

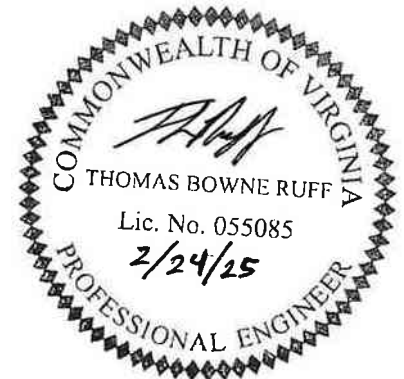
IRON HORSE DATA CENTER REZONING

(FORMERLY EAST ASHLAND – TRADEPORT95)

Traffic Impact Analysis

Hanover County
Town of Ashland

February 2024
Revised July 2024
Revised February 2025



Prepared For:

WestDulles Properties, Inc.
on behalf of
TradePort Ashland Land, LLC
TradePort Hanover Land, LLC

TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.



Contact: Thomas Ruff, PE, PTOE, AICP

1001 Boulders Parkway, Suite 300 • Richmond, VA 23225
(804) 200-6500 phone • (804) 560-1438 fax
www.timmons.com

PAGE INTENTIONALLY BLANK

TABLE OF CONTENTS

TABLE OF CONTENTS.....	I
APPENDICES	II
LIST OF TABLES.....	III
LIST OF FIGURES	III
1 EXECUTIVE SUMMARY.....	1-1
1.1 PROJECT OVERVIEW	1-1
1.2 STUDY LIMITS	1-2
1.3 PRINCIPAL FINDINGS	1-4
1.4 RECOMMENDATIONS	1-4
2 BACKGROUND INFORMATION	2-1
2.1 DESCRIPTION OF ON-SITE DEVELOPMENT	2-1
2.2 STUDY LIMITS	2-1
2.3 EXISTING ROADWAYS	2-2
2.4 FUTURE IMPROVEMENTS	2-3
2.5 OTHER MODES OF TRANSPORTATION.....	2-3
3 2022 EXISTING CONDITIONS	3-1
3.1 EXISTING TRAFFIC VOLUMES	3-1
3.2 CAPACITY ANALYSES.....	3-2
3.3 2022 EXISTING CONDITIONS ANALYSIS	3-4
4 APPROVED BACKGROUND DEVELOPMENTS.....	4-1
5 2033 BACKGROUND CONDITIONS	5-1
5.1 BACKGROUND FORECASTING METHODOLOGY	5-1
5.2 BACKGROUND 2033 CAPACITY ANALYSES	5-1
6 2039 BACKGROUND CONDITIONS	6-1
6.1 BACKGROUND FORECASTING METHODOLOGY	6-1
6.2 BACKGROUND 2039 CAPACITY ANALYSES	6-1
7 TRIP GENERATION AND DISTRIBUTION	7-1
7.1 SITE TRIP GENERATION	7-1
7.2 PRIMARY TRIP DISTRIBUTION METHODOLOGY.....	7-2
7.3 TRAFFIC ASSIGNMENT	7-2
8 2033 TOTAL FUTURE CONDITIONS	8-1
8.1 TOTAL FUTURE TRAFFIC VOLUMES	8-1
8.2 2033 TOTAL FUTURE CAPACITY ANALYSES.....	8-1
9 2039 TOTAL FUTURE CONDITIONS	9-1
9.1 TOTAL FUTURE TRAFFIC VOLUMES	9-1
9.2 2039 TOTAL FUTURE CAPACITY ANALYSES.....	9-1
10 ADDITIONAL ANALYSIS	10-1
10.1 TURN LANE WARRANT ANALYSIS	10-1
11 CONCLUSIONS.....	11-1
11.1 PRINCIPAL FINDINGS	11-1
11.2 RECOMMENDATIONS	11-1

APPENDICES

Appendix A – Hanover County and VDOT Comments and Responses

Appendix B – Scoping Agreement

Appendix C – Traffic Counts

Appendix D – Conceptual Drawings of Site Improvements

Appendix E – Existing Traffic Signal Timings and Signal Plans

Appendix F – SYNCHRO Calibration Worksheets

Appendix G – Capacity Analysis Worksheets for Existing Conditions

Appendix H – Capacity Analysis Worksheets for 2033 Background Conditions

Appendix I – Capacity Analysis Worksheets for 2039 Background Conditions

Appendix J – Bowman Data Center Study, March 2023

Appendix K – Capacity Analysis Worksheets for 2033 Total Conditions

Appendix L – Capacity Analysis Worksheets for 2039 Total Conditions

Appendix M – Turn Lane Warrant Analysis

LIST OF TABLES

TABLE 3-1: 2019 VDOT TRAFFIC DATA	3-1
TABLE 3-2: TRAFFIC DATA COMPARISON	3-1
TABLE 3-3: LEVEL OF SERVICE DEFINITIONS	3-3
TABLE 3-4: UNSIGNALIZED AND SIGNALIZED INTERSECTION LEVEL OF SERVICE CRITERIA	3-4
TABLE 3-5: INTERSECTION LEVEL OF SERVICE AND DELAY SUMMARY 2022 EXISTING TRAFFIC (PART 1)	3-6
TABLE 3-6: INTERSECTION LEVEL OF SERVICE AND DELAY SUMMARY 2022 EXISTING TRAFFIC (PART 2)	3-7
TABLE 5-1: INTERSECTION LEVEL OF SERVICE AND DELAY SUMMARY 2033 BACKGROUND TRAFFIC (PART 1)	5-3
TABLE 5-2: INTERSECTION LEVEL OF SERVICE AND DELAY SUMMARY 2033 BACKGROUND TRAFFIC (PART 2)	5-4
TABLE 6-1: INTERSECTION LEVEL OF SERVICE AND DELAY SUMMARY 2039 BACKGROUND TRAFFIC (PART 1)	6-3
TABLE 6-2: INTERSECTION LEVEL OF SERVICE AND DELAY SUMMARY 2039 BACKGROUND TRAFFIC (PART 2)	6-4
TABLE 7-1: TRIP GENERATION SUMMARY	7-1
TABLE 8-1: INTERSECTION LEVEL OF SERVICE AND DELAY SUMMARY 2033 TOTAL FUTURE TRAFFIC (PART 1)	8-3
TABLE 8-2: INTERSECTION LEVEL OF SERVICE AND DELAY SUMMARY 2033 TOTAL FUTURE TRAFFIC (PART 2)	8-4
TABLE 8-3: INTERSECTION LEVEL OF SERVICE AND DELAY SUMMARY 2033 TOTAL FUTURE TRAFFIC (PART 3)	8-5
TABLE 9-1: INTERSECTION LEVEL OF SERVICE AND DELAY SUMMARY 2039 TOTAL FUTURE TRAFFIC (PART 1)	9-3
TABLE 9-2: INTERSECTION LEVEL OF SERVICE AND DELAY SUMMARY 2039 TOTAL FUTURE TRAFFIC (PART 2)	9-4
TABLE 9-3: INTERSECTION LEVEL OF SERVICE AND DELAY SUMMARY 2039 TOTAL FUTURE TRAFFIC (PART 3)	9-5

LIST OF FIGURES

FIGURE 1-1: VICINITY MAP/STUDY INTERSECTIONS
FIGURE 1-2: DATA CENTER CONCEPTUAL SITE PLAN
FIGURE 1-3: DATA CENTER CONCEPTUAL SITE PLAN
FIGURE 2-1: EXISTING INTERSECTION GEOMETRY
FIGURE 2-2: PROPOSED INTERSECTION GEOMETRY
FIGURE 3-1: 2022 EXISTING TRAFFIC VOLUMES
FIGURE 5-1: 2033 BACKGROUND TRAFFIC VOLUMES
FIGURE 6-1: 2039 BACKGROUND TRAFFIC VOLUMES
FIGURE 7-1: DATA CENTER TRIP DISTRIBUTION
FIGURE 7-2: DATA CENTER SITE TRIPS
FIGURE 8-1: 2033 TOTAL FUTURE TRAFFIC VOLUMES
FIGURE 9-1: 2039 TOTAL FUTURE TRAFFIC VOLUMES

PAGE INTENTIONALLY BLANK

1 EXECUTIVE SUMMARY

This report presents the findings of the traffic impact analysis prepared for WestDulles Properties' rezoning of the Iron Horse Data Center project in Hanover County and the Town of Ashland, Virginia. The first edition of this report was submitted on February 29, 2024. Review comments were received from VDOT on April 22, 2024 and from Hanover County on May 23, 2024. A copy of the comments and Timmons Group responses are included in Appendix A.

1.1 PROJECT OVERVIEW

The proposed data center development is located to the south of Route 54 (Patrick Henry Hwy), east of Mt. Hermon Road, and west of Woodside Lane in both Hanover County and the Town of Ashland. The proposed residential development is located to the east of I-95, south of Mechumps Creek, and west of Mt. Hermon Road. A site location map is shown on Figure 1-1 (all figures located at the end of their respective chapter).

East Ashland is currently zoned as a Planned Unit Development (PUD) within the Town of Ashland and mixed use (MX) within Hanover County. The Applicant is proposing to rezone a portion of the site to Business (B-2 Ashland; B-3 Hanover) and Light Industrial (M-1 Ashland; M-2 Hanover) which will accommodate the development of data center as a land use option.

The Applicant is proposing to develop the site in one phase, consisting of the following (with the understanding that explicit site plans will be required for each part of development):

- 3.3 million GSF Data Center
 - 1,800,000 GSF within the Town of Ashland
 - 1,500,000 GSF within Hanover County

The buildout of the development is anticipated to occur by 2033. For the purposes of this analysis, all of the data center buildings will be constructed in one phase by 2033. A conceptual site plan is shown on Figures 1-2 and 1-3.

Access to the data center site will be provided via two (2) driveways connecting to Route 54 (Entrances A and B) and one (1) driveway connecting Mt. Hermon Road (Entrance C).

The site plan provided is intended for informational purposes only and is conceptual in nature. The proposed driveways shown do not represent the final site layout and are subject to site plan approval with the Town, County, and VDOT. Therefore, for the purposes of this analysis, it was assumed that there would be no partial access driveways along the parcel's frontage on Route 54. All proposed entrances will require entrance permit approval at such time that development plans occur.

As shown in Table 8-1, when complete, the total proposed development will generate 297 external trips (163 in and 134 out) during the AM peak, 99 external trips (30 in and 69 out) during the PM peak, and 2,475 external weekday daily trips.

The purpose of this analysis is to determine the impact of the traffic generated by the proposed development on the surrounding roadway network. The scope of this study was developed in conjunction with the Virginia Department of Transportation (VDOT), Town of Ashland, and Hanover County staff at a scoping meeting held virtually on March 18, 2022. A copy of the scoping agreement is included in Appendix B.

1.2 STUDY LIMITS

As outlined in the scoping agreement, the study limits include the following 10 existing intersections (see Figure 1-1):

1. Route 54 and US Route 1 (Washington Hwy) (signalized);
2. Route 54 and Cottage Green Drive (signalized);
3. Route 54 and Hill Carter Parkway (signalized);
4. Route 54 and Carter Road (unsignalized);
5. Route 54 and I-95 SB ramps (unsignalized);
6. Route 54 and I-95 NB ramps (unsignalized);
7. Route 54 and Telecourt Road (unsignalized);
8. Route 54 and Mt. Hermon Road (unsignalized);
9. Route 54 and Woodside Lane (unsignalized); and
10. Route 54 and Goddins Hill Road (unsignalized).

In accordance with the scoping agreement, analyses were completed for the weekday AM and PM peak hours for the following scenarios:

1. 2022 Existing Traffic Conditions
2. 2033 Background Traffic Conditions (without the development of the site)
3. 2033 Future Traffic Conditions (with total development of the site)
4. 2039 Background Traffic Conditions (without the development of the site)
5. 2039 Future Traffic Conditions (with total development of the site)

The following steps were taken to determine the potential traffic impacts associated with this project:

1. Data Collection – Directional turning movement counts (TMCs) were conducted at the study intersections on May 5, 2022 when public schools were in session. In addition, 12-hour TMCs were collected at the intersection of Route 54/Mt. Hermon Rd. The TMCs were comparable to the 2019 VDOT average daily traffic along Route 54. Therefore, in agreement with VDOT, the Town of Ashland, and Hanover County, the 2022 peak hour TMCs were not adjusted for COVID factors since the counts indicate normal traffic conditions in the study area.
2. Traffic Growth – In order to be conservative and account for development outside the study area, a 1.5% annual growth rate was applied to the study area road network. The growth rate was compounded annually for each future scenario.
3. Other Development Trip Generation – The traffic generated by one (1) other development in the vicinity was included in the analyses under background conditions, including improvements to the roadway network proffered by the other development.
4. Trip Generation – Traffic generated by the proposed development was estimated using the 11th Edition of the Institute of Transportation Engineers' *Trip Generation Manual* and data collected at existing data center sites in Virginia.
5. Traffic Distributions – The distribution of trips generated by the proposed development was based on the existing traffic volumes, the nature of the proposed uses, and the surrounding roadway network.
6. Traffic Projections – Future traffic volumes were determined using the existing traffic counts, the 1.5% growth rate noted above, the trips generated by the other approved development, and the trips generated by the site.
7. Traffic Capacity Analysis – Level of service calculations for existing, background, and future conditions were performed using SYNCHRO for signalized and unsignalized intersections.
8. Queuing Analysis – The simulated maximum and HCS 95th percentile queue lengths were reviewed at the study intersections to determine turn lane storage needs.

This traffic impact analysis (TIA) has been prepared in accordance with (1) the procedures outlined in the VDOT Traffic Impact Analysis Regulations (henceforth referred to as Chapter 527), (2) the VDOT Traffic Operations and Safety Analysis Manual (TOSAM), and (3) the Scope of Study agreed upon between Hanover County, VDOT, Town of Ashland, and Timmons Group (See Appendix B for the original scoping agreement).

1.3 PRINCIPAL FINDINGS

The 2022 existing conditions analysis indicates that the Route 54 corridor operates well during both peak hours. No major queueing or delay challenges are noted at the study intersections, with the exception of the southbound approach experiencing long delays at Route 54/I-95 SB on/off ramp intersection.

Under 2033, and 2039 Background analyses, the Route 54 corridor is able to handle increases in traffic volumes without degrading operations until year 2039. By 2039, many movements at Route 54/US Route 1 are over capacity and excessive queues impact operations of the overall intersection.

The Iron Horse Data Center development (2033) will be accommodated through constructing VDOT-approved standard turn lanes at the intersection of Site Entrance A and Route 54.

At Site Entrances B and C, no right or left turn lanes are warranted.

With the site improvements described above and under 2033 and 2039 Total conditions, there are no significant capacity or queueing issues noted at the study intersections beyond those background issues previously noted. Retiming traffic signals along Route 54 will provide added capacity to the corridor.

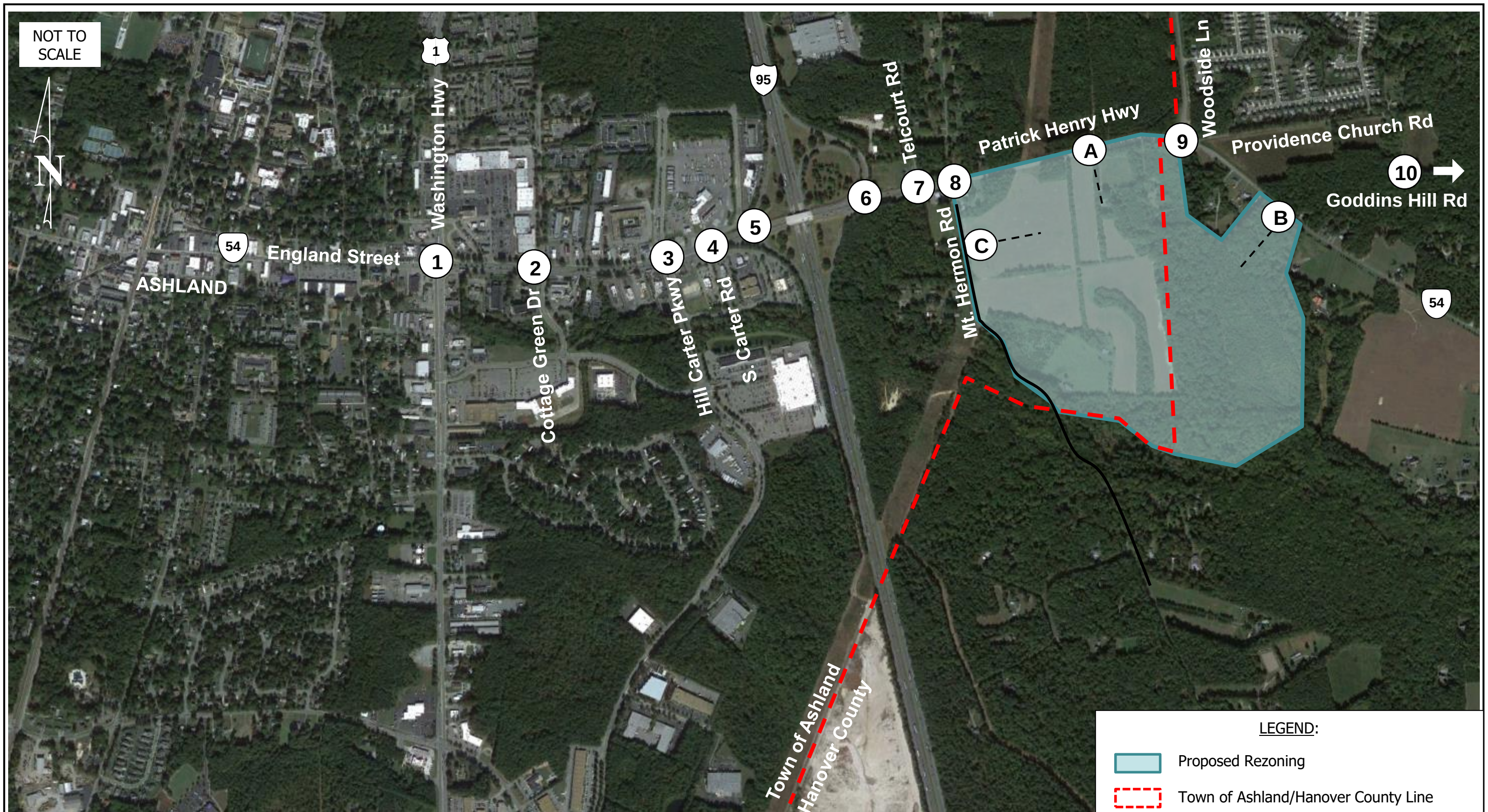
1.4 RECOMMENDATIONS

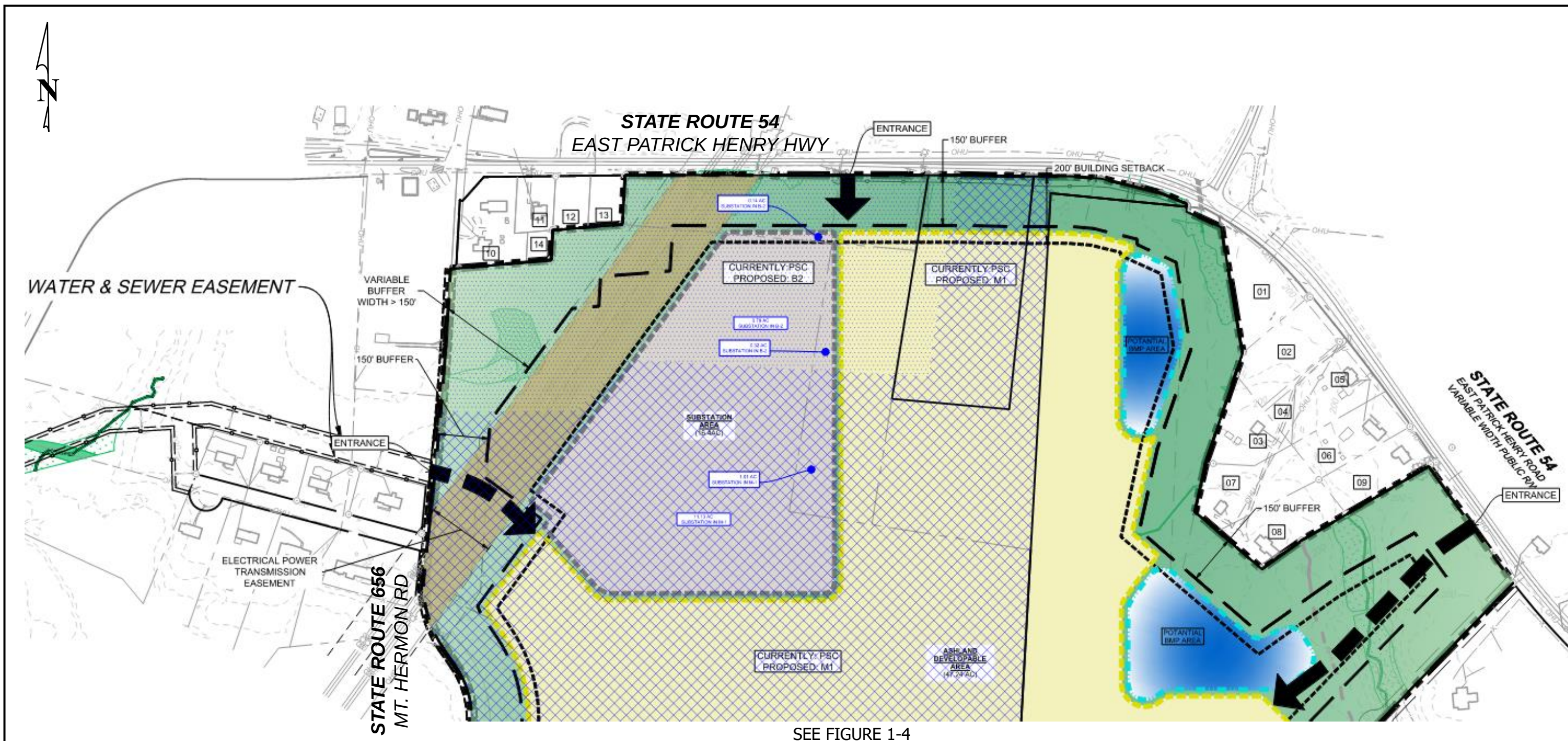
The focus of this report is to identify a comprehensive access plan that provides functional access to the site and preserves the capacity of the surrounding roadway network. This report identifies the proposed phasing of the development and the roadway improvements associated with each phase. To accommodate the anticipated traffic associated with the Iron Horse Data Center development, the recommended improvement plan is as follows:

