ROUTE 50 STARS SAFETY AND OPERATIONAL IMPROVEMENTS STUDY – ARLINGTON COUNTY

Final Traffic Report

August 4, 2020

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Prepared for:

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1. INTRODUCTION

1.1 BACKGROUND

The Virginia Department of Transportation (VDOT) has initiated this Strategically Targeted Affordable Roadway Solutions (STARS) study to evaluate operational and safety conditions along Arlington Boulevard (US Route 50) from Route 120 (Glebe Road) to Route 6622 (Fillmore Street) and identify improvements to address the identified safety and operational deficiencies that can be incorporated into VDOT's Six-Year Improvement Plan (SYIP). This study identifies and evaluates alternatives and technical solutions to mitigate the safety issues and to improve traffic operations and alleviate congestion.

Route 50 between Glebe Road and Fillmore Street was identified as part of the STARS Program in response to both safety and operational deficiencies including a lack of access management along the study corridor. This six-lane section of Route 50 with three lanes per direction from east of the Glebe Road interchange to Fillmore Street is undivided and does not have turn lanes at the majority of the signalized and stop-controlled intersections creating a high potential for rear end and angle crashes due to a lack of turn lanes and access control. The five-year historical crash rate within the study area is approximately 20 percent higher than the Statewide Urban Principal Arterial crash rate and approximately twice the Northern Virginia Primary Roads crash rate, indicating significant safety deficiencies within the study area along Route 50. The average daily traffic volume (ADT) along Route 50 within the study area is 64,800 in 2019 and is the highest daily traffic volume compared to other six lane sections of Route 50 between Route 7 and the Washington, D.C. line; however, this section of Route 50 does not contain a raised median or other access management features that are typical for a six-lane roadway facility.

The Framework Document (see **Appendix A**) outlines the scope of work of the traffic study including the study area, traffic forecasting and analysis methodology, study assumptions, and general types of improvement alternatives to be considered. The Framework Document was signed and approved by VDOT NOVA District, VDOT Transportation Mobility and Planning Division (TMPD), and Arlington County in September 2019.

1.2 STUDY AREA / PROJECT LOCATION

As shown in **Figure 1-1**, the study area consists of approximately 0.6 miles of Route 50 between Glebe Road to the west and Fillmore Street to the east and includes the two signalized Route 50 ramp intersections along Glebe Road. The land uses surrounding Route 50 are primarily residential and institutional. Thomas Jefferson Middle School and Alice West Fleet Elementary School are located in the southwest corner of the study area and the Columbia Gardens Cemetery is located in the northwest corner of the study area. Several places of worship are located within the study area along North Jackson Street, North Irving Street, North Highland Street, and South Fenwick Street. Long Branch Elementary School is located in the northeast corner of the study area, along the east side of Fillmore Street. The Route 27 (Washington Boulevard) interchange is located just east of the study area.

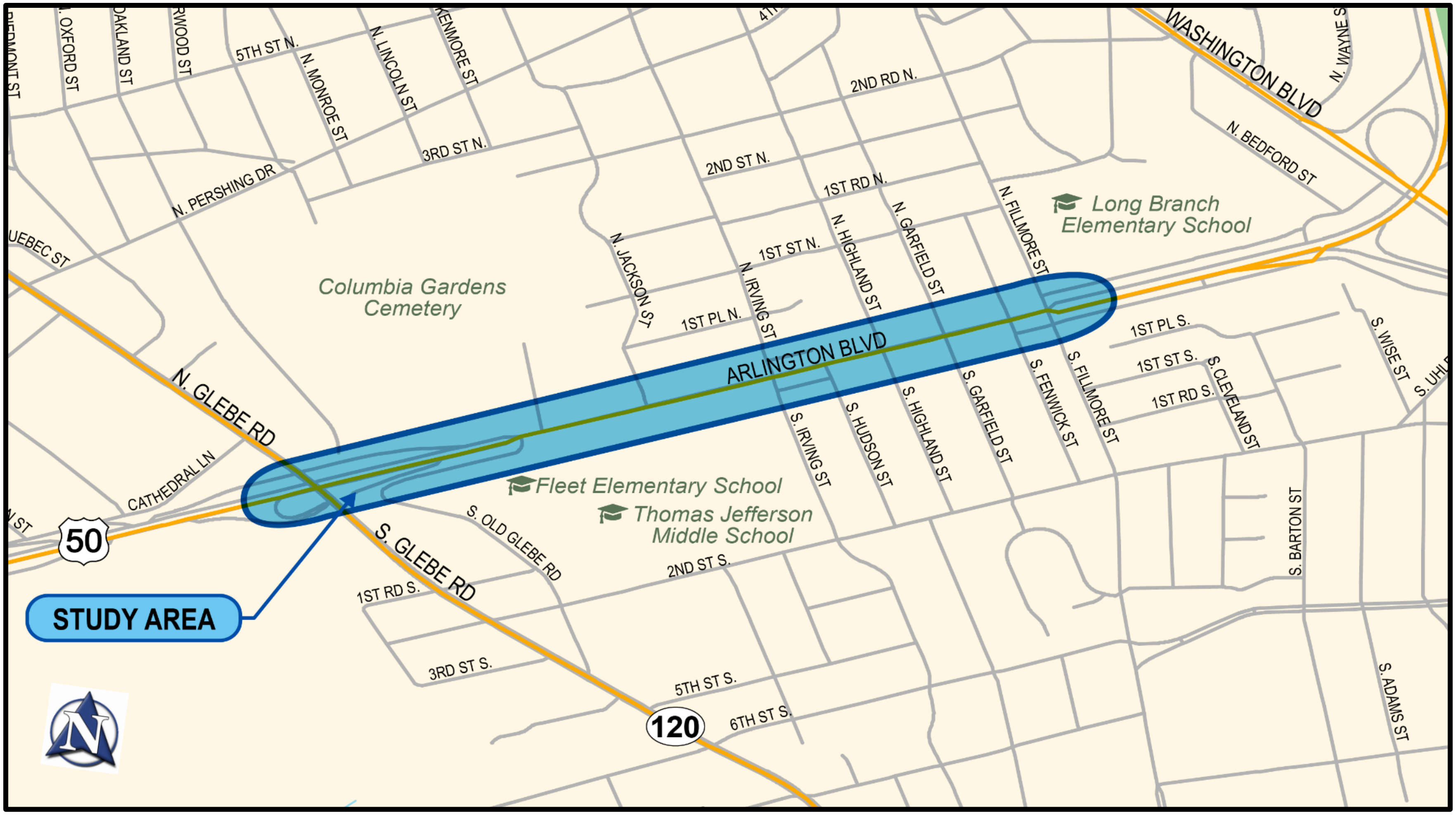
The following intersections are included within the study area:

1. N Glebe Road and Route 50 Westbound ramp (Signalized)
2. N Glebe Road and Route 50 Eastbound ramp (Signalized)
3. Route 50 at Old Glebe Road (Unsignalized)
4. Route 50 and N Jackson Street (Unsignalized)
5. Route 50 and Irving Street (Signalized)
6. Route 50 and Hudson Street (Unsignalized)
7. Route 50 and Highland Street (Unsignalized)
8. Route 50 and Garfield Street (Unsignalized)
9. Route 50 and Fenwick Street (Unsignalized)
10. Route 50 and Fillmore Street (Signalized)
11. N Fillmore Street and Route 50 Frontage Road (Unsignalized)
12. N Fillmore Street and Route 50 Frontage Road (Unsignalized)

The following ramp junctions along Route 50 are included as part of this study:

1. Route 50 Eastbound On-Ramp from Glebe Road
2. Route 50 Westbound Off-Ramp to Glebe Road

Figure 1-1: Study Area



2. EXISTING CONDITIONS

2.1 EXISTING ROADWAY NETWORK

Route 50 is classified as an Other Principal Arterial and runs east-west with a 45 mile per hour speed limit. Within the study area, Route 50 has three lanes in each direction with no median along most of the corridor and no turn lanes at most intersections. There is a concrete median barrier west of Old Glebe Road and a grass median east of Fillmore Street. On-street parking is permitted along the south side of Route 50 between Garfield Street and Fenwick Street. Portions of frontage roads run parallel to Route 50 on the north and south sides that provide access to residential properties. South of Route 50, there are frontage road sections between Irving Street and Hudson Street, between Fenwick Street and Fillmore Street, and east of Fillmore Street. North of Route 50, there are frontage road sections in the vicinity of Irving Street and east of Fillmore Street.

Figures 2-1a and 2-1b depict the existing corridor characteristics within the study area including locations of traffic signals, stop-controlled intersections, driveways, on-street parking, and Washington Metropolitan Area Transit Authority (WMATA) bus stops. There are two traffic signals within the study area at Irving Street and Fillmore Street. There are six stop-controlled intersections in the study area located at South Old Glebe Road, Jackson Street, Hudson Street, Highland Street, Garfield Street, and Fenwick Street. In addition to the two signalized intersections and six stop-controlled intersections, there are four driveways on the north side of Route 50 and six driveways on the south side of Route 50. There is an interchange at Glebe Road at the west end of the study area and an interchange at Washington Boulevard east of the study area.

Figure 2-1a: Existing Corridor Features

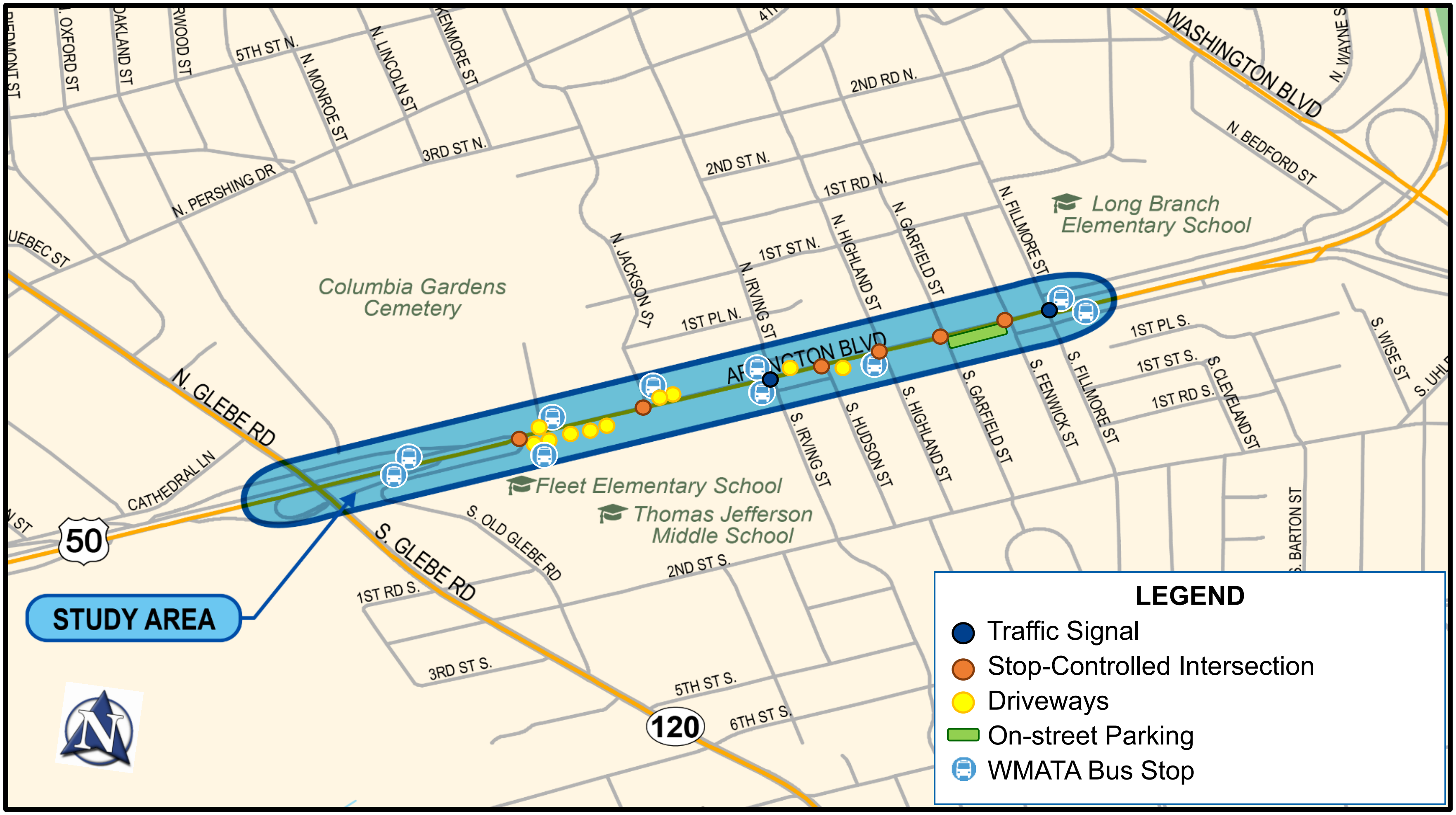
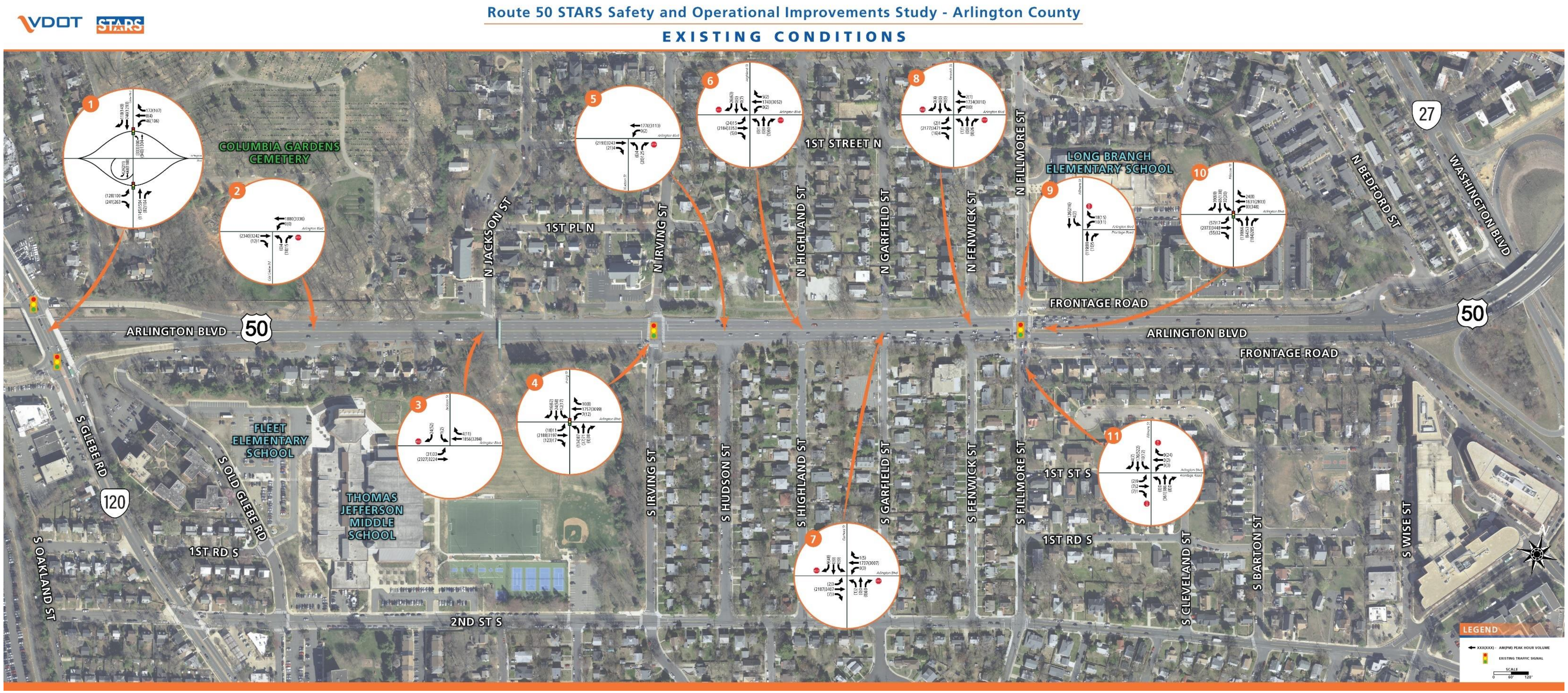


Figure 2-1b: Existing Corridor



The following is a summary of each of the study intersections along Route 50:

2.1.1 Route 50 at Old Glebe Road (Unsignalized)

This unsignalized three-legged intersection is located approximately 0.17 miles east of the Glebe Road overpass. Eastbound and westbound Route 50 each have three through lanes that also serve westbound left turns and eastbound right turns onto Old Glebe Road. Northbound Old Glebe Road has one shared left-turn/right-turn lane and operates under stop control. The Arlington Boulevard Trail is along the south side of Route 50 and intersects with Old Glebe Road. A concrete median barrier separating both direction of Route 50 begins just west of Old Glebe Road, potentially making it difficult for vehicles to turn left from Old Glebe Road onto westbound Route 50. Five residential driveways are located along the south side of Route 50 just east of Old Glebe Road.

2.1.2 Route 50 at Jackson Street (Unsignalized)

This unsignalized three-legged intersection is located approximately 0.29 miles east of the Glebe Road overpass and 0.11 miles west of the Irving Street intersection. Eastbound and westbound Route 50 each have three through lanes that also serve eastbound left turns and westbound right turns onto Jackson Street. Southbound Jackson Street has one shared left-turn/right-turn lane and operates under stop control. A crosswalk is provided on the north leg of the intersection. The pedestrian bridge over Route 50 is located immediately to the east of Jackson Street.

2.1.3 Route 50 at Irving Street (Signalized)

This signalized four-legged intersection is located approximately 0.40 miles east of the Glebe Road overpass. Eastbound Route 50 has three through lanes and a right-turn lane with left turns accommodated from the innermost through lane. Westbound Route 50 has three through lanes with left turns and right turns accommodated from the through lanes. Eastbound and westbound Route 50 operate with permissive left-turn phasing. Northbound and southbound Irving Street have a shared left-turn/through/right-turn lane and operate with concurrent phasing. Pedestrian crossings including pedestrian signals and push-buttons are located on all four legs of the intersection. There are frontage roads north of Route 50 on both sides of Irving Street and south of Route 50 east of Irving Street. The frontage road intersections approaching Irving Street are stop-controlled and Irving Street has the right-of-way. However, due to the close proximity of the frontage road intersection to Route 50 (less than 50 feet), Irving Street vehicles oftentimes will not block the intersection and will allow a frontage road vehicle to enter the intersection. A sidewalk and signal upgrade project was completed in fall 2018 at the intersection of Route 50 and Irving Street to improve access and safety for pedestrians, transit users, bicyclists and vehicles (UPC 96751). The project was funded using HSIP funds.

2.1.4 Route 50 at Hudson Street (Unsignalized)

This unsignalized three-legged intersection is located approximately 0.04 miles east of the Irving Street intersection. Eastbound and westbound Route 50 each have three through lanes that also serve westbound left turns and eastbound right turns onto Hudson Street. Northbound Hudson Street has one shared left-turn/right-turn lane and operates under stop control. A crosswalk is provided on the south leg of the intersection. A frontage road is provided on the south side of Route 50 and west of Hudson Street. The unsignalized frontage road intersection on Hudson Street is located at the stop bar on Hudson Street at Route 50.

2.1.5 Route 50 at Highland Street (Unsignalized)

This unsignalized four-legged intersection is located approximately 0.10 miles east of the Irving Street intersection. Eastbound Route 50 has three through lanes and a right-turn lane and westbound Route 50 has three through lanes. Eastbound and westbound left turns and westbound right turns are accommodated from the through lanes. Northbound and southbound Highland Street each have one shared left-turn/through/right-turn lane and operate under stop control. There are pedestrian crossings on the north and south legs.

2.1.6 Route 50 at Garfield Street (Unsignalized)

This unsignalized four-legged intersection is located approximately 0.15 miles east of the Irving Street intersection and 0.09 miles west of the Fillmore Street intersection. Eastbound and westbound Route 50 have three through lanes with left turns and right turns accommodated from the through lanes. Northbound and southbound Garfield Street each have one shared left-turn/through/right-turn lane and operate under stop control. There are pedestrian crosswalks on the north and south legs.

2.1.7 Route 50 at Fenwick Street (Unsignalized)

This unsignalized four-legged intersection is located approximately 0.21 miles east of the Irving Street intersection and 175 feet west of the Fillmore Street intersection. Eastbound and westbound Route 50 have three through lanes with left turns and right turns accommodated from the through lanes. Northbound and southbound Fenwick Street each have one shared left-turn/through/right-turn lane and operate under stop control. There are pedestrian crosswalks on the north and south legs. There is a frontage road on the south side of Route 50 and east of Fenwick Street. The unsignalized frontage road intersection on Fenwick Street is located at the stop bar on Fenwick Street at Route 50. The eastbound left-turn lane approaching the Fillmore Street intersection extends into the Fenwick Street intersection.

2.1.8 Route 50 at Fillmore Street (Signalized)

This signalized four-legged intersection is located approximately 0.24 miles east of the Irving Street intersection and 0.33 miles west of the Washington Boulevard overpass. Eastbound and westbound Route 50 have a left-turn lane, two through lanes, and a shared through/right-turn lane. Eastbound and westbound Route 50 operate with protected left-turn phasing. Northbound and southbound Irving Street each have a shared left-turn/through lane and a right-turn lane and operate with concurrent phasing. Overlap phases are provided are provided for the northbound and southbound right-turn movements. Pedestrian crossings with pedestrian signals and push-buttons are located on all four legs of the intersection. There are frontage roads on the north side of Route 50 east of Fillmore Street and on the south side of Route 50 east and west of Fillmore Street. Occasionally, Route 50 vehicles use the frontage roads in the vicinity of the intersection to bypass the traffic signal at Fillmore Street. The frontage road intersections approaching Fillmore Street are stop-controlled and Fillmore Street has the right-of-way. South of Route 50, the northbound Fillmore Street stop bar is located south of the frontage road intersection. However, based on field observations, vehicles from the frontage roads or Fillmore Street will queue at the crosswalk at Route 50 rather than at the stop bar south of the frontage road. North of Route 50, the southbound Fillmore Street stop bar is located south of the frontage road intersection although there is an additional stop bar north of the frontage road as well with a sign informing motorists not to block the intersection. There is also signage prohibiting motorists from turning left from the frontage road onto southbound Fillmore Street north of Route 50 during PM peak weekday hours.

During field observations, the westbound left-turn lane onto Fillmore Street did not have adequate storage during the PM peak hour. The westbound left-turn queue length extends out of the turn lane and into the through lane, obstructing westbound Route 50 through traffic. Of the 40 total crashes which occurred at the Fillmore Street and Route 50 intersection between January 2014 through December 2018, 29 crashes (73 percent) were either angle or rear end crashes. The high frequency of rear end crashes can be partially attributed to long queues and delays approaching the intersection during peak periods. The westbound Route 50 left-turn lane queues spilling into the through lanes during the PM peak hour create the potential for rear end crashes.

In 2018, Arlington County completed an upgrade to the traffic signal at Route 50 and Fillmore Street including improvements to pavement markings, pedestrian curb ramps, and crossings in order to improve access and safety for pedestrians, transit users, bicyclists and vehicles.

2.2 MULTIMODAL ACCOMMODATIONS

Although the Route 50 corridor is a heavily traveled commuter route with a high percentage of passenger car usage, there are substantial pedestrian and bicycle accommodations as well as bus transit facilities along Route 50 within the study corridor.

The Arlington Boulevard Trail consists of an eight-foot to ten-foot wide asphalt shared use trail along the north and south sides of Route 50 extending the entire limits of the study area. The South Irving Street/ Arlington Boulevard Phase II Arlington Boulevard Trail Improvement Project involved improvements to the trail along the south side of Route 50 from west of Irving Street to Fillmore Street and was recently completed in 2019. The improvements included the construction of new portions of the Arlington Boulevard Trail adjacent to the frontage roads where the trail was previously located along frontage roads.

Along the north side of Route 50, the Arlington Boulevard Trail is located on the frontage road east of Irving Street as well as the frontage road east of Fillmore Street. Other than those two locations, the Arlington Boulevard Trail is a separated asphalt trail without vehicular access. At the signalized intersections of Route 50 at Irving Street and Route 50 at Fillmore Street, there are crosswalks with pedestrian signals and push-buttons on all four legs of the intersections. In addition to crossing Route 50 at Irving Street or Fillmore Street, pedestrians and bicyclists also have the opportunity to cross over Route 50 on the pedestrian bridge located east of Jackson Street.

As shown in **Figure 2-1a**, there are five bus stops on Route 50 per direction served by WMATA Route 4A. Typically, there are approximately 30 transit buses per day serving the corridor. Bus stops are located at the following locations:

- Eastbound Route 50, west of the on-ramp from northbound Glebe Road
- Eastbound Route 50, East of Old Glebe Road
- Eastbound Route 50, southwest corner of the Irving Street intersection
- Eastbound Route 50, southwest corner of the Highland Street intersection
- Eastbound Route 50, east of Fillmore Street
- Westbound Route 50, west of the off-ramp to Glebe Road
- Westbound Route 50, east of the Columbia Gardens Cemetery entrance
- Westbound Route 50, east of Jackson Street
- Westbound Route 50, northwest corner of the Irving Street intersection
- Westbound Route 50, northeast corner of the Fillmore Street intersection

2.3 TRAFFIC DATA COLLECTION

Traffic Volumes: Classified six-hour (6:30 AM to 9:30 AM and 3:30 PM to 6:30 PM) turning movement counts were collected by Peggy Malone & Associates (PMA) on Wednesday, May 29, 2019 at the signalized Route 50 ramp intersections on Glebe Road, Route 50 and Irving Street and Fillmore Street, and unsignalized intersections of Route 50 and Old Glebe Road, Jackson Street, Hudson Street, Highland Street, Garfield Street, Fenwick Street, and the Route 50 north and south frontage roads at Fillmore Street. Forty-eight hour classified counts were collected by PMA on Route 50 between Old Glebe Road and Jackson Street and between Highland Street and Garfield Street on May 29 - 30, 2019. **Appendix B** contains the raw traffic count data.

Queues: Weekday intersection queue lengths at the signalized and unsignalized study intersections were collected on Wednesdays or Thursdays in May 2019 or June 2019. Queue lengths were collected for at least five consecutive cycle lengths at signalized intersections and during a 15-minute period on stop-controlled approaches to unsignalized intersections during the AM and PM peak hours. Maximum queue lengths were then calculated based on the number of vehicles observed during the queuing observations.

During field observations, the maximum observed queue lengths on northbound Fillmore Street were approximately 1,175 feet (10 vehicles past the 2nd Street intersection) during the AM peak hour and approximately 700 feet during the PM peak hour. The northbound queues do not clear during each signal cycle. Southbound Fillmore Street maximum queue lengths approaching Route 50 were shorter than northbound queues. The southbound Fillmore Street maximum queue lengths were 300 feet during the AM peak hour and 150 feet during the PM peak hour. During field observations, the maximum queue lengths on northbound Irving Street were 400 feet during the AM peak hour and 350 feet during the PM peak hour. Southbound Irving Street maximum queue lengths were 100 feet during the AM peak hour and 150 feet during the PM peak hour. Typically, northbound and southbound Irving Street queue lengths clear during a single phase.

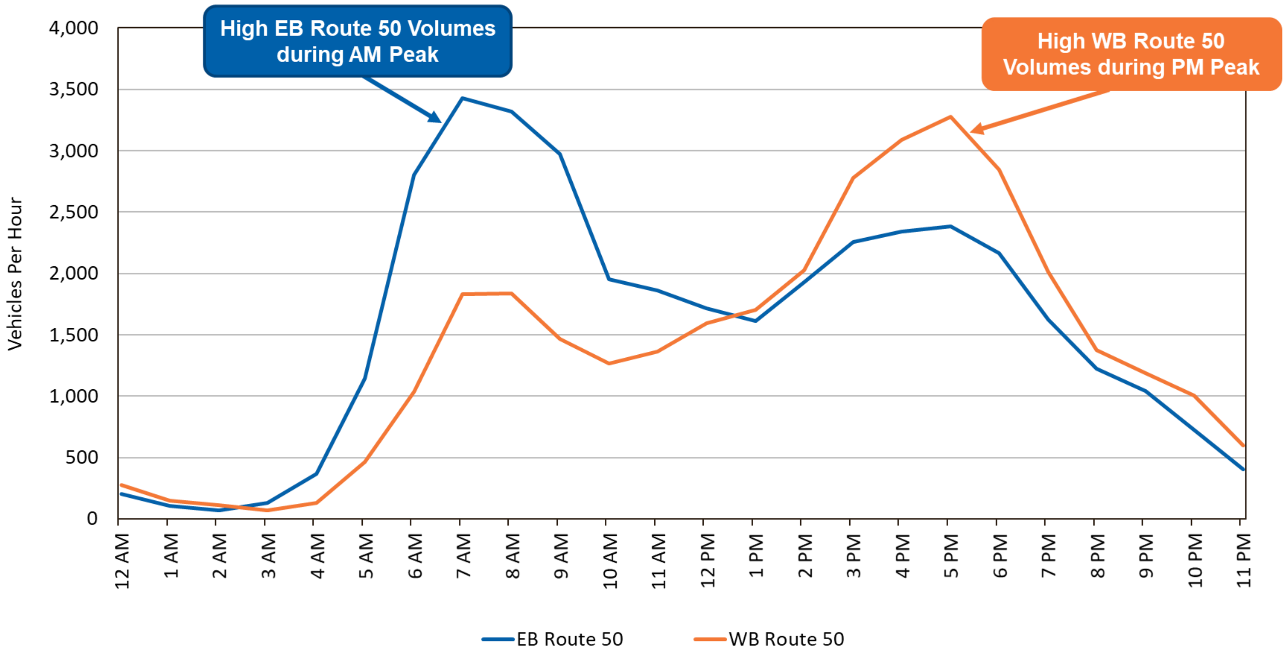
During field observations, eastbound Route 50 maximum queue lengths at Fillmore Street extended beyond Irving Street during both peak hours to approximately Pershing Drive (XX miles west of Glebe Road) during the AM peak hour and approximately 530 feet west of the Irving Street intersection during the PM peak hour. Westbound Route 50 maximum queue lengths were approximately 125 feet at Irving Street and approximately 750 feet at Fillmore Street during the AM peak hour. During the PM peak hour, westbound Route 50 experienced a rolling queue from Irving Street which sometimes extended to Fillmore Street and a maximum queue from Fillmore Street to approximately the Washington Boulevard off-ramp.

Travel Times: Travel time runs were performed along eastbound and westbound Route 50 from Glebe Road to west of the Washington Boulevard interchange during both the AM and PM peak hours. Travel time runs were completed in May 2019 and were performed on a Wednesday when school was in session using the floating car method where the drivers traveled with the average speed of traffic. GPS devices were used to record vehicle speeds. The speeds and travel times were segmented at each unsignalized and signalized intersection along the Route 50 corridor as well as the Glebe Road overpass and the Route 50 frontage road entrance located just west of the Washington Boulevard interchange. At least ten travel runs per direction were conducted during each peak period. Detailed values are summarized in the VISSIM Model Calibration and Validation Summary in **Section 5.1.5.**

2.4 EXISTING TRAFFIC VOLUMES

Figure 2-2 depicts hourly traffic volumes on eastbound and westbound Route 50 east of Glebe Road. As shown, eastbound Route 50 experiences higher traffic volumes during the AM peak hours when motorists are traveling eastbound toward Washington, D.C. while westbound Route 50 experiences higher traffic volumes during the PM peak hours when motorists are traveling toward more residential areas. Peak traffic volumes based on data collected east of Glebe Road along eastbound Route 50 during the AM peak hour are approximately 3,400 vehicles per hour (VPH) and approximately 3,300 VPH along westbound Route 50 during the PM peak hour.

