. Intersections lighting includes installing luminaires at the intersection proper and on the approaches. Alternative 3 assumes that the following major intersections within the study limits are lighted:

- SR 157/Nuckols Road (existing traffic signal)
- SR 157/Wintergreen Road/Linsey Lakes Drive (new single-lane roundabout)

- SR 157/Francistown Road (new single-lane roundabout)
- SR 157/Staples Mill Road (modified traffic signal)

Retiming signal change intervals to ITE standards

The standard error from the clearinghouse for this countermeasure is large enough to result in a calculated potential increase in crashes. Still, applying proper signal timing to an intersection is more likely to reduce crashes than result in an increase. Alternative 3 assumes that the signal timing at the SR 157/Staples Mill Road intersection is updated to ITE standards when improved to the future Alternative 1 configuration.

Conversion of two-way stop-controlled intersections into roundabout

Replacing a two-way stop-controlled intersection with a single-lane roundabout can reduce total crashes by 29 to 49 percent and injury crashes by 68 to 88 percent on urban/suburban facilities. An operational analysis of various intersection control forms (all-way stop, roundabout, and traffic signal) at the SR 157/Francistown Road intersection determined that a single-lane roundabout would perform the best. Alternative 3 assumes that the SR 157/Linsey Lakes Drive and SR 157/Francistown Road intersections are converted to single-lane roundabouts.

Reduce AADT

Reducing AADT on roadway segments and at intersections can reduce total crashes anywhere from 6 to 70 percent and fatal/injury crashes by 7 to 100 percent on urban/suburban arterial facilities depending on the magnitude of the reduction. Alternative 3 will generally reduce AADT on the existing portion of Springfield Road between the SR 157/Linsey Lakes Drive and SR 157/Francistown Road intersections due to the diversion of as much as 75 percent of the total corridor traffic to the new alignment and disconnecting existing Springfield Road to through vehicles between Echo Lake Drive and Echo Lake Park. However, disconnecting SR 157 at Echo Lake Park will force some local trips to reroute via the new alignment, resulting in a net increase in AADT at the SR 157/Linsey Lakes Drive and SR 157/Francistown Road intersections, resulting in a potential increase in crashes due at these locations relative to the no-build condition.

Additional Recommended Countermeasures

As noted previously, the study corridor contains roadway characteristics that are also somewhat consistent with a rural road. As such, Chapter 10 (Rural Two Lane Roadways) countermeasures applicable to the study corridor were also included.

Achieve roadside hazard rating of 3

Provision of a 10 foot clear zone and guardrail would help achieve a roadside hazard rating of three, and is expected to reduce total crashes by 6 to 18 percent and fatal crashes by 9 to 19 percent on rural two-lane facilities. Alternative 3 assumes a ten foot clear zone is provided on all segments A through C, E, and Q as part of the design changes to the SR 157 study corridor. Segment D already provides a minimum clear zone of 10 feet. No guardrail is assumed on segments M.1, M.2, and N.1 to address the high frequency of crashes since Alternative 3 closes these segments to through traffic.

Alternative 3 Safety Summary

Table P3 shows the results of the urban/suburban analysis of Alternative 3 compared with the future no-build.

Table P3 Predicted Annual Crashes for Alternative 3 (Chapter 12)

Alternative	Predicted Annual Crashes		
	Fatal/Injury	Property Damage Only	Total
No-Build	6.71	12.66	19.37
Alternative 3	5.13	10.27	15.40
Percent Change	-24%	-15%	-20%

According to Table P3, Alternative 3 is predicted to reduce the crash frequency along Springfield Road by an average of 20 percent. Fatal/injury crashes are predicted to be reduced by 24 percent and property damage only crashes by 15 percent.

Safety Benefit/Cost Analysis Methodology

Disclaimer:

VDOT does not have statewide calibration factors to adjust the generic HSM methods to specific VDOT facilities. As such, calculating an **absolute** dollar value benefit for the predicted reduction in crashes for Alternative 2 compared to the no-build condition is not possible. In this case, the calculated cost benefit of alternatives compared to the no-build condition is valid only for relative comparison between alternatives. If calibration factors are developed by VDOT in the future, it would be possible to calculate the actual expected average number of crashes for the no-build and Alternative 3 conditions and calculate an absolute dollar value benefit of Alternative 3 relative to the no-build scenario.