- Route 54 at Site Entrance A
 - Construct one (1) eastbound left turn lane and one (1) westbound left turn lane.

Given the preliminary nature of the development plan, the exact location of the site entrances along Route 54 (or other internal site roadways) will be defined during the site plan stage. All construction of roadway improvements is subject to Town, County, and VDOT approval, including assistance on obtaining any required right-of-way not owned by the Applicant. Additional entrances to individual parcels within the development, or other modifications to access along Route 54 that may be developed as part of the site plan review process, are not explicitly discussed within this report. If the development pattern changes and additional traffic is shifted to different entrances, the turn lane warrant analysis will need to be performed for the prevailing layout and traffic volumes at that time of construction.

During the site plan review process, the Applicant will submit a Construction Traffic Management Plan (CTMP) for review and approval by VDOT, Hanover County, and the Town of Ashland to mitigate any traffic impacts caused by construction. The number and location of construction entrances, as well as construction traffic access routes will be presented in the CTMP.





NOT TO SCALE

SEE FIGURE 1-3



NOT TO SCALE

PAGE INTENTIONALLY BLANK

2 BACKGROUND INFORMATION

2.1 DESCRIPTION OF ON-SITE DEVELOPMENT

The proposed data center development is located to the south of Route 54 (Patrick Henry Hwy), east of Mt. Hermon Road, and west of Woodside Lane in both Hanover County and the Town of Ashland. A site location map is shown on Figure 1-1 (all figures located at the end of their respective chapter).

East Ashland is currently zoned as a Planned Unit Development (PUD) within the Town of Ashland and mixed use (MX) within Hanover County. The Applicant is proposing to rezone a portion of the site to Business (B-2 Ashland; B-3 Hanover) and Light Industrial (M-1 Ashland; M-2 Hanover) which will accommodate the development of data center as a land use option.

The Applicant is proposing to develop the site in one phase, consisting of the following (with the understanding that explicit site plans will be required for each part of development):

- 3.3 million GSF Data Center
 - 1,800,000 GSF within the Town of Ashland
 - 1,500,000 GSF within Hanover County

The buildout of the development is anticipated to occur by 2033. For the purposes of this analysis, all of the data center buildings will be completed by 2033. A conceptual site plan is shown on Figures 1-2 and 1-3.

Access to the data center site will be provided via two (2) driveways connecting to Route 54 (Entrances A and B) and one (1) driveway connecting Mt. Hermon Road (Entrance C).

The site plan provided is intended for informational purposes only and is conceptual in nature. The proposed driveways shown do not represent the final site layout and are subject to site plan approval with the Town, County, and VDOT. Therefore, for the purposes of this analysis, it was assumed that there would be no partial access driveways along the parcel's frontage on Route 54. All proposed entrances will require entrance permit approval at such time that development plans occur.

2.2 STUDY LIMITS

As outlined in the scoping agreement, the study limits include the following 10 existing intersections:

1. Route 54 and US Route 1 (Washington Hwy) (signalized);
2. Route 54 and Cottage Green Drive (signalized);
3. Route 54 and Hill Carter Parkway (signalized);
4. Route 54 and Carter Road (unsignalized);
5. Route 54 and I-95 SB ramps (unsignalized);
6. Route 54 and I-95 NB ramps (unsignalized);
7. Route 54 and Telcourt Road (unsignalized);
8. Route 54 and Mt. Hermon Road (unsignalized);
9. Route 54 and Woodside Lane (unsignalized); and
10. Route 54 and Goddins Hill Road (unsignalized).

2.3 EXISTING ROADWAYS

Route 54 (England Street/Patrick Henry Hwy) is a divided highway with six lanes between US Route 1 and I-95. It is an undivided 2-lane roadway outside this segment. It is functionally classified as a Minor Arterial and has a posted speed limits of 25 mph west of US Route 1, 35 mph between US Route 1 and Carter Rd, 45 mph between Carter Rd and Woodside Ln, and 55 mph east of Woodside Ln. According to the 2019 VDOT Traffic Counts, Route 54 carries approximately 25,000 vehicles per day between US Route 1 and I-95 and 6,000 vpd between I-95 and eastern Ashland Town Line. The roadway only has sidewalks west of Hill Carter Pkwy. There are no on-street bike lanes in the study area.

Hill Carter Parkway is a four-lane divided roadway with auxiliary turning lanes. It is functionally classified as a major collector with a posted speed limit of 35 mph. There are sidewalks along one side and shared-use path on the other side. There are no on-street bike lanes.

Goddins Hill Road is a two-lane undivided roadway functionally classified as a major collector with a speed limit of 45 mph. According to the 2019 VDOT Traffic Counts, Goddins Hill Road carries approximately 820 vehicles per day. The roadway does not have sidewalks or on-street bike lanes.

The remaining roadways within the study area are functionally classified as local roadways and are generally two-lane undivided roadways with a posted speed limit of 25 mph, with the exception of Mt. Hermon Road that has a posted speed limit of 40 mph. Only Cottage Green Drive has sidewalks of these local roads; all roadways have no on-street bike lanes.

The 2022 existing lane use and traffic control at the study intersections is shown on Figure 2-1.

2.4 FUTURE IMPROVEMENTS

The proposed development will construct improvements at the intersection of Route 54/Site Entrance A.

Improvements recommended with build out of the proposed development (completed by 2033):

- Route 54 and Site Entrance A
 - Construct 100' storage x 100' taper WB left turn lane.
 - Construct 100' storage x 100' taper EB right turn lane.

For the purposes of this analysis, the above improvements were analyzed starting in 2033 total conditions.

The future lane uses and traffic control at the study intersections are shown on Figure 2-2. Conceptual drawings of the proposed improvements are included in Appendix D.

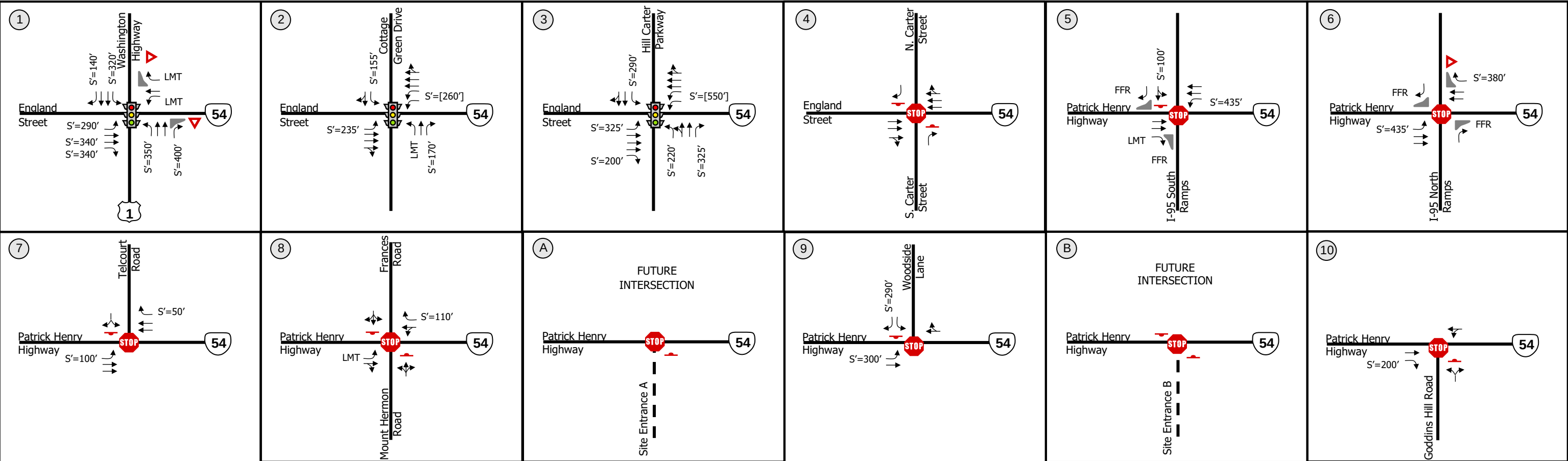
Based on information contained in the 2015 Ashland Transportation Plan, the Town and Hanover County have long-range plans to reconstruct the Route 54/I-95 interchange as a diverging diamond interchange. This project has been submitted to VDOT's SMART SCALE and has recently been approved for funding as of January 2025. The diverging diamond interchange was not analyzed as part of this report.

It was assumed that VDOT will retime the traffic signals along Route 54 periodically due to expected background development and overall growth in the study area. To reflect this, the traffic signal timings and offsets were optimized for all future conditions (2033 and 2039).

2.5 OTHER MODES OF TRANSPORTATION

Currently, there are no sidewalks/shared use paths in the vicinity of the project site as outlined in Section 2.3. The sidewalks/paths do not form a network connecting to other roadways inside or outside the study area. There are currently no transit routes within the study area.

PAGE INTENTIONALLY BLANK



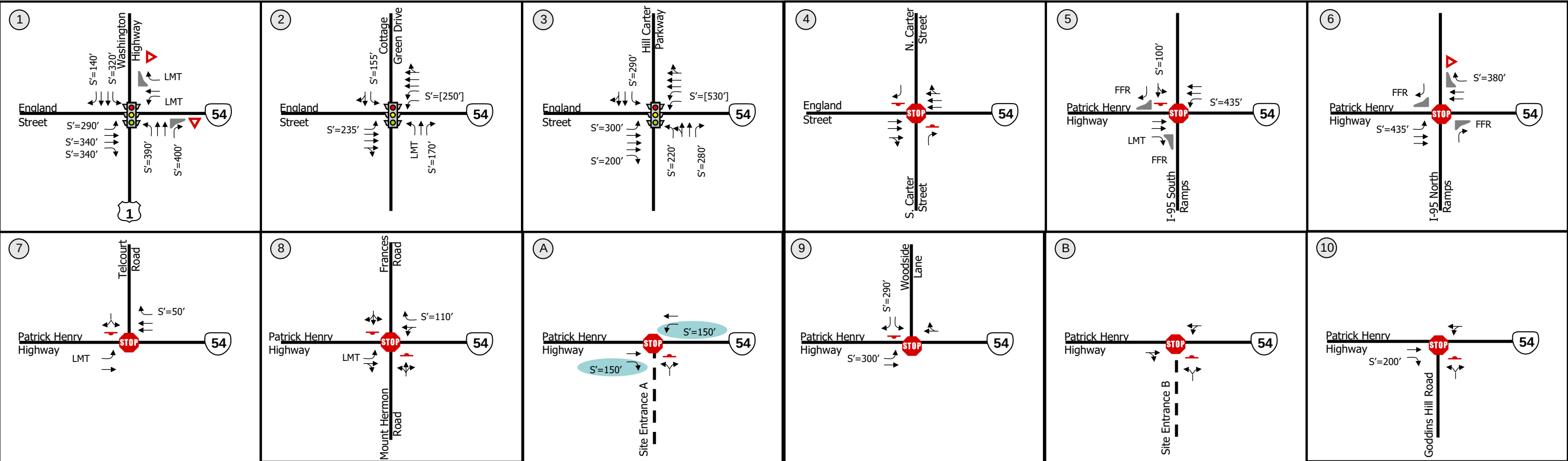
LEGEND:

- Existing Road
- Proposed Road
- S' Effective Storage Length (in feet)*
- FFR Free Flow Right
- LMT Lane Must Turn
- Signalized Intersection
- Stop Controlled Intersection
- Stop Sign Location
- Lane Configuration
- Channelization
- Yield

* Per TOSAM, effective storage is the full width storage plus 1/2 the taper. Dual turn lanes indicated in brackets.



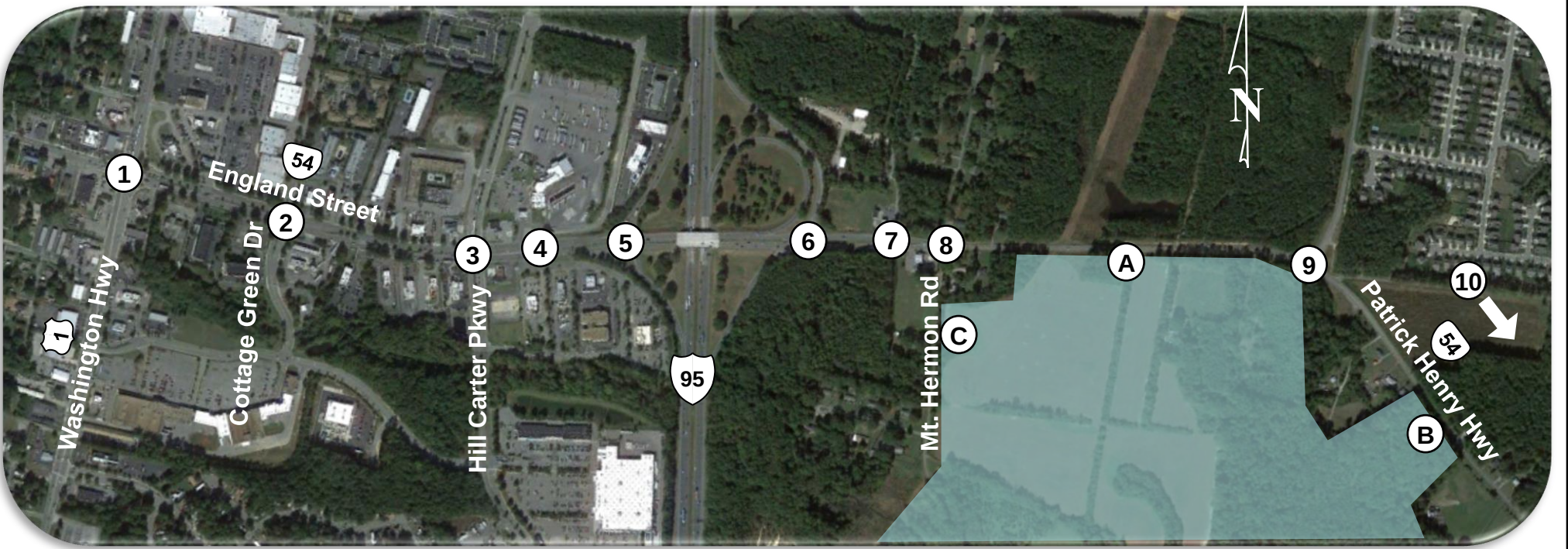
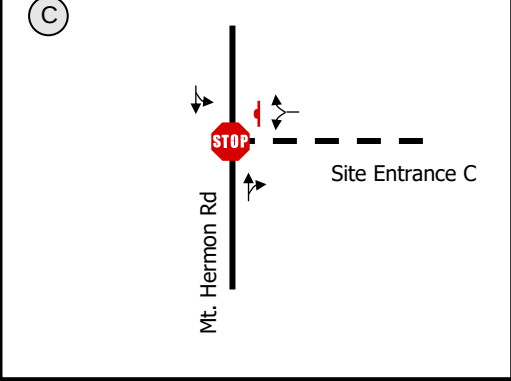
NOT TO SCALE



LEGEND:

- Existing Road
- Proposed Road
- S' Effective Storage Length (in feet)*
- FFR Free Flow Right
- LMT Lane Must Turn
- Signalized Intersection
- Stop Controlled Intersection
- Stop Sign Location
- Lane Configuration
- Channelization
- Yield
- Proposed Development Improvement

* Per TOSAM, effective storage is the full width storage plus 1/2 the taper. Dual turn lanes indicated in brackets.



NOT TO SCALE

3 2022 EXISTING CONDITIONS

3.1 EXISTING TRAFFIC VOLUMES

Existing peak hour turning movement counts (TMC) were conducted at each of the ten (10) study intersections during the AM (7:00-9:00) and PM (4:00-6:00) peak hour timeframes. The counts were conducted on May 5, 2022 on a typical weekday when public schools were in session. In addition, 12-hour TMCs were collected at the intersection of Route 54 and Mt. Hermon Road. The counts included heavy vehicles by movement, pedestrians, and bikes.

The 2022 TMCs were compared to the 2019 VDOT Traffic Data (AADT) to determine the impact COVID-19 may have had on the traffic patterns within the study area. The 2019 data was selected to provide a more conservative comparison because the 2021 data is lower and traffic patterns had not returned to pre-COVID levels in 2021. As shown in Table 3-1, there were 25,000 vehicles per day on Route 54 between US Route 1 and I-95 with a K-Factor of 0.096 and Directional Factor of 0.566. The AADT was multiplied by the K- and Directional Factors to find the estimated peak hour traffic volumes.

**Table 3-1: 2019 VDOT Traffic Data
Route 54 between US Route 1 and I-95**

VDOT 2019 AADT	Hourly Volume (higher direction)	Hourly Volume (lower direction)
25,000	1358	1042

The 2022 peak hour traffic volumes on mainline Route 54 were compared to the estimated peak hour volumes calculated from the 2019 VDOT AADT in the same location. As shown in Table 3-2, the 2022 traffic volumes are within 80% - 99% of the pre-COVID traffic volumes in 2019. Therefore, it was found that traffic volumes have returned to similar pre-pandemic levels and the 2022 TMCs were not adjusted.

