

APPENDIX A – FRAMEWORK DOCUMENT



STARS Route 28 and Dulles Toll Road/Dulles Greenway Study DRAFT Traffic Operations Analysis Framework Document (version 4, 1/9/2019)

1. Introduction

Over the past several years a number of improvements in the Route 28 corridor and surrounding roadway network have been completed. In August 2017, the Virginia Department of Transportation (VDOT) completed a project that added one lane to southbound Route 28 from Sterling Boulevard to Route 50. In addition, in February 2017 the Innovation Avenue Interchange partially opened to traffic (right-in/right-out), with complete opening in the spring of 2017. Prior to these projects, southbound Route 28 experienced congestion in the morning peak period. While the widening increased capacity of the southbound Route 28 through movements, the interchange area continues to experience reoccurring congestion during the morning and afternoon peak periods.

In addition to these roadway changes, land development and traffic continues to grow in areas around Route 28 corridor in both Fairfax and Loudoun counties. The extension of the Metrorail Silver Line to points west of the Dulles Airport in Loudoun County is expected to be completed by 2020. The provision of multi-modal improvements, such as Metrorail line and transit service to the new Metrorail stations, is expected to attract new development to the Dulles Toll Road/Dulles Greenway and Route 28 corridors.

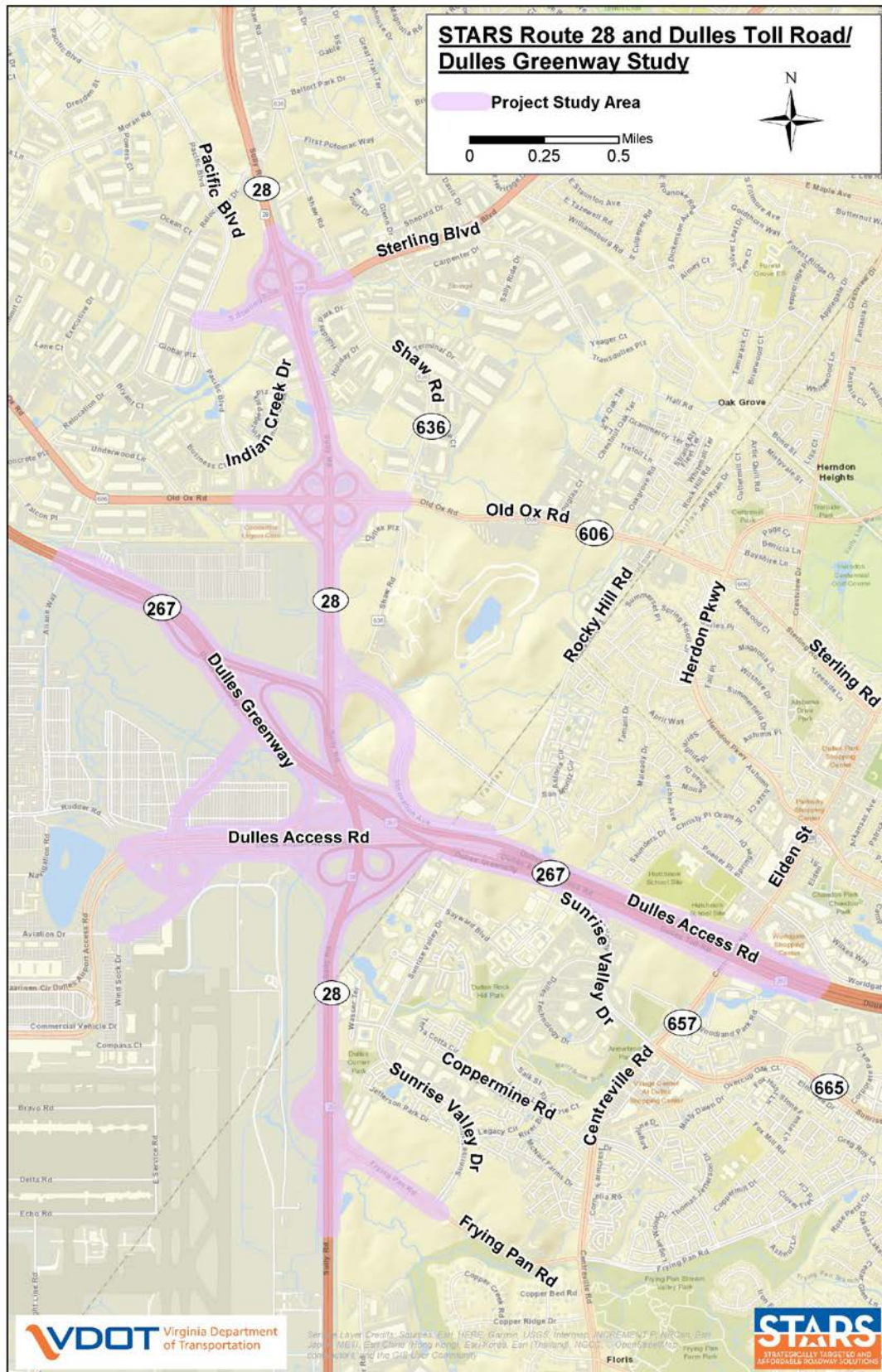
Roadway users and stakeholders have submitted requests to VDOT to assess the traffic and safety conditions at this interchange area and identify solutions to address identified issues.

This document outlines the scope of work for the traffic forecasting and analysis associated with the Route 28 and Dulles Toll Road/Dulles Greenway Study. This framework document defines the modeling methodology and assumptions required to: balance existing peak period traffic volumes; create the origin-destination (O-D) trip table; develop and calibrate an existing VISSIM traffic simulation model for the study area; conduct future traffic forecasts; and the document defines the future scenarios to analyze.

1.1. Study Area Limits

The project study area, as shown in **Figure 1**, is defined as the 3-mile section of Route 28 between Frying Pan Road and Route 846 (S. Sterling Boulevard); the 2.5-mile section of Route 267 (Dulles Toll Road) between Route 657 (Centreville Road)/Elden Street and Dulles Greenway Toll Plaza west of Route 28; and the 2-mile section of Dulles Airport Access Road between Route 657 (Centreville Road)/Elden Street and Rudder Road.

Figure 1. Project Study Area





The following interchanges and ramps are included in the study area:

1. Route 28 and Frying Pan Road Interchange
2. Route 28/Route 267 (Dulles Toll Road)/Dulles Airport Access Road Interchange/Dulles Greenway
3. Route 28 and Innovation Avenue Interchange
4. Route 28 and Route 606 (Old Ox Road) Interchange
5. Route 28 and Route 846 (S. Sterling Boulevard) Interchange
6. Route 267 (Dulles Toll Road) and Route 657 (Centreville Road)/Elden Street Interchange

The following ten intersections are included in the study area:

1. Sunrise Valley Drive at Frying Pan Road
2. Pacific Boulevard at Route 606 (Old Ox Road)
3. Shaw Road at Route 606 (Old Ox Road)
4. Route 606 (Old Ox Road) and Route 28 northbound ramp
5. Pacific Boulevard at Route 846 (S. Sterling Boulevard)
6. Route 846 (S. Sterling Boulevard) and Route 28 northbound ramp
7. Route 846 (S. Sterling Boulevard) and Route 28 southbound ramp
8. Shaw Road at Route 846 (S. Sterling Boulevard)
9. Centreville Road and Dulles Toll Road Ramps South of Dulles Toll Road
10. Centreville Road and Dulles Toll Road Ramps North of Dulles Toll Road

1.2. Purpose and Need of the Study

The purpose and need of this study is to identify mitigation strategies to improve operations and safety at the interchange of Route 28 and Route 267 (Dulles Toll Road/Dulles Greenway), as well as the upstream and downstream freeway segments in the study area. This includes noted areas of the following significant bottlenecks:

- Improve roadway safety and traffic operations during the morning peak period between southbound Route 28 and eastbound Route 267 (Dulles Toll Road)
- Reduce congestion and improve traffic operations during the afternoon peak period from westbound Route 267 (Dulles Toll Road) to northbound Route 28



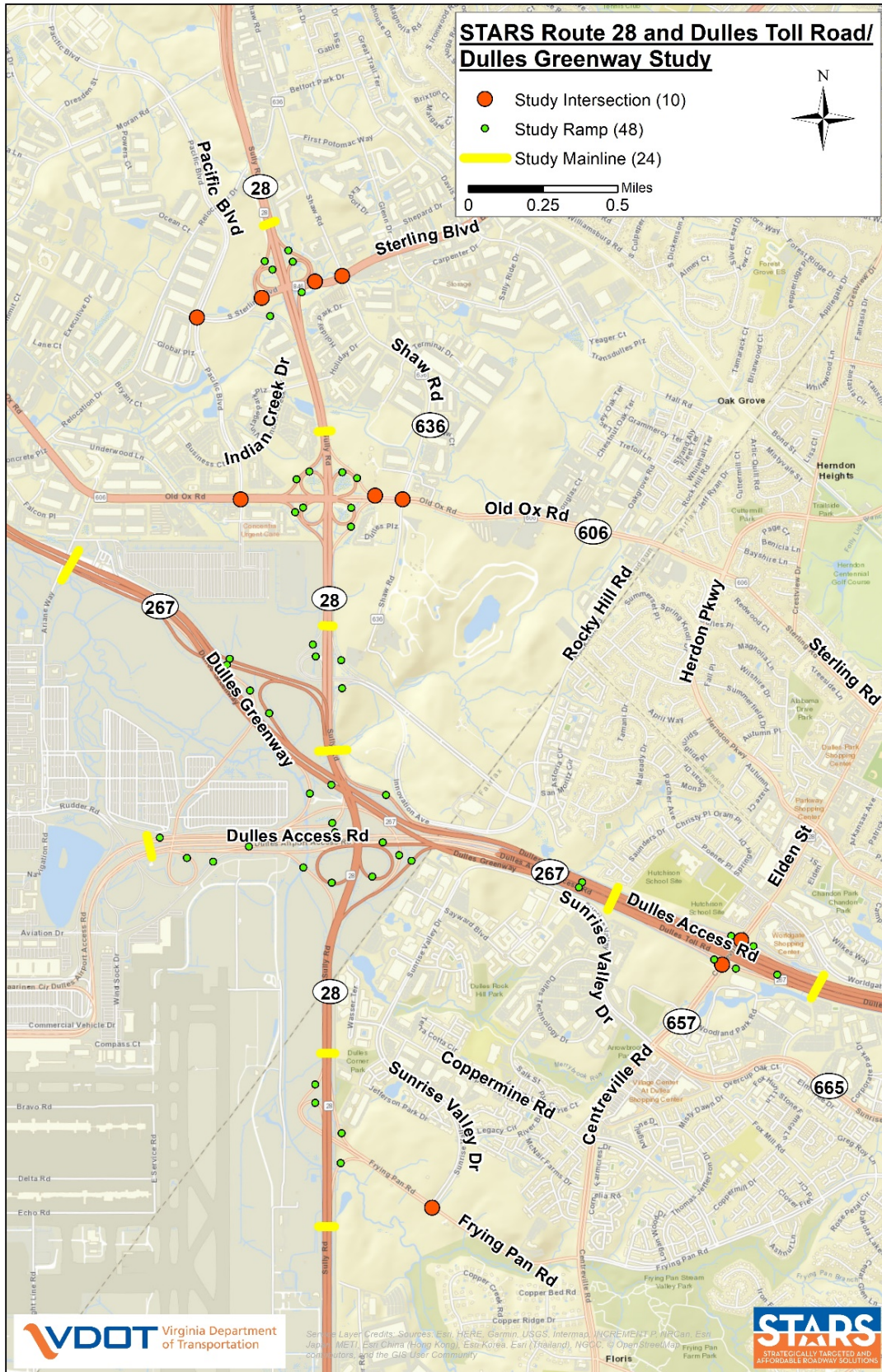
2. Data Collection

2.1. Traffic Volumes

Intersection turning movement traffic counts will be collected for the ten (10) intersections during the AM (6:30 – 9:30AM) and PM (4:00-7:00PM) peak periods on a typical weekday (Tuesday, Wednesday or Thursday). For mainline freeway segments, traffic counts will be conducted before and after each major interchange along with all the ramps in the Study area for one continuous week. Data will be collected in the first two weeks of November 2018 (exclusive of federal holidays or public school student holidays), prior to Thanksgiving, and will be summarized in 15-minute intervals.

Traffic count locations are shown in **Figure 2** and listed in **Appendix A: Data Collection Memorandum**.

Figure 2. Traffic Count Locations



2.2. Origin-Destination Data

The traffic simulation modeling effort will route vehicles through the traffic network according to origin-destination routing. Origin-destination data will be reviewed from the following sources:

- StreetLight Data, which via a VDOT subscription provides customized origin-destination data with a very high level of spatial accuracy based on aggregated cellular device GPS/location-based services data. StreetLight Data allows for a user to provide custom origins and destinations, such as on- and off-ramps for all freeways in a study area or entry/exit links to a study area. It is anticipated that StreetLight Data will be used as the basis for origin-destination routing for the existing conditions traffic analysis, at the very least for the freeway and ramp segments of the study area.
- MWCOG regional travel demand model, which outputs O-D matrices for various vehicle types between each traffic analysis zone (TAZ) in the Washington, DC, metropolitan area. The travel patterns within the model base year (2017) have been calibrated against 2007/2008 regional household travel survey data, so the travel patterns are somewhat dated. Additionally, this dataset is not as granular as needed to account for freeway weaving proportions. However, given that the travel demand model provides O-D matrices for future years, it is anticipated that these may be used as the basis for vehicle routing in future analysis year scenarios to develop growth rates for existing O-D pairs.

2.2.1. SPEEDS AND TRAVEL TIMES

Floating car travel will be conducted in November 2018 during the AM and PM peak periods. Wherever possible, travel times will be collected on the same days as traffic counts to minimize variability in the calibration process. Travel time segments are listed in the **Appendix A: Data Collection Memorandum**.

Time Periods

- Weekday (Tuesday, Wednesday or Thursday) AM Peak Period: runs beginning no earlier than 7:30 AM and concluding not later than 9:30 a.m.; and
- Weekday (Tuesday, Wednesday or Thursday) PM Peak Period: runs beginning no earlier than 4:30 PM and concluding not later than 6:30 p.m.

In addition, INRIX vehicle probe speed data has been queried for the study area using the RITIS Congestion Scan tool, which provides a “heat map” of vehicle speeds temporally and spatially along a corridor. This data has been pulled for “average weekdays” (Tuesday, Wednesday, and Thursday) for the 9 most recently available months of data (January 2018 through September 2018). This data has been queried for Route 28 northbound/southbound, SR 267 eastbound/westbound, and DAAR eastbound/westbound.

2.2.2. QUEUEING DATA

Queuing within the study area is notably inconsistent and can oscillate numerous times within the peak periods or be absent altogether on some days. A qualitative subjective assessment will be conducted for queue lengths at targeted locations in addition to the review of freeway mainline congestion/queues against the speed heat maps. Queueing along the SR 267 and Route 28 corridor mainlines will be provided via the INRIX heat map and verified against Google Maps’ typical traffic. Queueing along arterials and ramps will be obtained via screen captures from Google Maps’ typical traffic.

2.2.3. CRASH DATA

Five years of crash data (January 1, 2013 to December 31, 2017) will be used in this study. Available VDOT crash data will be collected for crashes reported on Route 28 and Route 267 (Dulles Toll Road and Dulles Greenway) within the study area.

2.2.4. TOLL BOOTH TRANSACTIONS

Toll Booth transactions for all the toll booths will be collected and provided to the project team from MWAA and the Dulles Greenway Operator (Toll Road Investors Partnership II – TRIP II). Details will include toll booth utilization per lane and dwell time at each lane.

2.2.5. ROADWAY WIDTH AND BRIDGE CLEARANCES

Existing roadway width and bridge clearance information will be collected from available existing roadway plans, assumed to be provided by either VDOT or one of the project stakeholders.

2.2.6. SIGNAL TIMINGS

Existing signal timings for the study intersections will be collected from VDOT to use in the existing condition analysis.

3. Analysis Scenarios

All analysis scenarios will be evaluated during the weekday AM peak period and PM peak period. The exact hours of analysis hours will be determined after assessing the traffic data and diurnal patterns.

The following is a summary of the analysis scenarios:

1. Existing Conditions (2018)
2. No-Build 2025 without eastbound Dulles Greenway/Dulles Toll Road widening from the main toll plaza to the Dulles Toll Road/Centreville Road Interchange
3. No-Build 2025 with eastbound Dulles Greenway/Dulles Toll Road widening from the main toll plaza to the Dulles Toll Road/Centreville Road Interchange
4. No-Build 2045
5. Build Alternative 1 – 2025
6. Build Alternative 1 - 2045
7. Build Alternative 2 – 2025
8. Build Alternative 2 - 2045
9. Build Alternative 3 – 2025
10. Build Alternative 3 - 2045
11. Build Alternative 4 – 2025
12. Build Alternative 4 – 2045

Assumptions related to the scenarios are provided below:

- **Existing Conditions** – Calibrated against 2018 traffic conditions and the 2017 MWCOG model.
- **No-Build (w/ CLRP) Conditions (2025 and 2045)** – The 2025 and 2045 No-Build scenario assumes the existing transportation system in addition to all projects funded for construction in the *National Capital Region's Draft 2017 CLRP* through 2025 and 2045. The TPB adopted the 2016 CLRP in November 2016.

Some of the regionally significant and corridor-specific projects include the following (taken from <http://www.mwcog.org/clrp/projects/highway.asp>). Projects listed below are numbered accordingly in **Figure 3**.

- For 2025, two No-Build scenarios will be evaluated - with and without the Dulles Greenway/Dulles Toll Road eastbound widening to three lanes between the main toll plaza and the Dulles Toll Road/Centreville Road Interchange. Based on the operational analysis and discussions with VDOT only one No-Build scenario will be carried forward to 2045 and to the Build scenarios.

Projects Implemented by 2025

1. Innovation Center Station is one of three new Metrorail stations in Fairfax County on the Silver Line that will open when Phase 2 construction is complete. Three additional stations will be located west of the site in Loudoun County, one being at the Dulles International Airport.
2. Route 606/Old Ox Road was widened to two lanes in each direction between Loudoun County Parkway and its current four-lane section east of the Dulles Greenway (Route 267) (Loudoun County). This project was completed in 2018.
3. Shellhorn Road and Sterling Boulevard will provide a new four-lane roadway between Loudoun County Parkway and Route 28 (Loudoun County)
4. Prentice Drive will be extended as a four-lane roadway from Lockridge Road to Shellhorn Road (Loudoun County)
5. Westwind Drive will be a new four-lane roadway between Old Ox Road and Loudoun County Parkway south/west of the Dulles Greenway (Loudoun County)
6. Eastbound Dulles Greenway/Dulles Toll Road will be widened to three lanes between the main toll plaza through the Dulles Toll Road/Centreville Road Interchange.

Projects Implemented by 2045

7. Bridge crossing of Dulles Toll Road at Innovation Center Station (Davis Drive Overpass). This will be a new four-lane roadway that will connect Innovation Avenue and Sunrise Valley Drive.
8. Route 28 has multiple improvements¹:
 - Complete widening to four lanes (all general purpose) in each direction between Route 7 and Route 267
 - Complete widening to four lanes (three general purpose and one HOV) in each direction between Route 267 and Westfields Boulevard
 - Widening to five lanes (four general purpose and one HOV) in each direction between Westfields Boulevard and I-66
9. Frying Pan Road will be widened to two lanes in each direction (four lanes total) between Sunrise Valley Drive and Fox Mill Road.
10. Route 286 (Fairfax County Parkway) will be widened to include an additional lane in each direction for HOV between the Route 267 and I-66.

¹ Note: Some of these transportation improvements are currently in place. Since the transportation analysis was calibrated to the year 2015, this list represents improvements beyond the 2015 transportation network.

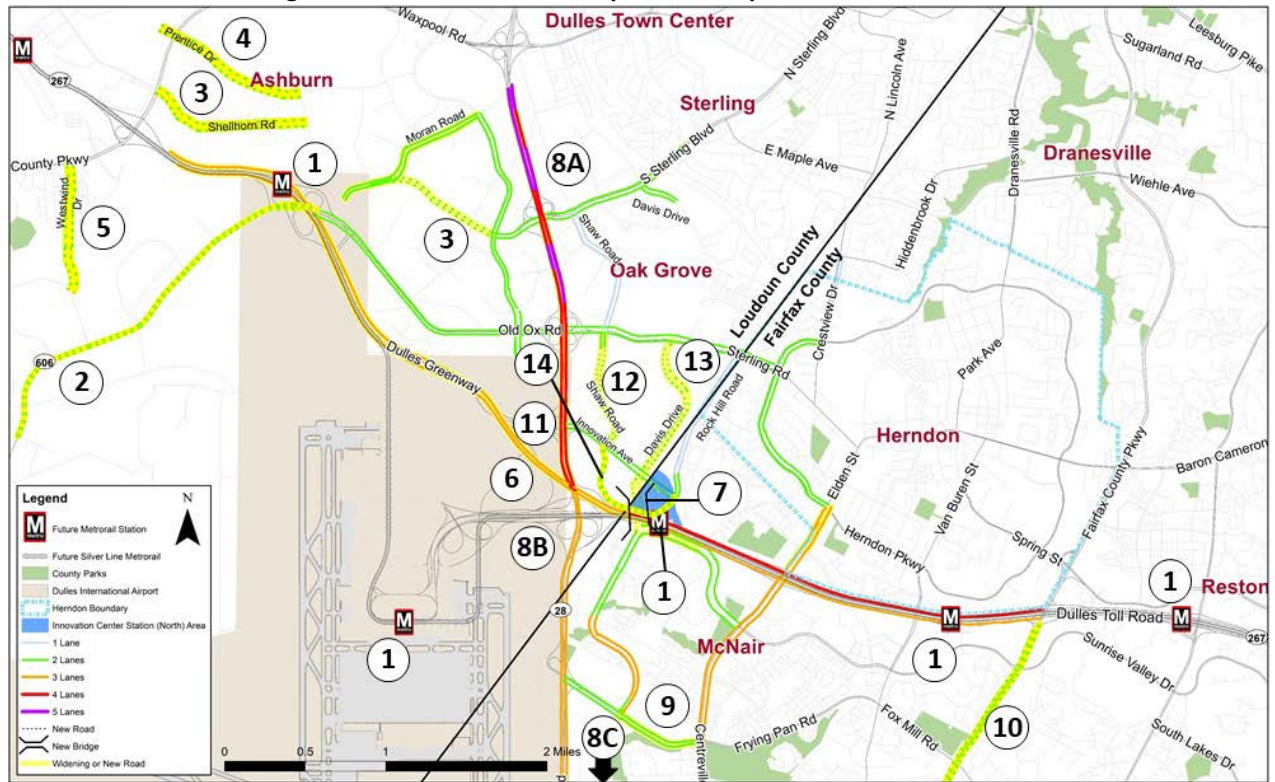


11. Westbound Dulles Greenway/Dulles Toll Road will be widened to three lanes between the main toll plaza through the Dulles Toll Road/Centreville Road Interchange.

Two developments, the Hub (formerly Dulles World Center) and Waterside were also factored into the 2045 planned network as they are located within the project study area. The developments, both located in Loudoun County, are considered to add the following transportation improvements to the baseline network based on approved proffers that require the developments to construct them:

12. Shaw Road will be a new four-lane roadway between its current terminus at Old Ox Road (Route 606) and Innovation Avenue. It will be widened to four lanes along its existing alignment south of Old Ox Road. This roadway is shown in the Loudoun County Countywide Transportation Plan (CTP) network.
13. Davis Drive will be a new four-lane roadway between Old Ox Road (Route 606) and Innovation Avenue. This roadway is also shown in the Loudoun County CTP network. This road is assumed to continue to the south of Innovation Avenue as the new bridge crossing of the Dulles Toll Road at Innovation Center Station described previously (Davis Drive Overpass). Note that the Loudoun County CTP network also shows Davis Drive north of Old Ox Road connecting to its present terminus south of Sterling Boulevard; this segment is not assumed to be included under baseline conditions.
14. A two-lane local collector road was assumed to the south of Innovation Avenue along its previous alignment. This road is assumed to continue south of the intersection of Shaw Road and Innovation Avenue, turn east and run under the proposed new crossing of the Dulles Toll Road, and then turn north to terminate at the intersection of Innovation Avenue and Rock Hill Road.

Figure 3. Future Planned Transportation Improvements



- Build Conditions** – Assumes the No-Build configuration as a base condition and will reflect geometry, access points, and lane configuration proposed in the conceptual design developed by the preliminary design team. Up to four build configurations will be developed and analyzed for both 2025 and 2045. The decision whether to include the Dulles Greenway widening from four to six lanes will be made by VDOT and the project stakeholders during the No-Build traffic analysis.

3.1. Screening Alternatives

The team will identify up to ten mitigation measures to address operational and safety issues identified in the 2045 No-Build Conditions. The ten mitigation measures will be screened using qualitative criteria and quantitative results from smaller hot-spot analyses. Mitigation measures to advance forward will be combined into up to four mitigation alternatives. VISSIM will be utilized to evaluate 2025 and 2045 conditions for up to four alternatives.

4. Travel Demand Modeling Methodology and Key Assumptions

The latest MWCOG travel demand model version based on the 3,722 traffic analysis zone (TAZ) system will be used in conjunction with Round 9.1 Cooperative Forecasts (socioeconomic data) for the Existing, 2025, and 2045 model years. The MWCOG model base year is 2017; a project Existing Conditions (year 2018) model will be prepared, modified and calibrated to reflect field counts. Modifications will be carried forward into future analysis year model scenarios.

The MWCOG model will be strategically modified with specific alterations to improve the accuracy and reliability of forecasts for the study corridor, roadways connected to the corridor, and transit services in the vicinity of the corridor. The calibration targets will be based on guidance from the FHWA Transportation Model Improvement Program (TMIP) *Travel Model Validation and Reasonableness Checking Manual* and the Virginia *Travel Demand Modeling Policies and Procedures Manual* (VTM). Because the MWCOG/TPB Model is already subject to scrutiny as a regional model which has been a subject of FHWA's TMIP Peer Review process, the validation process will focus on the study area and will compare daily counts versus model forecasts and AM and PM observed speeds and travel times to model speeds and travel times. **Table 1** provides a listing of travel demand model calibration criteria.

Alterations to the MWCOG travel demand model to improve corridor calibration may include:

- Highway network modifications to better represent study area facilities as they exist and are planned, such as modifications to link facility types. Ramps will be micro-coded to improve forecasts and correlation to the microsimulation process.
- Modifications to centroid connector locations (or adding/removing centroid connectors) to improve model loading for all modeled modes of transportation.
- A review of tolling sensitivity parameters for use of the Dulles Greenway and Dulles Toll Road.
- A review of airport passenger travel assumptions for use of the Dulles Airport Access Road.

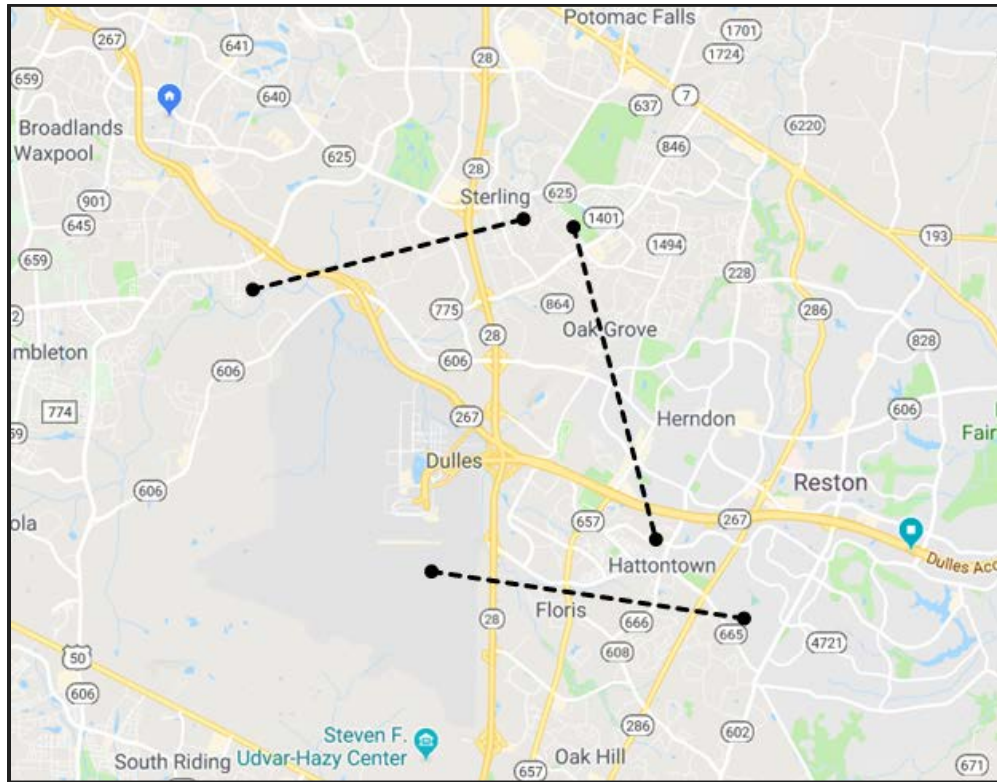
Table 1. Travel Demand Forecast Model Calibration Criteria

Calibration Scale	Calibration Check	Calibration Threshold			
Regional(Cutlines)	% Difference in Total Volume for Cutlines (24-Hour Volumes)	Cutline Volume	VTM	FHWA	Proposed
		50,000	10%	35%	10%
		100,000	8.75%	25%	10%
		150,000	7.50%	20%	10%
		200,000	6.25%	18%	8%
		250,000	5%	15%	7%
Study Area	R-Squared between modeled volume and counts on links (AM Period, PM Period, and 24-Hour Volumes)	VTM	FHWA	Proposed	
		0.9	0.88	0.9	
	% Difference in Total Volume by Facility Type (AM Period, PM Period, and 24-Hour Volumes)	Facility Type	VTM	FHWA	Proposed
		Freeways	6%	7%	6%
		Major Arterials	7%	10%	10%
		Minor Arterials	10%	15%	15%
	%RMSE by Facility Type (AM and PM Period)	Facility Type	VTM	FHWA	Proposed
		Freeways	30%	-	30%
		Major Arterials	45%	-	45%
		Minor Arterials	60%	-	60%
		Overall	40%	-	40%
	%RMSE by Facility Type (24-Hour Volumes)	Facility Type	VTM	FHWA	Proposed
		Freeways	20%	-	20%
		Major Arterials	35%	-	35%
		Minor Arterials	50%	-	50%
		Overall	30%	-	30%
	Travel Times (AM and PM Period)	No specific measures in VTM or FHWA; compare model outputs to floating car travel runs and check to see if travel times are within min and max of observed travel times. <u>Note that these are reasonableness checks only.</u>			

The following cut-lines, shown in Figure 4 will be used in the calibration process:

- North/West Cutline
 - Route 267 (Dulles Greenway) between Route 606 (Old Ox Road) and Loudoun County Parkway
 - Pacific Boulevard north of Route 846 (Sterling Blvd)
 - Route 28 between Route 846 (Sterling Blvd) and Route 625 (Waxpool Road)
 - Davis Drive north of Route 846 (Sterling Blvd)
- East Cutline
 - Route 846 (Sterling Boulevard) east of Route 28
 - Route 606 (Sterling Road) just west of Herndon Parkway
 - Route 267 (Dulles Toll Road) west of Centreville Road
 - Sunrise Valley Drive west of Centreville Road
- South Cutline
 - Route 28 between McLearen Road and Frying Pan Road
 - Centreville Road south of Dulles Toll Road
 - Monroe Street south of Dulles Toll Road
 - Fairfax County Parkway south of Dulles Toll Road

Figure 4. Cutlines for Model Calibration



4.1. Future Analysis Scenario Assumptions

The traffic analysis will assess operations for a project Design Year of 2045 and Interim Year of 2025. The traffic analysis will account for two No-Build scenarios in 2025, one No-Build scenario in 2045, and four Build alternatives. Separate travel demand model networks will be developed for each of the future-year scenarios to be used for forecasting traffic volumes.