Figure 2-2: Route 50 Hourly Traffic Volumes – East of Glebe Road



Annual Average Daily Traffic (AADT) values for 2019 along six-lane segments of Route 50 from Route 7 in Fairfax County to the Washington, D.C. line are shown in **Table 2-1**. Route 50 between Glebe Road and Washington Boulevard has the highest AADT with 64,800 vehicles while adjacent segments range from 50,400 to 60,300 vehicle per day west of the study area to Route 7 and 59,900 vehicles to the east of the study area to the Washington, D.C. line.

Table 2-1: Route 50 Daily Traffic Volumes

Route 50 Segment	2019 AADT
Route 7 to Arlington County Line	50,400
Fairfax County Line to Glebe Road	60,300
Glebe Road to Washington Boulevard **(STARS Study Area)**	64,800
Washington Boulevard to Washington, D.C. Line	59,900

RITIS travel time data in combination with traffic volume data along Route 50 was used to establish morning and evening peak periods and hours corresponding to the most congested conditions along Route 50 with the highest traffic volumes. Based on a review of hourly traffic volume data along eastbound and westbound Route 50, the AM peak hour was evaluated from 8:00 AM to 9:00 AM and the PM peak hour was evaluated from 5:00 PM to 6:00 PM. The identified peak hours for the traffic analysis correspond to the one-hour AM and PM peak hours with the highest traffic volumes and longest travel times.

Existing traffic volumes were balanced along Route 50 from the Glebe Road interchange to Fillmore Street. Traffic volumes on Glebe Road between the Route 50 ramp intersections as well as Fillmore Street between Route 50 and the frontage roads were also balanced. **Figures 2-3a and 2-3b** summarize the existing (2019) AM peak hour and PM peak hour traffic volumes within the study area, respectively. **Figures 2-3c and 2-3d** summarize the existing (2019) AM peak hour and PM peak hour pedestrian and bicyclist volumes within the study area, respectively. During both the AM and PM peak hours, the highest number of pedestrians and bicyclists crossing Route 50 occurs on the east leg of the Fillmore Street intersection.

Based on field-collected data along Route 50 at Highland Street on May 29, 2019, all three travel lanes are being utilized in each direction during the peak hours. **Table 2-2** shows the lane utilization percentages in each peak direction. During the AM peak hour, the leftmost travel lane of Route 50 in the eastbound direction (peak direction) carries 32% of the traffic among all three eastbound travel lanes. During the PM peak hour, the leftmost travel lane in the westbound direction (peak direction) carries 27% of the traffic among all three westbound travel lanes. The traffic utilization is slightly lower in the leftmost travel lanes during the peak hours due to vehicles avoiding downstream vehicles who are stopped in the leftmost through lanes to try to make left-turn movements onto Irving Street or side streets; however, traffic volumes are relatively evenly distributed between all three travel lanes indicating that the leftmost travel lane is not solely used as a de facto left-turn lane for intersections along the Route 50 corridor without left-turn lanes.

Table 2-2: Route 50 Lane Utilization

Peak Hour	Travel Direction	Traffic Volume (Percentage)			
		Left	Middle	Right	Total
AM Peak	Eastbound	1,118 (32%)	1,180 (34%)	1,167 (34%)	3,495 (100%)
PM Peak	Westbound	814 (27%)	1,184 (39%)	1,024 (34%)	3,022 (100%)

Figure 2-3a: Peak Hour Volumes – Existing AM Peak Hour

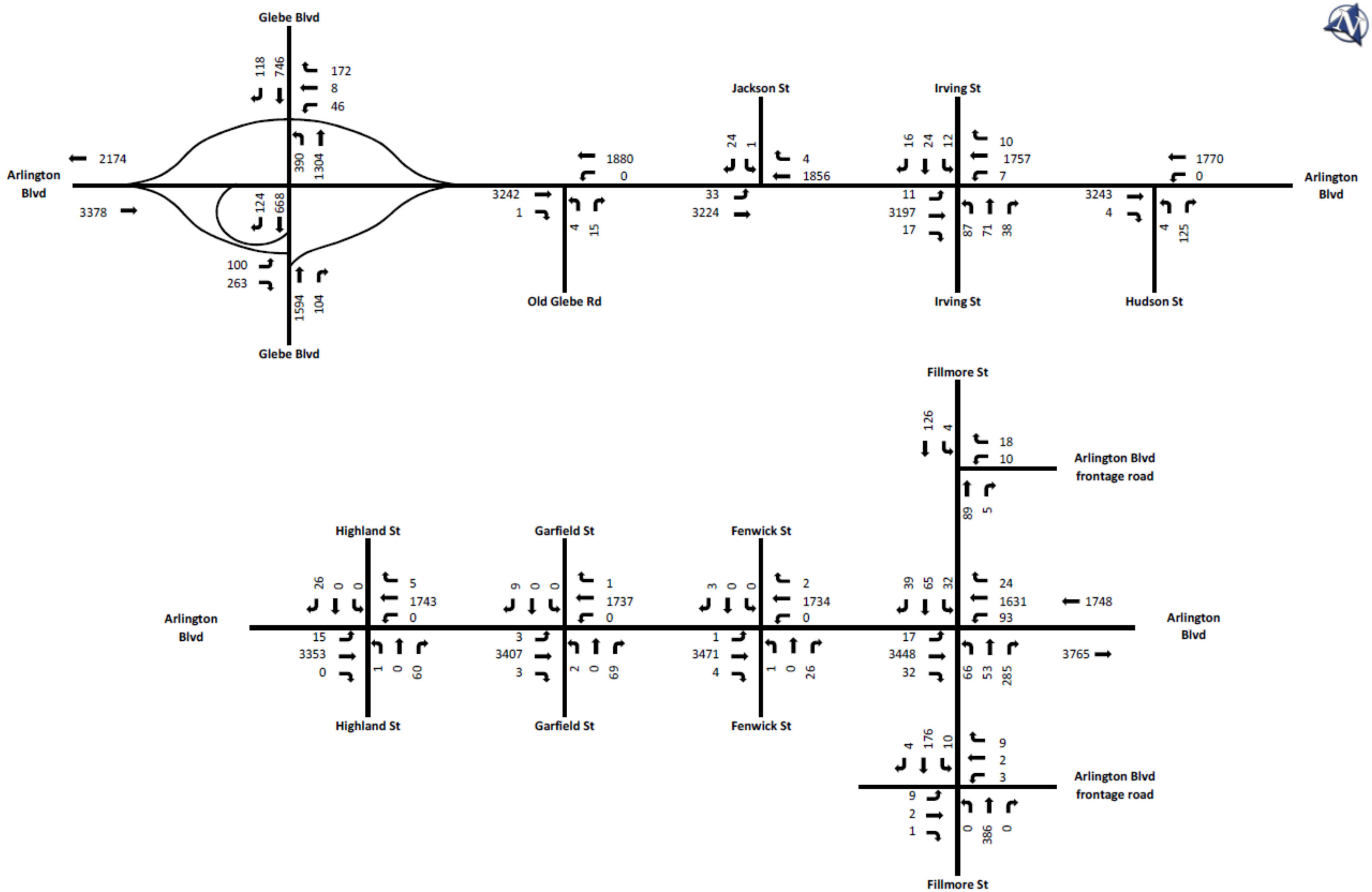


Figure 2-3b: Peak Hour Volumes – Existing PM Peak Hour

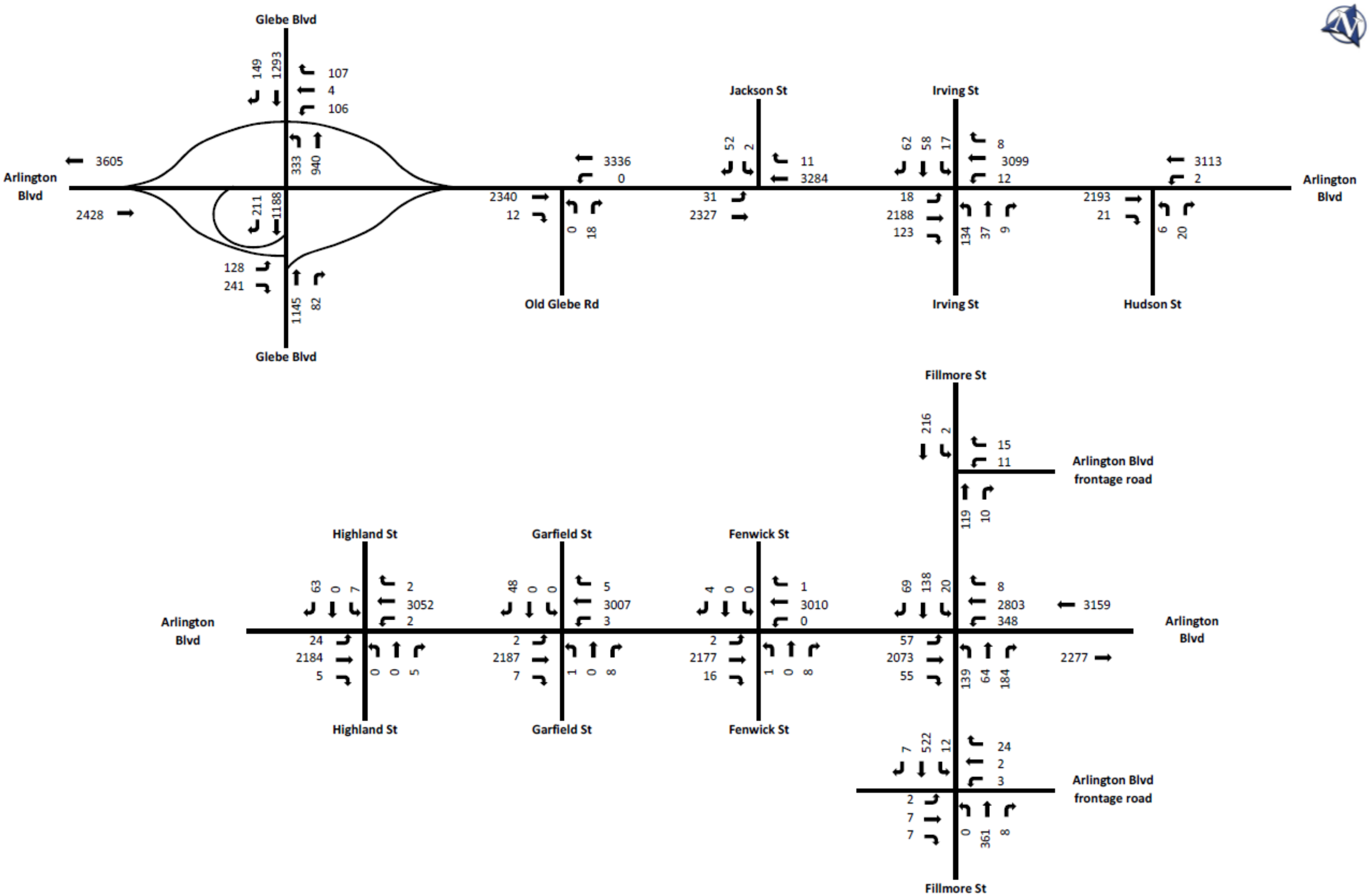


Figure 2-3c: Peak Hour Pedestrian and Bicyclist Volumes – Existing AM Peak Hour

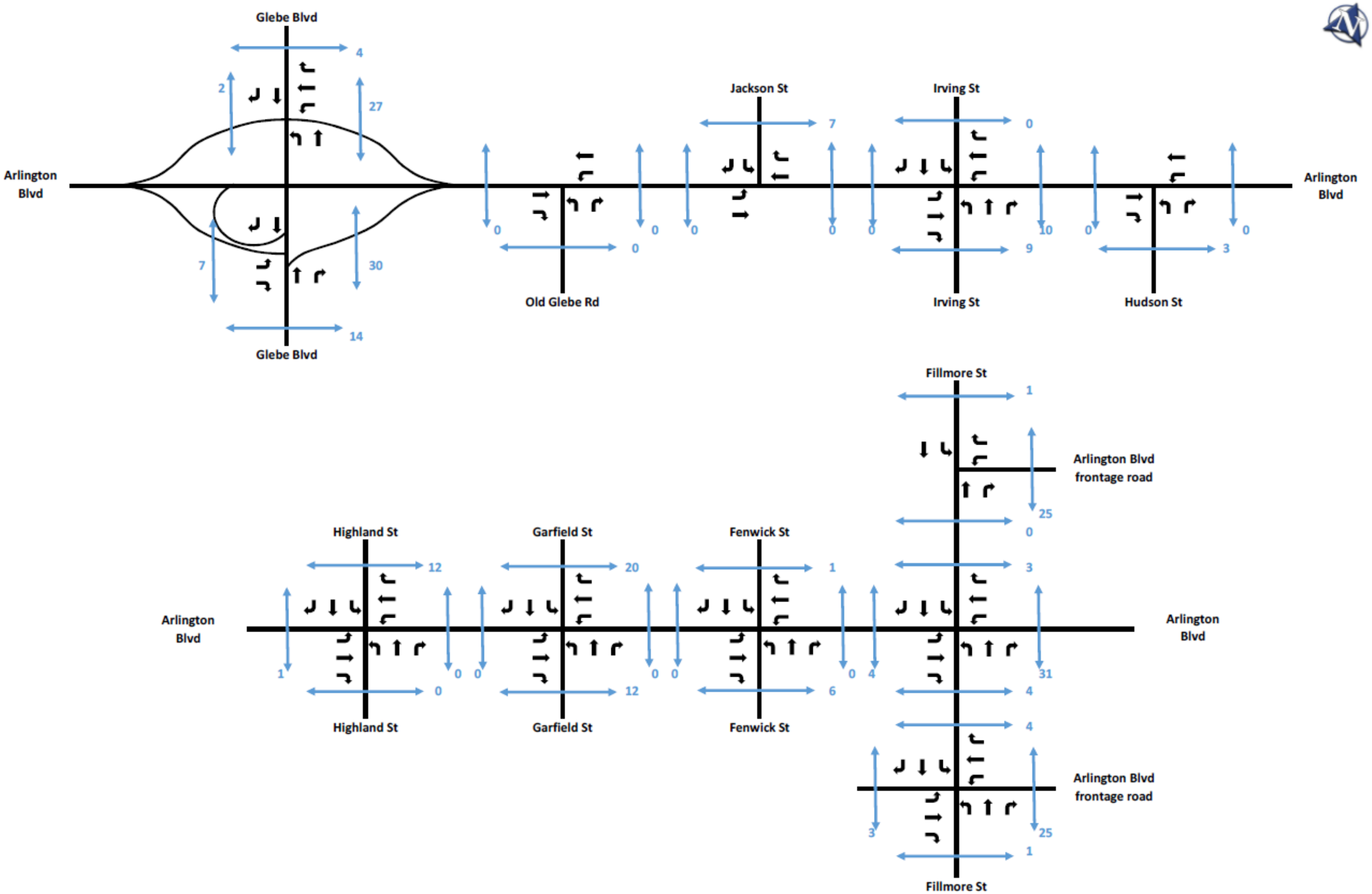
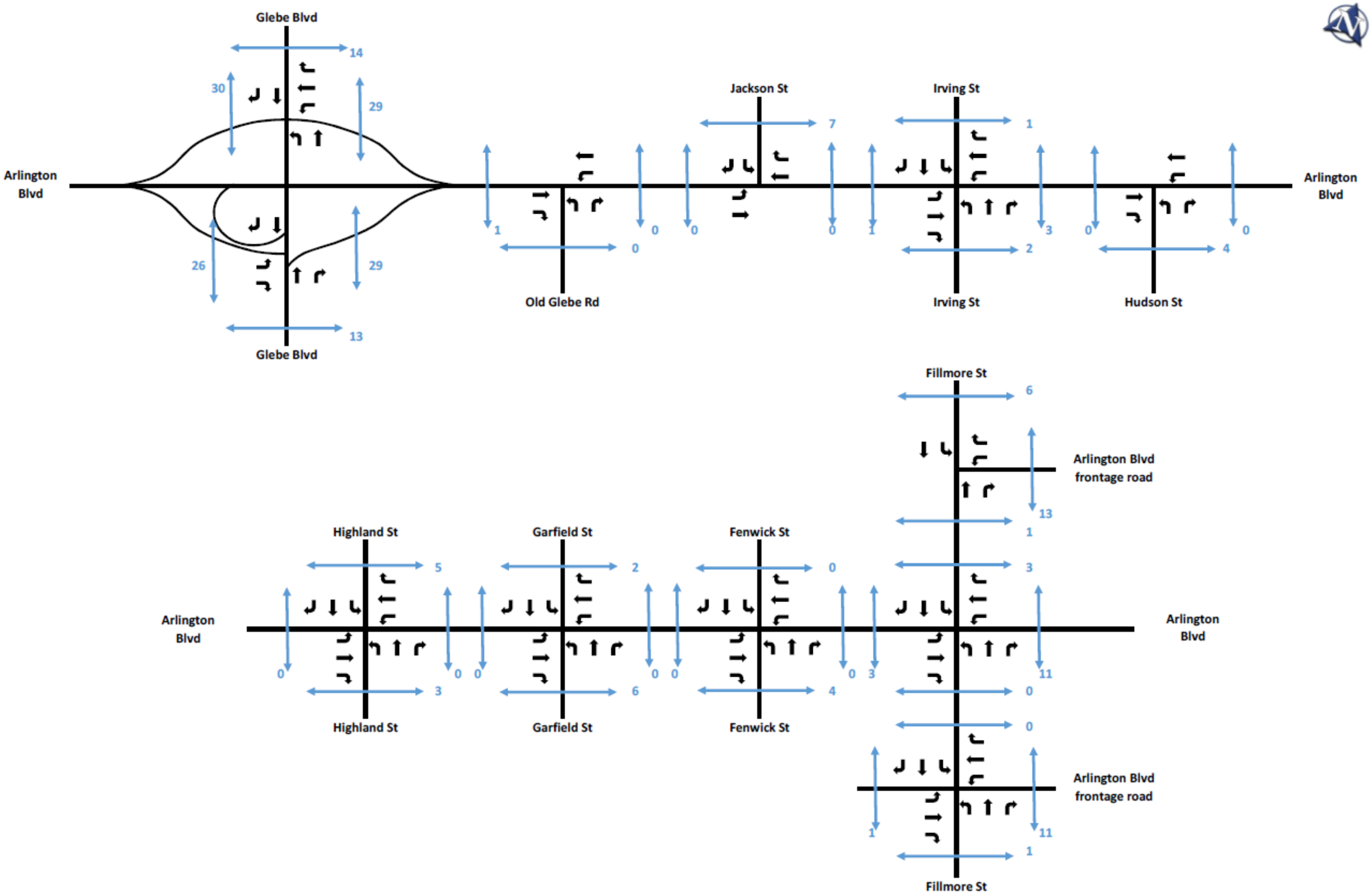


Figure 2-3d: Peak Hour Pedestrian and Bicyclist Volumes – Existing PM Peak Hour



3. SAFETY AND CRASH ANALYSIS

3.1 STUDY AREA CRASH DATA SUMMARY

Crash data within the study area was reviewed for a five-year period from January 1, 2014 through December 31, 2018. Crash data was obtained from the VDOT Tableau-Crash Analysis Tool (T-CAT) within the limits of the study area. Using the latitude and longitude information from each crash, the crash data was converted to a shapefile to geospatially depict the location of each crash. **Figure 3-1** depicts the crash locations by type and severity.

A total of 247 crashes were reported in the study area between January 1, 2014 and December 31, 2018. 158 (64 percent) of the crashes occurred along eastbound Route 50, 62 (25 percent) of the crashes occurred along westbound Route 50. The remaining 27 (11 percent) crashes occurred either along Glebe Road or the ramps serving the Glebe Road interchange. **Table 3-2** summarizes the crashes by collision type, severity, surface condition, weather condition, crash year, and time of the day. No crashes resulted in a fatal injury, but nine crashes resulted in severe injuries. 148 (60 percent) of the crashes were rear end collisions and 61 (25 percent) were angle crashes. The remaining 15 percent of the crashes were a combination of sideswipe (7 percent), fixed object (1 percent), and other crashes (8 percent). 212 (86 percent) crashes occurred on dry surface conditions and the remaining 35 crashes occurred on wet or snow/icy/shush or other surface conditions. 2016 had the highest number of crashes within the five-year period with 24 percent of all crashes occurring during this year. The greatest portion of crashes occurred during the PM peak period from 3:00 PM to 6:00 PM with 32 percent of all crashes occurring during this three-hour period. Five pedestrian and four bicycle crashes were reported including four pedestrian and one bicycle crash at the intersection of Route 50 and Fillmore Street, one bicycle crash at the intersection of Route 50 and Irving Street, and two bicycle crashes and one pedestrian crash along Glebe Road.

Calculated crash rates per 100 million vehicle miles traveled (VMT) along Route 50 were compared to VDOT's annually-published 2018 average crash rates per 100 million VMT for Northern Virginia Primary Roads and Statewide Urban Principal Arterials. As shown in **Table 3-1,** the crash rate per 100 million vehicle miles traveled (VMT) for Route 50 is 246.9. The 2018 Northern Virginia Primary Roads average crash rate is 125.7 and the 2018 Statewide Urban Other Principal Arterial average crash rate is 204.5. The Route 50 crash rate is 21 percent greater than the crash rate for Statewide Urban Other Principal Arterials and 96 percent greater than the Northern Virginia Primary Roads crash rate.

Table 3-1: Crash Rate per 100 Million Vehicle Miles Traveled

Facility	Crash Rate per 100 Million Vehicle Miles Traveled (100 MVMT)
Northern Virginia Primary Roads (2018)	125.7
Statewide Urban Principal Arterials (2018)	204.5
Route 50 Study Corridor (2014-2018)	246.9

Figure 3-1: Crashes by Type and Severity

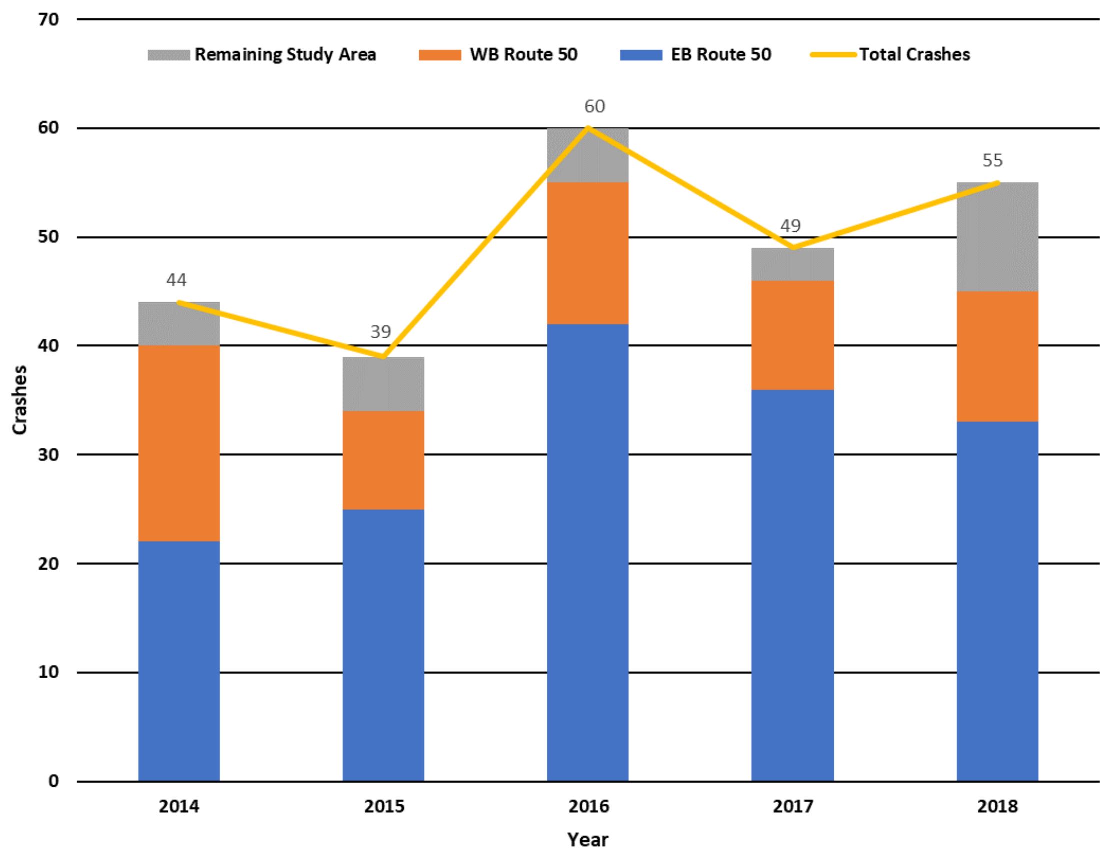
Table 3-2: Crash Summary

Crash Type		Number of Crashes			Total Crashes	% of Total Crashes
		EB Route 50	WB Route 50	Remaining Study Area		
Collision Type	Rear End	106	27	15	**148**	**59.9%**
	Sideswipe	8	5	3	**16**	**6.5%**
	Angle	35	22	4	**61**	**24.7%**
	Fixed Object	1	1	1	**3**	**1.2%**
	Other	8	7	4	**19**	**7.7%**
Crash Severity	Fatal Injury	0	0	0	**0**	**0.0%**
	Severe Injury	5	3	1	**9**	**3.6%**
	Visible Injury	26	13	7	**46**	**18.6%**
	Non-Visible Injury	2	3	1	**6**	**2.4%**
	Property Damage Only	125	43	18	**186**	**75.3%**
Surface Condition	Dry	132	55	25	**212**	**85.8%**
	Wet	24	7	2	**33**	**13.4%**
	Snowy/Icy/Slush	1	0	0	**1**	**0.4%**
	Other	1	0	0	**1**	**0.4%**
Weather Condition	No Adverse Conditions (Clear/Cloudy)	134	56	25	**215**	**87.0%**
	Rain/Mist	23	5	2	**30**	**12.1%**
	Snow/Sleet/Hail	1	1	0	**2**	**0.8%**
	Fog	0	0	0	**0**	**0.0%**
	Other	0	0	0	**0**	**0.0%**
Crash Year	2014	22	18	4	**44**	**17.8%**
	2015	25	9	5	**39**	**15.8%**
	2016	42	13	5	**60**	**24.3%**
	2017	36	10	3	**49**	**19.8%**
	2018	33	12	10	**55**	**22.3%**
Time	12 AM - 3 AM	2	1	2	**5**	**2.0%**
	3 AM - 6 AM	3	3	0	**6**	**2.4%**
	6 AM - 9 AM	23	15	3	**41**	**16.6%**
	9 AM - 12 PM	25	8	2	**35**	**14.2%**
	12 PM - 3 PM	21	4	6	**31**	**12.6%**
	3 PM - 6 PM	53	20	5	**78**	**31.6%**
	6 PM - 9 PM	24	10	6	**40**	**16.2%**
	9 PM - 12 AM	7	1	3	**11**	**4.5%**
Total Crashes by Facility		**158**	**62**	**27**	**247**	-

The Potential for Safety Improvement (PSI) rating is used by VDOT to identify locations where VDOT should consider an engineering review for possible mitigating countermeasures. Route 50 at Highland Street has a PSI of 64 within the NOVA District. Along Route 50, the segment between Jackson Street and Irving Street has a PSI of 144, the segment between Fenwick Street and Washington Boulevard interchange has a PSI of 177, and the segment between Old Glebe Road and Jackson street has a PSI of 254.

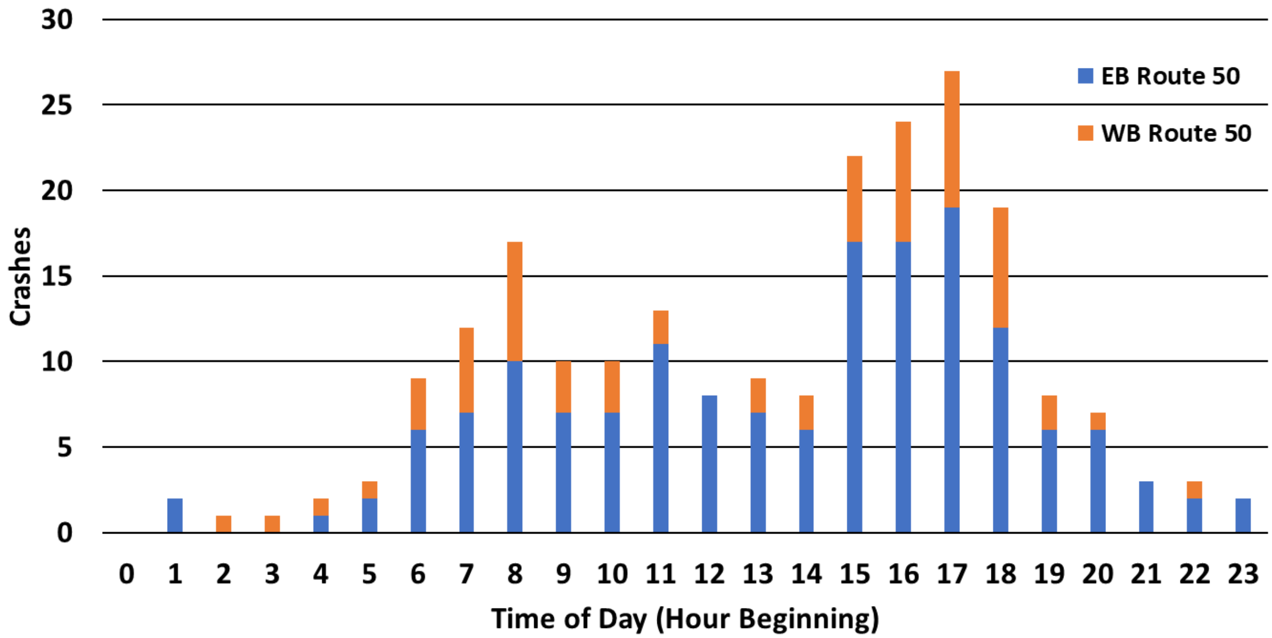
As shown in **Figure 3-2**, the total number of crashes per year within the study area has increased by 25 percent from 44 in 2014 to 55 in 2018 with a peak number of crashes occurring in 2016.

Figure 3-2: Crashes by Year by Facility



Crash data was reviewed by time of day as depicted in **Figure 3-3**. As shown, the highest frequency of crashes occurred along eastbound Route 50 during the evening peak rush hour. Although there is a pronounced peak in the number of crashes reported during the peak hours, 49 percent of the crashes reported along Route 50 occurred outside of the six hours during the AM peak (7 AM - 10 AM) and PM peak (3 PM – 6 PM) hours indicating a need for safety improvements throughout the day.

Figure 3-3: Route 50 Crashes by Time of Day



3.2 INTERSECTION CRASHES

Crashes reported at the study area intersections were identified geospatially using the latitude and longitude information for each crash. A total of 216 intersection crashes were identified at the ten study intersections during the five-year study period including 52 (24 percent) injury crashes.

Figure 3-4 depicts the crashes by intersection and crash type. As shown, the intersection of Route 50 at Irving Street had the highest number of reported crashes with 63 crashes during the five-year study period including 31 rear end and 22 angle crashes. The Route 50 at Fillmore Street intersection had the next highest number of reported crashes with 40 crashes including 21 rear end and eight angle crashes. The Highland Street, Garfield Street, and Jackson Street intersections had the next highest number of intersection crashes with 33, 22, and 20 crashes reported, respectively.