**Table 3-2: Traffic Data Comparison
Route 54 between US Route 1 and I-95**

Direction		2022 Traffic Data (vph)	Departure From AADT Hourly Volume
Eastbound	AM	924	89%
	PM	1239	91%
Westbound	AM	1027	99%
	PM	1091	80%

The raw traffic counts are included in Appendix C and the existing peak hour counts shown on Figure 3-1. The common peak hours for all study intersections were found to be 7:30-8:30 AM and 4:30-5:30 PM.

Existing signal timings and traffic signal plans for all intersections were provided by VDOT and are included in Appendix E.

3.2 CAPACITY ANALYSES

Capacity analysis allows traffic engineers to determine the impacts of traffic on the surrounding roadway network. The Highway Capacity Manual methodologies govern how the capacity analyses are conducted and how the results are interpreted. Levels of service (LOS) are determined for each part of the roadway network, with LOS A through D representing acceptable results and LOS E and F representing unacceptable results. Table 3-3 shows in detail how each of these levels of service are interpreted.

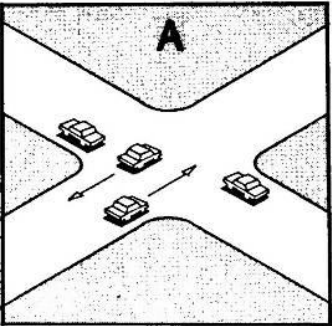
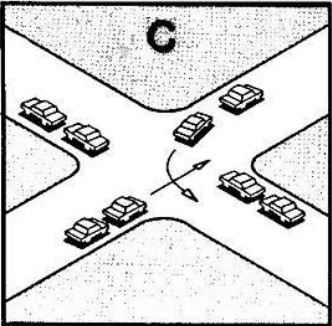
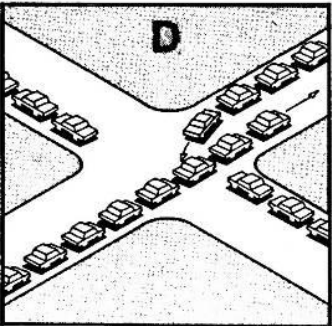
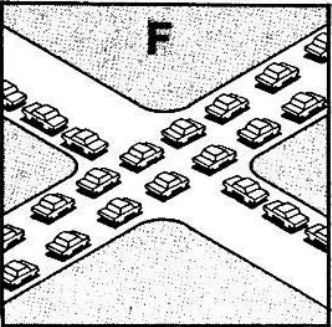
Capacity analyses were performed to assess existing (2022), background 2033/2039), and total future (2033/2039) operational conditions for the AM and PM peak hours of the study area. The signalized and unsignalized intersections were analyzed using SYNCHRO Version 11 based on HCM 2000 methodologies with the following assumptions:

- Level terrain;
- 12-foot lane widths;
- No parking activity or bus stops;
- Existing peak hour factor as determined by traffic counts (by intersection) for existing scenario;
- The higher of the existing peak hour factor as determined by traffic counts (by intersection) or a peak hour factor of 0.92; and
- Heavy vehicle percentage as determined by the traffic counts (by movement).

HCM 2000 methodologies were utilized for analysis as opposed to the latest HCM Sixth Edition or HCM 2010 methodologies. This selection is due to the non-standard NEMA phasing that is present at the some of the study intersections. The HCM Sixth Edition methodology only provides measures of effectiveness for signalized intersections following strict NEMA phasing.

The study area 2022 Existing SYNCHRO models were calibrated to meet TOSAM methodologies for average speed using the VDOT Sample Size Determination Tool Version 2.0. The results worksheets are included in Appendix F.

Table 3-3: 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 involves delay to all motorists due to congestion.	Very long queues may create lengthy 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 area 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 both unsignalized and signalized intersections, level of service is defined in terms of delay, a measure of driver discomfort, frustration, fuel consumption and lost travel time. Table 3-4 summarizes the delay associated with each LOS category:

Table 3-4: Unsignalized and Signalized Intersection Level of Service Criteria

<u>Unsignalized Intersections</u>		<u>Signalized Intersections</u>	
<u>Level of Service</u>	<u>Delay per Vehicle (sec)</u>	<u>Level of Service</u>	<u>Delay per Vehicle (sec)</u>
A	≤ 10.0	A	≤ 10.0
B	> 10.0 to ≤ 15.0	B	> 10.0 To ≤ 20.0
C	> 15.0 to ≤ 25.0	C	> 20.1 to ≤ 35.0
D	> 25.0 to ≤ 35.0	D	> 35.1 to ≤ 55.0
E	> 35.0 to ≤ 50.0	E	> 55.1 to ≤ 80.0
F	> 50.0	F	> 80.1

Queuing analysis allows traffic engineers to identify where vehicles queues are not adequately accommodated by existing storage bays and impact adjacent travel lanes.

Queuing analyses were conducted using both the HCM 2000 methodology (as calculated by SYNCHRO) and SimTraffic simulations. The Synchro 95th percentile queue is the maximum back of queue for a particular lane within a lane group considering 95th percentile traffic volumes. The SimTraffic maximum queues are the average maximum queues after 10 runs of 60 minutes each.

Note that it is possible for the 95th percentile queue to be higher than the SimTraffic maximum queue due to the method in which each software calculates its respective value. The 95th percentile queue is based on an HCM formula while the SimTraffic maximum queue varies based on simulation results.

3.3 2022 EXISTING CONDITIONS ANALYSIS

Table 3-3 summarizes the 2022 existing intersection LOS, delay, 95th percentile (Synchro), and maximum (SimTraffic) queue lengths based on the 2022 existing peak hour traffic volumes shown on Figure 3-1, the existing lane geometry (Figure 2-1), and the existing timings at the traffic signals. The corresponding SYNCHRO worksheets are included in Appendix G.

Note at Intersection #3 that the eastbound right movement is reporting excessive delay. This is an error with how Synchro is reporting delay for the intersection and may be caused by the pedestrian phase associated with the eastbound approach being turned on all the time. However, the 95th Percentile queue length is low which shows that vehicles are not waiting for the amount of time suggested by the control delay.

Note at Intersection #6 the I-95 off-ramps (SB right and NB right) are coded in Synchro as yield controlled approaches due to the existing signs at the intersection. However, the existing lane geometry for those movements includes a receiving lane for merging traffic. As shown by the SimTraffic queue lengths (0 ft), these movements operate as free-flowing despite the HCM reports showing delay.

As shown in Table 3-5, under 2022 existing conditions:

- At the signalized intersection of Route 54 and US Route 1, the overall intersection operates at a LOS C during both peak hours.
 - The mainline movements all operate at a LOS C or better during both peak hours. The northbound left operates at a LOS C/D during the AM/PM peaks, respectively. The NB thru operates at a LOS D/E during the AM/PM peaks, respectively. The southbound approach operates at a LOS D during both peak hours. The SB thru operates at a LOS E during the PM peak hour.
 - All movements have adequate turn bay storage to accommodate 95th percentile and maximum queue lengths.
- At the signalized intersection of Route 54 and Cottage Green Drive, the overall intersection operates at a LOS B/C during the AM/PM peaks, respectively.
 - The mainline through movements operate at a LOS B or better during both peak hours. The EB and WB lefts generally operate at a LOS D/E during both peak hours. The north- and southbound movements all operate at a LOS D during the AM peak hour. During the PM peak, The NB approach operates at a LOS E and the SB approach at a LOS D.
 - During the PM peak hour, the southbound left maximum queue exceeds the available storage, spilling back into the through lane. All other movements have adequate turn bay storage to accommodate 95th percentile and maximum queue lengths.
- At the signalized intersection of Route 54 and Hill Carter Parkway, the overall intersection operates at a LOS C/D during the AM/PM peaks, respectively.
 - The eastbound left and through movements operate at a LOS D and C, respectively during both peak hours. As previously mentioned, the delay for the EB right is not reported correctly at this intersection. The westbound left and through movements operate at a LOS D and B, respectively during both peak hours.
 - The northbound approach operates at a LOS D during both peak hours. The southbound approach operates at a LOS D/E during the AM/PM peaks, respectively. All 95th percentile and maximum queue lengths are contained within the available storage.
- At the unsignalized intersection of Route 54 and I-95 SB ramp, the mainline east- and westbound approaches operate at a LOS A during both peak hours. The southbound left/through movement operates at a LOS F during both peak hours.
- At the unsignalized intersection of Route 54 and I-95 NB ramp, the mainline east- and westbound approaches operate at a LOS A during both peak hours. As previously mentioned, the north- and southbound movements report delay due to the yield-control, however the movements behave more like free-flow right turns. The northbound right operates at a LOS B or better during both peak hours. The southbound right operates at a LOS D during both peak hours. All 95th percentile and maximum queue lengths are contained within the available storage.
- At all other unsignalized intersections (numbers 4, 7-10), the mainline east- and westbound movements all operate at a LOS A during both peak hours. All side street movements operate at acceptable levels (LOS C or better) during both peak hours. All 95th percentile and maximum queue lengths are contained within the available storage.

**Table 3-5: Intersection Level of Service and Delay Summary
2022 Existing Traffic (Part 1)**

Intersection and Type of Control	Movement and Approach	Turn Lane Storage (ft)	AM PEAK HOUR				PM PEAK HOUR			
			Delay ¹ (sec/veh)	LOS ¹	HCS 95th Percentile Queue Length (ft)	Simulated Maximum Queue Length (ft)	Delay ¹ (sec/veh)	LOS ¹	HCS 95th Percentile Queue Length (ft)	Simulated Maximum Queue Length (ft)
1. England St (E-W) US Route 1 (N-S) Signalized	EB Left	290	22.0	C	56	143	24.3	C	101	178
	EB Thru		31.1	C	160	192	33.9	C	196	215
	EB Right	340	27.5	C	0	79	29.9	C	0	75
	<i>EB Approach</i>		29.1	C	-	-	31.3	C	-	-
	WB Left		12.8	B	23	163	20.0	C	89	234
	WB Thru		25.4	C	#386	344	27.3	C	#460	543
	WB Right		0.3	A	39	0	0.2	A	0	27
	<i>WB Approach</i>		14.0	B	-	-	18.3	B	-	-
	NB Left	350	30.0	C	117	168	42.2	D	203	262
	NB Thru		38.2	D	95	162	56.7	E	225	227
	NB Right	400	0.1	A	0	0	0.2	A	0	0
	<i>NB Approach</i>		25.6	C	-	-	39.0	D	-	-
	SB Left	320	35.2	D	178	223	46.9	D	#226	256
	SB Thru		40.6	D	160	213	55.2	E	226	265
	SB Right	140	34.9	C	0	125	43.1	D	0	140
	<i>SB Approach</i>		38.0	D	-	-	50.9	D	-	-
	Overall		25.6	C	-	-	34.6	C	-	-
2. England St (E-W) Cottage Green Dr (N-S) Signalized	EB Left	235	72.8	E	m15	56	45.1	D	m45	71
	EB Thru - Right		19.1	B	149	223	15.7	B	132	216
	<i>EB Approach</i>		20.0	C	-	-	16.8	B	-	-
	WB Dual Left	260	78.2	E	32	76	70.5	E	47	93
	WB Thru - Right		2.4	A	38	180	11.0	B	75	223
	<i>WB Approach</i>		5.6	A	-	-	14.8	B	-	-
	NB Left		48.1	D	36	71	56.8	E	74	100
	NB Thru		46.0	D	13	53	56.6	E	77	100
	NB Right	170	45.6	D	0	33	53.0	D	0	61
	<i>NB Approach</i>		47.0	D	-	-	55.5	E	-	-
	SB Left	155	47.2	D	95	131	54.4	D	212	154
	SB Thru - Right		42.3	D	37	115	44.5	D	82	279
	<i>SB Approach</i>		45.7	D	-	-	51.6	D	-	-
	Overall		15.0	B	-	-	22.8	C	-	-
3. England St (E-W) Hill Carter Pkwy (N-S) Signalized	EB Left	325	41.5	D	m48	114	44.0	D	m82	97
	EB Thru		31.6	C	205	357	26.0	C	276	424
	EB Right	200	22.5	C	33	200	288.1	F	m84	200
	<i>EB Approach</i>		31.1	C	-	-	61.9	E	-	-
	WB Dual Left	550	38.8	D	90	116	48.6	D	125	139
	WB Thru - Right		19.3	B	201	203	19.9	B	220	256
	<i>WB Approach</i>		22.9	C	-	-	26.0	C	-	-
	NB Left	220	43.6	D	58	52	53.8	D	132	149
	NB Left - Thru		42.6	D	32	106	49.8	D	69	172
	NB Right	325	42.4	D	0	130	49.1	D	80	184
	<i>NB Approach</i>		42.6	D	-	-	50.2	D	-	-
	SB Left	290	51.9	D	91	220	61.2	E	101	181
	SB Thru - Right		40.3	D	18	70	50.8	D	23	52
	<i>SB Approach</i>		48.6	D	-	-	57.5	E	-	-
	Overall		29.3	C	-	-	45.7	D	-	-
4. England St (E-W) Carter Rd (N-S) Unsignalized	EB Thru - Right†		0.0	A	-	82	0.0	A	-	64
	<i>EB Approach</i>		0.0	A	-	-	0.0	A	-	-
	WB Thru - Right†		0.0	A	-	3	0.0	A	-	9
	<i>WB Approach</i>		0.0	A	-	-	0.0	A	-	-
	NB Right		10.8	B	8	65	11.9	B	5	61
	<i>NB Approach</i>		10.8	B	-	-	11.9	B	-	-
	SB Right		11.3	B	2	52	10.9	B	1	27
	<i>SB Approach</i>		11.3	B	-	-	10.9	B	-	-

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

† 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.

**Table 3-6: Intersection Level of Service and Delay Summary
2022 Existing Traffic (Part 2)**

Intersection and Type of Control	Movement and Approach	Turn Lane Storage (ft)	AM PEAK HOUR				PM PEAK HOUR			
			Delay ¹ (sec/veh)	LOS ¹	HCS 95th Percentile Queue Length (ft)	Simulated Maximum Queue Length (ft)	Delay ¹ (sec/veh)	LOS ¹	HCS 95th Percentile Queue Length (ft)	Simulated Maximum Queue Length (ft)
5. Patrick Henry Hwy (E-W) I-95 SB Ramps Unsignalized	EB Thru†		0.0	A	-	-	0.0	A	-	-
	EB Right†		0.0	A	-	-	0.0	A	-	-
	<i>EB Approach</i>		0.0	A	-	-	0.0	A	-	-
	WB Left	435	8.7	A	16	70	9.2	A	16	85
	WB Thru†		0.0	A	-	-	0.0	A	-	-
	<i>WB Approach</i>		1.6	A	-	-	1.5	A	-	-
	SB Left - Thru	150	62.0	F	7	32	97.5	F	35	80
	SB Right		18.0	C	58	0	16.2	C	47	0
	<i>SB Approach</i>		19.1	C	-	-	24.1	C	-	-
6. Patrick Henry Hwy (E-W) I-95 NB Ramps Unsignalized	EB Left	435	9.2	A	13	108	9.3	A	19	135
	EB Thru†		0.0	A	-	-	0.0	A	-	-
	<i>EB Approach</i>		3.8	A	-	-	3.6	A	-	-
	WB Thru†		0.0	A	-	5	0.0	A	-	2
	WB Right†	380	0.0	A	-	0	0.0	A	-	0
	<i>WB Approach</i>		0.0	A	-	-	0.0	A	-	-
	NB Right		9.6	A	13	0	10.5	B	23	0
	<i>NB Approach</i>		9.6	A	-	-	10.5	B	-	-
	SB Right		30.1	D	252	0	29.7	D	242	0
	<i>SB Approach</i>		30.1	D	-	-	29.7	D	-	-
7. Patrick Henry Hwy (E-W) Telcourt Rd (N-S) Unsignalized	EB Left		8.7	A	3	67	8.6	A	2	56
	EB Thru†		0.0	A	-	4	0.0	A	-	-
	<i>EB Approach</i>		0.8	A	-	-	0.5	A	-	-
	WB Thru†		0.0	A	-	-	0.0	A	-	2
	WB Right†	50	0.0	A	-	24	0.0	A	-	21
	<i>WB Approach</i>		0.0	A	-	-	0.0	A	-	-
	SB Left - Right		11.8	B	1	31	10.3	B	3	40
	<i>SB Approach</i>		11.8	B	-	-	10.3	B	-	-
8. Patrick Henry Hwy (E-W) Mt. Hermon Rd/Frances Rd (N-S) Unsignalized	EB Left		8.2	A	3	47	8.2	A	1	29
	EB Thru - Right†		0.0	A	-	-	0.0	A	-	-
	<i>EB Approach</i>		1.1	A	-	-	0.3	A	-	-
	WB Left - Thru		0.4	A	1	48	0.3	A	1	73
	WB Right†	110	0.0	A	-	-	0.0	A	-	-
	<i>WB Approach</i>		0.4	A	-	-	0.3	A	-	-
	NB Left-Thru-Right		19.5	C	11	72	22.3	C	21	64
	<i>NB Approach</i>		19.5	C	-	-	22.3	C	-	-
	SB Left-Thru-Right		11.9	B	7	42	12.0	B	5	35
	<i>SB Approach</i>		11.9	B	-	-	12.0	B	-	-
9. Patrick Henry Hwy (E-W) Woodside Ln (N-S) Unsignalized	EB Left	300	7.9	A	4	57	8.2	A	10	60
	EB Thru†		0.0	A	-	-	0.0	A	-	-
	<i>EB Approach</i>		1.9	A	-	-	2.7	A	-	-
	WB Thru - Right†		0.0	A	-	-	0.0	A	-	-
	<i>WB Approach</i>		0.0	A	-	-	0.0	A	-	-
	SB Left		11.8	B	16	61	12.5	B	15	53
	SB Right	290	11.8	B	16	73	12.5	B	15	70
	<i>SB Approach</i>		11.8	B	-	-	12.5	B	-	-
10. Patrick Henry Hwy (E-W) Goddins Hill Rd (N-S) Unsignalized	EB Thru†		0.0	A	-	-	0.0	A	-	-
	EB Right†	200	0.0	A	-	2	0.0	A	-	0
	<i>EB Approach</i>		0.0	A	-	-	0.0	A	-	-
	WB Left - Thru		2.8	A	6	53	1.3	A	2	34
	<i>WB Approach</i>		2.8	A	-	-	1.3	A	-	-
	NB Left - Right		12.4	B	9	49	11.8	B	14	48
	<i>NB Approach</i>		12.4	B	-	-	11.8	B	-	-

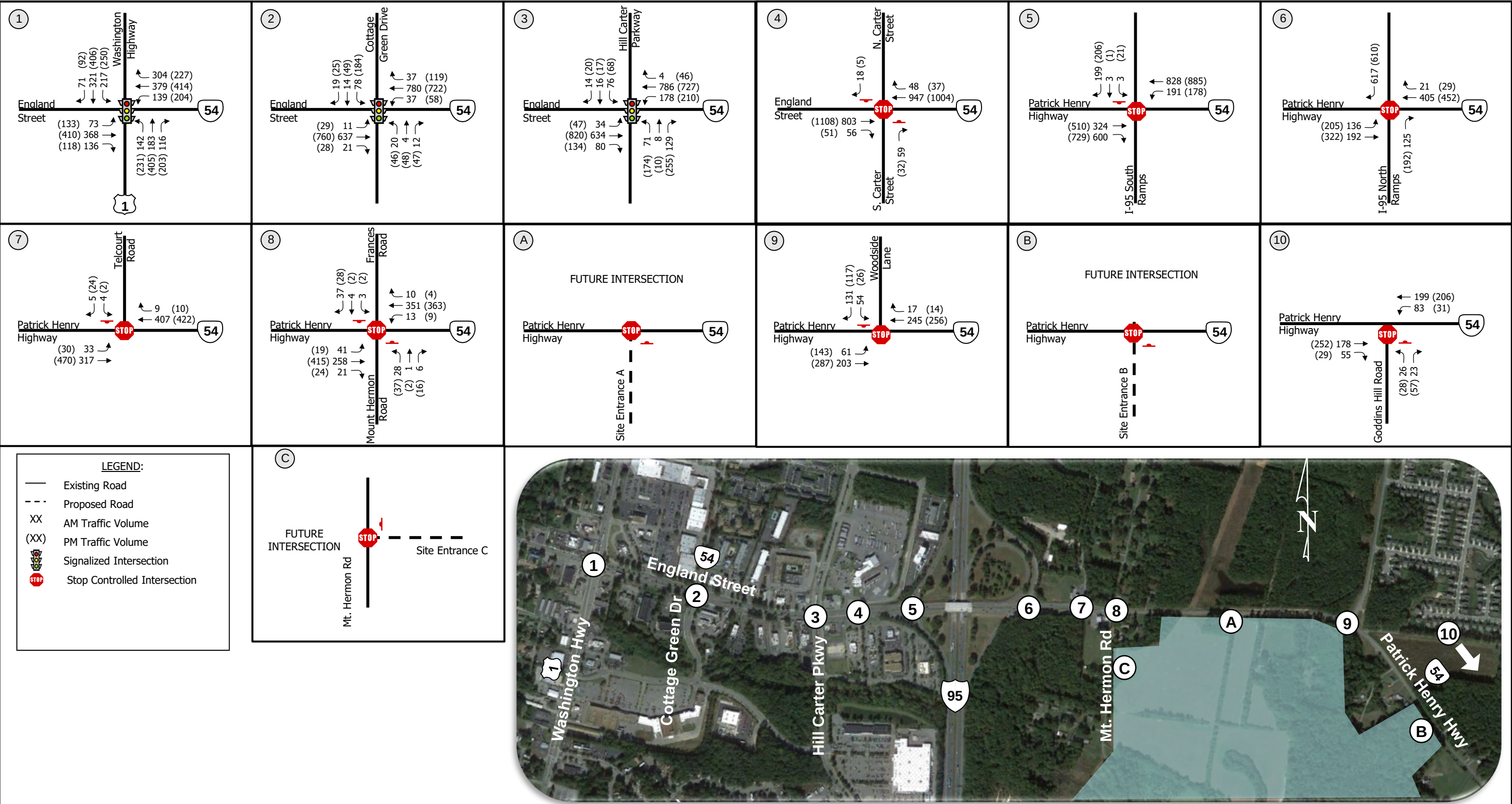
¹ Overall intersection LOS and delay reported for signalized intersections and roundabouts only.

