U.S. Route 60 Corridor
Richmond District

U.S. Route 60 Corridor – East Special Area Plan

Powhatan County, Virginia

March 2017

Revised June 2017

Prepared for:

Virginia Department of Transportation
Central Region Operations Traffic Engineering
(UPC 106217, Task Order #237)

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U.S. Route 60 Corridor – East Special Area Plan

From Chesterfield County Line to Route 678 (Rocky Oak Road)

Powhatan County, Virginia

Prepared for:

Virginia Department of Transportation
Central Region Operations
(UPC 106217, Task Order #237)

Prepared by:

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Executive Summary

Timmons Group performed an operational and improvement alternatives analysis of the U.S. Route 60 corridor in Powhatan County, extending from the Chesterfield County Line to Rocky Oak Road (Route 678) at Dorset Road (Route 622). The tasks associated with this analysis included:

- Existing AM and PM peak hour counts at the eight (8) study intersections.
- A review of recent crash history at the eight (8) study intersections (2011 – 2015).
- Calculation of annual growth rate based upon historic VDOT traffic count data and Powhatan County official planning and zoning documents.
- Developing future traffic forecasts for the year 2036 (20 years).
- Traffic capacity and queueing analysis at each of the eight (8) study intersections for existing (2016) conditions, background future conditions (2036) without improvements, and future conditions (2036) with improvements.
- Identifying potential intersection improvements aimed at improving operational issues within the study corridor.
- Stakeholder meetings with citizens (2 meetings), the Powhatan County Planning Commission, and the Powhatan County Board of Supervisors.

The key findings of the corridor analysis are as follows:

- The study intersections experienced approximately 20 crashes per year during the five-year study period. There are minimal trend lines drawn from the overall crash data. A large spike in the overall number of crashes occurred between 2013 and 2014, but the next year saw a regression to the general trends of the corridor.
- The U.S. Route 60 intersections with Stavemill Road and Dorset Road experienced the highest number of crashes over the five-year study period.
- At all four (4) signalized study intersections, mainline queuing issues are present which block access to existing turn lanes. The signalized intersections generally operate at overall acceptable levels of service; however, the side street approaches and mainline left turns operate at poor levels of service in both peak hours.
- At the four (4) unsignalized study intersections, the side street approaches (lefts) have poor levels of service, delays, and queues due to the volume on U.S. Route 60.
- Based on data provided by the County and VDOT, it is anticipated that the corridor will experience a 1.1% annual growth rate over the next twenty (20) years.
- Under 2036 background traffic conditions (with no improvements), the growth in traffic will exacerbate the issues at the study intersections identified under existing conditions.

- In order to accommodate the increase in traffic anticipated in 2036, the following improvements are recommended:
    - Optimize the signal timings throughout the corridor.
    - At the signalized U.S. Route 60/Stavemill Road intersection
        - Install second westbound left turn lane;
        - Add an overlap phase for the northbound right turn lane;
        - Restrict westbound U-turns; and
        - Modify the traffic signal to facilitate the above improvements.
    - In the vicinity of the South Creek One intersection
        - Add striping to the curb lane to clearly delineate the travel way.
    - At the unsignalized U.S. Route 60/Urbine Road/Batterson Road intersection
        - Install a dedicated southbound right turn lane.
    - At the signalized U.S. Route 60/Jude's Ferry Road intersection
        - Install second eastbound left turn lane;
        - Install a second northbound lane on Jude's Ferry Road for dual receiving lanes; and
        - Modify the traffic signal to facilitate the above improvements.

      NOTE: These improvements may not be required if school traffic utilizes the alternative route discussed below.
    - At the U.S. Route 60/New Dorset Road intersection
        - Install a dedicated northbound right turn lane.
    - At the U.S. Route 60/Batterson Road intersection
        - Install signage to encourage traffic traveling to Powhatan High School to make a left turn onto Batterson Road.
    - At the U.S. Route 60/Dorset Road intersection
        - Install an exclusive left turn lane on the northbound approach;
        - Implement concurrent side street phasing; and
        - Modify the traffic signal to facilitate the above improvements
    - At the Jude's Ferry Road/Batterson Road intersection
        - Install 110' inscribed diameter, single-lane roundabout.

- If traffic continues to grow as anticipated, there are several locations where turn lanes may need to be lengthened to accommodate the maximum queues.
- With the improvements noted above and the projected traffic volumes in 2036, each of the study intersections shows improvement in levels of service, queuing, and delay. Mainline queuing issues are associated only with the heavy through movement volumes and not turn lanes that are over capacity.
- Per the report findings, the U.S. Route 60 corridor is currently operating under capacity, with some intersections having specific operational issues. The individual intersection improvement options noted above provide reductions in operational issues and provide additional capacity to handle the 1.1% annual growth expected over the next 20 years.
    - The existing four-lane section (two lanes in each direction) of U.S. Route 60 will adequately accommodate the projected 2036 traffic volumes. The analysis does not demonstrate the need to widen U.S. Route 60 to six-lanes in the study corridor.

1 INTRODUCTION

At the request of the Virginia Department of Transportation (VDOT) Central Region Operations Traffic Engineering, a corridor safety and analysis study was performed along U.S. Route 60 (Anderson Highway), from the Chesterfield County Line to Route 678 (Rocky Oak Road) at Route 622 (Dorset Road) in Powhatan County, Virginia. The study area included the following eight (8) intersections:

1. U.S. Route 60/Route 634 (Stavemill Road/Luck Stone Road);
2. U.S. Route 60/South Creek One;
3. U.S. Route 60/Route 676 (Urbine Road)/Route 677 (Batterson Road);
4. U.S. Route 60/Route 613 (Jude's Ferry Road);
5. U.S. Route 60/Route 1043 (New Dorset Road);
6. U.S. Route 60/Route 677 (Batterson Road);
7. U.S. Route 60/Route 622 (Dorset Road); and
8. Jude's Ferry Road/Batterson Road.

The study area extents and intersections are shown on Figure 1-1 (all figures are presented at the end of the respective chapter).

1.1 PROJECT SCOPE

Per the scope of services (VDOT CRO Task Order #237) and the subsequent kick off meeting, the following steps were taken to assess intersection operations and crash history and identify recommended modifications related to intersection geometry and traffic control along the corridor:

1. Data Collection – Peggy Malone & Associates (PMA) performed peak hour directional turning movement counts at seven (7) signalized and unsignalized intersections along the U.S. Route 60 corridor, as well as the unsignalized intersection of Route 613 (Jude's Ferry Road) and Route 677 (Batterson Road) on March 3, 2016. This work was completed under a separate task order (VDOT CRO Task Order #258).
2. Crash Analysis – Timmons Group utilized publically available VDOT data for five (5) years of crash data, for the period of January 1, 2011 through December 31, 2015, for the study area. Timmons Group reviewed and compiled the crash data and prepared collision diagrams for the functional area of the eight (8) study intersections.
3. Future Volume Projections – Timmons Group projected future 2036 background traffic growth volumes using a VDOT-approved annual growth rate of 1.1% for the U.S Route 60 corridor.
4. Capacity Analysis – Timmons Group performed capacity analyses for the AM and PM peak hours for existing (2016) conditions, future (2036) background (without improvements), and future (2036) build conditions (with improvements) using Synchro 9.
5. Queuing Analysis – Timmons Group performed queuing analyses of the AM and PM peak hours for the existing (2016) conditions, future (2036) background (without improvements), and future (2036) build conditions (with improvements) using SimTraffic. The results of the queuing analyses were used to determine the recommended turn lane storage lengths.
6. Improvement Options – Timmons Group prepared schematic improvement options for each of the study intersections, where applicable.

7. Stakeholder Meetings – Timmons Group facilitated a total of four (4) stakeholder meetings with citizens, the Powhatan County Planning Commission, and the Powhatan County Board of Supervisors.

1.2 BACKGROUND INFORMATION

As part of the U.S. Route 60 Corridor East Special Area Plan, Powhatan County is currently preparing a master plan for the study area that extends from the Chesterfield County Line to Rocky Oak Road (Route 678) at Dorset Road (Route 622). The Special Area Plan provides analysis of the dynamics between land development and transportation, and the interacting influences within the study area. The Special Area Plan details a shared vision of the corridor area and recommended strategies to address land use and transportation issues based on residential/commercial build-out scenarios along the corridor study area. A draft copy of the U.S. Route 60 East Corridor Advance Planning Study was included as Appendix A (dated July 2016).

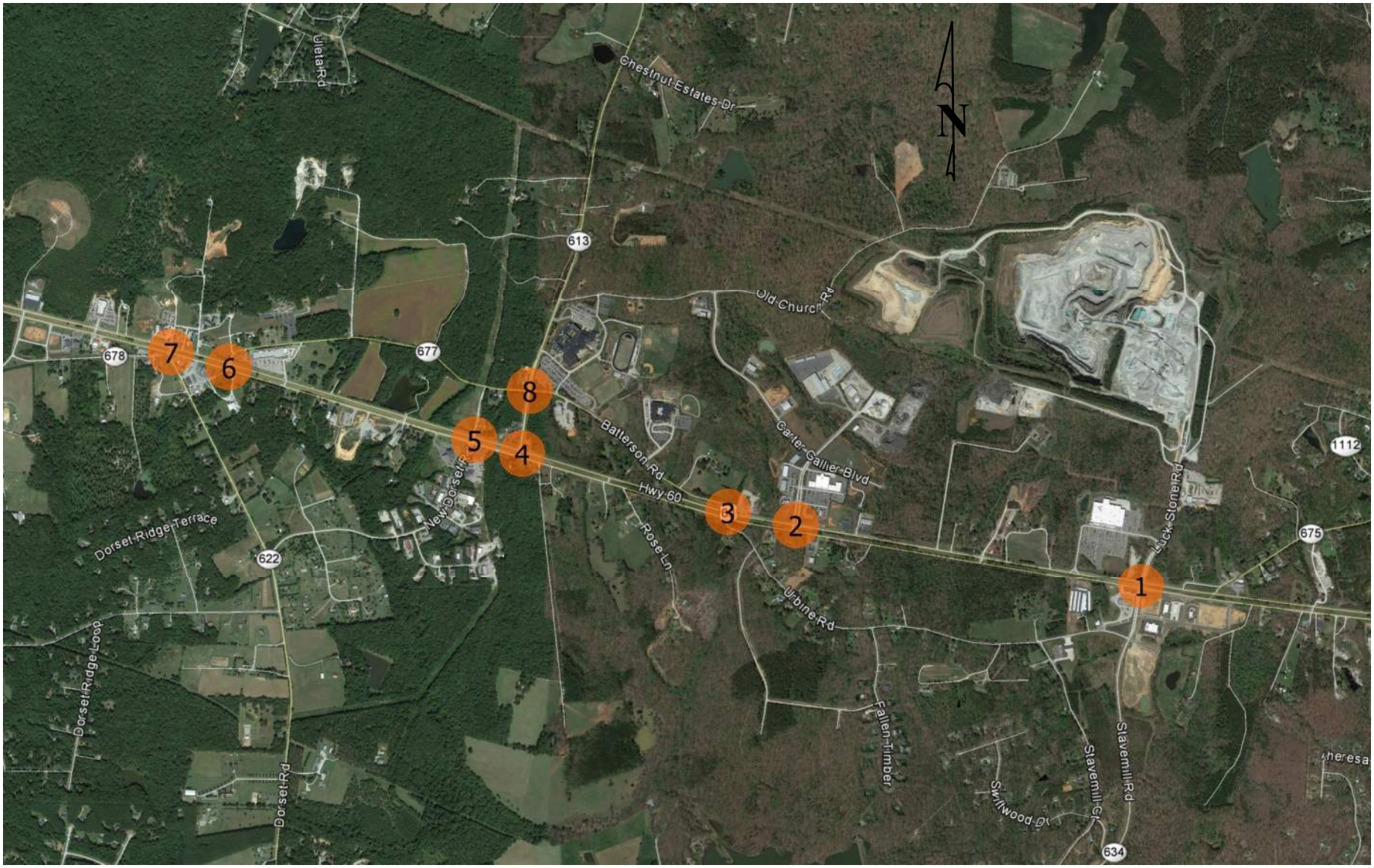
This report provides a supplemental transportation assessment to assist Powhatan County with managing land use and transportation decisions along the U.S. Route 60 corridor. The report documents expected growth along the U.S. Route 60 corridor, assessing potential build out scenarios for development in residential and commercial areas. Potential transportation improvements for the entire corridor and individual intersections are included.

U.S. Route 60 (Anderson Highway) is a 4-lane median divided facility with a posted speed limit of 55 mph within the study area and a typical median with of 60 feet. U.S. Route 60 is classified as an "other principal arterial" located in a rural area and acts as the major east-west thoroughfare for Powhatan County. U.S. Route 60 connects many major routes within Powhatan County and serves to provide direct access to Chesterfield County and Route 288 to the east and Cumberland County to the West. Current VDOT traffic data collected along the study area indicate volumes that range from 28,000 AADT on the western end (near Dorset Road) to 32,000 AADT on the eastern end (near the Chesterfield County line). U.S. Route 60 is designated as a Corridor of Statewide Significance (CoSS).

The study area includes the following eight (8) intersections:

1. U.S. Route 60/Route 634 (Stavemill Road/Luck Stone Road);
2. U.S. Route 60/South Creek One;
3. U.S. Route 60/Route 676 (Urbine Road)/Route 677 (Batterson Road);
4. U.S. Route 60/Route 613 (Jude's Ferry Road);
5. U.S. Route 60/Route 1043 (New Dorset Road);
6. U.S. Route 60/Route 677 (Batterson Road);
7. U.S. Route 60/Route 622 (Dorset Road); and
8. Jude's Ferry Road/Batterson Road.

Stavemill Road, Urbine Road, Batterson Road, Jude's Ferry Road, and Dorset Road are all classified as rural major collectors. All of the roadways that intersect with U.S. Route 60 have AADT volumes less than 6,000. All eight (8) intersections within the project area are shown on Figure 1-1.



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CRO Task Order #237
Study Intersections

Figure
1-1

2 DATA COLLECTION

Data collection for this project was completed under a previous VDOT CRO Task Order (#258), by Peggy Malone & Associates (PMA), and presented within this report in order to provide up-to-date information on the study area.

PMA collected AM and PM peak hour data on Thursday March 3, 2016. Peak hour directional turning movement counts were collected from 7 AM to 9 AM and from 4 PM to 7 PM. This data included heavy vehicles, U-turns, bicycle, and pedestrian counts. The peak hours across the U.S. Route 60 occurred from 7:00 – 8:00 AM and 4:45 – 5:45 PM.

The complete count data can be found in Appendix B and are summarized on Figure 2-1. The existing lane use and traffic control at the intersections is shown on Figure 2-2.

Current VDOT traffic data collected along the study area indicate average daily traffic along U.S. Route 60 ranges from 28,000 AADT on the western end (near Dorset Road) to 32,000 AADT on the eastern end (near the Chesterfield County line).

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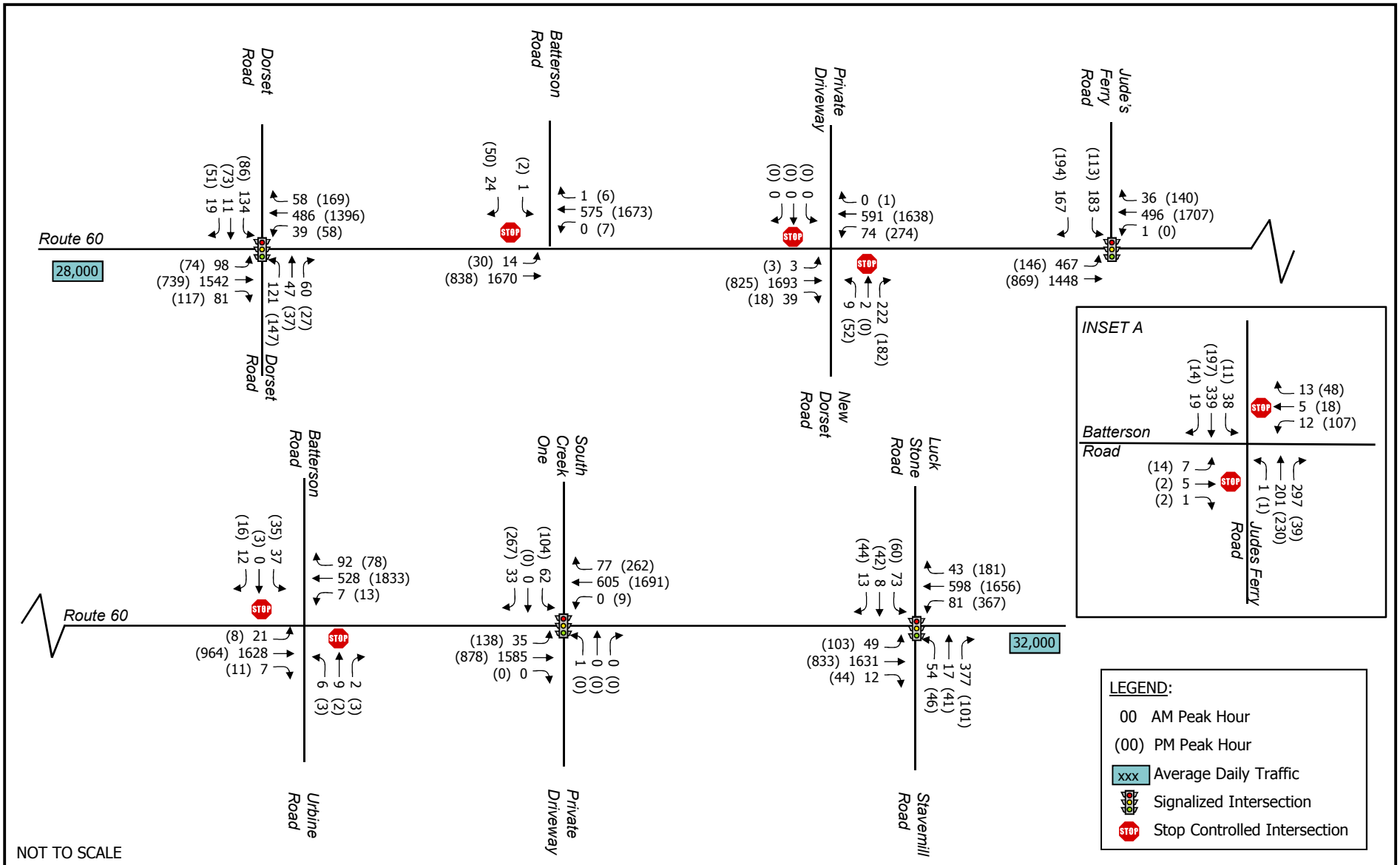

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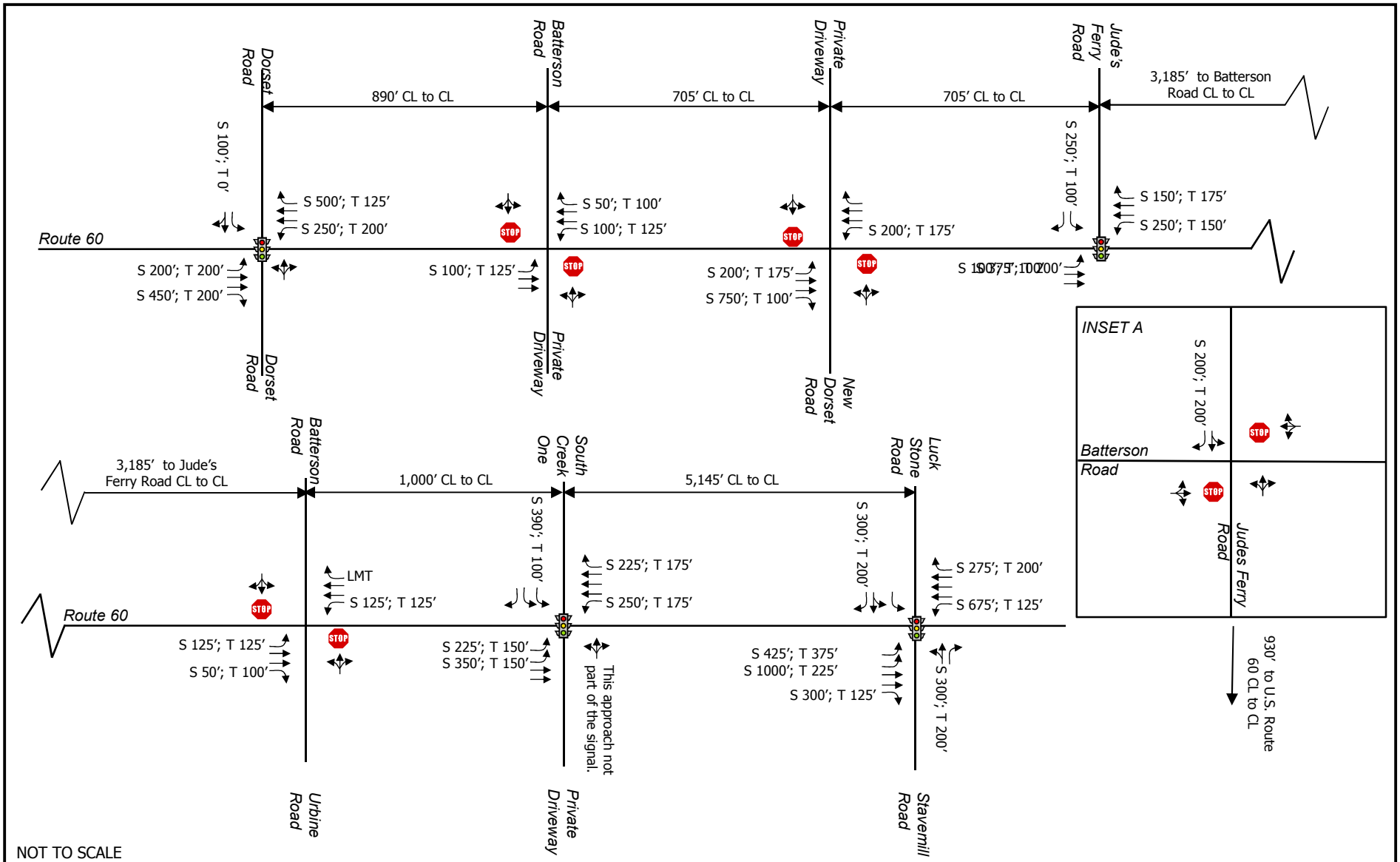
CRO Task Order #237
Existing (2016) Peak Hour Volumes

Figure
2-1



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CRO Task Order #237
Existing Lane Use and Traffic Control

Figure
2-2

3 CRASH ANALYSIS

Timmons Group utilized publicly available VDOT crash data, through the OutsideVDOT portal, for a five-year period from January 1, 2011 through December 31, 2015. The provided data set indicated that multiple crashes occurred within 500' of the eight (8) study intersections during the five-year review period. The crash analysis did not perform a review of all crashes that occurred along the corridor, only the study intersection locations. The crashes were analyzed by collision type and severity.