The travel demand model No-Build networks will include all roadway projects in the most up-to-date regional CLRP as listed in Section 3 of this framework. The Build network will include all the roadway projects included in No Build and the proposed mitigation measures for the Build alternative.

4.2. Methodology and Key Assumptions for Post-Processing of Modeling Results

Post-processing of travel demand model output is necessary to develop traffic volume forecasts for analysis of operations during peak periods/peak hours. Post-processing of travel demand forecasts for vehicular volumes will follow NCHRP 255/765 guidelines and the TFlowFuzzy methodology included in the VISUM planning tool for estimating balanced No-Build and Build peak period volumes. Existing balanced volumes will be developed outside of the MCOG travel demand model using field count data; origin-destination (O-D) routing will be obtained utilizing StreetLight Data and the O-D matrix will be adjusted using VISUM’s TFlowFuzzy methodology to match target balanced volumes along the corridor.

5. Traffic Operational Analysis Methods and Parameters

5.1. Traffic Analysis Tools

VISSIM Version 9.0 will be used for a comprehensive network traffic analysis performed within the study area limits. (Reference analysis tool selection matrix, *VDOT Traffic Operations and Safety Analysis Manual [TOSAM] V1.0*², Appendix D.) Calibration, based on simulated volume processed, travel times, queues, and speed profiles, will be performed against 2018 measured field conditions and traffic data. Surface street intersection operations will be evaluated through a combination of Synchro 10 (in order to develop preliminary optimization for phasing and signal timing) and VISSIM (for microsimulation and analysis).

5.2. Measures of Effectiveness

The following measures of effectiveness (MOEs) will be used for the operational analysis of the roadway network under existing and future No- Build and Build conditions. Wherever possible, MOEs will be provided in graphical format or GIS maps. These MOEs will be developed according to guidance from the VDOT TOSAM.

Freeway Performance Measures

- Simulated Average Speed (mph)
- Simulated Average Density (veh/ln/mile, color-coded similar to the equivalent Density-Based LOS Thresholds)
- Simulated Volume (vehicles per hour)

The VISSIM freeway MOEs will be reported for each freeway segment. Methodology for the merge/diverge/weave segment analyses will be consistent with procedures outlined in the *Highway Capacity Manual* for the area of influence within the designated segments. This methodology will be consistent with the TOSAM. In addition, the following freeway MOEs also are proposed for reporting in the IJR:

- **Percent of Demand Served.** Simulated Volume (*processed volumes*) divided by Actual Volume (*input volumes*).
- **Simulated Ramp Queue Length.** Reported average and maximum queue lengths (feet).
- **Simulated Travel Time.** Reported for select network origin-destination travel paths (seconds).
- **Congestion Heat Maps.** Incremental speeds reported for aggregated lanes, by time interval (mph).

Arterial/Intersection Performance Measures

- **Simulated Intersection Level of Service (LOS) and Average Control Delay.** Reported by approach and by intersection (sec/veh, color-coded in similar fashion as the equivalent Highway Capacity Manual (HCM) Delay-Based LOS Thresholds). Delay will be reported as “microsimulation delay” per guidance from the VDOT TOSAM.
- **Simulated Intersection Approach Queue.** Reported by movement (feet).
- **Percent of Demand Served.** Simulated Volume (*processed volumes*) divided by Actual Volume (*input volumes*).

² <http://www.virginia.gov/business/resources/TOSAM.pdf>

5.3. VISSIM Model Calibration Methodology and Criteria

5.3.1. CALIBRATION METHODOLOGY FOR BASE MODELS

The VISSIM models will be calibrated using guidance and direction provided in the *TOSAM*. Traffic volumes and travel time will be used as calibration measures for freeway segments. Calibration thresholds for each measure are summarized in Table 2.

Table 2. VISSIM Calibration Criteria and Acceptance Targets

Calibration Item	Basis	Criteria	Target
Simulated Traffic Volume (Intersections)	By Intersection Approach	Within $\pm 20\%$ for <100 vph	At least 85% of all Intersection Approaches
		Within $\pm 15\%$ for ≥ 100 vph to < 300 vph	
		Within $\pm 10\%$ for ≥ 300 vph to $< 1,000$ vph	
		Within $\pm 5\%$ for $\geq 1,000$ vph	
Simulated Traffic Volume (Freeways)	By Freeway Segment	Within $\pm 20\%$ for <100 vph	At least 85% of all Freeway Segments
		Within $\pm 15\%$ for ≥ 100 vph to < 300 vph	
		Within $\pm 10\%$ for ≥ 300 vph to $< 1,000$ vph	
		Within $\pm 5\%$ for $\geq 1,000$ vph	
Simulated Travel Time	By Route	Within $\pm 30\%$ for average travel times on arterials	At least 85% of all Travel Time Routes (Including Segments)
		Within $\pm 20\%$ for average travel times on freeways	
Maximum Simulated Queue Length	By Approach for Targeted Critical Locations	Modeled queues qualitatively reflect the impacts of observed queues	Qualitative Visual Match compared to Google Maps and INRIX
Visual Review of Bottleneck Locations	Targeted Critical Locations	Speed heat maps qualitatively reflect patterns and duration of congestions	Qualitative Subjective Assessment

- Traffic Volume:** Simulated throughput calibrated using data collected during the AM and PM peak hours. Freeway traffic volumes will be calibrated for mainline, diverge, merge, weave, and ramp segments. Intersection traffic volumes will be calibrated by turning movement volumes at the study intersections.
- Travel Time:** Simulated travel time calibrated using field data collected during the AM and PM peak hours.

3. **Speeds:** The criteria listed above deviates from TOSAM requirements for simulated average speeds. Speeds are highly variable on the freeway mainline as well as on the local arterial network and residential roadways and can vary substantially by hour and by day. Instead, the simulated average speed will be captured as part of the travel time calibration process and the visual review of bottleneck locations against speed heat maps will be conducted. Average speeds will still be extracted from the VISSIM models along the study corridors for SR 267 and Route 28 at one-half mile intervals and compared visually against speed heat maps generated from INRIX vehicle probe data.
4. **Queue Length:** Similarly, queuing within the study area is notably inconsistent and can oscillate numerous times within the peak periods or be absent altogether on some days. A qualitative subjective assessment will be conducted for queue lengths at targeted locations in addition to the review of freeway mainline congestion/queues against the speed heat maps. This calibration method is again a deviation from the TOSAM. The targeted locations identified below, where extensive queuing issues consistently exist, will be focused on as critical locations.
 - Ramp from SR 267 WB to Route 28 northbound
 - Ramp from Route 28 southbound to SR 267 EB
 - Ramp from SR 267 EB (Greenway) to Route 28 southbound

5.4. Simulation Time, Seeding Time and Number of Runs

After assessing the INRIX speed heat map for the SR 267 and Route 28 (pulled from RITIS for average Tuesdays, Wednesdays, and Thursdays from January 2018 to September 2018), **Figure 5 and 6** show the proposed analysis time periods and “network representative” or peak hours (for volume balancing purposes and MOE summaries). The consultant team recommends basing the analysis periods upon the magnitude of freeway congestion. Upon review of the INRIX speed data, the slowest speeds and heaviest queues during the AM peak period are along SR 267 eastbound and during the PM are along Route 28 northbound.

- AM: proposed analysis period from 7:30 AM to 9:30 AM; network representative hour from 8:00 AM to 9:00 AM.
- PM: proposed analysis period from 4:00 PM to 7:00 PM; network representative hour from 5:00 PM to 6:00 PM.

Figure 5: INRIX Speed Heat Map for Route 267 Eastbound and Proposed AM Analysis Periods

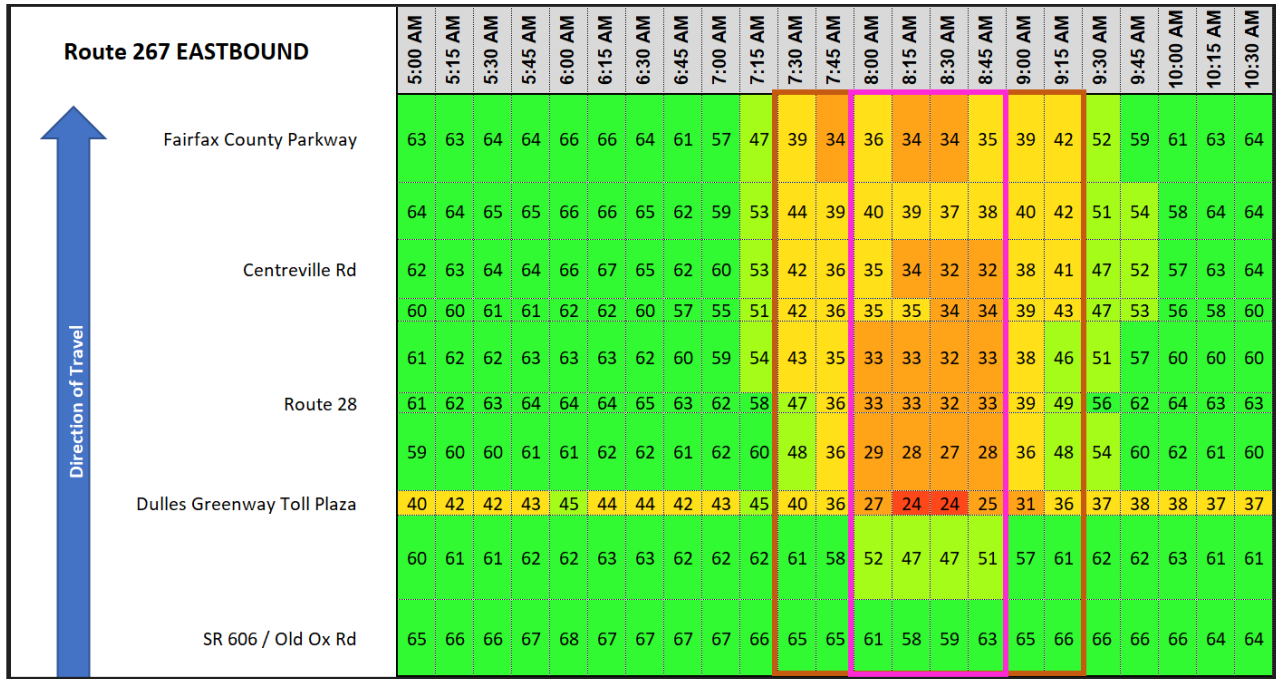


Figure 6: INRIX Speed Heat Map for Route 28 Southbound and Proposed AM Analysis Periods

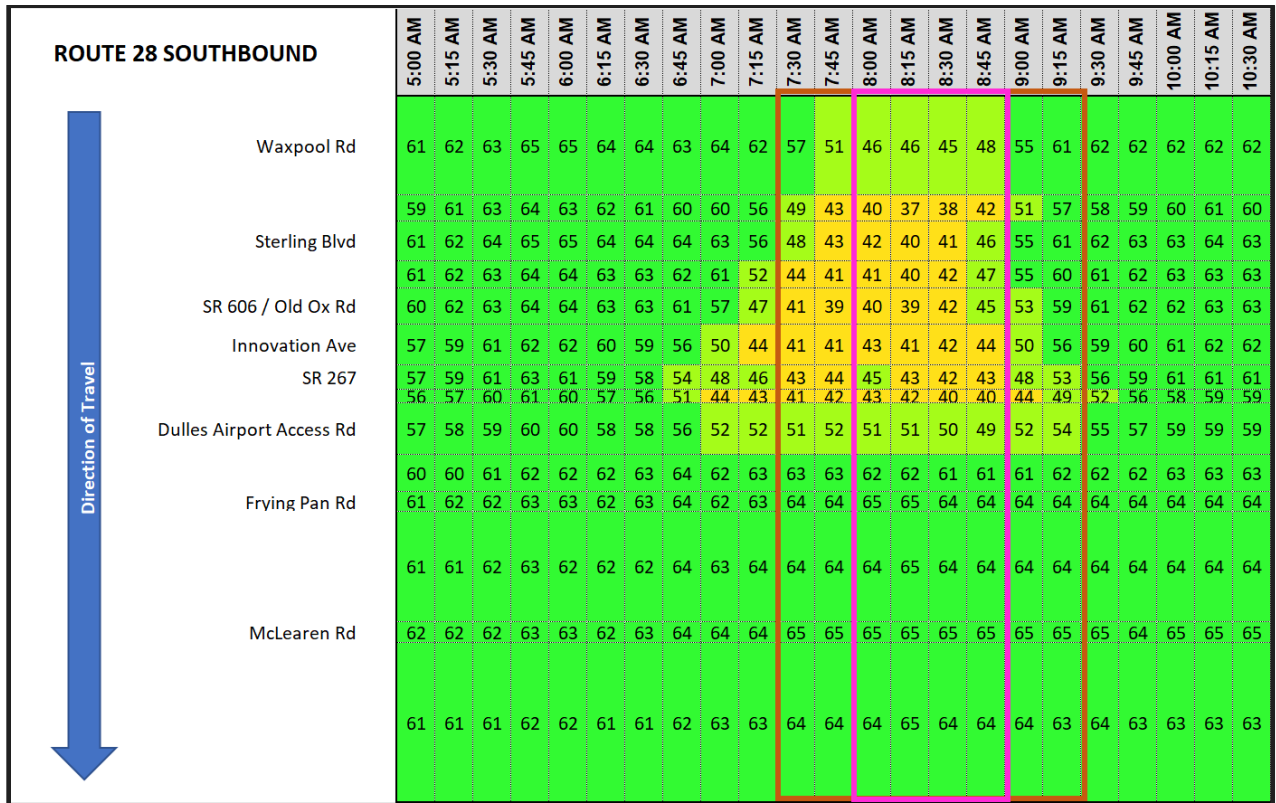
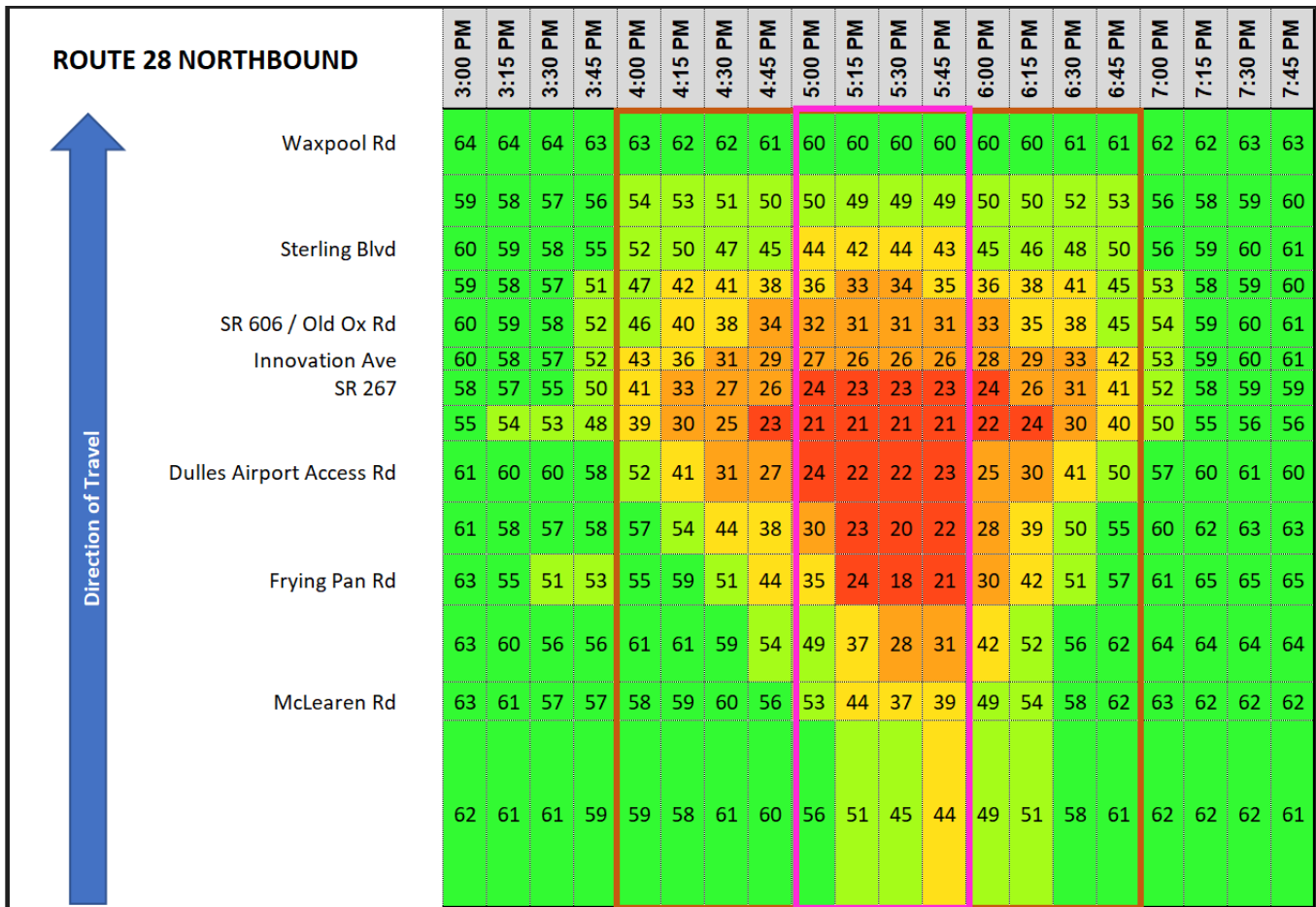


Figure 7: INRIX Speed Heat Map for Route 28 Northbound and Proposed PM Analysis Periods



VISSIM simulation seeding time will be determined using the average travel time for a vehicle to traverse the corridor in the peak travel direction during the peak hours. Given the stochastic nature of the VISSIM models, they need to be run with several different random seeds (to be determined based on statistical analysis) and the results need to be post-processed and averaged to determine the current state of traffic operations in the corridor. The total number of runs necessary for the analysis will be determined based on guidance from the TOSAM. The VDOT Sample Size Determination Tool, which was developed based on FHWA’s statistical process to ensure that an appropriate number of microsimulation runs are performed at a 95th percentile confidence level, will be used per guidance from the TOSAM.

5.5. Quality Control and Assurance

The development of VISSIM models includes an extensive quality assurance/quality control process. All network inputs entered by a modeler will be checked by another modeler not associated with the development of the section. All routes and signal settings will be checked by a second modeler different from the one who entered the inputs into the VISSIM models. Close coordination will be maintained throughout the modeling effort to incorporate adequate geometric improvements into the VISSIM models.

6. Safety Analysis

Using latest 5 years of crash data provided by VDOT, crash analyses will be completed for existing conditions. This analysis will be conducted to identify any potential hot spot locations within the study area. A qualitative crash analysis will include the freeway segments and interchanges within the study area as identified in Figure 1.

A qualitative safety analysis, such as documenting existing crash densities and predominant crash types on the arterials, interchange ramps, and intersections will be used to determine existing safety issues in the study area. Crash data will be analyzed based on location, type, severity, time, and day to identify existing crash patterns and safety concerns in the study area. Highway Safety Manual Crash Modification Factors, where available, will be applied to evaluate impacts of safety associated with improvement concepts.

7. Alternative Improvement Options and Concept Development

Alternative improvement options will be developed using any available electronic CAD design files (such as Silverline and Route 28 southbound lane improvements) and GIS to supplement as the base mapping. The alternatives will be shown as plan view to show horizontal alignments, vertical profiles at critical locations, identification of anticipated structures (bridges, retaining walls, etc.), and potential right-of-way impacts. These alternatives will be developed in Microstation and with an aerial image as a background. Based on the traffic and safety analysis and evaluation of the measures of effectiveness as defined by the stakeholders, a preferred concept will be selected. The preferred concept plan will be developed that will consist of the elements of the alternative concepts plus typical sections, anticipated construction limits, and identification of potential areas for stormwater management facilities. Planning level costs will be developed for each alternative concept and the preferred concept.

8. Project Milestones, Stakeholder Meetings, & Public Meeting

Six (6) meetings will be held with Technical Stakeholders and six (6) meetings will be held with Executive Stakeholders. One public meeting will be held as part of the project to collect input on the concepts.

Figure 8 on the next page shows a preliminary milestone schedule and list of the meeting topics. Appendix B includes contact information for each stakeholder.

Figure 8. Project Milestone & Stakeholder Meetings

Task	Description	Month 1		Month 2				Month 3				Month 4				Month 5				Month 6				Month 7				Month 8				Month 9				Month 10				Month 11				Month 12												
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51				
		1	Project Mangement and Meetings																																																					
	<i>Project Mangement and Coordination</i>																																																							
	<i>Technical Stakeholder Meetings</i>					1						2							3																																					
	<i>Executive Stakeholder Meetings</i>						1													2																																				
2	Data Collection and Data Analysis																																																							
	<i>Data Collection and Data Analysis</i>																																																							
3	Existing (2018) Conditions Analysis																																																							
	<i>Existing (2018) Conditions Analysis</i>																																																							
4	Travel Demand Model Forecast Modeling and Development of Future Traffic Volumes																																																							
	<i>Existing Conditions</i>																																																							
	<i>No-Build Conditions (2025 & 2045)</i>																																																							
	<i>Future Build Conditions</i>																																																							
5	Future No-Build Traffic Operational Analysis																																																							
	<i>Future No-Build Traffic Operational Analysis</i>																																																							
6	Concept Development																																																							
	<i>Concept Development (Options Development, Screening, and Refinement)</i>																																																							
7	Future Build Traffic Operations Analysis																																																							
	<i>Future Build Traffic Operations Analysis</i>																																																							
8	Public Meeting																																																							
	<i>Public Meeting</i>																																																							
9	Preferred Alternative																																																							
	<i>Preferred Alternative Concept Development</i>																																																							
	<i>Preferred Alternative Traffic Operations Analysis</i>																																																							
10	Report																																																							
	<i>Draft Report</i>																																																							
	<i>Stakeholder Review</i>																																																							
	<i>Final Report</i>																																																							

- Legend**
- Kimley-Horn Team Working Period and/or Draft Deliverables
 - Technical Stakeholder Meetings
 - Executive Stakeholder Meetings
 - Public Meeting

Technical Stakeholder Meetings

1. Kick-Off/Data Gathering
2. Existing Condition Analysis
3. Future No-Build Analysis
4. Screening of Alternatives
5. Future Build Analysis
6. Preferred Alternative (Preliminary Sketch/Cost Estimate)

Executive Stakeholder Meetings

1. Study Objectives & Criteria
2. No-Build Assumptions (Widening vs. No Widening)
3. Concept Alternatives
4. Concept Refinement
5. Future Build Analysis
6. Preferred Alternative (Preliminary Sketch/Cost Estimate)



9. Report Deliverables

- **Draft and Final Existing Conditions Technical Memorandum**
- **Draft and Final 2025 and 2045 No-Build Conditions Technical Memorandum**
- **Conceptual Layout (plan and profile) for one Build Alternative and Cost Estimate**
- **Draft and Final Project Report**
- **Six-Year Improvement Program (SYIP) / STARS Improvement Summary Sheets for short-term improvements**



Accepted and agreed upon by VDOT:

VDOT (Northern Virginia District):

Signature

Printed Name

Title

Date

Metropolitan Washington Airports Authority:

Signature

Printed Name

Title

Date

Fairfax County:

Signature

Printed Name

Title

Date

VDOT (Central Office):

Signature

Printed Name

Title

Date

Toll Road Investors Partnership II (TRIP II):

Signature

Printed Name

Title

Date

Loudoun County:

Signature

Printed Name

Title

Date



Appendix A: Data Collection Memorandum



STARS Route 28 and Dulles Toll Road/Dulles Greenway Study

Data Collection Locations

Turning Movement Counts

Turning movement traffic counts will be collected at the following ten (10) intersections during the AM (6:00-9:00 AM) and PM (4:00-7:00 PM) peak periods on a typical weekday (Tuesday, Wednesday or Thursday). Turning movement counts at 15-minute intervals, which consist of the collection of passenger cars, heavy vehicles and pedestrians, will be collected at the following locations:

Signalized Intersections

1. Sunrise Valley Drive at Frying Pan Road
2. Pacific Boulevard at Route 606 (Old Ox Road)
3. Shaw Road at Route 606 (Old Ox Road)
4. Pacific Boulevard at Route 846 (S. Sterling Boulevard)
5. Shaw Road at Route 846 (S. Sterling Boulevard)
6. Centreville Road and Dulles Toll Road Ramps South of Dulles Toll Road
7. Centreville Road and Dulles Toll Road Ramps North of Dulles Toll Road
8. Route 846 (S. Sterling Boulevard) and Route 28 southbound off-ramps
9. Route 846 (S. Sterling Boulevard) and Route 28 northbound off-ramps
10. Route 606 (Old Ox Road) and Route 28 northbound off-ramps

Adjacent intersections will be counted on the same day. The intersection counts and the ramp/mainline counts should be conducted in the same week.

Mainline (Video Counts)

One-week of video counts will be conducted at each of the following 24 mainline locations:

Route 28

1. Northbound Route 28 Mainline south of Frying Pan Road
2. Southbound Route 28 Mainline south of Frying Pan Road
3. Northbound Route 28 Mainline north of Frying Pan Road
4. Southbound Route 28 Mainline north of Frying Pan Road
5. Northbound Route 28 Mainline north of Dulles Toll Road
6. Southbound Route 28 Mainline north of Dulles Toll Road
7. Northbound Route 28 Mainline north of Innovation Avenue
8. Southbound Route 28 Mainline north of Innovation Avenue
9. Northbound Route 28 north of Route 606 (Old Ox Road)
10. Southbound Route 28 north of Route 606 (Old Ox Road)
11. Northbound Route 28 north of Route 846 (S. Sterling Boulevard)
12. Southbound Route 28 north of Route 846 (S. Sterling Boulevard)

Route 267 (Dulles Toll Road)/Dulles Access Road

13. Eastbound Route 267 (Dulles Greenway) west of Route 28 (west of Toll Plaza)
14. Westbound Route 267 (Dulles Greenway) west of Route 28 (west of Toll Plaza)
15. Eastbound Dulles Access Road west of Route 28 (east of Rudder Road bridge)
16. Westbound Dulles Access Road west of Route 28 (east of Rudder Road bridge)
17. Eastbound Route 267 (Dulles Toll Road) east of Route 28 (between Dulles Access Road Slip Ramps and Centreville Road Ramps)
18. Eastbound Dulles Access Road east of Route 28 (between Dulles Access Road Slip Ramps and Centreville Road Ramps)
19. Westbound Route 267 (Dulles Toll Road) east of Route 28 (between Dulles Access Road Slip Ramps and Centreville Road Ramps)
20. Westbound Dulles Access Road east of Route 28 (between Dulles Access Road Slip Ramps and Centreville Road Ramps)
21. Eastbound Route 267 (Dulles Toll Road) east of Centreville Road
22. Eastbound Dulles Access Road east of Centreville Road
23. Westbound Route 267 (Dulles Toll Road) east of Centreville Road
24. Westbound Dulles Access Road east of Centreville Road

Data will be collected and summarized by direction and by individual lane. Volumes will be disaggregated into a select number of vehicle classes (e.g., cars vs trucks) for every 15-minute interval.