† 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.

PAGE INTENTIONALLY BLANK



PAGE INTENTIONALLY BLANK

4 APPROVED BACKGROUND DEVELOPMENTS

Background developments in the study were based on coordination with VDOT, Town of Ashland, and Hanover County staff. The most recent aerial imagery was used to identify which developments had already been built. There were no developments determined by this methodology.

One background development was identified within the project vicinity, Hickory Grove, and was analyzed with the August 2022 edition of this report. Since then, VDOT and Hanover County have confirmed that the development was not approved. As a result, the projected site traffic and roadway improvements associated with Hickory Grove have been removed from this report.

No background developments have been approved in the vicinity of the project and no background developments are included in this report.

PAGE INTENTIONALLY BLANK

5 2033 BACKGROUND CONDITIONS

The background 2033 volumes were analyzed assuming future intersection geometry in conjunction with projected background traffic volumes. The background traffic volumes were developed based on a 1.5% annual growth rate.

5.1 BACKGROUND FORECASTING METHODOLOGY

The 1.5% annual growth rate discussed above was compounded annually for the 10-year period from 2022 to 2033 and applied to the existing traffic volumes. The resulting 2033 Background Traffic Volumes are shown on Figure 5-1.

5.2 BACKGROUND 2033 CAPACITY ANALYSES

Tables 5-1 and 5-2 summarizes the 2033 background intersection LOS, delay, 95th percentile (Synchro), and maximum (SimTraffic) queue lengths based on the 2033 background peak hour traffic volumes shown on Figure 5-1, the existing conditions lane geometry (Figure 2-1), and the existing timings at the traffic signals. Note that intersections A-C are shown as numbers 11-13 in the following analysis. The corresponding SYNCHRO worksheets are included in Appendix H.

Note at Intersection #3 that the eastbound right movement is reporting excessive delay. This is an error with how Synchro is reporting delay for the intersection and may be caused by the pedestrian phase associated with the eastbound approach being turned on all the time. However, the 95th Percentile queue length is low which shows that vehicles are not waiting for the amount of time suggested by the control delay.

Note at Intersection #6 the I-95 off-ramps (SB right and NB right) are coded in Synchro as yield controlled approaches due to the existing signs at the intersection. However, the existing lane geometry for those movements includes a receiving lane for merging traffic. As shown by the SimTraffic queue lengths (0 ft), these movements operate as free-flowing despite the HCM reports showing delay.

As shown in Tables 5-1 and 5-2 under 2033 background conditions:

- At the signalized intersection of Route 54 and US Route 1, the overall intersection will operate at a LOS C/D during the AM/PM peaks, respectively.
 - The eastbound approach will operate at a LOS C/D during the AM/PM peaks, respectively. The westbound approach will operate at a LOS B/C during the AM/PM peaks, respectively. The WB through will operate at a LOS D during both peak hours.
 - The northbound left movement will operate at a LOS C/E during the AM/PM peaks, respectively. The NB through will operate at a LOS D/E during the AM/PM peaks, respectively. The southbound left and through will both operate at a LOS D/E during the AM/PM peaks, respectively.
 - All movements have adequate turn bay storage to accommodate 95th percentile and maximum queue lengths.

- At the signalized intersection of Route 54 and Cottage Green Drive, the overall intersection will operate at a LOS B/C during the AM/PM peaks, respectively.
 - The mainline through movements will operate at a LOS B or better during both peak hours. The EB left will operate at a LOS E/D during the AM/PM peaks, respectively. The WB left will operate at a LOS F/E during the AM/PM peaks, respectively.
 - The northbound approach will operate at a LOS D/E during the AM/PM peaks, respectively. The southbound approach will operate at a LOS D during both peak hours. During the PM peak, the SB left maximum queue exceeds the available storage, spilling back into the through lane.
 - All other movements have adequate turn bay storage to accommodate 95th percentile and maximum queue lengths.
- At the signalized intersection of Route 54 and Hill Carter Parkway, the overall intersection will operate at a LOS C/D during the AM/PM peaks, respectively.
 - The mainline through movements will operate at a LOS C during both peak hours. The EB and WB lefts will operate at a LOS D during both peak hours. As previously mentioned, the delay for the EB right is not reported correctly at this intersection.
 - The northbound approach will operate at a LOS D during both peak hours. The NB left will operate at a LOS D/E during the AM/PM peaks, respectively. The southbound approach will operate at a LOS D/E during the AM/PM peaks, respectively. The SB left will operate at a LOS E during both peak hours.
 - All movements have adequate turn bay storage to accommodate 95th percentile and maximum queue lengths.
- At the unsignalized intersection of Route 54 and I-95 SB ramp, the mainline east- and westbound approaches operate at a LOS A during both peak hours. The southbound left/through movement operates at a LOS F during both peak hours. All movements have adequate turn bay storage to accommodate 95th percentile and maximum queue lengths.
- At the unsignalized intersection of Route 54 and I-95 NB ramp, the mainline east- and westbound approaches operate at a LOS A during both peak hours. As previously mentioned, the north- and southbound movements report delay due to the yield-control, however the movements behave more like free-flow right turns. The NB right operates at a LOS B or better during both peak hours. The SB right operates at a LOS F during both peak hours. All 95th percentile and maximum queue lengths are contained within the available storage.
- At the unsignalized intersection of Route 54 and Mt. Hermon Road/Frances Road, the mainline east- and westbound movements will operate at a LOS A during both peak hours. The northbound approach will operate at a LOS C/D during the AM/PM peaks, respectively. The southbound approach will operate at a LOS B during both peak hours. All movements have adequate turn bay storage to accommodate 95th percentile and maximum queue lengths.
- At all other unsignalized intersections (numbers 4, 7, 9-10), the mainline east- and westbound movements all operate at a LOS A during both peak hours. All side street movements operate at acceptable levels (LOS B or better) during both peak hours. All 95th percentile and maximum queue lengths are contained within the available storage.

**Table 5-1: Intersection Level of Service and Delay Summary
2033 Background Traffic (Part 1)**

Intersection and Type of Control	Movement and Approach	Turn Lane Storage (ft)	AM PEAK HOUR				PM PEAK HOUR			
			Delay ¹ (sec/veh)	LOS ¹	HCS 95th Percentile Queue Length (ft)	Simulated Maximum Queue Length (ft)	Delay ¹ (sec/veh)	LOS ¹	HCS 95th Percentile Queue Length (ft)	Simulated Maximum Queue Length (ft)
1. England St (E-W) US Route 1 (N-S) Signalized	EB Left	290	23.6	C	63	124	31.4	C	125	219
	EB Thru		32.8	C	187	207	37.8	D	232	257
	EB Right	340	28.0	C	11	108	32.1	C	11	84
	EB Approach		30.5	C	-	-	35.5	D	-	-
	WB Left		18.1	B	67	205	36.8	D	208	529
	WB Thru		37.0	D	#487	456	50.0	D	#590	719
	WB Right		0.4	A	46	27	0.3	A	0	227
	WB Approach		20.3	C	-	-	33.5	C	-	-
	NB Left	350	31.8	C	135	178	53.0	D	#290	293
	NB Thru		38.6	D	109	169	64.8	E	#292	336
	NB Right	400	0.1	A	0	0	0.2	A	0	0
	NB Approach		26.3	C	-	-	45.9	D	-	-
	SB Left	320	42.0	D	#240	294	65.9	E	#342	316
	SB Thru		44.4	D	185	297	62.3	E	#295	373
	SB Right	140	35.1	D	0	140	42.4	D	0	140
	SB Approach		42.4	D	-	-	61.1	E	-	-
	Overall		29.3	C	-	-	44.0	D	-	-
2. England St (E-W) Cottage Green Dr (N-S) Signalized	EB Left	235	77.5	E	m13	53	47.9	D	m49	82
	EB Thru - Right		16.7	B	139	215	19.2	B	m186	242
	EB Approach		17.7	B	-	-	20.2	C	-	-
	WB Dual Left	260	80.2	F	37	77	68.4	E	m38	147
	WB Thru - Right		2.3	A	38	199	13.3	B	175	254
	WB Approach		5.7	A	-	-	16.9	B	-	-
	NB Left		48.6	D	42	66	56.8	E	83	119
	NB Thru		45.9	D	14	58	56.7	E	86	114
	NB Right	170	45.4	D	0	35	52.5	D	0	78
	NB Approach		47.2	D	-	-	55.3	E	-	-
	SB Left	155	48.3	D	107	136	49.0	D	239	154
	SB Thru - Right		41.6	D	40	116	41.0	D	92	316
	SB Approach		46.4	D	-	-	46.7	D	-	-
	Overall		14.1	B	-	-	24.3	C	-	-
3. England St (E-W) Hill Carter Pkwy (N-S) Signalized	EB Left	325	37.6	D	m48	115	43.5	D	m91	114
	EB Thru		30.2	C	239	421	29.8	C	330	504
	EB Right	200	22.7	C	28	200	151.7	F	117	200
	EB Approach		29.8	C	-	-	46.8	D	-	-
	WB Dual Left	550	39.1	D	104	144	49.9	D	143	152
	WB Thru - Right		20.4	C	231	234	22.0	C	245	254
	WB Approach		23.9	C	-	-	27.9	C	-	-
	NB Left	220	44.4	D	68	58	57.6	E	#205	155
	NB Left - Thru		42.9	D	37	115	50.0	D	85	187
	NB Right	325	42.7	D	0	152	49.2	D	#102	238
	NB Approach		43.0	D	-	-	51.0	D	-	-
	SB Left	290	61.7	E	109	214	68.2	E	116	203
	SB Thru - Right		40.2	D	20	61	49.8	D	26	56
	SB Approach		55.6	E	-	-	61.6	E	-	-
	Overall		29.7	C	-	-	40.8	D	-	-
4. England St (E-W) Carter Rd (N-S) Unsignalized	EB Thru - Right†		0.0	A	-	49	0.0	A	-	140
	EB Approach		0.0	A	-	-	0.0	A	-	-
	WB Thru - Right†		0.0	A	-	7	0.0	A	-	-
	WB Approach		0.0	A	-	-	0.0	A	-	-
	NB Left		10.8	B	8	68	11.9	B	5	75
	NB Approach		10.8	B	-	-	11.9	B	-	-
	SB Right		11.3	B	2	63	10.9	B	1	27
	SB Approach		11.3	B	-	-	10.9	B	-	-

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

† 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.

**Table 5-2: Intersection Level of Service and Delay Summary
2033 Background Traffic (Part 2)**

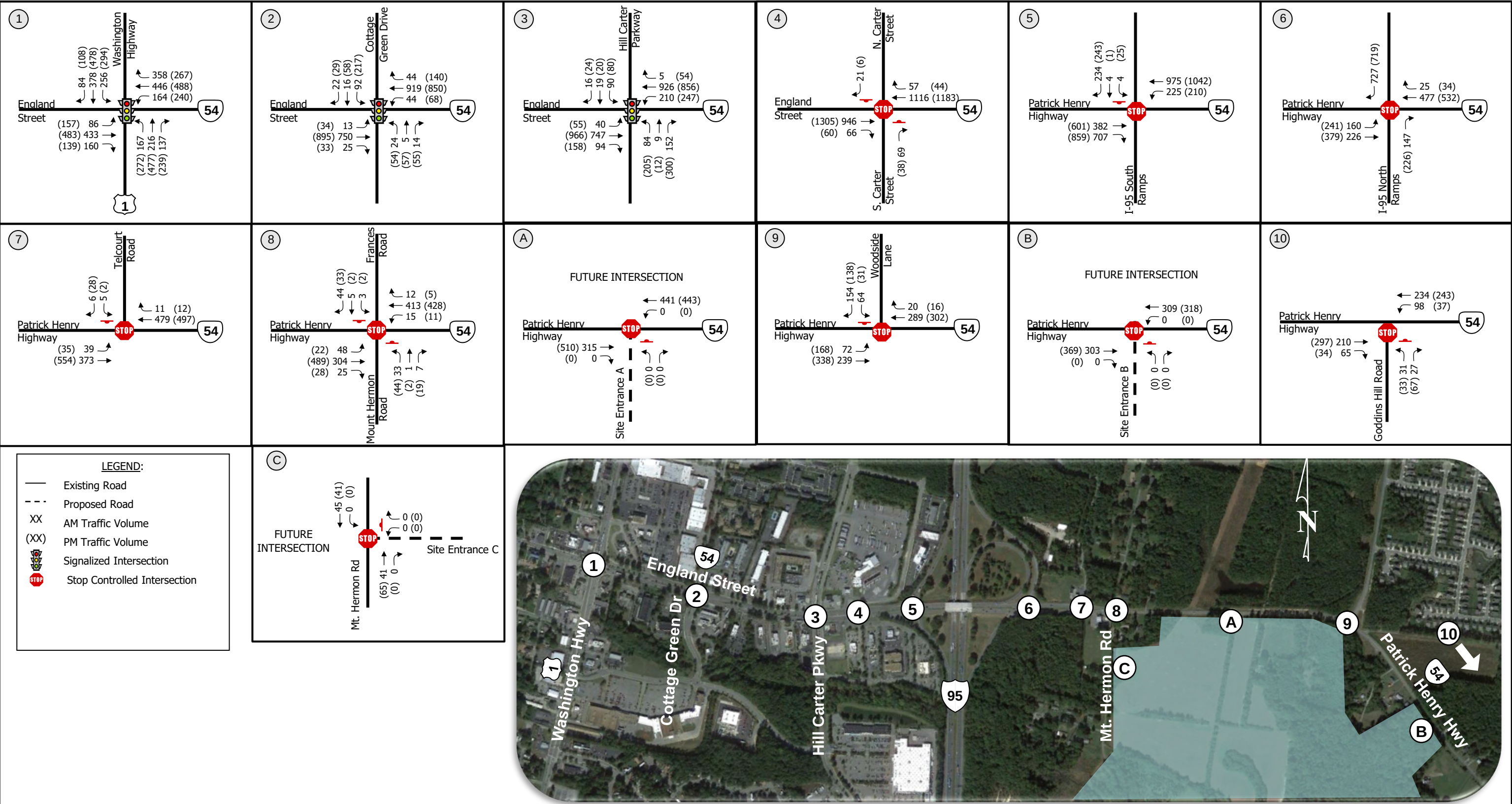
Intersection and Type of Control	Movement and Approach	Turn Lane Storage (ft)	AM PEAK HOUR				PM PEAK HOUR			
			Delay ¹ (sec/veh)	LOS ¹	HCS 95th Percentile Queue Length (ft)	Simulated Maximum Queue Length (ft)	Delay ¹ (sec/veh)	LOS ¹	HCS 95th Percentile Queue Length (ft)	Simulated Maximum Queue Length (ft)
5. Patrick Henry Hwy (E-W) I-95 SB Ramps Unsignalized	EB Thru†		0.0	A	-	13	0.0	A	-	2
	EB Right†		0.0	A	-	13	0.0	A	-	-
	<i>EB Approach</i>		0.0	A	-	-	0.0	A	-	-
	WB Left	435	9.0	A	22	73	9.9	A	22	102
	WB Thru†		0.0	A	-	-	0.0	A	-	-
	<i>WB Approach</i>		1.7	A	-	-	1.7	A	-	-
	SB Left - Thru	150	94.5	F	14	30	247.9	F	68	91
	SB Right		22.3	C	83	0	21.1	C	77	91
	<i>SB Approach</i>		24.5	C	-	-	43.1	E	-	-
6. Patrick Henry Hwy (E-W) I-95 NB Ramps Unsignalized	EB Left	435	9.7	A	16	110	9.9	A	26	126
	EB Thru†		0.0	A	-	-	0.0	A	-	-
	<i>EB Approach</i>		4.0	A	-	-	3.9	A	-	-
	WB Thru†		0.0	A	-	2	0.0	A	-	10
	WB Right†	380	0.0	A	-	0	0.0	A	-	0
	<i>WB Approach</i>		0.0	A	-	-	0.0	A	-	-
	NB Right		9.9	A	16	0	11.2	B	30	0
	<i>NB Approach</i>		9.9	A	-	-	11.2	B	-	-
7. Patrick Henry Hwy (E-W) Telcourt Rd (N-S) Unsignalized	EB Left		9.1	A	3	60	8.9	A	3	50
	EB Thru†		0.0	A	-	3	0.0	A	-	-
	<i>EB Approach</i>		0.9	A	-	-	0.5	A	-	-
	WB Thru†		0.0	A	-	-	0.0	A	-	-
	WB Right†	50	0.0	A	-	27	0.0	A	-	24
	<i>WB Approach</i>		0.0	A	-	-	0.0	A	-	-
	SB Left - Right		12.9	B	2	33	10.7	B	4	42
	<i>SB Approach</i>		12.9	B	-	-	10.7	B	-	-
8. Patrick Henry Hwy (E-W) Mt. Hermon Rd/Francis Rd (N-S) Unsignalized	EB Left		8.4	A	4	39	8.3	A	2	33
	EB Thru - Right†		0.0	A	-	2	0.0	A	-	2
	<i>EB Approach</i>		1.1	A	-	-	0.3	A	-	-
	WB Left - Thru		0.4	A	1	55	0.4	A	1	83
	WB Right†	110	0.0	A	-	0	0.0	A	-	-
	<i>WB Approach</i>		0.4	A	-	-	0.3	A	-	-
	NB Left-Thru-Right		25.4	D	19	62	30.1	D	35	61
	<i>NB Approach</i>		25.4	D	-	-	30.1	D	-	-
9. Patrick Henry Hwy (E-W) Woodside Ln (N-S) Unsignalized	SB Left-Thru-Right		13.2	B	10	53	12.9	B	7	48
	<i>SB Approach</i>		13.2	B	-	-	12.9	B	-	-
10. Patrick Henry Hwy (E-W) Goddins Hill Rd (N-S) Unsignalized	EB Left	300	8.1	A	5	50	8.5	A	13	76
	EB Thru†		0.0	A	-	-	0.0	A	-	-
	<i>EB Approach</i>		1.9	A	-	-	2.8	A	-	-
	WB Thru - Right†		0.0	A	-	5	0.0	A	-	6
	<i>WB Approach</i>		0.0	A	-	-	0.0	A	-	-
	SB Left		13.0	B	21	76	14.2	B	20	67
	SB Right	290	13.0	B	21	86	14.2	B	20	86
	<i>SB Approach</i>		13.0	B	-	-	14.2	B	-	-
10. Patrick Henry Hwy (E-W) Goddins Hill Rd (N-S) Unsignalized	EB Thru†		0.0	A	-	-	0.0	A	-	-
	EB Right†	200	0.0	A	-	-	0.0	A	-	-
	<i>EB Approach</i>		0.0	A	-	-	0.0	A	-	-
	WB Left - Thru		3.0	A	7	67	1.3	A	3	49
	<i>WB Approach</i>		3.0	A	-	-	1.3	A	-	-
	NB Left - Right		13.4	B	11	54	12.7	B	17	60
	<i>NB Approach</i>		13.4	B	-	-	12.7	B	-	-

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

† 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.