A benefit-cost (B/C) analysis was conducted for Alternative 2 using crash-cost values contained in the year 2012 Highway Safety Improvement Program (HSIP) Federal Year (FY) 2012-2013 worksheet published by VDOT. A dollar value benefit of the calculated reduction in total expected annual crashes was calculated for an assumed service life of the project of 25 years.

Predicted crashes were allocated on the KABCO scale based on the statewide crash distribution pattern for rural undivided roads year 2008 data (most are 2 lane, some are 4 lane) provided by VDOT. The allocated crashes were multiplied by their respective cost and again by the assumed 25-year service life. The sum of these totals represents the total cost of all predicted crashes for each scenario. Because the calculated cost benefit is only relative, results from the Chapter 12 (Table P3) analysis were used exclusively for the cost benefit comparison. Table P4 summarizes the cost benefit calculations.

Table P4 Cost Benefit Calculations – Alternative 3

Total Predicted Annual Crashes	Crash Severity	VDOT Distribution by Severity	Cost per Crash	Predicted Annual Crashes by Severity Type	25-Year Service Life Cost of Crashes
No-Build					
19.37	K – Killed	1.6%	\$5,038,456	0.31	\$39,048,034
	A – Incapacitating Injury	17.9%	\$275,161	3.46	\$23,801,426
	B – Non-incapacitating Injury	10.1%	\$98,140	1.95	\$4,784,325
	C – Possible Injury	13.8%	\$55,474	2.67	\$3,702,889
	O – No Injury	56.7%	\$9,029	10.98	\$2,478,460
TOTAL					\$73,815,134
Alternative 3					
15.40	K – Killed	1.6%	\$5,038,456	0.25	\$31,490,350
	A – Incapacitating Injury	17.9%	\$275,161	2.75	\$18,917,319
	B – Non-incapacitating Injury	10.1%	\$98,140	1.55	\$3,802,925
	C – Possible Injury	13.8%	\$55,474	2.12	\$2,940,122
	O – No Injury	56.7%	\$9,029	8.73	\$1,970,579
TOTAL					\$59,121,295
Cost Benefit of Alternative 3 compared to No-Build Scenario					\$14,693,839

As shown in Table P4, Alternative 3 is calculated to result in an uncalibrated overall cost benefit of \$14,693,839 compared to the no-build scenario.

At the request of VDOT, segments affected by the potential construction of a new alignment were separated out to isolate the relative cost-benefit of identified improvements. Table P5 isolates the total predicted annual crashes of existing SR 157 for just those segments affected by the proposed new alignment for both the no-build and Alternative 3 scenarios.

Table P5 Cost Benefit Calculations – Alternative 3 (Portion of SR 157 Affected by New Alignment)

Total Predicted Annual Crashes	Crash Severity	VDOT Distribution by Severity	Cost per Crash	Predicted Annual Crashes by Severity Type	25-Year Service Life Cost of Crashes
No-Build					
9.61	K – Killed	1.6%	\$5,038,456	0.15	\$19,367,825
	A – Incapacitating Injury	17.9%	\$275,161	1.72	\$11,833,230
	B – Non-incapacitating Injury	10.1%	\$98,140	0.97	\$2,381,392
	C – Possible Injury	13.8%	\$55,474	1.33	\$1,839,213
	O – No Injury	56.7%	\$9,029	5.44	\$1,227,689
TOTAL					\$36,649,348
Alternative 3					
6.18	K – Killed	1.6%	\$5,038,456	0.10	\$12,455,063
	A – Incapacitating Injury	17.9%	\$275,161	1.11	\$7,609,715
	B – Non-incapacitating Injury	10.1%	\$98,140	0.62	\$1,531,426
	C – Possible Injury	13.8%	\$55,474	0.85	\$1,182,761
	O – No Injury	56.7%	\$9,029	3.49	\$788,697
TOTAL					\$23,567,662
Cost Benefit of Alternative 3 compared to No-Build Scenario (Portion of SR 157 Affected by New Alignment)					\$13,081,686

Segments affected by the construction of a new alignment were isolated to compare the relative cost-benefit of improvements limited only to the sections of SR 157 impacted by the new alignment. As shown in Table P5, Alternative 3 is calculated to result in an uncalibrated cost benefit of \$13,081,686 compared to the no-build scenario on just the portion of SR 157 affected by the new alignment. Of the total \$14.7 million savings calculated for Alternative 3, roughly 89 percent (\$13.1M) is attributable to improvements to SR 157 between Linsey Lakes Road and Francistown Road.

General Information

Analyst	ACJ	Analysis Name	Alternative3-Chapter12	Date of Analysis	12/18/2012
Agency/Company	Kittelson & Associates, Inc.	Project Number/PIN #	11764.16	Comments	
State	Virginia	Site(s)	Springfield Road		
Region/Area/City/County	Glen Allen/Henrico County	Jurisdiction	Henrico County		

Analysis Summary Results

Crash Severity Distribution	Crash Frequency		
	Fatal and Injury (FI)	Property Damage Only (PDO)	Total
Total Predicted Crashes (entire study period)	4.73	9.16	13.90
Total Predicted Crashes (crashes/year)	4.73	9.16	13.90
Total Expected Crashes (entire study period)	0.29	0.00	0.29
Total Expected Crashes (crashes/year)	0.29	0.00	0.29
1 - Nuckols Road/Springfield Road	0.78	1.57	2.35
Total Predicted Crashes (crashes/year)	0.78	1.57	2.35
Total Expected Crashes (crashes/year)	0.03	0.00	0.03
A - Nuckols Road to Firsedide Drive	0.05	0.12	0.16
Total Predicted Crashes (crashes/year)	0.05	0.12	0.16
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
2 - Springfield Road/Fireside Drive	0.10	0.15	0.25
Total Predicted Crashes (crashes/year)	0.10	0.15	0.25
Total Expected Crashes (crashes/year)	0.01	0.00	0.01
B - Fireside Drive to Kingscroft Drive	0.09	0.24	0.33
Total Predicted Crashes (crashes/year)	0.09	0.24	0.33
Total Expected Crashes (crashes/year)	0.00	0.00	0.00

Analysis Summary Results

Crash Severity Distribution	Crash Frequency		
	Fatal and Injury (FI)	Property Damage Only (PDO)	Total
3 - Springfield Road/Kingscroft Drive	0.10	0.14	0.24
Total Predicted Crashes (crashes/year)	0.10	0.14	0.24
Total Expected Crashes (crashes/year)	0.01	0.00	0.01
C - Kingscroft Drive to Wendhurst Drive	0.04	0.10	0.14
Total Predicted Crashes (crashes/year)	0.04	0.10	0.14
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
4 - Springfield Road/Wendhurst Drive	0.09	0.13	0.22
Total Predicted Crashes (crashes/year)	0.09	0.13	0.22
Total Expected Crashes (crashes/year)	0.01	0.00	0.01
D - Wendhurst Drive to Jones Road	0.03	0.08	0.11
Total Predicted Crashes (crashes/year)	0.03	0.08	0.11
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
5 - Springfield Road/Jones Road	0.07	0.09	0.16
Total Predicted Crashes (crashes/year)	0.07	0.09	0.16
Total Expected Crashes (crashes/year)	0.01	0.00	0.01
E - Jones Road to Olde Milbrooke Way	0.06	0.15	0.21
Total Predicted Crashes (crashes/year)	0.06	0.15	0.21
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
6 - Springfield Road/Olde Milbrooke Way	0.40	0.71	1.12
Total Predicted Crashes (crashes/year)	0.40	0.71	1.12
Total Expected Crashes (crashes/year)	0.04	0.00	0.04

Analysis Summary Results

Crash Severity Distribution	Crash Frequency		
	Fatal and Injury (FI)	Property Damage Only (PDO)	Total
F - Olde Milbrooke Way to Linsey Lakes Drive	0.08	0.20	0.28
Total Predicted Crashes (crashes/year)	0.08	0.20	0.28
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
18 - Springfield Road/Linsey Lakes Drive/SR157	0.60	1.00	1.60
Total Predicted Crashes (crashes/year)	0.60	1.00	1.60
Total Expected Crashes (crashes/year)	0.06	0.00	0.06
R - Linsey Lakes Drive to Wintergreen Road	0.03	0.06	0.09
Total Predicted Crashes (crashes/year)	0.03	0.06	0.09
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
7 - Springfield Road/Wintergreen Road	0.12	0.20	0.32
Total Predicted Crashes (crashes/year)	0.12	0.20	0.32
Total Expected Crashes (crashes/year)	0.01	0.00	0.01
G - Wintergreen Road to Jacobs Creek Drive	0.04	0.08	0.12
Total Predicted Crashes (crashes/year)	0.04	0.08	0.12
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
8 - Springfield Road/Jacobs Creek Drive	0.09	0.13	0.22
Total Predicted Crashes (crashes/year)	0.09	0.13	0.22
Total Expected Crashes (crashes/year)	0.01	0.00	0.01
H - Jacobs Creek Drive to Wintercreek Drive	0.01	0.01	0.02
Total Predicted Crashes (crashes/year)	0.01	0.01	0.02