Ramp

One-week of video or tube counts will be conducted at each of the following 48 ramps:

Route 28 & Frying Pan Road Interchange (4 ramps)

1. Off-ramp from northbound Route 28 to Frying Pan Road
2. On-ramp from westbound Frying Pan Road to northbound Route 28
3. Off-ramp from southbound Route 28 to Frying Pan Road
4. On-ramp from westbound Frying Pan Road to southbound Route 28

Route 28 & Route 606 (Old Ox Road) Interchange (8 ramps)

5. Off-ramp from northbound Route 28 to eastbound Route 606 (Old Ox Road)
6. On-ramp from eastbound Route 606 (Old Ox Road) to northbound Route 28
7. Off-ramp from northbound Route 28 to westbound Route 606 (Old Ox Road)
8. On-ramp from westbound Route 606 (Old Ox Road) to northbound Route 28
9. Off-ramp from southbound Route 28 to westbound Route 606 (Old Ox Road)
10. On-ramp from westbound Route 606 (Old Ox Road) to southbound Route 28
11. Off-ramp from southbound Route 28 to eastbound Route 606 (Old Ox Road)
12. On-ramp from eastbound Route 606 (Old Ox Road) to southbound Route 28

Route 28 & Route 846 (S. Sterling Boulevard) Interchange (6 ramps)

13. Off-ramp from northbound Route 28 to eastbound Route 846 (S. Sterling Boulevard)
14. Off-ramp from northbound Route 28 to westbound Route 846 (S. Sterling Boulevard)
15. On-ramp from Route 846 (S. Sterling Boulevard) to northbound Route 28
16. Off-ramp from southbound Route 28 to Route 846 (S. Sterling Boulevard)
17. On-ramp from westbound Route 846 (S. Sterling Boulevard) to southbound Route 28
18. On-ramp from eastbound Route 846 (S. Sterling Boulevard) to southbound Route 28

Centreville Road & Dulles Toll Road Interchange (4 ramps)

19. Off-ramp from eastbound Route 267 (Dulles Toll Road) to Route 657 (Centreville Road)/Elden Street
20. On-ramp from Route 657 (Centreville Road)/Elden Street to eastbound Route 267 (Dulles Toll Road)
21. Off-ramp from westbound Route 267 (Dulles Toll Road) to Route 657 (Centreville Road)/Elden Street)
22. On-ramp from Route 657 (Centreville Road)/Elden Street to westbound Route 267 (Dulles Toll Road)

Dulles Access Road Slip-Ramps at Centreville Road Area (3 ramps)

23. Slip-ramp from eastbound Dulles Access Road to eastbound Route 267 (Dulles Toll Road), east of Centreville Road
24. Slip-ramp from eastbound Dulles Access Road to eastbound Route 267 (Dulles Toll Road), west of Centreville Road
25. Slip-ramp from westbound Dulles Access Road to eastbound Route 267 (Dulles Toll Road), west of Centreville Road

Dulles Access Road west of Route 28 Interchange (3 ramps)

26. Off-ramp from eastbound Dulles Access Road to Route 28 (Exit 9A), east of Rudder Road Bridge
27. On-ramp from Dulles Toll Road to westbound Dulles Access Road, east of Rudder Road Bridge
28. On-ramp from Airport to eastbound Dulles Access Road/Route 28
29. Slip-ramp from Airport to eastbound Dulles Access Road

Route 28 & Innovation Avenue Interchange (4 ramps)

30. Off-ramp from northbound Route 28 to Innovation Avenue
31. On-ramp from westbound Innovation Avenue to northbound Route 28
32. Off-ramp from southbound Route 28 to Innovation Avenue
33. On-ramp from westbound Innovation Avenue to southbound Route 28

Dulles Toll Road/Dulles Greenway & Route 28 Interchange (15 ramps)

34. Off-ramp from northbound Route 28 to eastbound Route 267 (Dulles Toll Road)
35. Off-ramp from northbound Route 28 to westbound Dulles Access Road
36. On-ramp from Airport to northbound Route 28
37. Slip-ramp from Airport to eastbound Dulles Access Road
38. On-ramp from westbound Route 267 (Dulles Toll Road) to northbound Route 28
39. Off-ramp from northbound Route 28 to westbound Route 267 (Dulles Greenway)
40. On-ramp from eastbound Route 267 (Dulles Greenway) to southbound Route 28
41. Off-ramp from eastbound Dulles Access Road to westbound (Dulles Greenway)
42. On-ramp from westbound Route 267 (Dulles Toll Road) to southbound Route 28
43. On-ramp from eastbound Route 267 (Dulles Greenway) to eastbound Route 267 (Dulles Toll Road)
44. Off-ramp from eastbound Route 267 (Dulles Greenway) to westbound Dulles Access Road
45. Off-ramp from southbound Route 28 to westbound Dulles Access Road
46. Off-ramp from westbound Dulles Access Road to Rudder Road
47. Off-ramp from southbound Route 28 to eastbound Route 267 (Dulles Toll Road)
48. On-ramp from Airport to southbound Route 28

Data will be collected and summarized by direction. Volumes will be disaggregated into a select number of vehicle classes (e.g., cars vs trucks) for every 15-minute interval.



Travel Time Runs

Travel time runs will be conducted in the study corridor for the routes listed below:

1. Northbound Route 28 from south of Frying Pan Road to north of S. Sterling Boulevard
2. Southbound Route 28 from north of S. Sterling Boulevard to south of Frying Pan Road
3. Eastbound Route 267 from west of the Dulles Greenway Toll Plaza to east of the Centreville Road to beyond project limit
4. Westbound Route 267 from east of the Centreville to beyond the Dulles Greenway toll plaza
5. Westbound Route 267 from east of the Centreville Road interchange to south of the Frying Pan Road (Southbound Route 28)
6. Westbound Route 267 from east of the Centreville Road interchange to north of the S. Sterling Boulevard (Northbound Route 28)
7. Eastbound from west of Dulles Greenway Toll plaza to south of the Frying Pan Road (Southbound Route 28)
8. Southbound from north of S. Sterling Boulevard to east of the Route 267 Centreville Road Interchange.

Travel time between the interchanges along each route will be documented.

Time Periods

- Weekday (Tuesday, Wednesday or Thursday) AM Peak Period: runs beginning no earlier than 7:30 AM and concluding not later than 9:30 AM; and
- Weekday (Tuesday, Wednesday or Thursday) PM Peak Period: runs beginning no earlier than 4:30 PM and concluding not later than 6:30 PM

Number of Runs

- 10 runs for each of the routes indicated above for both the time periods

Travel time information will be collected using GPS devices that will provide location coordinates, distance, time, and speed measurements for each travel time route identified above. During the travel time runs, locations where queueing begins will be recorded, specifically, the approximate mile marker and a time stamp. In addition, the location where queueing ends (i.e., the location where speeds noticeably begin to increase, and densities noticeably begin to decrease).

Appendix B: Stakeholder Members and Communications Protocol

Route 28 Stakeholders are listed below. Project communications should be conducted through the VDOT Project Manager. However, under some circumstances, the VDOT Project Manager may request Kimley-Horn to directly correspond with the stakeholders. In this case, the VDOT Project Manager will be copied on the correspondence.

Agency	Point of Contact	Email	Phone Number
VDOT Project Manager	Abi Lerner	abraham.lerner@vdot.virginia.gov	703-259-3345
Fairfax County	Mike Garcia Dan Stevens	Michael.Garcia3@fairfaxcounty.gov Daniel.Stevens@fairfaxcounty.gov	703-877-5832 703-877-5670
Loudoun County	Susan Glass	susan.glass@loudoun.gov	703-777-0251
Metropolitan Washington Airports Authority	Mike Hewitt	michael.hewitt@mwa.com	703-572-0264
Toll Road Investors Partnership II (TRIP II)	Greg Woodsmall	gwoodsmall@dullesgreenway.com	703-668-0029



STARS Route 28 and Dulles Toll Road/Dulles Greenway Study DRAFT Traffic Operations Analysis Framework (Revisions, 3/26/2019)

The Route 28 and Dulles Toll Road/Dulles Greenway Study Traffic Operations Analysis Framework Document (version 4, January 9, 2019) was issued to stakeholders for review and concurrence prior to the project kickoff meeting held February 14, 2019. As a result of discussions at the kick-off meeting, the following revisions are made to the signed framework document:

1. The 2025 No-Build Analysis Scenario will include the future Davis Drive extension north of Route 606 (Old Ox Road) and connecting to its present terminus south of Sterling Boulevard. This segment ***will be*** assumed to be included under baseline conditions by 2025.
2. Stakeholder member list is updated to include the Town of Herndon. Mark Duceman will be the primary point of contact and he may be reached via email at mark.ducemen@herndon.va.gov or via phone at 703-787-7380.
3. The 2025 No-Build Analysis Scenario will include the widening of northbound Route 28 from Route 267 (Dulles Toll Road) to Waxpool Road with one additional through travel lane (this project is funded through NVTVA but was mistakenly listed as complete by 2045).

APPENDIX B – TRAFFIC DATA COLLECTION MEMO



STARS Route 28 and Dulles Toll Road/Dulles Greenway Study

Data Collection Locations

Turning Movement Counts

Turning movement traffic counts will be collected at the following ten (10) intersections during the AM (6:00-9:00 AM) and PM (4:00-7:00 PM) peak periods on a typical weekday (Tuesday, Wednesday or Thursday). Turning movement counts at 15-minute intervals, which consist of the collection of passenger cars, heavy vehicles and pedestrians, will be collected at the following locations:

Signalized Intersections

1. Sunrise Valley Drive at Frying Pan Road
2. Pacific Boulevard at Route 606 (Old Ox Road)
3. Shaw Road at Route 606 (Old Ox Road)
4. Pacific Boulevard at Route 846 (S. Sterling Boulevard)
5. Shaw Road at Route 846 (S. Sterling Boulevard)
6. Centreville Road and Dulles Toll Road Ramps South of Dulles Toll Road
7. Centreville Road and Dulles Toll Road Ramps North of Dulles Toll Road
8. Route 846 (S. Sterling Boulevard) and Route 28 southbound off-ramps
9. Route 846 (S. Sterling Boulevard) and Route 28 northbound off-ramps
10. Route 606 (Old Ox Road) and Route 28 northbound off-ramps

Adjacent intersections will be counted on the same day. The intersection counts and the ramp/mainline counts should be conducted in the same week.

Mainline (Video Counts)

One-week of video counts will be conducted at each of the following 24 mainline locations:

Route 28

1. Northbound Route 28 Mainline south of Frying Pan Road
2. Southbound Route 28 Mainline south of Frying Pan Road
3. Northbound Route 28 Mainline north of Frying Pan Road
4. Southbound Route 28 Mainline north of Frying Pan Road
5. Northbound Route 28 Mainline north of Dulles Toll Road
6. Southbound Route 28 Mainline north of Dulles Toll Road
7. Northbound Route 28 Mainline north of Innovation Avenue
8. Southbound Route 28 Mainline north of Innovation Avenue
9. Northbound Route 28 north of Route 606 (Old Ox Road)
10. Southbound Route 28 north of Route 606 (Old Ox Road)
11. Northbound Route 28 north of Route 846 (S. Sterling Boulevard)
12. Southbound Route 28 north of Route 846 (S. Sterling Boulevard)

Route 267 (Dulles Toll Road)/Dulles Access Road

13. Eastbound Route 267 (Dulles Greenway) west of Route 28 (west of Toll Plaza)
14. Westbound Route 267 (Dulles Greenway) west of Route 28 (west of Toll Plaza)
15. Eastbound Dulles Access Road west of Route 28 (east of Rudder Road bridge)
16. Westbound Dulles Access Road west of Route 28 (east of Rudder Road bridge)
17. Eastbound Route 267 (Dulles Toll Road) east of Route 28 (between Dulles Access Road Slip Ramps and Centreville Road Ramps)
18. Eastbound Dulles Access Road east of Route 28 (between Dulles Access Road Slip Ramps and Centreville Road Ramps)
19. Westbound Route 267 (Dulles Toll Road) east of Route 28 (between Dulles Access Road Slip Ramps and Centreville Road Ramps)
20. Westbound Dulles Access Road east of Route 28 (between Dulles Access Road Slip Ramps and Centreville Road Ramps)
21. Eastbound Route 267 (Dulles Toll Road) east of Centreville Road
22. Eastbound Dulles Access Road east of Centreville Road
23. Westbound Route 267 (Dulles Toll Road) east of Centreville Road
24. Westbound Dulles Access Road east of Centreville Road

Data will be collected and summarized by direction and by individual lane. Volumes will be disaggregated into a select number of vehicle classes (e.g., cars vs trucks) for every 15-minute interval.

Ramp

One-week of video or tube counts will be conducted at each of the following 48 ramps:

Route 28 & Frying Pan Road Interchange (4 ramps)

1. Off-ramp from northbound Route 28 to Frying Pan Road
2. On-ramp from westbound Frying Pan Road to northbound Route 28
3. Off-ramp from southbound Route 28 to Frying Pan Road
4. On-ramp from westbound Frying Pan Road to southbound Route 28

Route 28 & Route 606 (Old Ox Road) Interchange (8 ramps)

5. Off-ramp from northbound Route 28 to eastbound Route 606 (Old Ox Road)
6. On-ramp from eastbound Route 606 (Old Ox Road) to northbound Route 28
7. Off-ramp from northbound Route 28 to westbound Route 606 (Old Ox Road)
8. On-ramp from westbound Route 606 (Old Ox Road) to northbound Route 28
9. Off-ramp from southbound Route 28 to westbound Route 606 (Old Ox Road)
10. On-ramp from westbound Route 606 (Old Ox Road) to southbound Route 28
11. Off-ramp from southbound Route 28 to eastbound Route 606 (Old Ox Road)
12. On-ramp from eastbound Route 606 (Old Ox Road) to southbound Route 28

Route 28 & Route 846 (S. Sterling Boulevard) Interchange (6 ramps)

13. Off-ramp from northbound Route 28 to eastbound Route 846 (S. Sterling Boulevard)
14. Off-ramp from northbound Route 28 to westbound Route 846 (S. Sterling Boulevard)
15. On-ramp from Route 846 (S. Sterling Boulevard) to northbound Route 28
16. Off-ramp from southbound Route 28 to Route 846 (S. Sterling Boulevard)
17. On-ramp from westbound Route 846 (S. Sterling Boulevard) to southbound Route 28
18. On-ramp from eastbound Route 846 (S. Sterling Boulevard) to southbound Route 28



Centreville Road & Dulles Toll Road Interchange (4 ramps)

19. Off-ramp from eastbound Route 267 (Dulles Toll Road) to Route 657 (Centreville Road)/Elden Street
20. On-ramp from Route 657 (Centreville Road)/Elden Street to eastbound Route 267 (Dulles Toll Road)
21. Off-ramp from westbound Route 267 (Dulles Toll Road) to Route 657 (Centreville Road)/Elden Street)
22. On-ramp from Route 657 (Centreville Road)/Elden Street to westbound Route 267 (Dulles Toll Road)

Dulles Access Road Slip-Ramps at Centreville Road Area (3 ramps)

23. Slip-ramp from eastbound Dulles Access Road to eastbound Route 267 (Dulles Toll Road), east of Centreville Road
24. Slip-ramp from eastbound Dulles Access Road to eastbound Route 267 (Dulles Toll Road), west of Centreville Road
25. Slip-ramp from westbound Dulles Access Road to eastbound Route 267 (Dulles Toll Road), west of Centreville Road

Dulles Access Road west of Route 28 Interchange (3 ramps)

26. Off-ramp from eastbound Dulles Access Road to Route 28 (Exit 9A), east of Rudder Road Bridge
27. On-ramp from Dulles Toll Road to westbound Dulles Access Road, east of Rudder Road Bridge
28. On-ramp from Airport to eastbound Dulles Access Road/Route 28
29. Slip-ramp from Airport to eastbound Dulles Access Road

Route 28 & Innovation Avenue Interchange (4 ramps)

30. Off-ramp from northbound Route 28 to Innovation Avenue
31. On-ramp from westbound Innovation Avenue to northbound Route 28
32. Off-ramp from southbound Route 28 to Innovation Avenue
33. On-ramp from westbound Innovation Avenue to southbound Route 28

Dulles Toll Road/Dulles Greenway & Route 28 Interchange (15 ramps)

34. Off-ramp from northbound Route 28 to eastbound Route 267 (Dulles Toll Road)
35. Off-ramp from northbound Route 28 to westbound Dulles Access Road
36. On-ramp from Airport to northbound Route 28
37. Slip-ramp from Airport to eastbound Dulles Access Road
38. On-ramp from westbound Route 267 (Dulles Toll Road) to northbound Route 28
39. Off-ramp from northbound Route 28 to westbound Route 267 (Dulles Greenway)
40. On-ramp from eastbound Route 267 (Dulles Greenway) to southbound Route 28
41. Off-ramp from eastbound Dulles Access Road to westbound (Dulles Greenway)
42. On-ramp from westbound Route 267 (Dulles Toll Road) to southbound Route 28
43. On-ramp from eastbound Route 267 (Dulles Greenway) to eastbound Route 267 (Dulles Toll Road)
44. Off-ramp from eastbound Route 267 (Dulles Greenway) to westbound Dulles Access Road
45. Off-ramp from southbound Route 28 to westbound Dulles Access Road
46. Off-ramp from westbound Dulles Access Road to Rudder Road
47. Off-ramp from southbound Route 28 to eastbound Route 267 (Dulles Toll Road)
48. On-ramp from Airport to southbound Route 28

Data will be collected and summarized by direction. Volumes will be disaggregated into a select number of vehicle classes (e.g., cars vs trucks) for every 15-minute interval.



Travel Time Runs

Travel time runs will be conducted in the study corridor for the routes listed below:

1. Northbound Route 28 from south of Frying Pan Road to north of S. Sterling Boulevard
2. Southbound Route 28 from north of S. Sterling Boulevard to south of Frying Pan Road
3. Eastbound Route 267 from west of the Dulles Greenway Toll Plaza to east of the Centreville Road to beyond project limit
4. Westbound Route 267 from east of the Centreville to beyond the Dulles Greenway toll plaza
5. Westbound Route 267 from east of the Centreville Road interchange to south of the Frying Pan Road (Southbound Route 28)
6. Westbound Route 267 from east of the Centreville Road interchange to north of the S. Sterling Boulevard (Northbound Route 28)
7. Eastbound from west of Dulles Greenway Toll plaza to south of the Frying Pan Road (Southbound Route 28)
8. Southbound from north of S. Sterling Boulevard to east of the Route 267 Centreville Road Interchange.

Travel time between the interchanges along each route will be documented.

Time Periods

- Weekday (Tuesday, Wednesday or Thursday) AM Peak Period: runs beginning no earlier than 7:30 AM and concluding not later than 9:30 AM; and
- Weekday (Tuesday, Wednesday or Thursday) PM Peak Period: runs beginning no earlier than 4:30 PM and concluding not later than 6:30 PM

Number of Runs

- 10 runs for each of the routes indicated above for both the time periods

Travel time information will be collected using GPS devices that will provide location coordinates, distance, time, and speed measurements for each travel time route identified above. During the travel time runs, locations where queueing begins will be recorded, specifically, the approximate mile marker and a time stamp. In addition, the location where queueing ends (i.e., the location where speeds noticeably begin to increase, and densities noticeably begin to decrease).

APPENDIX C – VOLUME BALANCING MEMO



MEMORANDUM

To: Abi Lerner, P.E.
VDOT Project Manager

From: Rob Prunty, P.E.
Geoff Giffin, P.E., PTOE
Anthony Gallo, P.E.
Kavita Boddu, P.E.
Danielle McCray, P.E.
Britton Hammit, Ph.D., EIT
Kimley-Horn and Associates, Inc.

Date: March 19, 2019

Subject: Route 28 and Dulles Toll Road/Dulles Greenway Study
Volume Balancing for Existing Conditions

Introduction

This memorandum summarizes the development of balanced traffic volumes for the existing conditions (2018) as part of the Route 28 and Dulles Toll Road/Dulles Greenway Interchange Study. The balanced freeway mainline and ramp volumes are provided alongside the corresponding balanced arterial turning movement counts at study intersections.

Data Collection

Mainline and ramp traffic classification counts were collected continuously on Tuesday, November 13, 2018 and Wednesday, November 14, 2018; counts on Thursday, November 15, 2018 were discarded due to adverse weather conditions impacting travel conditions due to school closing. Intersection turning movement counts were collected on Tuesday, November 13, 2018 from 6:30 AM to 9:30 AM and from 4:00 PM to 7:00 PM.

Weekday AM and PM Peak Hours

The weekday AM and PM study peak hours were determined from a review of INRIX speed data to identify the hours of most severe freeway congestion. The proposed peak hours and simulation analysis periods are consistent with the "Route 28 and Dulles Toll Road/Dulles Greenway Study Traffic Operations Analysis Framework Document". These peak hours are 8 AM to 9 AM and 5 PM to 6 PM. Reviewing the traffic data collected, the time periods where the network experienced the highest traffic volumes were 7:45-8:45 AM and from 4:45-5:45 PM. Both of these periods are 15 minutes prior to the most congested periods.

Balancing Methodology

The objective of volume balancing is to remove discrepancies between separate count locations to define consistent volumes throughout the network for traffic simulation purposes. The criterion for this procedure is to minimize the adjustments to the original volumes, specifically minimizing the number of vehicles removed from the network. The daily, AM peak hour, and PM peak hour traffic volumes for this project were balanced in the sequence shown in **Figure 1**. First, the northbound and southbound Route 28 mainlines and ramps were balanced. Next, eastbound and westbound Route 267 (Dulles Toll Road and Dulles Greenway) mainlines and ramps were balanced, holding the Route 28 corresponding balanced ramp volumes constant. Similarly, the eastbound and westbound Dulles Access Road mainlines and ramps were balanced, holding the Route 28 and Route 267 corresponding balanced ramp volumes constant. Finally, the study intersections were balanced holding the corresponding balanced ramp volumes from Route 28 and Route 267 constant. The balanced volumes were then rounded to the nearest five vehicles.

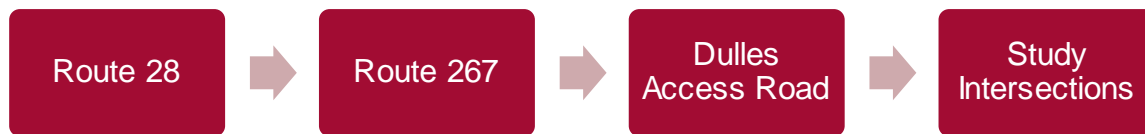


Figure 1 Volume Balancing Sequence

The intersection volumes were balanced by holding constant the approach and departure volumes controlled by freeway on- and off-ramps. The intersection turning movements at these locations were adjusted in accordance with the turning movement proportions defined by the original intersection counts. This procedure was repeated for the AM Peak Hour and PM Peak Hour.

Summary of Attachments

The PDF attachment to this memorandum contains the following graphics:

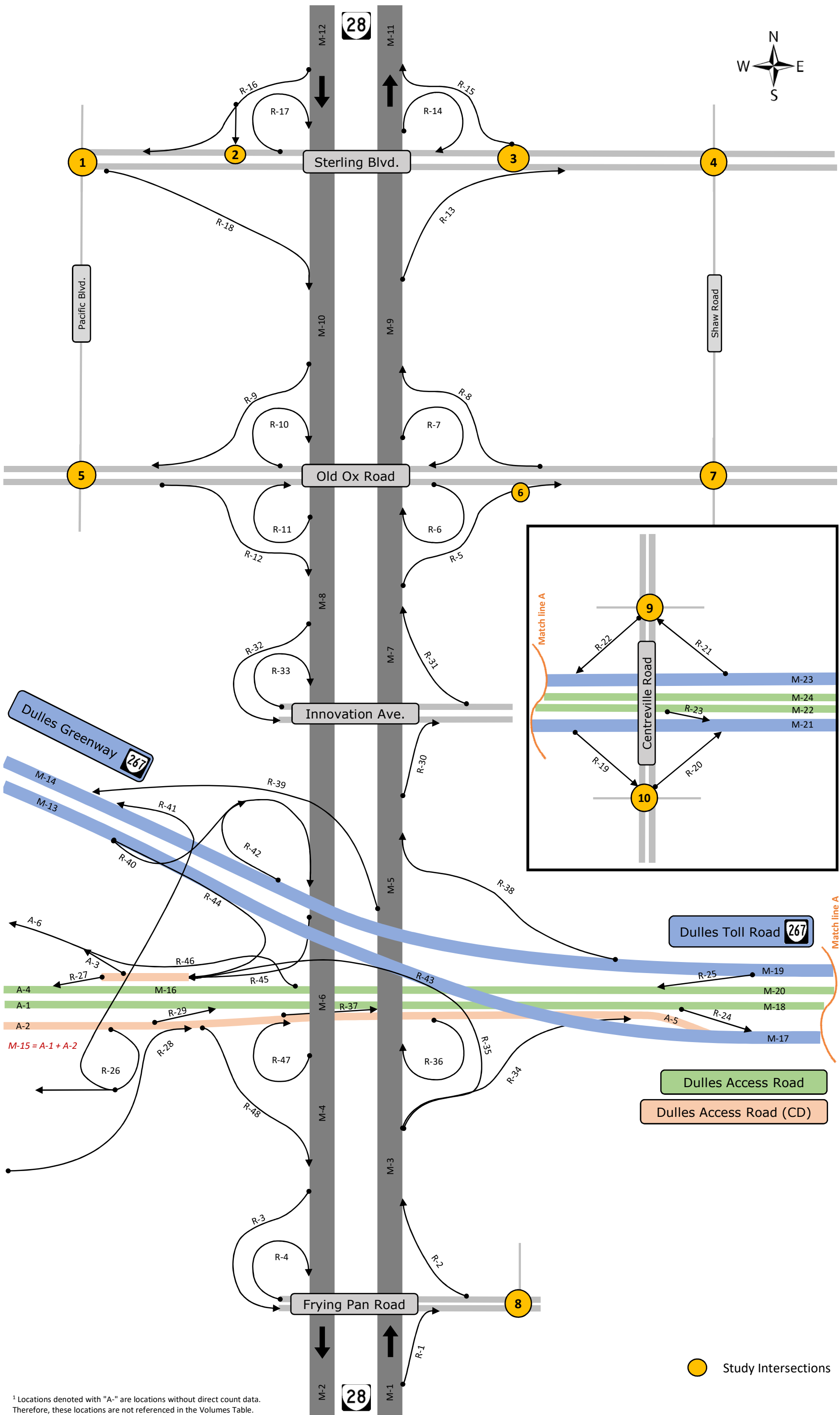
- Page 1 | Location key of count locations.
- Page 2 | Visual representation of balanced freeway and ramp volumes for existing year 2018 Average Daily Traffic.
- Page 3 | Tabular representation of unbalanced and balanced mainline and ramp volumes for 2018 Average Daily Traffic, highlighting the numeric and percent difference in vehicles.
- Page 4 | Visual representation of balanced freeway and ramp volumes for the existing year 2018 AM peak hour.
- Page 5 | Tabular representation of unbalanced and balanced mainline and ramp volumes for the 2018 AM peak hour, highlighting the numeric and percent difference in vehicles.
- Page 6 | Visual representation of balanced freeway and ramp volumes for the existing year 2018 PM peak hour.

- Page 7 | Tabular representation of unbalanced and balanced mainline and ramp volumes for the 2018 PM peak hour, highlighting the numeric and percent difference in vehicles.
- Page 8 | Visual representation of balanced intersection turning movement counts for the existing year 2018 AM and PM peak hours.
- Page 9 | Tabular representation of unbalanced and balanced intersection turning movement counts for the 2018 AM and PM peak hours, highlighting the numeric difference in vehicles.

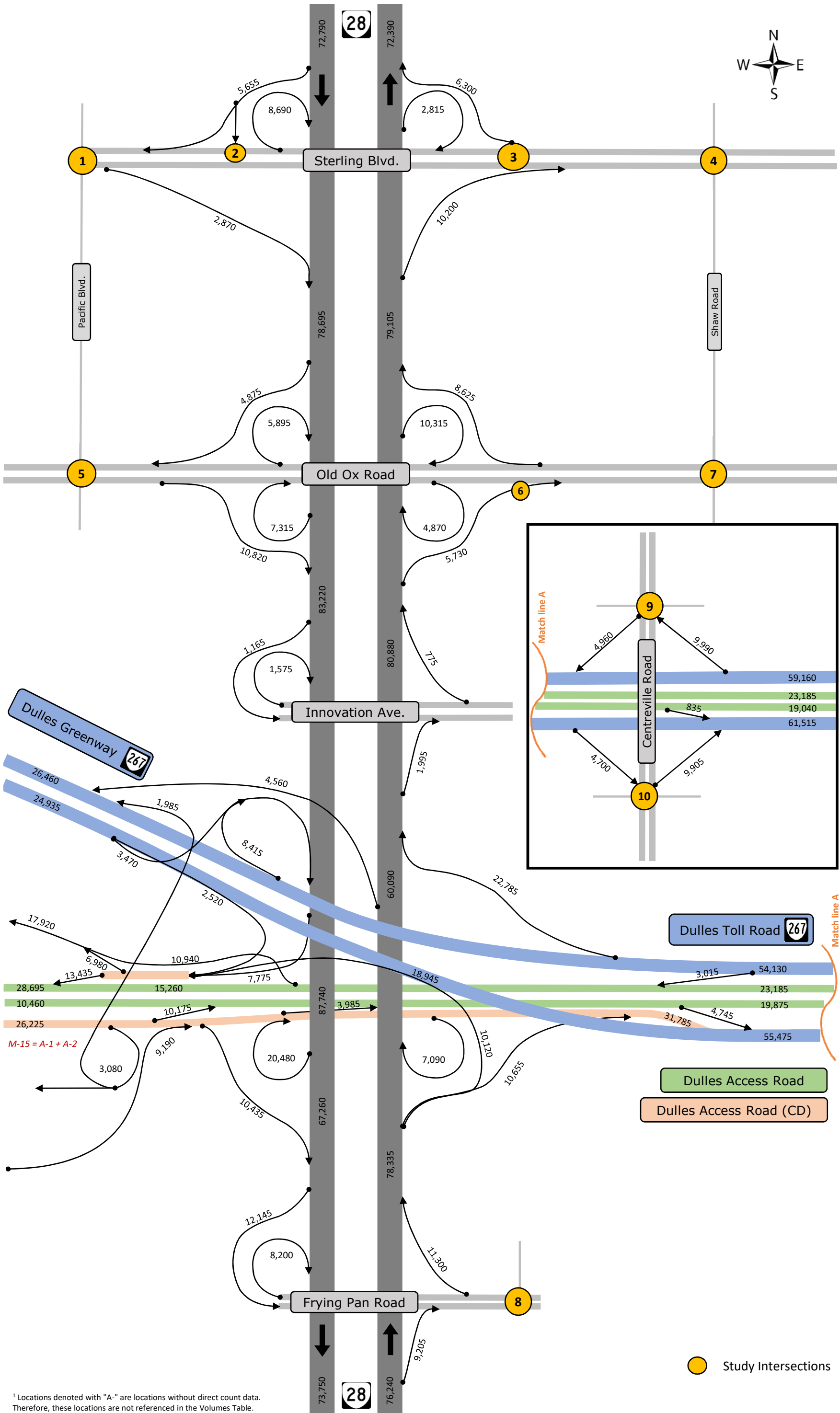
These attachments are best printed in 11x17.