PAGE INTENTIONALLY BLANK

6 2039 BACKGROUND CONDITIONS

The background 2039 volumes were analyzed assuming future intersection geometry in conjunction with projected background traffic volumes. The background traffic volumes were developed based on a 1.5% annual growth rate.

6.1 BACKGROUND FORECASTING METHODOLOGY

The 1.5% annual growth rate discussed above was compounded annually for the 16-year period from 2022 to 2039 and applied to the existing traffic volumes. The resulting 2039 Background Traffic Volumes are shown on Figure 6-1.

6.2 BACKGROUND 2039 CAPACITY ANALYSES

Tables 6-1 and 6-2 summarize the 2039 background intersection LOS, delay, 95th percentile (Synchro), and maximum (SimTraffic) queue lengths based on the 2039 background peak hour traffic volumes shown on Figure 6-1, the existing conditions lane geometry (Figure 2-1), and the existing timings at the traffic signals. Note that intersections A-C are shown as numbers 11-13 in the following analysis. The corresponding SYNCHRO worksheets are included in Appendix I.

Note at Intersection #3 that the eastbound right movement is reporting excessive delay. This is an error with how Synchro is reporting delay for the intersection and may be caused by the pedestrian phase associated with the eastbound approach being turned on all the time. However, the 95th Percentile queue length is low which shows that vehicles are not waiting for the amount of time suggested by the control delay.

Note at Intersection #6 the I-95 off-ramps (SB right and NB right) are coded in Synchro as yield controlled approaches due to the existing signs at the intersection. However, the existing lane geometry for those movements includes a receiving lane for merging traffic. As shown by the SimTraffic queue lengths (0 ft), these movements operate as free-flowing despite the HCM reports showing delay.

As shown in Tables 6-1 and 6-2 under 2039 background conditions:

- At the signalized intersection of Route 54 and US Route 1, the overall intersection will operate at a LOS C/E during the AM/PM peaks, respectively.
 - The eastbound approach will operate at a LOS C/D during the AM/PM peaks, respectively. The westbound approach will operate at a LOS C/D during the AM/PM peaks, respectively. The WB through will operate at a LOS D/E during the AM/PM peaks, respectively.
 - The northbound left will operate at a LOS C/E during the AM/PM peaks, respectively. The NB through will operate at a LOS D/E during the AM/PM peaks, respectively. The southbound left will operate at a LOS D/F during the AM/PM peaks, respectively. The SB approach will operate at a LOS D/F during the AM/PM peaks, respectively.
 - During the PM peak, the NB left maximum queue fills the available storage. During the PM peak, the SB left maximum queue exceeds the available storage, spilling into the through lanes and backing up through the intersection of College Ave. All other movements have adequate turn bay storage to accommodate 95th percentile and maximum queue lengths.

- At the signalized intersection of Route 54 and Cottage Green Drive, the overall intersection will operate at a LOS B/C during the AM/PM peaks, respectively.
 - The mainline through movements will operate at a LOS C or better during both peak hours. The EB left will operate at a LOS D during both peak hours. The WB left will operate at a LOS E during both peak hours.
 - The northbound and southbound approaches will operate at a LOS D during both peak hours.
 - During the PM peak, the SB left maximum queue exceeds the available storage, spiling back into the through lane. All other movements have adequate turn bay storage to accommodate 95th percentile and maximum queue lengths.
- At the signalized intersection of Route 54 and Hill Carter Parkway, the overall intersection will operate at a LOS C/D during the AM/PM peaks, respectively.
 - The mainline through movements will operate at a LOS C during both peak hours. The EB and WB lefts will operate at a LOS D during both peak hours. As previously mentioned, the delay for the EB right is not reported correctly at this intersection.
 - The northbound approach will operate at a LOS D during both peak hours. The NB left will operate at a LOS D/E during the AM/PM peaks, respectively. The southbound approach and left movement will operate at a LOS E during both peak hours.
 - All movements have adequate turn bay storage to accommodate 95th percentile and maximum queue lengths.
- At the unsignalized intersection of Route 54 and I-95 SB ramp, the mainline east- and westbound approaches operate at a LOS B or better during both peak hours. The southbound left/through movement operates at a LOS F during both peak hours.
 - All movements have adequate storage to accommodate 95th percentile and maximum queue lengths.
- At the unsignalized intersection of Route 54 and I-95 NB ramp, the mainline east- and westbound approaches operate at a LOS B during both peak hours. As previously mentioned, the north- and southbound movements report delay due to the yield-control, however the movements behave more like free-flow right turns. The NB right operates at a LOS B during both peak hours. The SB right operates at a LOS F during both peak hours. All 95th percentile and maximum queue lengths are contained within the available storage.
- At the unsignalized intersection of Route 54 and Mt. Hermon Road/Frances Road, the mainline east- and westbound movements will operate at a LOS A during both peak hours. The northbound approach will operate at a LOS D/E during the AM/PM peaks, respectively. The southbound approach will operate at a LOS B during both peak hours. All movements have adequate turn bay storage to accommodate 95th percentile and maximum queue lengths.
- At all other unsignalized intersections (numbers 4, 7, 9-10), the mainline east- and westbound movements all operate at a LOS A during both peak hours. All side street movements operate at acceptable levels (LOS B or better) during both peak hours. All 95th percentile and maximum queue lengths are contained within the available storage.

**Table 6-1: Intersection Level of Service and Delay Summary
2039 Background Traffic (Part 1)**

Intersection and Type of Control	Movement and Approach	Turn Lane Storage (ft)	AM PEAK HOUR				PM PEAK HOUR			
			Delay ¹ (sec/veh)	LOS ¹	HCS 95th Percentile Queue Length (ft)	Simulated Maximum Queue Length (ft)	Delay ¹ (sec/veh)	LOS ¹	HCS 95th Percentile Queue Length (ft)	Simulated Maximum Queue Length (ft)
1. England St (E-W) US Route 1 (N-S) Signalized	EB Left	290	25.8	C	68	152	38.6	D	162	228
	EB Thru		34.2	C	205	242	39.6	D	255	287
	EB Right	340	28.6	C	20	103	32.8	C	21	95
	EB Approach		31.8	C	-	-	38.2	D	-	-
	WB Left		21.4	C	95	248	49.4	D	#246	778
	WB Thru		51.6	D	#556	616	75.2	E	#679	876
	WB Right		0.5	A	51	45	0.3	A	0	571
	WB Approach		27.6	C	-	-	48.9	D	-	-
	NB Left	350	34.4	C	147	184	73.4	E	#374	350
	NB Thru		38.6	D	119	173	74.9	E	#335	628
	NB Right	400	0.2	A	0	0	0.2	A	0	80
	NB Approach		27.2	C	-	-	56.4	F	-	-
	SB Left	320	49.8	D	#214	311	101.9	F	#426	316
	SB Thru		47.5	D	#218	337	78.3	E	#338	658
	SB Right	140	35.1	D	0	140	42.7	D	0	140
	SB Approach		46.8	D	-	-	81.8	F	-	-
	Overall		33.3	C	-	-	56.6	E	-	-
2. England St (E-W) Cottage Green Dr (N-S) Signalized	EB Left	235	49.1	D	m12	62	50.3	D	m50	89
	EB Thru - Right		17.6	B	m123	267	22.8	C	m229	279
	EB Approach		18.2	B	-	-	23.8	C	-	-
	WB Dual Left	260	73.8	E	33	98	66.9	E	m41	178
	WB Thru - Right		4.5	A	31	229	14.9	B	194	332
	WB Approach		7.5	A	-	-	18.2	B	-	-
	NB Left		48.7	D	44	95	54.8	D	89	122
	NB Thru		45.8	D	14	52	54.7	D	93	110
	NB Right	170	45.3	D	0	39	51.2	D	0	76
	NB Approach		47.3	D	-	-	53.5	D	-	-
	SB Left	155	44.1	D	114	145	46.9	D	271	154
	SB Thru - Right		39.9	D	42	122	39.3	D	105	375
	SB Approach		42.8	D	-	-	44.7	D	-	-
	Overall		15.0	B	-	-	26.0	C	-	-
3. England St (E-W) Hill Carter Pkwy (N-S) Signalized	EB Left	325	36.2	D	m49	134	42.2	D	m99	146
	EB Thru		31.7	C	259	418	32.8	C	368	542
	EB Right	200	23.2	C	21	200	117.3	F	130	200
	EB Approach		31.0	C	-	-	44.6	D	-	-
	WB Dual Left	550	39.4	D	115	145	51.9	D	158	186
	WB Thru - Right		21.5	C	256	233	24.6	C	275	279
	WB Approach		24.8	C	-	-	30.4	C	-	-
	NB Left	220	44.5	D	72	70	60.6	E	#228	175
	NB Left - Thru		43.0	D	40	114	50.1	D	91	192
	NB Right	325	42.7	D	0	166	49.2	D	#120	268
	NB Approach		43.0	D	-	-	51.6	D	-	-
	SB Left	290	65.3	E	#118	219	60.2	E	127	201
	SB Thru - Right		39.9	D	22	72	47.9	D	27	54
	SB Approach		58.0	E	-	-	55.9	E	-	-
	Overall		30.7	C	-	-	40.8	D	-	-
4. England St (E-W) Carter Rd (N-S) Unsignalized	EB Thru - Right†		0.0	A	-	112	0.0	A	-	143
	EB Approach		0.0	A	-	-	0.0	A	-	-
	WB Thru - Right†		0.0	A	-	7	0.0	A	-	11
	WB Approach		0.0	A	-	-	0.0	A	-	-
	NB Right		10.8	B	8	81	11.9	B	5	91
	NB Approach		10.8	B	-	-	11.9	B	-	-
	SB Right		11.3	B	2	58	10.9	B	1	27
	SB Approach		11.3	B	-	-	10.9	B	-	-

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

† 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.

**Table 6-2: Intersection Level of Service and Delay Summary
2039 Background Traffic (Part 2)**

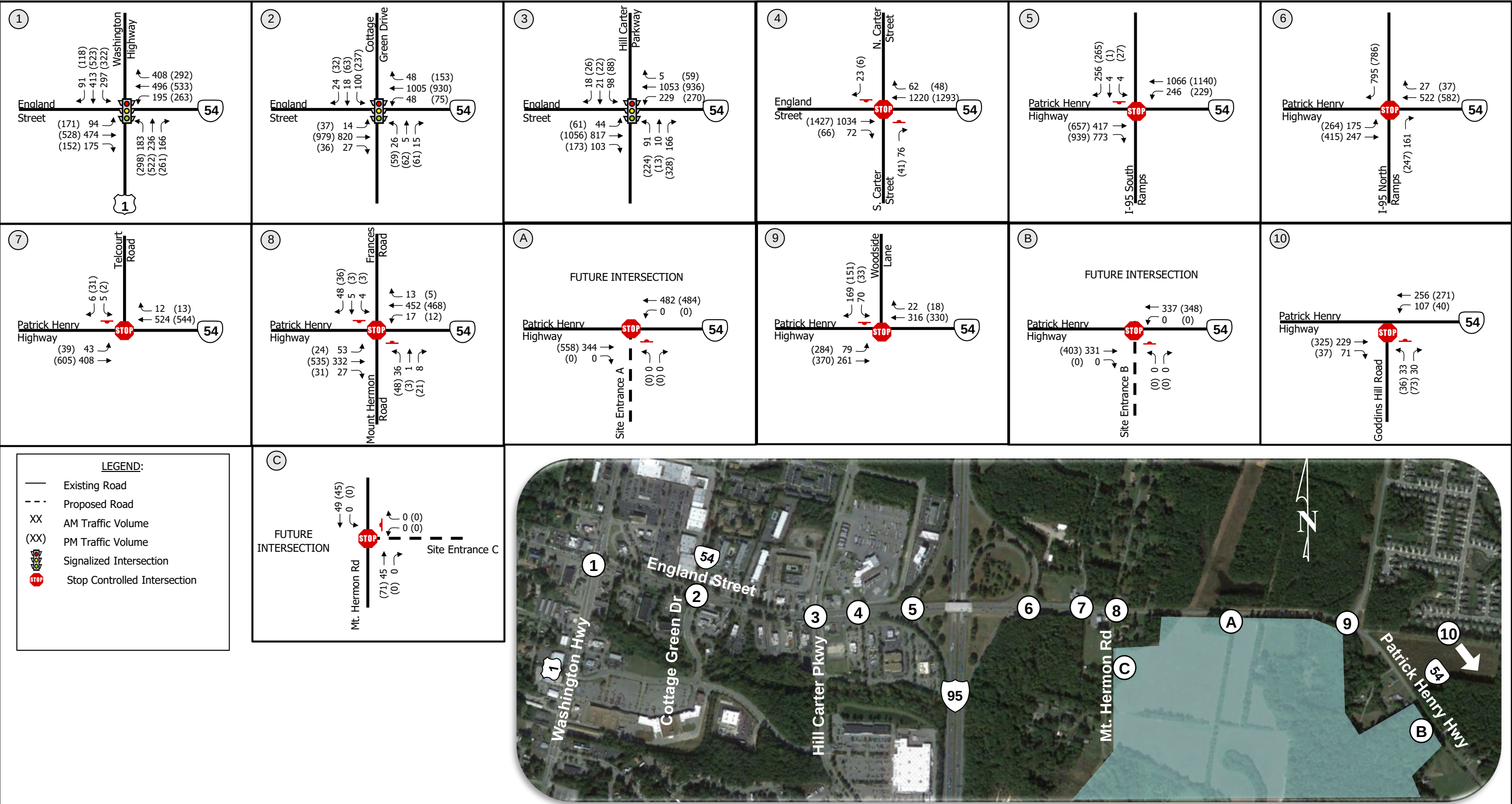
Intersection and Type of Control	Movement and Approach	Turn Lane Storage (ft)	AM PEAK HOUR				PM PEAK HOUR			
			Delay ¹ (sec/veh)	LOS ¹	HCS 95th Percentile Queue Length (ft)	Simulated Maximum Queue Length (ft)	Delay ¹ (sec/veh)	LOS ¹	HCS 95th Percentile Queue Length (ft)	Simulated Maximum Queue Length (ft)
5. Patrick Henry Hwy (E-W) I-95 SB Ramps Unsignalized	EB Thru†		0.0	A	-	2	0.0	A	-	3
	EB Right†		0.0	A	-	9	0.0	A	-	-
	<i>EB Approach</i>		0.0	A	-	-	0.0	A	-	-
	WB Left	435	9.3	A	26	97	10.3	B	26	118
	WB Thru†		0.0	A	-	-	0.0	A	-	-
	<i>WB Approach</i>		1.7	A	-	-	1.7	A	-	-
	SB Left - Thru	150	133.9	F	18	38	455.5	F	89	102
	SB Right		28.5	D	115	0	26.2	D	105	0
	<i>SB Approach</i>		31.5	D	-	-	67.4	F	-	-
6. Patrick Henry Hwy (E-W) I-95 NB Ramps Unsignalized	EB Left	435	10.1	B	19	125	10.4	B	31	144
	EB Thru†		0.0	A	-	-	0.0	A	-	-
	<i>EB Approach</i>		4.2	A	-	-	4.1	A	-	-
	WB Thru†		0.0	A	-	13	0.0	A	-	17
	WB Right†	380	0.0	A	-	0	0.0	A	-	0
	<i>WB Approach</i>		0.0	A	-	-	0.0	A	-	-
	NB Right		10.1	B	18	0	11.7	B	35	0
	<i>NB Approach</i>		10.1	B	-	-	11.7	B	-	-
	SB Right		126.3	F	724	0	126.0	F	703	0
	<i>SB Approach</i>		126.3	F	-	-	126.0	F	-	-
7. Patrick Henry Hwy (E-W) Telcourt Rd (N-S) Unsignalized	EB Left		9.3	A	4	68	9.1	A	4	54
	EB Thru†		0.0	A	-	5	0.0	A	-	-
	<i>EB Approach</i>		0.9	A	-	-	0.5	A	-	-
	WB Thru†		0.0	A	-	3	0.0	A	-	-
	WB Right†	50	0.0	A	-	25	0.0	A	-	29
	<i>WB Approach</i>		0.0	A	-	-	0.0	A	-	-
	SB Left - Right		13.7	B	2	33	11.3	B	5	50
	<i>SB Approach</i>		13.7	B	-	-	11.3	B	-	-
8. Patrick Henry Hwy (E-W) Mt. Hermon Rd/Francis Rd (N-S) Unsignalized	EB Left		8.6	A	4	40	8.5	A	2	29
	EB Thru - Right†		0.0	A	-	6	0.0	A	-	5
	<i>EB Approach</i>		1.1	A	-	-	0.3	A	-	-
	WB Left - Thru		0.5	A	1	75	0.4	A	1	74
	WB Right†	110	0.0	A	-	0	0.0	A	-	2
	<i>WB Approach</i>		0.4	A	-	-	0.4	A	-	-
	NB Left-Thru-Right		30.7	D	25	64	39.5	E	50	69
	<i>NB Approach</i>		30.7	D	-	-	39.5	E	-	-
	SB Left-Thru-Right		14.0	B	11	50	14.4	B	9	46
	<i>SB Approach</i>		14.0	B	-	-	14.4	B	-	-
9. Patrick Henry Hwy (E-W) Woodside Ln (N-S) Unsignalized	EB Left	300	8.2	A	5	51	8.6	A	15	99
	EB Thru†		0.0	A	-	-	0.0	A	-	-
	<i>EB Approach</i>		1.9	A	-	-	2.9	A	-	-
	WB Thru - Right†		0.0	A	-	7	0.0	A	-	2
	<i>WB Approach</i>		0.0	A	-	-	0.0	A	-	-
	SB Left		13.8	B	25	89	15.5	C	24	71
	SB Right	290	13.8	B	25	85	15.5	C	24	87
	<i>SB Approach</i>		13.8	B	-	-	15.5	C	-	-
10. Patrick Henry Hwy (E-W) Goddins Hill Rd (N-S) Unsignalized	EB Thru†		0.0	A	-	-	0.0	A	-	-
	EB Right†	200	0.0	A	-	9	0.0	A	-	4
	<i>EB Approach</i>		0.0	A	-	-	0.0	A	-	-
	WB Left - Thru		3.1	A	8	72	1.4	A	3	55
	<i>WB Approach</i>		3.1	A	-	-	1.4	A	-	-
	NB Left - Right		14.2	B	13	63	13.4	B	20	62
	<i>NB Approach</i>		14.2	B	-	-	13.4	B	-	-

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

† 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.