Analysis Summary Results

Crash Severity Distribution	Crash Frequency		
	Fatal and Injury (FI)	Property Damage Only (PDO)	Total
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
9 - Springfield Road/Wintercreek Drive	0.07	0.11	0.18
Total Predicted Crashes (crashes/year)	0.07	0.11	0.18
Total Expected Crashes (crashes/year)	0.01	0.00	0.01
I - Wintercreek Drive to Wamerwood Court	0.01	0.02	0.03
Total Predicted Crashes (crashes/year)	0.01	0.02	0.03
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
10 - Springfield Road/Wamerwood Court	0.03	0.03	0.06
Total Predicted Crashes (crashes/year)	0.03	0.03	0.06
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
J - Wamerwood Court to Bernard Mills Drive	0.02	0.03	0.05
Total Predicted Crashes (crashes/year)	0.02	0.03	0.05
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
11 - Springfield Road/Bernard Mills Drive	0.05	0.09	0.14
Total Predicted Crashes (crashes/year)	0.05	0.09	0.14
Total Expected Crashes (crashes/year)	0.01	0.00	0.01
K - Bernard Mills Drive to Olde Hartley Drive	0.01	0.01	0.02
Total Predicted Crashes (crashes/year)	0.01	0.01	0.02
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
12 - Springfield Road/Olde Hartley Drive	0.03	0.04	0.07

Analysis Summary Results

Crash Severity Distribution	Crash Frequency		
	Fatal and Injury (FI)	Property Damage Only (PDO)	Total
Total Predicted Crashes (crashes/year)	0.03	0.04	0.07
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
L - Olde Hartley Drive to Echo Lake Drive	0.01	0.01	0.01
Total Predicted Crashes (crashes/year)	0.01	0.01	0.01
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
13 - Springfield Road/Echo Lake Drive	0.02	0.04	0.06
Total Predicted Crashes (crashes/year)	0.02	0.04	0.06
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
M - Echo Lake Drive through End of Horizontal Curve 1	0.00	0.00	0.00
Total Predicted Crashes (crashes/year)	0.00	0.00	0.00
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
N - Start of Horizontal Curve 2 to Old Springfield Rd	0.00	0.00	0.00
Total Predicted Crashes (crashes/year)	0.00	0.00	0.00
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
14 - Springfield Road/Old Springfield Rd	0.04	0.06	0.10
Total Predicted Crashes (crashes/year)	0.04	0.06	0.10
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
O - Old Springfield Road to Rigney Terrace	0.01	0.02	0.03
Total Predicted Crashes (crashes/year)	0.01	0.02	0.03
Total Expected Crashes (crashes/year)	0.00	0.00	0.00

Analysis Summary Results

Crash Severity Distribution	Crash Frequency		
	Fatal and Injury (FI)	Property Damage Only (PDO)	Total
15 - Springfield Road/Rigney Terrace	0.03	0.05	0.08
Total Predicted Crashes (crashes/year)	0.03	0.05	0.08
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
P - Rigney Terrace to Francistown Road	0.01	0.02	0.03
Total Predicted Crashes (crashes/year)	0.01	0.02	0.03
Total Expected Crashes (crashes/year)	0.00	0.00	0.00
16 - SR 157/Springfield Road/Springfield Road/Francistown Road	0.46	0.99	1.45
Total Predicted Crashes (crashes/year)	0.46	0.99	1.45
Total Expected Crashes (crashes/year)	0.02	0.00	0.02
Q - Francistown Road to Staples Mill Road	0.24	0.59	0.84
Total Predicted Crashes (crashes/year)	0.24	0.59	0.84
Total Expected Crashes (crashes/year)	0.01	0.00	0.01
17 - Staples Mill Road/Springfield Road	0.92	1.90	2.82
Total Predicted Crashes (crashes/year)	0.92	1.90	2.82
Total Expected Crashes (crashes/year)	0.04	0.00	0.04

General Information

Analyst	ACJ	Analysis Name	Alternative3-Chapter12	Date of Analysis	12/18/2012
Agency/Company	Kittelson & Associates, Inc.	Project Number/PIN #	11764.16	Comments	
State	Virginia	Site(s)	Springfield Road		
Region/Area/City/County	Glen Allen/Henrico County	Jurisdiction	Henrico County		

Input Data

Segment Name	** Linsey Lakes Drive to Francistown Road		
Road Type	Two-lane undivided arterials (2U)		
Length of segment, L (mi)	0.830		
Analysis Year	2036		
AADT (veh/day)	7,650		
Type of on-street parking	None		
Land use	Residential/Other		
Curb length with parking			
Median width (ft)	10-ft (1-ft to 14-ft)		
Lighting	Yes		
Automated speed enforcement	No		
Major commercial driveways	0		
Minor commercial driveways	0		
Major industrial driveways	0		
Minor industrial driveways	0		
Major residential driveways	0		
Minor residential driveways	0		
Other driveways	0		
Speed category	>30mph		
Roadside fixed object density (fixed objects/mi)	75		
Offset to roadside fixed objects (ft)	10		
Calibration Factor, Cr	1.000		
Total Observed Crashes	FI	PDO	Total

Summary Results

	Fatal and Injury (FI)	Property Damage Only (PDO)	Total
Predicted Annual Avg Crash Frequency	0.4	1.1	1.5
Expected Annual Avg Crash Frequency	0.0	0.0	0.0
Roadway segment length, L (mi)	0.83	0.83	0.83
Crash rate (crashes/mi/year)	0.5	1.3	1.8

Crash Severity Distribution

	Fatal and Injury (FI)	Property Damage Only (PDO)	Total
Multiple-Vehicle			
Rear-end collisions	0.182	0.462	0.643
Head-on collisions	0.017	0.002	0.019
Angle collisions	0.021	0.047	0.068
Sideswipe, same direction	0.004	0.018	0.022
Sideswipe, opposite direction	0.018	0.033	0.051
Driveway-related collisions	0.000	0.000	0.000
Other multiple-vehicle collision	0.007	0.031	0.039
Subtotal	0.249	0.593	0.842
Single-Vehicle			
Collision with animal	0.004	0.032	0.036
Collision with fixed object	0.115	0.369	0.484
Collision with other object	0.002	0.006	0.008
Other single-vehicle collision	0.038	0.079	0.117
Collision with pedestrian	0.007		0.007

Appendix Q
Alternative 3 Preliminary
Estimate of Probable Cost

Springfield Road (SR 157) Alternatives Analysis
Task Order 12-023A

VDOT ITEM #	ITEM	Quantity	UNIT	UNIT PRICE	COST
	RECONSTRUCT MAINLINE	1,500	LF	\$532.84	\$799,264.45
	RECONSTRUCT LOCAL ROAD	8,000	LF	\$518.14	\$4,145,118.67
	NEW CONSTRUCTION MAINLINE	5,000	LF	\$625.49	\$3,127,469.08
	NEW CONSTRUCTION LOCAL ROAD	500	LF	\$656.59	\$328,296.91
	CUL-DE-SAC	2	EA	\$20,000.00	\$40,000.00
	STAPLES MILL INTERSECTION IMPROVEMENTS	1	LS	\$2,306,500.00	\$2,306,500.00
	GUARDRAIL	2,500	LF	\$22.00	\$55,000.00
	ROUNDABOUTS	2	EA	\$500,000.00	\$1,000,000.00
	INTERSECTION LIGHTING	4	EA	\$3,000.00	\$12,000.00
	CORRIDOR LIGHTING	7,500	LF	\$32.53	\$244,000.00
	CLOSE HART MILL ROAD	1	LS	\$20,000.00	\$20,000.00
	MAJOR DRAINAGE	1	LS	\$1,100,000.00	\$1,100,000.00
	WETLANDS MITIGATION	2	AC	\$50,000.00	\$100,000.00
	STREAM MITIGATION	200	LF	\$300.00	\$60,000.00
	BICYCLE/PEDESTRIAN PATH	1,000	LF	\$35.00	\$35,000.00
	WATER QUALITY (BASINS)	2	EA	\$15,000.00	\$30,000.00
	WATER QUALITY (FILTERRAS)	25	EA	\$10,000.00	\$250,000.00
					\$13,652,649.11

Sub Total from above	\$13,652,649.11
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CEI	\$2,047,897.37
PE	\$1,774,844.38

Total Section Cost	\$17,475,390.86
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