Conclusions

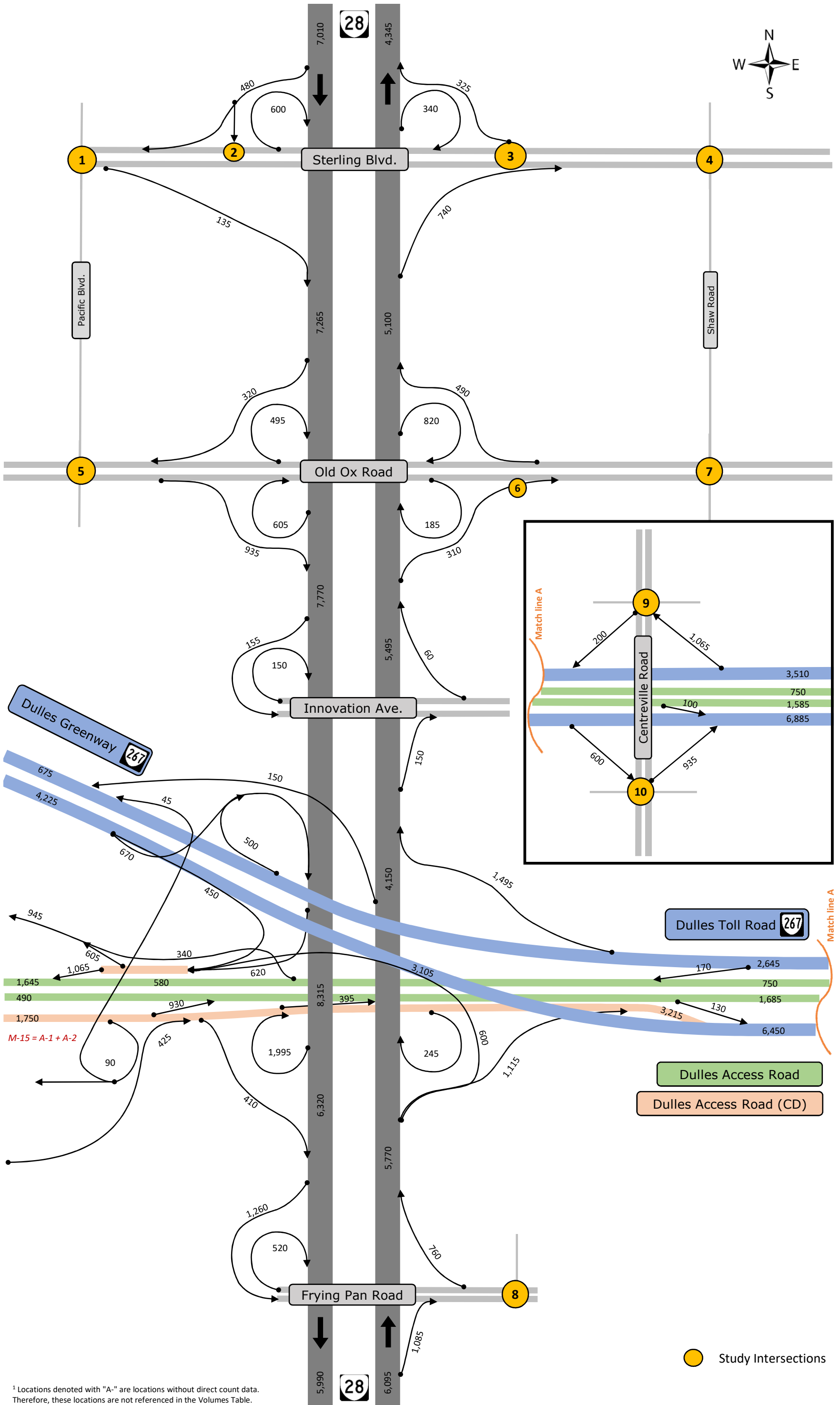
This memorandum and its attachments document the balanced traffic volumes in existing conditions for the Route 28 and Dulles Toll Road/Dulles Greenway Interchange Study. These balanced traffic volumes will be used to generate an origin-destination matrix in VISUM and calibrate the VISSIM microsimulation model. These traffic volumes will also provide the starting point volumes for future-year traffic volume forecasting.



¹ Locations denoted with "A-" are locations without direct count data. Therefore, these locations are not referenced in the Volumes Table.

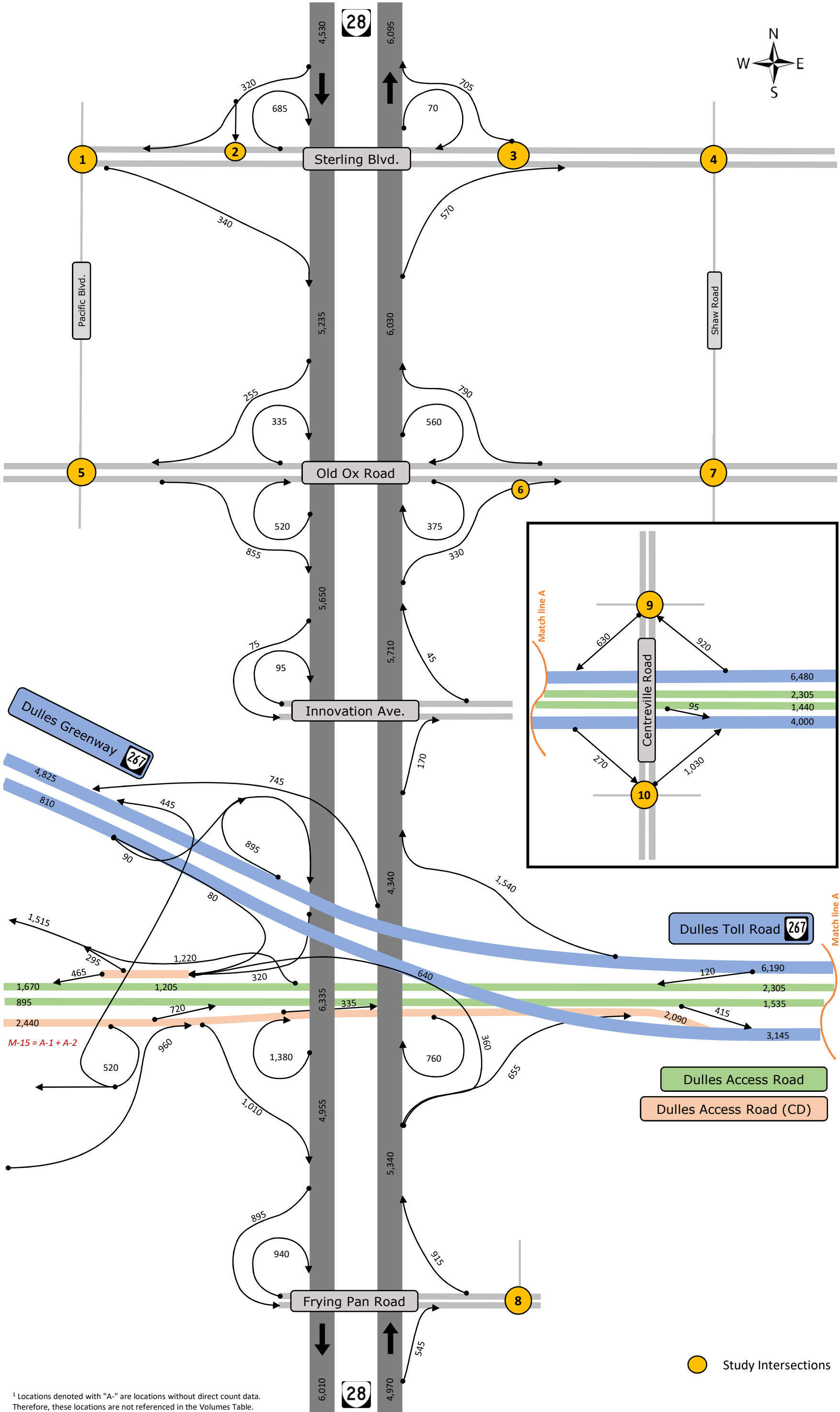


Unbalanced and Balanced Mainline and Ramp Volumes for Average Daily Traffic - 2018						
	Location	Location Key	Unbalanced Volumes	Balanced Volumes	Difference in Vehicles	Percent Difference
Mainline Segments	Northbound Route 28 Mainline south of Frying Pan Road	M-1	75,323	76,240	918	1.2%
	Southbound Route 28 Mainline south of Frying Pan Road	M-2	73,552	73,750	198	0.3%
	Northbound Route 28 Mainline north of Frying Pan Road	M-3	78,340	78,335	-5	0.0%
	Southbound Route 28 Mainline north of Frying Pan Road	M-4	65,725	67,260	1,535	2.3%
	Northbound Route 28 Mainline north of Route 267 (Dulles Toll Road)	M-5	59,893	60,090	198	0.3%
	Southbound Route 28 Mainline north of Route 267 (Dulles Toll Road)	M-6	86,005	87,740	1,736	2.0%
	Northbound Route 28 Mainline north of Innovation Avenue	M-7	79,710	80,880	1,171	1.5%
	Southbound Route 28 Mainline north of Innovation Avenue	M-8	82,370	83,220	850	1.0%
	Northbound Route 28 Mainline north of Route 606 (Old Ox Road)	M-9	79,537	79,105	-432	-0.5%
	Southbound Route 28 Mainline north of Route 606 (Old Ox Road)	M-10	77,213	78,695	1,483	1.9%
	Northbound Route 28 Mainline north of Route 846 (S. Sterling Boulevard)	M-11	72,392	72,390	-2	0.0%
	Southbound Route 28 Mainline north of Route 846 (S. Sterling Boulevard)	M-12	72,788	72,790	3	0.0%
	Eastbound Route 267 (Dulles Greenway) Mainline west of Route 28 & west of Toll Plaza	M-13	24,935	24,935	1	0.0%
	Westbound Route 267 (Dulles Greenway) Mainline west of Route 28 & west of Toll Plaza	M-14	26,458	26,460	3	0.0%
	Eastbound Dulles Access Road & Eastbound Dulles Access Road Collector/Distributor (CD) Mainline west of Route 28 & east of Rudder Road bridge	M-15	37,060	36,685	-375	-1.0%
	Westbound Dulles Access Road Mainline west of Route 28 & east of Rudder Road bridge	M-16	15,261	15,260	-1	0.0%
	Eastbound Route 267 (Dulles Toll Road) Mainline east of Route 28 (between Dulles Access Road Slip Ramps and Centreville Road Ramps)	M-17	55,620	55,475	-145	-0.3%
	Eastbound Dulles Access Road Mainline east of Route 28 (between Dulles Access Road Slip Ramps and Centreville Road Ramps)	M-18	20,415	19,875	-540	-2.7%
	Westbound Route 267 (Dulles Toll Road) Mainline east of Route 28 (between Dulles Access Road Slip Ramps and Centreville Road Ramps)	M-19	55,200	54,130	-1,070	-2.0%
	Westbound Dulles Access Road Mainline east of Route 28 (between Dulles Access Road Slip Ramps and Centreville Road Ramps)	M-20	23,082	23,185	103	0.4%
	Eastbound Route 267 (Dulles Toll Road) Mainline east of Centreville Road	M-21	61,188	61,515	328	0.5%
	Eastbound Dulles Access Road Mainline east of Centreville Road	M-22	19,042	19,040	-2	0.0%
	Westbound Route 267 (Dulles Toll Road) Mainline east of Route 228 (Centreville Road/Edsall Road)	M-23	58,305	59,160	855	1.5%
	Westbound Dulles Access Road Mainline east of Route 228 (Centreville Road/Edsall Road)	M-24	23,155	23,185	30	0.1%
Ramps	Off-ramp from northbound Route 28 to Route 608 (Frying Pan Road)	R-1	9,203	9,205	3	0.0%
	On-ramp from westbound Route 608 (Frying Pan Road) to northbound Route 28	R-2	11,168	11,300	132	1.2%
	Off-ramp from southbound Route 28 to Route 608 (Frying Pan Road)	R-3	12,114	12,145	32	0.3%
	On-ramp from westbound Route 608 (Frying Pan Road) to southbound Route 28	R-4	8,198	8,200	2	0.0%
	Off-ramp from northbound Route 28 to eastbound Route 606 (Old Ox Road)	R-5	5,731	5,730	-1	0.0%
	On-ramp from eastbound Route 606 (Old Ox Road) to northbound Route 28	R-6	4,814	4,870	57	1.2%
	Off-ramp from northbound Route 28 to westbound Route 606 (Old Ox Road)	R-7	10,313	10,315	2	0.0%
	On-ramp from westbound Route 606 (Old Ox Road) to northbound Route 28	R-8	8,524	8,625	101	1.2%
	Off-ramp from southbound Route 28 to westbound Route 606 (Old Ox Road)	R-9	4,864	4,875	12	0.2%
	On-ramp from westbound Route 606 (Old Ox Road) to southbound Route 28	R-10	5,894	5,895	1	0.0%
	Off-ramp from southbound Route 28 to eastbound Route 606 (Old Ox Road)	R-11	7,299	7,315	16	0.2%
	On-ramp from eastbound Route 606 (Old Ox Road) to southbound Route 28	R-12	10,818	10,820	2	0.0%
	Off-ramp from northbound Route 28 to eastbound Route 846 (S. Sterling Boulevard)	R-13	10,199	10,200	2	0.0%
	Off-ramp from northbound Route 28 to westbound Route 846 (S. Sterling Boulevard)	R-14	2,815	2,815	0	0.0%
	On-ramp from Route 846 (S. Sterling Boulevard) to northbound Route 28	R-15	6,227	6,300	73	1.2%
	Off-ramp from southbound Route 28 to Route 846 (S. Sterling Boulevard)	R-16	5,639	5,655	17	0.3%
	On-ramp from westbound Route 846 (S. Sterling Boulevard) to southbound Route 28	R-17	8,688	8,690	2	0.0%
	On-ramp from eastbound Route 846 (S. Sterling Boulevard) to southbound Route 28	R-18	2,869	2,870	2	0.1%
	Off-ramp from eastbound Route 267 (Dulles Toll Road) to Route 228 (Centreville Road/Edsall Road)	R-19	4,677	4,700	23	0.5%
	On-ramp from Route 228 (Centreville Road/Edsall Road) to eastbound Route 267 (Dulles Toll Road)	R-20	9,906	9,905	-1	0.0%
	Off-ramp from westbound Route 267 (Dulles Toll Road) to Route 228 (Centreville Road/Edsall Road)	R-21	9,989	9,990	2	0.0%
	On-ramp from Route 228 (Centreville Road/Edsall Road) to westbound Route 267 (Dulles Toll Road)	R-22	4,888	4,960	73	1.5%
	Slip-ramp from eastbound Dulles Airport Access Road to eastbound Route 267 (Dulles Toll Road) east of Route 228 (Centreville Road/Edsall Road)	R-23	833	835	2	0.2%
	Slip-ramp from eastbound Dulles Airport Access Road to eastbound Route 267 (Dulles Toll Road) west of Route 228 (Centreville Road/Edsall Road)	R-24	4,746	4,745	-1	0.0%
	Slip-ramp from westbound Route 267 (Dulles Toll Road) to westbound Dulles Access Road west of Route 228 (Centreville Road/Edsall Road)	R-25	3,017	3,015	-2	0.0%
	Off-ramp from eastbound Dulles Access Road (CD) to Route 267 (Dulles Greenway) and Rudder Road	R-26	3,063	3,080	18	0.6%
	On-ramp from westbound Dulles Access Road (CD) to westbound Dulles Access Road east of Rudder Road Bridge	R-27	13,436	13,435	-1	0.0%
	On-ramp from eastbound Aviation Blvd to eastbound Dulles Access Road (CD)	R-28	9,192	9,190	-2	0.0%
	Slip-ramp from eastbound Dulles Access Road (CD) to eastbound Dulles Access Road	R-29	10,122	10,175	53	0.5%
	Off-ramp from northbound Route 28 to Innovation Avenue	R-30	1,995	1,995	1	0.0%
	On-ramp from westbound Innovation Avenue to northbound Route 28	R-31	767	775	9	1.1%
	Off-ramp from southbound Route 28 to Innovation Avenue	R-32	1,161	1,165	4	0.3%
	On-ramp from westbound Innovation Avenue to southbound Route 28	R-33	1,574	1,575	1	0.1%
	Off-ramp from northbound Route 28 to eastbound Dulles Access Road (CD)	R-34	10,657	10,655	-2	0.0%
	Off-ramp from northbound Route 28 to westbound Dulles Access Road (CD)	R-35	10,121	10,120	-1	0.0%
	On-ramp from eastbound Dulles Access Road (CD) to northbound Route 28	R-36	7,007	7,090	84	1.2%
	Slip-ramp from eastbound Dulles Access Road (CD) to eastbound Dulles Access Road beneath Route 28 interchange	R-37	3,965	3,985	21	0.5%
	On-ramp from westbound Route 267 (Dulles Toll Road) to northbound Route 28	R-38	22,514	22,785	272	1.2%
	Off-ramp from northbound Route 28 to westbound Route 267 (Dulles Greenway)	R-39	4,558	4,560	3	0.1%
	On-ramp from eastbound Route 267 (Dulles Greenway) to southbound Route 28	R-40	3,471	3,470	-1	0.0%
	Off-ramp from eastbound Dulles Access Road (CD) to westbound (Dulles Greenway)	R-41	1,955	1,985	30	1.5%
	On-ramp from westbound Route 267 (Dulles Toll Road) to southbound Route 28	R-42	8,416	8,415	-1	0.0%
	On-ramp from eastbound Route 267 (Dulles Greenway) to eastbound Route 267 (Dulles Toll Road)	R-43	18,995	18,945	-50	-0.3%
	Off-ramp from eastbound Route 267 (Dulles Greenway) to westbound Dulles Access Road (CD)	R-44	2,505	2,520	15	0.6%
	Off-ramp from southbound Route 28 to westbound Dulles Access Road (CD)	R-45	7,757	7,775	18	0.2%
	Off-ramp from westbound Dulles Access Road to Rudder Road	R-46	10,938	10,940	2	0.0%
	Off-ramp from southbound Route 28 to eastbound Dulles Access Road (CD)	R-47	20,429	20,480	51	0.2%
	On-ramp from Dulles Access Road (CD) to southbound Route 28	R-48	10,435	10,435	0	0.0%



¹ Locations denoted with "A-" are locations without direct count data. Therefore, these locations are not referenced in the Volumes Table.

Unbalanced and Balanced Mainline and Ramp Volumes for AM Peak Hour - 2018						
	Location	Location Key	Unbalanced Volumes	Balanced Volumes	Difference in Vehicles	Percent Difference
Mainline Segments	Northbound Route 28 Mainline south of Frying Pan Road	M-1	6,091	6,095	5	0.1%
	Southbound Route 28 Mainline south of Frying Pan Road	M-2	5,951	5,990	40	0.7%
	Northbound Route 28 Mainline north of Frying Pan Road	M-3	5,578	5,770	192	3.4%
	Southbound Route 28 Mainline north of Frying Pan Road	M-4	6,284	6,320	36	0.6%
	Northbound Route 28 Mainline north of Route 267 (Dulles Toll Road)	M-5	4,019	4,150	132	3.2%
	Southbound Route 28 Mainline north of Route 267 (Dulles Toll Road)	M-6	8,360	8,315	-45	-0.5%
	Northbound Route 28 Mainline north of Innovation Avenue	M-7	5,342	5,495	154	2.8%
	Southbound Route 28 Mainline north of Innovation Avenue	M-8	7,799	7,770	-29	-0.4%
	Northbound Route 28 Mainline north of Route 606 (Old Ox Road)	M-9	5,152	5,100	-52	-1.0%
	Southbound Route 28 Mainline north of Route 606 (Old Ox Road)	M-10	7,140	7,265	126	1.7%
	Northbound Route 28 Mainline north of Route 846 (S. Sterling Boulevard)	M-11	4,347	4,345	-2	0.0%
	Southbound Route 28 Mainline north of Route 846 (S. Sterling Boulevard)	M-12	7,010	7,010	1	0.0%
	Eastbound Route 267 (Dulles Greenway) Mainline west of Route 28 & west of Toll Plaza	M-13	4,082	4,225	143	3.4%
	Westbound Route 267 (Dulles Greenway) Mainline west of Route 28 & west of Toll Plaza	M-14	674	675	2	0.2%
	Eastbound Dulles Access Road & Eastbound Dulles Access Road Collector/Distributor (CD) Mainline west of Route 28 & east of Rudder Road bridge	M-15	2,146	2,240	94	4.3%
	Westbound Dulles Access Road Mainline west of Route 28 & east of Rudder Road bridge	M-16	581	580	-1	-0.1%
	Eastbound Route 267 (Dulles Toll Road) Mainline east of Route 28 (between Dulles Access Road Slip Ramps and Centreville Road Ramps)	M-17	6,455	6,450	-5	-0.1%
	Eastbound Dulles Access Road Mainline east of Route 28 (between Dulles Access Road Slip Ramps and Centreville Road Ramps)	M-18	1,739	1,685	-54	-3.2%
	Westbound Route 267 (Dulles Toll Road) Mainline east of Route 28 (between Dulles Access Road Slip Ramps and Centreville Road Ramps)	M-19	2,627	2,645	19	0.7%
	Westbound Dulles Access Road Mainline east of Route 28 (between Dulles Access Road Slip Ramps and Centreville Road Ramps)	M-20	745	750	5	0.7%
	Eastbound Route 267 (Dulles Toll Road) Mainline east of Centreville Road	M-21	6,886	6,885	-1	0.0%
	Eastbound Dulles Access Road Mainline east of Centreville Road	M-22	1,587	1,585	-2	-0.1%
	Westbound Route 267 (Dulles Toll Road) Mainline east of Route 228 (Centreville Road/Edsall Road)	M-23	3,509	3,510	1	0.0%
	Westbound Dulles Access Road Mainline east of Route 228 (Centreville Road/Edsall Road)	M-24	744	750	6	0.8%
Ramps	Off-ramp from northbound Route 28 to Route 608 (Frying Pan Road)	R-1	1,085	1,085	0	0.0%
	On-ramp from westbound Route 608 (Frying Pan Road) to northbound Route 28	R-2	758	760	2	0.3%
	Off-ramp from southbound Route 28 to Route 608 (Frying Pan Road)	R-3	1,255	1,260	5	0.4%
	On-ramp from westbound Route 608 (Frying Pan Road) to southbound Route 28	R-4	519	520	2	0.3%
	Off-ramp from northbound Route 28 to eastbound Route 606 (Old Ox Road)	R-5	310	310	1	0.2%
	On-ramp from eastbound Route 606 (Old Ox Road) to northbound Route 28	R-6	185	185	0	0.0%
	Off-ramp from northbound Route 28 to westbound Route 606 (Old Ox Road)	R-7	820	820	1	0.1%
	On-ramp from westbound Route 606 (Old Ox Road) to northbound Route 28	R-8	492	490	-2	-0.4%
	Off-ramp from southbound Route 28 to westbound Route 606 (Old Ox Road)	R-9	320	320	0	0.0%
	On-ramp from westbound Route 606 (Old Ox Road) to southbound Route 28	R-10	494	495	2	0.3%
	Off-ramp from southbound Route 28 to eastbound Route 606 (Old Ox Road)	R-11	602	605	4	0.6%
	On-ramp from eastbound Route 606 (Old Ox Road) to southbound Route 28	R-12	933	935	2	0.2%
	Off-ramp from northbound Route 28 to eastbound Route 846 (S. Sterling Boulevard)	R-13	740	740	0	0.0%
	Off-ramp from northbound Route 28 to westbound Route 846 (S. Sterling Boulevard)	R-14	340	340	1	0.1%
	On-ramp from Route 846 (S. Sterling Boulevard) to northbound Route 28	R-15	325	325	0	0.0%
	Off-ramp from southbound Route 28 to Route 846 (S. Sterling Boulevard)	R-16	479	480	1	0.2%
	On-ramp from westbound Route 846 (S. Sterling Boulevard) to southbound Route 28	R-17	601	600	-1	-0.1%
	On-ramp from eastbound Route 846 (S. Sterling Boulevard) to southbound Route 28	R-18	137	135	-2	-1.1%
	Off-ramp from eastbound Route 267 (Dulles Toll Road) to Route 228 (Centreville Road/Edsall Road)	R-19	600	600	1	0.1%
	On-ramp from Route 228 (Centreville Road/Edsall Road) to eastbound Route 267 (Dulles Toll Road)	R-20	906	935	30	3.2%
	Off-ramp from westbound Route 267 (Dulles Toll Road) to Route 228 (Centreville Road/Edsall Road)	R-21	1,063	1,065	2	0.2%
	On-ramp from Route 228 (Centreville Road/Edsall Road) to westbound Route 267 (Dulles Toll Road)	R-22	198	200	2	1.0%
	Slip-ramp from eastbound Dulles Airport Access Road to eastbound Route 267 (Dulles Toll Road) east of Route 228 (Centreville Road/Edsall Road)	R-23	98	100	2	2.0%
	Slip-ramp from eastbound Dulles Airport Access Road to eastbound Route 267 (Dulles Toll Road) west of Route 228 (Centreville Road/Edsall Road)	R-24	125	130	6	4.3%
	Slip-ramp from westbound Route 267 (Dulles Toll Road) to westbound Dulles Access Road west of Route 228 (Centreville Road/Edsall Road)	R-25	170	170	1	0.3%
	Off-ramp from eastbound Dulles Access Road (CD) to Route 267 (Dulles Greenway) and Rudder Road	R-26	89	90	1	1.1%
	On-ramp from westbound Dulles Access Road (CD) to westbound Dulles Access Road east of Rudder Road Bridge	R-27	1,066	1,065	-1	-0.1%
	On-ramp from eastbound Aviation Blvd to eastbound Dulles Access Road (CD)	R-28	412	425	14	3.2%
	Slip-ramp from eastbound Dulles Access Road (CD) to eastbound Dulles Access Road	R-29	930	930	1	0.1%
	Off-ramp from northbound Route 28 to Innovation Avenue	R-30	149	150	1	0.7%
	On-ramp from westbound Innovation Avenue to northbound Route 28	R-31	59	60	1	1.7%
	Off-ramp from southbound Route 28 to Innovation Avenue	R-32	155	155	0	0.0%
	On-ramp from westbound Innovation Avenue to southbound Route 28	R-33	151	150	-1	-0.3%
	Off-ramp from northbound Route 28 to eastbound Dulles Access Road (CD)	R-34	1,114	1,115	2	0.1%
	Off-ramp from northbound Route 28 to westbound Dulles Access Road (CD)	R-35	600	600	1	0.1%
	On-ramp from eastbound Dulles Access Road (CD) to northbound Route 28	R-36	246	245	-1	-0.4%
	Slip-ramp from eastbound Dulles Access Road (CD) to eastbound Dulles Access Road beneath Route 28 interchange	R-37	393	395	2	0.5%
	On-ramp from westbound Route 267 (Dulles Toll Road) to northbound Route 28	R-38	1,497	1,495	-2	-0.1%
	Off-ramp from northbound Route 28 to westbound Route 267 (Dulles Greenway)	R-39	152	150	-2	-1.0%
	On-ramp from eastbound Route 267 (Dulles Greenway) to southbound Route 28	R-40	672	670	-2	-0.2%
	Off-ramp from eastbound Dulles Access Road (CD) to westbound (Dulles Greenway)	R-41	46	45	-1	-2.2%
	On-ramp from westbound Route 267 (Dulles Toll Road) to southbound Route 28	R-42	499	500	2	0.3%
	On-ramp from eastbound Route 267 (Dulles Greenway) to eastbound Route 267 (Dulles Toll Road)	R-43	3,180	3,105	-75	-2.4%
	Off-ramp from eastbound Route 267 (Dulles Greenway) to westbound Dulles Access Road (CD)	R-44	448	450	3	0.6%
	Off-ramp from southbound Route 28 to westbound Dulles Access Road (CD)	R-45	620	620	1	0.1%
	Off-ramp from westbound Dulles Access Road to Rudder Road	R-46	340	340	1	0.1%
	Off-ramp from southbound Route 28 to eastbound Dulles Access Road (CD)	R-47	1,988	1,995	8	0.4%
	On-ramp from Dulles Access Road (CD) to southbound Route 28	R-48	410	410	0	0.0%



Dulles Greenway 267

Dulles Toll Road 267

M-15 = A-1 + A-2

Dulles Access Road
Dulles Access Road (CD)

● Study Intersections

¹ Locations denoted with "A-" are locations without direct count data. Therefore, these locations are not referenced in the Volumes Table.