PAGE INTENTIONALLY BLANK

7 TRIP GENERATION AND DISTRIBUTION

7.1 SITE TRIP GENERATION

Data centers are relatively new uses and trip generation information is limited. Typically, trips are generated based on data contained in the 11th Edition of the ITE Trip Generation Manual. However, the ITE data contains studies for only two (2) similar uses both of which were studied in the 2010 timeframe and states *"caution should be used when applying trip generation rates for data centers, as the database contains a small number of sites with limited data"*.

VDOT Traffic Impact Analysis Administrative Guidelines states that if certain criteria are not met (at least three data points, standard deviation less than 110% of the average rate, etc.), *"a rate based upon the study of similar local sites should be considered."*

In March 2023, Bowman Consulting Group published a trip generation study of six (6) existing data center sites in Virginia. The study analyzed the trips generated by each site over the course of a full year and averaged the trips to determine rates for the AM peak hour, PM peak hour, and average daily trips. The study was approved by VDOT Central Office and VDOT Richmond District as the preferred method for trip generation calculation for a data center. A copy of the Bowman study is included in Appendix J.

As shown in Table 7-1, when complete, the total proposed development will generate 297 external trips (163 in and 134 out) during the AM peak, 99 external trips (30 in and 69 out) during the PM peak, and 2,475 external weekday daily trips.

Table 7-1: Trip Generation Summary

Buildout - Iron Horse Data Center Development										
Land Use	Size	Units	Land Use Code	AM Peak Hour			Weekday PM Peak Hour			Average Daily Trips
				In	Out	Total	In	Out	Total	
1. Data Center Trips ⁽¹⁾										
Data Center (Town of Ashland)	1,800,000	SF		89	73	162	16	38	54	1,350
Data Center (Hanover County)	1,500,000	SF		74	61	135	14	31	45	1,125
Total Data Center Trips				163	134	297	30	69	99	2,475
Total External Primary Trips				163	134	297	30	69	99	2,475

Notes:

Trip generation based on *AWS Data Center Trip Generation Assessment* prepared by Bowman Consulting Group, March 2023.

(1) Entering & exiting distributions taken from the ITE *Trip Generation Manual*, 11th Edition.

7.2 PRIMARY TRIP DISTRIBUTION METHODOLOGY

The distribution of external trips generated by the proposed development was based on the existing travel patterns, the nature of the site, and local knowledge.

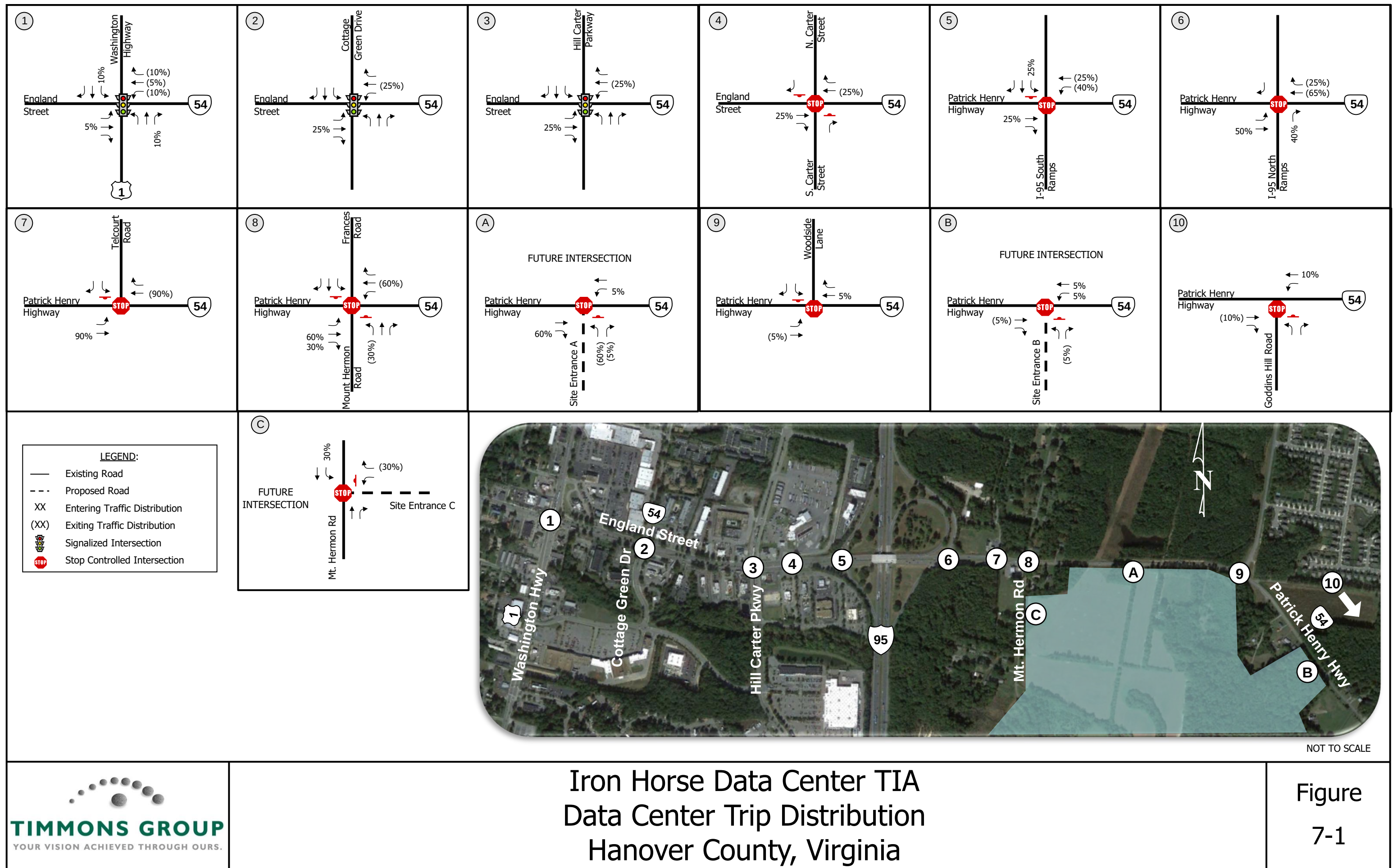
The following directional distributions were assumed for primary passenger vehicle trips to/from the proposed development:

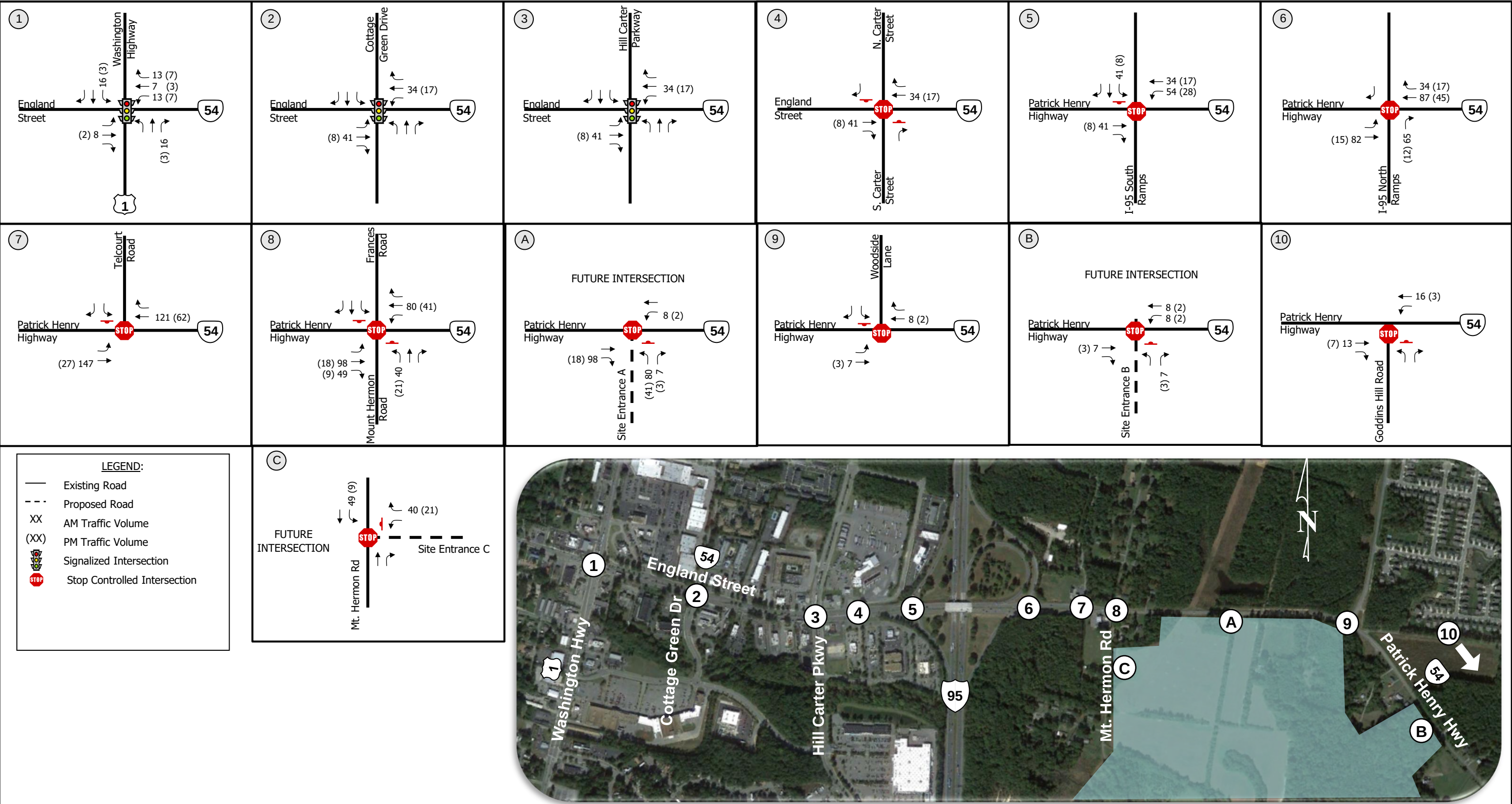
- To/from the west on Route 54 – 5%
- To/from the north on US Route 1 – 10%
- To/from the south on US Route 1 – 10%
- To/from the north on I-95 – 25%
- To/from the south on I-95 – 40%
- To/from the east on Route 54 – 10%

Directional distributions were then applied to the study intersections as shown on Figure 7-2.

7.3 TRAFFIC ASSIGNMENT

The trip distribution percentages described above for the external site trips were applied to the trip generation shown in Table 7-1 to distribute the external site trips the surrounding roadway network. The resulting site generated external trips are shown on Figure 7-3.





8 2033 TOTAL FUTURE CONDITIONS

To complete the analysis of the 2033 total conditions of the proposed development, the estimated site trips were added to the background 2033 volumes. The projected volumes were then used to complete the capacity analysis.

8.1 TOTAL FUTURE TRAFFIC VOLUMES

To generate the 2033 total future traffic volumes, the site trips (Figure 7-2) were added to the background 2033 traffic volumes (Figure 5-1). The resulting 2033 total future traffic volumes are shown on Figure 8-1.

8.2 2033 TOTAL FUTURE CAPACITY ANALYSES

Tables 8-1 through 8-3 summarizes the 2033 total future intersection LOS, delay, 95th percentile (Synchro), and maximum (SimTraffic) queue lengths based on the 2033 total future peak hour traffic volumes shown on Figure 8-1, the Phase 2 future lane geometry (Figure 2-3), and optimized timings at the traffic signals. Note that intersections A-C are shown as numbers 11-14 in the following analysis. The corresponding SYNCHRO worksheets for 2033 total future analyses are included in Appendix K.

Note at Intersection #3 that the eastbound right movement is reporting excessive delay. This is an error with how Synchro is reporting delay for the intersection and may be caused by the pedestrian phase associated with the eastbound approach being turned on all the time. However, the 95th Percentile queue length is low which shows that vehicles are not waiting for the amount of time suggested by the control delay.

Note at Intersection #6 the I-95 off-ramps (SB right and NB right) are coded in Synchro as yield controlled approaches due to the existing signs at the intersection. However, the existing lane geometry for those movements includes a receiving lane for merging traffic. As shown by the SimTraffic queue lengths (0 ft), these movements operate as free-flowing despite the HCM reports showing delay.

As shown in Tables 8-1 through 8-3 under 2033 total future:

- At the signalized intersection of Route 54 and US Route 1, the overall intersection will operate at a LOS C/D during the AM/PM peaks, respectively.
 - The eastbound approach will operate at a LOS D during both peak hours. The westbound approach will operate at a B/C during the AM/PM peaks, respectively. The WB through will operate at a LOS C/D during the AM/PM peaks, respectively.
 - The northbound left will operate at a LOS C/D during the AM/PM peaks, respectively. The NB through will operate at a LOS D/E during the AM/PM peaks, respectively. The southbound approach will operate at a LOS D during both peak hours. The SB left will operate at a LOS D/E during the AM/PM peaks, respectively.
 - During both peak hours, the SB thru maximum queue blocks the storage for the SB right. All other movements have adequate turn bay storage to accommodate 95th percentile and maximum queue lengths.

- At the signalized intersection of Route 54 and Cottage Green Drive, the overall intersection will operate at a LOS A/B during the AM/PM peaks, respectively.
 - The mainline through movements will operate at a LOS B or better during both peak hours. The EB left will operate at a LOS D during both peak hours. The WB left will operate at a LOS E/C during the AM/PM peaks, respectively.
 - The northbound approach and left movement will operate at a LOS D/E during the AM/PM peaks, respectively. The southbound approach and left movement will operate at a LOS D during both peak hours.
 - During the PM peak, the SB left maximum queue exceeds the available storage, spilling back into the through lane. All other movements have adequate turn bay storage to accommodate 95th percentile and maximum queue lengths.
- At the signalized intersection of Route 54 and Hill Carter Parkway, the overall intersection will operate at a LOS C during both peak hours.
 - The mainline through movements will operate at a LOS C or better during both peak hours. The WB left will operate at a LOS D/E during the AM/PM peaks, respectively. As previously mentioned, the delay for the EB right is not reported correctly at this intersection.
 - The northbound approach will operate at a LOS D during both peak hours. The NB left will operate at a LOS D/E during the AM/PM peaks, respectively. The southbound approach and left will operate at a LOS E during both peak hours.
 - All movements have adequate turn bay storage to accommodate 95th percentile and maximum queue lengths.
- At the unsignalized intersection of Route 54 and I-95 SB ramp, the east- and westbound mainline movements operate at a LOS B or better during both peak hours. The southbound left/through movement operates at a LOS F during both peak hours.
 - All other movements have adequate storage to accommodate 95th percentile and maximum queue lengths.
- At the unsignalized intersection of Route 54 and I-95 NB ramp, the mainline east- and westbound approaches operate at a LOS B or better during both peak hours. As previously mentioned, the north- and southbound movements report delay due to the yield-control, however the movements behave more like free-flow right turns. The NB right operates at a LOS B during both peak hours. The SB right operates at a LOS E during both peak hours. All maximum queue lengths are contained within the available storage.
- At the unsignalized intersection of Route 54 and Mt. Hermon Road/Frances Road, the east- and west-bound mainline movements operate at a LOS A during both peak hours.
 - The northbound approach will operate at a LOS F during both peak hours. The southbound approach will operate at a LOS B during both peak hours.
 - All movements have adequate turn bay storage to accommodate 95th percentile and maximum queue lengths.
- At the unsignalized intersection of Route 54 and Site Entrance A, the east- and west-bound mainline movements will operate at a LOS A during both peak hours. The northbound approach will operate at a LOS C during both peak hours. All movements have adequate turn bay storage to accommodate 95th percentile and maximum queue lengths.
- At all other unsignalized intersections (numbers 4, 7, 9-10, 12-13), the mainline movements (free-flowing) all operate at a LOS A during both peak hours. All side street movements (stop-controlled) operate at acceptable levels (LOS C or better) during both peak hours. All 95th percentile and maximum queue lengths are contained within the available storage.

**Table 8-1: Intersection Level of Service and Delay Summary
2033 Total Future Traffic (Part 1)**

Intersection and Type of Control	Movement and Approach	Turn Lane Storage (ft)	AM PEAK HOUR				PM PEAK HOUR			
			Delay ¹ (sec/veh)	LOS ¹	HCS 95th Percentile Queue Length (ft)	Simulated Maximum Queue Length (ft)	Delay ¹ (sec/veh)	LOS ¹	HCS 95th Percentile Queue Length (ft)	Simulated Maximum Queue Length (ft)
1. England St (E-W) US Route 1 (N-S) Signalized	EB Left	290	34.8	C	62	180	57.3	E	#144	258
	EB Thru		36.9	D	190	207	40.8	D	242	321
	EB Right	340	30.6	C	11	102	34.1	C	12	81
	EB Approach		35.2	D	-	-	42.9	D	-	-
	WB Left		14.1	B	86	264	25.4	C	67	314
	WB Thru		27.3	C	#418	441	39.0	D	#567	523
	WB Right		0.4	A	68	0	0.3	A	0	0
	WB Approach		15.0	B	-	-	25.2	C	-	-
	NB Left	350	34.4	C	138	169	50.5	D	#276	320
	NB Thru		39.5	D	111	154	63.3	E	#292	351
	NB Right	400	0.2	A	0	0	0.2	A	0	0
	NB Approach		26.7	C	-	-	44.4	D	-	-
	SB Left	320	52.3	D	#280	294	58.0	E	#336	318
	SB Thru		42.8	D	181	264	52.3	D	258	398
	SB Right	140	34.6	C	0	140	40.5	D	0	140
	SB Approach		45.4	D	-	-	52.8	D	-	-
	Overall		29.4	C	-	-	40.8	D	-	-
2. England St (E-W) Cottage Green Dr (N-S) Signalized	EB Left	235	50.3	D	m15	60	51.4	D	m46	82
	EB Thru - Right		5.2	A	101	174	16.1	B	m288	377
	EB Approach		5.9	A	-	-	17.3	B	-	-
	WB Dual Left	260	59.3	E	20	73	29.3	C	52	96
	WB Thru - Right		1.9	A	5	263	4.6	A	136	224
	WB Approach		4.4	A	-	-	6.1	A	-	-
	NB Left		48.6	D	42	82	56.8	E	83	98
	NB Thru		45.9	D	14	64	56.7	E	86	121
	NB Right	170	45.4	D	0	36	52.5	D	0	89
	NB Approach		47.2	D	-	-	55.3	E	-	-
	SB Left	155	48.8	D	107	145	54.2	D	239	154
	SB Thru - Right		41.7	D	40	114	42.9	D	91	306
	SB Approach		46.8	D	-	-	50.9	D	-	-
	Overall		8.6	A	-	-	19.1	B	-	-
3. England St (E-W) Hill Carter Pkwy (N-S) Signalized	EB Left	325	46.9	D	47	112	26.6	C	m62	102
	EB Thru		14.4	B	222	358	9.4	A	95	318
	EB Right	200	22.6	C	16	200	6.1	A	m6	200
	EB Approach		16.6	B	-	-	9.8	A	-	-
	WB Dual Left	550	40.0	D	106	138	56.5	E	#163	177
	WB Thru - Right		20.8	C	245	240	25.2	C	280	298
	WB Approach		24.2	C	-	-	31.8	C	-	-
	NB Left	220	43.6	D	64	53	57.0	E	157	165
	NB Left - Thru		42.3	D	36	106	49.8	D	80	194
	NB Right	325	42.1	D	0	160	49.0	D	89	90
	NB Approach		42.4	D	-	-	50.8	D	-	-
	SB Left	290	61.7	E	109	235	67.3	E	116	212
	SB Thru - Right		40.2	D	20	77	49.7	D	26	50
	SB Approach		55.6	E	-	-	61.0	E	-	-
	Overall		24.8	C	-	-	27.6	C	-	-
4. England St (E-W) Carter Rd (N-S) Unsignalized	EB Thru - Right†		0.0	A	-	95	0.0	A	-	51
	EB Approach		0.0	A	-	-	0.0	A	-	-
	WB Thru - Right†		0.0	A	-	2	0.0	A	-	30
	WB Approach		0.0	A	-	-	0.0	A	-	-
	NB Right		11.7	B	10	73	13.0	B	7	74
	NB Approach		11.7	B	-	-	13.0	B	-	-
	SB Right		11.9	B	3	62	11.6	B	1	33
	SB Approach		11.9	B	-	-	11.6	B	-	-

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

† 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.

\$ - Delay exceeds 300s

**Table 8-2: Intersection Level of Service and Delay Summary
2033 Total Future Traffic (Part 2)**

Intersection and Type of Control	Movement and Approach	Turn Lane Storage (ft)	AM PEAK HOUR				PM PEAK HOUR			
			Delay ¹ (sec/veh)	LOS ¹	HCS 95th Percentile Queue Length (ft)	Simulated Maximum Queue Length (ft)	Delay ¹ (sec/veh)	LOS ¹	HCS 95th Percentile Queue Length (ft)	Simulated Maximum Queue Length (ft)
5. Patrick Henry Hwy (E-W) I-95 SB Ramps Unsignalized	EB Thru†		0.0	A	-	26	0.0	B	-	6
	EB Right†		0.0	A	-	-	0.0	B	-	-
	EB Approach		0.0	A	-	-	0.0	B	-	-
	WB Left	435	9.5	A	26	94	10.1	B	26	98
	WB Thru†		0.0	A	-	-	0.0	B	-	3
	WB Approach		2.1	A	-	-	1.8	B	-	-
	SB Left - Thru	150	585.2	F	149	119	386.0	F	96	104
	SB Right		23.5	C	88	94	21.5	C	79	84
	SB Approach		120.4	F	-	-	66.1	F	-	-
6. Patrick Henry Hwy (E-W) I-95 NB Ramps Unsignalized	EB Left	435	10.2	B	18	126	10.2	B	27	124
	EB Thru†		0.0	A	-	-	0.0	A	-	-
	EB Approach		3.5	A	-	-	3.9	A	-	-
	WB Thru†		0.0	A	-	11	0.0	A	-	13
	WB Right†	380	0.0	B	-	0	0.0	B	-	0
	WB Approach		0.0	A	-	-	0.0	A	-	-
	NB Right		13.3	B	38	0	15.3	C	51	0
	NB Approach		13.3	B	-	-	15.3	C	-	-
7. Patrick Henry Hwy (E-W) Telcourt Rd (N-S) Unsignalized	SB Right		102.4	F	598	0	87.0	F	533	0
	SB Approach		102.4	F	-	-	87.0	F	-	-
	EB Left		9.6	A	4	61	9.2	A	3	54
	EB Thru†		0.0	A	-	-	0.0	A	-	-
	EB Approach		0.7	A	-	-	0.5	A	-	-
	WB Thru†		0.0	A	-	4	0.0	A	-	2
	WB Right†	50	0.0	A	-	28	0.0	A	-	24
	WB Approach		0.0	A	-	-	0.0	A	-	-
8. Patrick Henry Hwy (E-W) Mt. Hermon Rd/Frances Rd (N-S) Unsignalized	SB Left - Right		15.1	C	2	38	11.1	B	4	49
	SB Approach		15.1	C	-	-	11.1	B	-	-
	EB Left	150	8.7	A	4	47	8.5	A	2	35
	EB Thru†		0.0	A	-	-	0.0	A	-	-
	EB Right†		0.0	A	-	6	0.0	A	-	2
	EB Approach		0.8	A	-	-	0.3	A	-	-
	WB Left	150	8.5	A	1	23	8.7	A	1	22
	WB Thru†		0.0	A	-	-	0.0	A	-	0
9. Patrick Henry Hwy (E-W) Woodside Ln (N-S) Unsignalized	WB Right†	110	0.0	A	0	0	0.0	A	0	0
	WB Approach		0.2	A	-	-	0.2	A	-	-
	NB Left-Thru-Right		54.1	F	72	82	42.9	E	63	80
	NB Approach		54.1	F	-	-	42.9	E	-	-
	SB Left-Thru-Right		15.2	C	12	56	13.5	B	7	40
	SB Approach		15.2	C	-	-	13.5	B	-	-
	EB Left	300	8.1	A	5	53	8.5	A	13	68
	EB Thru†		0.0	A	-	-	0.0	A	-	-
10. Patrick Henry Hwy (E-W) Goddins Hill Rd (N-S) Unsignalized	EB Right†	200	0.0	A	-	0	0.0	A	-	2
	EB Approach		0.0	A	-	-	0.0	A	-	-
	WB Left - Thru		2.9	A	7	60	1.3	A	3	52
	WB Approach		2.9	A	-	-	1.3	A	-	-
	NB Left - Right		13.8	B	11	61	12.8	B	17	55
	NB Approach		13.8	B	-	-	12.8	B	-	-
	SB Left		13.1	B	21	76	14.2	B	20	58
	SB Right	290	13.1	B	21	86	14.2	B	20	81
	SB Approach		13.1	B	-	-	14.2	B	-	-

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

† 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.

\$ - Delay exceeds 300s

**Table 8-3: Intersection Level of Service and Delay Summary
2033 Total Future Traffic (Part 3)**

Intersection and Type of Control	Movement and Approach	Turn Lane Storage (ft)	AM PEAK HOUR				PM PEAK HOUR			
			Delay ¹ (sec/veh)	LOS ¹	HCS 95th Percentile Queue Length (ft)	Simulated Maximum Queue Length (ft)	Delay ¹ (sec/veh)	LOS ¹	HCS 95th Percentile Queue Length (ft)	Simulated Maximum Queue Length (ft)
11. Patrick Henry Hwy (E-W) Site Entrance A (N-S) Unsignalized	EB Thru†		0.0	A	-	-	0.0	A	-	-
	EB Right†	150	0.0	A	-	0	0.0	A	-	0
	<i>EB Approach</i>		<i>0.0</i>	<i>A</i>	-	-	<i>0.0</i>	<i>A</i>	-	-
	WB Left	150	8.2	A	1	26	8.6	A	0	12
	WB Thru†		0.0	A	-	-	0.0	A	-	-
	<i>WB Approach</i>		<i>0.1</i>	<i>A</i>	-	-	<i>0.0</i>	<i>A</i>	-	-
	NB Left - Right		18.2	C	24	63	21.5	C	16	52
	<i>NB Approach</i>		<i>18.2</i>	<i>C</i>	-	-	<i>21.5</i>	<i>C</i>	-	-
12. Patrick Henry Hwy (E-W) Site Entrance B (N-S) Unsignalized	EB Thru - Right†		0.0	A	-	-	0.0	A	-	-
	<i>EB Approach</i>		<i>0.0</i>	<i>A</i>	-	-	<i>0.0</i>	<i>A</i>	-	-
	WB Left - Thru		0.3	A	1	31	0.1	A	0	8
	<i>WB Approach</i>		<i>0.3</i>	<i>A</i>	-	-	<i>0.1</i>	<i>A</i>	-	-
	NB Left - Right		10.1	B	1	30	10.5	B	0	30
	<i>NB Approach</i>		<i>10.1</i>	<i>B</i>	-	-	<i>10.5</i>	<i>B</i>	-	-
13. Site Entrance C (E-W) Mt. Hermon Rd (N-S) Unsignalized	WB Left - Right		8.6	A	3	44	8.7	A	2	33
	<i>WB Approach</i>		<i>8.6</i>	<i>A</i>	-	-	<i>8.7</i>	<i>A</i>	-	-
	NB Thru - Right†		0.0	A	-	-	0.0	A	-	-
	<i>NB Approach</i>		<i>0.0</i>	<i>A</i>	-	-	<i>0.0</i>	<i>A</i>	-	-
	SB Left - Thru		3.9	A	3	17	1.4	A	0	22
	<i>SB Approach</i>		<i>3.9</i>	<i>A</i>	-	-	<i>1.4</i>	<i>A</i>	-	-

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

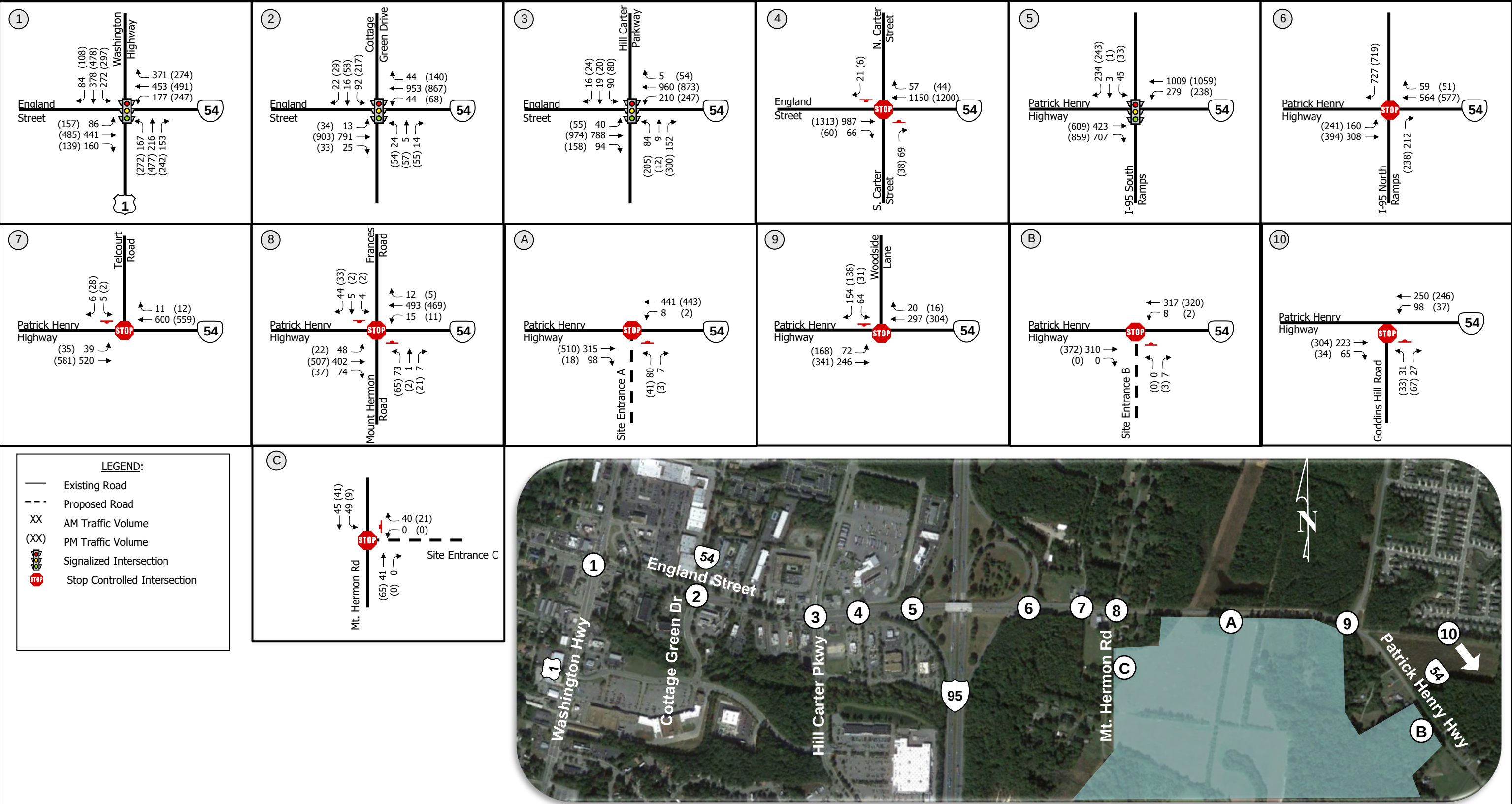
† SYNCHRO does not provide level of service or delay for unsignalized movements with no conflicting volumes.

- 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.

\$ - Delay exceeds 300s

PAGE INTENTIONALLY BLANK



NOT TO SCALE

PAGE INTENTIONALLY BLANK

9 2039 TOTAL FUTURE CONDITIONS

To complete the analysis of the 2039 total conditions, the estimated site trips were added to the background 2039 volumes. The projected volumes were then used to complete the capacity analysis.

9.1 TOTAL FUTURE TRAFFIC VOLUMES

To generate the 2039 total future traffic volumes, the site trips (Figure 7-2) were added to the background 2039 traffic volumes shown on Figure 6-1. The resulting 2039 total future traffic volumes are shown on Figure 9-1.

9.2 2039 TOTAL FUTURE CAPACITY ANALYSES

Tables 9-1 through 9-3 summarize the 2039 total future intersection LOS, delay, 95th percentile (Synchro), and maximum (SimTraffic) queue lengths based on the 2039 total future peak hour traffic volumes shown on Figure 9-1, the Phase 2 future lane geometry (Figure 2-3), and optimized timings at the traffic signals. Note that intersections A-C are shown as numbers 11-13 in the following analysis. The corresponding SYNCHRO worksheets for 2039 total future analyses are included in Appendix L.

Note at Intersection #3 that the eastbound right movement is reporting excessive delay. This is an error with how Synchro is reporting delay for the intersection and may be caused by the pedestrian phase associated with the eastbound approach being turned on all the time. However, the 95th Percentile queue length is low which shows that vehicles are not waiting for the amount of time suggested by the control delay.

Note at Intersection #6 the I-95 off-ramps (SB right and NB right) are coded in Synchro as yield controlled approaches due to the existing signs at the intersection. However, the existing lane geometry for those movements includes a receiving lane for merging traffic. As shown by the SimTraffic queue lengths (0 ft), these movements operate as free-flowing despite the HCM reports showing delay.

As shown in Tables 9-1 through 9-3 under 2039 total future conditions:

- At the signalized intersection of Route 54 and US Route 1, the overall intersection will operate at a LOS C/D during the AM/PM peaks, respectively.
 - The eastbound approach will operate at a LOS D/E during the AM/PM peaks, respectively. The EB left will operate at a LOS D/F during the AM/PM peaks, respectively.
 - The northbound left will operate at a LOS D/E during the AM/PM peaks, respectively. The NB through will operate at a LOS D/E during the AM/PM peaks, respectively. The southbound approach will operate at a LOS D/E during both peak hours. The SB left will operate at a LOS E/F during the AM/PM peaks, respectively.
 - During the PM peak: The EB left maximum queue exceeds the available storage, spilling back into the through lanes and backing up through the intersection with Louisiana St. The SB left maximum queue exceeds the available storage, spilling into the through lanes and backing up through the intersection with College Ave. During both peak hours, the SB thru maximum queue blocks the storage for the SB right.
 - All other movements have adequate turn bay storage to accommodate 95th percentile and maximum queue lengths.

- At the signalized intersection of Route 54 and Cottage Green Drive, the overall intersection will operate at a LOS B/C during the AM/PM peaks, respectively.
 - The mainline through movements will operate at a LOS B or better during both peak hours. The EB left will operate at a LOS C/D during the AM/PM peaks, respectively. The WB left will operate at a LOS E/C during the AM/PM peaks, respectively. The northbound and southbound approaches will operate at a LOS D during both peak hours.
 - During the PM peak, the SB left maximum queue exceeds the available storage, spiling back into the through lane. All other movements have adequate turn bay storage to accommodate 95th percentile and maximum queue lengths.
- At the signalized intersection of Route 54 and Hill Carter Parkway, the overall intersection will operate at a LOS C during both peak hours.
 - The mainline through movements will operate at a LOS C or better during both peak hours. The EB left will operate at a LOS D/C during the AM/PM peaks, respectively. The WB left will operate at a LOS D/E during the AM/PM peaks, respectively. As previously mentioned, the delay for the EB right is not reported correctly at this intersection.
 - The northbound approach will operate at a LOS D during both peak hours. The southbound approach will operate at a LOS D/E during the AM/PM peaks, respectively. The SB left will operate at a LOS E during both peak hours.
 - All movements have adequate turn bay storage to accommodate 95th percentile and maximum queue lengths.
- At the unsignalized intersection of Route 54 and I-95 SB ramp, the overall intersection will operate at a LOS B during both peak hours.
 - The mainline movements all operate at a LOS B or better during both peak hours. The southbound left/through movement operates at a LOS F during both peak hours.
 - During the PM peak hour, the SB left/through movement maximum queue fills the available storage. All other movements have adequate storage to accommodate 95th percentile and maximum queue lengths.
- At the unsignalized intersection of Route 54 and I-95 NB ramp, the mainline east- and westbound approaches operate at a LOS C or better during both peak hours. As previously mentioned, the north- and southbound movements report delay due to the yield-control, however the movements behave more like free-flow right turns. The NB right operates at a LOS C or better during both peak hours. The SB right operates at a LOS F during both peak hours. All maximum queue lengths are contained within the available storage.
- At the unsignalized intersection of Route 54 and Mt. Hermon Road/Frances Road, the mainline east- and west-bound movements will operate at a LOS A during both peak hours.
 - The northbound approach will operate at a LOS F during both peak hours. The southbound approach will operate at a LOS C during both peak hours.
 - All movements have adequate turn bay storage to accommodate 95th percentile and maximum queue lengths.
- At the unsignalized intersection of Route 54 and Site Entrance A, the east- and west-bound mainline movements will operate at a LOS A during both peak hours. The northbound approach will operate at a LOS C during both peak hours. All movements have adequate turn bay storage to accommodate 95th percentile and maximum queue lengths.
- At all other unsignalized intersections (numbers 4, 7, 9-10, 12-13), the mainline movements (free-flowing) all operate at a LOS B or better during both peak hours. All side street movements (stop-controlled) operate at acceptable levels (LOS C or better) during both peak hours. All 95th percentile and maximum queue lengths are contained within the available storage.