Table 3-1 shows the number of crashes per year by collision type for the entire U.S. Route 60 corridor. Angle crashes and rear end crashes were the most common crash type during the five-year study period, comprising approximately 95% of all reported crashes at all eight (8) study intersections. The only other types of crashes were fixed object – off road crashes, which represented six (6) crashes within the study period and comprised approximately 5% of all reported crashes each.

Table 3-1: Crash Summary by Collision Type

Collision Type	2011	2012	2013	2014	2015	Total	%
Rear End	6	3	11	19	13	52	46%
Angle	12	12	9	13	8	54	48%
Fixed Object - Off Road	1	1	0	1	3	6	5%
Total Crashes	*19*	*16*	*20*	*33*	*24*	*112*	*100%*

Table 3-2 shows the number of crashes per year by crash severity. During the 2011 to 2015 study period, there were 49 injury-only crashes and 63 property damage only crashes. As shown, there were slightly more property damage only crashes at the study intersections.

Table 3-2: Crash Summary by Severity

Crash Severity	2011	2012	2013	2014	2015	Total	%
Fatal Crashes	0	0	0	0	0	0	0%
Injury Only Crashes	7	7	12	14	9	49	44%
Prop. Damage Only Crashes	12	9	8	19	15	63	56%
Total Crashes	*19*	*16*	*20*	*33*	*24*	*112*	*100%*

Cumulatively, the study intersections experienced approximately 20 crashes per year during the five-year study period. There are minimal trend lines drawn from the overall crash data. A large spike in the overall number of crashes occurred between 2013 and 2014, but the next year saw a regression to the general trends of the corridor. The data does not indicate the reason behind the spike and subsequent regression.

The following eight (8) tables (Tables 3-3 through 3-10) display the collision type and severity for all crashes that occurred at the study intersections.

Table 3-3 shows the number of crashes that occurred at the intersection of U.S. Route 60 and Stavemill Road during the five-year study period. There is a noticeable increase in crashes between the 2011-2013 period to the 2014-2015 period. Stavemill Road was realigned around 2010 and Wal-Mart was constructed and opened to the north of the intersection in 2012. Beginning in late 2015, more commercial development has occurred on the southeast corner of the intersection. Figure 3-1 displays the crash diagram of all 27 crashes that occurred at this intersection during the study period.

Table 3-3: Crash Summary – Stavemill Road

Crash Severity	**2011**	**2012**	**2013**	**2014**	**2015**	**Total**	**%**
Fatal Crashes	0	0	0	0	0	0	0%
Injury Only Crashes	1	1	1	5	3	11	41%
Prop. Damage Only Crashes	2	1	2	5	6	16	59%
Total Crashes	*3*	*2*	*3*	*10*	*9*	*27*	*100%*
Collision Type	**2011**	**2012**	**2013**	**2014**	**2015**	**Total**	**%**
Rear End	2	0	2	8	5	17	63%
Angle	1	2	1	2	2	8	30%
Fixed Object - Off Road	0	0	0	0	2	2	7%
Total Crashes	*3*	*2*	*3*	*10*	*9*	*27*	*100%*

Table 3-4 shows the number of crashes that occurred at the intersection of U.S. Route 60 and South Creek One during the five-year study period. There is no noticeable pattern for the crashes at this intersection; there have been approximately three (3) each year. Figure 3-2 displays the crash diagram of all 16 crashes that occurred at this intersection during the study period.

Table 3-4: Crash Summary – South Creek One

Crash Severity	**2011**	**2012**	**2013**	**2014**	**2015**	**Total**	**%**
Fatal Crashes	0	0	0	0	0	0	0%
Injury Only Crashes	2	3	1	2	1	9	56%
Prop. Damage Only Crashes	1	1	2	1	2	7	44%
Total Crashes	*3*	*4*	*3*	*3*	*3*	*16*	*100%*
Collision Type	**2011**	**2012**	**2013**	**2014**	**2015**	**Total**	**%**
Rear End	1	2	2	2	2	9	56%
Angle	2	2	1	1	0	6	38%
Fixed Object - Off Road	0	0	0	0	1	1	6%
Total Crashes	*3*	*4*	*3*	*3*	*3*	*16*	*100%*

Table 3-5 shows the number of crashes that occurred at the intersection of U.S. Route 60 and Urbine Road/Batterson Road during the five-year study period. There is no noticeable pattern for the crashes at this intersection; there have been approximately three (3) each year. Figure 3-3 displays the crash diagram of all 17 crashes that occurred at this intersection during the study period.

Table 3-5: Crash Summary – Urbine Road/Batterson Road

Crash Severity	**2011**	**2012**	**2013**	**2014**	**2015**	**Total**	**%**
Fatal Crashes	0	0	0	0	0	0	0%
Injury Only Crashes	0	2	1	1	2	6	35%
Prop. Damage Only Crashes	3	2	2	1	3	11	65%
Total Crashes	*3*	*4*	*3*	*2*	*5*	*17*	*100%*
Collision Type	**2011**	**2012**	**2013**	**2014**	**2015**	**Total**	**%**
Rear End	0	0	0	0	2	2	12%
Angle	3	3	3	1	3	13	76%
Fixed Object - Off Road	0	1	0	1	0	2	12%
Total Crashes	*3*	*4*	*3*	*2*	*5*	*17*	*100%*

Table 3-6 shows the number of crashes that occurred at the intersection of U.S. Route 60 and Jude's Ferry Road during the five-year study period. There is no noticeable pattern for the crashes at this intersection; there have been approximately two (2) each year. Figure 3-4 displays the crash diagram of all 10 crashes that occurred at this intersection during the study period.

Table 3-6: Crash Summary – Jude's Ferry Road

Crash Severity	**2011**	**2012**	**2013**	**2014**	**2015**	**Total**	**%**
Fatal Crashes	0	0	0	0	0	0	0%
Injury Only Crashes	1	0	2	1	0	4	40%
Prop. Damage Only Crashes	1	1	0	3	1	6	60%
Total Crashes	*2*	*1*	*2*	*4*	*1*	*10*	*100%*
Collision Type	**2011**	**2012**	**2013**	**2014**	**2015**	**Total**	**%**
Rear End	1	0	2	3	1	7	70%
Angle	0	1	0	1	0	2	20%
Fixed Object - Off Road	1	0	0	0	0	1	10%
Total Crashes	*2*	*1*	*2*	*4*	*1*	*10*	*100%*

Table 3-7 shows the number of crashes that occurred at the intersection of U.S. Route 60 and New Dorset Road during the five-year study period. There is no noticeable pattern for the crashes at this intersection; there has been approximately one (1) each year. Figure 3-5 displays the crash diagram of all five (5) crashes that occurred at this intersection during the study period.

Table 3-7: Crash Summary – New Dorset Road

Crash Severity	**2011**	**2012**	**2013**	**2014**	**2015**	**Total**	**%**
Fatal Crashes	0	0	0	0	0	0	0%
Injury Only Crashes	0	0	0	1	0	1	20%
Prop. Damage Only Crashes	2	1	0	1	0	4	80%
Total Crashes	*2*	*1*	*0*	*2*	*0*	*5*	*100%*
Collision Type	**2011**	**2012**	**2013**	**2014**	**2015**	**Total**	**%**
Rear End	1	0	0	0	0	1	20%
Angle	1	1	0	2	0	4	80%
Fixed Object - Off Road	0	0	0	0	0	0	0%
Total Crashes	*2*	*1*	*0*	*2*	*0*	*5*	*100%*

Table 3-8 shows the number of crashes that occurred at the intersection of U.S. Route 60 and Batterson Road during the five-year study period. There is no noticeable pattern for the crashes at this intersection; there has been approximately one (1) each year. Figure 3-6 displays the crash diagram of all seven (7) crashes that occurred at this intersection during the study period.

Table 3-8: Crash Summary – Batterson Road

Crash Severity	**2011**	**2012**	**2013**	**2014**	**2015**	**Total**	**%**
Fatal Crashes	0	0	0	0	0	0	0%
Injury Only Crashes	1	0	0	2	2	5	71%
Prop. Damage Only Crashes	0	0	1	1	0	2	29%
Total Crashes	*1*	*0*	*1*	*3*	*2*	*7*	*100%*
Collision Type	**2011**	**2012**	**2013**	**2014**	**2015**	**Total**	**%**
Rear End	0	0	1	2	1	4	57%
Angle	1	0	0	1	1	3	43%
Fixed Object - Off Road	0	0	0	0	0	0	0%
Total Crashes	*1*	*0*	*1*	*3*	*2*	*7*	*100%*

Table 3-9 shows the number of crashes that occurred at the intersection of U.S. Route 60 and Dorset Road during the five-year study period. There is a noticeable increase in crashes between the 2013/2014 years. However, the number of crashes in 2015 falls more in line with the average. A review of the area shows that there has been minimal development along the roadway and properties which could explain the change. Figure 3-7 displays the crash diagram of all 25 crashes that occurred at this intersection during the study period.

Table 3-9: Crash Summary –Dorset Road

Crash Severity	**2011**	**2012**	**2013**	**2014**	**2015**	**Total**	**%**
Fatal Crashes	0	0	0	0	0	0	0%
Injury Only Crashes	2	1	6	2	1	12	48%
Prop. Damage Only Crashes	2	1	1	6	3	13	52%
Total Crashes	*4*	*2*	*7*	*8*	*4*	*25*	*100%*
Collision Type	**2011**	**2012**	**2013**	**2014**	**2015**	**Total**	**%**
Rear End	1	0	4	4	2	11	44%
Angle	3	2	3	4	2	14	56%
Fixed Object - Off Road	0	0	0	0	0	0	0%
Total Crashes	*4*	*2*	*7*	*8*	*4*	*25*	*100%*

Table 3-9 shows the number of crashes that occurred at the intersection of Jude's Ferry Road and Batterson Road during the five-year study period. There is no noticeable pattern for the crashes at this intersection; there has been approximately one (1) each year. Figure 3-8 displays the crash diagram of all five (5) crashes that occurred at this intersection during the study period.

Table 3-10: Crash Summary – Jude's Ferry Road at Batterson Road

Crash Severity	**2011**	**2012**	**2013**	**2014**	**2015**	**Total**	**%**
Fatal Crashes	0	0	0	0	0	0	0%
Injury Only Crashes	0	0	1	0	0	1	20%
Prop. Damage Only Crashes	1	2	0	1	0	4	80%
Total Crashes	*1*	*2*	*1*	*1*	*0*	*5*	*100%*
Collision Type	**2011**	**2012**	**2013**	**2014**	**2015**	**Total**	**%**
Rear End	0	1	0	0	0	1	20%
Angle	1	1	1	1	0	4	80%
Fixed Object - Off Road	0	0	0	0	0	0	0%
Total Crashes	*1*	*2*	*1*	*1*	*0*	*5*	*100%*

The crashes along the entire corridor are shown on Figures 3-9 through 3-11. None of the intersections or study segments are within the Top 100 locations for crashes in the Richmond District.

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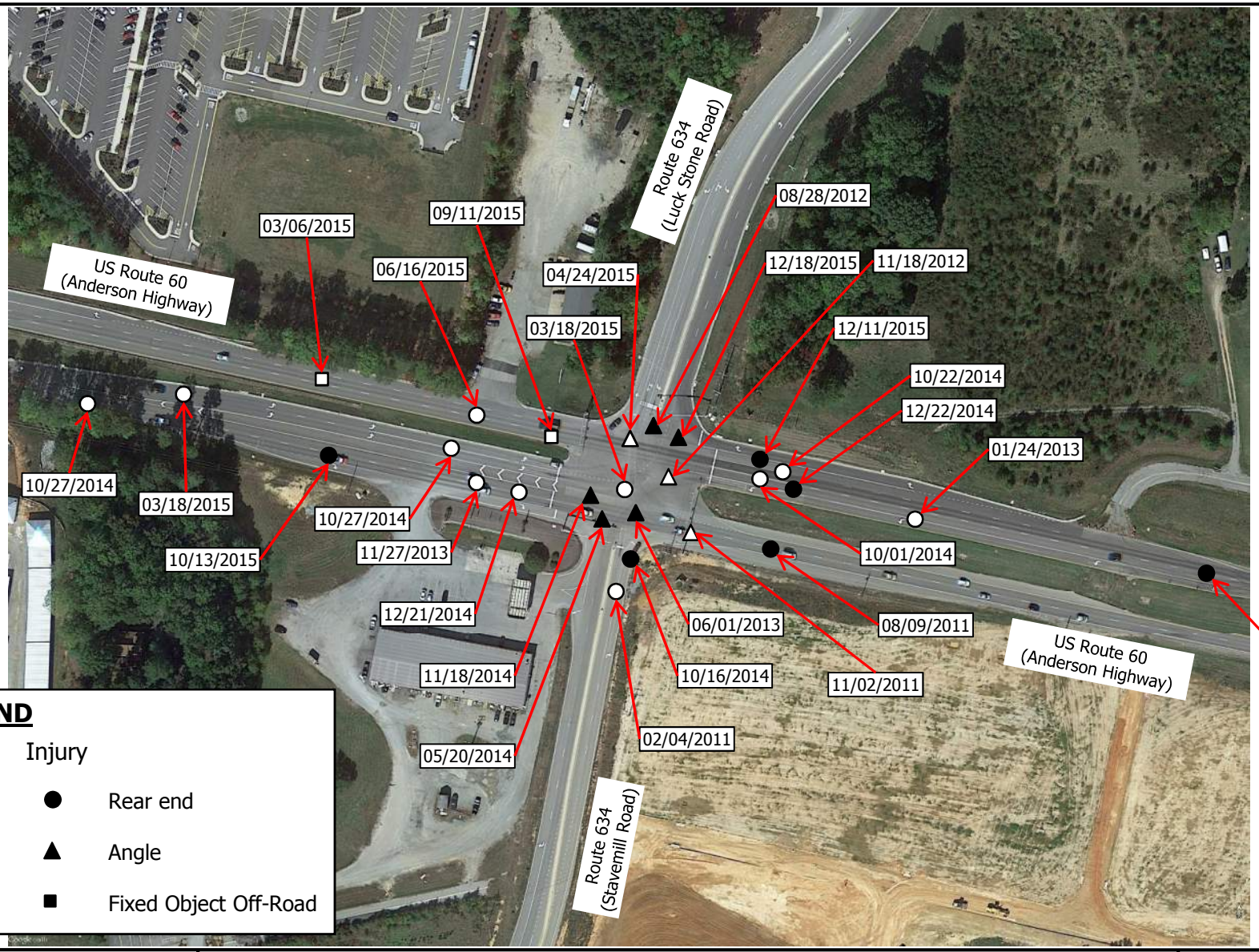

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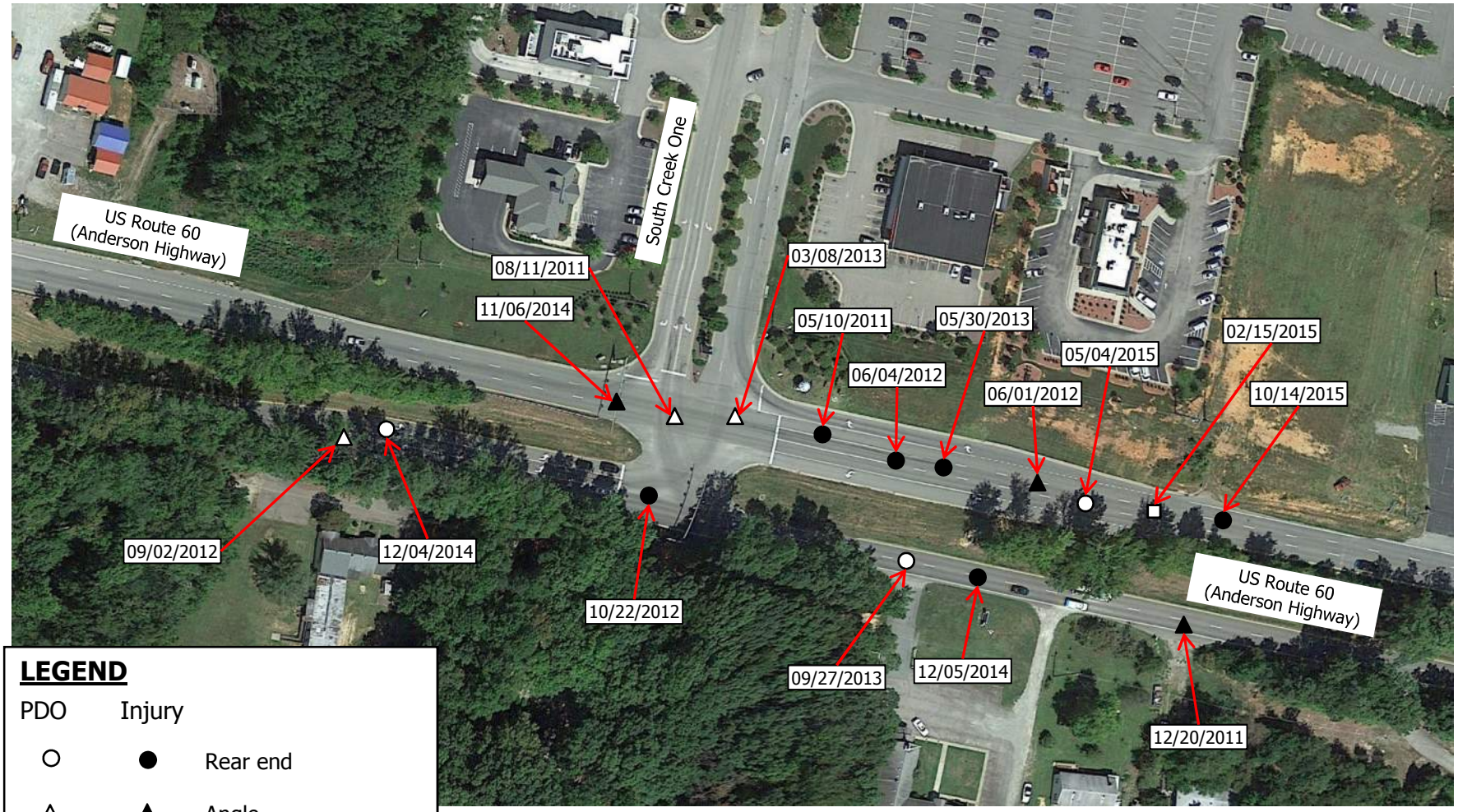
CRO Task Order #237
U.S. Route 60 at Stavemill Road/Luck Stone Road
2011-2015 Crashes

Figure
3-1



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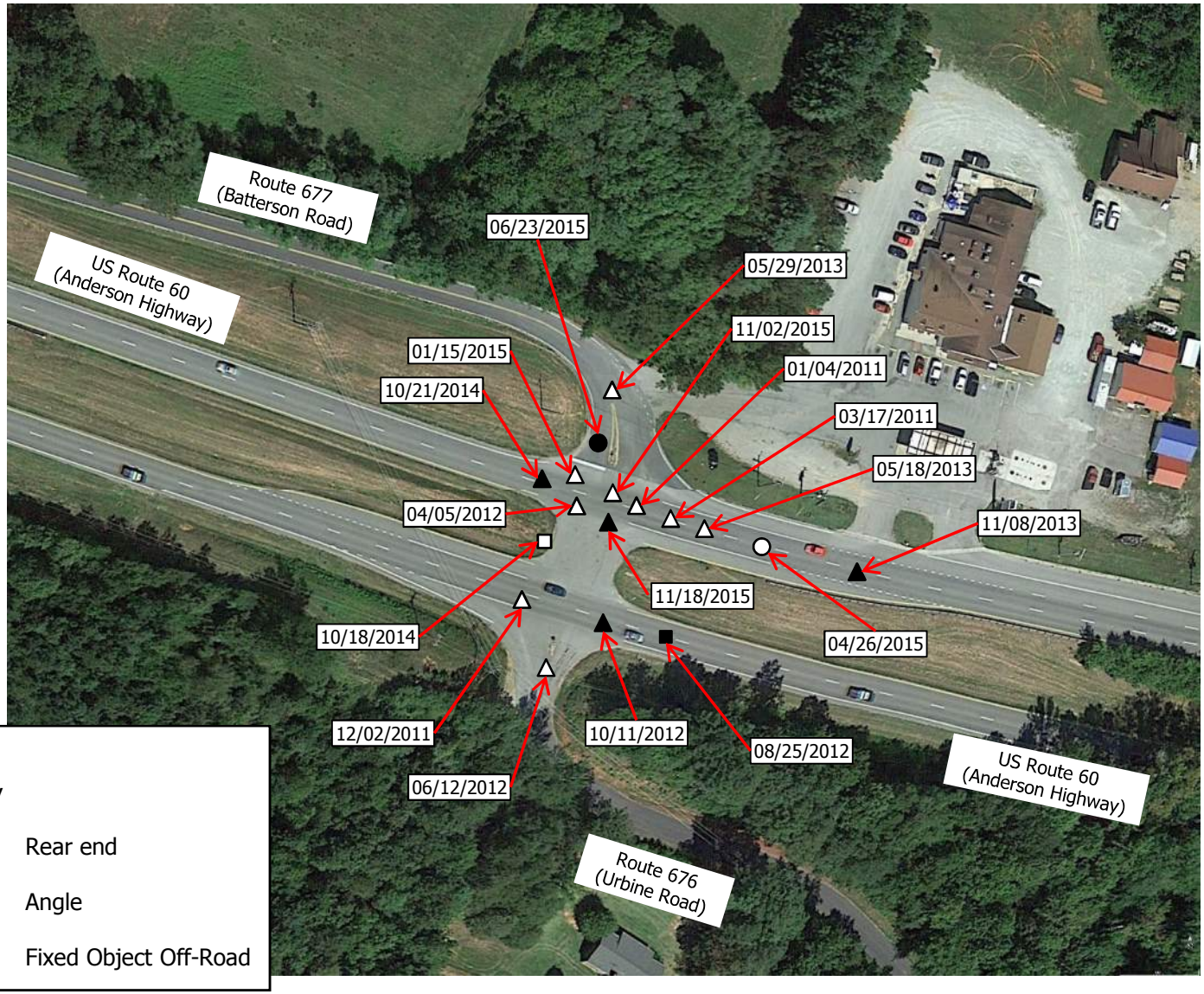
CRO Task Order #237
U.S. Route 60 at South Creek One
2011-2015 Crashes

Figure
3-2



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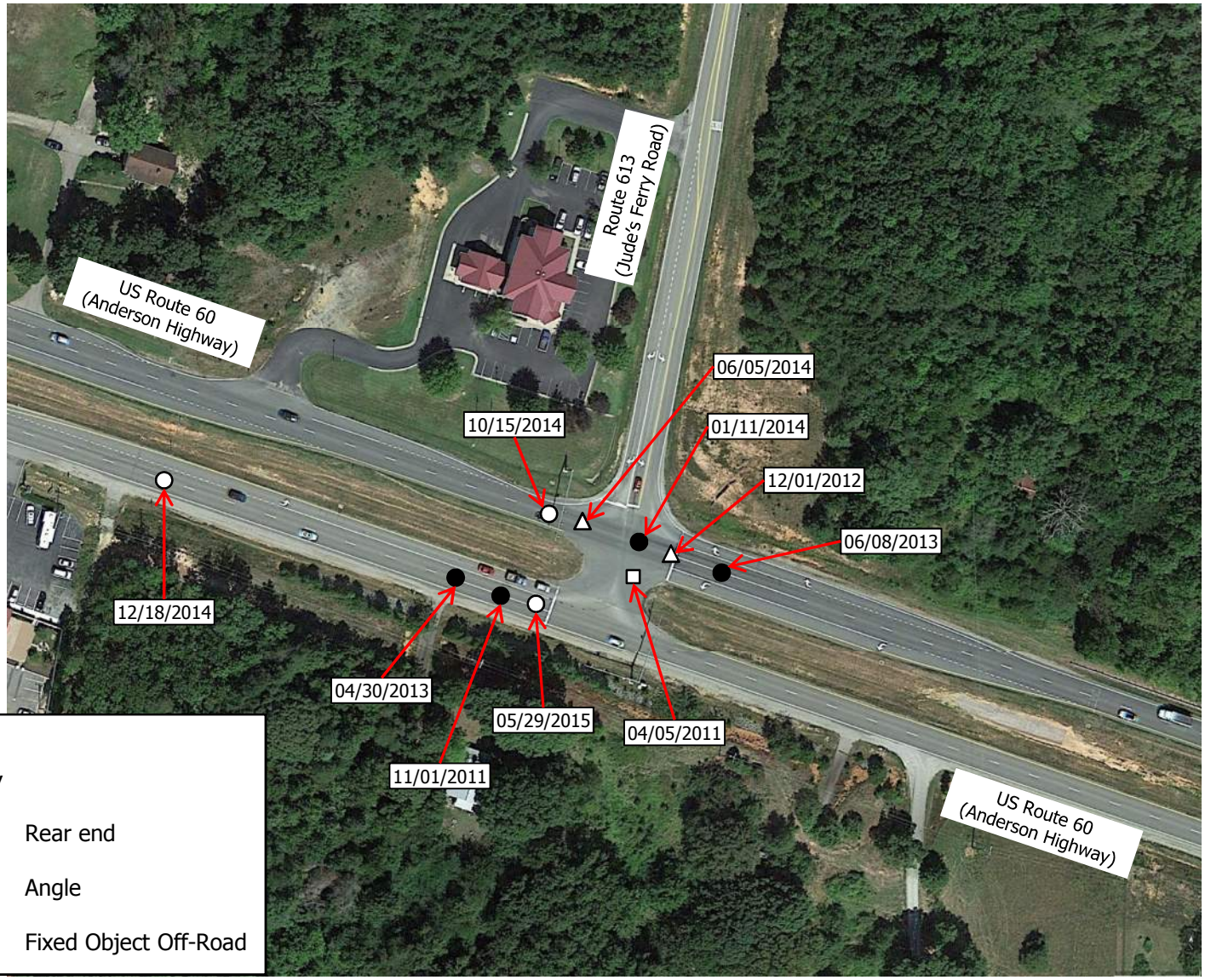
U.S. Route 60 at Urbine Road/Batterson Road
2011-2015 Crashes

Figure
3-3



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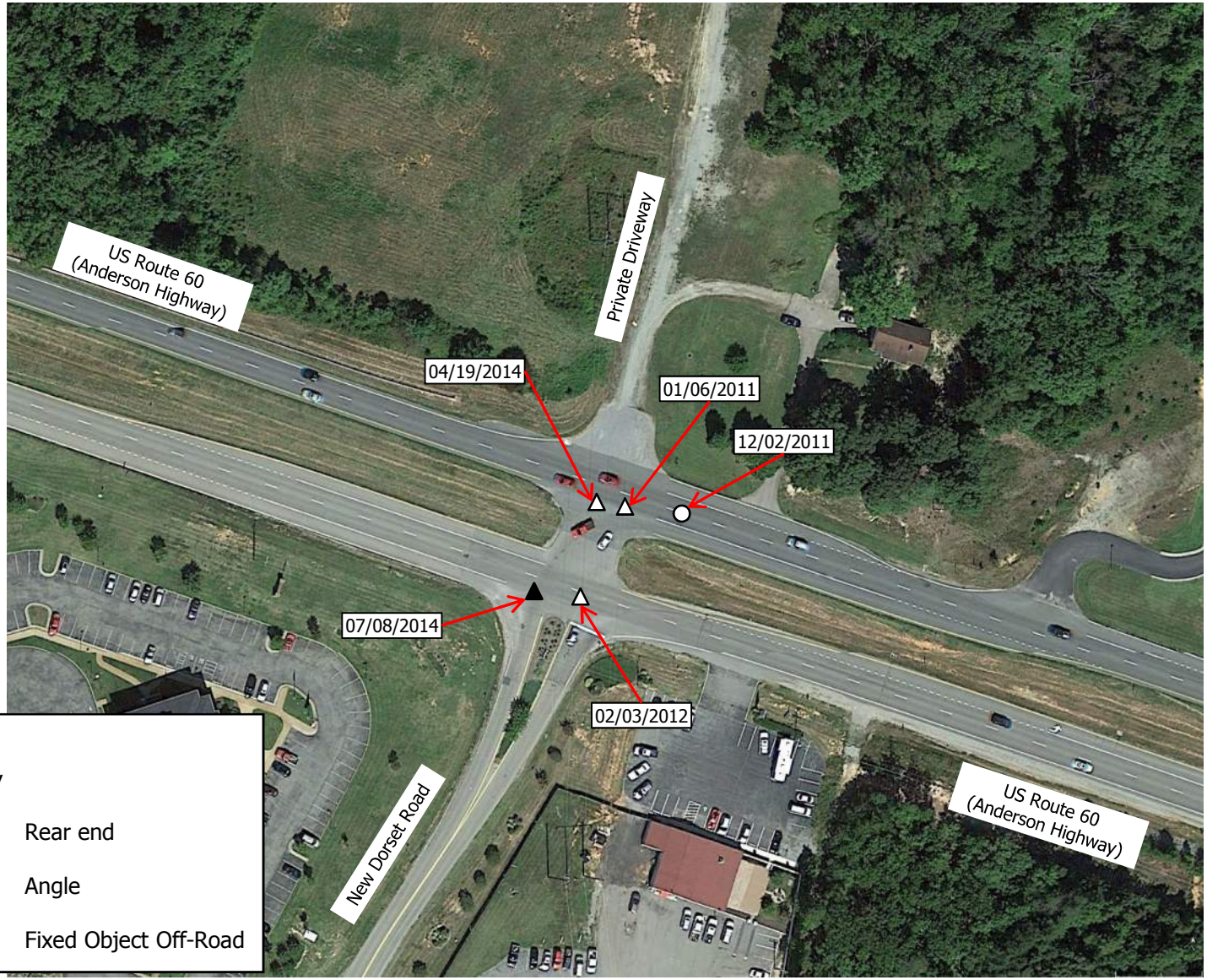
CRO Task Order #237
U.S. Route 60 at Jude's Ferry Road
2011-2015 Crashes

Figure
3-4



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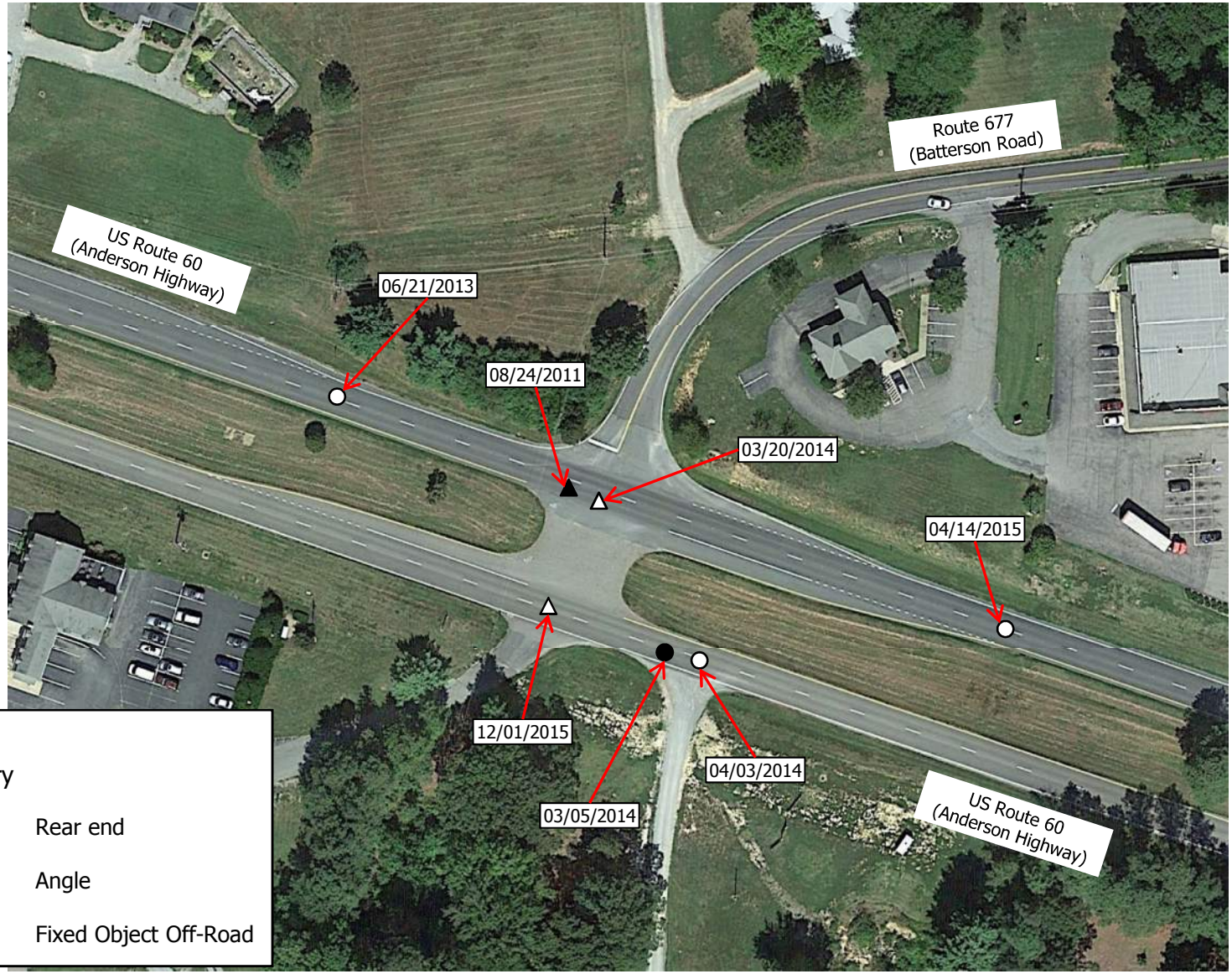
CRO Task Order #237
U.S. Route 60 at New Dorset Road
2011-2015 Crashes

Figure
3-5



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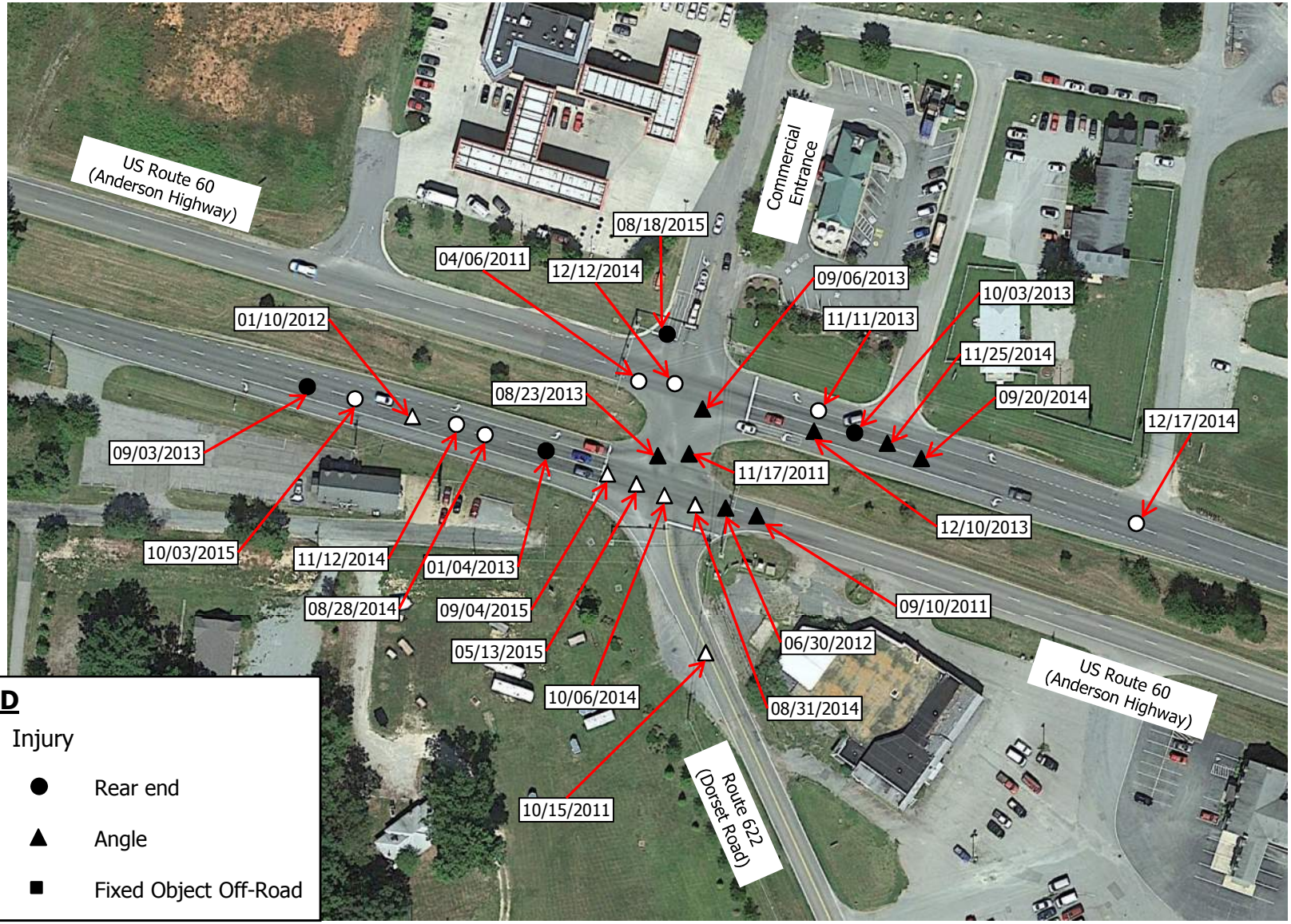
CRO Task Order #237
U.S. Route 60 at Batterson Road
2011-2015 Crashes

Figure
3-6



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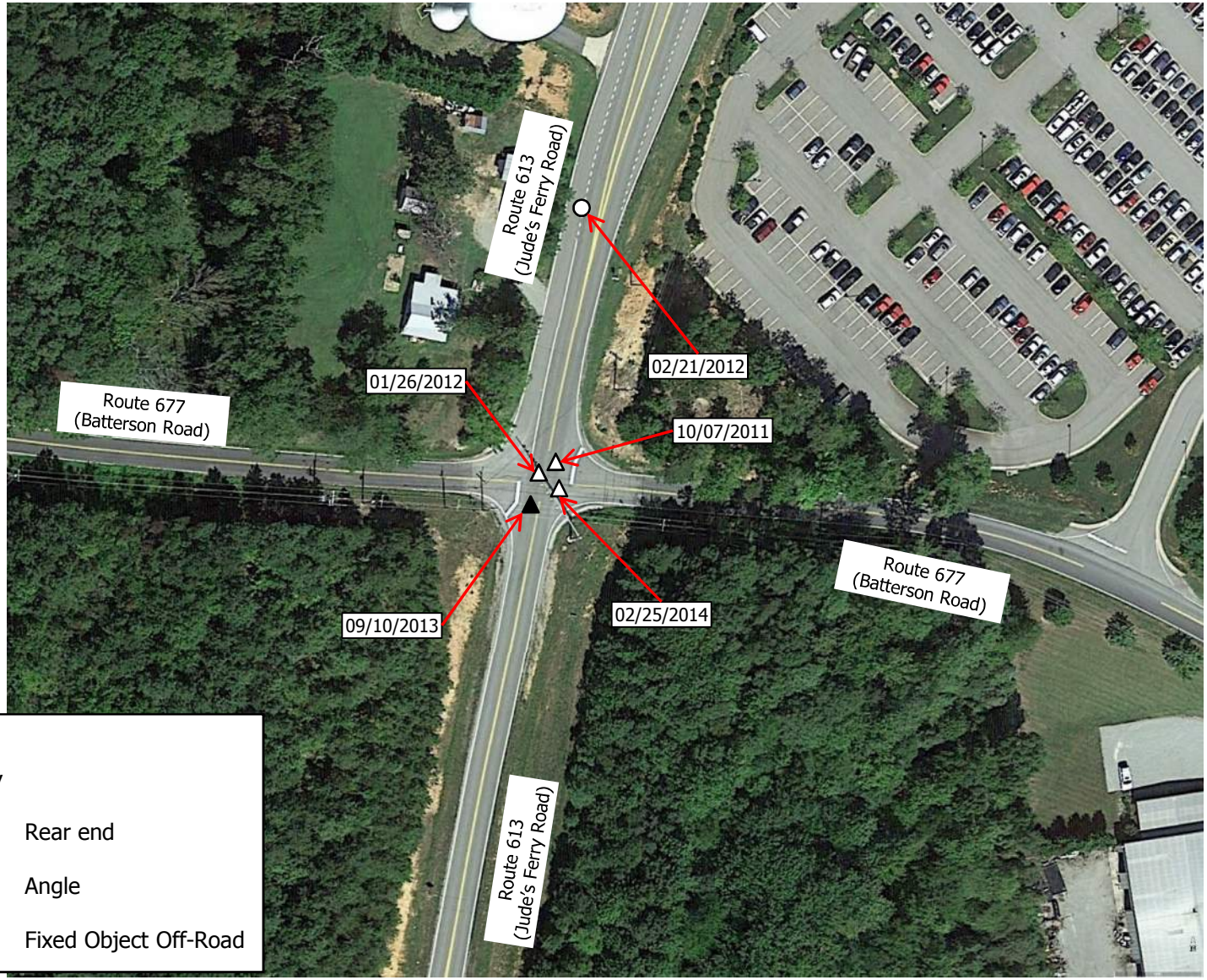
CRO Task Order #237
U.S. Route 60 at Dorset Road
2011-2015 Crashes

Figure
3-7



LEGEND

PDO	Injury	
○	●	Rear end
△	▲	Angle
□	■	Fixed Object Off-Road

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CRO Task Order #237
Jude's Ferry Road at Batterson Road
2011-2015 Crashes

Figure
3-8

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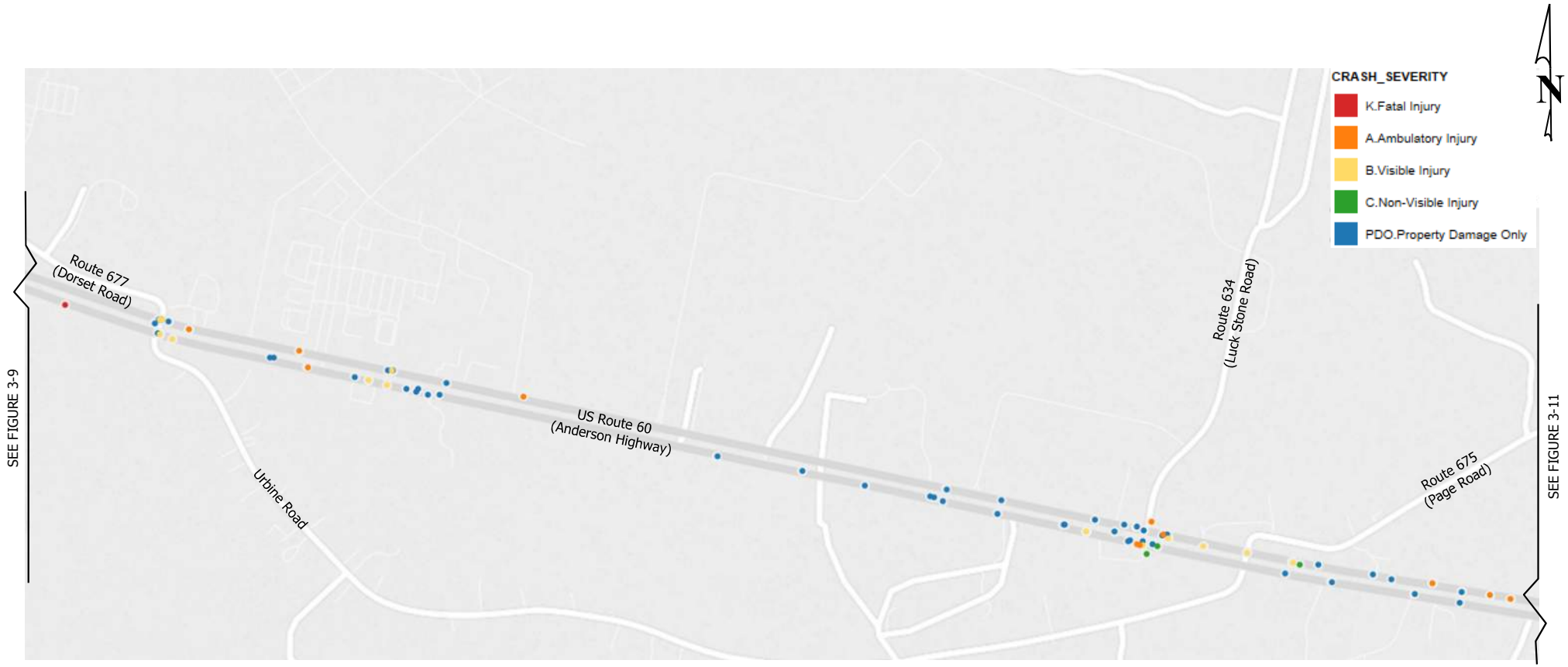
CRO Task Order #237
US Route 60 Corridor Crashes – Segment 1
2010-2015

Figure
3-9



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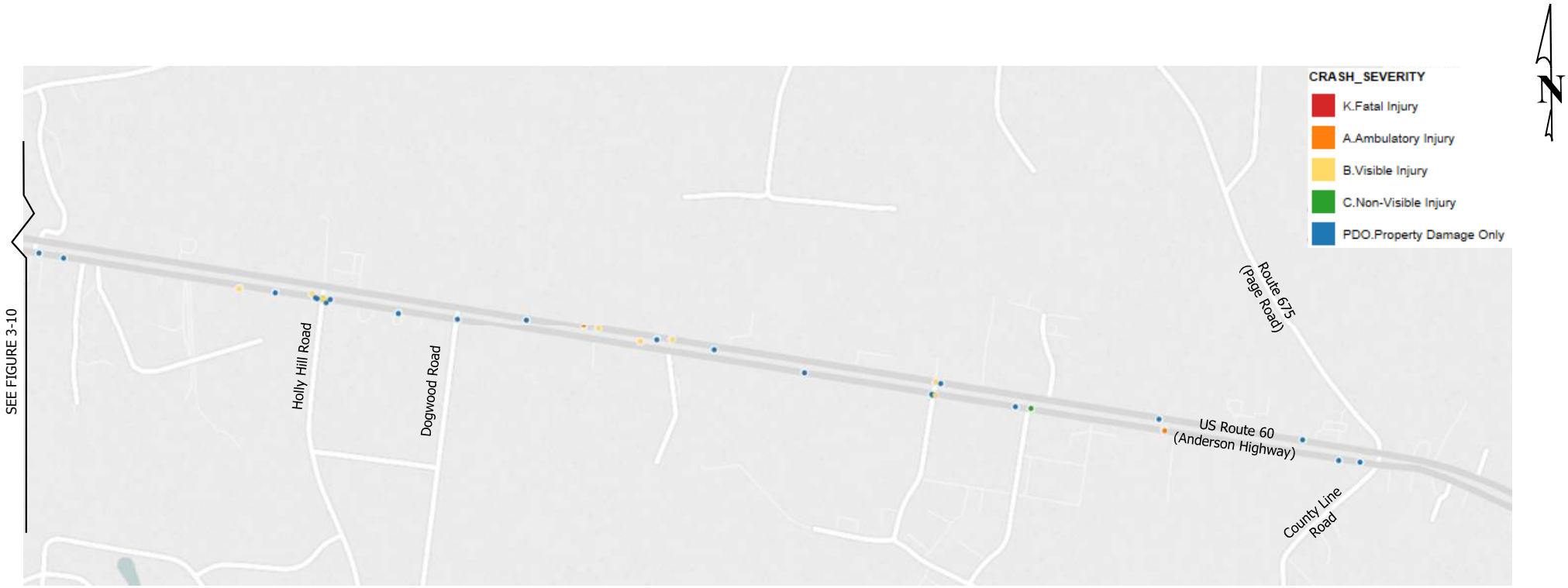
CRO Task Order #237
US Route 60 Corridor Crashes – Segment 2
2010-2015

Figure
3-10



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CRO Task Order #237
US Route 60 Corridor Crashes – Segment 3
2010-2015

Figure
3-11

4 EXISTING CONDITIONS ANALYSIS

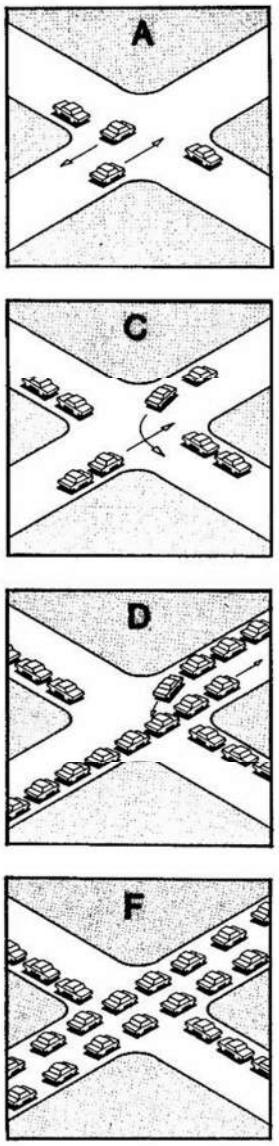
The existing 2016 volumes were analyzed assuming existing intersection geometry, traffic, controls, and signal timings. The existing geometry intersections provides auxiliary left and right turn lanes for the mainline approaches of U.S. Route 60. There are four (4) signalized intersections and four (4) unsignalized intersections within the study area.

4.1 CAPACITY ANALYSES

Capacity analysis allows traffic engineers to determine the impacts of traffic on the surrounding roadway network. The Transportation Research Board's (TRB) Highway Capacity Manual (HCM) methodologies govern how the capacity analyses are conducted and how the results are interpreted. There are six letter grades of Levels of Service (LOS) from A to F, with LOS A representing the best operating conditions and LOS F the worst operating conditions. Table 4-1 shows in detail how each of these levels of service are interpreted.

Table 4-1: Level of Service Definitions

Level of Service	Roadway Segments or Controlled Access Highways	Intersections
A	Free flow, low traffic density.	No vehicle waits longer than one signal indication.
B	Delay is not unreasonable, stable traffic flow.	On a rare occasion motorists wait through more than one signal indication.
C	Stable condition, movements somewhat restricted due to higher volumes, but not objectionable for motorists.	Intermittently drivers wait through more than one signal indication, and occasionally backups may develop behind left turning vehicles, traffic flow still stable and acceptable.
D	Movements more restricted, queues and delays may occur during short peaks, but lower demands occur often enough to permit clearing, thus preventing excessive backups.	Delays at intersections may become extensive with some, especially left-turning vehicles waiting two or more signal indications, but enough cycles with lower demand occur to permit periodic clearance, thus preventing excessive backups.
E	Actual capacity of the roadway invloves delay to all motorists due to congestion.	Very long queues may create lengthly delays, especially for left-turning vehicles.
F	Forced flow with demand volumes greater than capacity resulting in complete congestion. Volumes drop to zero in extreme cases.	Backups from locations downstream restrict or prevent movement of vehicles out of approach creating a storage ares during part or all of an hour.



SOURCE: *"A Policy on Design of Design of Urban Highways and Arterial Streets"* - AASHTO, 1973 based upon material published in *"Highway Capacity Manual"*, National Academy of Sciences, 1965.

For signalized and unsignalized intersections, level of service is defined in terms of delay, a measure of driver discomfort, frustration, fuel consumption and lost travel time. Table 4-2 summarizes the delay associated with each LOS category for signalized and unsignalized intersections.

Table 4-2: Signalized and Unsignalized Intersection Level of Service Criteria

Signalized Intersections		Unsignalized Intersections	
Level of Service	Control Delay per Vehicle (sec/veh)	Level of Service	Average Control Delay (sec/veh)
A	≤ 10	A	0 to 10
B	> 10 to ≤ 20	B	> 10 to ≤ 15
C	> 20 to ≤ 35	C	> 15 to ≤ 25
D	> 35 to ≤ 55	D	> 25 to ≤ 35
E	> 55 to ≤ 80	E	> 35 to ≤ 50
F	> 80	F	> 50

Source: Exhibit 16-2 and Exhibit 17-2 from TRB's "Highway Capacity Manual 2000"

Capacity analyses were performed to assess existing (2016) operational conditions. The signalized and unsignalized intersections were analyzed using SYNCHRO Version 9 (Build 910, Rev 24) based on HCM 2000 methodologies with the following assumptions:

- Level terrain;
- 12-foot lane widths;
- No parking activity, pedestrians, or bus stops;
- Peak hour factor (PHF) by approach from turning movement counts (see Appendix B) for 2016 existing analyses and PHF of 0.88 per for future analyses per TOSAM guidelines; and
- Heavy vehicle percentages from turning movement counts (see Appendix B).

For the existing signalized intersection analysis, the signal timing and phasing data was taken directly from the EPAC data provided by VDOT.

Queuing analyses were also performed to assess existing (2016) operational conditions. The unsignalized and signalized queue lengths were analyzed using SYNCHRO/SimTraffic. The models were loaded for 15 minutes and recorded for four 15-minute intervals (one hour total) using the PHF for the second interval and the Anti-PHF for the first, third, and fourth intervals. The results of ten simulation runs were averaged together to determine the maximum queue length over the course of the peak hour. The reported delay, level of service calculations, and 95th percentile queues were created using HCS methodology. The reported maximum queue lengths were calculated by SimTraffic.

4.2 2016 EXISTING CONDITIONS

Table 4-3 summarizes the 2016 existing intersection LOS, delay, and queue lengths based on the 2016 existing traffic volumes. The corresponding SYNCHRO worksheets are included in Appendix C. The results for each intersection are show in Table 4-3 and summarized below:

U.S. Route 60 at Stavemill Road (signalized) operates at an overall level of service (LOS) E during the AM peak hour and at LOS C during the PM peak hour. The eastbound and westbound mainline approaches operate at LOS D or better during both the AM and PM peak hours. The northbound and southbound approaches both operate at LOS E or F during the AM peak and at LOS D during the PM peak hour. All individual left turn movements operate at LOS E or D during both the AM and PM peak hours.

The westbound left turn movement has maximum queues that extend beyond the existing turn lane storage during the PM peak hour and the northbound left turn movement has maximum queues that extend beyond the existing turn lane storage during the AM peak hour. It should be noted that both the westbound left and northbound left turn queues are within 30 feet of the provided storage length and could be contained within the respective turn lane taper.

During the AM peak hour, the queues for the mainline through movement of eastbound U.S. Route 60 extend beyond the access to the left and right turn lanes, which may prevent traffic from entering the auxiliary turn lanes. In addition, the queues in the northbound right turn lane extend beyond the access to the left-through lane, which prevents traffic from entering this movement. During the PM peak hour, maximum simulated queues on both the eastbound and westbound mainline through movements of U.S. Route 60 extend beyond the left and right turn lanes access.

U.S. Route 60 at South Creek One (signalized) operates at an overall LOS A during the AM peak hour and at LOS B during the PM peak hour. The eastbound and westbound mainline approaches operate at LOS B or better during both the AM and PM peak hours. The northbound approach operates at LOS D during both the AM and PM peak hours. The southbound approach operates at LOS D during both the AM and PM peak hours. The mainline left turn movements operate at LOS E or F during both the AM and PM peak hours.

The available turn lane storage is sufficient to accommodate the 95th percentile and maximum queue lengths during the AM and PM peak hours at the U.S. Route 60 at South Creek One intersection. During the AM peak hour, the queues for the mainline through movement of eastbound U.S. Route 60 extend beyond the access to the dual left turn lanes, which may prevent traffic from entering the auxiliary turn lane. During the PM peak hour, maximum simulated queues only on the westbound mainline through movement of U.S. Route 60 extend beyond the left and right turn lanes access.

U.S. Route 60 and Urbine Road/Batterson Road (unsignalized) – All movements operate at LOS D or better during both the AM and PM peak hours, with the exception of the northbound approach during the AM peak hour, which operates at LOS E, and the southbound approach during the PM peak hour, which operates at LOS F. The mainline movements on eastbound and westbound U.S. Route 60 operate at LOS C or better during both the AM and PM peak hours. There are no queuing issues observed at this intersection.

U.S. Route 60 at Jude's Ferry Road (signalized) operates at an overall LOS C during the AM peak hour and at LOS B during the PM peak hour. The eastbound and westbound mainline approaches operate at LOS C or better during both the AM and PM peak hours. The southbound approach operates at LOS E during the AM peak hour and at LOS D during the PM peak hour with the southbound left turn lane operating at LOS F and E in the AM and PM peak hours, respectively.

The eastbound and southbound left turn movement has maximum queues that extend beyond the existing turn lane storage during the AM peak hour. During the AM peak hour, the queues for the mainline through movements of eastbound and westbound U.S. Route 60 extend beyond the access to the left and right turn lanes, which may prevent traffic from entering the auxiliary turn lanes. During the PM peak hour, maximum simulated queues on the westbound mainline through only movement of U.S. Route 60 extend beyond the left and right turn lanes access.

U.S. Route 60 and New Dorset Road (unsignalized) - The mainline movements on eastbound and westbound U.S. Route 60 operate at LOS C or better during both the AM and PM peak hours. The northbound approach operates at LOS F during the AM peak hour and at LOS D during the PM peak hour. The southbound approach operates at LOS F during both the AM and PM peak hours. There are no queuing issues observed at this intersection on the mainline approaches. Although both HCM and SimTraffic show large queues for the NB approach, there is minimal traffic utilizing this intersection and the queues are a result of the traffic currently on the mainline approaches.

U.S. Route 60 and Batterson Road (unsignalized) - All movements and approaches operate at LOS C or better during both the AM and PM peak hours. The mainline movements on eastbound and westbound U.S. Route 60 operate at LOS C or better during both the AM and PM peak hours. There are no queuing issues observed at this intersection.

U.S. Route 60 at Dorset Road (signalized) operates at an overall LOS E during the AM peak hour and at LOS D during the PM peak hour. The eastbound approach operates at LOS D during the AM peak hour and at LOS C during the PM peak hour. The westbound approach operates at LOS B during the AM peak hour and at LOS D during the PM peak hour. The northbound and southbound approaches operate at LOS E or worse during both the AM and PM peak hours.

The eastbound left turn movement experiences maximum queues that extend beyond the existing turn lane storage during the AM peak hour. During the AM peak hour, the queues for the mainline eastbound through movements of U.S. Route 60 extend beyond the access to the left and right turn lanes, which may prevent traffic from entering the auxiliary turn lanes. During the PM peak hour, maximum simulated queues on the mainline westbound through movements of U.S. Route 60 extend beyond the left and right turn lanes access. The northbound and southbound approaches experience some queuing.

Jude's Ferry Road and Batterson Road (unsignalized) - All movements and approaches operate at LOS C or better during both the AM and PM peak hours, with the exception of the eastbound approach of Batterson Road, which operates at LOS D during the AM peak hour. There are no queuing issues observed at this intersection.