Unbalanced and Balanced Mainline and Ramp Volumes for PM Peak Hour - 2018						
	Location	Location Key	Unbalanced Volumes	Balanced Volumes	Difference in Vehicles	Percent Difference
Mainline Segments	Northbound Route 28 Mainline south of Frying Pan Road	M-1	4,971	4,970	-1	0.0%
	Southbound Route 28 Mainline south of Frying Pan Road	M-2	5,980	6,010	30	0.5%
	Northbound Route 28 Mainline north of Frying Pan Road	M-3	5,353	5,340	-13	-0.2%
	Southbound Route 28 Mainline north of Frying Pan Road	M-4	4,818	4,955	137	2.8%
	Northbound Route 28 Mainline north of Route 267 (Dulles Toll Road)	M-5	4,231	4,340	110	2.6%
	Southbound Route 28 Mainline north of Route 267 (Dulles Toll Road)	M-6	6,106	6,335	230	3.7%
	Northbound Route 28 Mainline north of Innovation Avenue	M-7	5,718	5,710	-8	-0.1%
	Southbound Route 28 Mainline north of Innovation Avenue	M-8	5,533	5,650	117	2.1%
	Northbound Route 28 Mainline north of Route 606 (Old Ox Road)	M-9	6,009	6,030	22	0.4%
	Southbound Route 28 Mainline north of Route 606 (Old Ox Road)	M-10	5,118	5,235	117	2.3%
	Northbound Route 28 Mainline north of Route 846 (S. Sterling Boulevard)	M-11	6,090	6,095	5	0.1%
	Southbound Route 28 Mainline north of Route 846 (S. Sterling Boulevard)	M-12	4,528	4,530	3	0.1%
	Eastbound Route 267 (Dulles Greenway) Mainline west of Route 28 & west of Toll Plaza	M-13	810	810	0	0.0%
	Westbound Route 267 (Dulles Greenway) Mainline west of Route 28 & west of Toll Plaza	M-14	4,674	4,825	152	3.2%
	Eastbound Dulles Access Road & Eastbound Dulles Access Road Collector/Distributor (CD) Mainline west of Route 28 & east of Rudder Road bridge	M-15	3,325	3,335	10	0.3%
	Westbound Dulles Access Road Mainline west of Route 28 & east of Rudder Road bridge	M-16	1,194	1,205	12	1.0%
	Eastbound Route 267 (Dulles Toll Road) Mainline east of Route 28 (between Dulles Access Road Slip Ramps and Centreville Road Ramps)	M-17	3,144	3,145	2	0.0%
	Eastbound Dulles Access Road Mainline east of Route 28 (between Dulles Access Road Slip Ramps and Centreville Road Ramps)	M-18	1,582	1,535	-47	-3.0%
	Westbound Route 267 (Dulles Toll Road) Mainline east of Route 28 (between Dulles Access Road Slip Ramps and Centreville Road Ramps)	M-19	6,150	6,190	40	0.6%
	Westbound Dulles Access Road Mainline east of Route 28 (between Dulles Access Road Slip Ramps and Centreville Road Ramps)	M-20	2,251	2,305	55	2.4%
	Eastbound Route 267 (Dulles Toll Road) Mainline east of Centreville Road	M-21	3,969	4,000	31	0.8%
	Eastbound Dulles Access Road Mainline east of Centreville Road	M-22	1,439	1,440	2	0.1%
	Westbound Route 267 (Dulles Toll Road) Mainline east of Route 228 (Centreville Road/Edsall Road)	M-23	6,479	6,480	1	0.0%
	Westbound Dulles Access Road Mainline east of Route 228 (Centreville Road/Edsall Road)	M-24	2,304	2,305	1	0.0%
Ramps	Off-ramp from northbound Route 28 to Route 608 (Frying Pan Road)	R-1	545	545	1	0.1%
	On-ramp from westbound Route 608 (Frying Pan Road) to northbound Route 28	R-2	913	915	2	0.2%
	Off-ramp from southbound Route 28 to Route 608 (Frying Pan Road)	R-3	892	895	4	0.4%
	On-ramp from westbound Route 608 (Frying Pan Road) to southbound Route 28	R-4	942	940	-2	-0.2%
	Off-ramp from northbound Route 28 to eastbound Route 606 (Old Ox Road)	R-5	330	330	0	0.0%
	On-ramp from eastbound Route 606 (Old Ox Road) to northbound Route 28	R-6	376	375	-1	-0.1%
	Off-ramp from northbound Route 28 to westbound Route 606 (Old Ox Road)	R-7	560	560	1	0.1%
	On-ramp from westbound Route 606 (Old Ox Road) to northbound Route 28	R-8	791	790	-1	-0.1%
	Off-ramp from southbound Route 28 to westbound Route 606 (Old Ox Road)	R-9	253	255	2	0.8%
	On-ramp from westbound Route 606 (Old Ox Road) to southbound Route 28	R-10	336	335	-1	-0.1%
	Off-ramp from southbound Route 28 to eastbound Route 606 (Old Ox Road)	R-11	519	520	1	0.2%
	On-ramp from eastbound Route 606 (Old Ox Road) to southbound Route 28	R-12	855	855	1	0.1%
	Off-ramp from northbound Route 28 to eastbound Route 846 (S. Sterling Boulevard)	R-13	572	570	-2	-0.3%
	Off-ramp from northbound Route 28 to westbound Route 846 (S. Sterling Boulevard)	R-14	70	70	1	0.7%
	On-ramp from Route 846 (S. Sterling Boulevard) to northbound Route 28	R-15	706	705	-1	-0.1%
	Off-ramp from southbound Route 28 to Route 846 (S. Sterling Boulevard)	R-16	321	320	-1	-0.3%
	On-ramp from westbound Route 846 (S. Sterling Boulevard) to southbound Route 28	R-17	687	685	-2	-0.3%
	On-ramp from eastbound Route 846 (S. Sterling Boulevard) to southbound Route 28	R-18	338	340	2	0.6%
	Off-ramp from eastbound Route 267 (Dulles Toll Road) to Route 228 (Centreville Road/Edsall Road)	R-19	268	270	2	0.7%
	On-ramp from Route 228 (Centreville Road/Edsall Road) to eastbound Route 267 (Dulles Toll Road)	R-20	1,030	1,030	1	0.0%
	Off-ramp from westbound Route 267 (Dulles Toll Road) to Route 228 (Centreville Road/Edsall Road)	R-21	890	920	31	3.4%
	On-ramp from Route 228 (Centreville Road/Edsall Road) to westbound Route 267 (Dulles Toll Road)	R-22	631	630	-1	-0.1%
	Slip-ramp from eastbound Dulles Airport Access Road to eastbound Route 267 (Dulles Toll Road) east of Route 228 (Centreville Road/Edsall Road)	R-23	96	95	-1	-1.0%
	Slip-ramp from eastbound Dulles Airport Access Road to eastbound Route 267 (Dulles Toll Road) west of Route 228 (Centreville Road/Edsall Road)	R-24	413	415	3	0.6%
	Slip-ramp from westbound Route 267 (Dulles Toll Road) to westbound Dulles Access Road west of Route 228 (Centreville Road/Edsall Road)	R-25	116	120	4	3.4%
	Off-ramp from eastbound Dulles Access Road (CD) to Route 267 (Dulles Greenway) and Rudder Road	R-26	514	520	6	1.2%
	On-ramp from westbound Dulles Access Road (CD) to westbound Dulles Access Road east of Rudder Road Bridge	R-27	467	465	-2	-0.3%
	On-ramp from eastbound Aviation Blvd to eastbound Dulles Access Road (CD)	R-28	959	960	1	0.1%
	Slip-ramp from eastbound Dulles Access Road (CD) to eastbound Dulles Access Road	R-29	717	720	4	0.5%
	Off-ramp from northbound Route 28 to Innovation Avenue	R-30	169	170	2	0.9%
	On-ramp from westbound Innovation Avenue to northbound Route 28	R-31	46	45	-1	-2.2%
	Off-ramp from southbound Route 28 to Innovation Avenue	R-32	74	75	1	1.3%
	On-ramp from westbound Innovation Avenue to southbound Route 28	R-33	97	95	-2	-1.6%
	Off-ramp from northbound Route 28 to eastbound Dulles Access Road (CD)	R-34	657	655	-2	-0.3%
	Off-ramp from northbound Route 28 to westbound Dulles Access Road (CD)	R-35	358	360	2	0.6%
	On-ramp from eastbound Dulles Access Road (CD) to northbound Route 28	R-36	759	760	2	0.2%
	Slip-ramp from eastbound Dulles Access Road (CD) to eastbound Dulles Access Road beneath Route 28 interchange	R-37	333	335	2	0.6%
	On-ramp from westbound Route 267 (Dulles Toll Road) to northbound Route 28	R-38	1,539	1,540	2	0.1%
	Off-ramp from northbound Route 28 to westbound Route 267 (Dulles Greenway)	R-39	745	745	0	0.0%
	On-ramp from eastbound Route 267 (Dulles Greenway) to southbound Route 28	R-40	90	90	1	0.6%
	Off-ramp from eastbound Dulles Access Road (CD) to westbound (Dulles Greenway)	R-41	445	445	0	0.0%
	On-ramp from westbound Route 267 (Dulles Toll Road) to southbound Route 28	R-42	894	895	1	0.1%
	On-ramp from eastbound Route 267 (Dulles Greenway) to eastbound Route 267 (Dulles Toll Road)	R-43	632	640	9	1.3%
	Off-ramp from eastbound Route 267 (Dulles Greenway) to westbound Dulles Access Road (CD)	R-44	79	80	2	1.9%
	Off-ramp from southbound Route 28 to westbound Dulles Access Road (CD)	R-45	317	320	3	0.9%
	Off-ramp from westbound Dulles Access Road to Rudder Road	R-46	1,211	1,220	10	0.8%
	Off-ramp from southbound Route 28 to eastbound Dulles Access Road (CD)	R-47	1,374	1,380	7	0.5%
	On-ramp from Dulles Access Road (CD) to southbound Route 28	R-48	1,009	1,010	1	0.1%

Route 846 | Sterling Blvd

I-1: Pacific Boulevard at Route 846 (S. Sterling Boulevard)		I-2: Route 846 (S. Sterling Boulevard) and southbound Route 28 off-ramps		I-3: Route 846 (S. Sterling Boulevard) and northbound Route 28 off-ramps		I-4: Shaw Road at Route 846 (S. Sterling Boulevard)	
20 (15) 430 (180) 335 (620)	520 (245) 55 (15) 255 (140)	180 (59) 300 (255)	600 (685) 650 (335)	340 (70)	270 (470) 910 (955)	59 (111) 50 (25) 20 (20)	25 (15) 1005 (1035) 205 (220)
10 (10) 25 (25) 10 (10)	10 () 145 (500) 95 (360)	320 (670)		55 (235) 565 (695)	740 (570)	75 (65) 900 (1080) 315 (115)	100 (275) 25 (60) 215 (365)

Route 606 | Old Ox Road

I-5: Pacific Boulevard at Route 606 (Old Ox Road)		I-6: Route 606 (Old Ox Road) and northbound Route 28 off-ramps		I-7: Shaw Road at Route 606 (Old Ox Road)	
195 (255) 70 (45) 290 (500)	525 (305) 970 (1245) 90 (50)	820 (560)	490 (790) 950 (1125)	160 (205) 25 (30) 200 (250)	215 (250) 1125 (1555) 25 (40)
165 (220) 1530 (1200) 105 (100)	145 (215) 40 (50) 75 (45)	1465 (1210) 185 (375)	230 (220) 80 (110)	175 (165) 1455 (1190) 140 (170)	155 (140) 25 (45) 60 (45)

AM Peak Hour Counts (PM Peak Hour Counts)

¹Volumes were balanced then rounded to the nearest five vehicles. Therefore, direct comparison of these counts with the controlling freeway mainline and ramp volumes results in a difference of five vehicles in some locations.

Frying Pan Road

I-8: Sunrise Valley Drive at Route 608 (Frying Pan Road)	
570 (1125) 15 (35)	65 (35) 605 (725)
1520 (705) 830 (730)	

Centreville Road

I-9: Centreville Road and Dulles Toll Road Ramps north of Dulles Toll Road		I-10: Centreville Road and Dulles Toll Road Ramps south of Dulles Toll Road	
571 (272) 0001 (5225)	320 (395) 745 (525)	5151 (5695) 522 (205)	
	85 (355) 1185 (1430)	275 (155) 325 (115)	995 (1630) 705 (780)

Unbalanced and Balanced Intersection Turning Movement Counts for AM Peak Hour (8-9AM) - 2018

Map ID	1			2			3			4			5			6			7			8			9			10				
	Pacific Boulevard at Route 846 (S. Sterling Boulevard)			Route 846 (S. Sterling Boulevard) and southbound Route 28 off-ramps			Route 846 (S. Sterling Boulevard) and northbound Route 28 off-ramps			Shaw Road at Route 846 (S. Sterling Boulevard)			Pacific Boulevard at Route 606 (Old Ox Road)			Route 606 (Old Ox Road) and northbound Route 28 off-ramps			Shaw Road at Route 606 (Old Ox Road)			Sunrise Valley Drive at Route 608 (Frying Pan Road)			Centreville Road and Dulles Toll Road Ramps north of Dulles Toll Road			Centreville Road and Dulles Toll Road Ramps south of Dulles Toll Road				
	Bal	Unbal	Veh Diff	Bal	Unbal	Veh Diff	Bal	Unbal	Veh Diff	Bal	Unbal	Veh Diff	Bal	Unbal	Veh Diff	Bal	Unbal	Veh Diff	Bal	Unbal	Veh Diff	Bal	Unbal	Veh Diff	Bal	Unbal	Veh Diff	Bal	Unbal	Veh Diff	Bal	Unbal
NBU	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
NBL	10	10	0	0	0	0	0	0	0	100	95	5	75	75	0	0	0	0	155	150	5	0	0	0	85	90	-5	0	0	0		
NBT	145	145	0	0	0	0	0	0	0	25	25	0	40	40	0	80	70	10	25	25	0	0	0	0	1185	1185	0	995	990	5		
NBR	95	90	5	0	0	0	740	735	5	215	215	0	145	140	5	230	200	30	60	60	0	0	0	0	0	0	705	750	-45			
SBU	0	0	0	0	0	0	0	0	0	0	0	0	5	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
SBL	335	325	10	300	280	20	0	0	0	20	20	0	290	275	15	0	0	0	200	200	0	15	15	0	0	0	0	225	240	-15		
SBT	430	430	0	0	0	0	0	0	0	50	50	0	70	70	0	0	0	0	25	25	0	0	0	0	1000	995	5	1515	1515	0		
SBR	20	20	0	180	165	15	340	170	170	65	60	5	195	195	0	820	820	0	160	155	5	670	620	50	115	120	-5	0	0	0		
EBU	0	0	0	0	0	0	0	0	0	10	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
EBL	10	10	0	0	0	0	55	55	0	75	75	0	165	165	0	0	0	0	175	170	5	1520	1645	-125	0	0	0	275	290	-15		
EBT	25	25	0	320	320	0	565	535	30	900	895	5	1530	1455	75	1465	1465	0	1455	1410	45	830	900	-70	0	0	0	0	0	0		
EBR	10	10	0	0	0	0	0	0	0	315	310	5	105	105	0	185	185	0	140	135	5	0	0	0	0	0	0	325	340	-15		
WBU	0	0	0	0	0	0	0	0	0	0	0	0	10	10	0	0	0	0	10	10	0	0	0	0	0	0	0	0	0	0		
WBL	255	250	5	0	0	0	0	0	0	205	205	0	90	90	0	0	0	0	25	25	0	0	0	0	745	785	-40	0	0	0		
WBT	55	50	5	650	650	0	910	880	30	1005	960	45	970	935	35	950	950	0	1125	1100	25	605	560	45	0	0	0	0	0	0		
WBR	520	510	10	600	410	190	270	255	15	25	25	0	525	510	15	490	500	-10	215	215	0	65	65	0	320	340	-20	0	0	0		

Unbalanced and Balanced Intersection Turning Movement Counts for PM Peak Hour (5-6PM) - 2018

Map ID	1			2			3			4			5			6			7			8			9			10				
	Pacific Boulevard at Route 846 (S. Sterling Boulevard)			Route 846 (S. Sterling Boulevard) and southbound Route 28 off-ramps			Route 846 (S. Sterling Boulevard) and northbound Route 28 off-ramps			Shaw Road at Route 846 (S. Sterling Boulevard)			Pacific Boulevard at Route 606 (Old Ox Road)			Route 606 (Old Ox Road) and northbound Route 28 off-ramps			Shaw Road at Route 606 (Old Ox Road)			Sunrise Valley Drive at Route 608 (Frying Pan Road)			Centreville Road and Dulles Toll Road Ramps north of Dulles Toll Road			Centreville Road and Dulles Toll Road Ramps south of Dulles Toll Road				
	Bal	Unbal	Veh Diff	Bal	Unbal	Veh Diff	Bal	Unbal	Veh Diff	Bal	Unbal	Veh Diff	Bal	Unbal	Veh Diff	Bal	Unbal	Veh Diff	Bal	Unbal	Veh Diff	Bal	Unbal	Veh Diff	Bal	Unbal	Veh Diff	Bal	Unbal	Veh Diff	Bal	Unbal
NBU	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
NBL	0	0	0	0	0	0	0	0	0	275	265	10	45	45	0	0	0	0	140	140	0	0	0	0	355	370	-15	0	0	0		
NBT	500	500	0	0	0	0	0	0	0	60	60	0	50	50	0	110	100	10	45	45	0	0	0	0	1430	1430	0	1630	1630	0		
NBR	360	360	0	0	0	0	570	600	-30	365	365	0	215	215	0	220	200	20	45	45	0	0	0	0	0	0	780	820	-40			
SBU	0	0	0	0	0	0	0	0	0	0	0	0	5	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
SBL	620	625	-5	255	240	15	0	0	0	20	20	0	500	505	-5	0	0	0	250	250	0	35	35	0	0	0	0	250	265	-15		
SBT	180	180	0	0	0	0	0	0	0	25	25	0	45	45	0	0	0	0	30	30	0	0	0	0	1325	1325	0	1595	1580	15		
SBR	15	15	0	65	60	5	70	75	-5	110	105	5	255	255	0	560	530	30	205	205	0	1125	1340	-215	275	280	-5	0	0	0		
EBU	0	0	0	0	0	0	0	0	0	5	5	0	0	0	0	0	0	0	10	10	0	5	5	0	0	0	0	0	0	0		
EBL	10	10	0	0	0	0	235	225	10	65	65	0	220	220	0	0	0	0	165	160	5	705	710	-5	0	0	0	155	145	10		
EBT	25	25	0	670	670	0	695	675	20	1080	1065	15	1200	1210	-10	1210	1210	0	1190	1170	20	730	735	-5	0	0	0	0	0	0		
EBR	10	10	0	0	0	0	0	0	0	115	110	5	100	100	0	375	405	-30	170	165	5	0	0	0	0	0	0	115	105	10		
WBU	0	0	0	0	0	0	0	0	0	0	0	0	5	5	0	0	0	0	10	10	0	0	0	0	0	0	0	0	0	0		
WBL	140	140	0	0	0	0	0	0	0	220	220	0	50	50	0	0	0	0	40	40	0	0	0	0	525	525	0	0	0	0		
WBT	15	15	0	335	335	0	955	940	15	1035	1000	35	1245	1205	40	1125	1125	0	1555	1550	5	725	860	-135	0	0	0	0	0	0		
WBR	245	240	5	685	665	20	470	455	15	15	15	0	305	295	10	790	780	10	250	250	0	35	35	0	395	395	0	0	0	0		

*Volumes were balanced then rounded to the nearest five vehicles. Therefore, direct comparison of these counts with the controlling freeway mainline and ramp volumes results in a difference of five vehicles in some locations.

APPENDIX D – VISSIM CALIBRATION TECHNICAL MEMO

MEMORANDUM

To: Ivan Horodyskyj, P.E., VDOT NoVA District Traffic Engineer
Abi Lerner, P.E., VDOT Project Manager

From: Rob Prunty, P.E.
Kavita Boddu, P.E.
Anthony Gallo, P.E.
Britton Hammit, Ph.D., EIT
Kimley-Horn and Associates, Inc.

Date: March 25, 2019

Subject: Route 28 and Dulles Toll Road/Dulles Greenway Study
Traffic Analysis Microsimulation Calibration Results Memorandum

Introduction

This memorandum documents the Existing Conditions (2018) VISSIM calibration results for the Route 28 and Dulles Toll Road/Dulles Greenway Interchange Study. This process followed the agreed-upon methodology for VISSIM model calibration as documented in the project framework document (dated January 9, 2019). The traffic microsimulation calibration methodology was based on guidance set forth in the VDOT *Traffic Operations and Safety Analysis Manual* (TOSAM)¹, Version 1.0 (released November 2015), with deviations from TOSAM requirements noted where applicable in this memorandum.

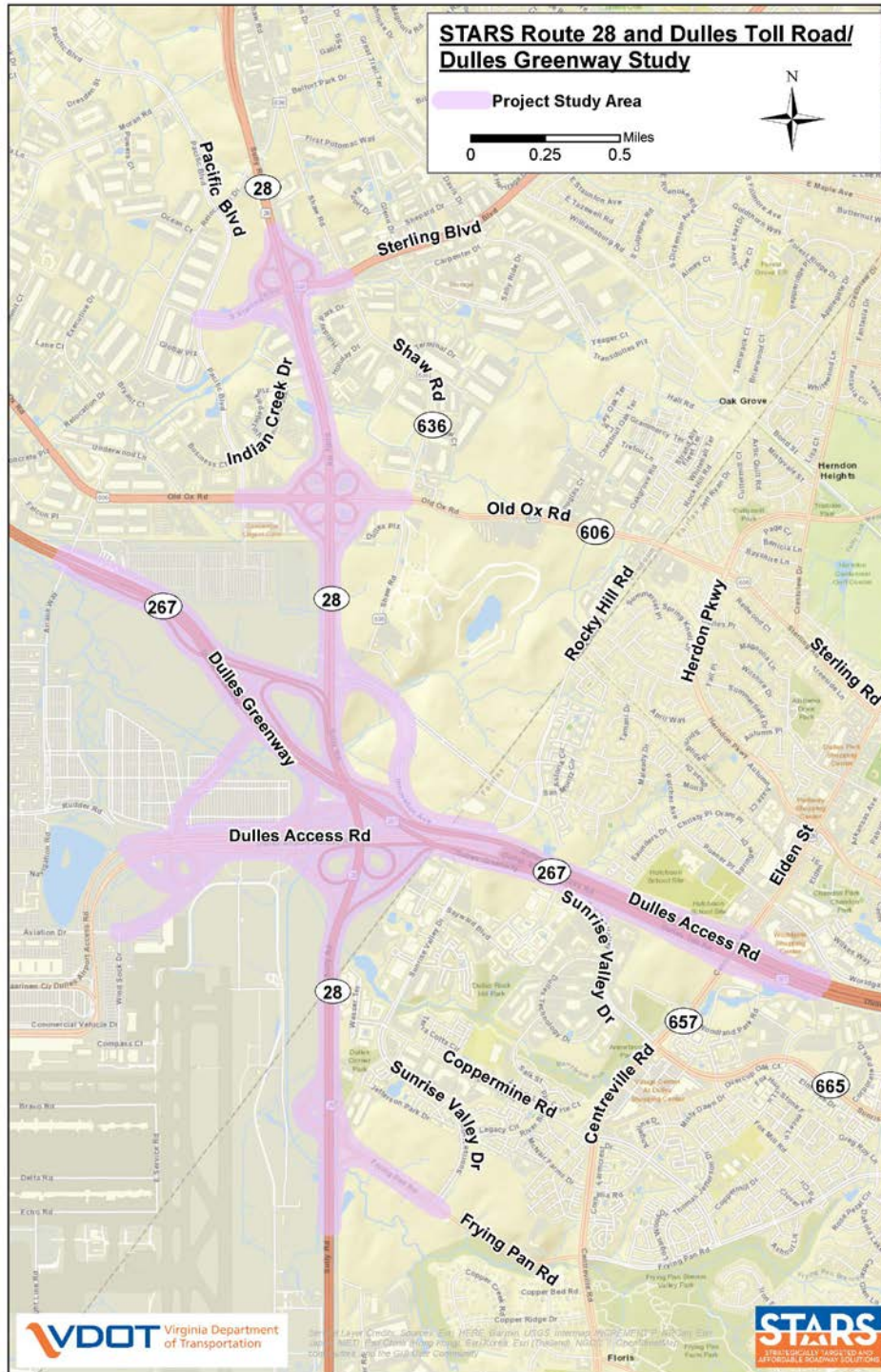
VISSIM Calibration Overview and Methodology

VISSIM Network Overview

VISSIM Version 9.0 is being used for a comprehensive network traffic analysis performed within the study area limits. The VISSIM model network includes all freeways and arterials shown in **Figure 1**, including arterial signalized intersections. Calibration, based on simulated volume processed, travel times, queues, and speed profiles, has been performed against 2018 measured field conditions and traffic data.

¹ <http://www.virginiadot.org/business/resources/TOSAM.pdf>

Figure 1. Project Study Area



Purpose of a Calibration

The purpose of a simulation model is to investigate the impacts of the proposed improvement alternatives. Calibration is the adjustment of the model parameters to improve the model’s ability to reproduce observed traffic conditions. It is the required step during any traffic analysis to ensure the model can reproduce local driver behavior and traffic performance characteristics, and calibration should be done prior to evaluating different alternatives. VISSIM, like most simulation models, is designed to be flexible enough that an analyst can correctly calibrate the network to match the location conditions at a reasonably accurate level. However, the default values will (almost) never give accurate results for a specific area. Therefore, calibration is required to adjust the VISSIM model parameters to replicate the traffic characteristics of the Study Area.

Calibration Methodology and Thresholds

The VISSIM models have been calibrated using guidance and direction provided in the TOSAM. **Table 1** provides the calibration thresholds for each measure; a discussion is provided following the table of each metric and any deviations from TOSAM requirements.

Table 1. VISSIM Calibration Criteria and Acceptance Targets

Calibration Item	Basis	Criteria	Target
Simulated Traffic Volume (Intersections)	By Intersection Approach	Within ± 20% for <100 vph	At least 85% of all Intersection Approaches
		Within ± 15% for ≥ 100 vph to < 300 vph	
		Within ± 10% for ≥ 300 vph to < 1,000 vph	
		Within ± 5% for ≥ 1,000 vph	
Simulated Traffic Volume (Freeways)	By Freeway Segment	Within ± 20% for <100 vph	At least 85% of all Freeway Segments
		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	By Route	Within ± 30% for average travel times on arterials	At least 85% of all Travel Time Routes (Including Segments)
		Within ± 20% for average travel times on freeways	
Maximum Simulated Queue Length	By Approach for Targeted Critical Locations	Modeled queues qualitatively reflect the impacts of observed queues	Qualitative Visual Match compared to Google Maps and INRIX

Calibration Item	Basis	Criteria	Target
Visual Review of Bottleneck Locations	Targeted Critical Locations	Speed heat maps qualitatively reflect patterns and duration of congestions	Qualitative Subjective Assessment

- **Traffic Volume:** Simulated throughput calibrated using data collected during the AM and PM peak hours. Freeway traffic volumes will be calibrated for mainline, diverge, merge, weave, and ramp segments. Intersection traffic volumes will be calibrated by total approach volumes at the study intersections.
- **Travel Time:** Simulated travel time calibrated using field data collected during the AM and PM peak periods. Floating car travel times were collected over a two-hour period with one half-hour interval on either side of the AM and PM peak hours; model travel times have been collected and calibrated over those same periods. All travel times are along freeway segments.
- **Speeds:** The criteria listed above deviates from TOSAM requirements for simulated average speeds. The TOSAM requires that the top 85 percent of network links (based on link travel volumes) or a select number of critical links and/or movements, as determined by the DTE or his/her designee, meet a calibration threshold of average speeds within 5 mph for arterials and 7 mph for highways. In this project study area, speeds are highly variable on the freeway mainline and can vary substantially by hour and by day. The simulated average speed has been captured as part of the travel time calibration process and the visual review of bottleneck locations against speed heat maps. Average speeds have been extracted from the VISSIM models along the study corridors for Route 267 and Route 28 at one-quarter mile intervals and compared visually against speed heat maps generated from INRIX vehicle probe data.
- **Queue Length:** The calibration method for queue length is again a deviation from TOSAM. Queuing within the study area is notably inconsistent and can oscillate numerous times within the peak periods or be absent altogether on some days. A qualitative subjective assessment has been conducted for queue lengths at targeted ramp locations in addition to the review of freeway mainline congestion/queues against the speed heat maps. The targeted locations identified below, where extensive queuing issues consistently exist, have been focused on as critical locations:
 - Route 28 / Route 267 Interchange
 - Ramp from Dulles Toll Road westbound to Route 28 northbound
 - Ramp from Route 28 southbound to Route 267 eastbound
 - Ramp from Route 267 (Dulles Greenway) eastbound/westbound combined to Route 28 southbound
 - Ramp from Route 28 northbound to Route 267 eastbound

- Frying Pan Road Interchange
 - Frying Pan Road eastbound approach to Sunrise Valley Drive
 - Route 28 northbound and southbound off-ramps to Frying Pan Road
 - Ramp from Frying Pan Road to Route 28 northbound
- Route 267 / Centreville Road Interchange
 - Ramp from Dulles Toll Road westbound to Centreville Road

Simulation Peak Hours and Analysis Periods

After assessing the INRIX speed heat map for the Route 267 and Route 28 (pulled from RITIS for average Tuesdays, Wednesdays, and Thursdays from January 2018 to September 2018), the project team recommended basing the analysis periods upon the magnitude of freeway congestion. Upon review of the INRIX speed data, the slowest speeds and heaviest queues during the AM peak period are along Route 267 (Dulles Toll Road) eastbound and Route 28 southbound, and during the PM are along Route 28 northbound.