**Table 9-1: Intersection Level of Service and Delay Summary
2039 Total Future Traffic (Part 1)**

Intersection and Type of Control	Movement and Approach	Turn Lane Storage (ft)	AM PEAK HOUR				PM PEAK HOUR			
			Delay ¹ (sec/veh)	LOS ¹	HCS 95th Percentile Queue Length (ft)	Simulated Maximum Queue Length (ft)	Delay ¹ (sec/veh)	LOS ¹	HCS 95th Percentile Queue Length (ft)	Simulated Maximum Queue Length (ft)
1. England St (E-W) US Route 1 (N-S) Signalized	EB Left	290	40.2	D	67	206	104.3	F	#229	274
	EB Thru		38.4	D	209	262	43.4	D	265	452
	EB Right	340	30.8	C	20	96	35.1	D	22	122
	EB Approach		36.8	D	-	-	54.1	D	-	-
	WB Left		15.3	B	130	263	30.6	C	#99	487
	WB Thru		33.0	C	#485	578	51.2	D	#647	687
	WB Right		0.5	A	73	0	0.3	A	0	156
	WB Approach		17.8	B	-	-	32.3	C	-	-
	NB Left	350	39.4	D	#168	222	72.8	E	#355	345
	NB Thru		40.0	D	120	163	74.9	E	#335	610
	NB Right	400	0.2	A	0	0	0.3	A	0	39
	NB Approach		28.6	C	-	-	56.1	E	-	-
	SB Left	320	64.1	E	#333	313	82.7	F	#419	320
	SB Thru		43.5	D	197	445	55.9	E	#302	568
	SB Right	140	34.1	C	0	140	40.2	D	0	140
	SB Approach		50.0	D	-	-	63.0	E	-	-
	Overall		32.2	C	-	-	50.8	D	-	-
2. England St (E-W) Cottage Green Dr (N-S) Signalized	EB Left	235	33.3	C	m16	65	52.2	D	m44	130
	EB Thru - Right		7.1	A	m118	171	18.5	B	m317	430
	EB Approach		7.5	A	-	-	19.7	B	-	-
	WB Dual Left	260	55.8	E	m20	78	28.7	C	m55	109
	WB Thru - Right		4.5	A	299	284	5.7	A	224	252
	WB Approach		6.7	A	-	-	7.2	A	-	-
	NB Left		48.7	D	44	88	54.8	D	89	125
	NB Thru		45.7	D	14	49	54.7	D	93	123
	NB Right	170	45.3	D	0	43	51.2	D	0	97
	NB Approach		47.3	D	-	-	53.5	D	-	-
	SB Left	155	44.6	D	114	141	54.2	D	268	154
	SB Thru - Right		40.1	D	42	128	42.0	D	103	340
	SB Approach		43.3	D	-	-	50.7	D	-	-
	Overall		10.2	B	-	-	20.4	C	-	-
3. England St (E-W) Hill Carter Pkwy (N-S) Signalized	EB Left	325	46.1	D	m48	119	26.0	C	m69	133
	EB Thru		16.8	B	240	397	9.9	A	102	387
	EB Right	200	24.3	C	20	200	3.9	A	m6	200
	EB Approach		18.9	B	-	-	9.8	A	-	-
	WB Dual Left	550	40.2	D	114	137	60.7	E	#185	193
	WB Thru - Right		23.3	C	271	242	27.8	C	299	321
	WB Approach		26.4	C	-	-	34.8	C	-	-
	NB Left	220	43.5	D	69	77	57.3	E	169	164
	NB Left - Thru		42.2	D	39	114	49.4	D	87	188
	NB Right	325	42.0	D	0	154	50.5	D	133	270
	NB Approach		42.3	D	-	-	51.6	D	-	-
	SB Left	290	51.1	D	#121	240	62.5	E	129	232
	SB Thru - Right		38.4	D	22	67	48.3	D	28	94
	SB Approach		47.5	D	-	-	57.5	E	-	-
	Overall		26.2	C	-	-	28.8	C	-	-
4. England St (E-W) Carter Rd (N-S) Unsignalized	EB Thru - Right†		0.0	A	-	100	0.0	A	-	80
	EB Approach		0.0	A	-	-	0.0	A	-	-
	WB Thru - Right†		0.0	A	-	19	0.0	A	-	82
	WB Approach		0.0	A	-	-	0.0	A	-	-
	NB Right		12.2	B	12	85	13.7	B	8	80
	NB Approach		12.2	B	-	-	13.7	B	-	-
	SB Right		12.4	B	4	71	12.0	B	1	32
	SB Approach		12.4	B	-	-	12.0	B	-	-

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

† 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.

\$ - Delay exceeds 300s

**Table 9-2: Intersection Level of Service and Delay Summary
2039 Total Future Traffic (Part 2)**

Intersection and Type of Control	Movement and Approach	Turn Lane Storage (ft)	AM PEAK HOUR				PM PEAK HOUR			
			Delay ¹ (sec/veh)	LOS ¹	HCS 95th Percentile Queue Length (ft)	Simulated Maximum Queue Length (ft)	Delay ¹ (sec/veh)	LOS ¹	HCS 95th Percentile Queue Length (ft)	Simulated Maximum Queue Length (ft)
5. Patrick Henry Hwy (E-W) I-95 SB Ramps Unsignalized	EB Thru†		0.0	A	-	49	0.0	B	-	11
	EB Right†		0.0	A	-	-	0.0	B	-	-
	EB Approach		0.0	A	-	-	0.0	B	-	-
	WB Left	435	9.9	A	30	123	10.6	B	30	126
	WB Thru†		0.0	A	-	-	0.0	B	-	3
	WB Approach		2.1	A	-	-	1.9	B	-	-
	SB Left - Thru	150	929.6	F	167	127	688.3	F	119	140
	SB Right		30.4	D	122	296	26.9	D	107	278
	SB Approach		174.3	F	-	-	105.8	F	-	-
6. Patrick Henry Hwy (E-W) I-95 NB Ramps Unsignalized	EB Left	435	10.7	B	22	142	10.8	B	33	154
	EB Thru†		0.0	A	-	-	0.0	A	-	-
	EB Approach		3.7	A	-	-	4.1	A	-	-
	WB Thru†		0.0	A	-	11	0.0	A	-	11
	WB Right†	380	0.0	B	-	0	0.0	B	-	0
	WB Approach		0.0	A	-	-	0.0	A	-	-
	NB Right		14.1	B	44	0	17.1	C	64	0
	NB Approach		14.1	B	-	-	17.1	C	-	-
	SB Right		163.2	F	836	0	143.9	F	758	0
	SB Approach		163.2	F	-	-	143.9	F	-	-
7. Patrick Henry Hwy (E-W) Telcourt Rd (N-S) Unsignalized	EB Left		9.9	A	5	72	9.4	A	4	58
	EB Thru†		0.0	A	-	15	0.0	A	-	-
	EB Approach		0.7	A	-	-	0.5	A	-	-
	WB Thru†		0.0	A	-	2	0.0	A	-	-
	WB Right†	50	0.0	A	-	30	0.0	A	-	27
	WB Approach		0.0	A	-	-	0.0	A	-	-
	SB Left - Right		16.1	C	3	34	11.8	B	5	45
	SB Approach		16.1	C	-	-	11.8	B	-	-
8. Patrick Henry Hwy (E-W) Mt. Hermon Rd/Frances Rd (N-S) Unsignalized	EB Left	150	8.8	A	5	41	8.6	A	2	32
	EB Thru†		0.0	A	-	-	0.0	A	-	-
	EB Right†		0.0	A	-	4	0.0	A	-	2
	EB Approach		0.8	A	-	-	0.3	A	-	-
	WB Left	150	8.6	A	1	25	8.8	A	1	25
	WB Thru†		0.0	A	-	-	0.0	A	-	2
	WB Right†	110	0.0	A	0	2	0.0	A	0	0
	WB Approach		0.3	A	-	-	0.2	A	-	-
	NB Left-Thru-Right		78.8	F	98	85	62.0	F	89	75
	NB Approach		78.8	F	-	-	62.0	F	-	-
	SB Left-Thru-Right		16.2	C	14	57	15.2	C	9	59
	SB Approach		16.2	C	-	-	15.2	C	-	-
9. Patrick Henry Hwy (E-W) Woodside Ln (N-S) Unsignalized	EB Left	300	8.2	A	6	52	8.6	A	15	79
	EB Thru†		0.0	A	-	-	0.0	A	-	-
	EB Approach		1.9	A	-	-	2.9	A	-	-
	WB Thru - Right†		0.0	A	-	4	0.0	A	-	2
	WB Approach		0.0	A	-	-	0.0	A	-	-
	SB Left		14.0	B	25	89	15.5	C	24	72
	SB Right	290	14.0	B	25	91	15.5	C	24	87
	SB Approach		14.0	B	-	-	15.5	C	-	-
10. Patrick Henry Hwy (E-W) Goddins Hill Rd (N-S) Unsignalized	EB Thru†		0.0	A	-	-	0.0	A	-	-
	EB Right†	200	0.0	A	-	9	0.0	A	-	0
	EB Approach		0.0	A	-	-	0.0	A	-	-
	WB Left - Thru		3.0	A	8	78	1.4	A	3	52
	WB Approach		3.0	A	-	-	1.4	A	-	-
	NB Left - Right		14.6	B	14	72	13.6	B	21	63
	NB Approach		14.6	B	-	-	13.6	B	-	-

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

† 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.

\$ - Delay exceeds 300s

**Table 9-3: Intersection Level of Service and Delay Summary
2039 Total Future Traffic (Part 3)**

Intersection and Type of Control	Movement and Approach	Turn Lane Storage (ft)	AM PEAK HOUR				PM PEAK HOUR			
			Delay ¹ (sec/veh)	LOS ¹	HCS 95th Percentile Queue Length (ft)	Simulated Maximum Queue Length (ft)	Delay ¹ (sec/veh)	LOS ¹	HCS 95th Percentile Queue Length (ft)	Simulated Maximum Queue Length (ft)
11. Patrick Henry Hwy (E-W) Site Entrance A (N-S) Unsignalized	EB Thru†		0.0	A	-	-	0.0	A	-	-
	EB Right†	150	0.0	A	-	0	0.0	A	-	0
	<i>EB Approach</i>		<i>0.0</i>	<i>A</i>	-	-	<i>0.0</i>	<i>A</i>	-	-
	WB Left	150	8.3	A	1	24	8.7	A	0	18
	WB Thru†		0.0	A	-	-	0.0	A	-	-
	<i>WB Approach</i>		<i>0.1</i>	<i>A</i>	-	-	<i>0.0</i>	<i>A</i>	-	-
	NB Left - Right		20.0	C	28	71	24.4	C	19	54
	<i>NB Approach</i>		<i>20.0</i>	<i>C</i>	-	-	<i>24.4</i>	<i>C</i>	-	-
12. Patrick Henry Hwy (E-W) Site Entrance B (N-S) Unsignalized	EB Thru - Right†		0.0	A	-	-	0.0	A	-	-
	<i>EB Approach</i>		<i>0.0</i>	<i>A</i>	-	-	<i>0.0</i>	<i>A</i>	-	-
	WB Left - Thru		0.3	A	1	35	0.1	A	0	24
	<i>WB Approach</i>		<i>0.3</i>	<i>A</i>	-	-	<i>0.1</i>	<i>A</i>	-	-
	NB Left - Right		10.3	B	1	30	10.8	B	0	27
	<i>NB Approach</i>		<i>10.3</i>	<i>B</i>	-	-	<i>10.8</i>	<i>B</i>	-	-
13. Site Entrance C (E-W) Mt. Hermon Rd (N-S) Unsignalized	WB Left - Right		8.7	A	3	46	8.7	A	2	35
	<i>WB Approach</i>		<i>8.7</i>	<i>A</i>	-	-	<i>8.7</i>	<i>A</i>	-	-
	NB Thru - Right†		0.0	A	-	-	0.0	A	-	-
	<i>NB Approach</i>		<i>0.0</i>	<i>A</i>	-	-	<i>0.0</i>	<i>A</i>	-	-
	SB Left - Thru		3.8	A	3	20	1.3	A	0	12
	<i>SB Approach</i>		<i>3.8</i>	<i>A</i>	-	-	<i>1.3</i>	<i>A</i>	-	-

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

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

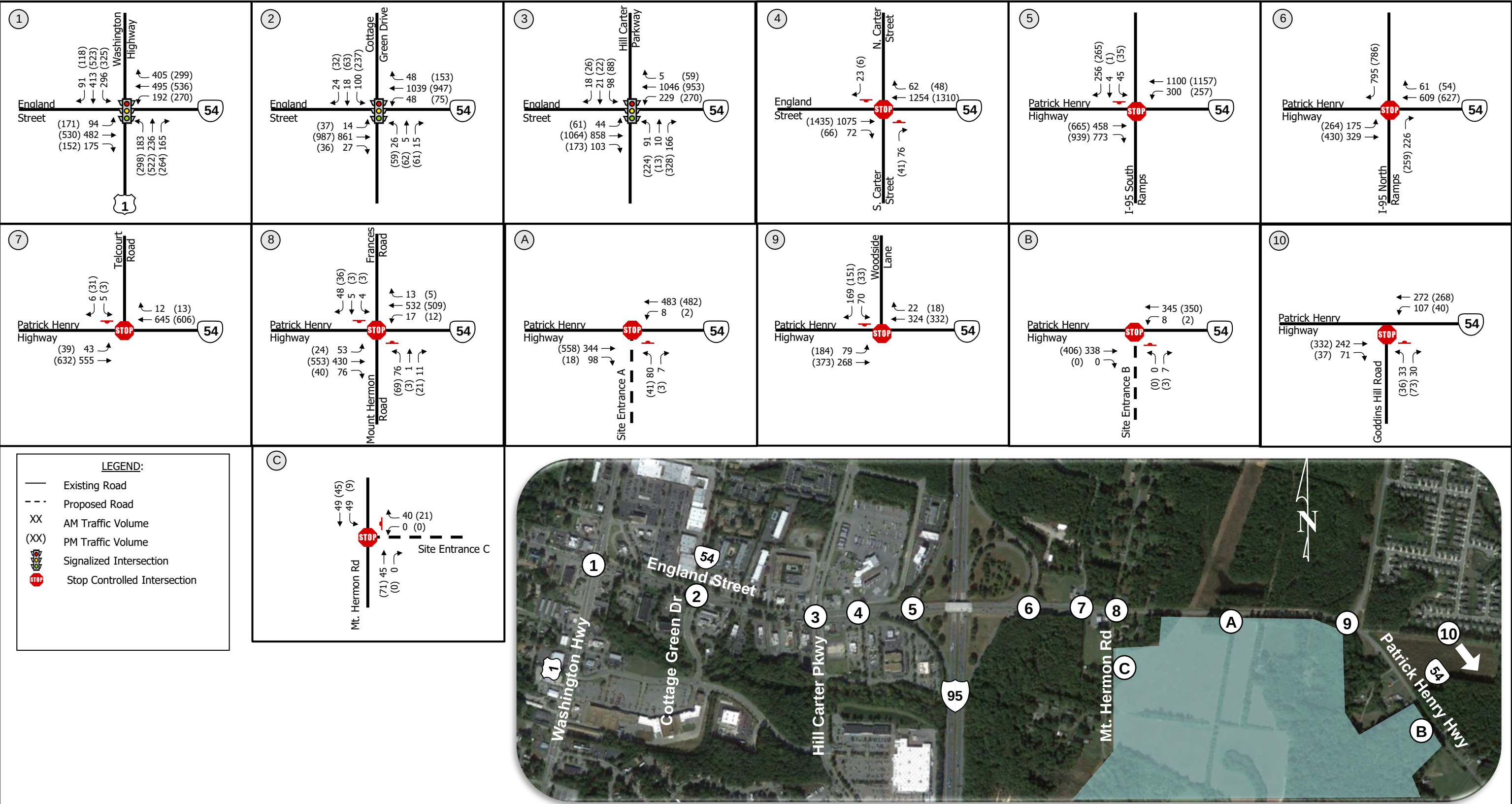
- 95th percentile volume exceeds capacity, queue may be longer. Queue shown is maximum after two cycles.

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

\$ - Delay exceeds 300s

PAGE INTENTIONALLY BLANK

PAGE INTENTIONALLY BLANK



PAGE INTENTIONALLY BLANK

10 ADDITIONAL ANALYSIS

The goal of the following chapter is to provide an analysis of potential improvements within the study area that may impact the analysis or recommendations for the Iron Horse Data Center Development.

10.1 TURN LANE WARRANT ANALYSIS

The study area includes multiple unsignalized intersections that currently do not have turn lanes. To gauge the impacts of the proposed site trips on the existing roadway network, turn lane warrant analyses were completed for the following movements with the 2033 and 2039 total traffic volumes:

1. EB Right on Route 54 at Site Entrance "A";
2. WB Left on Route 54 at Site Entrance "A";
3. EB Right on Route 54 at Site Entrance "B";
4. WB Left on Route 54 at Site Entrance "B";
5. SB Left on Mt. Hermon Road at Site Entrance "C"; and
6. and NB Right on Mt. Hermon Road at Site Entrance "C".

The appropriate right and left turn lane warrant nomographs from Appendix F of the VDOT *Road Design Manual* were used to complete the turn lane warrant analyses for each of the listed movements.

The turn lane warrant analysis indicates that turn lanes are warranted for the following movements under 2033 total conditions:

1. EB Right on Route 54 at Site Entrance "A" (100' storage with 100' taper); and
2. WB Left on Route 54 at Site Entrance "A" (100' storage with 100' taper).

Given the posted 45 MPH speed limit and urban classification on Route 54 west of Woodside Lane, the minimum turn lane sizing for turn lanes at Mt. Hermon Road and Site Entrance "A" is 100 feet storage with 100 feet taper.

The remaining movements analyzed at Site Entrances "B" and "C" do not meet the warrants for installation of a turn lane under 2033 and 2039 total conditions (with build out of the proposed development).

Copies of the turn lane nomographs are included in Appendix M.

PAGE INTENTIONALLY BLANK

11 CONCLUSIONS

Analyses were performed for the 2022 existing volumes, the 2033/2039 background volumes (including all background developments and growth), and the 2033/2039 total volumes, which includes site traffic generated by the Iron Horse Data Center development.

11.1 PRINCIPAL FINDINGS

The 2022 existing conditions analysis indicates that the Route 54 corridor operates well during both peak hours. No major queueing or delay challenges are noted at the study intersections, with the exception of the southbound approach experiencing long delays at Route 54/I-95 SB on/off ramp intersection.

Under 2033, and 2039 Background analyses, the Route 54 corridor is able to handle increases in traffic volumes without degrading operations until year 2039. By 2039, many movements at Route 54/ US Route 1 are over capacity and excessive queues impact operations of the overall intersection.

The Iron Horse Data Center development (2033) will be accommodated through constructing VDOT-approved standard turn lanes at the intersection of Site Entrance A and Route 54.

At Site Entrances B and C, no right or left turn lanes are warranted.

With the site improvements described above and under 2033 and 2039 Total conditions, there are no significant capacity or queueing issues noted at the study intersections beyond those background issues previously noted. Retiming traffic signals along Route 54 will provide added capacity to the corridor.

11.2 RECOMMENDATIONS

The focus of this report is to identify a comprehensive access plan that provides functional access to the site and preserves the capacity of the surrounding roadway network. This report identifies the proposed phasing of the development and the roadway improvements associated with each phase. To accommodate the anticipated traffic associated with the Iron Horse Data Center development, the recommended improvement plan is as follows:

- Route 54 at Site Entrance A
 - Construct one (1) eastbound left turn lane and one (1) westbound left turn lane.

Given the preliminary nature of the development plan, the exact location of the site entrances along Route 54 (or other internal site roadways) will be defined during the site plan stage. All construction of roadway improvements is subject to Town, County, and VDOT approval, including assistance on obtaining any required right-of-way not owned by the Applicant. Additional entrances to individual parcels within the development, or other modifications to access along Route 54 that may be developed as part of the site plan review process, are not explicitly discussed within this report. If the development pattern changes and additional traffic is shifted to different entrances, the turn lane warrant analysis will need to be performed for the prevailing layout and traffic volumes at that time of construction.

During the site plan review process, the Applicant will submit a Construction Traffic Management Plan (CTMP) for review and approval by VDOT, Hanover County, and the Town of Ashland to mitigate any traffic impacts caused by construction. The number and location of construction entrances, as well as construction traffic access routes will be presented in the CTMP.

PAGE INTENTIONALLY BLANK