Table 4-3: Intersection Level of Service, Delay, and Queue Summary
2016 Existing Conditions

Intersection and Type of Control	Movement and Approach	Turn Lane Storage (ft)	AM PEAK HOUR				PM PEAK HOUR			
			Delay [1] (sec/veh)	LOS [1]	HCM 95th Percentile Queue Length (ft)	SimTraffic Maximum Queue Length[2] (ft)	Delay [1] (sec/veh)	LOS [1]	HCM 95th Percentile Queue Length (ft)	SimTraffic Maximum Queue Length[2] (ft)
1. US Route 60 (E-W) at Stavemill Road (N-S) Signalized	EB Dual Left [3]	863	63.0	E	m41	71	70.5	E	76	92
	EB Thru		44.7	D	#975	464	25.1	C	390	230
	EB Right	363	14.1	B	m0	95	23.5	C	1	37
	EB Approach		*45.0*	*D*	--	--	*29.8*	*C*	--	--
	WB Left	738	57.1	E	121	131	67.7	E	#534	621
	WB Thru		14.1	B	131	171	21.3	C	440	615
	WB Right	375	12.4	B	0	47	14.3	B	39	76
	WB Approach		*18.8*	*B*	--	--	*28.5*	*C*	--	--
	NB Left-Thru	400	51.8	D	107	373	55.2	E	121	140
	NB Right	LMT	189.9	F	#382	640	47.8	D	0	84
	NB Approach		*168.1*	*F*	--	--	*51.3*	*D*	--	--
	SB Left	LMT	56.6	E	68	101	54.5	D	82	96
	SB Left-Thru		56.5	E	68	51	54.6	D	86	89
	SB Right	400	52.7	D	0	19	49.7	D	0	49
	SB Approach		*56.0*	*E*	--	--	*53.1*	*D*	--	--
	Overall		57.6	E	--	--	31.1	C	--	--
2. US Route 60 (E-W) at South Creek One (N-S) Signalized	EB Dual Left [3]	363	58.8	E	m24	46	66.6	E	88	92
	EB Thru-Right		6.3	A	470	149	6.7	A	183	68
	EB Approach		*7.4*	*A*	--	--	*14.8*	*B*	--	--
	WB Left	338	95.5	F	m3	7	80.5	F	m13	36
	WB Thru		0.2	A	1	59	3.0	A	38	277
	WB Right	313	0.1	A	0	33	0.9	A	0	113
	WB Approach		*0.3*	*A*	--	--	*3.0*	*A*	--	--
	NB L-T-R		53.7	D	12	22	45.4	D	11	23
	NB Approach		*53.7*	*D*	--	--	*45.4*	*D*	--	--
	SB Left	440	58.2	E	62	43	48.4	D	83	90
	SB Left-Thru		58.2	E	61	102	48.7	D	85	135
	SB Right	LMT	53.7	D	0	54	81.4	F	#252	171
	SB Approach		*56.7*	*E*	--	--	*72.2*	*E*	--	--
	Overall		7.4	A	--	--	14.3	B	--	--
3. US Route 60 (E-W) at Urbine Road (N-S) Unsignalized	EB Left	188	8.8	A	2	26	18.5	C	3	18
	EB Thru		†	†	†	0	†	†	†	0
	EB Right	100	†	†	†	0	†	†	†	0
	EB Approach		*†*	*†*	--	--	*†*	*†*	--	--
	WB Left	188	14.9	B	1	40	10.5	B	2	33
	WB Thru		†	†	†	0	†	†	†	0
	WB Right	LMT	†	†	†	0	†	†	†	0
	WB Approach		*†*	*†*	--	--	*†*	*†*	--	--
	NB L-T-R		41.3	E	12	68	25.8	D	3	45
	NB Approach		*41.3*	*E*	--	--	*25.8*	*D*	--	--
	SB L-T-R		20.6	C	17	105	77.5	F	65	203
	SB Approach		*20.6*	*C*	--	--	*77.5*	*F*	--	--
4. US Route 60 (E-W) at Jude's Ferry Road (N-S) Signalized	EB Left	475	43.9	D	m396	430	80.1	F	m#189	196
	EB Thru		17.1	B	m424	369	3.6	A	m72	75
	EB Approach		*23.6*	*C*	--	--	*14.6*	*B*	--	--
	WB U-Turn	325	57.9	E	m4	0	87.9	F	m2	21
	WB Thru		19.8	B	249	171	18.6	B	#830	391
	WB Right	238	6.0	A	5	66	1.8	A	m4	237
	WB Approach		*19.0*	*B*	--	--	*17.4*	*B*	--	--
	SB Left	300	82.6	F	#282	264	55.4	E	144	163
	SB Right	LMT	46.8	D	65	166	49.2	D	118	218
	SB Approach		*65.5*	*E*	--	--	*51.4*	*D*	--	--
	Overall		28.0	C	--	--	19.8	B	--	--

2016 Existing Conditions (Continued)

Intersection and Type of Control	Movement and Approach	Turn Lane Storage (ft)	AM PEAK HOUR				PM PEAK HOUR			
			Delay [1] (sec/veh)	LOS [1]	HCM 95th Percentile Queue Length (ft)	SimTraffic Maximum Queue Length[2] (ft)	Delay [1] (sec/veh)	LOS [1]	HCM 95th Percentile Queue Length (ft)	SimTraffic Maximum Queue Length[2] (ft)
5. US Route 60 (E-W) at	EB Left	288	8.4	A	0	17	12.9	B	0	20
New Dorset Road (N-S)	EB Thru		†	†	†	0	†	†	†	0
Unsignalized	EB Right	800	†	†	†	5	†	†	†	4
	EB Approach		*†*	*†*	--	--	*†*	*†*	--	--
	WB Left	288	19.5	C	23	186	12.8	B	46	194
	WB Thru		†	†	†	0	†	†	†	0
	WB Right	150	†	†	†	0	†	†	†	0
	WB Approach		*†*	*†*	--	--	*†*	*†*	--	--
	NB L-T-R		95.0	F	234	946	34.3	D	123	1096
	NB Approach		*95.0*	*F*	--	--	*34.3*	*D*	--	--
	SB L-T-R		297.0	F	14	30	1108.2	F	24	24
	SB Approach		*297.0*	*F*	--	--	*1108.2*	*F*	--	--
6. US Route 60 (E-W) at	EB Left	163	8.8	A	1	30	15.9	C	7	86
Batterson Road (S)	EB Thru		†	†	†	0	†	†	†	0
Unsignalized	*EB Approach*		*†*	*†*	--	--	*†*	*†*	--	--
	WB U-Turn	163	0.0	A	0	14	0.0	A	0	33
	WB Thru		†	†	†	0	†	†	†	0
	WB Right	100	†	†	†	0	†	†	†	0
	WB Approach		*†*	*†*	--	--	*†*	*†*	--	--
	SB Left-Right		10.6	B	3	33	20.7	C	17	91
	SB Approach		*10.6*	*B*	--	--	*20.7*	*C*	--	--
7. US Route 60 (E-W) at	EB Left	300	56.0	E	135	295	55.5	E	101	115
Dorset Road (N-S)	EB Thru		55.3	E	#923	608	21.6	C	278	233
Signalized	EB Right	550	16.3	B	3	134	17.0	B	0	40
	EB Approach		*53.5*	*D*	--	--	*23.7*	*C*	--	--
	WB Left	350	86.2	F	m74	58	49.3	D	m56	349
	WB Thru		12.2	B	102	78	34.3	C	#718	504
	WB Right	563	19.1	B	0	6	48.6	D	m45	151
	WB Approach		*17.8*	*B*	--	--	*36.4*	*D*	--	--
	NB L-T-R		170.9	F	#390	627	97.5	F	#314	325
	NB Approach		*170.9*	*F*	--	--	*97.5*	*F*	--	--
	SB Left		68.6	E	#200	202	49.7	D	115	245
	SB Thru-Right		48.0	D	39	100	75.6	E	#234	432
	SB Approach		*64.7*	*E*	--	--	*69.1*	*E*	--	--
	Overall		56.4	E	--	--	40.4	D	--	--
8. Jude's Ferry Road (N-S) at	EB L-T-R		28.7	D	9	38	14.6	B	4	32
Batterson Road (E-W)	*EB Approach*		*28.7*	*D*	--	--	*14.6*	*B*	--	--
Unsignalized	WB L-T-R		21.5	C	14	49	16.7	C	46	107
	WB Approach		*21.5*	*C*	--	--	*16.7*	*C*	--	--
	NB L-T-R		0.0	A	0	20	0.0	A	0	7
	NB Approach		*†*	*†*	--	--	*†*	*†*	--	--
	SB Left-Thru		1.6	A	5	281	0.5	A	1	22
	SB Right	300	†	†	†	0	†	†	†	0
	SB Approach		*†*	*†*	--	--	*†*	*†*	--	--

[1] Overall intersection LOS and delay reported for signalized intersections and roundabouts only.

[2] For movements with multiple lanes, queue reported is maximum in any one lane.

[3] Dual left turn lanes; average storage is provided.

† SYNCHRO does not provide level of service or delay for unsignalized movements with no conflicting volumes.

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

m - Volume for 95th percentile queue is metered by upstream signal.

5 2036 VOLUME PROJECTIONS

In order to project the 2016 existing volumes to the designated 2036 design year (+20 years), Timmons Group examined the following sources:

- U.S. Route 60 East Corridor Advance Planning Study (dated July 2016)
- 2010 Powhatan County Long-Range Comprehensive Plan
- 2014 Powhatan County Zoning Ordinance
- Expected Residential/Commercial Developments
- Historic VDOT Traffic Count Data
- Discussions with Powhatan County and VDOT Officials

As a result, it was determined that a 1.1% annual growth rate was appropriate for the corridor and the timeframe.

This growth rate was applied to all roads located within the study area. No specific adjacent projects/developments have been identified in the vicinity that would impact specific approaches or need to be accounted for beyond the cited growth rate.

The resulting 2036 Peak Hour Traffic Volumes are shown on Figure 5-1.

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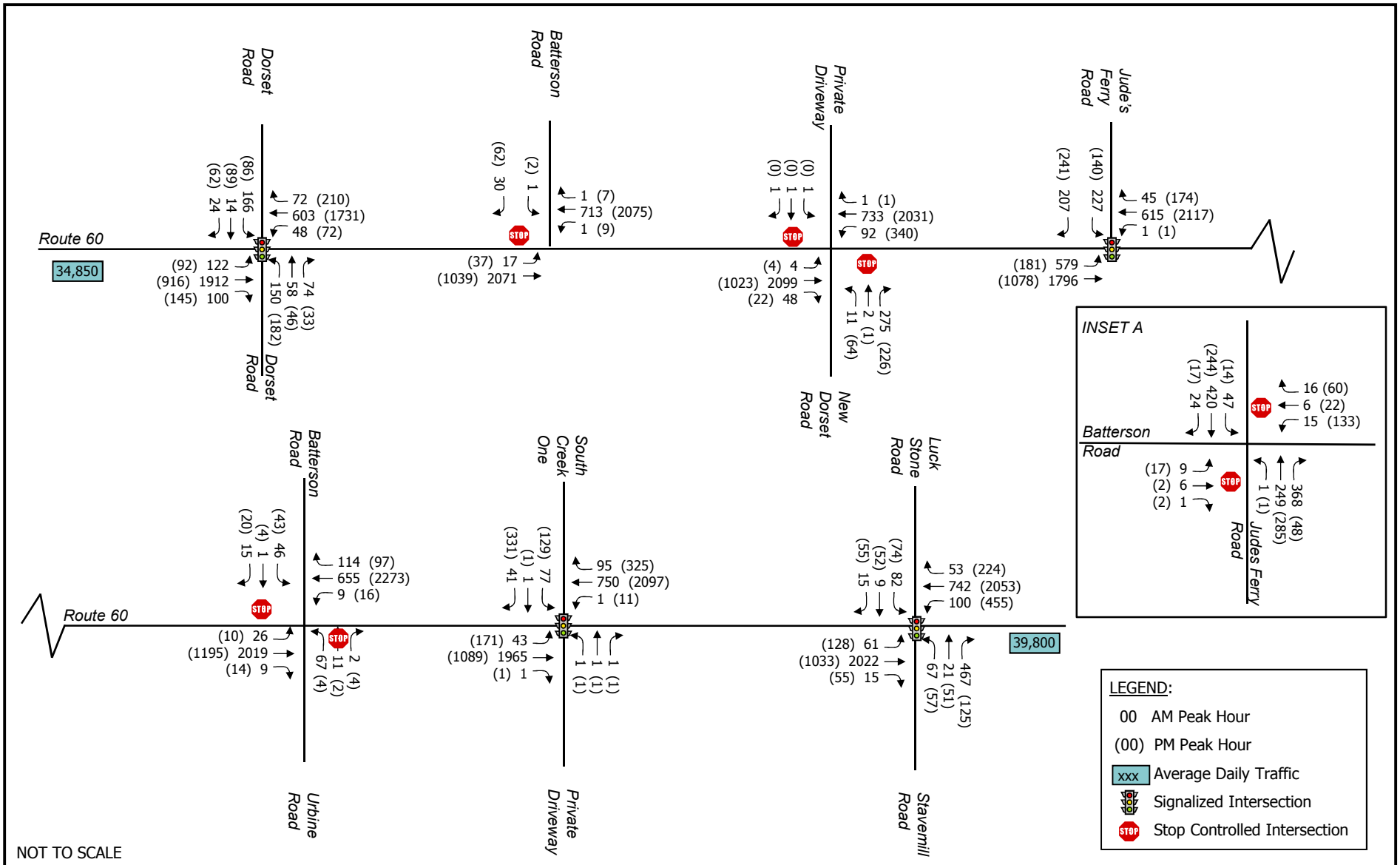

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CRO Task Order #237
Projected (2036) Peak Hour Volumes

Figure
5-1

6 2036 BACKGROUND CONDITIONS ANALYSIS

The 2036 background volumes shown on Figure 5-1 were analyzed assuming existing intersection geometry, traffic, and controls.

6.1 CAPACITY ANALYSES

For the signalized intersection analysis, the cycle lengths were adjusted based on the natural cycle lengths determined by SYNCHRO with a minimum length of 80 seconds and a maximum length of 160 seconds; it should be noted that the yellow and all-red times from the EPAC data remained the same. No other changes were made from the existing conditions analysis.

6.2 2036 BACKGROUND CONDITIONS

Table 6-1 summarizes the 2036 background intersection LOS, delay, and queue lengths based on the 2036 background traffic volumes. The corresponding SYNCHRO worksheets are included in Appendix D.

U.S. Route 60 at Stavemill Road (signalized) will operate at an overall LOS F during the AM peak hour and at LOS C during the PM peak hour. The eastbound approach worsens to operate at LOS F during the AM peak hour and operates at LOS D during the PM peak hour. The westbound approach continues to operate at LOS C during both the AM and PM peak hours. The northbound and southbound approaches will both operate at LOS E or worse during both the AM and PM peaks. All individual left turn movements will operate at LOS E or D during both the AM and PM peak hours.

The northbound left turn movement will have maximum queues that extend beyond the existing turn lane storage during the AM peak hour. The westbound left turn movement will have maximum queues that extend beyond the existing turn lane storage during the PM peak hour.

During the AM peak hour, the queues for the mainline through movement of eastbound U.S. Route 60 will extend beyond the access to the left and right turn lanes, which may prevent traffic from entering the auxiliary turn lanes. In addition, the queues in the northbound right turn lane will extend beyond the access to the left-through lane, which will prevent traffic from entering this movement. During the PM peak hour, maximum simulated queues on the westbound mainline through movement will extend beyond only the right turn lanes access. The queuing issues that exist under 2016 existing conditions will continue to exist under 2036 background conditions.

U.S. Route 60 at South Creek One (signalized) will continue to operate at an overall LOS A during the AM peak hour and at LOS B during the PM peak hour. The eastbound and westbound mainline approaches will continue to operate at LOS B or better during both the AM and PM peak hours. The northbound and southbound approaches will operate at LOS E during the AM peak hour and at LOS D during the PM peak hour. All individual left turn movements will operate at LOS D or E during both the AM and PM peak hours.

The available turn lane storage is sufficient to accommodate the 95th percentile and maximum queue lengths during the AM and PM peak hours at the U.S. Route 60 at South Creek One intersection. During the PM peak hour, maximum simulated queues only on the westbound mainline through movement of U.S. Route 60 will extend beyond the left and right turn lanes access.

U.S. Route 60 and Urbine Road/Batterson Road (unsignalized) – The mainline movements on eastbound and westbound U.S. Route 60 will continue to operate at LOS D or better during both the AM and PM peak hours. The northbound approach will operate at LOS F during both the AM and PM peak hours. The southbound approach will operate at LOS D during the AM peak hour and at LOS F during the PM peak hour. There are no queuing issues observed at this intersection.

U.S. Route 60 at Jude's Ferry Road (signalized) will operate at an overall LOS B during the AM peak hour and at LOS C during the PM peak hour. The eastbound approach will operate at LOS A during the AM peak hour and at LOS B during the PM peak hour. The westbound mainline approach will operate at LOS D during the AM peak hour and at LOS B during the PM peak hour. The southbound approach will operate at LOS E during the AM peak hour and at LOS F during the PM peak hour.

The eastbound and southbound left turn movement will experience maximum queues that extend beyond the existing turn lane storage during the AM peak hour. The westbound right turn movement will experience maximum simulated queues that extend beyond the existing turn lane storage during the PM peak hour. During the AM and PM peak hours, the queues for the mainline through movements of westbound U.S. Route 60 will extend beyond the access to the left and right turn lanes, which may prevent traffic from entering the auxiliary turn lanes.

U.S. Route 60 and New Dorset Road (unsignalized) - The mainline movements on eastbound and westbound U.S. Route 60 will operate at LOS D or better during both the AM and PM peak hours. The northbound and southbound approaches will operate at LOS F during both the AM and PM peak hours. There are no queuing issues observed at this intersection on the mainline approaches. Although both HCM and SimTraffic show large queues for the northbound approach, there is minimal traffic utilizing this intersection and the queues are a result of the traffic currently on the mainline approaches. The southbound approach does not currently generate any traffic and the poor LOS, delay, and queue results are not expected to impact the remainder of the corridor.

U.S. Route 60 and Batterson Road (unsignalized) - All movements and approaches will operate at LOS D or better during both the AM and PM peak hours. The mainline movements on eastbound and westbound U.S. Route 60 will operate at LOS C or better during both the AM and PM peak hours. There are no queuing issues observed at this intersection.

U.S. Route 60 at Dorset Road (signalized) will operate at an overall LOS F during the AM peak hour and at LOS E during the PM peak hour. The eastbound approach will worsen to operate at LOS F during the AM peak hour and at LOS C during the PM peak hour. The westbound approach will operate at LOS C during the AM peak hour and at LOS D during the PM peak hour. The northbound and southbound approaches will operate at LOS F during both the AM and PM peak hours.

The eastbound and westbound left turn movements will experience maximum queues that extend beyond the existing turn lane storage during both the AM and PM peak hours. During the AM and PM peak hours, the queues for the mainline eastbound through movements of U.S. Route 60 will extend beyond the access to the left and right turn lanes, which may prevent traffic from entering the auxiliary turn lanes. During the PM peak hour, maximum simulated queues on the mainline westbound through movements of U.S. Route 60 will extend beyond the left and right turn lanes access. The northbound and southbound approaches will experience some queuing issues.

Jude's Ferry Road and Batterson Road (unsignalized) - All movements and approaches will operate at LOS C or better during both the AM and PM peak hours. There are no queuing issues observed at this intersection.

Table 6-1: Intersection Level of Service, Delay, and Queue Summary
2036 Background Conditions

Intersection and Type of Control	Movement and Approach	Turn Lane Storage (ft)	AM PEAK HOUR				PM PEAK HOUR			
			Delay [1] (sec/veh)	LOS [1]	HCM 95th Percentile Queue Length (ft)	SimTraffic Maximum Queue Length[2] (ft)	Delay [1] (sec/veh)	LOS [1]	HCM 95th Percentile Queue Length (ft)	SimTraffic Maximum Queue Length[2] (ft)
1. US Route 60 (E-W) at Stavemill Road (N-S) Signalized	EB Dual Left [3]	863	69.9	E	m40	137	57.7	E	93	104
	EB Thru		93.7	F	#1243	594	36.5	D	#427	310
	EB Right	363	13.7	B	m0	234	26.6	C	1	82
	EB Approach		*92.5*	*F*	--	--	*38.3*	*D*	--	--
	WB Left	738	105.8	F	#218	274	64.0	E	#571	635
	WB Thru		14.4	B	152	194	22.3	C	525	807
	WB Right	375	12.2	B	0	47	13.0	B	35	189
	WB Approach		*24.5*	*C*	--	--	*28.5*	*C*	--	--
	NB Left-Thru	400	50.4	D	129	400	84.5	F	#196	178
	NB Right	LMT	282.4	F	#570	781	52.5	D	0	114
	NB Approach		*245.5*	*F*	--	--	*67.3*	*E*	--	--
	SB Left	LMT	102.3	F	#107	136	76.9	E	#134	117
	SB Left-Thru		102.3	F	#106	118	75.1	E	#136	119
	SB Right	400	58.4	E	0	20	54.6	D	0	60
	SB Approach		*96.1*	*F*	--	--	*69.5*	*E*	--	--
	Overall		99.2	F	--	--	35.0	C	--	--
2. US Route 60 (E-W) at South Creek One (N-S) Signalized	EB Dual Left [3]	363	66.5	E	m26	52	49.8	D	m101	124
	EB Thru-Right		3.3	A	117	98	8.9	A	m410	149
	EB Approach		*4.7*	*A*	--	--	*14.4*	*B*	--	--
	WB Left	338	57.5	E	m3	10	88.8	F	m15	148
	WB Thru		1.9	A	25	73	8.2	A	124	544
	WB Right	313	0.8	A	2	36	1.6	A	m10	261
	WB Approach		*1.8*	*A*	--	--	*7.7*	*A*	--	--
	NB L-T-R		56.4	E	12	21	43.0	D	9	23
	NB Approach		*56.4*	*E*	--	--	*43.0*	*D*	--	--
	SB Left	440	64.2	E	74	70	45.8	D	91	118
	SB Left-Thru		66.1	E	74	111	46.0	D	92	149
	SB Right	LMT	56.4	E	0	48	65.4	E	244	257
	SB Approach		*62.1*	*E*	--	--	*59.9*	*E*	--	--
	Overall		6.2	A	--	--	15.6	B	--	--
3. US Route 60 (E-W) at Urbine Road (N-S) Unsignalized	EB Left	188	9.3	A	2	36	34.0	D	7	35
	EB Thru		†	†	†	0	†	†	†	0
	EB Right	100	†	†	†	0	†	†	†	0
	EB Approach		*†*	*†*	--	--	*†*	*†*	--	--
	WB Left	188	19.6	C	3	35	12.0	B	2	41
	WB Thru		†	†	†	0	†	†	†	0
	WB Right	LMT	†	†	†	0	†	†	†	0
	WB Approach		*†*	*†*	--	--	*†*	*†*	--	--
	NB L-T-R		83.3	F	31	114	54.8	F	11	60
	NB Approach		*83.3*	*F*	--	--	*54.8*	*F*	--	--
	SB L-T-R		33.1	D	35	181	410.6	F	167	454
	SB Approach		*33.1*	*D*	--	--	*410.6*	*F*	--	--
4. US Route 60 (E-W) at Jude's Ferry Road (N-S) Signalized	EB Left	475	14.0	B	m263	388	116.3	F	m#305	309
	EB Thru		3.3	A	m121	278	3.4	A	m96	186
	EB Approach		*5.9*	*A*	--	--	*19.7*	*B*	--	--
	WB U-Turn	325	108.0	F	m4	13	44.7	D	m1	8
	WB Thru		41.1	D	177	312	20.1	C	#1114	782
	WB Right	238	18.5	B	15	211	0.5	A	m1	238
	WB Approach		*39.7*	*D*	--	--	*18.6*	*B*	--	--
	SB Left	300	71.1	E	#309	296	113.6	F	#252	296
	SB Right	LMT	45.5	D	69	300	63.0	E	#200	411
	SB Approach		*58.9*	*E*	--	--	*81.6*	*F*	--	--
	Overall		18.9	B	--	--	25.1	C	--	--

2036 Background Conditions (Continued)

Intersection and Type of Control	Movement and Approach	Turn Lane Storage (ft)	AM PEAK HOUR				PM PEAK HOUR			
			Delay [1] (sec/veh)	LOS [1]	HCM 95th Percentile Queue Length (ft)	SimTraffic Maximum Queue Length[2] (ft)	Delay [1] (sec/veh)	LOS [1]	HCM 95th Percentile Queue Length (ft)	SimTraffic Maximum Queue Length[2] (ft)
5. US Route 60 (E-W) at	EB Left	288	8.6	A	0	28	16.6	C	1	30
New Dorset Road (N-S)	EB Thru		†	†	†	0	†	†	†	0
Unsignalized	EB Right	800	†	†	†	0	†	†	†	0
	EB Approach		*†*	*†*	--	--	*†*	*†*	--	--
	WB Left	288	34.2	D	53	285	18.4	C	93	286
	WB Thru		†	†	†	0	†	†	†	0
	WB Right	150	†	†	†	0	†	†	†	0
	WB Approach		*†*	*†*	--	--	*†*	*†*	--	--
	NB L-T-R		420.8	F	553	1087	274.4	F	463	1101
	NB Approach		*420.8*	*F*	--	--	*274.4*	*F*	--	--
	SB L-T-R		**	F	**	45	**	F	**	42
	SB Approach		***	*F*	--	--	***	*F*	--	--
6. US Route 60 (E-W) at	EB Left	163	9.4	A	2	34	22.2	C	13	135
Batterson Road (S)	EB Thru		†	†	†	0	†	†	†	0
Unsignalized	*EB Approach*		*†*	*†*	--	--	*†*	*†*	--	--
	WB U-Turn	163	0.0	A	0	9	0.0	A	0	41
	WB Thru		†	†	†	0	†	†	†	0
	WB Right	100	†	†	†	0	†	†	†	0
	WB Approach		*†*	*†*	--	--	*†*	*†*	--	--
	SB Left-Right		11.3	B	4	55	31.9	D	35	336
	SB Approach		*11.3*	*B*	--	--	*31.9*	*D*	--	--
7. US Route 60 (E-W) at	EB Left	300	50.5	D	171	300	98.0	F	#195	217
Dorset Road (N-S)	EB Thru		107.3	F	#1203	1485	24.9	C	358	406
Signalized	EB Right	550	14.6	B	15	550	18.2	B	38	95
	EB Approach		*99.7*	*F*	--	--	*29.9*	*C*	--	--
	WB Left	350	165.5	F	m#86	76	48.2	D	m67	349
	WB Thru		15.4	B	297	84	45.6	D	m#827	586
	WB Right	563	22.7	C	m2	5	6.1	A	m6	287
	WB Approach		*26.2*	*C*	--	--	*41.6*	*D*	--	--
	NB L-T-R		209.0	F	#496	903	177.8	F	#434	894
	NB Approach		*209.0*	*F*	--	--	*177.8*	*F*	--	--
	SB Left		182.6	F	#326	334	54.6	D	147	489
	SB Thru-Right		52.9	D	49	71	199.4	F	#407	503
	SB Approach		*158.6*	*F*	--	--	*163.5*	*F*	--	--
	Overall		96.7	F	--	--	60.9	E	--	--
8. Jude's Ferry Road (N-S) at	EB L-T-R		28.7	D	9	42	17.7	C	7	39
Batterson Road (E-W)	*EB Approach*		*28.7*	*D*	--	--	*17.7*	*C*	--	--
Unsignalized	WB L-T-R		21.6	C	14	60	24.8	C	90	136
	WB Approach		*21.6*	*C*	--	--	*24.8*	*C*	--	--
	NB L-T-R		0.0	A	0	26	0.0	A	0	4
	NB Approach		*†*	*†*	--	--	*†*	*†*	--	--
	SB Left-Thru		1.6	A	5	284	0.6	A	1	42
	SB Right	300	†	†	†	0	†	†	†	0
	SB Approach		*†*	*†*	--	--	*†*	*†*	--	--

[1] Overall intersection LOS and delay reported for signalized intersections and roundabouts only.

[2] For movements with multiple lanes, queue reported is maximum in any one lane.

[3] Dual left turn lanes; average storage is provided.

† SYNCHRO does not provide level of service or delay for unsignalized movements with no conflicting volumes.

**Delay greater than 9999.99 seconds cannot be calculated by SYNCHRO.

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

m - Volume for 95th percentile queue is metered by upstream signal.

7 RECOMMENDED IMPROVEMENTS

The following section describes the recommended operational/safety improvements for the eight (8) study intersections along the U.S. Route 60 corridor. The goal of the improvements was to provide realistic options without requiring excessive right-of-way, utility, or construction costs. The improvement options for each intersection can be found on Figures 7-1 through 7-9.

7.1 U.S. ROUTE 60 AT STAVEMILL ROAD/LUCK STONE ROAD

A review of the 2036 projected traffic volumes shows that the westbound left turn lane on U.S. Route 60 will have more than 400 left turning vehicles during the PM peak hour. In addition, the operational analysis for the existing and background volumes shows that the westbound left turn movement will see excessive queues and delays.

In order to address the heavy westbound left turn movement, the proposed improvement option is to install a second westbound left turn lane. The current turn lane has approximately 600 feet of storage. While a longer westbound left turn lane could be accommodated in the median, the main issue is that a single left turn lane would limit the number of vehicles that can get through the signal during the peak hour. An additional turn lane would provide more capacity for vehicles making the maneuver and reduce the green time needed to push through the intersection. The proposed dual left turn lane could be installed within the median with no right-of-way impacts. The median has minimal grade differential and would likely require minimal, if any, utility relocation costs.

Southbound Stavemill Road has two receiving lanes for approximately 725' (second lane drops as a right turn lane at Urbine Road) which can accommodate the second left turn lane.

It is also recommended that an overlap phase be added to the signal operation to increase the capacity of the northbound right turn lane. This will allow the northbound right movement to have a protected green while the westbound left turn lane has a green indication. The restriction of westbound u-turns will be required to install the overlap.

A traffic signal modification will be required to facilitate these improvements.

Figure 7-1 illustrates the potential layout of a second left turn lane for the westbound approach at the study intersection. The improvement is shown for illustrative purposes only; minor design revisions may be necessary.

7.2 U.S. ROUTE 60 AT SOUTH CREEK ONE

The existing movements and approaches are currently not over capacity nor expected to reach capacity under 2036 conditions. The auxiliary turn lanes on U.S. Route 60, including the existing eastbound dual left turn lane, are adequate to accommodate the existing and background traffic volumes. Given the future development potential within the South Creek One site, the southbound approach may need to be improved to accommodate traffic patterns.

Figure 7-2 illustrates the existing layout of the study intersection. No improvements are proposed at this intersection. It is recommended to add striping to the inside curb lane in the vicinity of the intersection to clearly delineate the travel way.

7.3 U.S. ROUTE 60 AT URBINE ROAD/BATTERSON ROAD

The existing movements and approaches are currently not over capacity nor expected to reach capacity under 2036 conditions. Given the traffic volumes on the mainline and the fact that the intersection is unsignalized, there are heavy queues associated with the left turns on the southbound approach. The current approach configuration for the southbound approach is one lane allowing all movements.

In order to address the queues on the southbound approach of Batterson Road, the proposed improvement option is to install an exclusive southbound right turn lane. This will allow traffic turning right onto U.S. Route 60 to bypass the left turn queue.

There are some grading costs, right-of-way acquisitions, and possible overhead utility relocation costs associated with the improvement.

It is important to note that the intersection will not meet VDOT or County signalized intersection spacing standards and therefore a traffic signal cannot be installed at the intersection.

Figure 7-3 illustrates the potential layout of a right turn lane for the southbound approach at the study intersection. The improvement is shown for illustrative purposes only; minor design revisions may be necessary.

7.4 U.S. ROUTE 60 AT JUDE'S FERRY ROAD

A review of the 2036 projected traffic volumes shows that the eastbound left turn lane on U.S. Route 60 will have more than 500 left turning vehicles during the AM peak hour, many of which are associated with the Powhatan County High School located north on Jude's Ferry Road. Accordingly, the operational analysis for the existing and background volumes shows that the eastbound left turn movement will see excessive queues and delays.

The remaining movements and approaches are currently not over capacity nor expected to reach capacity under 2036 conditions. The southbound approach experiences moderate traffic volume and operational issues. Any improvement options to improve the southbound approach would require the acquisition of right-of-way and relocation of major overhead power utilities.

In order to address the heavy eastbound left turn movement, the proposed improvement option is to install a second eastbound left turn lane. The current turn lane has approximately 400 feet of storage. Due to the proximity to the New Dorset Road intersection to the west, there is no potential to extend the existing eastbound left turn lane. The proposed dual left turn lane could be installed within the median with no right-of-way impacts. The median has minimal grade differential and would likely require minimal, if any, utility relocation costs.

The installation of the dual westbound left turn lane would require the installation of a second receiving lane on Jude's Ferry Road. There are right-of-way, grading, and utility relocation costs associated with this improvement. The receiving lane on Jude's Ferry Road could be installed without impacting the intersection of Batterson Road to the north.

A traffic signal modification will be required to facilitate these improvements.

These improvements may not be required if school traffic utilizes the alternative Batterson Road route discussed below.

Figure 7-4 illustrates the potential layout of a second left turn lane for the eastbound approach at the study intersection. The improvement is shown for illustrative purposes only; minor design revisions may be necessary.

7.5 U.S. Route 60 at New Dorset Road

The existing movements and approaches are currently not over capacity nor expected to reach capacity under 2036 conditions. Given the traffic volumes on the mainline and the fact that the intersection is unsignalized, there are heavy queues associated with the northbound left approach. The current configuration for the northbound approach is one lane allowing all movements. The existing geometry is wide enough that two vehicles can queue side-by-side, however, there are no pavement markings or physical space to contain the vehicles on this approach.

In order to address the queues on the northbound approach of New Dorset Road, the proposed improvement option is to install an exclusive northbound right turn lane. This will allow vehicles turning right onto U.S. Route 60 to bypass the left turn queue.

There are some grading costs, right-of-way acquisitions, and possible overhead utility relocation costs. Given the existing wide median on New Dorset Road, there is potential to remove the median to install the turn lane improvements to minimize right-of-way acquisition.

It is important to note that the intersection will not meet VDOT or County signalized intersection spacing standards and therefore a traffic signal cannot be installed at the intersection.

Figure 7-5 illustrates the potential layout of a right turn lane for the southbound approach at the study intersection. The improvement is shown for illustrative purposes only; minor design revisions may be necessary.

7.6 U.S. Route 60 at Batterson Road

The existing movements and approaches are currently not over capacity nor expected to reach capacity under 2036 conditions. The auxiliary turn lanes on U.S. Route 60 are adequate to accommodate the existing and background traffic volumes. There is limited development potential along Batterson Road that would require the improvement of existing facilities.

Figure 7-6 illustrates the existing layout of the study intersection. No improvements are proposed at this intersection.

7.7 U.S. Route 60 at Dorset Road

The existing movements and approaches are currently not over capacity nor expected to reach capacity under 2036 conditions, with the exception of the northbound approach. The northbound approach experiences moderate traffic volume and operational issues, partially due to the geometric limitations of the approach. Any improvement options to improve the northbound approach would require the acquisition of right-of-way and relocation of major overhead power utilities.

In order to address the northbound approach, the proposed improvement option is to install a second approach lane and separate the approach into a dedicated left turn lane and a shared through-right lane. The current approach configuration for the northbound approach is one lane allowing all movements.

It is also recommended to implement concurrent (at the same time) phasing on the side streets. This will allow the north and southbound approaches to run at the same time and therefore dedicate more green time to the mainline.

Due to the proximity of commercial property to the east, the approach improvements may need to be installed on the western side of the road. From field visits, there is minimal grading issues with the site if widened to the west. Improvement costs may be higher at this intersection due to the costs of right-of-way acquisition and overhead utility relocation.

A traffic signal modification will be required to facilitate these improvements.

Figure 7-7 illustrates the potential layout of the exclusive right turn lane for the northbound approach at the study intersection. The improvement is shown for illustrative purposes only; minor design revisions may be necessary.

7.8 Batterson Road – Alternate School Access Route

A review of the existing signalized intersection operations of U.S. Route 60 at Jude's Ferry Road shows that the school peak hours cause additional operational and queuing issues along the corridor. Specifically, the heavy volume of eastbound left turning vehicles, over 500, creates additional delays and queuing on the U.S. Route 60 corridor. In addition, the unsignalized intersection of Jude's Ferry Road at Batterson Road must accommodate traffic from two schools during the school peak hours.

By nature, the school traffic creates a very intense peak period that is of limited duration (30 minutes or less). As discussed in section 7.4 above, the volumes indicate the need for a second eastbound left turn lane onto Jude's Ferry Road.

However, in examining the corridor as a whole, a potential alternative school access route was identified. Batterson Road connects U.S. Route 60 to Jude's Ferry Road and currently operates well below capacity. Further, during the AM peak hour, left turns from U.S. Route 60 onto Batterson Road experience minimal delay.

In order to address the traffic volume issues associated with the schools in this area, the proposed improvement would be to encourage school bus routes, employees, parents, and students to utilize Batterson Road as an entry point to reach the schools. This could be accomplished through signage on U.S. Route 60 and a marketing campaign within the schools.

Figure 7-8 illustrates the potential layout of an alternate school access route that utilizes Batterson Road between U.S. Route 60 and Jude's Ferry Road.

7.9 Jude's Ferry Road at Batterson Road

The existing movements and approaches are currently not over capacity nor expected to reach capacity under 2036 conditions. There is limited development potential along either Jude's Ferry Road or Batterson Road that would require the improvement of existing facilities. There is also minimal safety issues demonstrated over the past 5 years at this intersection.

However, given the intense peak period associated with start/end of the school schedule and the alternative access route discussed in section 7.8, several improvement options (traffic signal, roundabout) were considered at the intersection.

A traffic signal will provide increased capacity at the intersection but it is unlikely that a traffic volumes will warrant the installation of a traffic signal. Further a traffic signal will stop northbound traffic on Jude's Ferry Road which potentially could impact the intersection at U.S. Route 60.

A roundabout will increase the capacity of the intersection, provide for the alternative access route, reduce the conflict points at the intersection, and provide traffic calming. All vehicles approaching the intersection will slow down and must yield to traffic already in the roundabout. This will give priority to vehicles using the alternative school route on Batterson Road.

It is recommended that a single-lane roundabout with a 110-foot inscribed diameter (minimum VDOT standard) be installed at the intersection.

Figure 7-9 illustrates the potential layout of a 110-foot inscribed diameter, single-lane roundabout at the study intersection. Further analysis could shift the roundabout to minimize right-of-way and utility conflicts. The improvement is shown for illustrative purposes only; minor design revisions may be necessary.