- AM: simulation analysis period from 7:30 AM to 9:30 AM; network representative hour from 8:00 AM to 9:00 AM. See **Figure 2** and **Figure 3**.
- PM: simulation analysis period from 4:00 PM to 7:00 PM; network representative hour from 5:00 PM to 6:00 PM. See **Figure 4**.

Figure 2: INRIX Speed Heat Map for Route 267 Eastbound and AM Analysis Period/Peak Hour

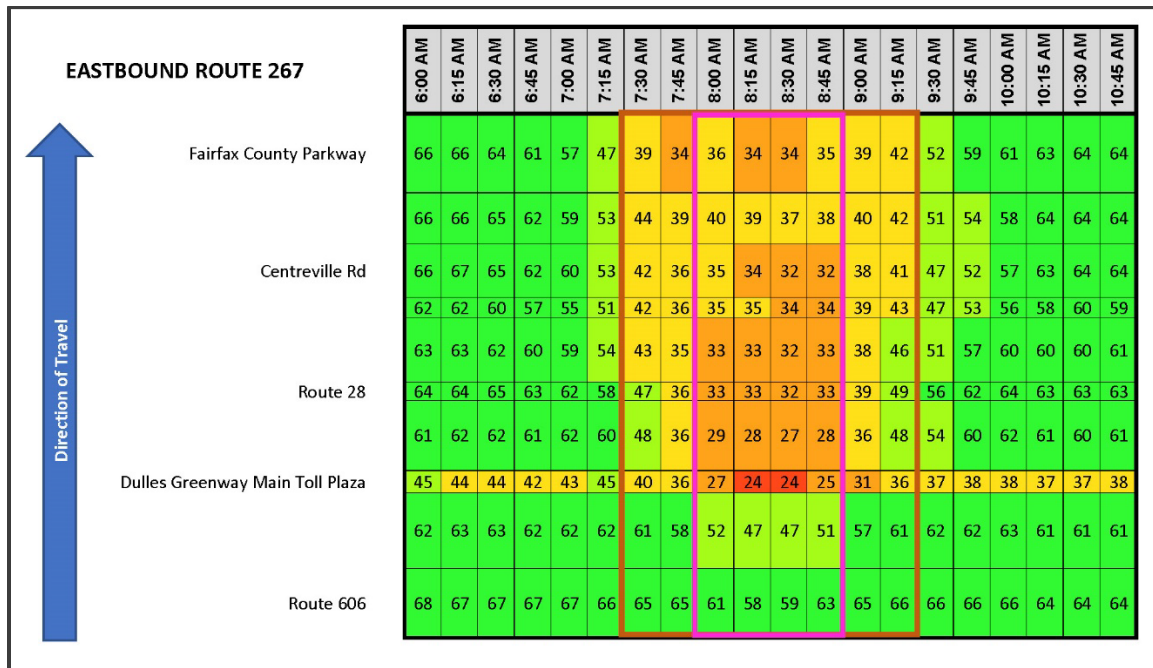


Figure 3: INRIX Speed Heat Map for Route 28 Southbound and AM Analysis Period/Peak Hour

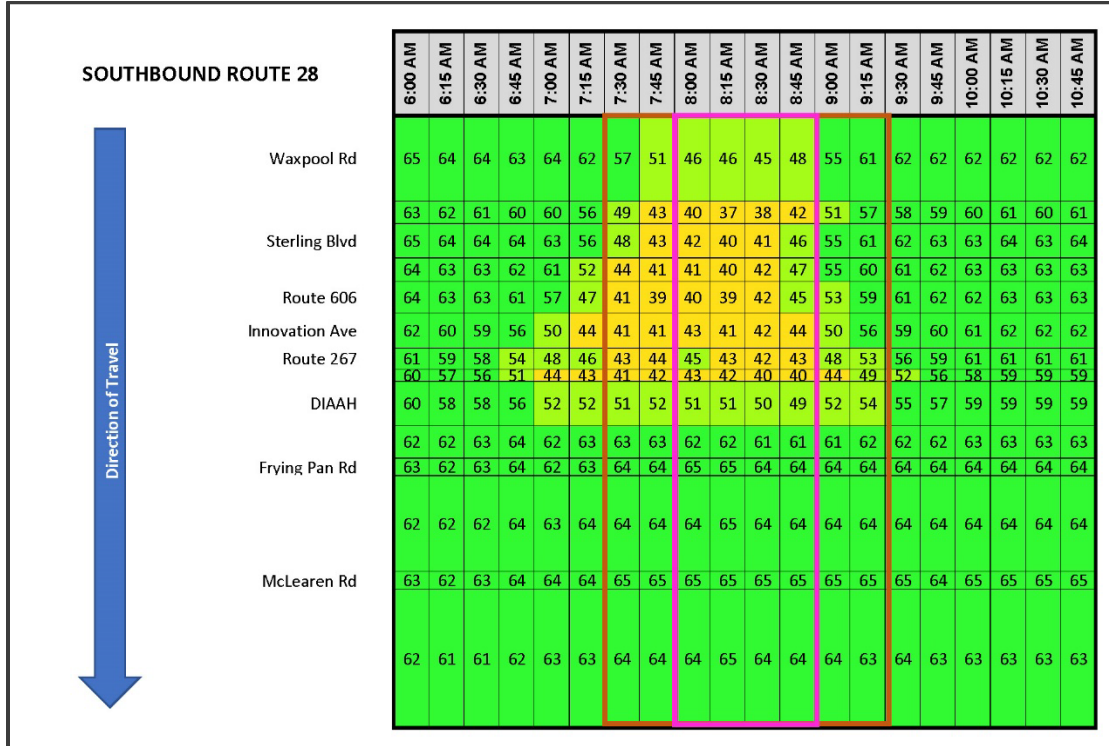
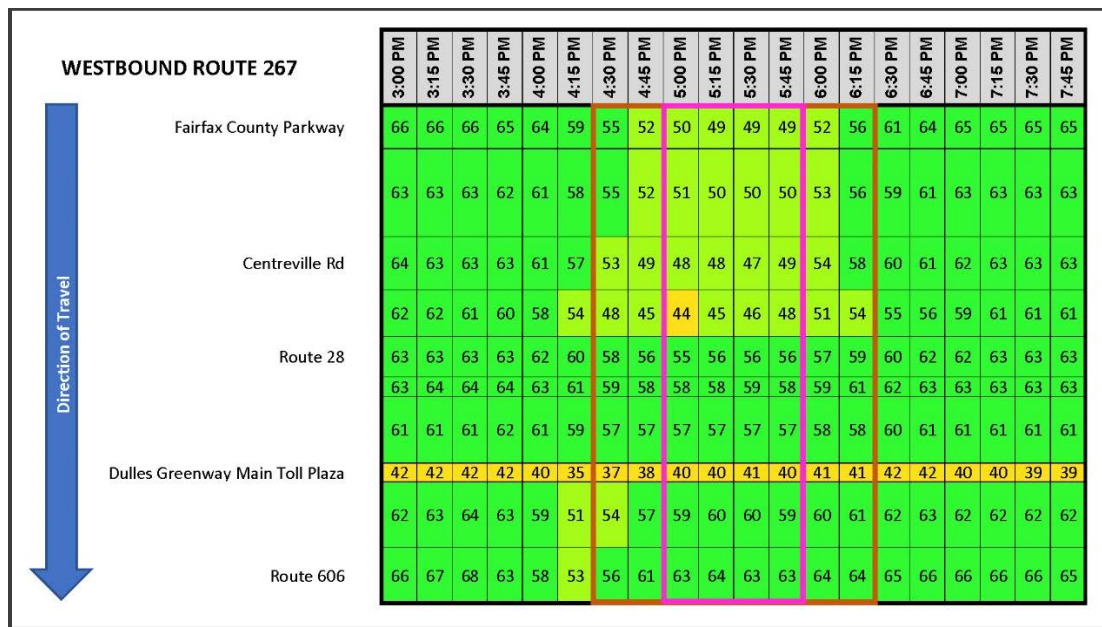


Figure 4: INRIX Speed Heat Map for Route 28 Northbound and PM Analysis Period/Peak Hour



Seeding Period

The seeding period is the period the model requires for the network-wide volumes to become stable. The length of the seeding period depends on numerous network factors like the size of the network and level of congestion. A seeding step is needed to ensure that output data is not collected until the end of the seeding period is reached. If it is collected earlier, simulation measures (e.g., travel time and congestion) may be under-reported. The guidance from VDOT suggests that seeding time should be determined based on either the existing peak hour travel time to traverse between the farthest points of the study network in the peak direction of travel or twice the off-peak travel time between the network study limits. Based on end-to-end travel times collected during both periods, a seeding period of 30 minutes was found to be adequate for the AM and PM models.

Number of Model Runs

Given the stochastic nature of the microsimulation, VISSIM models need to be run with several different random seeds. The results need to be post-processed and averaged to determine the representative state of traffic operations in the study network. To obtain a statistically valid result, the number of runs necessary for the analysis were determined based on VDOT Sample Size Determination Tool as shown in **Figure 5** for the AM peak and **Figure 6** for the PM peak. Average link speed was identified as the MOE for the Sample Size Determination Tool using the following locations, chosen based on their recurring fluctuating congestion and critical impact on traffic operations:

- AM peak – Route 28 southbound between off-ramp to Dulles Airport and off-ramp to Route 267 eastbound
- PM peak – Route 28 northbound between on-ramp from Route 267 westbound and off-ramp to Innovation Avenue

Following the steps of the VDOT Sample Size Determination Tool, as shown in the figures, it was determined that 10 runs were sufficient for both the AM and PM scenarios. Therefore, the final results from the calibration models and future scenario models will be reported using the average of 10 simulation runs.

Figure 5. VDOT Sample Size Determination Tool – AM Peak

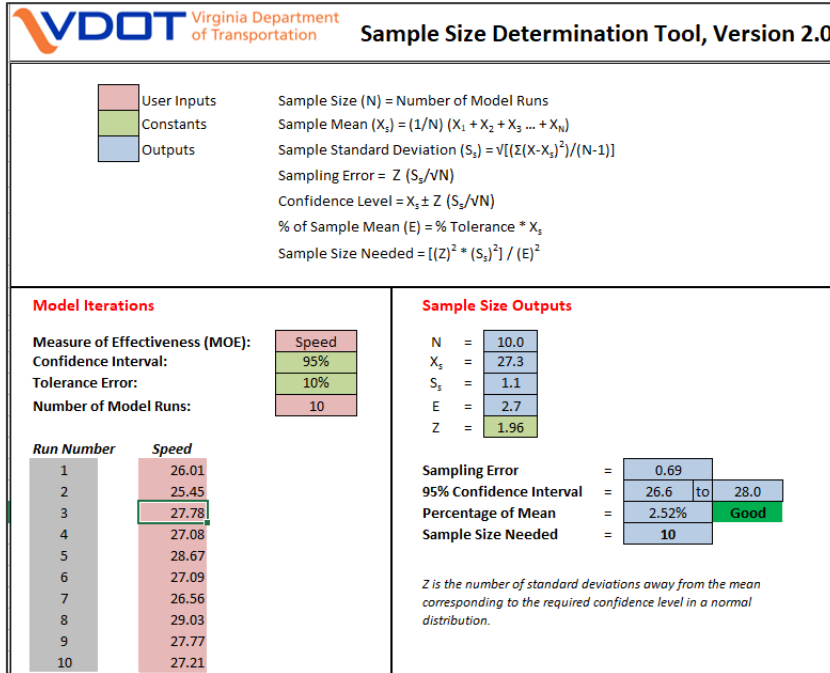
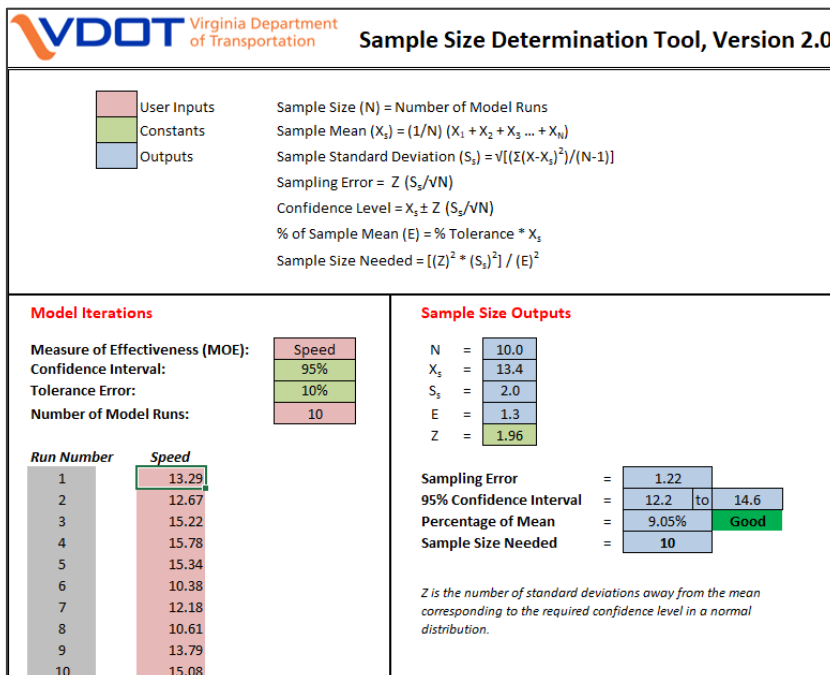


Figure 6. VDOT Sample Size Determination Tool – PM Peak



Calibration Parameters and Adjustments

Calibrating the AM and PM peak period existing VISSIM models involved adjusting specific parameters to achieve the target volume, travel time, speed, and queueing thresholds. The primary parameters that were adjusted included the following:

Lane Change Distances

Lane-change look-back distances is the distance in the VISSIM model where a vehicle will start attempting to make a lane change to a target lane prior to an off-ramp, a lane-drop, or change in direction in travel. This lane-change distance is a parameter on every connector in the VISSIM network, and its default change distance value is 656 feet. This distance is typically acceptable for low speed, intersection turning movements; however, it would provide extremely challenging lane changing behavior for freeway diverges and lane drops. As a starting point in the VISSIM model, the lane-change distance for diverges and lane drops was modified to match the first field-observed way-finding sign. This distance is typically one mile upstream of an off-ramp. The parameter was then adjusted on a case-by-case basis at different locations with the goal of calibrating existing queues, speeds, and travel times within the study area.

Driver Behavior – Car-Following Adjustments

VISSIM incorporates two different car-following models – one for freeways and one for arterials. In combination with other operational parameters, analysts have the ability to adjust these parameters as needed to achieve desired flow conditions. In addition to other parameters, such as vehicle speed, heavy vehicle percentage, and number of lanes, the car-following parameters effectively change roadway capacity, vehicle spacing and headways.

The car-following parameters adjusted during the calibration process for freeways were modified based on previous experiences with similar type of networks and operations, engineering judgment, and field observations. They were typically adjusted if a field condition (i.e. poor vertical sight distance, narrow lateral clearances, etc.) warranted a change from VISSIM default parameters. From the list of car-following parameters that can be modified, three are the most sensitive for calibration:

- CC0 – Standstill Distance is defined as the desired distance between stopped cars. This parameter is typically used to increase or decrease vehicle spacing while vehicles are in queue and is used during calibration to affect queue duration and length. CC0 was changed to range from 4.93 to 5.50 depending on location.
- CC1 – Headway Time is not a direct measure of headway time but rather a factor that affects the following (minimum desired safety) distance. The higher this value, the more cautious the driver is, thus reducing capacity. In the case of high volumes, it is the following distance that has the strongest influence on capacity. Based on default VISSIM parameters (including CC1), the capacity of an urban freeway link is approximately 1,900 vehicles/hour/lane (vphpl). CC1 was changed from 0.90 to values ranging from 0.8 to 1.10 seconds depending on location.
- CC2 – Following Variation is the longitudinal oscillation and how much more distance than the desired safety distance a driver allows before moving closer to the vehicle in front. CC2 was changed to range from 6.52 to 21.00 depending on location.

All of the above changes are within the acceptable thresholds set forth in TOSAM.

Driver Behavior – Lane-Change Adjustments

Another important parametric change focused on the lane-changing parameters. VISSIM includes parameters for necessary (in order to make a turning movement) and discretionary lane changes (for more room/higher speed). The lane-change parameters were modified from default values in order to achieve more realistic lane-change behavior in the model. Most of the model modifications occurred at high-volume merges. Three main parameters were changed: (1) the maximum and accepted deceleration between the vehicle making a necessary lane change and the vehicle that vehicle is moving ahead of, (2) the safety reduction factor, and (3) the maximum deceleration rate for cooperative breaking.

Adjustments in the lane-change parameters were used to better replicate actual driver behavior under congested and severe weaving conditions in the simulation model. It is important to note that many of these changes are link-specific to account for the variations in geometric and accompanying driver behaviors along the corridor. Furthermore, values may differ between the AM and PM peak hours since motorists will change their lane-change aggressiveness based on prevailing traffic conditions.

Adjustments for External Congestion

During the AM peak period, congestion along eastbound Route 267 spills back from the weaving movements east of Centreville Road. Initial VISSIM runs, which did not include these weaving movements, resulted in a lack of congestion on the network at this location. Streetlight O-D estimations were collected to determine the number of vehicles exiting at Fairfax County Parkway, an off-ramp just east of the study area. These results showed 14 percent of vehicles traveling east of the Centreville Road on-ramp exit onto Fairfax County Parkway. These weaving movements were replicated in the model by generating updated O-D routes that included vehicles exiting Route 267 at Fairfax County Parkway. After incorporating these additional downstream weaving patterns, congestion increased noticeably; however, the travel speeds along the corridor were still too high to match field conditions. Therefore, a reduced speed area was added at the downstream end of the eastbound Route 267 corridor to emulate downstream congestion. The combination of these two strategies enabled realistic representation of traffic conditions on the eastbound Route 267 corridor in the project study area.

During the PM peak period, congestion along Route 28 northbound spills back from a left-side off-ramp to Waxpool Road downstream of the project study area. Initial VISSIM runs, which did not include this ramp, showed minimal congestion forming along Route 28 northbound even with significant tests of modification to driver behavior. This lack of congestion makes sense intuitively given the peak-hour throughput volumes along Route 28 northbound north of Sterling Boulevard – approximately 6,000 vph for a four-lane freeway section is well below its hypothetical capacity. However, upon reviewing StreetLight Data O-D estimates for the PM peak period, greater than 30 percent of all northbound traffic is destined for this left-side off-ramp, which was not originally accounted for in the VISSIM model. The project team developed a new set of O-D routes using StreetLight Data and VISUM to account for the Waxpool Road ramp; O-D pairs between other locations in the network remained unchanged. This new set of O-D routes produces a significant

amount of weaving volume along Route 28 northbound, with vehicles making necessary lane changes into the left-most lanes and results in the desired queue formation upstream along Route 28 in the project study area.

VISSIM Calibration Results

EXISTING AM MODEL

Volume Calibration Results

Throughput volumes produced by the VISSIM model were compared to balanced traffic counts based on the criteria described in previous section. **Table 2** summarizes the comparison of freeways and ramps based on volume criteria for northbound and southbound Route 28 and for eastbound and westbound Route 267 and the DIAAH. Overall, 98 percent of all freeway and ramp segments on the network meet the volume difference threshold, which is greater than the calibration target of 85 percent, indicating the model is meeting the freeway and ramp volume target. **Table 3** provides comparison results for all arterial approaches within the study area. As shown, 94 percent of all arterial approaches meet the volume difference threshold, which is greater than the calibration target of 85 percent, indicating the model is meeting the arterial volume target. Tables within **Attachment A** provide the freeway segments, ramps and intersection demand versus throughput comparison.

Table 2. Existing AM – Summary of Freeway/Ramp Volume Calibration

	Volume Criteria	Subtotal	Total	Percent	Target	Target Met
Segments (n = 125)	Within ±20% for < 100 vph	3	122	98%	85%	Yes
	Within ± 15% for ≥ 100 vph to < 300 vph	11				
	Within ± 10% for ≥ 300 vph to < 1,000 vph	40				
	Within ± 5% for ≥ 1,000 vph	68				

Table 3. Existing AM – Summary of Arterial Volume Calibration

	Volume Criteria	Subtotal	Total	Percent	Target	Target Met
Approaches (n = 34)	Within ±20% for < 100 vph	2	32	94%	85%	Yes
	Within ± 15% for ≥ 100 vph to < 300 vph	4				
	Within ± 10% for ≥ 300 vph to < 1,000 vph	14				
	Within ± 5% for ≥ 1,000 vph	12				

Travel Time Calibration Results

Travel times produced from the VISSIM model were compared to field measurements based on the criteria described in previous sections. **Table 4** and **Figure 6** summarize the results for the following corridor segments:

- Route 28 Northbound: Frying Pan Road to Sterling Boulevard

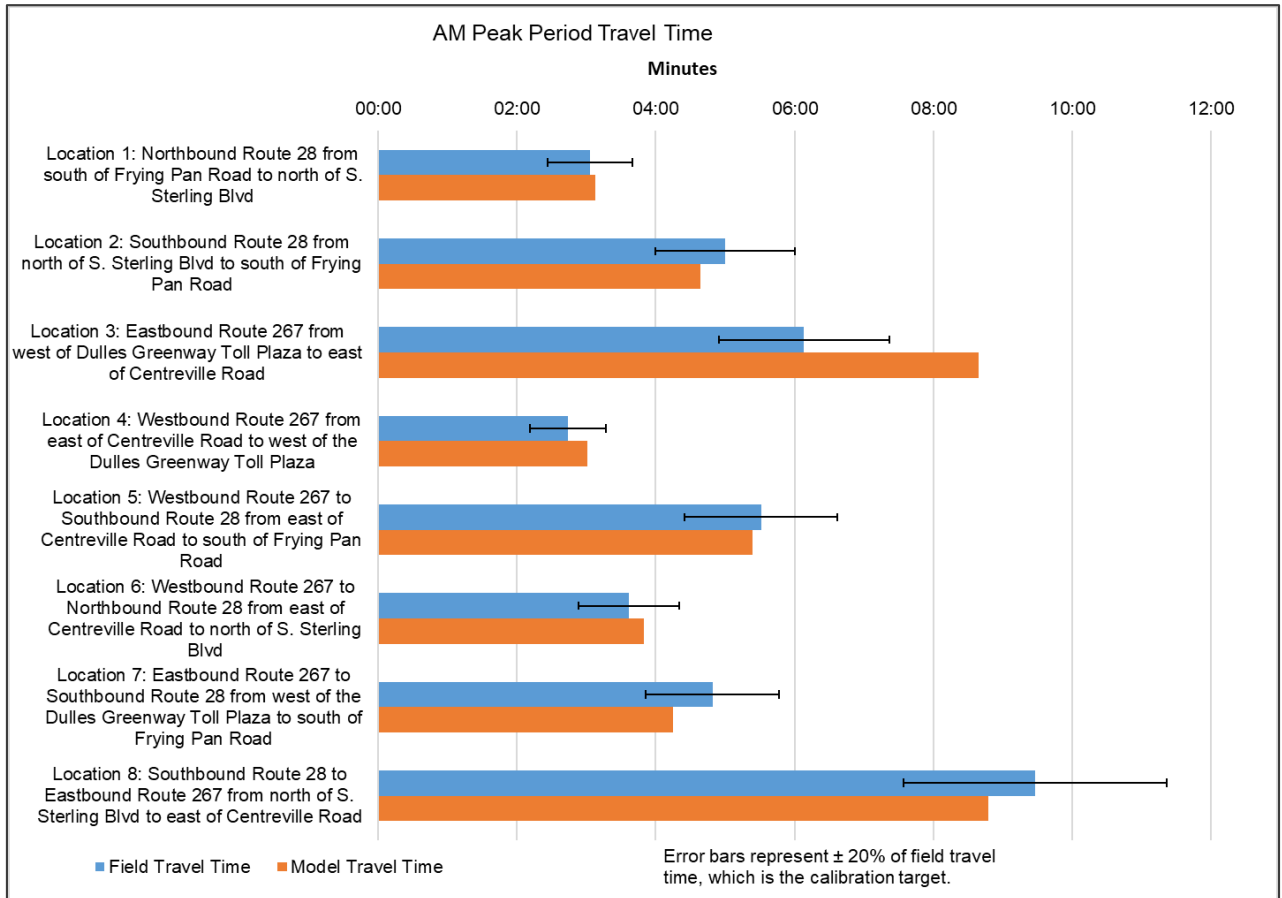
- Route 28 Southbound: Sterling Boulevard to Frying Pan Road
- Route 267 Eastbound: Dulles Greenway Toll Plaza to Centreville Road
- Route 267 Westbound: Centreville Road to Dulles Greenway Toll Plaza
- Route 267 Westbound to Route 28 Southbound: Centreville Road to Frying Pan Road
- Route 267 Westbound to Route 28 Northbound: Centreville Road to Sterling Boulevard
- Route 267 Eastbound to Route 28 Southbound: Dulles Greenway Toll Plaza to Frying Pan Road
- Route 28 Southbound to Route 267 Eastbound: Sterling Boulevard to Centreville Road

In **Figure 6**, calibration targets are depicted with high-low bars on field travel-time measures. As shown in this figure and in **Table 4**, calibration targets are met for 88 percent of the segments. The only travel time segment not meeting the calibration criteria is the end-to-end travel time along eastbound Route 267 through the network (41 percent greater than average field conditions); however, evaluation of the travel times from INRIX shows that the VISSIM average travel time on this segment is within the INRIX range of travel times, and the speed heat map for this segment (provided in the next section) reasonably matches INRIX vehicle probe data. The model is still meeting the overall travel time target. Detailed travel time results for each of the sub-segments is provided in **Attachment A**.

Table 4. Existing AM – Summary of Travel Time Calibration

	Travel Time Criteria	Total	Percent	Target	Target Met
Routes (n = 8)	Within ±20% for average travel time on freeways	7	88%	85%	Yes

Figure 7. Existing AM – Travel Time Results



Bottleneck Locations, Length, and Duration of Backups

Comparison of INRIX data with travel speeds measured in the model every one-quarter mile provides a useful way for checking bottleneck locations as well as the extent and temporal distribution of mainline queues and overall congestion. **Figure 7** depicts the “heat map” diagrams for the entire corridor for northbound and southbound Route 28 in the AM period, while **Figure 8** depicts these diagrams for Route 267 (Dulles Greenway/Dulles Toll Road). As shown, there is a very reasonable match between INRIX and VISSIM results. The results for the AM model are reasonably close to what is observed from INRIX data in terms of specific bottleneck locations, length, and duration of backups.

Simulated Queue Length

As noted earlier, queuing within the study area is notably inconsistent and can oscillate numerous times within the peak periods or be absent altogether on some days. As noted previously, a qualitative subjective assessment was conducted for queue lengths at targeted locations in addition to the review of freeway mainline congestion/queues against the speed heat maps as

shown above. Based on the VISSIM results, the modeled queues qualitatively reflect the impacts of observed queues at most of the locations that were identified. **Table 5** provides a summary of the queue length calibration, and detailed results with a subjective comparison at each targeted queue location is provided in **Attachment A**.

Table 5. Existing AM – Summary of Queue Length Calibration

	Queue Criteria	Total	Percent	Target	Target Met
Approaches (n = 8)	Modeled queues qualitatively reflect the impacts of observed queues (e.g., spillback from ramp intersections, turn bay, or downstream intersection)	8	100%	85%	Yes

Figure 8. Existing AM – Speed Diagrams: Comparison of VISSIM Speeds to INRIX along Route 28 Northbound/Southbound

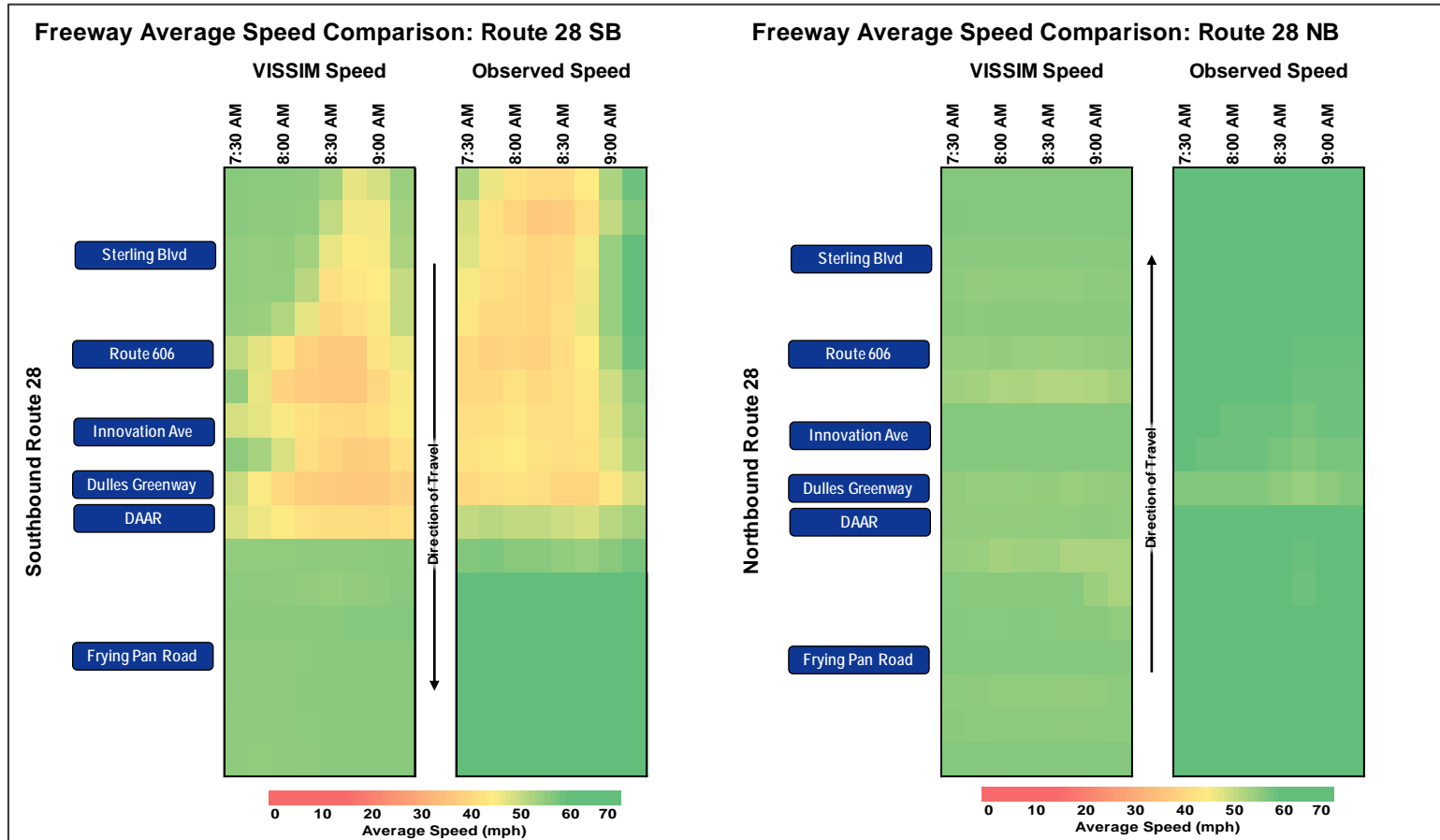
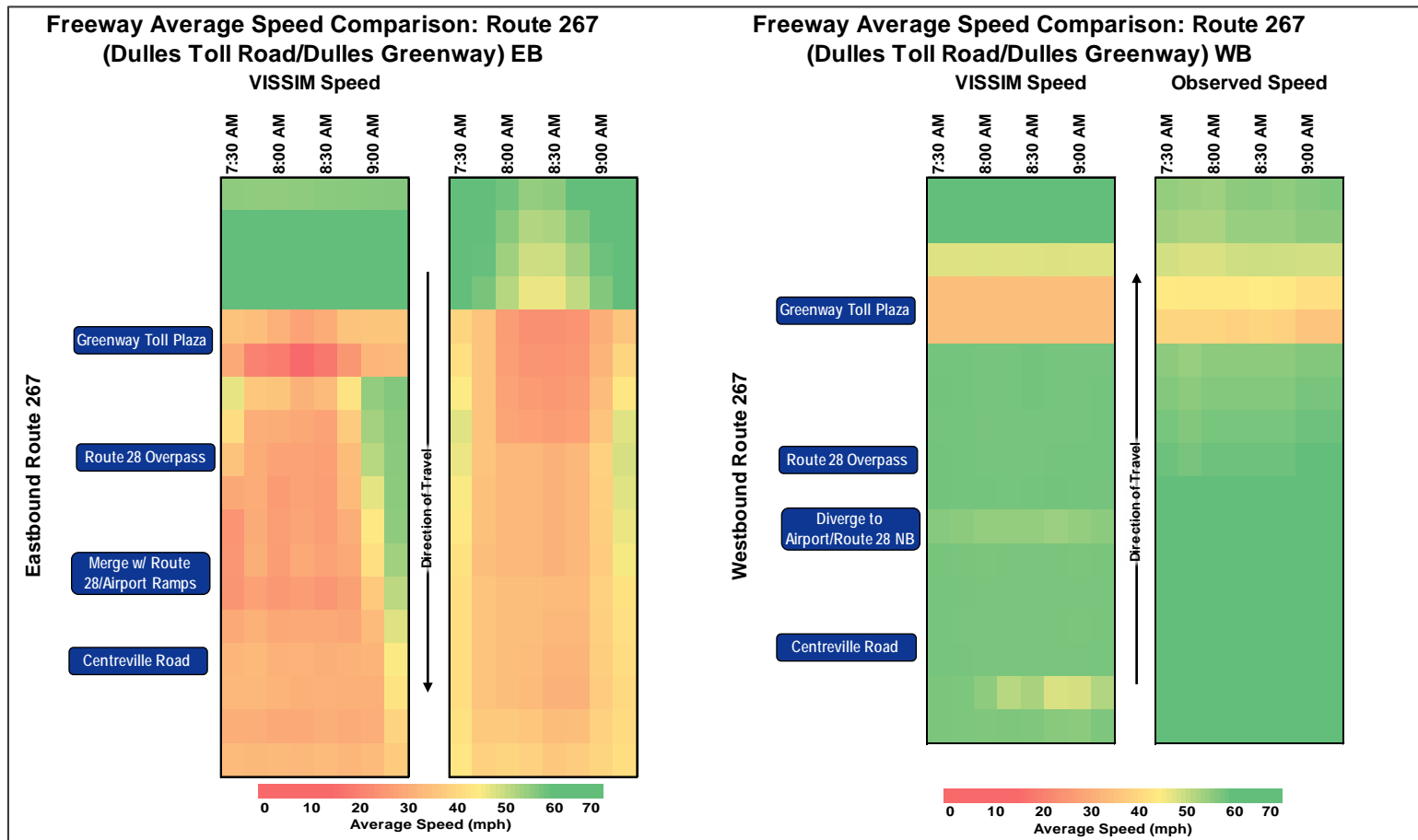


Figure 9. Existing AM – Speed Diagrams: Comparison of VISSIM Speeds to INRIX along Route 267 (Dulles Toll Road/Dulles Greenway) Eastbound/Westbound



Calibration Summary

Table 6 provides an overall summary of calibration for the AM peak period. The Existing AM peak period VISSIM model is considered reasonably calibrated.

Table 6. AM Peak Period Calibration Summary

Calibration Item	Basis	Criteria	Total	Percent	Target	Target Met
Simulated Traffic Volume (Intersections)	Approaches (n = 34)	Within ±20% for <100 vph	32	94%	85%	Yes
		Within ±15% for ≥ 100 vph to < 300 vph				
		Within ±10% for ≥ 300 vph to < 1,000 vph				
		Within ±5% for ≥ 1,000 vph				
Simulated Traffic Volume (Freeways)	Segments (n = 125)	Within ±20% for <100 vph	122	98%	85%	Yes
		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	Routes (n = 8)	Within ±20% for average travel time on freeways	7	88%	85%	Yes
Maximum Simulated Queue Length	Approaches (n = 8)	Modeled queues qualitatively reflect the impacts of observed queues				Reasonably Calibrated
Visual Review of Bottleneck Locations	Targeted Critical Locations	Speed heat maps qualitatively reflect patterns and duration of congestions				Reasonably Calibrated

EXISTING PM MODEL

Volume Calibration Results

Throughput volumes produced by the VISSIM model were compared to balanced traffic counts based on the criteria described in previous section. **Table 7** summarizes the comparison based on volume criteria for freeway segments and ramps consistent with the AM segments. In the northbound direction, there are some mainline segments which do not meet the targets; however, overall, 86 percent of the segments meet the criteria, exceeding the calibration target of 85 percent. Also, as seen in **Table 8** below, 97 percent of the intersection approaches meet the target of 85 percent criteria. Tables within **Attachment B** provide the freeway segments, ramps and intersection demand versus throughput comparison.

Table 7. Existing PM – Summary of Freeway/Ramp Volume Calibration

	Volume Criteria	Subtotal	Total	Percent	Target	Target Met
Segments (n = 125)	Within ±20% for < 100 vph	7	108	86%	85%	Yes
	Within ±15% for ≥ 100 vph to < 300 vph	5				
	Within ±10% for ≥ 300 vph to < 1,000 vph	36				
	Within ±5% for ≥ 1,000 vph	60				

Table 8. Existing PM – Summary of Arterial Volume Calibration

	Volume Criteria	Subtotal	Total	Percent	Target	Target Met
Approaches (n = 34)	Within ±20% for < 100 vph	1	33	97%	85%	Yes
	Within ±15% for ≥ 100 vph to < 300 vph	4				
	Within ±10% for ≥ 300 vph to < 1,000 vph	14				
	Within ±5% for ≥ 1,000 vph	14				

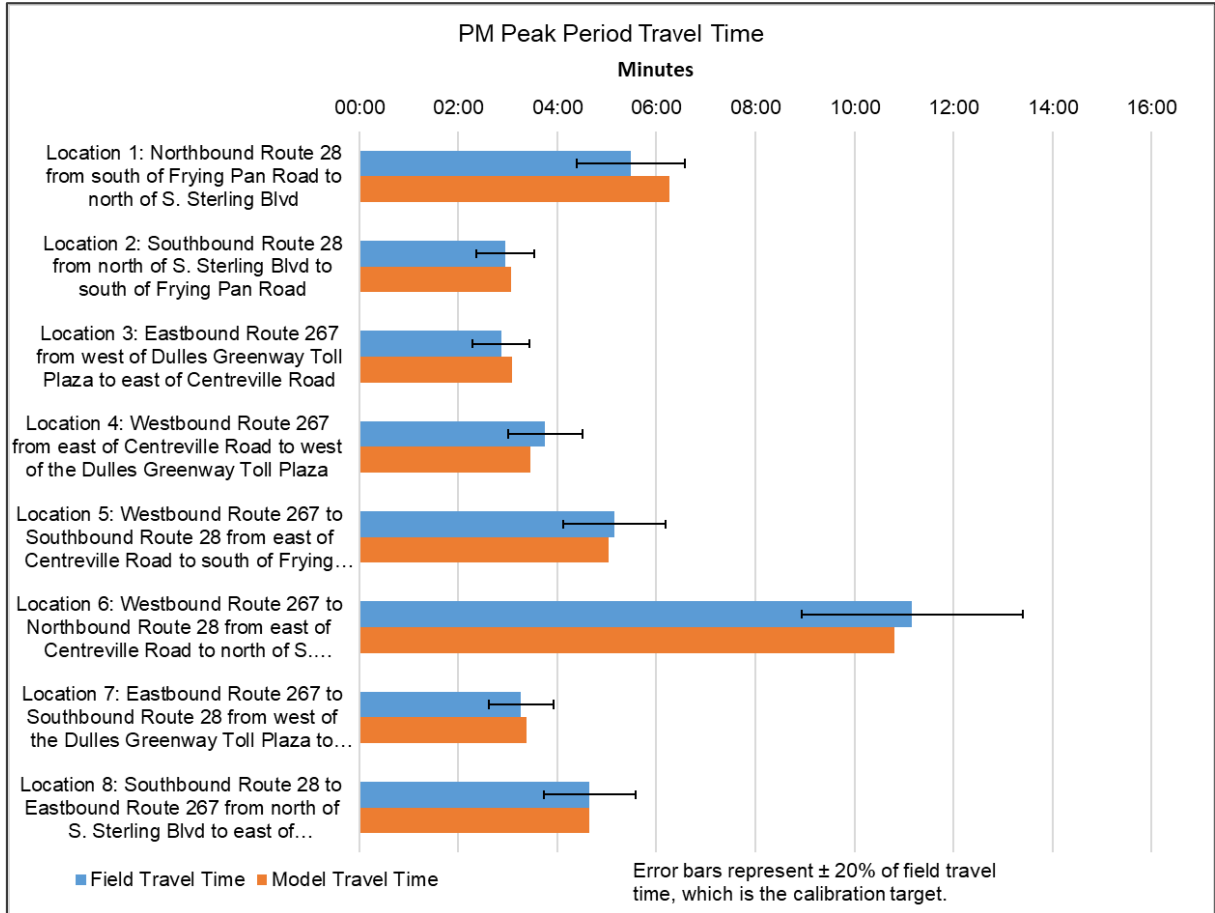
Travel Time Calibration Results

Travel times produced from the VISSIM model were compared to field measures based on the criteria described in previous sections. **Table 9** and **Figure 9** summarize the results for the same corridor segments as shown for the AM. In **Figure 9**, calibration targets are depicted with high-low bars on field travel-time measures. As shown in this figure and in **Table 9**, calibration targets are met for all segments. Detailed travel time results for each of the sub-segments is provided in **Attachment B**.

Table 9. Existing PM – Summary of Travel Time Calibration

	Travel Time Criteria	Total	Percent	Target	Target Met
Routes (n = 8)	Within ±20% for average travel time on freeways	8	100%	85%	Yes

Figure 10. Existing PM – Travel Time Results



Bottleneck Locations, Length, and Duration of Backups

Comparison of INRIX data with travel speeds measured in the model every one-quarter mile provides a useful way for checking bottleneck locations as well as the extent and temporal distribution of mainline queues and overall congestion. **Figure 10** depicts the “heat map” diagrams for the entire corridor for northbound and southbound Route 28 in the AM period, while **Figure 11** depicts these diagrams for Route 267 (Dulles Greenway/Dulles Toll Road). As shown, there is a very reasonable match between INRIX and VISSIM results. It is important to note, that while this comparison provides a powerful way of checking the general validity of the model, other measures such as travel time and volumes are significantly more reliable and were given higher priority in the calibration process. Nevertheless, the results for the PM model are reasonably close to what is observed from INRIX data in terms of specific bottleneck locations, length, and duration of backups.

Simulated Queue Length

As noted earlier, queuing within the study area is notably inconsistent and can oscillate numerous times within the peak periods or be absent altogether on some days. As noted previously, a

qualitative subjective assessment was conducted for queue lengths at targeted locations in addition to the review of freeway mainline congestion/queues against the speed heat maps as shown above. Based on the VISSIM results, the modeled queues qualitatively reflect the impacts of observed queues at most of the locations that were identified. **Table 10** provides a summary of the queue length calibration, and detailed results with a subjective comparison at each targeted queue location is provided in the **Appendix**.

Table 10. Existing PM – Summary of Queue Length Calibration

	Queue Criteria	Total	Percent	Target	Target Met
Approaches (n = 8)	Modeled queues qualitatively reflect the impacts of observed queues (e.g., spillback from ramp intersections, turn bay, or downstream intersection)	8	100%	85%	Yes

Figure 11. Existing PM – Speed Diagrams: Comparison of VISSIM Speeds to INRIX along Route 28 Northbound/Southbound

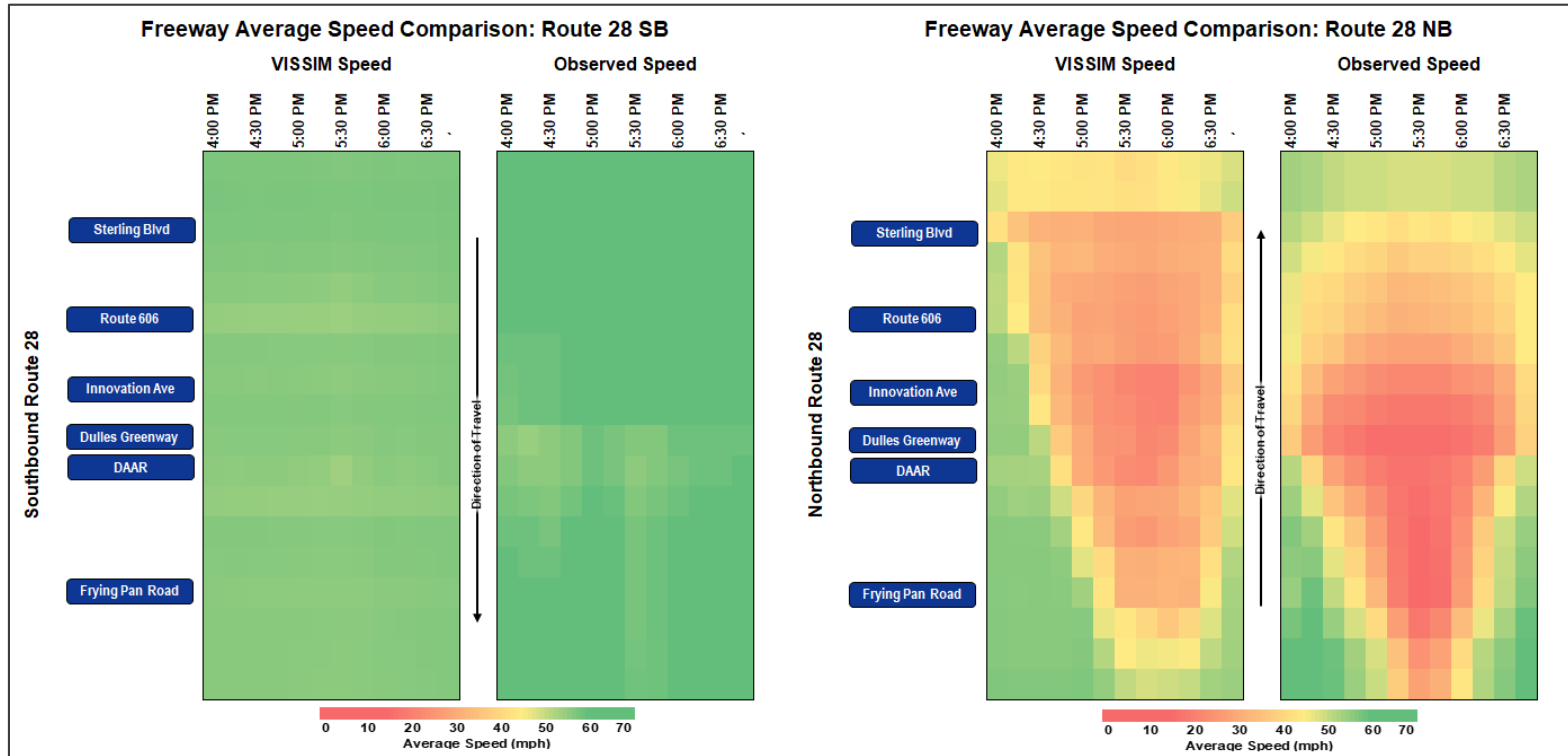
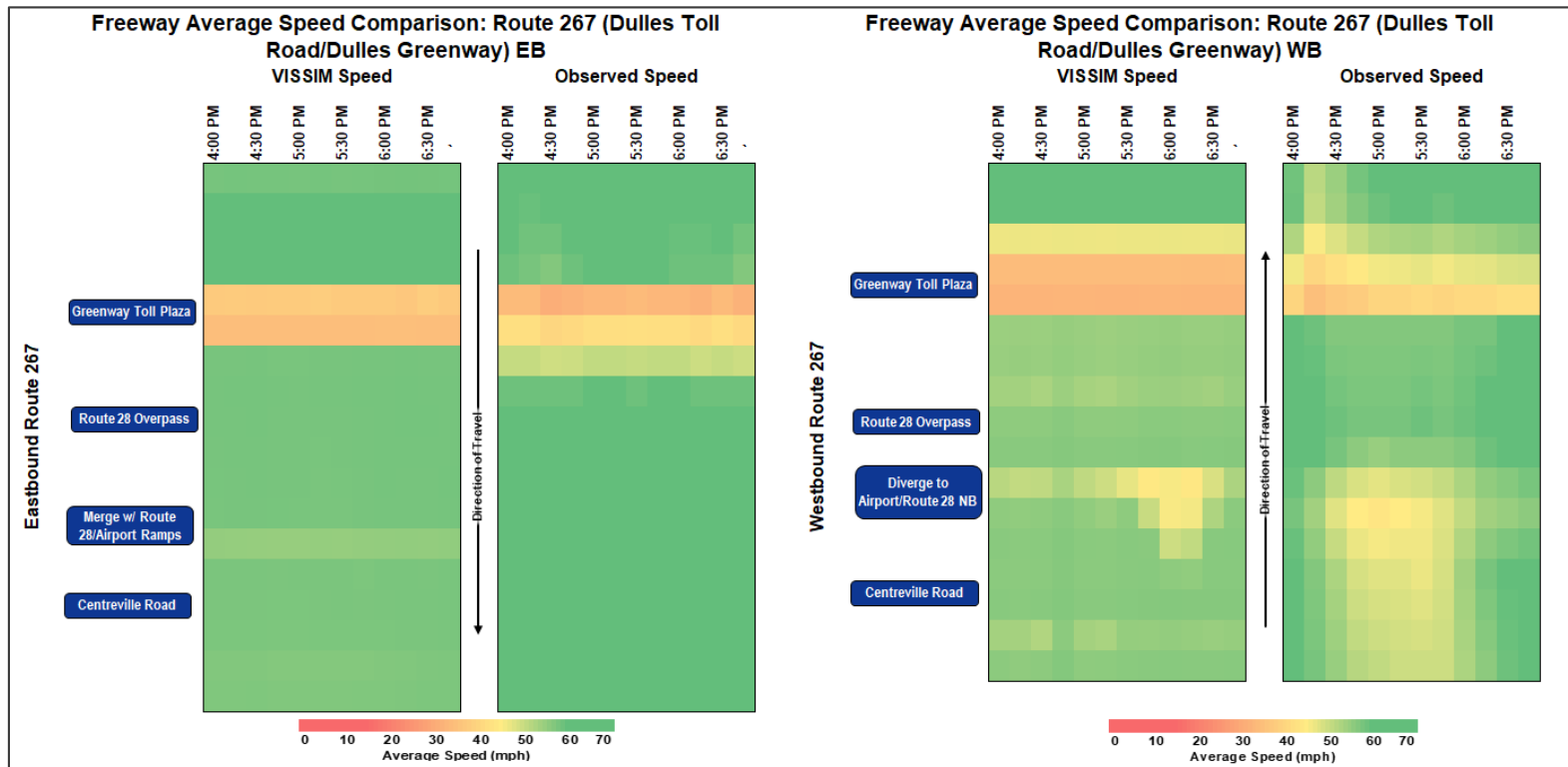


Figure 12. Existing PM – Speed Diagrams: Comparison of VISSIM Speeds to INRIX along Route 267 (Dulles Toll Road/Dulles Greenway) Eastbound/Westbound



Calibration Summary

Table 11 provides an overall summary of calibration for the PM peak period. The Existing PM peak period VISSIM model is considered reasonably calibrated.

Table 11. PM Peak Period Calibration Summary

Calibration Item	Basis	Criteria	Total	Percent	Target	Target Met
Simulated Traffic Volume (Intersections)	Approaches (n = 34)	Within ±20% for <100 vph	33	97%	85%	Yes
		Within ±15% for ≥ 100 vph to < 300 vph				
		Within ±10% for ≥ 300 vph to < 1,000 vph				
		Within ±5% for ≥ 1,000 vph				
Simulated Traffic Volume (Freeways)	Segments (n = 125)	Within ±20% for <100 vph	108	86%	85%	Yes
		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	Routes (n = 8)	Within ±20% for average travel time on freeways	8	100%	85%	Yes
Maximum Simulated Queue Length	Approaches (n = 8)	Modeled queues qualitatively reflect the impacts of observed queues				Reasonably Calibrated
Visual Review of Bottleneck Locations	Targeted Critical Locations	Speed heat maps qualitatively reflect patterns and duration of congestions				Reasonably Calibrated

Summary

Based on the results obtained from the VISSIM AM and PM models, and their comparison with field data for all the calibration measures listed in previous sections, therefore the models are reasonably calibrated to the standards and guidelines established by VDOT and, therefore, these models can be used as base model to develop future scenarios.



Attachment A: AM Peak Period Calibration Detailed Summary Tables

- Freeway/Ramp Individual Link Volume Calibration
- Arterial Intersection Volume Calibration
- Travel Time Calibration
- Speed Heat Map Calibration
- Queue Length Calibration

AM Peak Period Calibration Summary

Calibration Item	Basis	Criteria	Total	Percent	Target	Target Met
Simulated Traffic Volume (Intersections)	Approaches (n = 34)	Within ± 20% for <100 vph	32	94%	85%	Yes
		Within ± 15% for ≥ 100 vph to < 300 vph				
		Within ± 10% for ≥ 300 vph to < 1,000 vph				
		Within ± 5% for ≥ 1,000 vph				
Simulated Traffic Volume (Freeways)	Segments (n = 125)	Within ± 20% for <100 vph	122	98%	85%	Yes
		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	Routes (n = 8)	Within ± 20% for average travel time on freeways	7	88%	85%	Yes
Maximum Simulated Queue Length	Approaches (n = 8)	Modeled queues qualitatively reflect the impacts of observed queues				Reasonably Calibrated
Visual Review of Bottleneck Locations	Targeted Critical Locations	Speed heat maps qualitatively reflect patterns and duration of congestions				Reasonably Calibrated

* Deviation from TOSAM Requirements

1. Simulated Average Speed – Speeds are highly variable on the interstate mainline as well as on the local arterial network and residential roadways, and can vary substantially by hour and by day. Simulated average speed was captured as part of the travel time calibration process and the visual review of bottleneck locations against speed heat maps.

2. Simulated Queue Length – Queuing within the study area is notably inconsistent and can oscillate numerous times within the peak periods, or be absent altogether on some days. A qualitative subjective assessment was conducted for queue lengths at targeted locations in addition to the review of freeway mainline congestion/queues against the speed heat maps.

Volume Calibration and MOEs (Freeways)

AM Peak Hour (8:00 AM - 9:00 AM)

		Subtotal	Total	Percent	Target	Target Met
Segments (n = 125)	Within ± 20% for < 100 vph	3	122	98%	85%	Yes
	Within ± 15% for ≥ 100 vph to < 300 vph	11				
	Within ± 10% for ≥ 300 vph to < 1,000 vph	40				
	Within ± 5% for ≥ 1,000 vph	68				

Facility	Segment	Type	Balanced Count (vph)	VISSIM Throughput (vph)	Difference (vph)	Difference (%)
Northbound Route 28	Mainline south of Frying Pan Road	Basic	6,092	6,082	-10	0%
	Mainline south of Frying Pan Road	Diverge	6,092	6,079	-13	0%
	Between off-ramp to Frying Pan Road and on-ramp from Frying Pan Road	Basic	5,007	4,994	-13	0%
	Between on-ramp from Frying Pan Road and off-ramp to Route 267 EB/Dulles Airport	Weave	5,765	5,739	-26	0%
	Between off-ramp to Route 267 EB/Dulles Airport and on-ramp from Route 267 EB	Basic	4,052	4,039	-13	0%
	Between on-ramp from Route 267 EB and off-ramp to Route 267 WB	Weave	4,298	4,256	-42	-1%
	Between off-ramp to Route 267 WB and on-ramp from Route 267 WB	Basic	4,146	4,135	-12	0%
	Between on-ramp from Route 267 WB and off-ramp to Innovation Ave	Weave	5,643	5,538	-105	-2%
	Between off-ramp to Innovation Ave and on-ramp from Innovation Ave	Basic	5,494	5,431	-63	-1%
	Between on-ramp from Innovation Ave and off-ramp to Route 606 EB	Weave	5,553	5,453	-100	-2%
	Between off-ramp to Route 606 EB and on-ramp from Route 606 EB	Basic	5,244	5,192	-52	-1%
	Between on-ramp from Route 606 EB and off-ramp to Route 606 WB	Weave	5,429	5,260	-168	-3%
	Between off-ramp to Route 606 WB and on-ramp from Route 606 WB	Basic	4,609	4,566	-43	-1%
	Between on-ramp from Route 606 WB and off-ramp to Sterling Blvd EB	Weave	5,101	5,040	-61	-1%
	Between off-ramp to Sterling Blvd EB and off-ramp to Sterling Blvd WB	Diverge	4,361	4,259	-102	-2%
Between off-ramp to Sterling Blvd WB and on-ramp from Sterling Blvd	Basic	4,022	3,968	-54	-1%	
Mainline north of Sterling Blvd	Basic	4,347	4,284	-64	-1%	
Southbound Route 28	Mainline north of Sterling Blvd	Basic	7,010	6,965	-44	-1%
	Between off-ramp to Sterling Blvd and on-ramp from Sterling Blvd WB	Basic	6,528	6,433	-96	-1%
	Between on-ramp from Sterling Blvd WB and on-ramp from Sterling Blvd EB	Basic	7,129	7,009	-120	-2%
	Between on-ramp from Sterling Blvd EB and off-ramp to Route 606 WB	Weave	7,265	7,010	-255	-4%
	Between off-ramp to Route 606 WB and on-ramp from Route 606 WB	Basic	6,944	6,756	-188	-3%
	Between on-ramp from Route 606 WB and off-ramp to Route 606 EB	Weave	7,437	7,046	-391	-5%
	Between off-ramp to Route 606 EB and on-ramp from Route 606 EB	Basic	6,833	6,691	-142	-2%
	Between on-ramp from Route 606 EB and off-ramp to Innovation Ave	Weave	7,766	7,538	-228	-3%
	Between off-ramp to Innovation Ave and on-ramp from Innovation Ave	Basic	7,610	7,452	-158	-2%
	Between on-ramp from Innovation Ave and on-ramp from Route 267	Basic	7,761	7,469	-292	-4%
	Between on-ramp from Route 267 and off-ramp to Dulles Airport	Weave	8,931	8,604	-327	-4%
	Between off-ramp to Dulles Airport and off-ramp to Route 267 EB	Diverge	8,308	8,034	-274	-3%
	Between off-ramp to Route 267 EB and on-ramp from Route 267 EB	Basic	6,311	6,194	-117	-2%
	Between on-ramp from Route 267 EB and off-ramp to Frying Pan Road	Weave	6,721	6,587	-135	-2%
	Between off-ramp to Frying Pan Road and on-ramp from Frying Pan Road	Basic	5,460	5,368	-92	-2%
Mainline south of Frying Pan Road	Merge	5,979	5,881	-98	-2%	
Mainline south of Frying Pan Road	Basic	5,979	5,887	-92	-2%	
Eastbound Route 267	Mainline west of Dulles Greenway Toll Plaza	Basic	4,218	4,225	7	0%
	Between Dulles Greenway Toll Plaza and mainline from Route 28/Dulles Airport	Basic	3,099	3,272	172	6%
	Mainline leaving Dulles Airport near Rudder Road	Weave	1,752	1,738	-14	-1%
	Between off-ramp to Rudder Road/Route 267 WB and off-ramp to DAAR EB (west)	Diverge	1,663	1,630	-33	-2%
	Between off-ramp to DAAR EB and on-ramp from Aviation Dr	Basic	734	736	2	0%
	Between on-ramp from Aviation Dr and off-ramp to Route 28 SB	Weave	1,159	1,135	-24	-2%
	Between off-ramp to Route 28 SB and off-ramp to DAAR EB (east)	Diverge	749	699	-50	-7%
	Between off-ramp to DAAR EB (east) and on-ramp from Route 28 SB	Basic	356	347	-9	-2%
	Between on-ramp from Route 28 SB and off-ramp to Route 28 NB	Weave	2,353	2,212	-141	-6%
	Between off-ramp to Route 28 NB and on-ramp from Route 28 NB	Basic	2,107	2,002	-104	-5%
	Between on-ramp from Route 28 NB and DTR Toll Plaza	Basic	3,220	3,114	-106	-3%
	Between DTR Toll Plaza and on-ramp from DAAR EB (west)	Merge	3,220	3,107	-113	-4%
	Between on-ramp from DAAR EB (west) and mainline from Dulles Greenway	Basic	3,349	3,240	-109	-3%
	Mainline between on-ramps from Dulles Greenway & Route 28/Dulles Airport/DAAR and off-ramp to Centreville Road	Weave	6,448	6,387	-61	-1%
	Between off-ramp to Centreville Road and on-ramp from DAAR EB (east)	Basic	5,849	5,903	54	1%
Between on-ramp from DAAR EB (east) and on-ramp from Centreville Road	Merge	5,950	6,006	56	1%	
Mainline east of Centreville Road	Merge	6,885	6,911	25	0%	
Mainline east of Centreville Road	Basic	6,885	6,861	-25	0%	

AM Volume Calibration (Freeways)

Facility	Segment	Type	Balanced Count (vph)	VISSIM Throughput (vph)	Difference (vph)	Difference (%)
Westbound Route 267	Mainline east of off-ramp to DAAR WB	Diverge	3,509	3,461	-48	-1%
	Between off-ramp to DAAR WB and off-ramp to Centreville Road	Basic	3,509	3,503	-6	0%
	Between off-ramp to DAAR WB and off-ramp to Centreville Road	Diverge	3,509	3,480	-29	-1%
	Between off-ramp to Centreville Road and on-ramp from Centreville Road	Basic	2,444	2,433	-11	0%
	Between on-ramp from Centreville Road and off-ramp to Dulles Airport	Weave	2,642	2,622	-21	-1%
	Between off-ramp to Dulles Airport and off-ramp to Route 28 NB	Diverge	2,472	2,430	-43	-2%
	Between off-ramp to Route 28 NB and off-ramp to Route 28 SB	Basic	976	980	4	0%
	Between off-ramp to Route 28 NB and off-ramp to Route 28 SB	Diverge	976	976	0	0%
	Between off-ramp to Route 28 SB and Dulles Greenway Toll Plaza	Basic	477	481	4	1%
Mainline west of Dulles Greenway Toll Plaza	Basic	675	675	0	0%	
Eastbound DAAR	Mainline leaving Dulles Airport near Rudder Road	Basic	494	494	-1	0%
	Between on-ramp from Route 267 EB (west) and on-ramp from Route 267 EB (east)	Merge	1,424	1,432	8	1%
	Between on-ramp from Route 267 EB (east) and off-ramp to Route 267 EB (west)	Merge	1,817	1,831	14	1%
	Between on-ramp from Route 267 EB (east) and off-ramp to Route 267 EB (west)	Diverge	1,817	1,811	-5	0%
	Between off-ramp to Route 267 EB (west) and off-ramp to Route 267 EB (east)	Basic	1,688	1,703	15	1%
	Between off-ramp to Route 267 EB (west) and off-ramp to Route 267 EB (east)	Diverge	1,688	1,656	-32	-2%
Mainline east of Centreville Road	Basic	1,587	1,606	19	1%	
Westbound DAAR	Mainline east of on-ramp from Route 267 WB	Basic	750	752	2	0%
	Between on-ramp from Route 267 WB near Centreville Road and on-ramp from Route 267 WB to Dulles Airport	Merge	750	755	5	1%
	Between on-ramp from Route 267 WB near Centreville Road and on-ramp from Route 267 WB to Dulles Airport	Basic	750	761	11	2%
	Between on-ramp from Route 267 WB to Dulles Airport and off-ramp to Rudder Road (Rental Car Return/Economy Parking)	Weave	920	927	8	1%
	Between off-ramp to Rudder Road (Rental Car Return/Economy Parking) and on-ramps from Route 28/Route 267 EB	Basic	580	589	9	2%
	Mainline west of on-ramps from Route 28/Route 267 EB	Basic	1,646	1,616	-31	-2%

AM Volume Calibration (Freeways)

Facility	Segment	Type	Balanced Count (vph)	VISSIM Throughput (vph)	Difference (vph)	Difference (%)
Frying Pan Road	Route 28 NB to Frying Pan Road EB		1,085	1,078	-7	-1%
	Frying Pan Road WB to Route 28 NB		758	768	10	1%
	Route 28 SB to Frying Pan Road EB		1,261	1,255	-6	0%
	Frying Pan Road WB to Route 28 SB		519	503	-16	-3%
Route 267	Route 28 NB to Route 267 EB/Dulles Airport (Combined)		1,713	1,723	10	1%
	Route 28 NB to Dulles Airport		600	605	5	1%
	Route 28 NB to Route 267 EB		1,114	1,112	-2	0%
	Route 267 EB to Route 28 NB		246	245	-1	0%
	Route 28 NB to Route 267 WB		152	152	0	0%
	Route 267 WB to Route 28 NB		1,497	1,447	-50	-3%
	Route 267 EB to Route 28 SB		672	667	-5	-1%
	Route 267 WB to Route 28 SB		499	494	-4	-1%
	Route 267 EB/WB to Route 28 SB (Combined)		1,170	1,158	-12	-1%
	Route 28 SB to Dulles Airport		622	574	-49	-8%
	Route 28 SB to Route 267 EB		1,997	1,901	-96	-5%
	Route 267 EB to Route 28 SB		410	418	8	2%
Innovation Avenue	Route 28 NB to Innovation Ave EB		149	144	-5	-3%
	Innovation Ave WB to Route 28 NB		59	60	1	1%
	Route 28 SB to Innovation Ave EB		156	143	-13	-8%
	Innovation Ave WB to Route 28 SB		151	149	-1	-1%
Route 606 / Old Ox Road	Route 28 NB to Route 606 EB		310	296	-13	-4%
	Route 606 EB to Route 28 NB		185	191	6	3%
	Route 28 NB to Route 606 WB		820	816	-4	0%
	Route 606 WB to Route 28 NB		492	499	7	1%
	Route 28 SB to Route 606 WB		322	295	-27	-8%
	Route 606 WB to Route 28 SB		494	494	1	0%
	Route 28 SB to Route 606 EB		604	550	-55	-9%
Sterling Blvd	Route 606 EB to Route 28 SB		933	923	-10	-1%
	Route 28 NB to Sterling Blvd EB		740	745	5	1%
	Route 28 NB to Sterling Blvd WB		340	345	5	1%
	Sterling Blvd to Route 28 NB		325	331	6	2%
	Route 28 SB to Sterling Blvd		481	488	7	1%
	Sterling Blvd WB to Route 28 SB		601	606	5	1%
Route 267 / Centreville Road	Sterling Blvd EB to Route 28 SB		137	129	-8	-6%
	Route 267 EB to Centreville Road		600	618	19	3%
	Centreville Road to Route 267 EB		936	910	-26	-3%
	Route 267 WB to Centreville Road		1,065	1,046	-19	-2%
	Centreville Road to Route 267 WB		198	205	7	4%
Various Dulles Airport / DAAR Ramps	Route 267 EB to Dulles Airport		448	450	3	1%
	Route 267 WB to Dulles Airport		170	172	2	1%
	DAAR WB to Rudder Road		340	353	13	4%
	Ramps from Route 267 EB/Route 28 to Rudder Road		603	584	-20	-3%
	Ramps from Route 267 EB/Route 28 to Dulles Airport		1,066	1,046	-20	-2%
	DAAR EB (Outer Lanes) to Rudder Road		89	88	-1	-1%
	Dulles Airport to Route 267 WB		46	45	-1	-2%
	Aviation Blvd to Route 267 EB		425	424	-1	0%
	Route 267 EB to DAAR EB (west)		930	934	5	1%
	Route 267 EB to DAAR EB (east)		393	396	3	1%
	DAAR EB to Route 267 EB (west)		129	134	5	4%
DAAR EB to Route 267 EB (east)		101	101	-1	-1%	

Volume Calibration and MOEs (Intersections)

AM Peak Hour (8:00 AM - 9:00 AM)

	Volume Criteria	Subtotal	Total	Percent	Target	Target Met
Approaches (n = 34)	Within ± 20% for < 100 vph	2	32	94%	85%	Yes
	Within ± 15% for ≥ 100 vph to < 300 vph	4				
	Within ± 10% for ≥ 300 vph to < 1,000 vph	14				
	Within ± 5% for ≥ 1,000 vph	12				

#	Intersection	Approach	Movement	Balanced Count (vph)		VISSIM Throughput (vph)		Difference (vph)		Difference (%)	
1	Route 846 (Sterling Boulevard) and Pacific Boulevard	NB	LT	10	250	10	247	0	-3	0%	-1%
			TH	145		148		3		2%	
			RT	95		89		-6		-6%	
		SB	LT	335	785	334	782	-1	-3	0%	0%
			TH	430		427		-3		-1%	
			RT	20		21		1		5%	
		EB	LT	10	45	10	42	0	-3	0%	-7%
			TH	25		24		-1		-4%	
			RT	10		8		-2		-20%	
		WB	LT	255	830	246	836	-9	6	-4%	1%
			TH	55		53		-2		-4%	
			RT	520		537		17		3%	
Intersection				1,910		1,907		-3		0%	
2	Route 846 (Sterling Boulevard) and Route 28 SB Off-Ramp	SB	LT	300	480	307	487	7	7	2%	1%
			RT	180		180		0		0%	
		EB	TH	320	320	319	319	-1	-1	0%	0%
			WB	TH		650		651		1	
		Intersection				1,450		1,457		7	
3	Route 846 (Sterling Boulevard) and Route 28 NB Ramps	NB	RT	740	740	745	745	5	5	1%	1%
		EB	LT	55	620	54	627	-1	7	-2%	1%
			TH	565		573		8		1%	
		WB	TH	910	1,180	907	1,185	-3	5	0%	0%
			RT	270		278		8		3%	
		Intersection				2,540		2,557		17	
4	Route 846 (Sterling Boulevard) and Shaw Road	NB	LT	100	340	103	341	3	1	3%	0%
			TH	25		24		-1		-4%	
			RT	215		213		-2		-1%	
		SB	LT	20	135	16	131	-4	-4	-20%	-3%
			TH	50		52		2		4%	
			RT	65		63		-2		-3%	
		EB	U	10	1,300	13	1,316	3	16	30%	1%
			LT	75		79		4		5%	
			TH	900		909		9		1%	
			RT	315		315		0		0%	
		WB	LT	205	1,235	205	1,231	0	-4	0%	0%
			TH	1,005		1,003		-2		0%	
			RT	25		23		-2		-8%	
Intersection				3,010		3,019		9		0%	

AM Volume Calibration (Intersections)

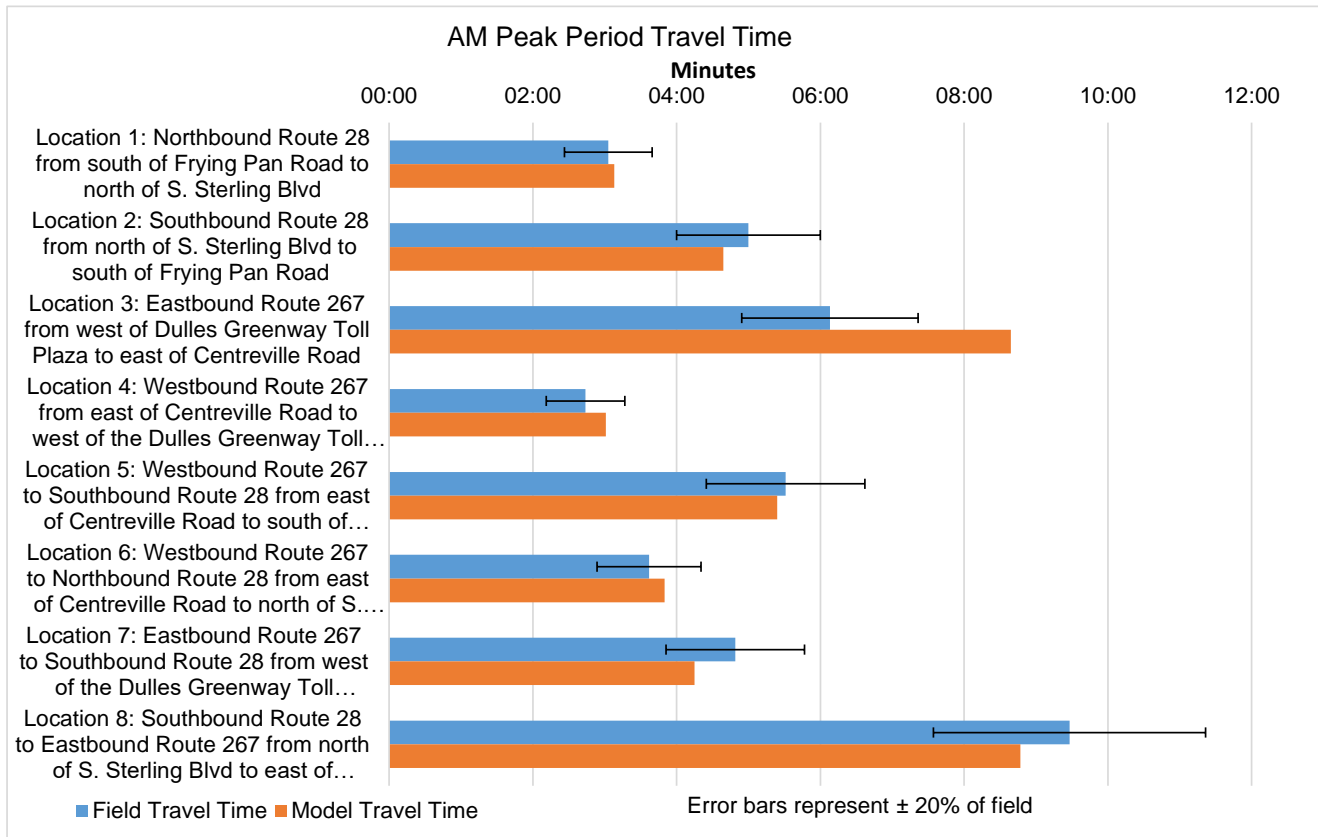
#	Intersection	Approach	Movement	Balanced Count (vph)		VISSIM Throughput (vph)		Difference (vph)		Difference (%)		
5	Route 606 (Old Ox Road) and Pacific Boulevard	NB	LT	75	260	76	260	1	0	1%	0%	
			TH	40		44		4		10%		
			RT	145		139		-6		-4%		
		SB	U	5	560	3	550	-2	-10	-40%	-2%	
			LT	290		287		-3		-1%		
			TH	70		68		-2		-3%		
		EB	RT	195	1,800	192	1,837	-3	37	-2%	2%	
			LT	165		170		5		3%		
			TH	1,530		1,561		31		2%		
		WB	RT	105	1,595	105	1,579	0	-16	0%	-1%	
			U	10		10		0		0%		
			LT	90		89		-1		-1%		
			TH	970		970		0		0%		
		RT	525	510	-15	-3%						
Intersection				4,215		4,226		11		0%		
6	Route 606 (Old Ox Road) and Route 28 NB Off-Ramp	NB	TH	80	80	79	79	-1	-1	-1%	-1%	
			EB	TH	1,465	1,465	1,413	1,413	-52	-52	-4%	-4%
		WB	TH	950	950	955	955	5	5	1%	1%	
		Intersection				2,495		2,447		-48		-2%
		7	Route 606 (Old Ox Road) and Shaw Road	NB	LT	155	240	151	237	-4	-3	-3%
TH	25				27	2		8%				
RT	60				59	-1		-2%				
SB	LT			200	385	203	380	3	-5	2%	-1%	
	TH			25		22		-3		-12%		
	RT			160		155		-5		-3%		
EB	LT			175	1,770	167	1,732	-8	-38	-5%	-2%	
	TH			1,455		1,429		-26		-2%		
	RT			140		134		-6		-4%		
WB	U			10	1,375	10	1,400	0	25	0%	2%	
	LT			25		23		-2		-8%		
	TH			1,125		1,150		25		2%		
	RT			215		217		2		1%		
Intersection				3,770		3,749		-21		-1%		
8	Sunrise Valley Drive and Frying Pan Road	SB	LT	15	685	15	689	0	4	0%	1%	
			RT	670		673		3		0%		
		EB	LT	1,520	2,350	1,518	2,335	-2	-15	0%	-1%	
			TH	830		817		-13		-2%		
		WB	TH	605	670	597	664	-8	-6	-1%	-1%	
			RT	65		67		2		3%		
		Intersection				3,705		3,688		-17		0%
9	Centreville Road and Dulles Toll Road WB Ramps	NB	LT	85	1,270	85	1,276	0	6	0%	0%	
			TH	1,185		1,191		6		1%		
		SB	TH	1,000	1,115	1,005	1,123	5	8	1%	1%	
			RT	115		118		3		3%		
		WB	LT	745	1,065	683	995	-62	-70	-8%	-7%	
			RT	320		311		-9		-3%		
Intersection				3,450		3,394		-56		-2%		
10	Centreville Road and Dulles Toll Road EB Ramps	NB	TH	995	1,700	986	1,687	-9	-13	-1%	-1%	
			RT	705		701		-4		-1%		
		SB	LT	225	1,740	227	1,525	2	-215	1%	-12%	
			TH	1,515		1,298		-217		-14%		
		EB	LT	275	600	294	626	19	26	7%	4%	
			RT	325		332		7		2%		
		Intersection				4,040		3,838		-202		-5%

Travel Time Calibration

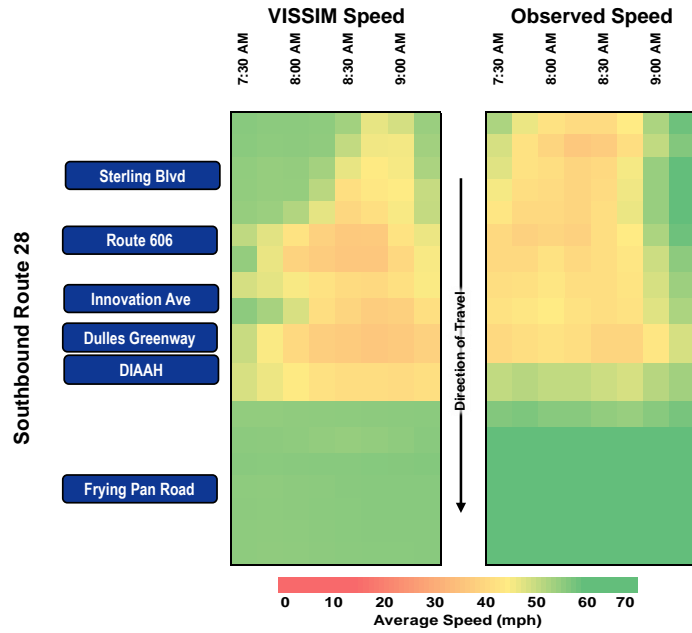
AM Peak Period (7:30 AM - 9:30 AM)

	Travel Time Criteria	Total	Percent	Target	Target Met
Routes (n = 8)	Within ± 20% for average travel time on freeways	7	88%	85%	Yes

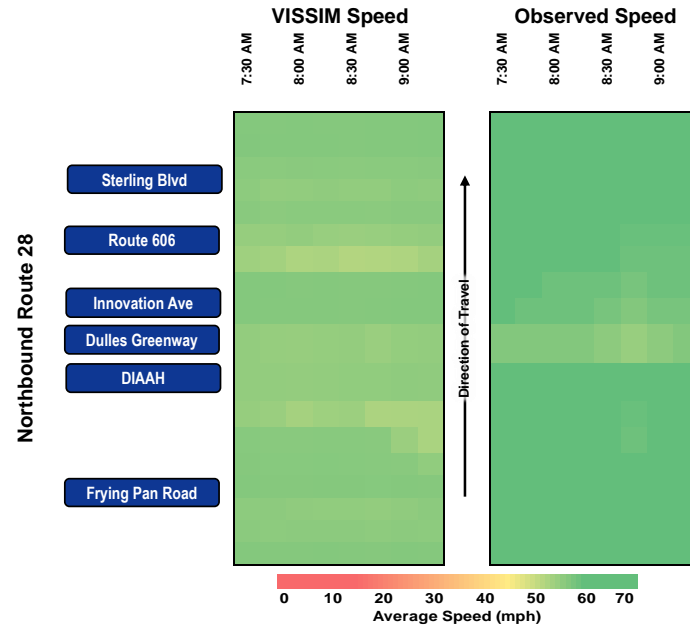
Segment ID	Route	Peak Period Travel Time			
		Field (MM:SS)	VISSIM (MM:SS)	Difference (MM:SS)	Difference (%)
Location 1: Northbound Route 28 from south of Frying Pan Road to north of S. Sterling Blvd		03:03	03:08	00:05	3%
Location 2: Southbound Route 28 from north of S. Sterling Blvd to south of Frying Pan Road		05:00	04:39	-00:21	-7%
Location 3: Eastbound Route 267 from west of Dulles Greenway Toll Plaza to east of Centreville Road		06:08	08:39	02:31	41%
Location 4: Westbound Route 267 from east of Centreville Road to west of the Dulles Greenway Toll Plaza		02:44	03:01	00:17	10%
Location 5: Westbound Route 267 to Southbound Route 28 from east of Centreville Road to south of Frying Pan Road		05:31	05:24	-00:07	-2%
Location 6: Westbound Route 267 to Northbound Route 28 from east of Centreville Road to north of S. Sterling Blvd		03:37	03:50	00:13	6%
Location 7: Eastbound Route 267 to Southbound Route 28 from west of the Dulles Greenway Toll Plaza to south of Frying Pan Road		04:49	04:15	-00:34	-12%
Location 8: Southbound Route 28 to Eastbound Route 267 from north of S. Sterling Blvd to east of Centreville Road		09:28	08:47	-00:41	-7%



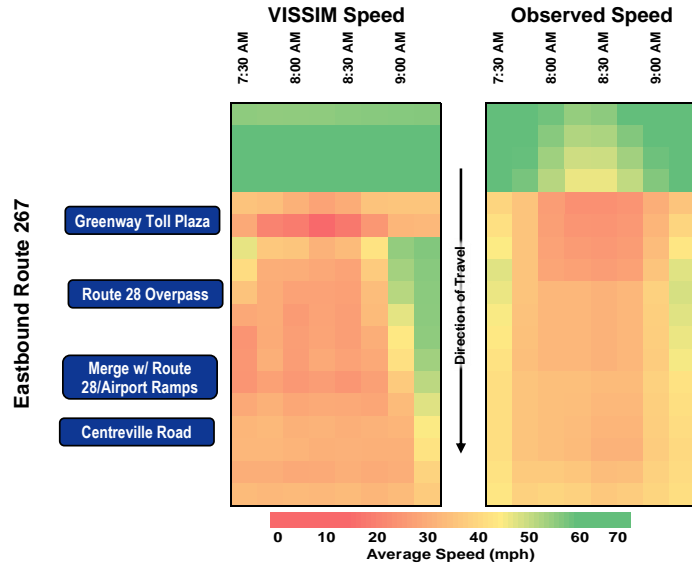
Freeway Average Speed Comparison: Route 28 SB



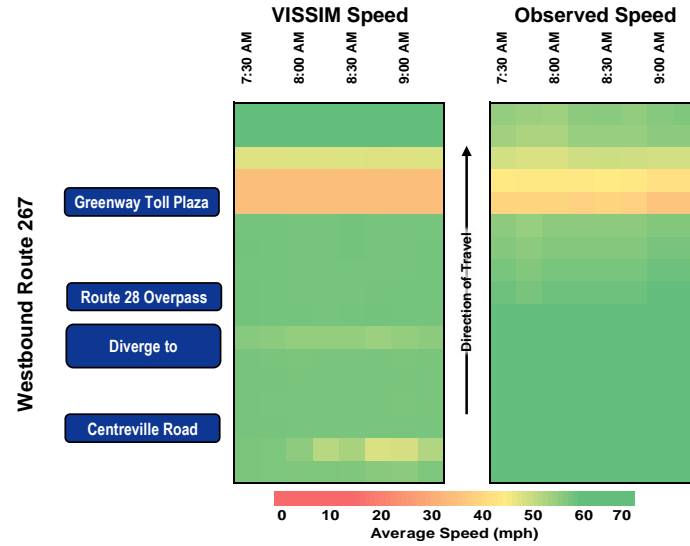
Freeway Average Speed Comparison: Route 28 NB



Freeway Average Speed Comparison: Route 267 (Dulles Toll Road/Dulles Greenway) EB



Freeway Average Speed Comparison: Route 267 (Dulles Toll Road/Dulles Greenway) WB



Queue Length Calibration

AM Peak Period (7:30 AM - 9:30 AM)

	Queue Criteria	Total	Percent	Target	Target Met
Approaches (n = 8)	Modeled queues qualitatively reflect the impacts of observed queues (e.g., spillback from ramp intersections, turn bay, or downstream intersection)	8	100%	85%	Yes

Interchange	Location	Observed Max Queue (feet)	VISSIM Max Queue (feet)	Max Queue Difference (feet)	Max Queue Difference (%)	Field Conditions Represented (Yes/No)	Field-Observed Queue Description	VISSIM Queue Description
Route 28 / Route 267 Interchange	Ramp from Route 267 WB to Route 28 NB	0	0	0	-	Y	No observed queue in AM peak.	
	Ramp from Route 267 EB/WB (Combined) to Route 28 SB	1,000	707	-293	-29%	Y	Queues in field observed to spill back beyond the merge from the 267 EB and 267 WB off-ramps	Queues in VISSIM spill back to the merge of on-ramps from Route 267 EB and Route 267 WB.
	Ramp from Route 28 NB to Route 267 EB	1,800	2,364	564	31%	Y	Queues in field observed to spill back approximately to the ramp from Route 28 NB to Dulles Airport.	Queues in VISSIM spill back to the ramp from Route 28 NB to Dulles Airport, occasionally spilling back to the Route 28 NB mainline.
Route 28 / Frying Pan Road Interchange	Frying Pan Rd EBL approaching Sunrise Valley Dr	1,350	1,359	9	1%	Y	Queues in field observed to approximately spill back to Route 28 off-ramps.	Queues in VISSIM observed to spill back to the Route 28 off-ramps.
	Route 28 SB off-ramp to Frying Pan Road	2,400	3,171	771	32%	Y	Queues in field observed to approximately spill back to Route 28 SB mainline.	Queues in VISSIM spill back to the Route 28 SB mainline, occasionally creating queuing on the Route 28 SB mainline.
	Route 28 NB off-ramp to Frying Pan Road	1,200	1,294	94	8%	Y	Queues in field observed to approximately spill back to Route 28 NB mainline.	Queues in VISSIM spill back to approximately the Route 28 NB mainline.
	Ramp from Frying Pan Road to Route 28 NB	0	63	63	-	Y	No observed queue in AM peak.	
Route 267 / Centreville Road Interchange	Route 267 WB off-ramp to Centreville Rd	1,500	2,700	1,200	80%	Y	Queues in field observed to spill back to almost reach the Route 267 WB mainline.	Queues in VISSIM on the off-ramp spill back to approximately the Route 267 mainline and occasionally create queuing on the mainline itself.



Attachment B: PM Peak Period Calibration Detailed Summary Tables

- Freeway/Ramp Individual Link Volume Calibration
- Arterial Intersection Volume Calibration
- Travel Time Calibration
- Speed Heat Map Calibration
- Queue Length Calibration

PM Peak Period Calibration Summary

Calibration Item	Basis	Criteria	Total	Percent	Target	Target Met
Simulated Traffic Volume (Intersections)	Approaches (n = 34)	Within ± 20% for <100 vph	33	97%	85%	Yes
		Within ± 15% for ≥ 100 vph to < 300 vph				
		Within ± 10% for ≥ 300 vph to < 1,000 vph				
		Within ± 5% for ≥ 1,000 vph				
Simulated Traffic Volume	Segments (n = 125)	Within ± 20% for <100 vph	108	86%	85%	Yes
		Within ± 5% for ≥ 1,000 vph				
Simulated Travel Time	Routes (n = 8)	Within ± 20% for average travel time on freeways	8	100%	85%	Yes
Maximum Simulated Queue Length	Approaches (n = 8)	Modeled queues qualitatively reflect the impacts of observed queues				Reasonably Calibrated
Visual Review of Bottleneck Locations	Targeted Critical Locations	Speed heat maps qualitatively reflect patterns and duration of congestions				Reasonably Calibrated

* Deviation from TOSAM Requirements

1. Simulated Average Speed – Speeds are highly variable on the interstate mainline as well as on the local arterial network and residential roadways, and can vary substantially by hour and by day. