

Alternatives Analysis

Springfield Road (SR 157) Alternatives Analysis

Henrico County, Virginia

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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.