Figure 3-4: Intersection Crashes by Type

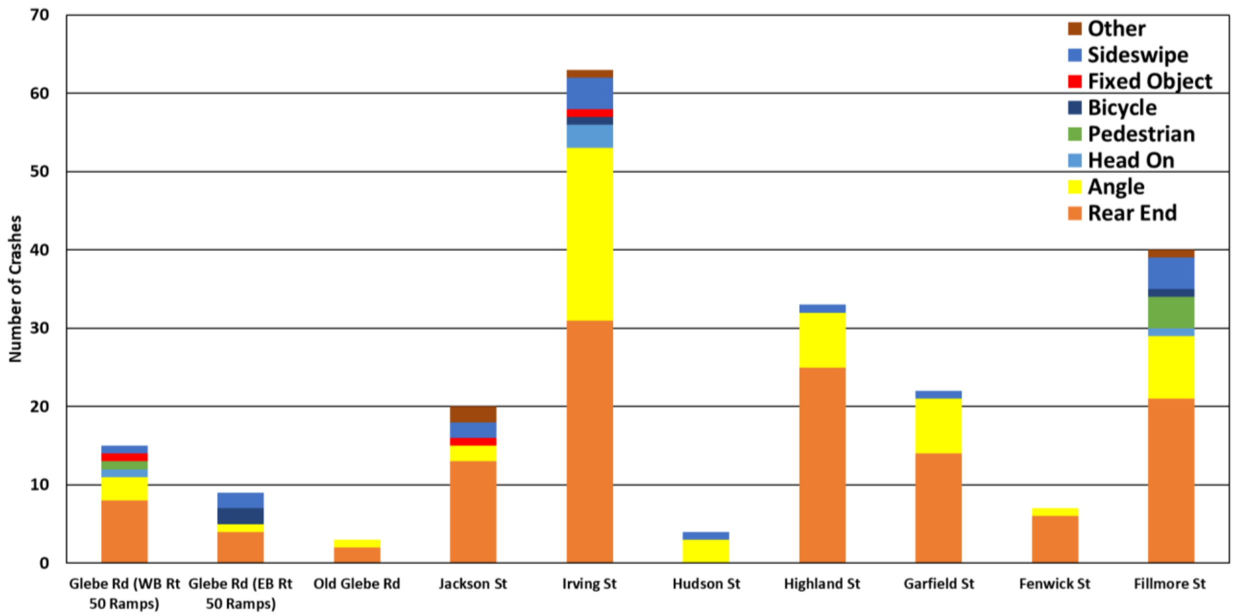


Table 3-3 summarizes the crashes by intersection and severity. Route 50 at Irving Street and Route 50 at Fillmore Street both had the highest number of injury crashes with 13 injury crashes during the five-year study period. The Route 50 at Highland Street intersection experienced the next highest number injury crashes with 8 injury crashes. These three intersections account for 65 percent of the injury crashes at the ten total intersections.

Table 3-3: Intersection Crashes by Severity (January 2014 – December 2018)

Intersection	Fatal Injury	Severe Injury	Visible Injury	Non-Visible Injury	Property Damage Only	Total
Glebe Rd at WB Rt 50 Ramps	0	1	3	1	10	**15**
Glebe Rd at EB Rt 50 Ramps	0	0	3	0	6	**9**
Route 50 at Old Glebe Rd	0	0	0	0	3	**3**
Route 50 at Jackson St	0	1	3	0	16	**20**
Route 50 at Irving St	0	2	10	1	50	**63**
Route 50 at Hudson St	0	0	1	0	3	**4**
Route 50 at Highland St	0	1	5	2	25	**33**
Route 50 at Garfield St	0	0	3	0	19	**22**
Route 50 at Fenwick St	0	0	2	0	5	**7**
Route 50 at Fillmore St	0	3	9	1	27	**40**
Total	**0**	**8**	**39**	**5**	**164**	**216**

Table 3-4 summarizes the crashes by intersection and collision type. As shown, rear end crashes are the most predominant crash type at the study intersections with 124 (57 percent) rear end crashes. Of these, 31 (25 percent) occurred at the Route 50 and Irving Street intersection, 25 (20 percent) occurred at the Route 50 at Highland Street intersection, and 21 (17 percent) occurred at the Route 50 at Fillmore Street intersection. Angle crashes were the next most predominant crash type with 55 (25 percent) angle crashes. Of the 55 angle crashes 22, (40 percent) occurred at the Route 50 and Irving Street intersection and 8 (15 percent) occurred at the Route 50 and Fillmore Street intersection.

Table 3-4: Intersection Crashes by Type (January 2014 – December 2018)

Intersection	Rear End	Angle	Sideswipe	Fixed Object	Head On	Pedestrian	Bicycle	Other	Total
Glebe Rd at WB Rt 50 Ramps	8	3	1	1	1	1	0	0	**15**
Glebe Rd at EB Rt 50 Ramps	4	1	2	0	0	0	2	0	**9**
Route 50 at Old Glebe Rd	2	1	0	0	0	0	0	0	**3**
Route 50 at Jackson St	13	2	2	1	0	0	0	2	**20**
Route 50 at Irving St	31	22	4	1	3	0	1	1	**63**
Route 50 at Hudson St	0	3	1	0	0	0	0	0	**4**
Route 50 at Highland St	25	7	1	0	0	0	0	0	**33**
Route 50 at Garfield St	14	7	1	0	0	0	0	0	**22**
Route 50 at Fenwick St	6	1	0	0	0	0	0	0	**7**
Route 50 at Fillmore St	21	8	4	0	1	4	1	1	**40**
Total	**124**	**55**	**16**	**3**	**5**	**5**	**4**	**4**	**216**

Figure 3-5 summarizes the left-turn angle crashes by intersection and direction of travel. As shown, Irving Street had the greatest number of left-turn crashes with 11 total crashes. Of the 11 total crashes, 7 crashes (64%) involved motorists turning left onto Irving Street from westbound Route 50 and 3 crashes involved motorists turning left from Irving Street from eastbound Route 50. Garfield Street had the next highest number of left-turn crashes with 7 total crashes. Of the 7 total crashes, 5 crashes (71%) were the result of motorists attempting to turn left onto westbound Route 50 from Garfield Street.

Figure 3-5: Left-Turn Crashes by Intersection

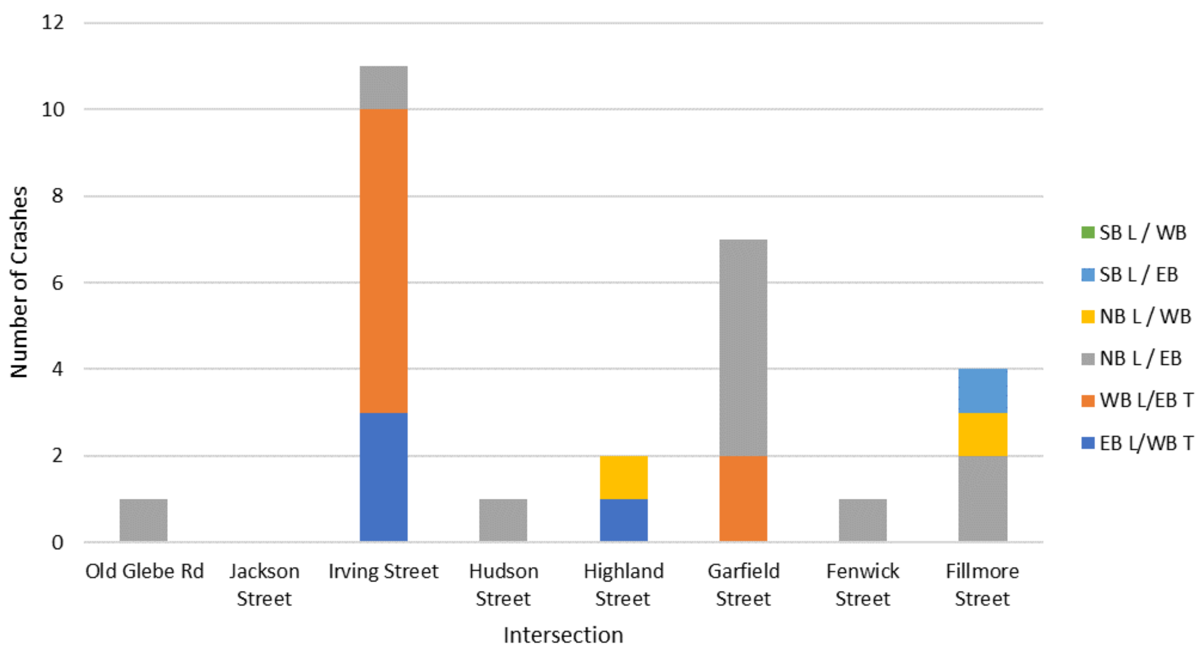
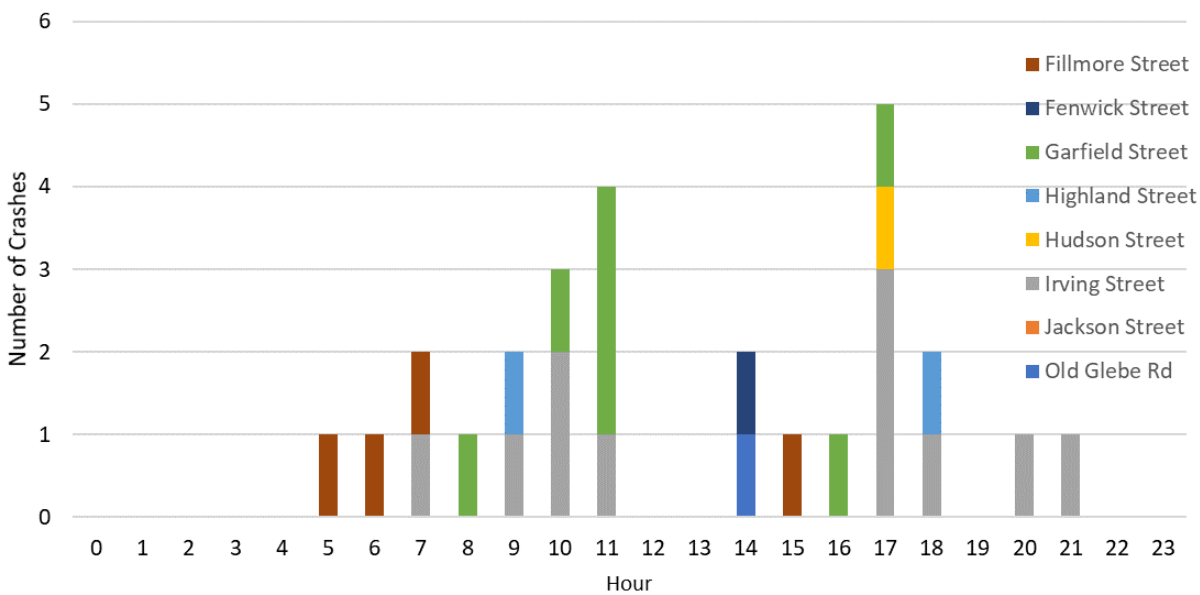


Figure 3-6 summarizes left-turn angle crashes by intersection and time of day. As shown, the hour of 5 PM to 6 PM had the greatest number of left-turn crashes with five total crashes. The hour of 11 AM to 12 PM had the next greatest number of crashes with four total crashes. The hour of 10 AM to 11 AM had the third highest number of crashes with three total crashes. Although there is a pronounced peak in the number of crashes reported during the peak hours, 56 percent of the crashes reported along Route 50 occurred outside of the six hours during the AM peak (7 AM - 10 AM) and PM peak (3 PM – 6 PM) hours indicating a need for safety improvements throughout the day.

Figure 3-6: Left-Turn Crashes by Intersection and Time of Day



3.2.1 Route 50 at Irving Street

The Route 50 at Irving Street intersection had the highest number of total intersection crashes (63 crashes) and rear end crashes (31 crashes) within the study area. Route 50 at Irving Street also has the highest number of injury crashes (13 crashes) within the study area. In addition, 22 angle crashes were reported at the intersection. One crash involved a motorist who ran a red light and struck a bicyclist crossing Route 50 in the crosswalk, which resulted in a severe injury. The high frequency of rear end crashes can be attributed to congestion during peak periods combined with a lack of left-turn lanes on eastbound and westbound Route 50 at Irving Street. The lack of left-turn lanes along Route 50 at Irving Street causes some motorists to avoid the innermost through lanes (see **Figure 3-7**), creates longer queues and delays in the rightmost through lanes, reduces the efficiency of the signalized intersection, and thereby increasing delays on all approaches. Motorists who do not avoid the leftmost through lane may not anticipate having to stop for a left-turning vehicle to Irving Street, creating the potential for rear end crashes. Ten of the 22 angle crashes involved motorists traveling along Route 50 and turning left onto Irving Street where no left-turn lanes are provided and permissive left-turn phasing is provided. Left-turning motorists may have difficulty finding gaps in the heavy Route 50 traffic volumes, creating the potential for left-turn crashes. Of the ten left-turn crashes, seven involved westbound Route 50 left turns onto Irving Street and three involved eastbound Route 50 left turns onto Irving Street.

Figure 3-7: Eastbound Route 50 approaching Irving Street

3.2.2 Route 50 at Fillmore Street

The Route 50 at Fillmore Street intersection had the second highest total intersection crashes (40 crashes), the highest number of injury crashes (13 crashes), and the third highest number of rear end crashes (21 crashes) in the study area. Of the 40 total crashes, 29 crashes (73 percent) were either angle or rear end crashes. The high frequency of rear end crashes can be partially attributed to long queues and delays approaching the intersection during peak periods. Additionally, the westbound Route 50 left-turn lane storage fills up during the PM peak hour causing queues to extend into the through lanes and create the potential for rear end crashes.

The Route 50 at Fillmore Street intersection had the highest number of pedestrian and bicycle crashes with five reported during the study period. All five pedestrian and bicycle crashes resulted in injuries and four involved pedestrians and one involved a bicyclist. The following is a summary of each of the crashes:

- A vehicle was traveling eastbound on Route 50 in the left lane with a green traffic signal indication at Fillmore Street. A bicyclist crossed Route 50 on the west side of Fillmore Street in the crosswalk against the "DO NOT WALK" indication and was struck by the motorist causing visible injuries.
- A vehicle was traveling westbound on Route 50 approaching Fillmore Street in the left lane. A pedestrian was walking south across Route 50 while not in the crosswalk and against the "DO NOT WALK" indication and was struck by the vehicle causing visible injuries.

- A vehicle was traveling southbound on Fillmore Street and made a left turn onto eastbound Route 50. The motorists had a green signal indication, but they did not yield to the pedestrian in the crosswalk who had a "WALK" indication and struck the pedestrian causing visible injuries.
- A vehicle was traveling westbound on Route 50 and disregarded a red signal indication at Fillmore Street and struck a pedestrian causing severe injuries.
- A vehicle was making a right turn from Fillmore Street on to eastbound Route 50 with a green signal indication and failed to yield to a pedestrian and struck the pedestrian causing visible injuries.

3.2.3 Route 50 at Highland Street

The Route 50 at Highland Street intersection had the third highest total number of crashes (33 crashes), the third highest number of injury crashes (8 crashes), and the second highest number of rear end crashes (25 crashes). Of the 33 total crashes, 32 (97 percent) crashes were either rear end or angle crashes. Six of the rear end crashes involved a left turn onto Highland Street blocking through traffic along Route 50.

3.2.4 Route 50 at Garfield Street

The Route 50 at Garfield Street intersection had 22 total crashes including three that resulted in an injury. Fourteen of the 22 crashes were rear end crashes including eleven along eastbound Route 50 and three along westbound Route 50. Based on a review of the individual crash reports, five angle crashes were the result of motorist making left turns from northbound Garfield Street to westbound Route 50. Two of the angle crashes were the result of a motorist traveling along westbound Route 50 and turning left onto Garfield Street.

3.2.5 Route 50 at Jackson Street

The Route 50 at Jackson Street intersection had 20 total crashes including four that resulted in an injury. Thirteen of the crashes were rear end crashes, five of which were the result of a motorist attempting to make a left turn from Route 50 onto Jackson Street. Ten of the rear end crashes occurred along eastbound Route 50 and three of the rear end crashes occurred along westbound Route 50.

3.2.6 Route 50 at Fenwick Street

The Route 50 at Fenwick Street intersection had seven total crashes including two that resulted in an injury. Six of the crashes were rear end crashes and one of the crashes was an angle crash. The rear end crashes are potentially related to the congestion at the Route 50 at Fillmore Street intersection located less than 200 feet to the east of Fenwick Street. All seven crashes occurred along eastbound Route 50.

3.2.7 Route 50 at Hudson Street

The Route 50 at Hudson Street intersection had four total crashes including one that resulted in an injury. Three of the crashes were angle crashes and one of the crashes was a sideswipe crash. All four crashes occurred along eastbound Route 50.

3.2.8 Route 50 at Old Glebe Road

The Route 50 at Old Glebe Road intersection had three total crashes all of which resulted in property damage only. Two of the crashes were rear end crashes and one of the crashes was an angle crash. All three crashes occurred along eastbound Route 50.

4. FUTURE TRAFFIC VOLUMES

Traffic volumes were developed for a horizon year of 2030 as this study is focused on identifying immediate or intermediate term improvements to address the identified safety and operational deficiencies. For the 2030 horizon year, volumes were developed for both No Build conditions with no improvements within the study area as well as for each Build Alternative (see **Section 6.3.1**).

4.1 TRAFFIC FORECASTING METHODOLOGY

The Traffic Volumes Forecasts Development Memorandum located in **Appendix C** documents the forecast methodology and development of future year forecasts. VDOT's Statewide Planning System (SPS) data and the most recently adopted MWCOG model (Version 2.3.75) were reviewed to identify annual growth rates for the study area. **Table 4-1** depicts the 2018 annual average daily traffic volumes (AADT) and daily projections and the resulting calculated compounded annual growth rates for each source. As shown, annual growth rates range from 0.4% along Route 50 to 2.2% along Fillmore Street according to VDOT's SPS. A review of year 2019 daily volumes from the MWCOG model revealed that traffic volumes along this section of Route 50 are significantly less than existing daily traffic volumes (21,160 per the MWCOG model versus weekday daily counts of approximately 67,000). Therefore, the SPS growth rates were used as the primary source for establishing recommended annual growth rates with one exception. Along Fillmore Street, the SPS calculated growth rate of 2.18% was adjusted to a nominal growth rate of 0.5% due to the lower growth rate forecasts by the MWCOG model and the lack of development opportunities along the Fillmore Street corridor. The selected growth rates were applied to the existing turning movements within the study area to develop future background traffic volumes for the 2030 horizon year. Traffic volumes along Glebe Road between the Route 50 ramp intersections as well as along Fillmore Street between Route 50 and the frontage roads were balanced. The recommended annual growth rates are summarized in **Table 4-1**.

Table 4-1: Recommended Growth Rates

Facility	From	To	Statewide Planning System (SPS)			MWCOG Model			Recommended Growth Rate 2018 ADT
			2018 ADT	2045 ADT	Annual Growth Rate	2019 ADT	2030 ADT	Annual Growth Rate	
Route 50 – Arlington Boulevard	Glebe Road	Fillmore Street	61,802	68,178	0.36%	21,160	22,475	0.22%	0.4%
Fillmore Street	North of Route 50	South of Route 50	9,206	16,496	2.18%	11,524	11,926	0.13%	0.5%
Glebe Road	Route 50	South of Route 50	31,180	35,979	0.53%	44,778	43,446	-0.11%	0.5%
Glebe Road	Route 50	North of Route 50	26,304	34,811	1.04%	41,990	37,610	-0.41%	1.0%

4.2 NO BUILD CONDITIONS TRAFFIC VOLUMES

The growth rates were applied to the existing turning movements within the study area to develop future background traffic volumes for the 2030 horizon year. Future traffic volumes were balanced as necessary between study intersections. **Figures 4-1a and 4-1b** depict the 2030 No Build scenario traffic volumes for the AM and PM peak hours, respectively.

Figure 4-1a: Peak Hour Volumes – 2030 No Build AM Peak Hour

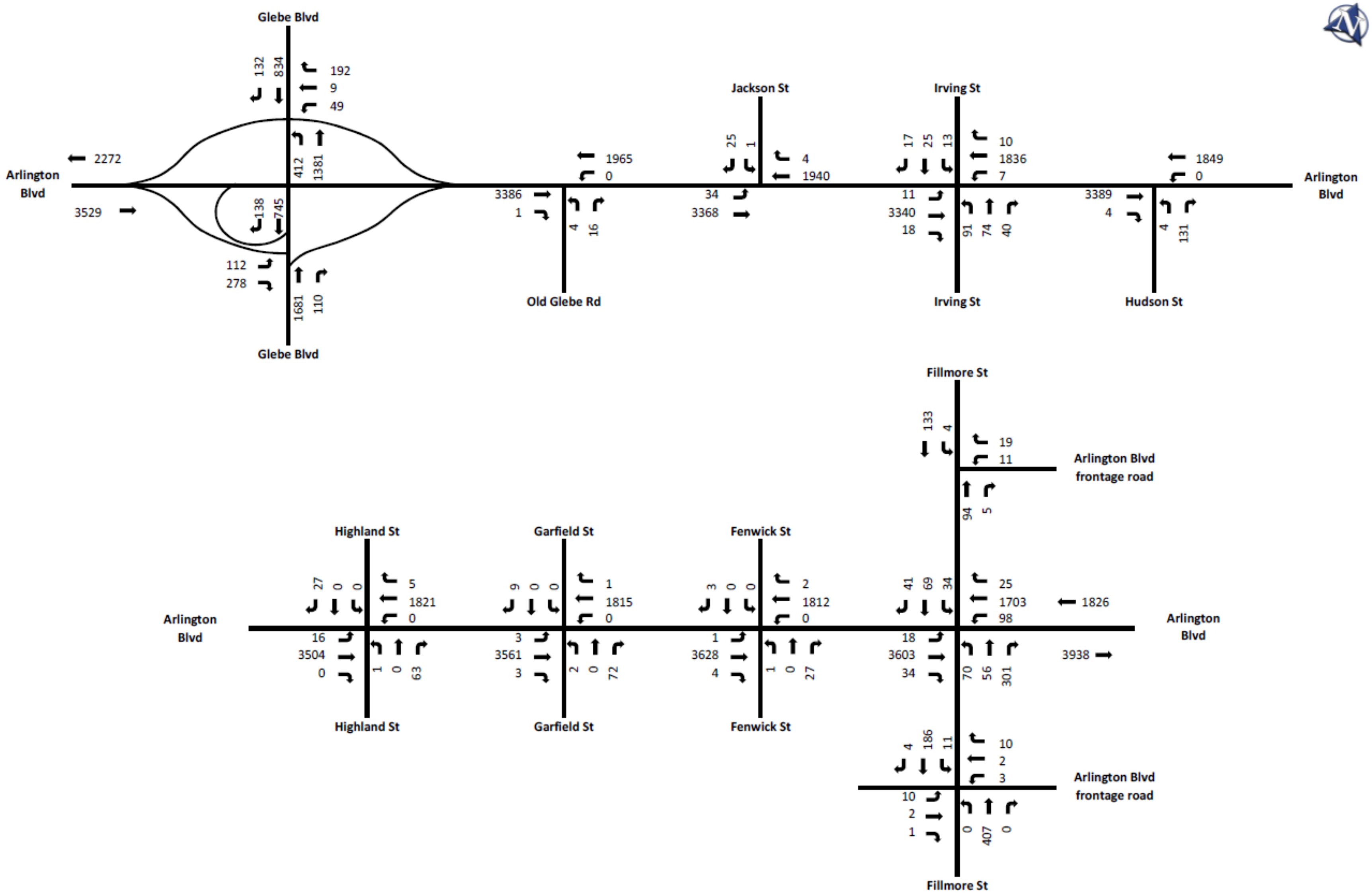
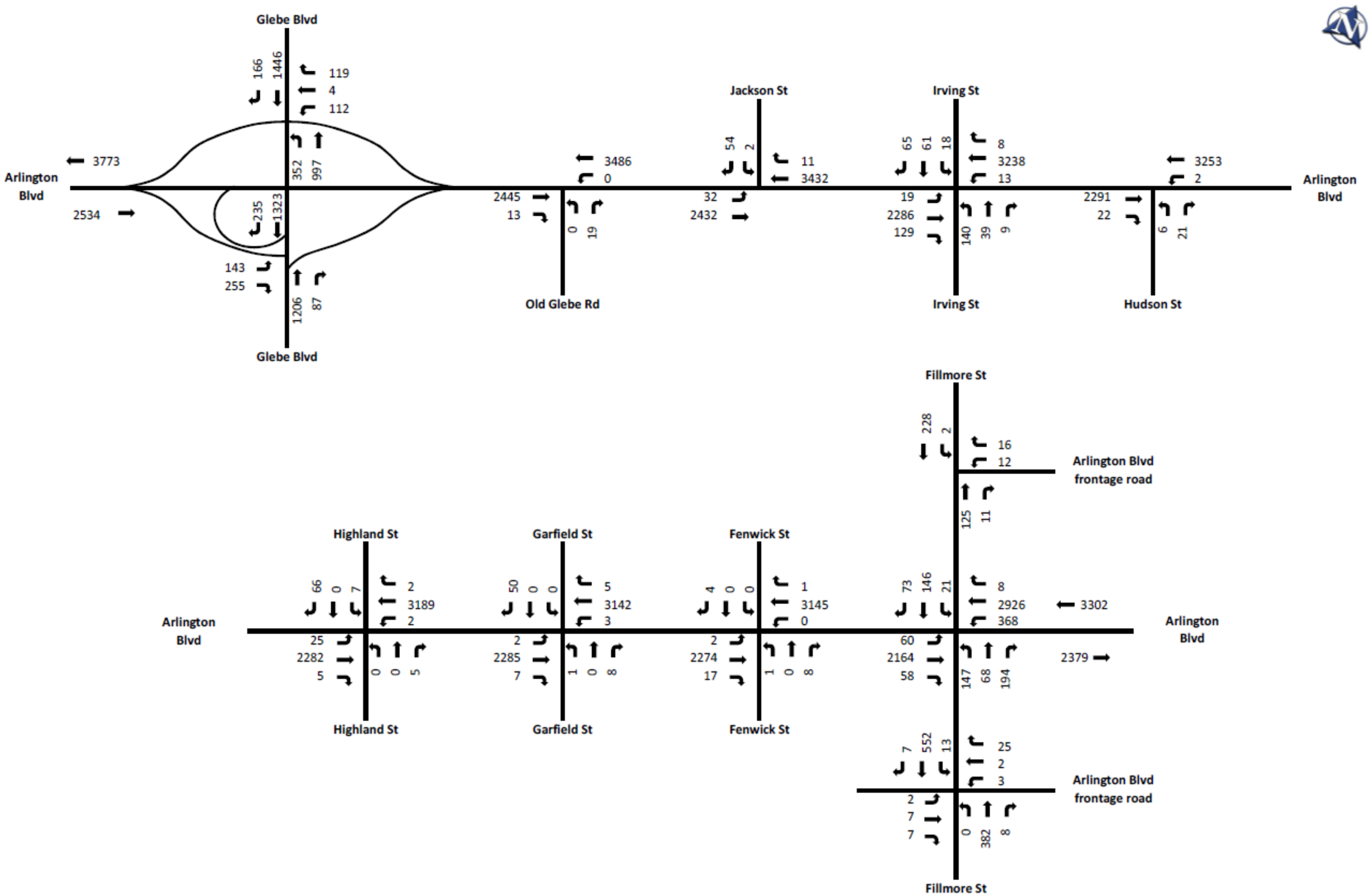


Figure 4-1b: Peak Hour Volumes – 2030 No Build PM Peak Hour



5. EXISTING AND NO BUILD TRAFFIC OPERATIONS ANALYSIS

Traffic operations within the study area were evaluated for the AM and PM peak hours for existing (2019), 2030 No Build, and 2030 Build conditions (see **Chapter 8**). The results of the VISSIM microsimulation are documented for the measures of effectiveness (MOEs) in accordance with the TOSAM as specified in the Framework Document.

5.1 TRAFFIC OPERATIONS ANALYSIS METHODOLOGY

5.1.1 Analysis Tools

The traffic operations and simulation analyses were performed using VISSIM (version 8). Synchro (version 10.3) was used to screen the initial improvement options and develop signal timings for future 2030 conditions. Existing signal timing data (see **Appendix D**) and existing Synchro networks for the study area were provided by Arlington County and used to establish existing timing inputs. Inputs and analysis methodologies were consistent with VDOT's *Traffic Operations and Safety Analysis Manual (TOSAM)*.

5.1.2 VISSIM Model Development and Analysis Periods

Existing conditions VISSIM models were developed for both the AM peak (8:00 AM – 9:00 AM) and PM peak (5:00 PM - 6:00 PM) periods for the operations study area. The existing conditions VISSIM models were developed in accordance with VDOT's Traffic Operations and Safety Analysis Manual – Version 1.0 (TOSAM) and VISSIM Version 8 which included lane geometry based on aerial photography and field observations to produce the study area network, desired speeds based on posted speed limits, static traffic assignment setup including vehicle inputs, vehicle compositions, and vehicle travel routes, and traffic signal timings provided by Arlington County. Traffic volume inputs were developed in 15-minute intervals in conjunction with the balanced hourly traffic counts along the corridor. Static vehicle routes were consistent through the entire simulation period based on balanced peak hour traffic volumes and were coded approaching each intersection or decision point. Vehicle compositions were consistent through the entire simulation period and unique for each entry link into the VISSIM network based on calculated truck percentages from the collected traffic counts. Pedestrian timings were included as part of the development of timings in Synchro where appropriate.

There are no "No Build" improvements proposed along Route 50 within the study limits in the National Capital Region Transportation Planning Board's financially constrained element of Visualize 2045 and the VDOT Six-Year Improvement Plan. Therefore, roadway geometry in the 2030 No Build VISSIM files matches existing conditions. Future No Build models were modified to incorporate the Build alternatives and generate each of the 2030 Build VISSIM models.

5.1.3 Simulation Time and Seeding Period

The VISSIM models were developed for one hour (3,600 seconds) during the AM and PM peak periods (8:00 AM to 9:00 AM and 5:00 AM to 6:00 PM). The VISSIM models also include a seeding period to ensure that the model is properly loaded prior to producing measures of effectiveness. The seeding period should generally be based on the time it takes for a vehicle to travel the entire corridor during the peak hour in the peak direction. The seeding period should also allow time for traffic congestion to build before the analysis hour begins. The VISSIM models include a 90 minute (5,400 second) seeding period from 6:30 to 8:00 AM and 3:30 to 5:00 PM to ensure proper loading of the model prior to the peak hours.

5.1.4 VISSIM Model Number of Runs

Appendix F of the TOSAM provides guidance on the use of the VDOT Sample Size Determination Tool, which is based on the FHWA 95th percentile confidence level sample size determination methodology. The measures of effectiveness (MOE) selected for the sample size determination were travel times and volumes. These two MOEs were evaluated along Route 50 as noted below:

- Eastbound and westbound Route 50 travel time, Glebe Road overpass to Irving Street
- Eastbound and westbound Route 50 travel time, Irving Street to Fillmore Street
- Eastbound and westbound Route 50 volume, Glebe Road overpass to Irving Street
- Eastbound and westbound Route 50 volume, Irving Street to Fillmore Street

The vehicle travel times and volumes were collected from VISSIM for each run and the Sample Size Determination Tool was run to determine the number of required simulation runs. The Sample Size Determination Tool indicated that 10 runs are sufficient for all locations during the AM and PM peak hours. The Sample Size Determination Tool spreadsheets for all scenarios are included in **Appendix E**.

5.1.5 VISSIM Model Calibration and Validation

The calibration criteria used for the VISSIM microscopic model includes intersection volumes and travel times as shown in **Table 5-1** and is based on the approved Framework Document. The VISSIM Base Model Development and Calibration Methodology and Validation Memorandum is located in **Appendix E**. A quantitative comparison of maximum queue lengths was also performed between the observed and simulated queue lengths to confirm the model is reasonably matching observed congestion. Simulated turning movement volumes at signalized intersections and approach volumes at unsignalized intersections were collected using Node Summaries, travel times were collected using Vehicle Travel Times, and simulated maximum queue lengths were collected using Queue Counters in VISSIM. Simulated maximum queue lengths were used to guide the calibration process but were not considered a formal calibration measure. Due to the variability in queue length, the effort was focused at critical locations where recurring congestion causes extensive queueing. Due to extensive queues that form along eastbound and westbound Route 50, mainline through queue calibration focused on whether queues extend through upstream intersections, consistent with field observations.

Table 5-1: VISSIM Model Calibration Criteria

Simulated Measure	Calibration Thresholds
Simulated Traffic Volume (vehicles per hour): • 85% of movements at critical (signalized) intersections • 85% of approaches for unsignalized intersections	Within ± 20% for <100 vph Within ± 15% for ≥ 100 vph to <300 vph Within ± 10% for ≥ 300 vph to <1,000 vph Within ± 5% for ≥ 1,000 vph
Simulated Travel Time (seconds): • 85% of the Route 50 segments between signalized intersections • Overall corridor from the Glebe Road overpass to west of the Washington Boulevard interchange	Within ± 30% of observed travel times
Maximum Queue Length (feet) • EB Route 50 approaching Irving Street and Fillmore Street • WB Route 50 approaching Irving Street and Fillmore Street	Quantitative comparison to field observations

During the VISSIM model calibration process, parameters such as driver behavior, lane change distances, priority rules, and stop sign locations were adjusted to achieve the target thresholds.

Traffic Volume Calibration: The traffic volume calibration results for both AM and PM peak hours are shown in **Table 5-2** for each of the calibration thresholds. Calibration criteria and thresholds are presented for each of the four traffic volume groups. For both the AM and PM peak hours, traffic volumes were reviewed for all movements at critical intersections and all approaches for unsignalized intersections within the VISSIM model study area and classified into the four volume groups. As shown in **Table 5-2**, the signalized traffic turning movements and unsignalized traffic approaches within the model study area meet the 85-percent calibration criteria for all volume groups in both the AM and PM peak hour models.

Table 5-2: Peak Hour Traffic Volume Summary

Simulated Measure	Calibration Thresholds	% Meeting Calibration Thresholds			
		AM Peak Hour		PM Peak Hour	
		Signalized Turns	Unsignalized Approaches	Signalized Turns	Unsignalized Approaches
Simulated Traffic Volume (vph): • 85% of movements at critical (signalized) intersections • 85% of approaches for unsignalized	Within ± 20% for <100 vph	95%	100%	100%	100%
	Within ± 15% for ≥100 vph to <300 vph	100%	100%	100%	100%
	Within ± 10% for ≥300 vph to <1,000 vph	100%	100%	100%	100%
	Within ± 5% for ≥1,000 vph	100%	100%	100%	100%
	Total	**97%**	**100%**	**100%**	**100%**

Travel Times: Travel times for the VISSIM model were compared to the field-measured travel times which were collected during the peak hours. **Tables 5-3 and 5-4** summarize the observed travel times, the VISSIM simulated travel times, and the percent difference along eastbound and westbound Route 50, respectively.

As shown in **Table 5-3**, for all of the travel time segments along eastbound Route 50, 100% of the travel times meet the calibration threshold of 30% for the segment travel times. Additionally, the corridor total travel time meets the calibration threshold of 30% with a 20% difference in the AM peak hour and a 4% difference in the PM peak hour.

Table 5-3: AM & PM Eastbound Peak Hour Travel Time Summary

Segment	AM Peak			PM Peak		
	Observed Travel Time (sec)	Simulated Travel Time (sec)	Percent Difference	Observed Travel Time (sec)	Simulated Travel Time (sec)	Percent Difference
From Glebe Road overpass	-	-	-	-	-	-
To Irving Street	135	99	27%	55	50	9%
To Fillmore Street	48	47	1%	55	55	-1%
To west of Washington Boulevard interchange	23	19	14%	20	19	4%
Corridor Total	**206**	**165**	**20%**	**130**	**125**	**4%**

As shown in **Table 5-4**, for all of the travel time segments along westbound Route 50, 100% of the travel times meet the calibration threshold of 30% for the segment travel times. Additionally, the corridor total travel time meets the calibration threshold of 30% with a -2% difference in the AM peak hour and a 21% difference in the PM peak hour.

Table 5-4: AM & PM Westbound Peak Hour Travel Time Summary

Segment	AM Peak			PM Peak		
	Observed Travel Time (sec)	Simulated Travel Time (sec)	Percent Difference	Observed Travel Time (sec)	Simulated Travel Time (sec)	Percent Difference
From west of Washington Boulevard interchange	-	-	-	-	-	-
To Fillmore Street	28	31	-12%	69	50	28%
To Irving Street	25	23	8%	37	29	22%
To Glebe Road overpass	34	34	0%	38	36	5%
Corridor Total	**86**	**88**	**-2%**	**144**	**114**	**21%**

Queue Lengths: Maximum queue lengths from the VISSIM models were compared to the field-observed maximum queue lengths on Route 50. Due to the variability in queue lengths along the corridor, calibration was focused at critical locations where recurring congestion causes extensive queueing. Due to extensive queues that form along eastbound and westbound Route 50, mainline through queue calibration focused on whether queues extend through upstream signalized intersections and interchanges.

Table 5-5 summarizes the field-observed maximum queue lengths, the VISSIM-modeled maximum queue lengths, and the differences for each mainline direction during the AM and PM peak hours. As shown in **Table 5-5**, the only maximum approach queue which extends into an upstream signalized intersection in the study area is eastbound Route 50 at Fillmore Street which extends into the Irving Street signalized intersection during the AM and PM peak hours. The VISSIM results showed similar maximum queue lengths on this approach during the AM peak hour and 4 vehicles (9%) less during the PM peak hour. On the westbound Route 50 approach to Irving Street, the VISSIM results are within 5 and 9 vehicles of the field observations during the AM and PM peak hours, respectively.

Table 5-5: Peak Hour Maximum Queue Length Summary

Approach	AM Peak				PM Peak			
	Observed Max Queue, feet (veh)	Simulated Max Queue, feet (veh)	Difference (%)	Difference (veh)	Observed Max Queue, feet (veh)	Simulated Max Queue, feet (veh)	Difference (%)	Difference (veh)
EB Route 50 at Irving Street	4,900 (196)	3,280 (131)	-33%	-65	530 (21)	673 (27)	27%	6
EB Route 50 at Fillmore Street	1,200 (48)	1,200 (48)	0%	0	1,200 (48)	1,096 (44)	-9%	-4
WB Route 50 at Fillmore Street	500-750 (20-30)	422 (16)	-18% to -45%	-4 to -14	2,600 (104)	1,657 (66)	-36%	-38
WB Route 50 at Irving Street	125 (5)	244 (10)	95%	5	700-1,160 (28-46)	932 (37)	33% to -19%	9 to -9

Entering the study corridor along the peak eastbound Route 50 direction approaching Irving Street and along the peak westbound Route 50 direction approaching Fillmore Street, the VISSIM model maximum queue lengths are less than field observations by 33 and 36 percent during the AM and PM peak hours, respectively. Although the maximum queues extend outside of the study area limits, the links entering the VISSIM model were extended to capture the back of the simulated queue. However, upstream intersections and interchanges outside of the study area were not included in the VISSIM model as noted above due to data not being available as part of this study effort. The differences between observed maximum queue lengths and simulated maximum queue lengths entering the Route 50 study corridor in the peak directions can be attributed to upstream interchanges outside of the study area causing friction and congestion which impacts the maximum queue lengths. During the AM peak hour, the eastbound Route 50 maximum queue length approaching Irving Street extends through the George Mason Drive interchange to approximately Pershing Drive partially due to congestion at the George Mason Drive and Glebe Road interchanges as well as the eastbound Route 50 weave between George Mason Drive and Glebe Road, which are located outside the study area and therefore not included in the VISSIM models. During the PM peak hour, the westbound Route 50 maximum queue length approaching Fillmore Street extends through the Washington Boulevard interchange to approximately the off-ramp to Washington Boulevard partially due to congestion occurring at the merges and diverges at the Washington Boulevard interchange which is located outside the study area and therefore not included in the VISSIM models.

Although there are differences between the simulated maximum queue lengths and the maximum observed queue lengths, the general extent of queuing reflects field conditions within the study limits. The simulated queue lengths under No Build conditions will be used as baseline for comparison to Build conditions queue lengths to evaluate the effectiveness of study alternatives. Therefore, it can be concluded that the model is reasonably calibrated for the purposes of the study to compare alternatives under consideration. The peak direction maximum queue lengths on Route 50 entering the study corridor serve as relative maximum queue lengths to compare future year design alternatives and do not represent actual field maximum queue lengths due to the traffic margining issues outside of the study area at the Washington Boulevard interchange and west of Glebe Road that are not included in the simulation models.

5.1.6 Measures of Effectiveness

Measures of effectiveness (MOE's) from the VISSIM outputs were used to document operations. Study area intersections were evaluated using vehicle throughput (vehicles per hour), delay (seconds/vehicle), and maximum queue length (feet). The Route 50 corridor was evaluated using travel times (minutes). In accordance with the TOSAM, level of service (LOS) is not provided as an MOE; however, metrics such as "severe congestion" and "light traffic conditions" corresponding to LOS are used to depict congestion levels. Operational conditions for the intersections are color-coded to reflect various congestion levels based on density and delay thresholds established in the Highway Capacity Manual 2010 (HCM). **Table 5-6** summarizes the thresholds for signalized and unsignalized intersections.

Table 5-6: Intersection Measures of Effectiveness

Congestion Level	Intersections	
	Signalized	Unsignalized
	Average Delay (sec/veh)	Average Delay (sec/veh)
Light Traffic	≤35	≤25
Moderate Traffic	>35 - 55	>25 – 35
Heavy Congestion	>55 – 80	>35 - 50
Severe Congestion	>80	>50

5.2 EXISTING CONDITIONS TRAFFIC OPERATIONS

5.2.1 Route 50 Travel Times

Figures 5-1a and 5-1b summarize the cumulative travel times for eastbound and westbound Route 50, respectively, during the AM peak hour under existing conditions within the study area limits between signalized intersections. During the AM peak hour, the peak travel direction along Route 50 is eastbound toward Washington, D.C. The simulated existing corridor travel times along Route 50 during the AM peak hour are 2.8 minutes in the eastbound direction and 1.5 minutes in the westbound direction. For comparison purposes, the free-flow travel time along Route 50 with no congestion at signalized intersections is approximately 0.9 minutes.

Figure 5-1a: AM Peak Hour – Eastbound Route 50 Cumulative Travel Times (Existing Conditions)

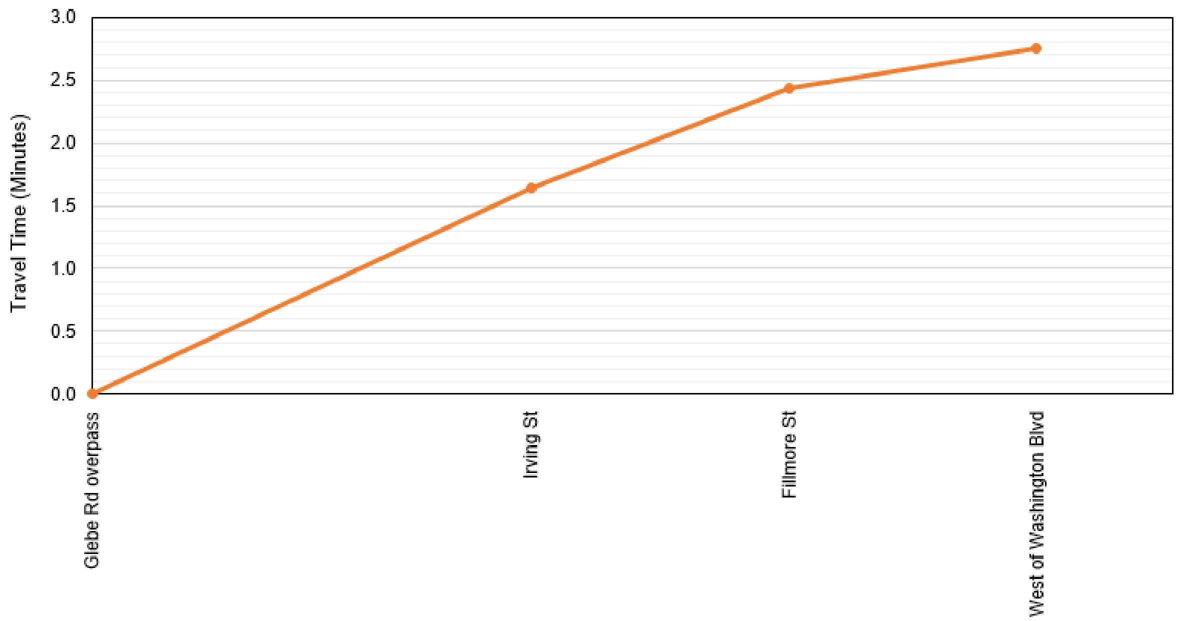
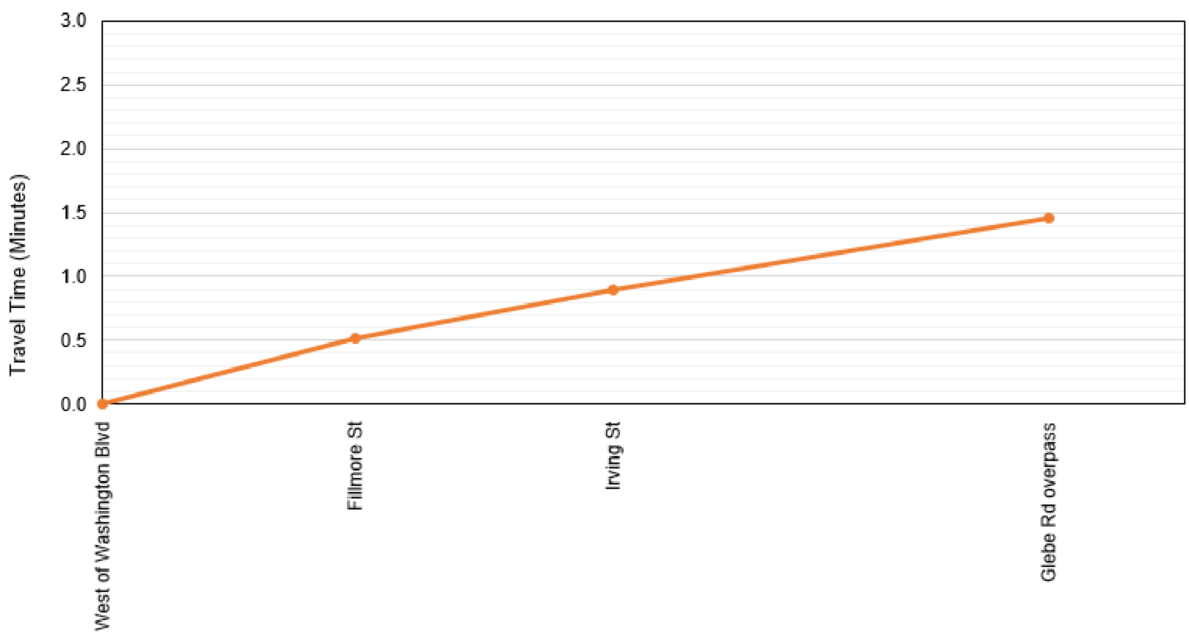


Figure 5-1b: AM Peak Hour – Westbound Route 50 Cumulative Travel Times (Existing Conditions)



Figures 5-2a and 5-2b summarize the cumulative travel times for eastbound and westbound Route 50, respectively, during the PM peak hour under existing conditions within the study area limits between signalized intersections. During the PM peak hour, the peak travel direction along Route 50 is westbound away from Washington, D.C. The simulated existing corridor travel times along Route 50 during the AM peak hour are 2.1 minutes in the eastbound direction and 1.9 minutes in the westbound direction. For comparison purposes, the free-flow travel time along Route 50 with no congestion at signalized intersections is approximately 0.9 minutes.

Figure 5-2a: PM Peak Hour – Eastbound Route 50 Cumulative Travel Times (Existing Conditions)

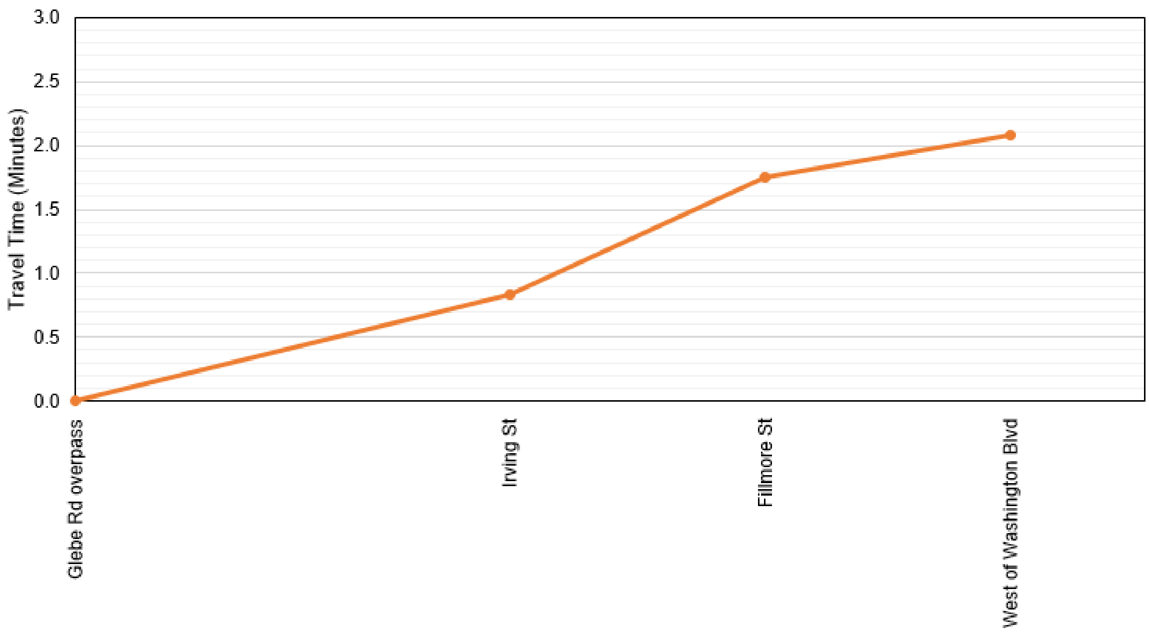
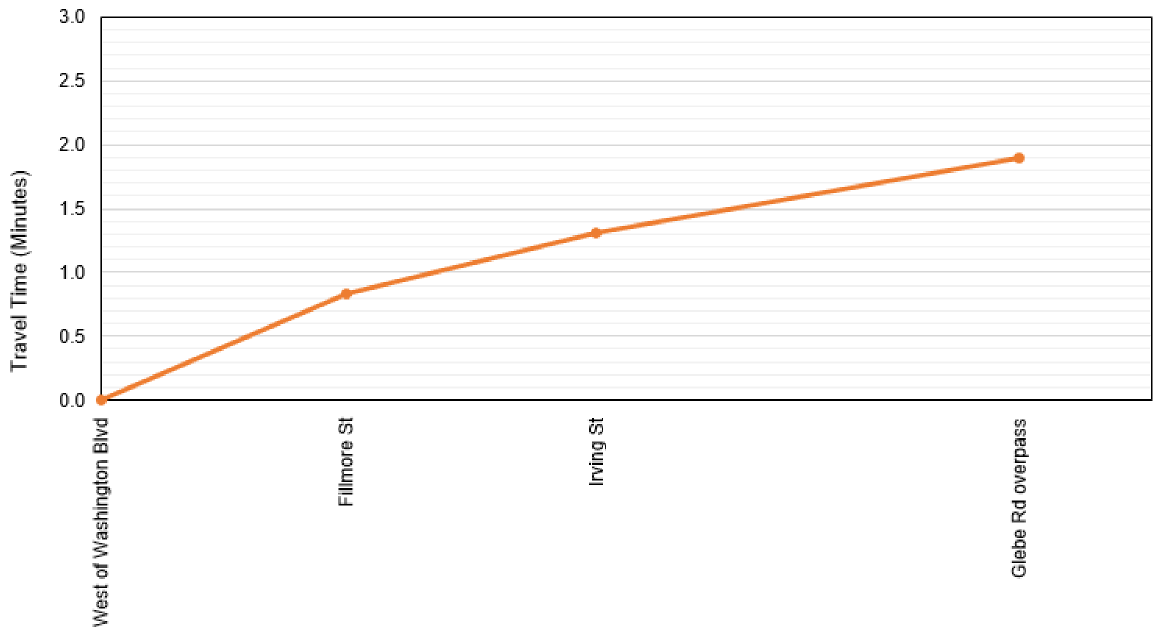


Figure 5-2b: PM Peak Hour – Westbound Route 50 Cumulative Travel Times (Existing Conditions)



5.2.2 Intersection Operations

Table 5-7 depicts overall intersection delay as well as the highest approach delay for both signalized and unsignalized intersections within the study area for the AM and PM peak hours for existing conditions. During both the AM and PM peak hours, all of the overall intersections operate under light or moderate traffic conditions with two exceptions. The signalized Route 50 intersection at Fillmore Street operates under heavy congestion during the PM peak hour due to high delays on the northbound Fillmore Street approach. The unsignalized Fillmore Street intersection at the south frontage road operates under severe congestion during the AM peak hour and PM peak hour due to the proximity of the frontage road intersection along Fillmore Street in relation to Route 50 and the inefficient operation of the frontage road intersection in relation to the signalized intersection. Although the majority of the intersections along Route 50 operate with overall light or moderate traffic conditions, seven of the eight intersections along Route 50 have minor street approaches with heavy or severe congestion in either the AM or PM peak hour with delays up to 135 seconds during the AM peak hour and up to 256 seconds during the PM peak hour. The minor street approach delays at the unsignalized intersections of Old Glebe Road, Hudson Street, Highland Street, Garfield Street, and Fenwick Street can be attributed to motorists being unable to find a gap in the heavy traffic volumes along eastbound and westbound Route 50.

Table 5-7: Intersection Delay Summary (Existing Conditions)

Intersection	Intersection Control	Existing Conditions Delay, (s)		
			AM Peak Hour	PM Peak Hour
Glebe Road at WB Route 50 ramps	Signalized	Overall	16	21
		Highest Approach	*77*	*62*
Glebe Road at EB Route 50 ramps	Signalized	Overall	22	15
		Highest Approach	*86*	*62*
Route 50 at Old Glebe Road	Stop	Overall	15	1
		Highest Approach	*63*	*9*
Route 50 at Jackson Street	Stop	Overall	14	1
		Highest Approach	*22*	*16*
Route 50 at Irving Street	Signalized	Overall	46	16
		Highest Approach	*123*	*84*
Route 50 at Hudson Street	Stop	Overall	6	2
		Highest Approach	*112*	*31*
Route 50 at Highland Street	Stop	Overall	4	3
		Highest Approach	*44*	*23*
Route 50 at Garfield Street	Stop	Overall	5	4
		Highest Approach	*106*	*20*
Route 50 at Fenwick Street	Stop	Overall	6	6
		Highest Approach	*53*	*37*
Route 50 at Fillmore Street	Signalized	Overall	35	58
		Highest Approach	*135*	*256*
Fillmore Street at North Frontage Road	Stop	Overall	33	28
		Highest Approach	*60*	*45*
Fillmore Street at South Frontage Road	Stop	Overall	83	96
		Highest Approach	*128*	*247*

5.3 2030 NO BUILD CONDITIONS TRAFFIC OPERATIONS

The No Build Alternative has been included for evaluation as a benchmark for the comparison of future conditions and impacts. The No Build Alternative would retain the same geometry as existing conditions including the undivided six-lane Route 50 facility with unrestricted access to all side streets within the study area and no turn lanes at Irving Street. There are no “No Build” improvements are proposed along Route 50 within the study limits in the National Capital Region Transportation Planning Board’s financially constrained element of Visualize 2045 and the VDOT Six-Year Improvement Plan.

5.3.1 Route 50 Travel Times

AM Peak Hour

A comparison of overall corridor travel times for existing conditions and 2030 No Build conditions is summarized in **Figures 5-3a and 5-3b** for eastbound and westbound Route 50 during the AM peak hour. Under 2030 No Build conditions, the eastbound total travel time is 3.3 minutes, which is 0.5 minutes greater than existing conditions. This increase in travel time primarily occurs in the first corridor segment approaching Irving Street. The Irving Street signal meters downstream traffic which results in similar travel times east of Irving Street between Existing and 2030 No Build conditions. The westbound travel time of 1.5 minutes is approximately the same as existing conditions.

Figure 5-3a: AM Peak Hour – Eastbound Route 50 Cumulative Travel Times (Existing and 2030 No Build Conditions)

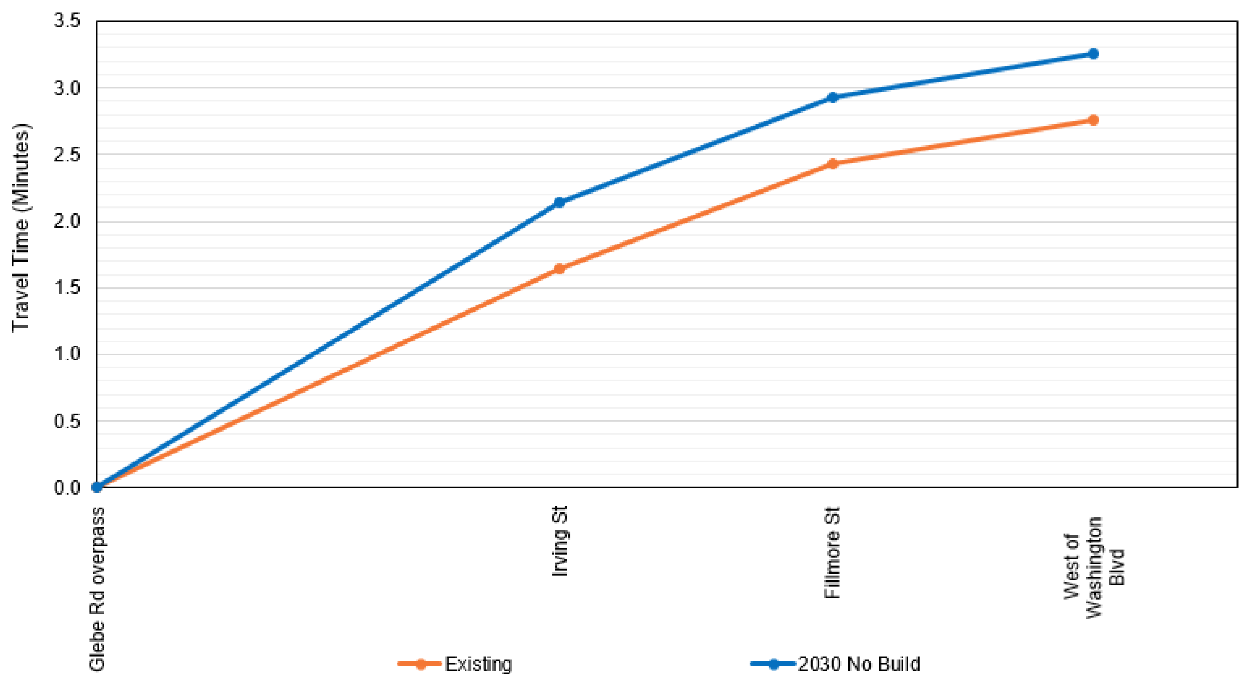
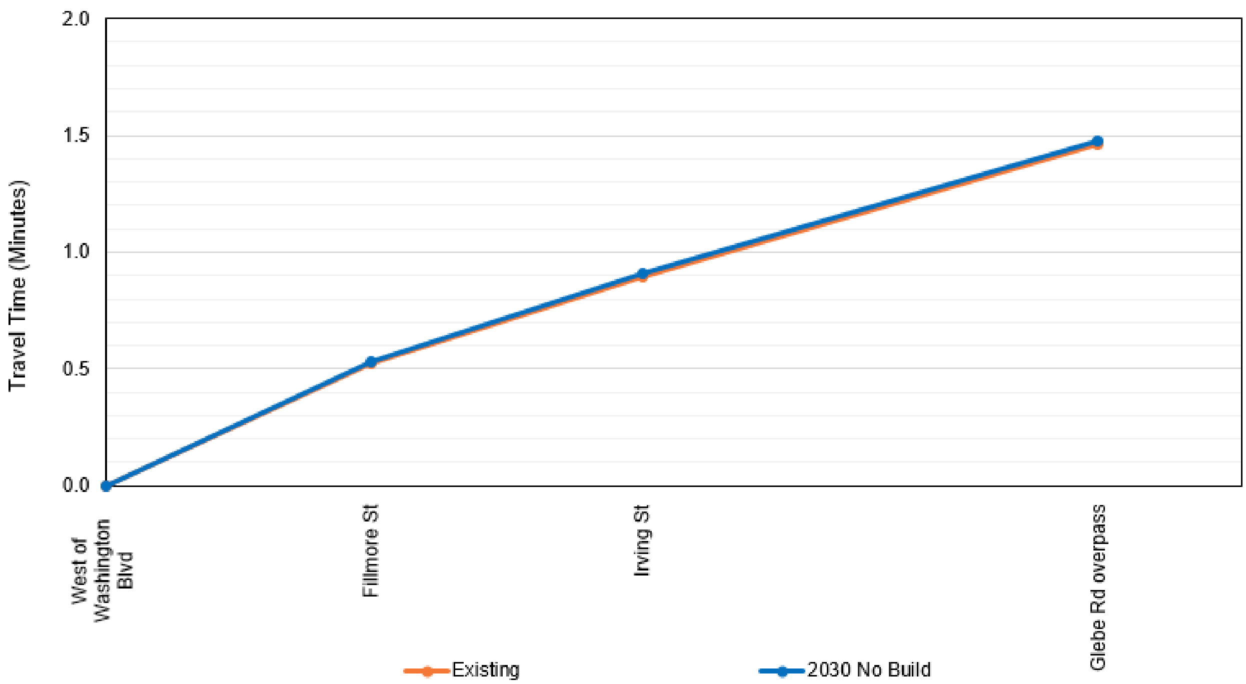


Figure 5-3b: AM Peak Hour – Westbound Route 50 Cumulative Travel Times (Existing and 2030 No Build Conditions)



PM Peak Hour

A comparison of overall corridor travel times for existing conditions and 2030 No Build conditions is summarized in **Figures 5-4a and 5-4b** for eastbound and westbound Route 50 during the PM peak hour. Under 2030 No Build conditions, the eastbound total travel time is 2.4 minutes, which is 0.3 minutes greater than existing conditions. This increase in travel time is due to a 7 second increase approaching Irving Street and a 12 second increase approaching Fillmore Street. The westbound travel time is 2.0 minutes under 2030 No Build conditions, which is 0.1 minutes greater than existing conditions.

Figure 5-4a: PM Peak Hour – Eastbound Route 50 Cumulative Travel Times (Existing and 2030 No Build Conditions)

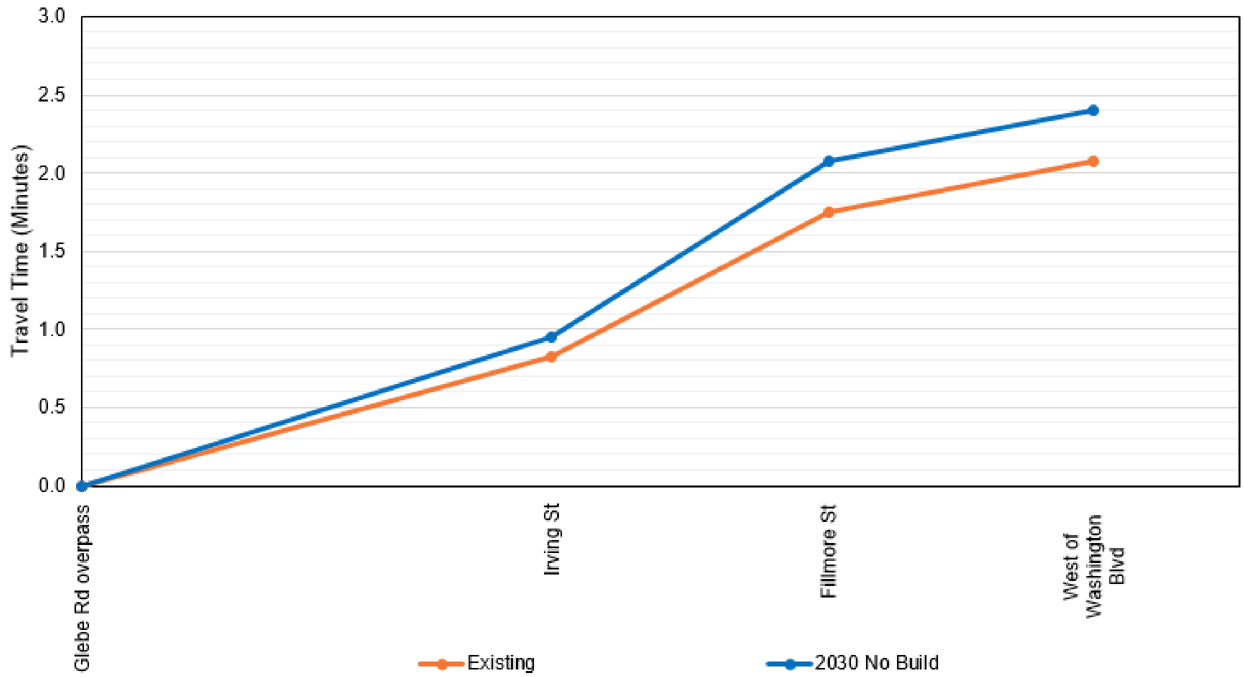
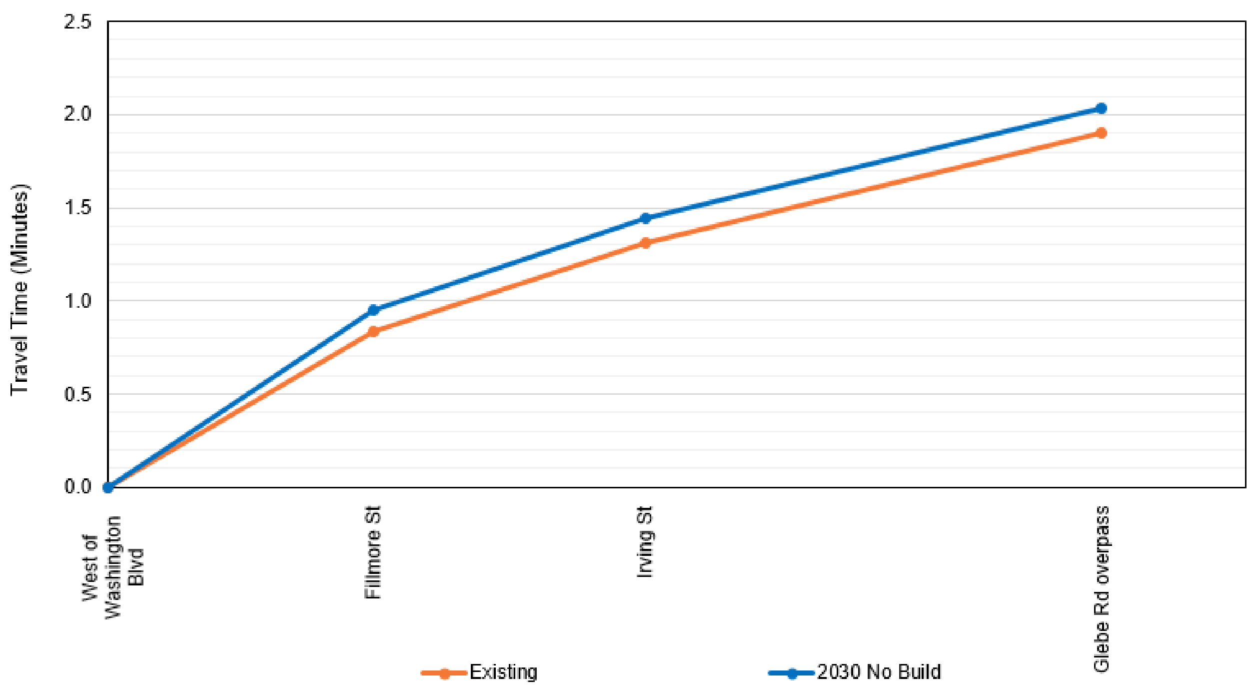


Figure 5-4b: PM Peak Hour – Westbound Route 50 Cumulative Travel Times (Existing and 2030 No Build Conditions)



5.3.2 Intersection Operations

Table 5-8 depicts overall intersection delay for both signalized and unsignalized intersections within the study area for the AM and PM peak hours for 2030 No Build conditions. Similar to existing conditions, it should be noted that although the majority of the intersections operate with overall light traffic conditions, the minor street approaches to Route 50 often experience heavy or severe congestion.

AM Peak Hour

During the AM peak hour, intersection delays under No Build conditions degraded at five intersections compared to existing conditions. The operations at Route 50 at Irving Street and Fillmore Street at the north frontage road degraded from moderate traffic conditions under existing conditions to heavy congestion under No Build conditions. Operations at the intersections of Glebe Road at the eastbound Route 50 ramps, Route 50 at Old Glebe Road, and Route 50 at Fillmore Street degraded from light traffic conditions under existing conditions to moderate traffic conditions under No Build conditions.

Although the majority of the intersections along Route 50 operate with overall light or moderate traffic conditions, seven of the eight intersections along Route 50 have minor street approaches with heavy or severe congestion in the AM peak hour with delays up to 210 seconds. Similar to existing conditions, the minor street approach delays to the unsignalized intersections at Old Glebe Road, Hudson Street, Highland Street, Garfield Street, and Fenwick Street can be attributed to motorists being unable to find a gap in the heavy traffic volumes along eastbound and westbound Route 50.

PM Peak Hour

During the PM peak hour, intersection delays under No Build conditions remained at the same congestion level as under existing conditions with one exception. The operations of Route 50 at Fillmore Street degraded from heavy congestion under existing conditions to severe congestion under No Build conditions. Four of the eight intersections along Route 50 have minor street approaches with heavy or severe congestion in the PM peak hour with delays up to 450 seconds.

Table 5-8: Intersection Delay Summary (Existing and 2030 No Build Conditions)

Intersection	Intersection Control	Scenario	Delay, (s)			
			Existing		No Build	
			AM Peak Hour	PM Peak Hour	AM Peak Hour	PM Peak Hour
Glebe Road at WB Route 50 ramps	Signalized	Overall	16	21	19	26
		Highest Approach	*77*	*62*	*92*	*71*
Glebe Road at EB Route 50 ramps	Signalized	Overall	22	15	38	34
		Highest Approach	*86*	*62*	*150*	*137*
Route 50 at Old Glebe Road	Stop	Overall	15	1	27	2
		Highest Approach	*63*	*9*	*70*	*12*
Route 50 at Jackson Street	Stop	Overall	14	1	18	3
		Highest Approach	*22*	*16*	*28*	*22*
Route 50 at Irving Street	Signalized	Overall	46	16	63	21
		Highest Approach	*123*	*84*	*151*	*90*
Route 50 at Hudson Street	Stop	Overall	6	2	6	3
		Highest Approach	*112*	*31*	*132*	*38*
Route 50 at Highland Street	Stop	Overall	4	3	5	5
		Highest Approach	*44*	*23*	*52*	*33*
Route 50 at Garfield Street	Stop	Overall	5	4	6	5
		Highest Approach	*106*	*20*	*161*	*28*
Route 50 at Fenwick Street	Stop	Overall	6	6	6	8
		Highest Approach	*53*	*37*	*63*	*42*
Route 50 at Fillmore Street	Signalized	Overall	35	58	42	81
		Highest Approach	*135*	*256*	*210*	*450*
Fillmore Street at North Frontage Road	Stop	Overall	33	28	36	31
		Highest Approach	*60*	*45*	*66*	*50*
Fillmore Street at South Frontage Road	Stop	Overall	83	96	132	162
		Highest Approach	*128*	*247*	*204*	*441*

6. ALTERNATIVES CONSIDERED

6.1 ALTERNATIVES DEVELOPMENT AND SCREENING PROCESS

A Stakeholder Working Group (SWG) comprised of VDOT representatives, Arlington County representatives, and the study team convened to discuss potential improvement alternatives to meet the needs of the corridor and enhance safety and operations. Representatives from the following agencies are included in the SWG:

- VDOT Transportation and Mobility Planning Division
- VDOT NOVA Transportation and Land Use
- VDOT Northern Region Operations
- VDOT NOVA Traffic Engineering
- VDOT NOVA Preliminary Engineering
- VDOT NOVA Transportation Planning
- Arlington County Department of Environmental Services – Traffic Engineering and Operations
- Arlington County Department of Environmental Services – Transportation Planning
- Study team (WRA and RK&K)

Based on a review of the existing safety conditions and existing and future year No Build traffic analysis results, conceptual alternatives were developed by the SWG to address the identified deficiencies. Public and stakeholder coordination was then initiated to inform the development and refinement of the conceptual alternatives including a public meeting, an online virtual presentation, a live virtual community meeting with a question and answer session, and two public surveys.

The following is a summary of the alternatives considered and evaluated including a No Build Alternative in order to provide a baseline for comparison.

6.2 NO BUILD ALTERNATIVE

The No Build Alternative has been included for evaluation as a benchmark for the comparison of future conditions and impacts. The No Build Alternative would retain the same geometry as existing conditions including the undivided six-lane Route 50 facility with unrestricted access to all side streets within the study area and no turn lanes at Irving Street. There are no planned improvements along Route 50 within the study limits in the National Capital Region Transportation Planning Board's financially constrained element of Visualize 2045 and the VDOT Six Year Improvement Program (SYIP).

6.3 BUILD ALTERNATIVES

The alternatives development process included the identification of alternatives for the Route 50 corridor including the eight study intersections along Route 50. Reasonable design alternatives were considered with a goal of addressing the identified safety and operational deficiencies.

In addition to the five alternatives and four supplemental improvement options described below, other alternatives such as a four-lane section with turn lanes and a seven-lane section with three lanes in each direction and a two-way left-turn lane were considered by the SWG. The alternative with a seven-lane section with a two-way left-turn lane was not considered further because it would not address the access management issues associated with the unsignalized intersections and the identified safety issues at these intersections.

An alternative with two travel lanes in each direction of Route 50, a raised median, and dedicated left-turn lanes at Irving Street and Fillmore Street was considered and a detailed operational analysis is summarized in **Appendix F**. This alternative would repurpose the existing innermost travel lanes along Route 50 as a raised median with left-turn lanes and would not require widening of Route 50. This scenario was not carried forward for more detailed study or presented to the public due to the operational issues that this alternative would create along this already congested section of Route 50. The average daily traffic volume (ADT) on Route 50 within the study area is approximately 64,800 vehicles per day and Route 50 within the study area has the highest volumes along Route 50 from Route 7 in Fairfax County to the Washington, D.C. line as shown in **Table 2-1**. Reducing the number of through lanes on Route 50 from six lanes to four lanes would reduce capacity and create substantial delays, especially at the signalized intersections along the corridor. In addition, Route 50 to the east and west of the study area consists of six travel lanes and reducing the number of travel lanes in this portion of the corridor would create a bottleneck. As shown in **Table 2-2**, all six travel lanes on Route 50 are currently being utilized with the percentage of traffic in each of the through lanes in the peak direction ranging from 27% to 40%. Although traffic utilization in slightly lower in the leftmost travel lanes in the peak direction (32% in the eastbound travel direction in the AM peak hour and 27% in the westbound travel direction in the PM peak hour) due to left-turning vehicles stopping in the through lanes, traffic volumes are relatively evenly distributed between all three travel lanes indication that the leftmost travel lane is not solely used as a de facto left-turn lane.

Based on the VISSIM operations analysis, reducing the number of travel lanes to a four-lane section on Route 50 would reduce capacity that would result in over 900 eastbound vehicles exceeding the capacity along Route 50 during the AM peak hour and over 1,100 westbound vehicles exceeding the capacity along Route 50 during the PM peak hour A portion of these vehicles would likely take alternate travel routes to avoid delays along Route 50 including Glebe Road, Washington Boulevard, and neighborhood streets such as 2nd Street. During the public engagement activities, diversion of traffic from Route 50 to alternate routes including neighborhood streets was repeatedly noted at a community concern. In addition, lane continuity throughout the corridor would suffer as a result of a through travel lane being dropped along both eastbound and westbound Route 50 entering the study area at Glebe Road and Washington Boulevard. This would cause motorists to make last minute lane changes and the potential for safety and operational issues where the lanes are reduced from three lanes to two lanes.

In summary, although a four-lane section with a raised median on Route 50 would eliminate the need for any widening along Route 50 within the study area and allow for the installation of left-turn lanes, it was not considered in more detail based on a review of traffic volumes and the capacity and operational analysis results. Therefore, an alternative with a four-lane section with a raised median and turn lanes was not carried forward for further conceptual design or analysis.

The SWG identified five alternatives for Route 50 and four supplemental options which could be independently included with any of the alternatives to be presented to the public for consideration and feedback.

As discussed in **Section 4.1**, growth rates were applied to the existing turning movements within the study area to develop future 2030 No Build conditions traffic volumes. Traffic volumes were developed for each Build Alternative by reassigning traffic to the study area roadways depending on the proposed improvements and movement restrictions under consideration.

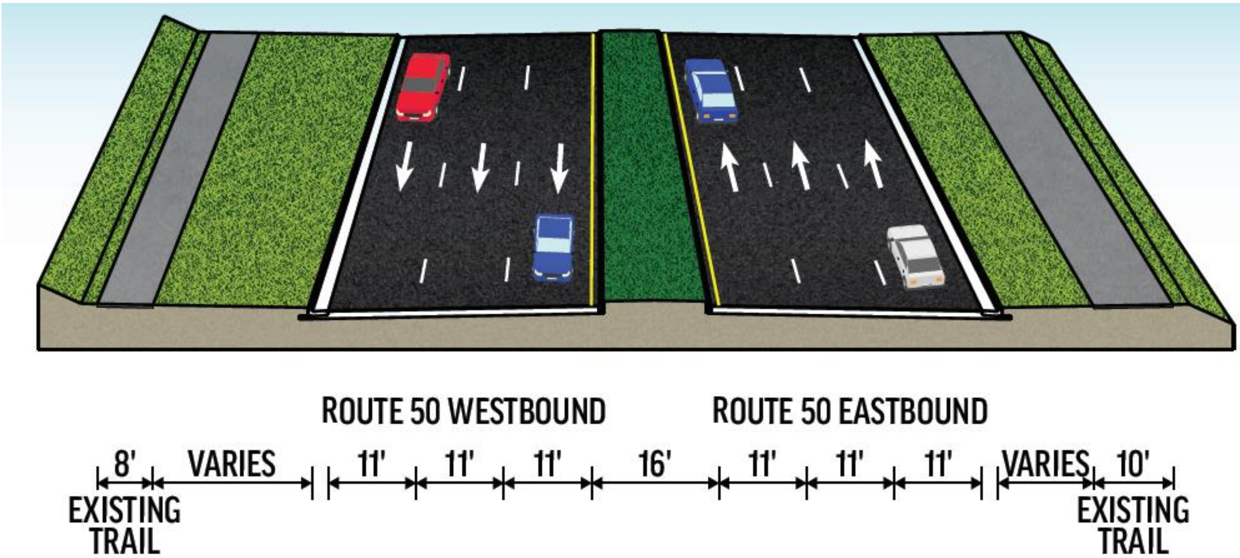
6.3.1 Route 50 Corridor Alternatives

All five alternatives for Route 50 include the extension of the left-turn lane on westbound Route 50 to Fillmore Street from 320 feet to 1,000 feet as well as the removal of on-street parking spaces on eastbound Route 50 between Garfield Street and Fenwick Street.

There are three variations of Alternative 1 (Alternatives 1a, 1b, and 1c) which each include a 14-foot raised grass median with a 1-foot offset to the travel lane with left-turn lanes at Irving Street and Fillmore Street and three travel lanes in each direction. The median would narrow at the left-turn lanes at Fillmore Street and Irving Street. The existing 8-foot and 10-foot wide trails on each side of Route 50 would remain or be reconstructed if they are impacted by the widening to accommodate the raised median. The installation of a raised grass median would restrict left-turn movements to and from unsignalized minor street approaches as well as through movements from unsignalized approaches to Route 50. The movement prohibitions at the unsignalized intersections would result in approximately 70 vehicles in the AM peak hour and approximately 85 vehicles in the PM peak hour to be reassigned to alternate routes in the corridor in the 2030 analysis year. Alternate routes include Irving Street, Fillmore, Glebe Road, Washington Boulevard, and roads parallel to Route 50.

The typical section for Alternatives 1a, 1b and 1c will maintain the same number of travel lanes that are currently provided along Route 50 in each direction. The widening of Route 50 would be limited to the amount of widening needed to construct the 16-foot median along the center of the roadway or approximately 8 feet on each side of Route 50. The existing roadway will not require widening in existing areas that include an 8-foot paved shoulder as these shoulders will be converted to the outer travel lanes. The proposed typical section will include curb and gutter to minimize grading and adjacent impacts. The typical section will maintain the minimum allowable 11-foot lane widths along the study corridor.

Figure 6-1: Typical Section - Alternatives 1a, 1b, and 1c



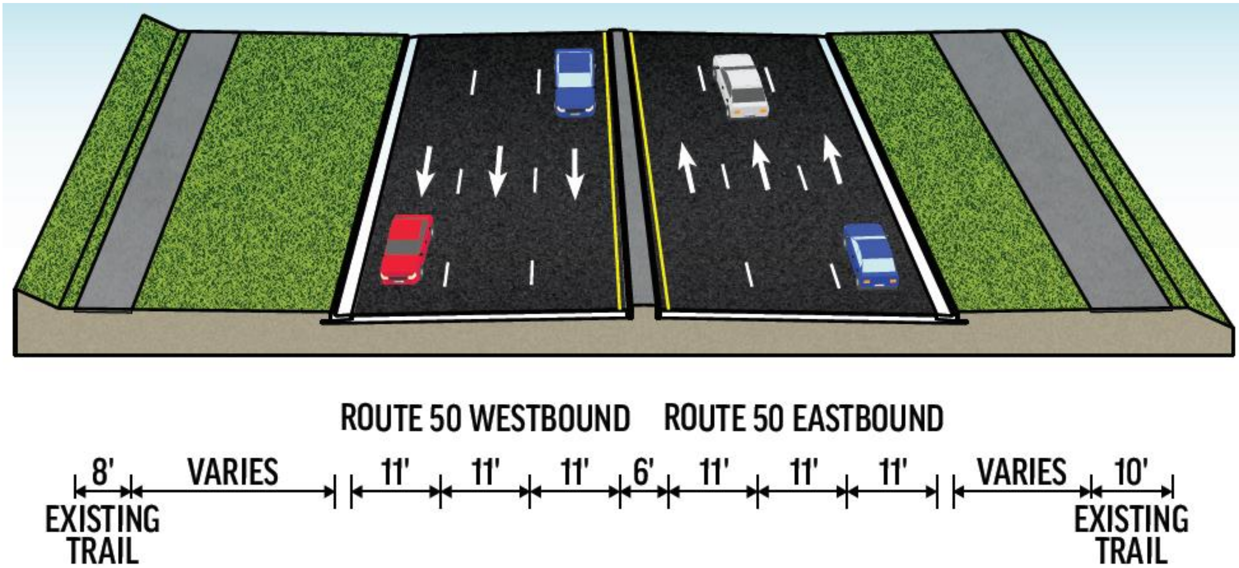
Alternative 1a (see **Figure 6-3**) includes a 16-foot raised median to prohibit left turns to and from the unsignalized intersections as shown in **Figure 6-1**. Three 11-foot travel lanes would be provided in each direction of Route 50 and openings in the median would be provided at the signalized intersections at Fillmore Street and Irving Street. New left-turn lanes would be installed on eastbound and westbound Route 50 at Irving Street that would reduce the potential for rear end crashes and help to balance traffic in each of the three through lanes along Route 50, increasing the safety and efficiency of intersection operations. Protected left-turn phasing would be provided similar to the existing Fillmore Street intersection to reduce the potential for left-turn angle crashes. As a result of the raised median, the left-turn volumes onto Irving Street and Fillmore Street are expected to increase. **Figures 6-4a and 6-4b** depict the AM and PM peak hour volumes for Alternative 1a.

Alternative 1b (see **Figure 6-5**) has the same typical section (see **Figure 6-1**) and similar geometry as Alternative 1a but includes some movement prohibitions. The through movements from Irving Street to cross Route 50 and the left-turn movements from Fillmore Street to Route 50 are prohibited with signing. Under existing conditions, the highest volume of pedestrians crossing Route 50 occurs at Fillmore Street. The left turn prohibitions from Fillmore Street would reduce pedestrian and bicycle conflicts; however, it may be difficult to enforce the turn restrictions. The prohibition of left-turn movements from Fillmore Street would also increase the efficiency of the concurrent traffic signal operation along Fillmore Street so that northbound and southbound left-turning vehicles would not block through vehicles attempting to travel through the intersection. Similarly, at Irving Street, the prohibition of through movements from Irving Street would allow northbound and southbound left turns from Irving Street to turn concurrently without yielding to opposing through vehicles, increasing the efficiency of signal operations. By prohibiting the Irving Street through movements and Fillmore Street left-turn movements, a portion of vehicular traffic would be rerouted to other routes including Irving Street, Fillmore Street, routes parallel to Route 50, and other roads outside the study area. **Figures 6-6a and 6-6b** depict the AM and PM peak hour volumes for Alternative 1b.

Alternative 1c (see **Figure 6-7**) also has the same typical section (see **Figure 6-1**) and similar geometry as Alternatives 1a and 1b but includes different movement prohibitions from Alternative 1b. Left turns from Irving Street to Route 50 and through movements from Fillmore Street across Route 50 would be prohibited with signing. Similar to limiting the left turns from Fillmore Street in Alternative 1b, by prohibiting the left turns from Irving Street in Alternative 1c, pedestrian and bicycle conflicts at the Irving Street intersection would be reduced. However, it may be difficult to enforce the movement restrictions at Irving Street and Fillmore Street. The prohibition of left-turn movements from Irving Street would also increase the efficiency of the concurrent traffic signal operation along Irving Street so that northbound and southbound left-turning vehicles would not block through vehicles attempting to travel through the intersection. Similarly, at Fillmore Street, the prohibition of through movements from Fillmore Street would allow northbound and southbound left turns from Fillmore Street to turn concurrently without yielding to opposing through vehicles, increasing the efficiency of signal operations. It should be noted that Alternative 1c would increase left-turn movements from Fillmore Street, the location with the highest pedestrian crossings of Route 50. By prohibiting the Irving Street left-turn movements and Fillmore Street through movements, a portion of vehicular traffic would be rerouted to other routes including Irving Street, Fillmore Street, routes parallel to Route 50, and other roads outside the study area. **Figures 6-8a and 6-8b** depict the AM and PM peak hour volumes for Alternative 1c.

Alternative 2 (see **Figure 6-9**) includes a 4-foot raised concrete median with a 1-foot offset to the travel lane (see **Figure 6-2**) which would result in less widening of Route 50 compared to Alternative 1. Similar to Alternative 1, the raised median would prohibit left-turns to and from unsignalized side streets. Left-turning movements from Route 50 to Irving Street would be prohibited with signs and left-turn lanes would not be provided which would divert traffic to the Fillmore Street intersection. Prohibiting the left-turns onto Irving Street results in reduced conflict points at Irving Street but a longer eastbound Route 50 travel time due to more traffic turning onto Fillmore Street. The left-turn prohibitions onto Irving Street may be difficult to enforce, especially during off-peak periods. Similar to Alternative 1a, 1b, and 1c, the westbound left-turn lane storage at Fillmore Street would be extended. **Figures 6-11a and 6-11b** depict the AM and PM peak hour volumes for Alternative 2.

Figure 6-2: Typical Section – Alternative 2



The typical section for Alternative 2 will maintain the same number of travel lanes that are currently provided along Route 50 in each direction. Alternative 2 will require less widening than Alternatives 1a, 1b and 1c. The widening is limited to the amount needed to construct the 4-foot median along the center of the roadway. Therefore, the amount of widening to each side is approximately 2 feet. The existing roadway will not require widening in existing areas that include an 8-foot paved shoulder as portions of these shoulders will be converted to the outer travel lanes. The proposed typical section will include curb and gutter to minimize grading and adjacent impacts. The typical section will maintain the minimum allowable 11-foot lane widths along the study corridor.

Alternative 3 (see **Figure 6-10**) would have the same cross section as existing conditions with no median or physical separation between the two travel directions of Route 50. Left-turns at unsignalized intersections would be prohibited with signing and right-in/right-out islands. Similar to Alternative 2, left turns onto Irving Street would be prohibited and no left-turn lanes would be provided which would divert traffic to Fillmore Street. Similar to Alternative 2, prohibiting left turns onto Irving Street results in reduced conflict points at Irving Street but a longer eastbound Route 50 travel time due to more traffic turning onto Fillmore Street. Alternative 2 requires no widening of Route 50, but enforcement of the turn restrictions would be difficult and would likely require overhead sign structures to install the No Left Turn signs along Route 50. The volumes forecasts for Alternative 3 are expected to be the same as Alternative 2 because prohibited and permitted turning movements are the same between both alternatives. **Figures 6-11a and 6-11b** depict the AM and PM peak hour volumes for Alternative 3.

Figure 6-3: Alternative 1a – Raised Median with Left-Turn Lanes at Irving Street and Fillmore Street

Figure 6-4a: Peak Hour Volumes – 2030 Build Alternative 1a AM Peak Hour

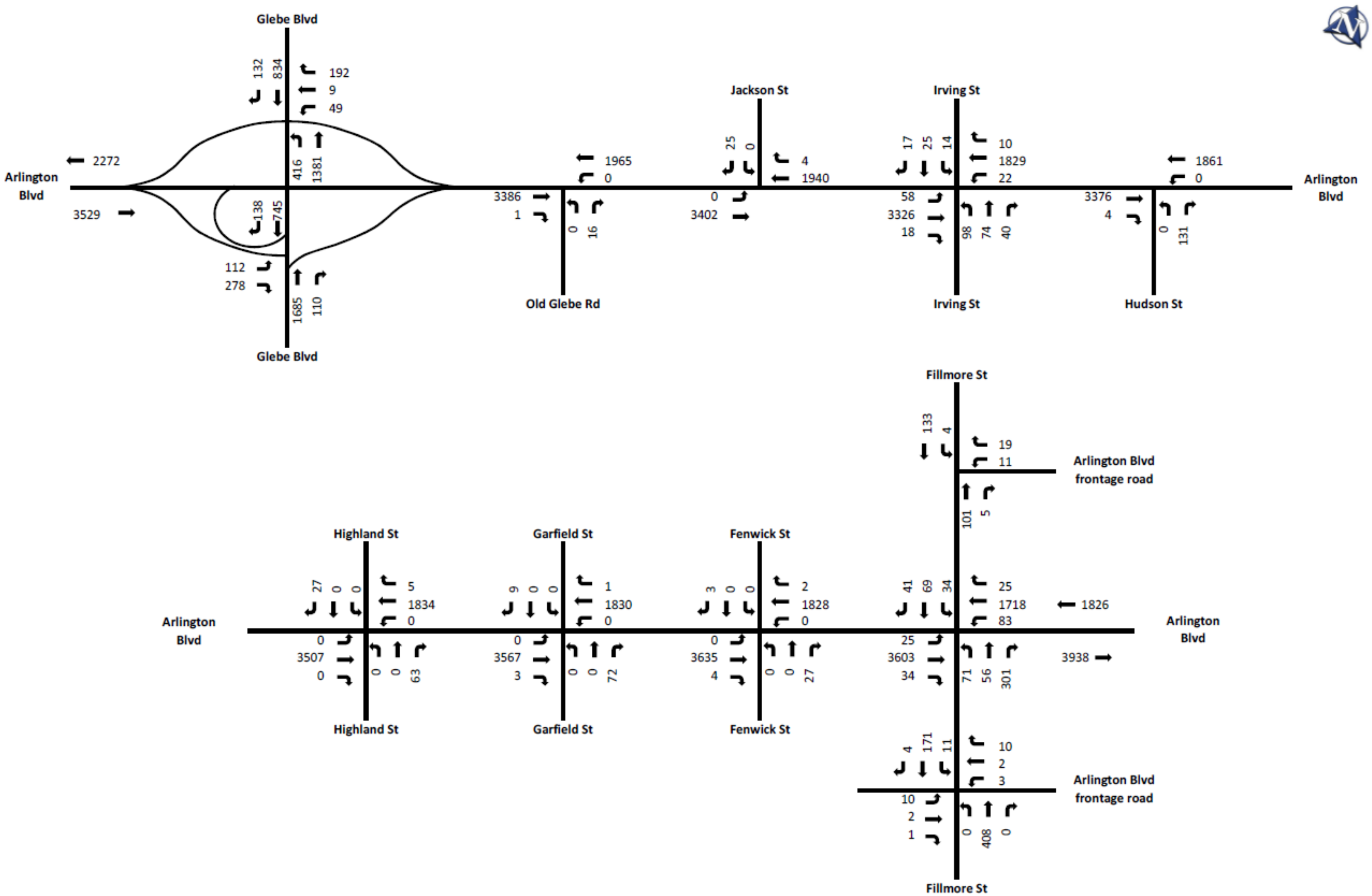


Figure 6-4b: Peak Hour Volumes – 2030 Build Alternative 1a PM Peak Hour

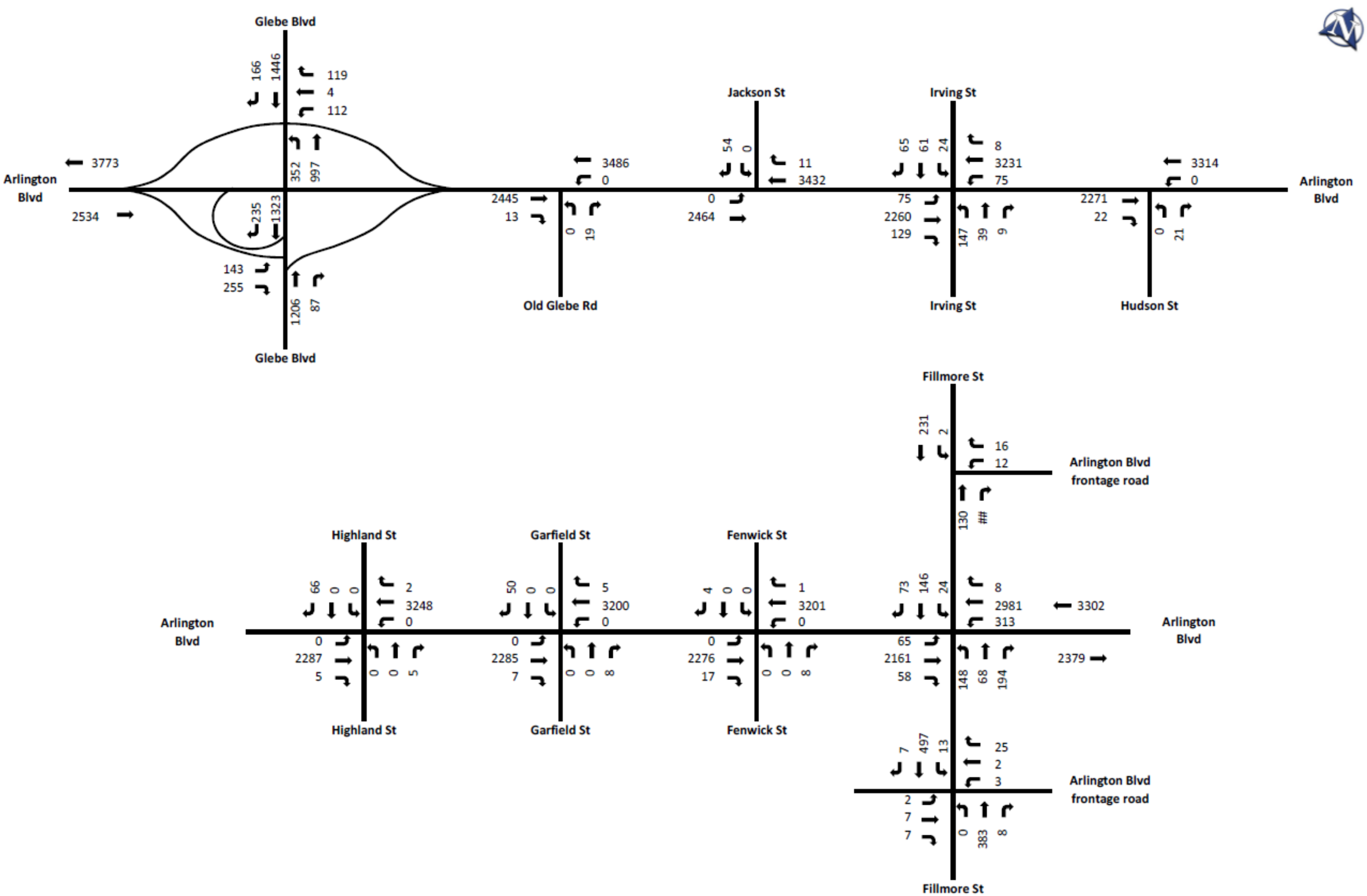


Figure 6-5: Alternative 1b – Raised Median with Left-Turn Lanes at Irving Street and Fillmore Street

Figure 6-6a: Peak Hour Volumes – 2030 Build Alternative 1b AM Peak Hour

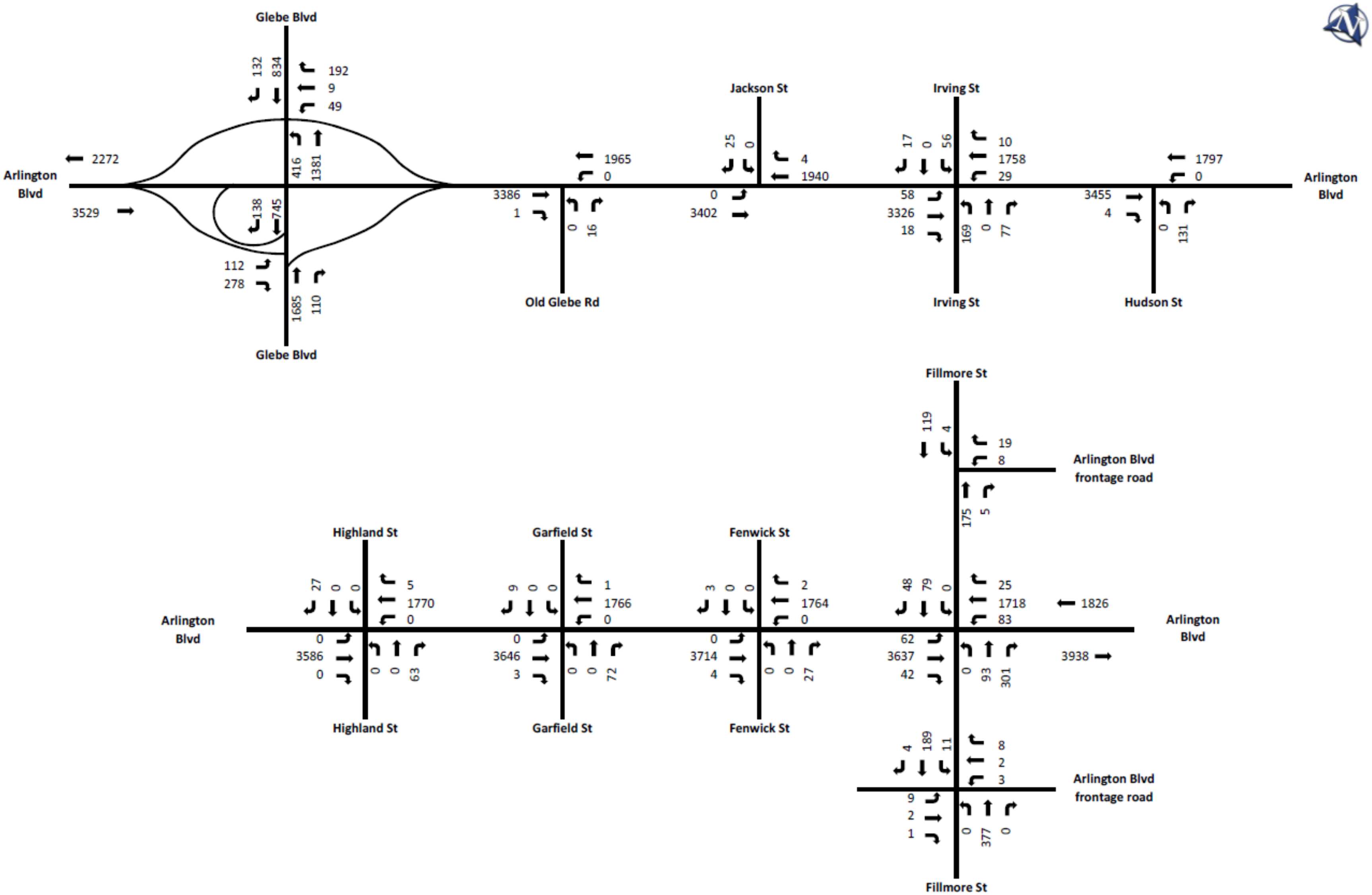


Figure 6-6b: Peak Hour Volumes – 2030 Build Alternative 1b PM Peak Hour

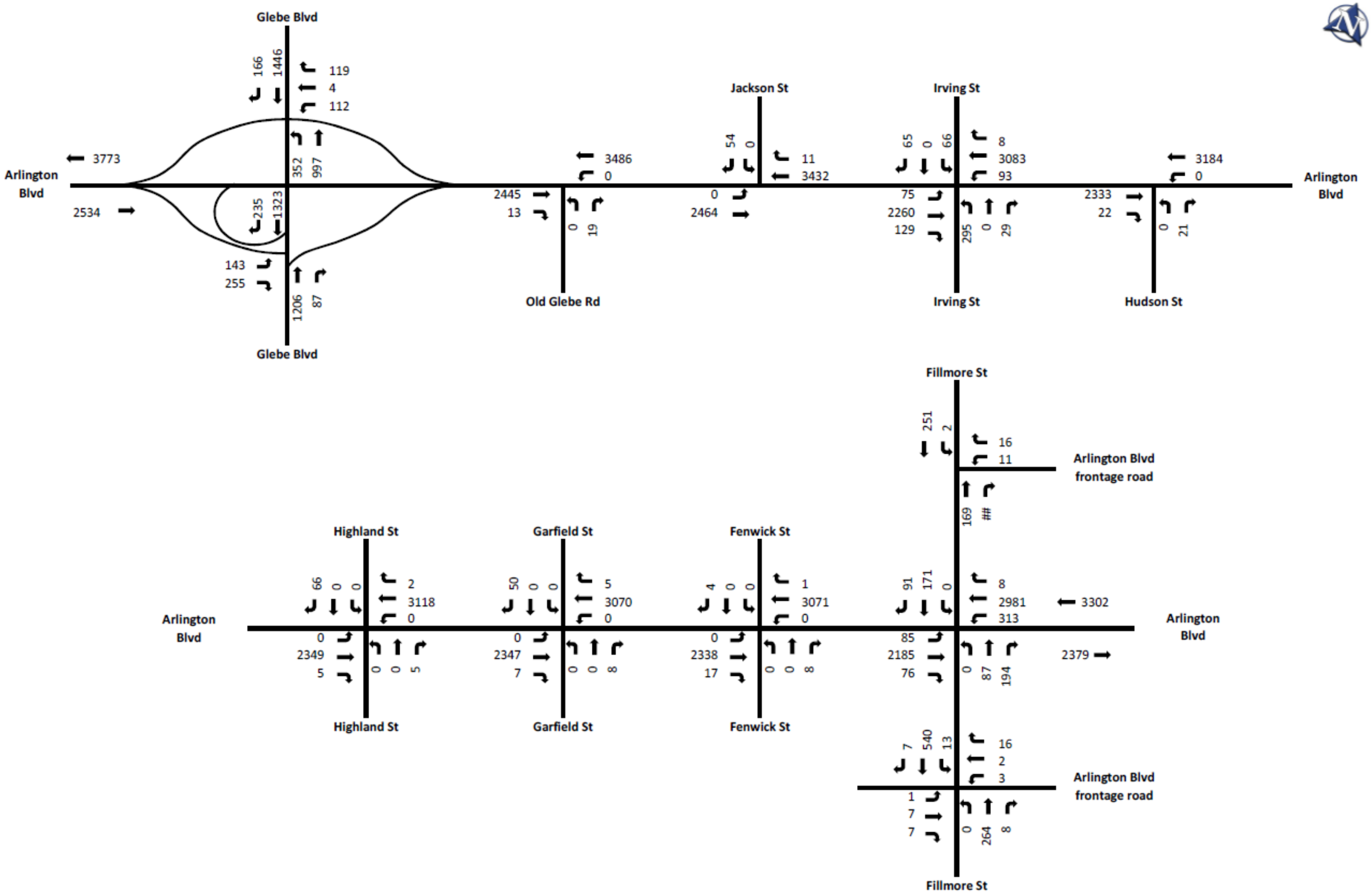


Figure 6-7: Alternative 1c – Raised Median with Left-Turn Lanes at Irving Street and Fillmore Street

Figure 6-8a: Peak Hour Volumes – 2030 Build Alternative 1c AM Peak Hour

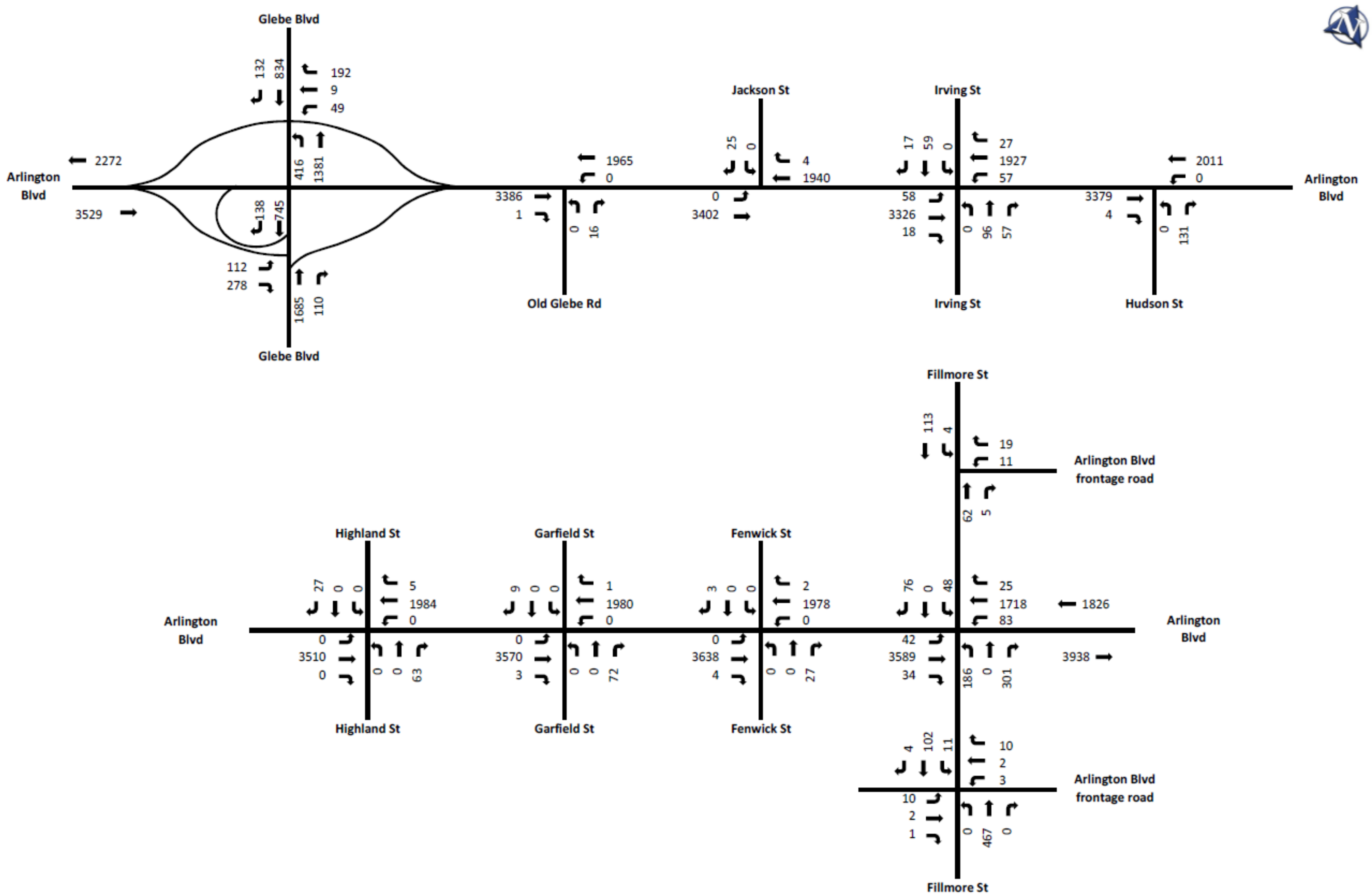


Figure 6-8b: Peak Hour Volumes – 2030 Build Alternative 1c PM Peak Hour

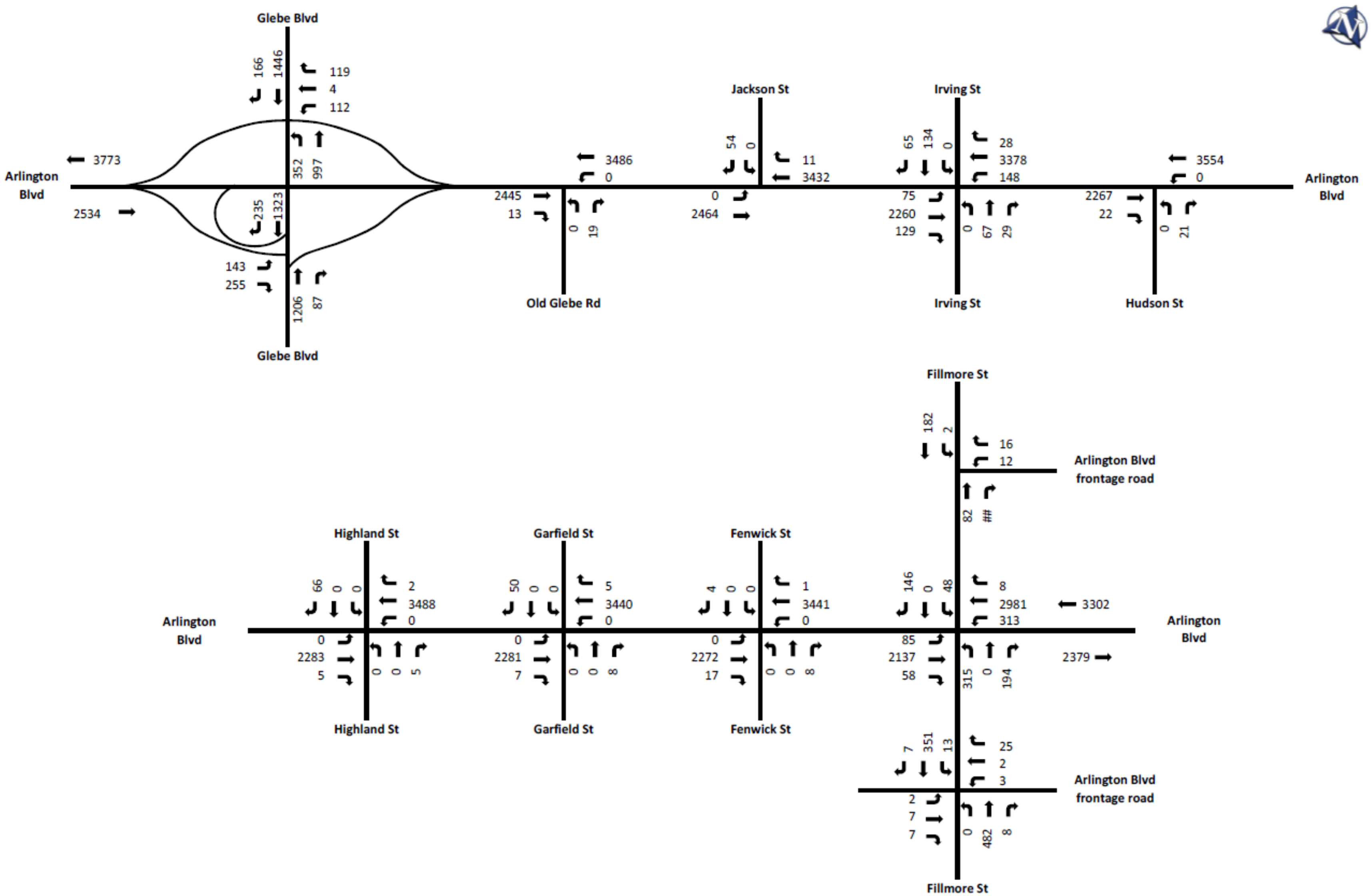


Figure 6-9: Alternative 2 – Raised Median with Left-Turn Lanes at Fillmore Street

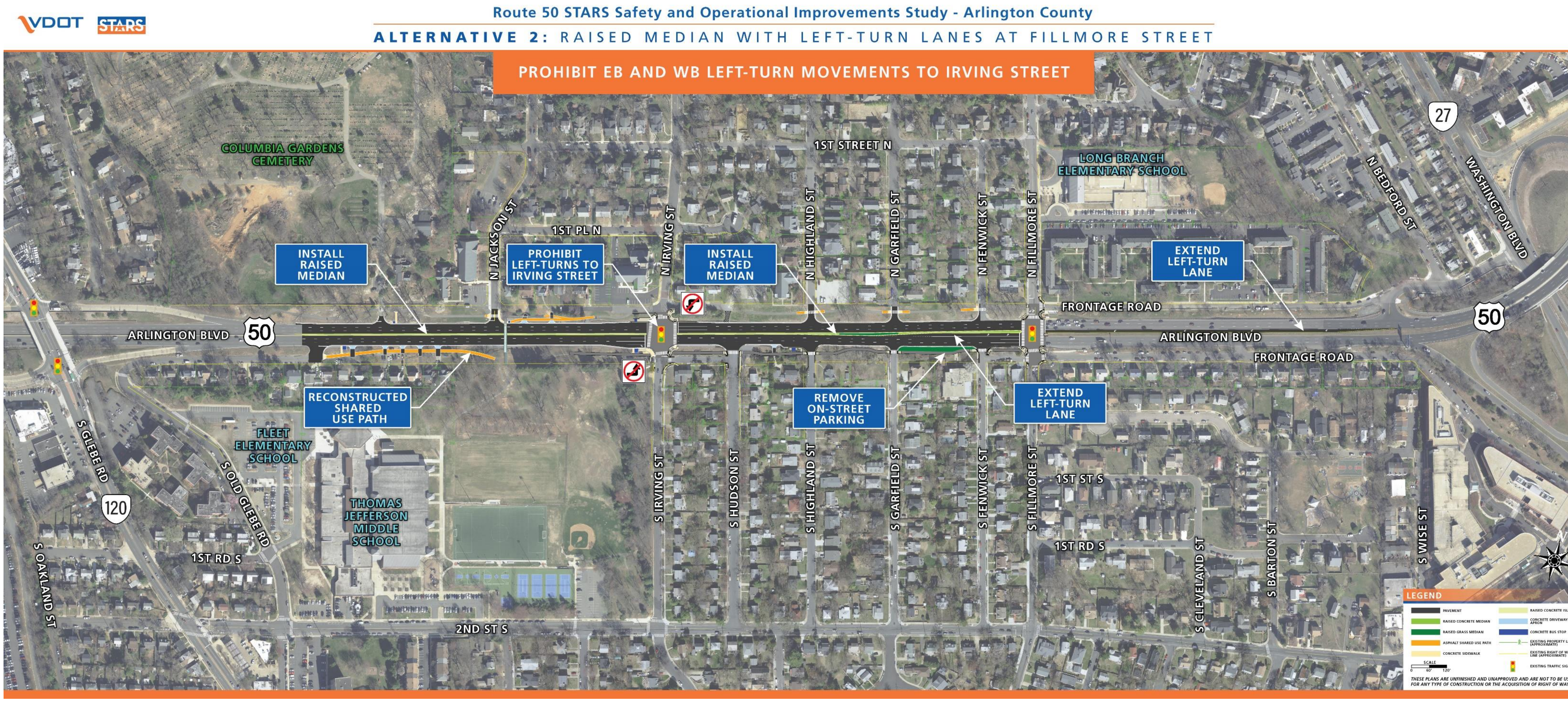


Figure 6-10: Alternative 3 – No Left Turns at Unsignalized Intersections

Figure 6-11a: Peak Hour Volumes – 2030 Build Alternative 2 and Alternative 3 AM Peak Hour

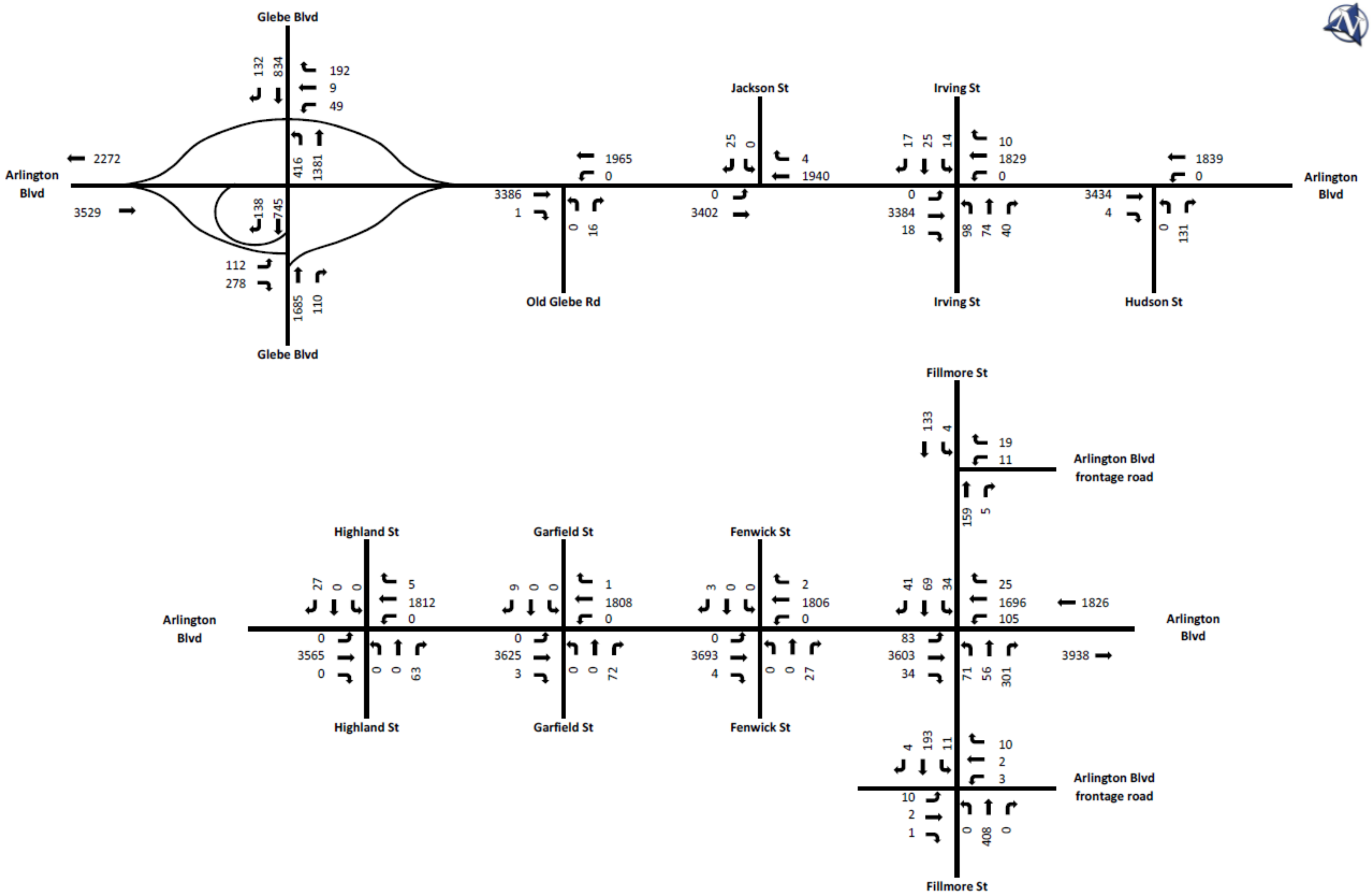
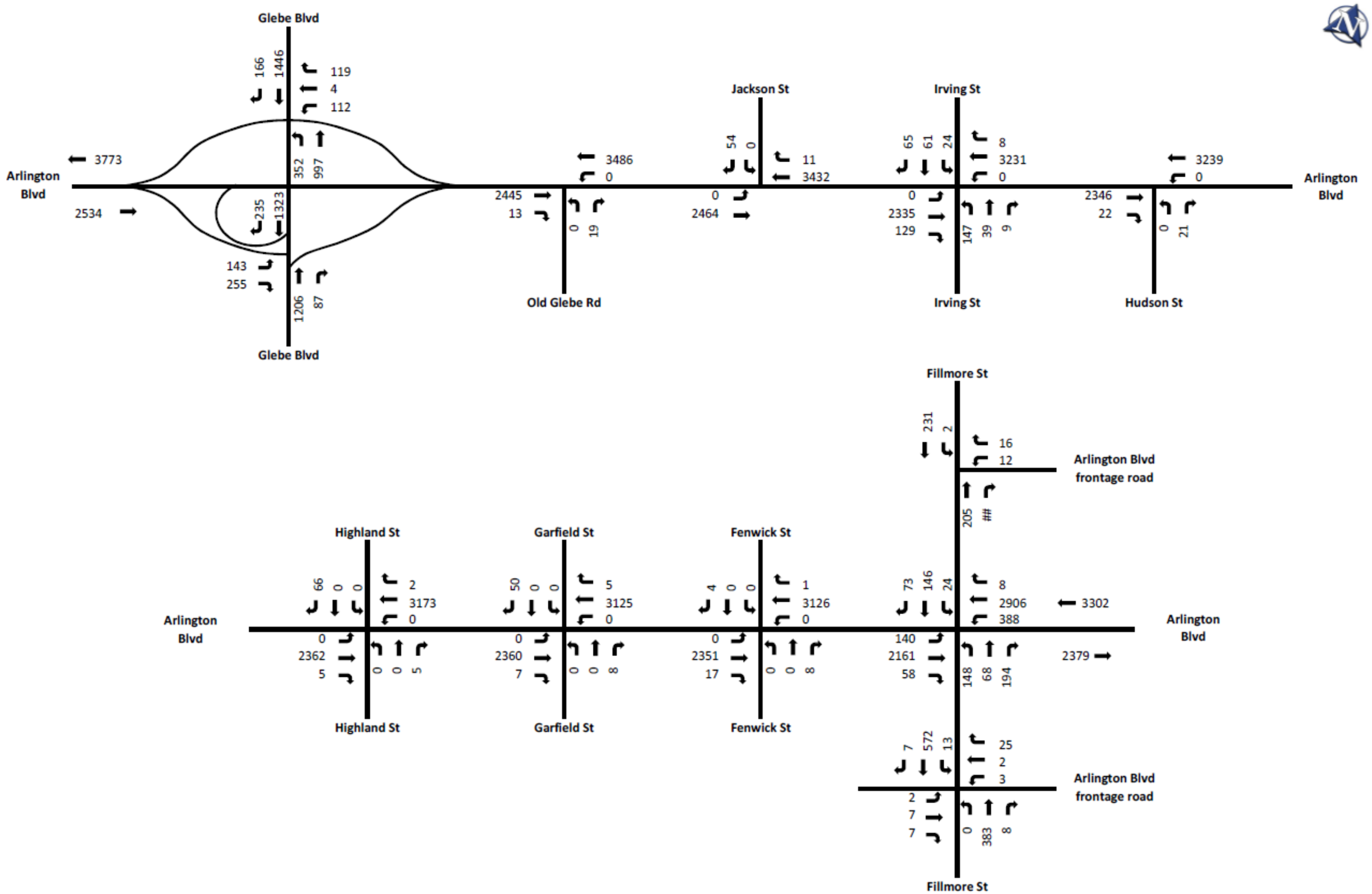


Figure 6-11b: Peak Hour Volumes – 2030 Build Alternative 2 and Alternative 3 PM Peak Hour

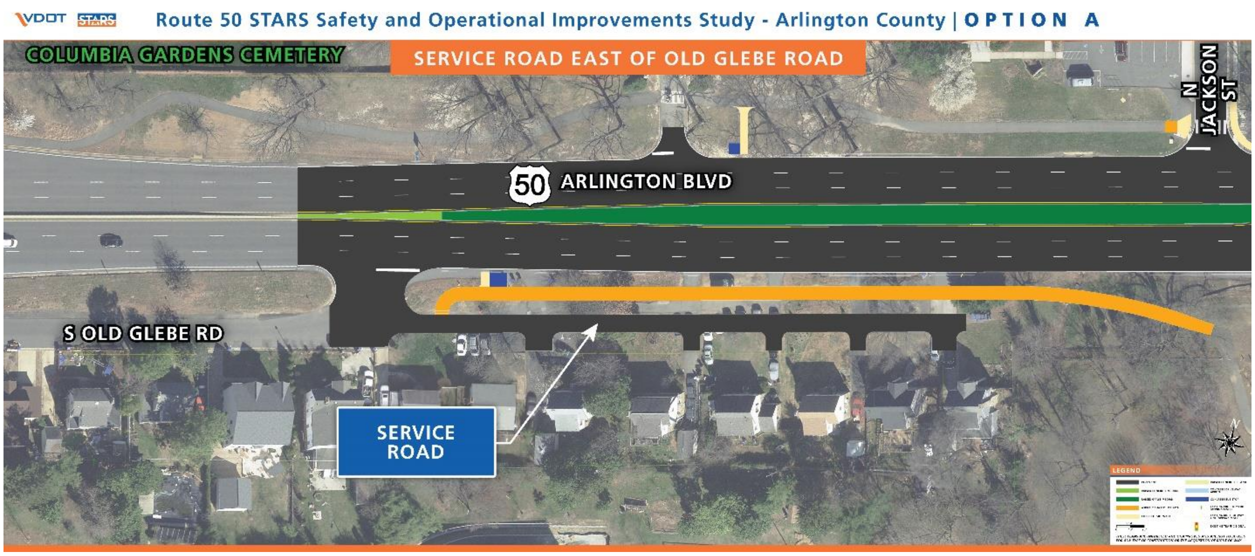


6.3.2 Supplemental Options

Four independent supplemental options were considered which could each be implemented with any of the five Alternatives under consideration.

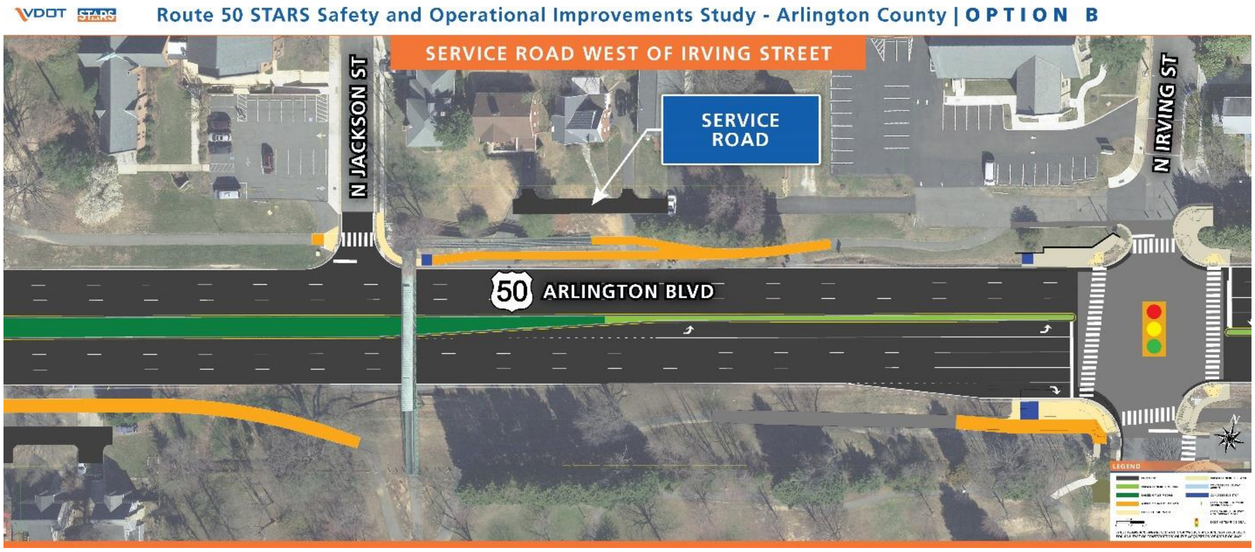
Option A (see **Figure 6-12**) is a service road serving as an extension of Olde Glebe Road. The service road would eliminate five residential driveways on Route 50 and improve safety by reducing conflict points on Route 50 as well as conflict points along the Arlington Boulevard Trail.

Figure 6-12: Option A – Service Road East of Old Glebe Road



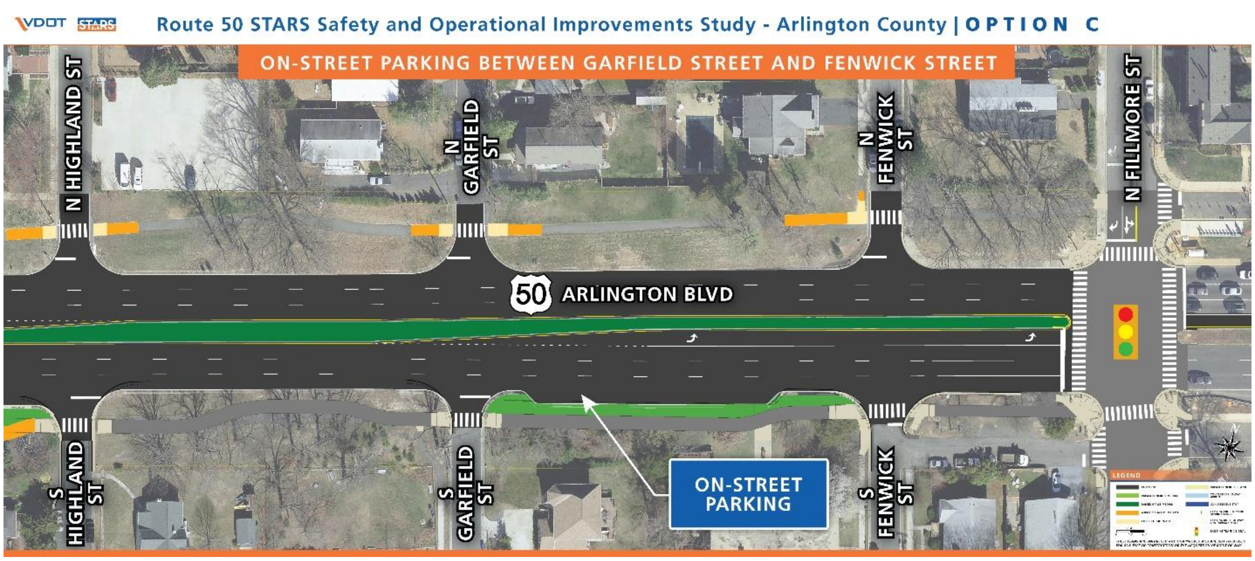
Option B (see **Figure 6-13**) is an extension of the service road north of Route 50 and west of Irving Street that would eliminate two residential driveways on Route 50 and improve vehicular safety and pedestrian safety by reducing conflict points on Route 50 as well as eliminating two conflict points along the Arlington Boulevard Trail.

Figure 6-13: Option B – Service Road West of Irving Street



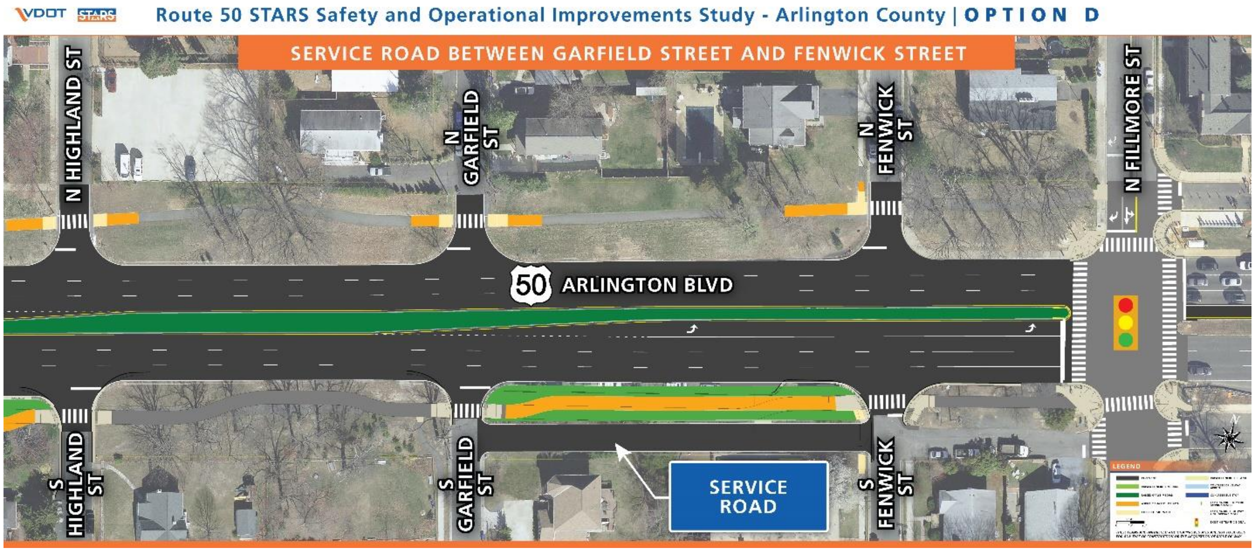
Option C (see **Figure 6-14**) maintains the nine on-street parking spaces between Garfield Street and Fenwick Street where parking is currently allowed. The Congregation Etz Hayim uses these parking spaces for their handicapped members as well as pick-up and drop-off for services and events. Maintaining parking along Route 50 does not eliminate the potential for conflicts when vehicles enter and exit the parking spaces. It should be noted that it is very atypical for a corridor such as Route 50 to have on-street parking.

Figure 6-14: Option C – On-Street Parking between Garfield Street and Fenwick Street



Option D (see **Figure 6-15**) extends the service road between Garfield Street and Fenwick Street in conjunction with the removal of on-street parking on Route 50. On-street parking would be permitted on the new service road.

Figure 6-15: Option D – Service Road between Garfield Street and Fenwick Street



7. SAFETY ASSESSMENT OF THE ALTERNATIVES

With the anticipated growth in travel demand along Route 50, congestion will increase and correspondingly, crash frequency will increase under future No Build conditions. The alternatives under consideration will improve safety, reduce conflict points, and reduce the potential for crashes.

7.1 SUMMARY OF CRASH MODIFICATION FACTORS

The Highway Safety Manual (HSM) presents a variety of quantitative methods for estimating crash frequency or severity for various facility types including the application of crash modification factors (CMF). The quantitative safety analysis focuses on the review of available CMFs contained in the Crash Modification Factors Clearinghouse and their application to the alternatives under consideration. The Crash Modification Factors Clearinghouse is a web-based comprehensive listing of available CMFs including both those included and not included in the HSM. A CMF is a multiplicative factor used to compute the expected number of crashes after implementing a given countermeasure at a specific location. Applicable CMFs were identified for each of the proposed design elements and applied to calculate the predicted change in crash frequency. In addition to a review of CMFs, a comparison of merging, diverging, and crossing conflict points along Route 50 under No Build conditions and with the alternatives under consideration was also performed.

The predictive methods contained in the HSM may be used to document the safety impacts associated with proposed improvements and determine the impact that changes will have on crash frequency and safety. However, the available predictive methods in the HSM do not evaluate six lane roadway facilities which is planned as part of the Build Alternative. Therefore, the quantitative safety analysis focused on the application of CMFs to historical crash frequency as well as a comparison of conflict points.

Table 7-1 summarizes the relevant CMFs discussed below. The CMFs were applied to Route 50 from Glebe Road to east of Fillmore Street where corridor improvements are proposed to calculate the predicted crash frequency for each location.

Table 7-1: Application of Crash Modification Factors

Design Element	Crash Type (Severity)	Crash Modification Factor	CMF ID	CMF Star Rating	Historical Crash Frequency (2014 – 2018)	Predicted Crash Frequency (2014 – 2018)	Change in Crashes (2014 – 2018)
Install raised median (Alternatives 1a, 1b, 1c, and 2)	Injury and Fatal	0.78	22	5	52	41	-11
	Property Damage Only	1.09	23	5	168	183	15
Extend WB left-turn lane at Fillmore Street (Alternatives 1a, 1b, 1c, 2, and 3)	Injury and Fatal	0.85	VA State Preferred CMF List		13	11	-2
	Property Damage Only	1.00	VA State Preferred CMF List		27	27	0
Install EB and WB left-turn lanes at Irving Street (Alternatives 1a, 1b, and 1c)	Injury and Fatal	0.83	274	5	13	11	-2
	Property Damage Only	0.81	270	3	50	41	-10
Install EB and WB protected left-turn phasing at Irving Street (Alternatives 1a, 1b, and 1c)	Injury and Fatal	0.01	333	5	1	0	-1
	Property Damage Only	0.01	333	5	9	0	-9

A summary of major design elements associated with the alternatives under consideration that may contribute to safety within the study limits are discussed below.

7.1.1 Install Raised Median along Route 50 (Alternatives 1a, 1b, 1c, and 2)

The installation of a raised median along Route 50 with Alternatives 1a, 1b, 1c, and 2 will improve access management along the Route 50 corridor and reduce the potential for angle crashes and rear end crashes, particularly at unsignalized intersections where left-turn lanes and signalization is not provided. Sixty percent of crashes reported along Route 50 were rear end collisions and 25 percent were angle crashes.

Although signalized pedestrian crossings are provided at the Route 50 at Irving Street and Route 50 at Fillmore Street intersections and a pedestrian overpass is provided just east of Jackson Street, there is the potential that pedestrians will attempt to cross at midblock locations or at unsignalized intersections. A raised median will provide a refuge area and allow pedestrians to cross one direction of traffic at a time, significantly reducing the complexity of the pedestrian crossing. Additionally, although the signalized pedestrian crossings of Route 50 at Irving Street and Fillmore Street are timed such that pedestrians can cross both the eastbound and westbound Route 50 travel directions within the allocated pedestrian signal timings, a raised median provides a refuge area for a pedestrian who may potentially become “trapped” in the middle of the intersection and is not able to cross both directions of Route 50.

The CMF for installing a raised median between the eastbound and westbound Route 50 travel lanes (CMF ID 22 and 23) is 0.78 for injury and fatal crashes indicating a 22 percent reduction in the most severe types of crashes and 1.09 for property damage only (PDO) crashes indicating a 9 percent increase in the less severe types of crashes. **Table 7-1** summarizes the application of this CMF to reported crashes along Route 50 within the study limits. By applying this CMF, the predicted crash frequency along Route 50 with the installation of a raised median is reduction of 11 injury crashes and an increase in 15 property damage only crashes.

7.1.2 Extend the Westbound Route 50 Left-Turn at Fillmore Street

All five alternatives include the extension of the westbound Route 50 left-turn lane at Fillmore Street. Under existing conditions, queue lengths frequently extend outside of the westbound left-turn storage and impede westbound Route 50 through traffic during the PM peak hours. The CMF for extending a left-turn lane is 0.85 for injury and fatal crashes indicating a 15 percent reduction in the most severe types of crashes. **Table 7-1** summarizes the application of this CMF to reported crashes along Route 50 within the study limits. By applying this CMF, the predicted crash frequency along Route 50 is reduced by 2 injury crashes.

7.1.3 Install Eastbound and Westbound Route 50 Left-Turn Lanes at Irving Street (Alternatives 1a, 1b, and 1c)

Alternatives 1a, 1b, and 1c include the installation of eastbound and westbound Route 50 left-turn lanes onto Irving Street where left-turn lanes are not currently present. The CMF for the installation of a left-turn lane (CMF ID 274 and 270) is 0.83 (or a 17 percent reduction) for injury and fatal crashes and 0.81 (or a 19 percent reduction) for property damage only crashes. **Table 7-1** summarizes the application of these CMFs to reported crashes at the intersection. By applying this CMF, the crash frequency at the Route 50 at Irving Street intersection is predicted to decrease by approximately 2 injury crashes and 10 property damage only crashes.

7.1.4 Install Eastbound and Westbound Route 50 Protected Left-Turn Phasing at Irving Street (Alternatives 1a, 1b, and 1c)

Alternatives 1a, 1b, and 1c include the installation of eastbound and westbound Route 50 protected left-turn phasing at Irving Street that will significantly reduce the potential for left-turn angle crashes involving Route 50 motorists turning onto Irving Street. Ten left-turn crashes were reported involving left turns onto Irving Street during the study period. The CMF for the installation of protected-only phasing (CMF ID 333) is 0.01 (or a 99 percent reduction) for injury and fatal crashes and property damage only crashes. **Table 7-1** summarizes the application of this CMF to reported crashes along Route 50 within the study area. By applying this CMF, the crash frequency along Route 50 within the study area is predicted to decrease by approximately 1 injury crash and 9 property damage only crashes.

7.2 SUMMARY OF CONFLICT POINTS

Table 7-2 summarizes the conflict points under No Build and Build conditions for each of the alternatives under consideration. As shown, there are currently a total of 187 conflict points at the eight intersections along Route 50 including 89 crossing conflict points, the type of conflict points that typically result in angle crashes, the most severe types of crashes. All five of the Build alternatives will reduce the total number of conflict points by over 50% (over 100 conflict points). The majority of these conflict point reductions are due to the prohibition of left-turn movements to and from unsignalized side streets. Alternative 1a would reduce the number of crossing conflict points by 57 (64%) and total conflict points by 105 (56%). Alternatives 1b and 1c would reduce the number of crossing conflict points by 73 (82%) and total conflict points by 129 (69%). Conflict point reductions are greater with Alternatives 1b and 1c compared to Alternative 1a due to the four prohibited movements at Fillmore Street and Irving Street. Prohibiting the northbound and southbound through movements at Irving Street and the northbound and southbound left-turn movements at Fillmore Street under Alternative 1b eliminates 8 crossing conflict points and 12 total conflict points at each of the Irving Street and Fillmore Street intersections. Similar to Alternative 1b, prohibiting the northbound and southbound left-turn movements at Irving Street and the northbound and southbound through movements at Fillmore Street under Alternative 1c eliminates 8 crossing conflict points and 12 total conflict points at each of the Irving Street and Fillmore Street intersections. Alternatives 2 and 3 would reduce the number of crossing conflict points by 65 (73%) and total conflict points by 117 (63%). Conflict point reductions are greater with Alternatives 2 and 3 compared to Alternative 1a due to the two prohibited movements. Prohibiting the eastbound and westbound left-turn movements to Irving Street with Alternatives 2 and 3 eliminates 8 crossing conflict points and 12 total conflict points at Irving Street.

It should also be noted that by eliminating left-turn movements to and from unsignalized side streets, the number of conflict points with the Arlington Boulevard Trail will decrease. Alternatives 1b and 1c will reduce the number of pedestrian and bicyclist conflict points on the Arlington Boulevard Trail by the greatest amount due to the prohibition of select side street movements from Irving Street and Fillmore Street.

Table 7-2: Alternatives Conflict Point Comparison

Intersection	No Build				Build Alternative															
					Alternative 1a				Alternative 1b				Alternative 1c				Alternative 2/3			
	Diverging	Merging	Crossing	Total	Diverging	Merging	Crossing	Total	Diverging	Merging	Crossing	Total	Diverging	Merging	Crossing	Total	Diverging	Merging	Crossing	Total
Old Glebe Rd	3	3	3	9	1	1	0	2	1	1	0	2	1	1	0	2	1	1	0	2
Jackson St	3	3	3	9	1	1	0	2	1	1	0	2	1	1	0	2	1	1	0	2
Irving St	8	8	16	32	8	8	16	32	6	6	8	20	6	6	8	20	6	6	8	20
Hudson St	3	3	3	9	1	1	0	2	1	1	0	2	1	1	0	2	1	1	0	2
Highland St	8	8	16	32	2	2	0	4	2	2	0	4	2	2	0	4	2	2	0	4
Garfield St	8	8	16	32	2	2	0	4	2	2	0	4	2	2	0	4	2	2	0	4
Fenwick St	8	8	16	32	2	2	0	4	2	2	0	4	2	2	0	4	2	2	0	4
Fillmore St	8	8	16	32	8	8	16	32	6	6	8	20	6	6	8	20	8	8	16	32
Total	49	49	89	187	25	25	32	82	21	21	16	58	21	21	16	58	23	23	24	70
Conflict Point Reduction																				
Old Glebe Rd	-				-2	-2	-3	-7	-2	-2	-3	-7	-2	-2	-3	-7	-2	-2	-3	-7
Jackson St	-				-2	-2	-3	-7	-2	-2	-3	-7	-2	-2	-3	-7	-2	-2	-3	-7
Irving St	-				0	0	0	0	-2	-2	-8	-12	-2	-2	-8	-12	-2	-2	-8	-12
Hudson St	-				-2	-2	-3	-7	-2	-2	-3	-7	-2	-2	-3	-7	-2	-2	-3	-7
Highland St	-				-6	-6	-16	-28	-6	-6	-16	-28	-6	-6	-16	-28	-6	-6	-16	-28
Garfield St	-				-6	-6	-16	-28	-6	-6	-16	-28	-6	-6	-16	-28	-6	-6	-16	-28
Fenwick St	-				-6	-6	-16	-28	-6	-6	-16	-28	-6	-6	-16	-28	-6	-6	-16	-28
Fillmore St	-				0	0	0	0	-2	-2	-8	-12	-2	-2	-8	-12	0	0	0	0
Total Conflict Point Reduction	**-**				**-24**	**-24**	**-57**	**-105**	**-28**	**-28**	**-73**	**-129**	**-28**	**-28**	**-73**	**-129**	**-26**	**-26**	**-65**	**-117**
% Conflict Point Reduction	**-**				**-49%**	**-49%**	**-64%**	**-56%**	**-57%**	**-57%**	**-82%**	**-69%**	**-57%**	**-57%**	**-82%**	**-69%**	**-53%**	**-53%**	**-73%**	**-63%**

Table 7-3 summarizes the reduction in conflict points on the Arlington Boulevard Trail as well as Route 50 for each Option. Option A eliminates 10 conflict points between the driveways and Route 50 and five conflict points between the driveways and the Arlington Boulevard Trail. Pedestrians and bicyclists on the Arlington Boulevard Trail would no longer have to cross five driveways where conflicts with vehicles could potentially occur. Similar to Option A, Option B also reduces the number of conflict points on Route 50 and the Arlington Boulevard Trail by removing the driveway access to Route 50 and providing a frontage road for the driveways that the Arlington Boulevard Trail does not cross. With Option B, all four conflict points would be eliminated on Route 50 and two conflict points would be eliminated on the Arlington Boulevard Trail. Because Option C maintains the on-street parking between Garfield Street and Fenwick Street, no conflict points would be reduced on Route 50 or the Arlington Boulevard Trail. With the removal of the on-street parking between Garfield Street and Fenwick Street under Option D, two conflict points would be eliminated on Route 50. It should also be noted that the Alternatives along Route 50 also include the removal of parking along Route 50 and would also result in the removal of conflicts associated with parking maneuvers along Route 50.

Table 7-3: Reduction of Conflict Points - Options

Option	Conflict Point Reduction	
	Route 50	Arlington Boulevard Trail
Option A – Service Road East of Old Glebe Road	10	5
Option B – Service Road west of Irving Street	4	2
Option C – On-Street Parking Between Garfield Street and Fenwick Street	0	0
Option D – Service Road between Garfield Street and Fenwick Street	2	0

8. BUILD CONDITION TRAFFIC OPERATIONS ANALYSIS

Five alternatives were analyzed as part of the 2030 Build scenarios. The results of the VISSIM microsimulation are documented for the measures of effectiveness (MOEs) in accordance with the TOSAM as specified in the Framework Document.

Along Route 50, corridor and segment travel times (minutes) are presented. Signalized and unsignalized intersections within the study area are evaluated using vehicle throughput (vehicles per hour), delay (seconds/vehicle), and maximum queue length (feet). LOS is not provided as an MOE; however, metrics such as “severe congestion”, and “light traffic conditions” corresponding to LOS are used to depict congestion levels as shown in **Table 5-6**. Detailed intersection volumes by movement and delays by movement, approach, and overall intersection for Build conditions are provided in **Appendix G**.

8.1 2030 BUILD CONDITIONS TRAFFIC OPERATIONS

8.1.1 Route 50 Travel Times

AM Peak Hour - 2030 Build Conditions

Figures 8-1a and 8-1b depict the AM peak hour existing and 2030 cumulative travel times for eastbound and westbound Route 50, respectively. Lower travel times under the 2030 Build alternatives are attributed to the removal of left-turn movements to and from Route 50 at unsignalized side streets as well as the addition of turn lanes and turn lane improvements at Irving Street and Fillmore Street with all alternatives under consideration. It should be noted that due to similar turn restrictions and turn lane improvements, the travel times and intersection delays are expected to be consistent between Alternatives 2 and 3 during both the AM and PM peak hours. Therefore, for the purposes of the travel time and intersection analysis, Alternatives 2 and 3 will be referred to as Alternatives 2/3.

Under 2030 Build conditions, the AM peak hour eastbound travel time improves the greatest with Alternative 1a. The Alternative 1a travel time is reduced to 2.2 minutes (1.1 minute reduction compared to No Build conditions) with the majority of the travel time savings occuring in the first segment approaching Irving Street. Alternative 1b experiences eastbound travel times of 2.5 minutes (0.8 minute reduction), Alternative 1c has eastbound travel times of 3.3 minutes (0 minute reduction), and Alternatives 2/3 have eastbound travel times of 2.6 minutes (0.7 minute reduction).

The AM peak hour westbound travel times in the off-peak direction remain approximately the same with Alternatives 1c and 2/3 as No Build conditions (1.5 minutes) while travel times with Alternatives 1a and 1b remain approximately the same (approximately 0.1 minute increase) compared to No Build conditions.

Figure 8-1a: AM Peak Hour – Eastbound Route 50 Cumulative Travel Times (Existing and 2030 Conditions)

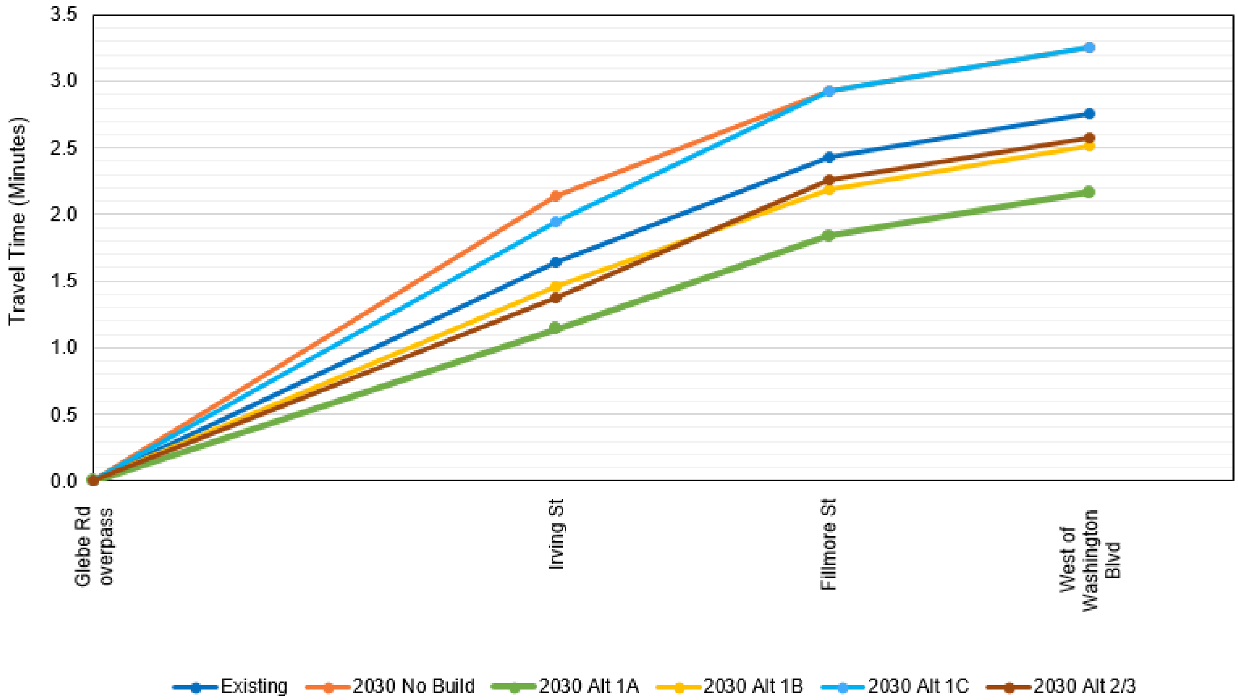
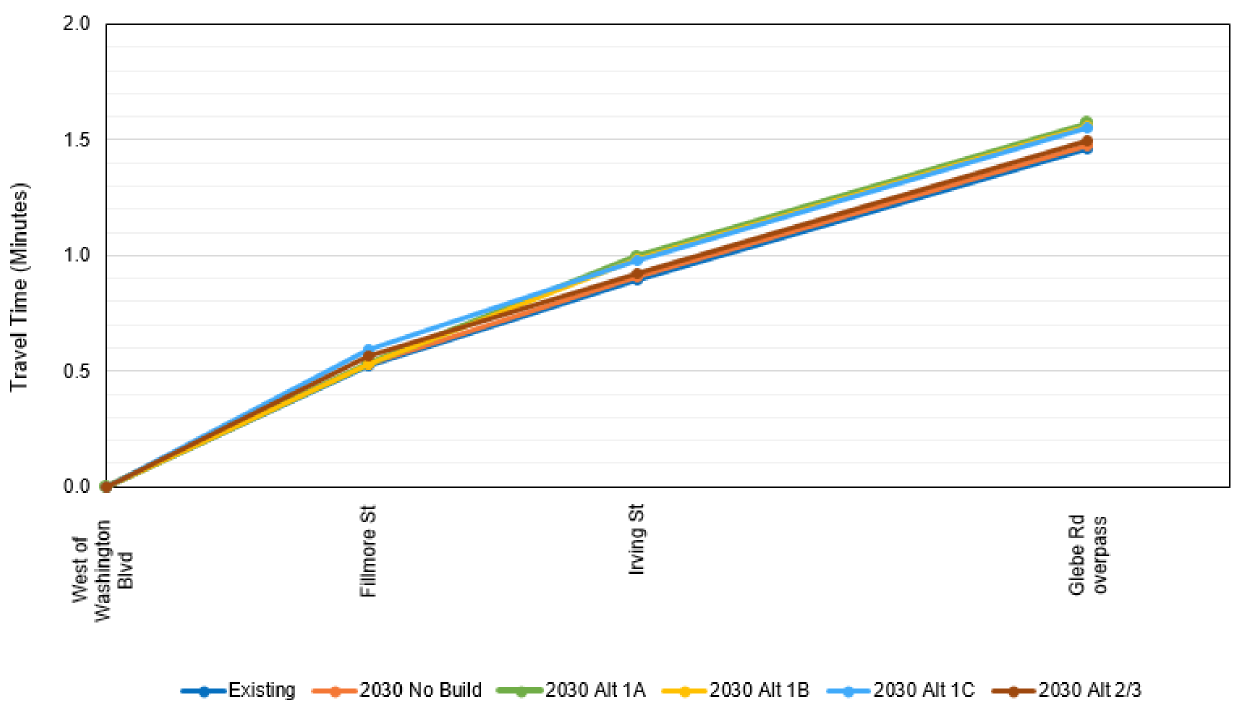


Figure 8-1b: AM Peak Hour – Westbound Route 50 Cumulative Travel Times (Existing and 2030 Conditions)



PM Peak Hour - 2030 Build Conditions

Figures 8-2a and 8-2b depict the AM peak hour existing and 2030 cumulative travel times for eastbound and westbound Route 50, respectively. Lower travel times under the 2030 Build alternatives are attributed to the removal of left-turn movements to and from Route 50 at unsignalized side streets as well as the addition of turn lanes and turn lane improvements at Irving Street and Fillmore Street with all alternatives under consideration. It should be noted that due to similar turn restrictions and turn lane improvements, the travel times and intersection delays are expected to be consistent between Alternatives 2 and 3 during both the AM and PM peak hours. Therefore, for the purposes of the travel time and intersection analysis, Alternatives 2 and 3 will be referred to as Alternatives 2/3.

Under 2030 Build conditions, the PM peak hour eastbound travel time improve the greatest with Alternatives 1a, 1b, and 1c. Alternatives 1a, 1b, and 1c have eastbound travel times of 1.9 minutes (0.5 minute reduction compared to No Build conditions) with the majority of the travel time savings occurring between Irving Street and Fillmore Street. Alternatives 2/3 have eastbound travel times of 2.1 minutes (0.3 minute reduction compared to No Build conditions).

The PM peak hour westbound travel times remain approximately the same with Alternatives 1a, 1b, and 1c as No Build conditions (2.0 minutes) while Alternatives 2/3 decrease to 1.7 minutes (0.3 minute reduction compared to No Build conditions).

Figure 8-2a: PM Peak Hour – Eastbound Route 50 Cumulative Travel Times (Existing and 2030 Conditions)

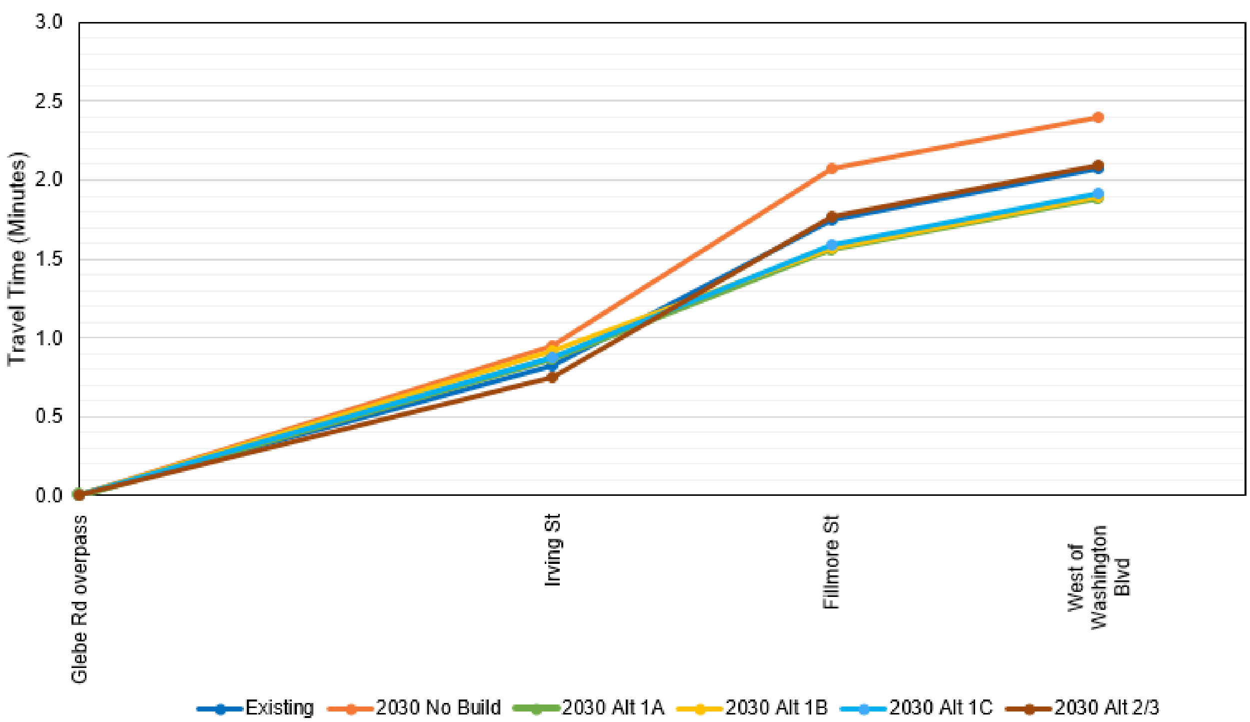
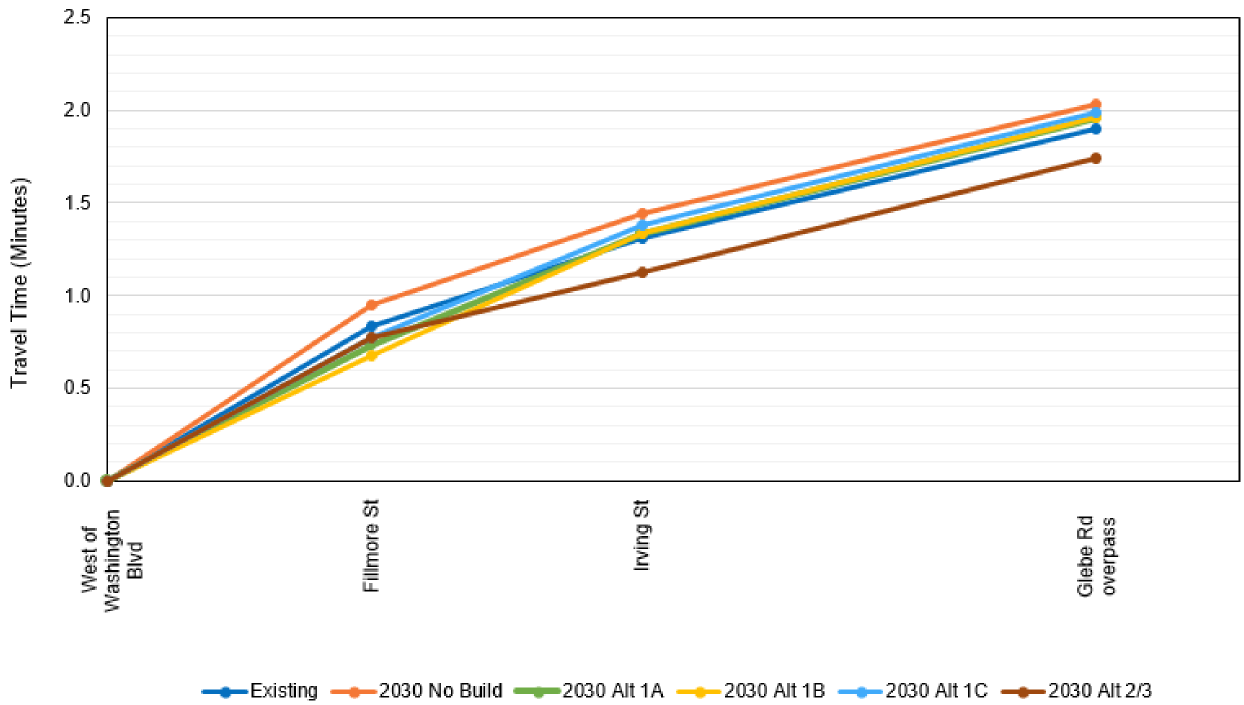


Figure 8-2b: PM Peak Hour – Westbound Route 50 Cumulative Travel Times (Existing and 2030 Conditions)



8.1.2 Intersection Operations

Table 8-1 depicts overall intersection delays for both signalized and unsignalized intersections within the study area for the AM and PM peak hours for Existing, 2030 No Build, and 2030 Build conditions. **Table 8-2** depicts delays by movement for the Irving Street and Fillmore Street intersections on Route 50 during the AM and PM peak hours under Existing, 2030 No Build, and 2030 Build conditions. The overall study intersections operate with light or moderate traffic in all Build scenarios, with the exception of the Fillmore Street frontage road intersections and Route 50 at Fillmore Street. However, the majority of movements from the side streets to Route 50 operate with heavy or severe congestion.

As shown in **Table 8-2**, the extension of the westbound left-turn lane from Route 50 to Fillmore Street with all Build alternatives results in lower delays for the westbound left-turn movement at Fillmore Street during the AM and PM peak hours. In addition, maximum queue lengths in the westbound left-turn lanes to Fillmore Street do not extend beyond the proposed 1,000-foot left-turn storage length during the AM and PM peak hours with all Build alternatives. The installation of a dedicated eastbound left-turn lane and protected left-turn phasing at Irving Street results in lower delays for the eastbound left-turn movement while the installation of a dedicated westbound left-turn lane and protected left-turn phasing at Irving Street results in higher delays for the westbound left-turn movement with Alternatives 1a, 1b, and 1c. It should be noted that although delays will increase, the installation of a protected left-turn phase will significantly improve safety for left turns from Route 50 to Irving Street and opposing through vehicles.

As shown in **Figures 8-3a and 8-3b**, the prohibitions of side street movements from Irving Street and Fillmore Street to Route 50 with Alternatives 1b and 1c result in the majority of movements from Irving Street and Fillmore Street experiencing reductions in delay due to the more efficient operation. With Alternatives 1b and 1c, the prohibition of certain side street movements at Irving Street and Fillmore Street allows the side streets movements to operate more efficiently during the concurrent signal phase without yielding to opposing vehicles which increases signal efficiency and reduces delays.

AM Peak Hour

With Alternative 1a, the operations at the intersections of Route 50 at Old Glebe Road, Route 50 at Irving Street, and Route 50 at Fillmore Street improve to light traffic conditions while all other intersections remain at the same congestion level as No Build conditions. Alternative 1b also improves operations at Route 50 at Old Glebe Road and Route 50 at Fillmore Street to light traffic conditions and Route 50 at Irving Street to moderate traffic conditions. Alternative 1B also improves the Fillmore Street at north frontage road intersection to light traffic conditions from heavy congestion under No Build conditions and improves the Fillmore Street at south frontage road intersection to heavy congestion from severe congestion under No Build conditions. Alternative 1c improves Fillmore Street at the north frontage road to light traffic conditions from heavy congestion under No Build conditions, improves Route 50 at Old Glebe Road to light traffic conditions as well as improves Route 50 at Irving Street to moderate traffic conditions. Alternatives 2 and 3 also improves Route 50 at Old Glebe Road to light traffic conditions and improves Route 50 at Irving Street and Fillmore Street at the north frontage road to moderate traffic conditions.

PM Peak Hour

With Alternatives 1a, 1b, 1c, and 2/3, operations at Route 50 at Fillmore Street improve to moderate traffic conditions, light traffic conditions, moderate traffic conditions, and heavy congestion, respectively, from severe congestion under No Build conditions. With Alternatives 1c and 2/3, Fillmore Street at the north frontage road improves to light traffic conditions from moderate traffic under No Build conditions. Compared to severe congestion under No Build conditions, operations at Fillmore Street and the south frontage road improve to light traffic conditions with Alternative 1b. All other intersections remain at the same level of congestion with the Build alternatives as No Build conditions.

Table 8-1: Intersection Delay Summary

Intersection	Intersection Control	Average Delay (seconds)											
		Existing		No Build		Build Alt 1a		Build Alt 1b		Build Alt 1c		Build Alt 2/3	
		AM Peak Hour	PM Peak Hour	AM Peak Hour	PM Peak Hour	AM Peak Hour	PM Peak Hour	AM Peak Hour	PM Peak Hour	AM Peak Hour	PM Peak Hour	AM Peak Hour	PM Peak Hour
Glebe Road at WB Route 50 ramps	Signalized	16	21	19	26	19	24	19	25	19	25	18	25
Glebe Road at EB Route 50 ramps	Signalized	22	15	38	34	32	31	30	37	32	29	31	29
Route 50 at Old Glebe Road	Stop	15	1	27	2	5	2	11	1	23	1	8	1
Route 50 at Jackson Street	Stop	14	1	18	3	8	1	11	1	16	1	11	1
Route 50 at Irving Street	Signalized	46	16	63	21	30	24	42	27	55	23	36	10
Route 50 at Hudson Street	Stop	6	2	6	3	3	3	4	3	7	3	7	1
Route 50 at Highland Street	Stop	4	3	5	5	3	2	4	3	5	3	5	2
Route 50 at Garfield Street	Stop	5	4	6	5	4	3	6	3	16	3	9	4
Route 50 at Fenwick Street	Stop	6	6	6	8	8	3	7	3	11	4	9	7
Route 50 at Fillmore Street	Signalized	35	58	42	81	32	53	28	28	41	42	41	66
Fillmore Street at North Frontage Road	Stop	33	28	36	31	37	29	19	26	19	13	29	24
Fillmore Street at South Frontage Road	Stop	83	96	132	162	91	162	45	11	89	101	91	159

Table 8-2: Irving Street and Fillmore Street Intersection Delay Summary

Intersection	Movement	Average Delay (seconds)											
		Existing		No Build		Build Alt 1a		Build Alt 1b		Build Alt 1c		Build Alt 2/3	
		AM Peak Hour	PM Peak Hour	AM Peak Hour	PM Peak Hour	AM Peak Hour	PM Peak Hour	AM Peak Hour	PM Peak Hour	AM Peak Hour	PM Peak Hour	AM Peak Hour	PM Peak Hour
Route 50 at Irving Street	NB Left	127	86	156	92	103	94	113	84	-	-	102	94
	NB Through	128	78	154	86	105	95	-	-	92	61	104	94
	NB Right	105	79	137	72	86	79	93	73	68	36	84	78
	SB Left	82	61	87	65	92	57	76	56	-	-	92	57
	SB Through	79	58	78	57	79	60	-	-	83	71	79	60
	SB Right	35	37	45	41	42	47	49	39	46	58	42	43
	EB Left	112	170	145	221	111	106	108	79	108	107	-	-
	EB Through	65	17	91	26	36	19	54	22	82	20	49	12
	EB Right	14	8	14	10	14	11	15	12	18	12	17	7
	WB Left	65	69	55	60	129	106	125	101	122	81	-	-
	WB Through	2	10	2	11	7	18	7	21	3	18	1	1
	WB Right	3	11	2	12	4	17	5	21	2	18	1	3
	Overall	**46**	**16**	**63**	**21**	**30**	**24**	**42**	**27**	**55**	**23**	**36**	**10**
Route 50 at Fillmore Street	NB Left	177	299	251	491	183	475	-	-	143	210	188	497
	NB Through	174	293	252	490	181	468	107	77	-	-	187	490
	NB Right	118	210	193	407	128	389	66	20	104	158	132	415
	SB Left	88	65	98	70	102	67	-	-	86	68	100	66
	SB Through	87	65	96	69	99	67	83	68	-	-	95	67
	SB Right	14	13	14	18	18	16	12	16	11	11	5	15
	EB Left	81	78	78	79	82	60	90	81	87	73	95	75
	EB Through	29	36	29	48	24	23	27	21	40	24	35	43
	EB Right	31	35	34	47	26	23	30	21	46	26	37	43
	WB Left	193	156	273	193	119	83	117	86	115	85	176	129
	WB Through	13	37	13	50	14	26	13	23	17	28	15	29
	WB Right	10	33	13	43	14	26	13	24	18	27	16	28
	Overall	**35**	**58**	**42**	**81**	**32**	**53**	**28**	**28**	**41**	**42**	**41**	**66**

Figure 8-3a: AM Peak Hour – Irving Street and Fillmore Street Approach Delays

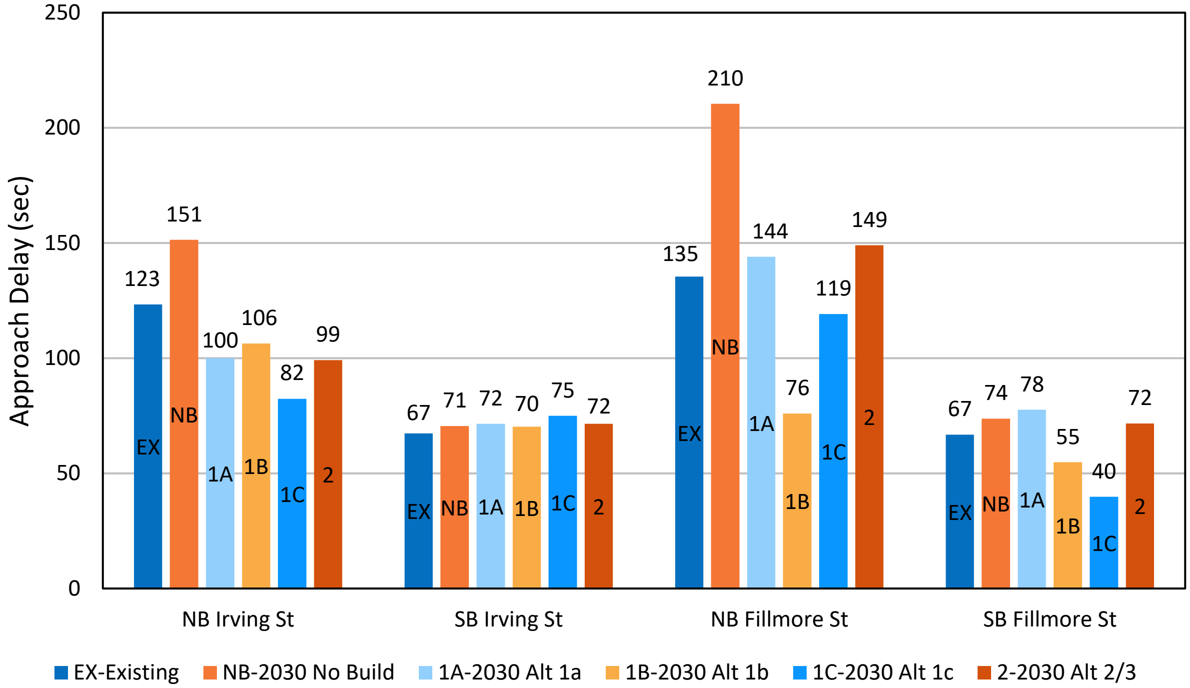
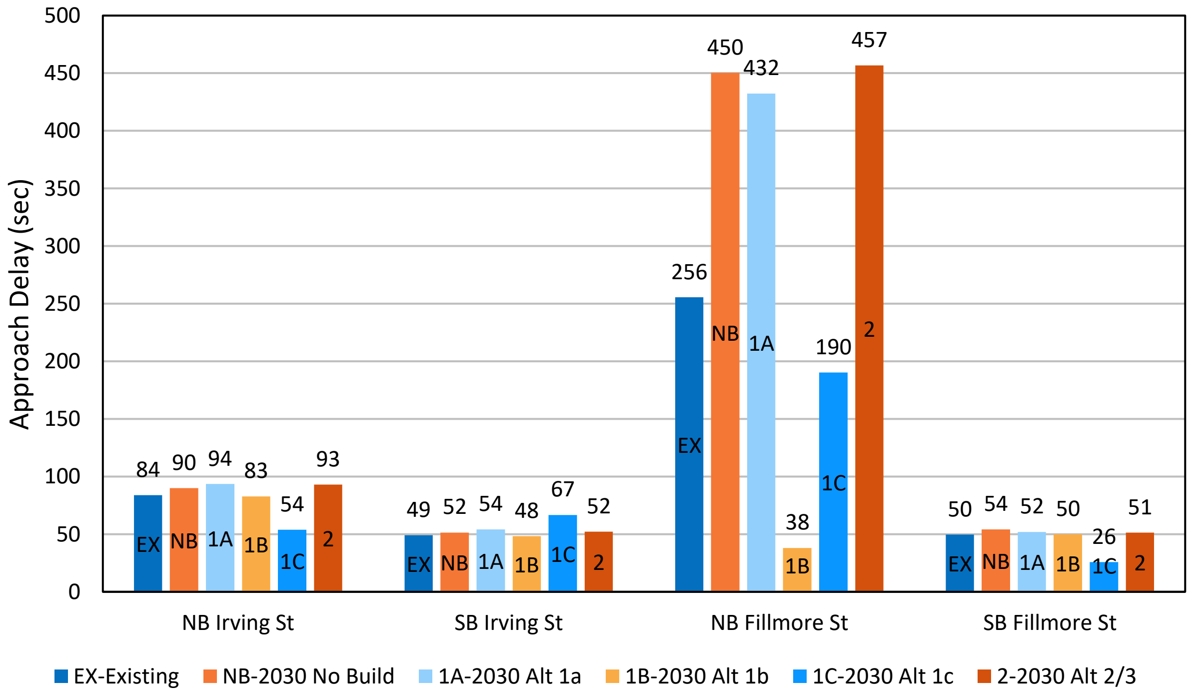


Figure 8-3b: PM Peak Hour – Irving Street and Fillmore Street Approach Delays



9. PUBLIC INVOLVEMENT

A public meeting was held in November 2019 to introduce the public to the study and inform the public about existing safety and traffic operational conditions in the corridor. An online survey was conducted in November 2019 to collect the public's opinions on the current issues and prioritization of their concerns. As a result of the restrictions on holding in-person public involvement activities, a virtual presentation was provided on the VDOT Study website beginning in late April 2020 to update the public on the study's progress and present the improvement alternatives under consideration. A second survey was conducted to collect the public's feedback on the proposed alternatives from April 30 to June 15, 2020. An additional virtual community meeting was held on June 8, 2020 to obtain additional feedback on the alternatives under consideration and respond to questions from the community and elected officials.

In the November 2019 survey, a total of 927 survey participants submitted feedback on issues in the corridor. When asked to rank their priorities, traffic congestion was ranked as the highest priority followed by highway safety and then pedestrian safety. Based on comments and survey questions regarding mobility in the corridor, citizens identified two main concerns of difficulty making left turns and difficulty crossing Route 50. This public feedback was considered by the Stakeholder Working Group when developing potential improvement alternatives.

During the second public survey conducted April 30 through June 15, 2020, a total of 1,221 survey participants submitted their ratings and opinions on each of the alternatives and supplemental options. Participants were asked to rank each of the Alternatives and scenarios including the No build scenario. **Table 9-1** summarizes the ratings for each scenario and the number of times a scenario was ranked. The scenarios were ranked on a scale of 1 to 5 with higher numbers indicating a greater preference for the scenario. Alternative 1a received the highest rank with an average of 3.7 and Alternatives 1b and 1c had the lowest average rank with average rankings of 2.2 and 2.1, respectively. In general, the alternatives that prohibited certain movements from Irving Street and Fillmore Street (i.e., Alternatives 1b and 1c) ranked the lowest and similar to No Build conditions. Options A, B, and D had an average rating of 3.1 and Option C had an average ranking of 2.2.

Table 9-1: Summary of Survey Rankings

Alternative/Option	Average Rank	Number of Rankings
No Build	2.1	1,195
Alternative 1a	3.7	1,004
Alternative 1b	2.2	684
Alternative 1c	2.1	621
Alternative 2	2.7	636
Alternative 3	2.6	637
Option A	3.1	846
Option B	3.1	619
Option C	2.2	595
Option D	3.1	579

10. PLANNING LEVEL COST ESTIMATES

Planning level cost estimates were developed for the alternatives under consideration using the *VDOT SYIP Projects Detailed Project Cost Estimate Summary, Version 01/21/2020 – CTS Modified* as well as the *VDOT Project Cost Estimating System (PCES), Version 7.10* for VDOT NOVA District. The cost estimates included Construction (CN), Right-of-Way and Utilities Relocation (ROW) and Preliminary Engineering (PE) costs. A contingency of 40% was included on the construction items estimate based on suggested contingencies for given risk levels on SYIP projects. **Table 10-1** summarizes the cost estimates for each improvement alternatives proposed and are expressed in year 2024 dollars. A detailed cost estimate will be prepared during the design phase of this project if the project is funded. Estimates should be adjusted for appropriate inflation costs when used in funding applications or project allocations. Planning level cost estimates are included in **Appendix H**.

Table 10-1: Planning Level Cost Estimates (Year 2024 Dollars)

Alternative	Cost Estimate			
	Preliminary Engineering (PE)	Right-of-Way/Utilities (ROW)	Construction (CN)	Total
Alternatives 1a, 1b, 1c	$1,236,250	$2,445,000	$12,570,400	$16,251,650
Alternative 2	$1,190,250	$2,445,000	$9,716,838	$13,352,088
Alternative 3	$678,500	$1,650,000	$4,115,815	$6,444,315

11. SELECTION OF PREFERRED ALTERNATIVE

The following criteria were used to evaluate the range of alternatives under consideration.

- **Left Turn Operations** for each alternative were rated based on the impact to safety for left-turning vehicles as well as wait times and interruption of traffic flow along Route 50. During the November 2019 public survey, the public identified left turn operations as a primary safety concern along the study corridor.
- **Pedestrian Safety** was rated based on the number of conflict points between pedestrians crossing Route 50 and turning vehicles. During the November 2019 public survey, the public identified pedestrian safety as a primary concern along the study corridor
- **Vehicle Conflict Points** were used as a measure to compare the potential for crashes based on the number of locations where vehicle travel paths cross. Alternatives with a lower number of conflict points generally result in greater safety benefits.
- **Separation Between the Route 50 Travel Lanes** was used as criteria for comparison because a median provides a physical deterrent for vehicles turning left to and from unsignalized side streets, provides additional safety by separating opposing directions of traffic, and can provide green space if the median is wide enough for grass. Alternatives with wider medians were rated better than narrower medians or no median.
- **Travel Time** was used to compare traffic operations along Route 50. Both the eastbound and westbound directions during the AM and PM peak hours were considered in the travel time comparison.
- **Enforcement of Turn Restrictions** was used to compare alternatives. Certain alternatives rely only signage or channelizing island to enforce turn restrictions while the alternatives with a physical median or fewer turn restrictions ranked more favorable.
- **Right-Of-Way Impacts** were compared in order to determine which alternatives would have the least impact to adjacent property owners. Alternatives which included the construction of a median and therefore would require widening ranked less favorable than the alternatives with no median proposed.
- **Tree Impacts** were evaluated for each of the alternatives. Generally, alternatives with a wider median result in greater impacts to trees.
- **Increase in Impervious Area** was evaluated for each of the alternatives. Generally, alternatives with a wider median result in a greater increase in impervious area.
- **Public Involvement Ranking** is based on the public feedback collected from the April through June 2020 online survey and consists of the average ratings that survey participants assigned each alternative.
- **Preliminary Cost** was considered to compare each alternative. Alternatives that include the construction of a median and roadway widening have a higher estimated cost.

Table 11-1 provides a comparison of alternatives under consideration including a rating of the alternatives from excellent to poor based on the evaluation criteria.

Table 11-1: Evaluation of Alternatives

Criteria	Existing (No Build)	Alternative 1: Wide Median with Turn Lanes			Alternative 2: Narrow Median	Alternative 3: No Median
		1a	1b	1c		
Left Turn Operations	Poor	Favorable	Excellent	Excellent	Favorable	Fair
Pedestrian Safety	Unfavorable	Fair	Excellent	Favorable	Fair	Fair
Vehicle Conflict Points *% Reduction of Conflict Points*	Poor *0%*	Favorable *-56%*	Excellent *-69%*	Excellent *-69%*	Favorable *-63%*	Favorable *-63%*
Separation Between Route 50 Travel Lanes	Poor	Excellent	Excellent	Excellent	Fair	Poor
Travel Time *Total of both EB and WB Route 50 during both AM and PM peak (minutes)*	Poor *9.2*	Excellent *7.6*	Favorable *7.9*	Unfavorable *8.7*	Favorable *7.9*	Favorable *7.9*
Enforcement of Turn Restrictions	--	Excellent	Fair	Fair	Fair	Poor
Right-of-Way Impacts	Excellent	Fair	Fair	Fair	Fair	Favorable
Tree Impacts [1]	Excellent *0 trees*	Unfavorable *18 trees*	Unfavorable *18 trees*	Unfavorable *18 trees*	Fair *14 trees*	Fair *8 trees*
Increase in Impervious Area [2]	Excellent *No increase*	Unfavorable *1.6 acres*	Unfavorable *1.6 acres*	Unfavorable *1.6 acres*	Fair *1.2 acres*	Favorable *0.2 acres*
Public Involvement Ranking	Poor 2.1	Excellent 3.7	Poor 2.2	Poor 2.1	Fair 2.7	Fair 2.6
Preliminary Cost	--	$14-18 million	$14-18 million	$14-18 million	$12-14 million	$5-7 million

Excellent	Favorable	Fair	Unfavorable	Poor

[1] Tree Impacts are approximate based on available aerial photography; construction of services roads with Options A and B results in impacts to 2 additional trees

[2] Construction of services roads with Options A and B increases impervious area by 0.4 acres

As shown in **Table 11-1**, the existing condition or No Build conditions has the poorest ratings because it does not address the identified safety and operational deficiencies along Route 50. The existing (No Build) scenario ranked the worst in every criteria category except right-of-way impacts, increase in impervious area, and tree impacts.

Alternative 1a has the overall highest ratings but also comes with a higher cost and greater impacts to right of way and trees, and an increased impervious area due to the widening required to install the median along Route 50. The public rated Alternative 1a a 3.7 on a scale of 1 to 5, the highest score of any of the alternatives under consideration. Alternative 1a would have a favorable impact on left-turn operations, reduction of vehicle conflict points, and has the lowest travel time along Route 50 of the alternatives under consideration.

Alternative 1b was ranked poorly by the public with a rating of 2.2 primarily due to the proposed turn restrictions at the Route 50 at Fillmore Street and Route 50 at Irving Street intersections. Alternative 1c was also ranked poorly by the public with a rating of 2.1 primarily due to the turn restrictions and also has the longest corridor travel times of the Build alternatives.

Alternative 3 was ranked poorly due to the lack of a raised median and separation between the Route 50 travel lanes and also due to the poor enforcement of turn restrictions. Alternative 3 had a fair rating by the public with a rating of 2.6. Without a raised median along Route 50, it will be difficult to enforce the prohibition of left turns to and from the side streets.

With the exception of impacts to trees and increase in impervious area, Alternative 1a and Alternative 2 did not receive any unfavorable or poor rankings. Alternative 1a ranked equal to or better than Alternative 2 with a few exceptions. Alternative 2 would reduce 7 percent more conflict points due to the prohibition of left turns at Irving Street; however, this would result in an increase in traffic along Fillmore Street, a community concern and enforcing the left-turn restrictions from Route 50 to Irving Street may be difficult. Alternative 2 also has lower cost of $12-14 million compared to Alternative 1a ($14-18 million) and would results in fewer tree impacts and less increase in impervious area.

Although the cost of Alternative 1a is higher than Alternative 2, Alternative 1a has the additional benefit of both Route 50 directions being physically separated by a 16-foot grass median which increases safety compared to a narrower median and would allow for a grass median. With Alternative 1a, vehicle conflict points would be reduced by 56 percent and the overall travel time through the corridor is the lowest of all five Alternatives. With Alternative 1a, all of the turning movements are permitted at the Irving Street intersection, which was a significant community concern by the community along Fillmore Street. The public ranked Alternative 1a the highest by a full point on a rating scale of 1 to 5 during the April to June 2020 public survey with a rating of 3.7. An additional benefit of Alternative 1a is that is does not result in issues related to the enforcement of turn restrictions. Therefore, Alternative 1a was selected as the Preferred Alternative by the SWG.

Options A and B which include the construction of service roads along Route 50 to serve residential driveways and remove conflict points along Route 50 received a public rating of 3.1. These two options are incorporated into the Preferred Alternative and will be evaluated in more detail as part of the detailed design stages including coordination with the impacted property owners.

While Alternative 1a removes parking along the south side of Route 50 between Garfield Street and Fenwick Street, Option C includes on-street parking in this area similar to existing conditions and was rated unfavorably by the public with a rating of 2.2. Many survey respondents noted concerns about the safety of the on-street parking with Option C; however, there was a portion of the survey respondents that voiced strong concerns regarding the loss of parking and a desire to maintain the on-street parking. Option D would remove the on-street parking along Route 50 and provide a service roadway along the south side of Route 50 between Garfield Street and Fenwick Street where on-street parking could be provided. Option D received a public rating of 3.1. Given the lack of consensus regarding the options that would impact the availability of parking along Route 50 between Garfield Street and Fenwick Street, the SWG determined that the selected alternative for this area would be refined at a later date if the project is funded.

Figure 11-1 depicts the Preferred Alternative including Alternative 1a as well as Options A and B.

Figure 11-1: Preferred Alternative

12. NEXT STEPS / PROJECT FUNDING

Arlington County submitted a pre-application to VDOT in April 2020 to apply for SMART SCALE funding for Alternative 1a. SMART SCALE allocates funding from the construction District grants Program (DGP) and High-Priority Projects Program (HPPP) to transportation projects based on a scoring process. The scoring process evaluates, scores, and ranks projects based on congestion mitigation, economic development, accessibility, safety, environmental quality, and land use factors. The location of the project determines the weight of each of these scoring factors in the calculation of the total score. For projects in the Northern Virginia District, the scoring factors with the highest weight are congestion (45%) and land use (20%).

The final SMART SCALE application is due in August 2020. Once project applications are approved for funding through SMART SCALE or other funding sources, the project would be incorporated into the VDOT Six-Year Improvement Plan, so it can enter the project development process.