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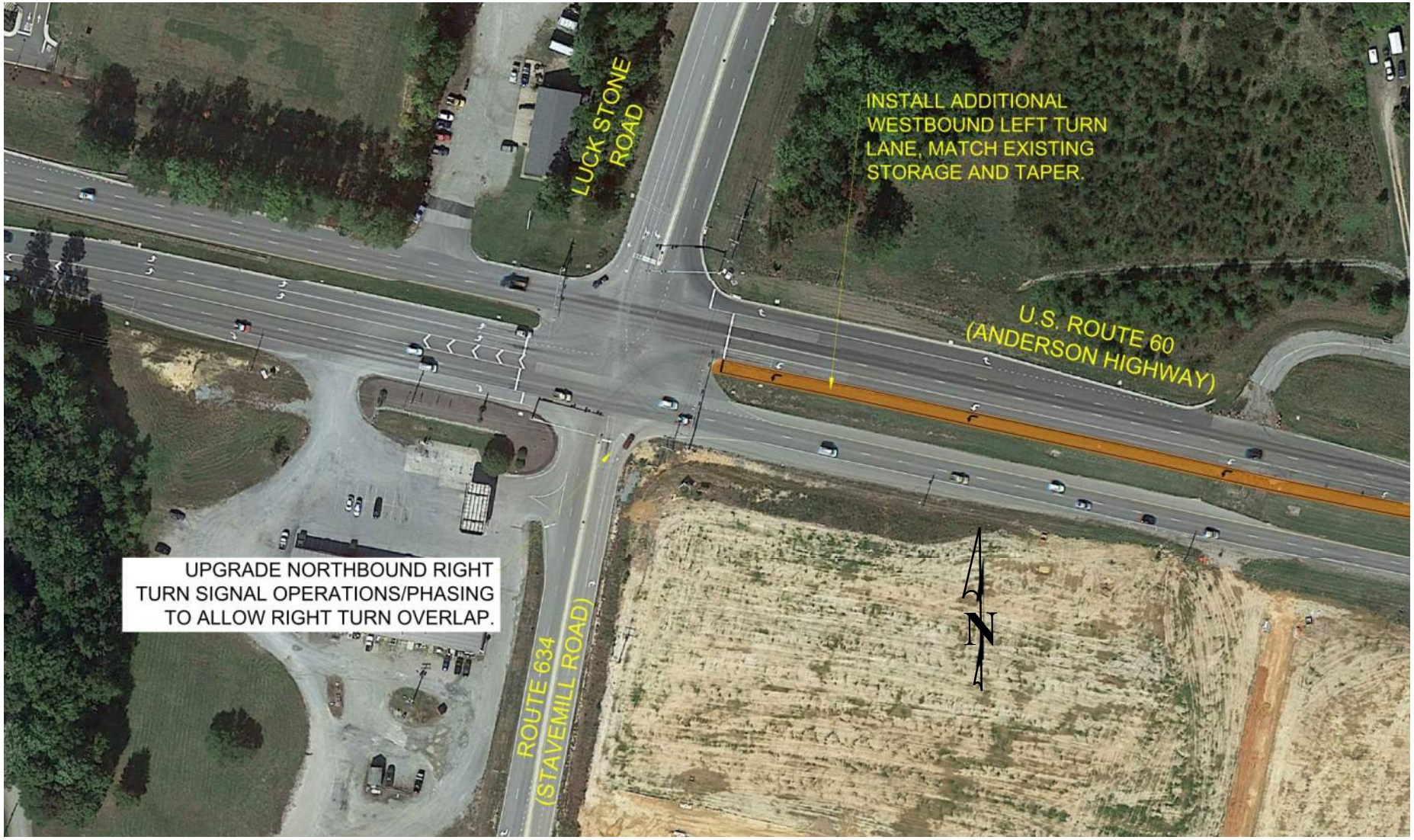

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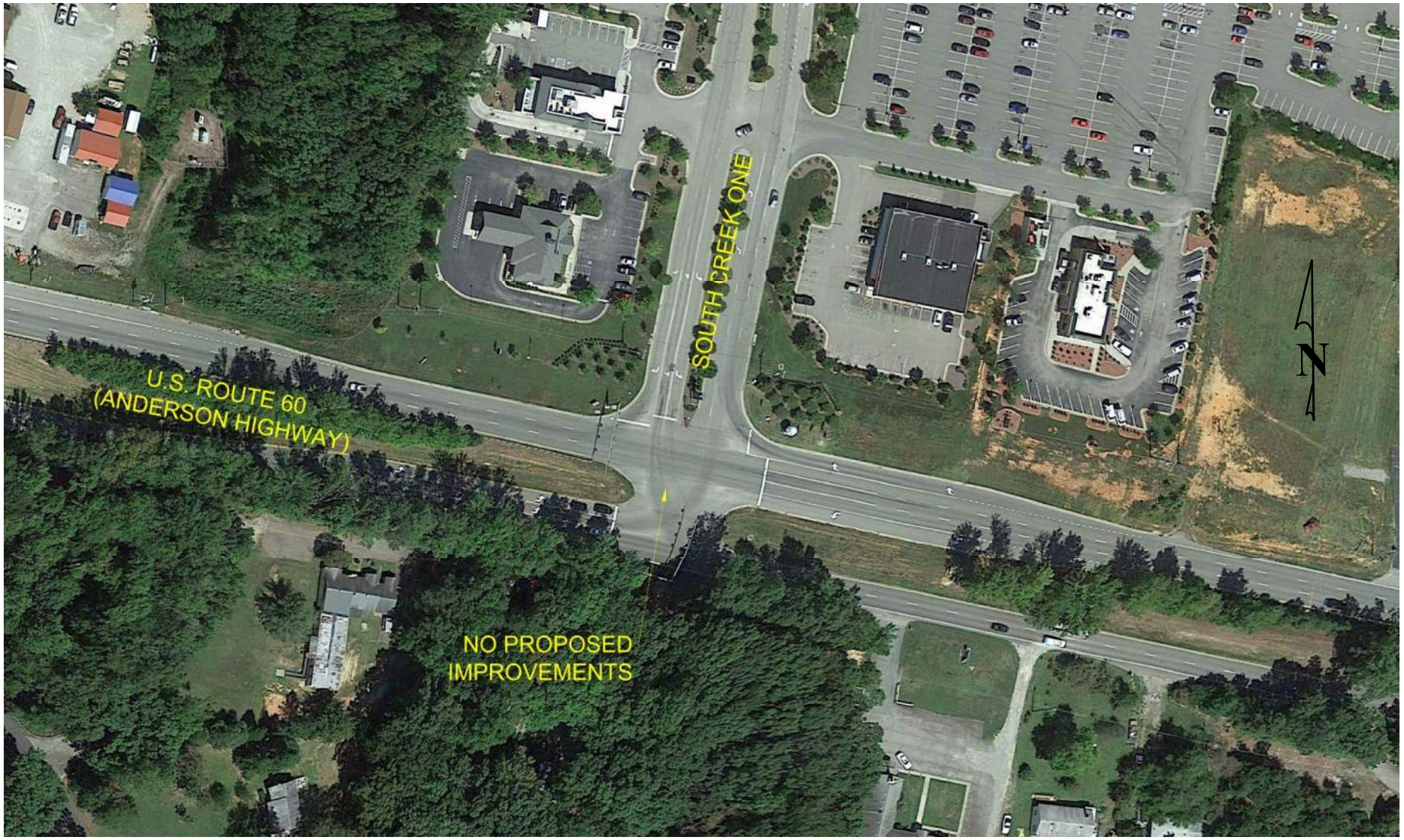
CRO Task Order #237
U.S. Route 60 at Stavemill Road/Luck Stone Road

Figure
7-1



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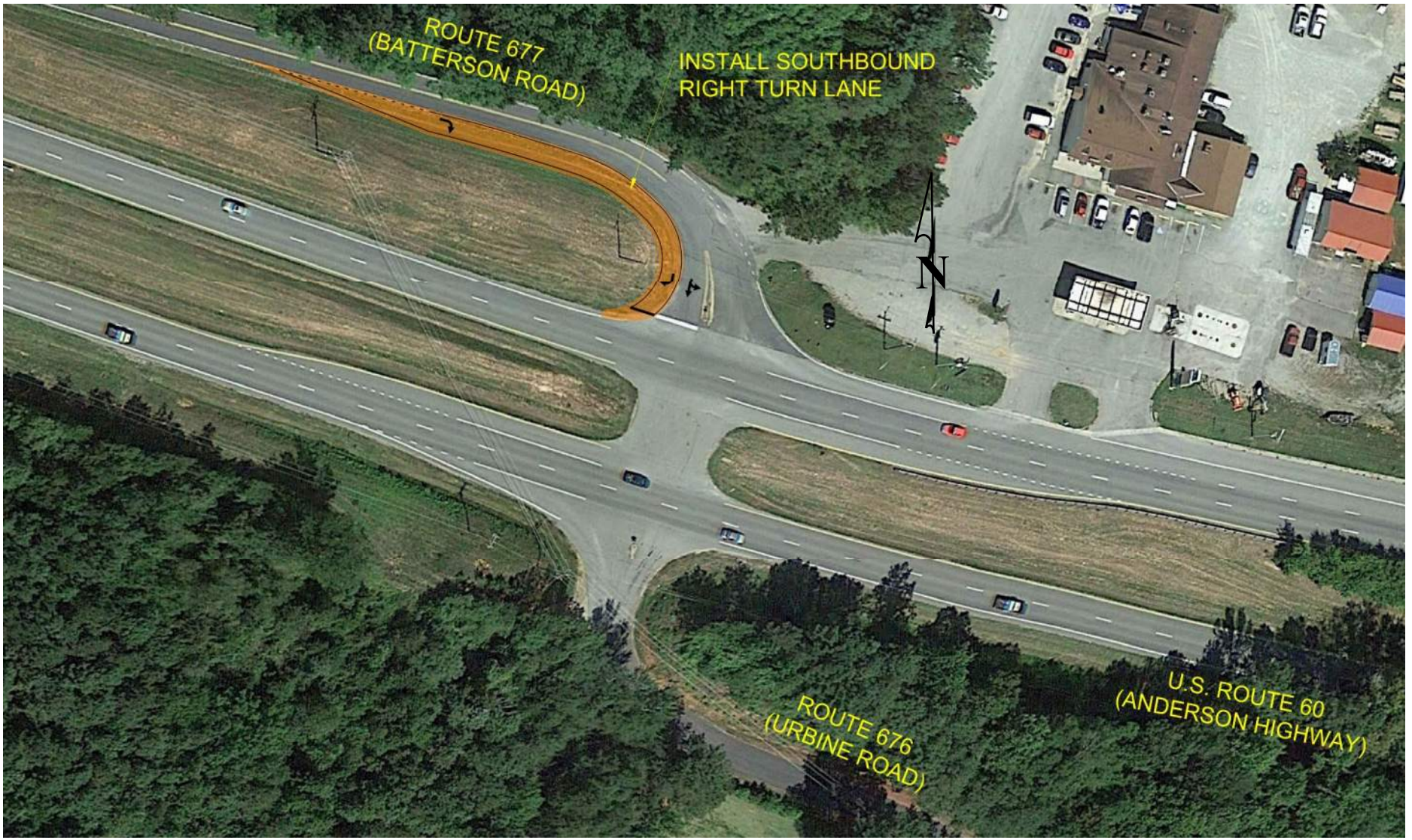
CRO Task Order #237
U.S. Route 60 at South Creek One

Figure
7-2



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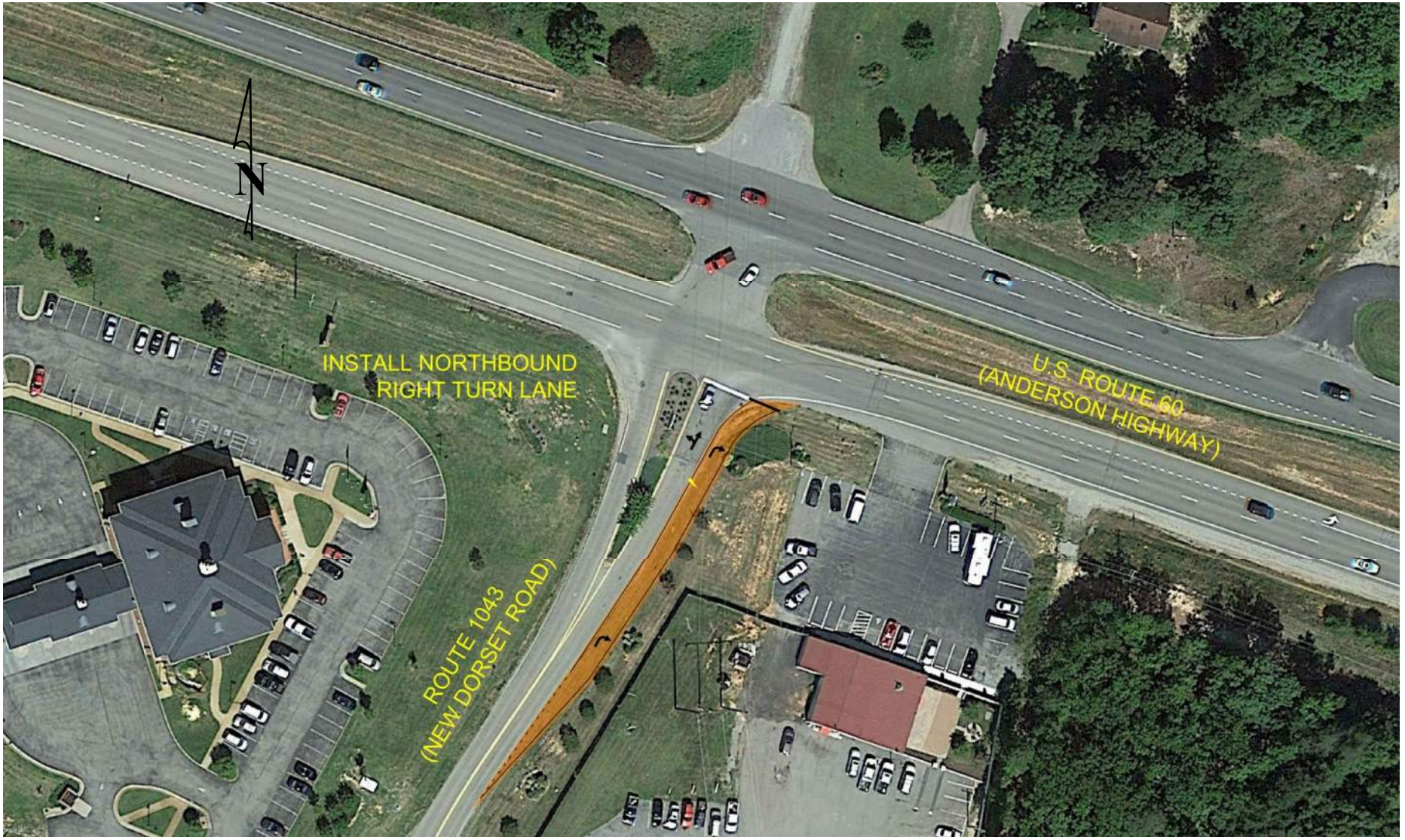
CRO Task Order #237
U.S. Route 60 at Urbine Road/Batterson Road

Figure
7-3

TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

CRO Task Order #237
U.S. Route 60 at Jude's Ferry Road

Figure
7-4



TIMMONS GROUP
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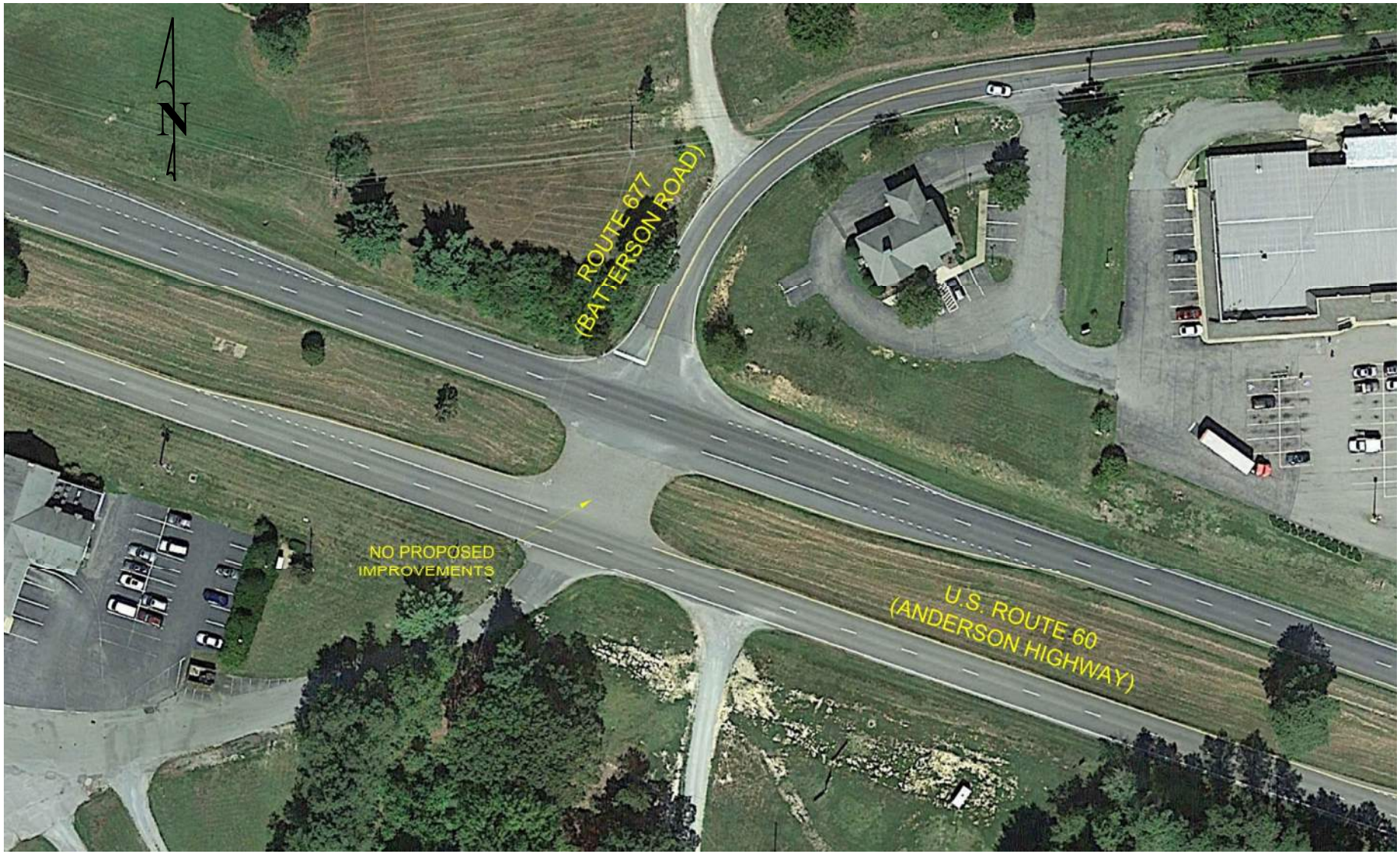
CRO Task Order #237
U.S. Route 60 at New Dorset Road

Figure
7-5



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CRO Task Order #237
U.S. Route 60 at Batterson Road

Figure
7-6

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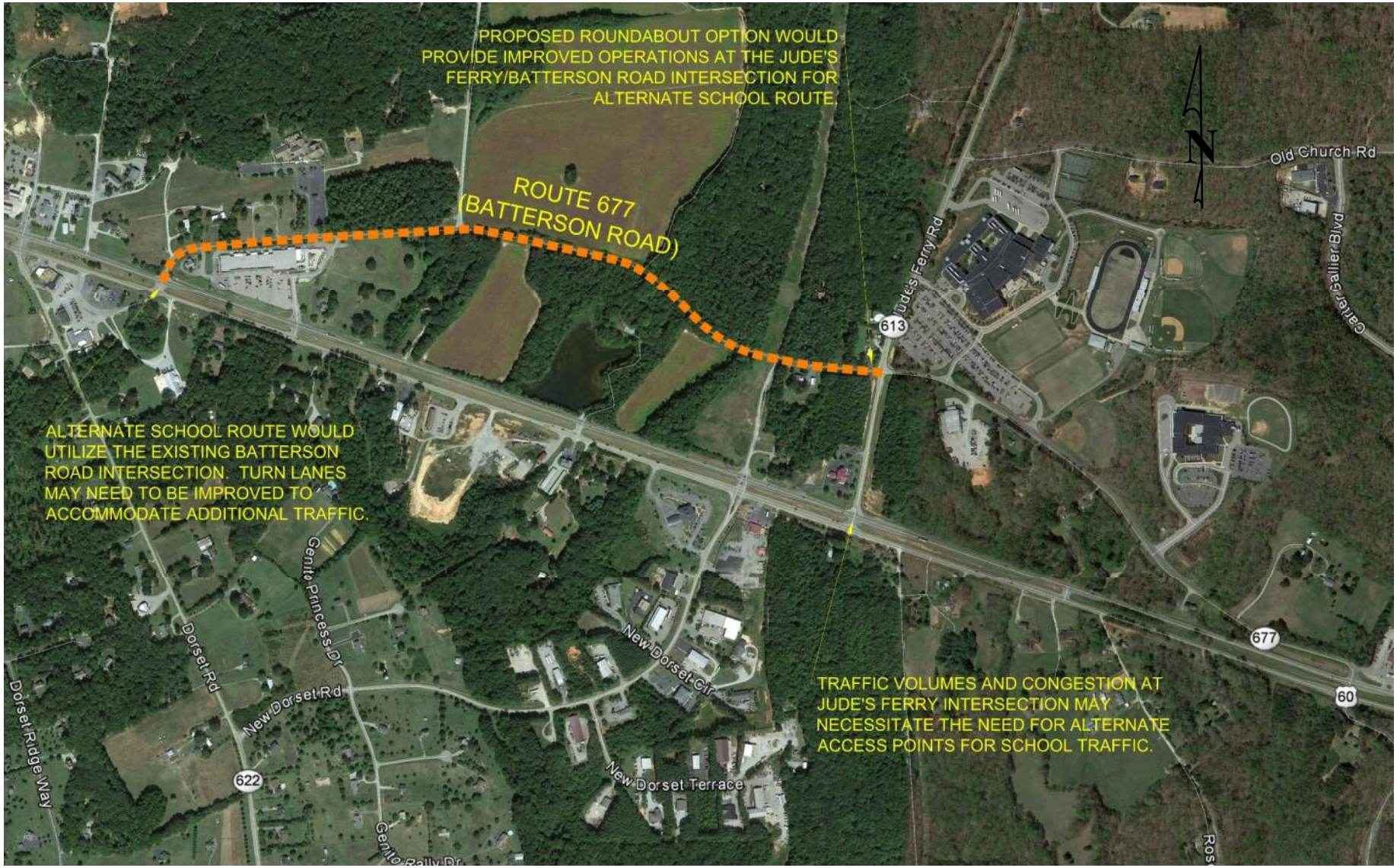
CRO Task Order #237
U.S. Route 60 at Dorset Road

Figure
7-7



TIMMONS GROUP
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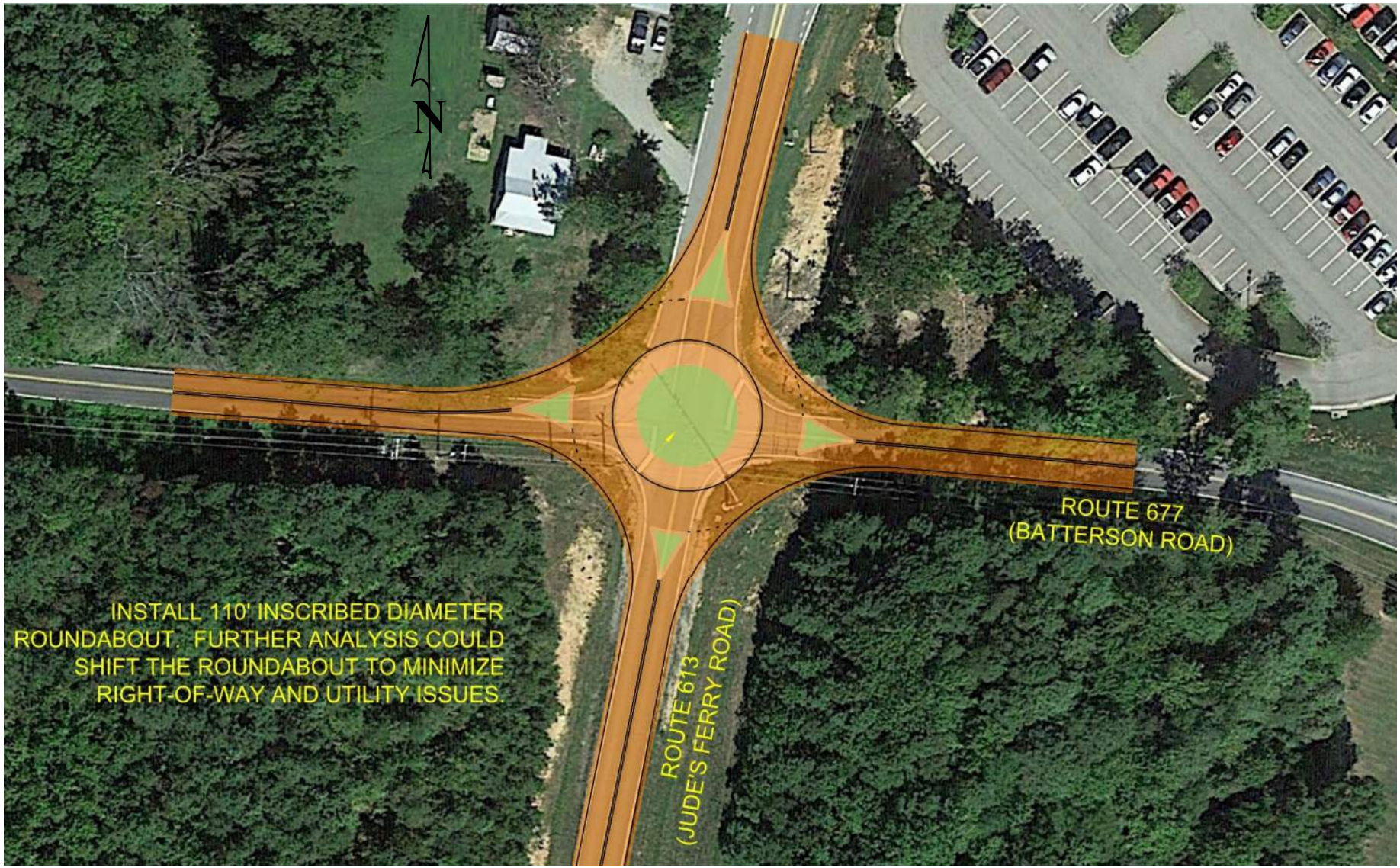
CRO Task Order #237
Batterson Road – Alternate School Access Route

Figure
7-8



TIMMONS GROUP
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CRO Task Order #237
Jude's Ferry Road at Batterson Road

Figure
7-9

8 2036 IMPROVED CONDITIONS ANALYSIS

The 2036 background volumes shown on Figure 5-1 were analyzed assuming improved intersection geometry, traffic, and controls as discussed in Chapter 7.

8.1 CAPACITY ANALYSES

For the signalized intersection analysis, the cycle lengths were adjusted based on the natural cycle lengths determined by SYNCHRO with a minimum length of 80 seconds and a maximum length of 160 seconds; it should be noted that the yellow and all-red times from the EPAC data remained the same. No other changes were made from the background conditions analysis.

8.2 2036 IMPROVED CONDITIONS

Table 8-1 summarizes the 2036 improved intersection LOS, delay, and queue lengths based on the 2036 background traffic volumes and the improved intersection geometries from Chapter 7. The corresponding SYNCHRO worksheets are included in Appendix E.

U.S. Route 60 at Stavemill Road (signalized) continues to operate at an overall LOS F during the AM peak hour and at LOS C during the PM peak hour, with lower queues and delays than the 2036 background analysis. The westbound left turn lane improves in both the level of service and delay experienced. The northbound approach which improves to operate at LOS D in the PM peak hour.

The introduction of the second westbound left turn lane has improved the movement to contain all 95th percentile queue and maximum simulated queues.

U.S. Route 60 at South Creek One (signalized) – No improvements are assumed at this intersection and therefore no changes from the background conditions analysis.

U.S. Route 60 and Urbine Road/Batterson Road (unsignalized - The installation of the southbound right turn lane will allow the southbound right to operate at LOS A with a queue of 33 feet in the AM peak hour and at LOS B with a queue of 304 feet in the PM peak hour.

U.S. Route 60 at Jude's Ferry Road (signalized) improves to operate at an overall LOS B during the AM peak hour and at LOS C during the PM peak hour. The eastbound approach operates at LOS B during the AM peak hour and at LOS A during the PM peak hour.

The eastbound left turn movement continues to have maximum queues that extend beyond the existing turn lane storage during the AM peak hour.

U.S. Route 60 and New Dorset Road (unsignalized - The installation of the northbound right turn lane will allow the northbound right to operate at LOS F with a queue of 395 feet in the AM peak hour and at LOS E with a queue of 400 feet in the PM peak hour.

U.S. Route 60 and Batterson Road (unsignalized) - No improvements are assumed at this intersection and therefore no changes from the background conditions analysis.

U.S. Route 60 at Dorset Road (signalized) improves to operate at an overall LOS E during both the AM and PM peak hours. The northbound approach will continue to operate at LOS F during both the AM and PM peak hours, albeit with lower delays and shorter queues than the 2036 background conditions. The improvements to the northbound approach has improved the overall LOS of the intersection and reduced queuing and delay.

Jude's Ferry Road and Batterson Road (unsignalized) will operate at LOS C or better during both the AM and PM peak hours. There are no queuing issues observed at this intersection.

If traffic continues to grow as anticipated, there are several locations in the corridor where turn lanes may need to be lengthened to accommodate the maximum queues.

Table 8-1: Intersection Level of Service, Delay and Queue Summary
2036 Improved Conditions

Intersection and Type of Control	Movement and Approach	Turn Lane Storage (ft)	AM PEAK HOUR				PM PEAK HOUR			
			Delay [1] (sec/veh)	LOS [1]	HCM 95th Percentile Queue Length (ft)	SimTraffic Maximum Queue Length[2] (ft)	Delay [1] (sec/veh)	LOS [1]	HCM 95th Percentile Queue Length (ft)	SimTraffic Maximum Queue Length[2] (ft)
1. US Route 60 (E-W) at Stavemill Road (N-S) Signalized	EB Dual Left [3]	863	64.2	E	m44	78	41.1	D	#81	110
	EB Thru		101.5	F	#1227	566	18.0	B	140	289
	EB Right	363	13.9	B	m0	226	18.3	B	1	50
	EB Approach		*99.8*	*F*	--	--	*20.5*	*C*	--	--
	WB Dual Left [3]	738	46.8	D	69	132	52.1	D	#234	365
	WB Thru		9.9	A	119	162	24.2	C	526	584
	WB Right	375	8.4	A	0	37	13.5	B	38	228
	WB Approach		*13.9*	*B*	--	--	*28.0*	*C*	--	--
	NB Left-Thru	400	101.7	F	#197	400	55.9	E	#148	172
	NB Right	LMT	196.2	F	#613	755	29.0	C	11	98
	NB Approach		*181.2*	*F*	--	--	*41.5*	*D*	--	--
	SB Left	LMT	101.8	F	#105	134	64.7	E	#100	114
	SB Left-Thru		98.9	F	#105	99	63.7	E	#96	109
	SB Right	400	57.9	E	0	22	46.8	D	0	78
	SB Approach		*94.4*	*F*	--	--	*58.9*	*E*	--	--
	Overall		91.0	F	--	--	27.9	C	--	--
2. US Route 60 (E-W) at South Creek One (N-S) Signalized	EB Dual Left [3]	363	52.6	D	m25	49	37.8	D	m99	99
	EB Thru-Right		3.6	A	111	90	6.0	A	160	126
	EB Approach		*4.7*	*A*	--	--	*10.3*	*B*	--	--
	WB Left	338	68.7	E	m3	3	99.9	F	m12	194
	WB Thru		1.5	A	m11	74	4.9	A	51	662
	WB Right	313	0.2	A	m0	39	0.4	A	m0	275
	WB Approach		*1.4*	*A*	--	--	*4.8*	*A*	--	--
	NB L-T-R		56.0	E	12	25	37.4	D	9	25
	NB Approach		*56.0*	*E*	--	--	*37.4*	*D*	--	--
	SB Left	440	64.9	E	73	92	40.0	D	83	97
	SB Left-Thru		66.6	E	73	136	40.1	D	84	128
	SB Right	LMT	56.1	E	0	64	57.9	E	#225	270
	SB Approach		*62.4*	*E*	--	--	*52.9*	*D*	--	--
	Overall		6.1	A	--	--	11.8	B	--	--
3. US Route 60 (E-W) at Urbine Road (N-S) Unsignalized	EB Left	188	9.3	A	2	20	33.8	D	6	32
	EB Thru		†	†	†	0	†	†	†	0
	EB Right	100	†	†	†	0	†	†	†	0
	EB Approach		*†*	*†*	--	--	*†*	*†*	--	--
	WB Left	188	19.6	C	3	36	12.0	B	2	41
	WB Thru		†	†	†	0	†	†	†	0
	WB Right	LMT	†	†	†	0	†	†	†	0
	WB Approach		*†*	*†*	--	--	*†*	*†*	--	--
	NB L-T-R		83.2	F	31	95	55.1	F	11	63
	NB Approach		*83.2*	*F*	--	--	*55.1*	*F*	--	--
	SB Left-Thru		31.1	D	32	131	344.4	F	167	434
	SB Right	300	0.0	A	0	37	0.0	A	0	300
	SB Approach		*31.1*	*D*	--	--	*344.4*	*F*	--	--
4. US Route 60 (E-W) at Jude's Ferry Road (N-S) Signalized	EB Dual Left [3]	475	25.7	C	m215	475	34.9	C	#136	362
	EB Thru		5.2	A	m129	699	2.4	A	48	343
	EB Approach		*10.2*	*B*	--	--	*7.0*	*A*	--	--
	WB U-Turn	325	82.9	F	m3	9	76.7	E	m1	9
	WB Thru		19.2	B	259	1259	42.8	D	#987	1019
	WB Right	238	5.7	A	5	237	0.2	A	m0	238
	WB Approach		*18.4*	*B*	--	--	*39.6*	*D*	--	--
	SB Left	300	70.2	E	#304	300	69.0	E	#208	244
	SB Right	LMT	45.1	D	69	448	97.2	F	#258	314
	SB Approach		*58.3*	*E*	--	--	*86.8*	*F*	--	--
	Overall		17.8	B	--	--	33.7	C	--	--

2036 Improved Conditions (Continued)

Intersection and Type of Control	Movement and Approach	Turn Lane Storage (ft)	AM PEAK HOUR				PM PEAK HOUR			
			Delay [1] (sec/veh)	LOS [1]	HCM 95th Percentile Queue Length (ft)	SimTraffic Maximum Queue Length[2] (ft)	Delay [1] (sec/veh)	LOS [1]	HCM 95th Percentile Queue Length (ft)	SimTraffic Maximum Queue Length[2] (ft)
5. US Route 60 (E-W) at	EB Left	288	8.8	A	0	264	17.5	C	1	36
New Dorset Road (N-S)	EB Thru		†	†	†	2513	†	†	†	0
Unsignalized	EB Right	800	†	†	†	485	†	†	†	0
	EB Approach		*†*	*†*	--	--	*†*	*†*	--	--
	WB Left	288	34.2	D	53	288	18.4	C	93	287
	WB Thru		†	†	†	680	†	†	†	0
	WB Right	150	†	†	†	0	†	†	†	0
	WB Approach		*†*	*†*	--	--	*†*	*†*	--	--
	NB Left-Thru		265.0	F	457	1086	36.3	E	124	1096
	NB Right	300	265.0	F	457	300	36.3	E	124	300
	NB Approach		*265.0*	*F*	--	--	*36.3*	*E*	--	--
	SB L-T-R		**	F	**	60	**	F	**	30
	SB Approach		****	*F*	--	--	****	*F*	--	--
6. US Route 60 (E-W) at	EB Left	163	9.4	A	2	46	22.2	C	13	153
Batterson Road (S)	EB Thru		†	†	†	0	†	†	†	0
Unsignalized	*EB Approach*		*†*	*†*	--	--	*†*	*†*	--	--
	WB U-Turn	163	0.0	A	0	7	0.0	A	0	30
	WB Thru		†	†	†	0	†	†	†	0
	WB Right	100	†	†	†	0	†	†	†	0
	WB Approach		*†*	*†*	--	--	*†*	*†*	--	--
	SB Left-Right		11.3	B	4	42	31.9	D	35	380
	SB Approach		*11.3*	*B*	--	--	*31.9*	*D*	--	--
7. US Route 60 (E-W) at	EB Left	300	50.1	D	170	300	155.9	F	#175	234
Dorset Road (N-S)	EB Thru		65.6	E	#1104	1276	23.2	C	315	596
Signalized	EB Right	550	11.8	B	0	550	16.7	B	25	201
	EB Approach		*62.2*	*E*	--	--	*33.0*	*C*	--	--
	WB Left	350	191.1	F	#114	99	35.1	D	m49	349
	WB Thru		8.5	A	73	120	51.4	D	m#723	561
	WB Right	563	19.1	B	0	22	4.7	A	m3	301
	WB Approach		*21.8*	*C*	--	--	*46.0*	*D*	--	--
	NB Left	300	57.2	E	#234	253	135.8	F	#284	296
	NB Thru-Right		150.3	F	#228	339	49.0	D	82	516
	NB Approach		*100.9*	*F*	--	--	*109.4*	*F*	--	--
	SB Left		98.8	F	#303	253	41.9	D	#149	492
	SB Thru-Right		60.9	E	51	83	162.7	F	#377	507
	SB Approach		*91.8*	*F*	--	--	*132.8*	*F*	--	--
	Overall		58.5	E	--	--	56.1	E	--	--
8. Jude's Ferry Road (N-S) at	EB L-T-R		28.7	D	9	55	17.7	C	7	39
Batterson Road (E-W)	*EB Approach*		*28.7*	*D*	--	--	*17.7*	*C*	--	--
Unsignalized	WB L-T-R		21.6	C	14	198	24.8	C	90	149
	WB Approach		*21.6*	*C*	--	--	*24.8*	*C*	--	--
	NB L-T-R		0.0	A	0	6	0.0	A	0	2
	NB Approach		*†*	*†*	--	--	*†*	*†*	--	--
	SB Left-Thru		1.6	A	5	561	0.6	A	1	38
	SB Right	300	†	†	†	139	†	†	†	0
	SB Approach		*†*	*†*	--	--	*†*	*†*	--	--

[1] Overall intersection LOS and delay reported for signalized intersections and roundabouts only.

[2] For movements with multiple lanes, queue reported is maximum in any one lane.

[3] Dual left turn lanes; average storage is provided.

† SYNCHRO does not provide level of service or delay for unsignalized movements with no conflicting volumes.

**Delay greater than 9999.99 seconds cannot be calculated by SYNCHRO.

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

m - Volume for 95th percentile queue is metered by upstream signal.

9 STAKEHOLDER MEETINGS

Timmons Group facilitate a total of four (4) stakeholder meetings through the course of this project. The meetings are summarized below and all citizen comments and exhibits from the meetings are included in Appendix F.

9.1 CITIZEN MEETING #1

The first citizen meeting was held on Wednesday, December 9, 2015 at the Huguenot Public Safety Building. The purpose of this meeting was to introduce the study to the public and receive citizen input on issues and opportunities within the study area.

9.2 PLANNING COMMISSION WORK SESSION

At the Tuesday, October 25, 2016 Powhatan County Planning Commission Work Session, Timmons Group presented the results/recommendations of the study and received any Planning Commission comments.

9.3 CITIZEN MEETING #2

The second citizen meeting was held on Wednesday, December 7, 2016 at the Huguenot Public Safety Building. The purpose of this meeting was to present to findings/recommendations of the study to the public and receive any citizen comments.

9.4 BOARD OF SUPERVISORS MEETING

At the Monday, December 12, 2016 Powhatan County Board of Supervisors Meeting, Timmons Group presented the results/recommendations of the study and received any Board of Supervisors comments.

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10 CONCLUSIONS

The key findings of the intersection analysis are as follows:

- The study intersections experienced approximately 20 crashes per year during the five-year study period. There are minimal trend lines drawn from the overall crash data. A large spike in the overall number of crashes occurred between 2013 and 2014, but the next year saw a regression to the general trends of the corridor.
- The U.S. Route 60 intersections with Stavemill Road and Dorset Road experienced the highest number of crashes over the five-year study period.
- At all four (4) signalized study intersections, mainline queuing issues are present which block access to existing turn lanes. The signalized intersections generally operate at overall acceptable levels of service; however, the side street approaches and mainline left turns operate at poor levels of service in both peak hours.
- At the four (4) unsignalized study intersections, the side street approaches (lefts) have poor levels of service, delays, and queues due to the volume on U.S. Route 60.
- Based on data provided by the County and VDOT, it is anticipated that the corridor will experience a 1.1% annual growth rate over the next twenty (20) years.
- Under 2036 background traffic conditions (with no improvements), the growth in traffic will exacerbate the issues at the study intersections identified under existing conditions.
- In order to accommodate the increase in traffic anticipated in 2036, the following improvements are recommended:
    - Optimize the signal timings throughout the corridor.
    - At the signalized U.S. Route 60/Stavemill Road intersection
        - Install second westbound left turn lane;
        - Add an overlap phase for the northbound right turn lane;
        - Restrict westbound U-turns; and
        - Modify the traffic signal to facilitate the above improvements.
    - In the vicinity of the South Creek One intersection
        - Add striping to the curb lane to clearly delineate the travel way.
    - At the unsignalized U.S. Route 60/Urbine Road/Batterson Road intersection
        - Install a dedicated southbound right turn lane.
    - At the signalized U.S. Route 60/Jude's Ferry Road intersection
        - Install second eastbound left turn lane;
        - Install a second northbound lane on Jude's Ferry Road for dual receiving lanes; and
        - Modify the traffic signal to facilitate the above improvements.

      NOTE: These improvements may not be required if school traffic utilizes the alternative route discussed below.
    - At the U.S. Route 60/New Dorset Road intersection
        - Install a dedicated northbound right turn lane.
    - At the U.S. Route 60/Batterson Road intersection
        - Install signage to encourage traffic traveling to Powhatan High School to make a left turn onto Batterson Road.

  - At the U.S. Route 60/Dorset Road intersection
    - Install an exclusive left turn lane on the northbound approach;
    - Implement concurrent side street phasing; and
    - Modify the traffic signal to facilitate the above improvements
  - At the Jude's Ferry Road/Batterson Road intersection
    - Install 110' inscribed diameter, single-lane roundabout.

- If traffic continues to grow as anticipated, there are several locations where turn lanes may need to be lengthened to accommodate the maximum queues.
- With the improvements noted above and the projected traffic volumes in 2036, each of the study intersections shows improvement in levels of service, queuing, and delay. Mainline queuing issues are associated only with the heavy through movement volumes and not turn lanes that are over capacity.
- Per the report findings, the U.S. Route 60 corridor is currently operating under capacity, with some intersections having specific operational issues. The individual intersection improvement options noted above provide reductions in operational issues and provide additional capacity to handle the 1.1% annual growth expected over the next 20 years.
  - The existing four-lane section (two lanes in each direction) of U.S. Route 60 will adequately accommodate the projected 2036 traffic volumes. The analysis does not indicate the need to widen U.S. Route 60 to six-lanes in the study corridor.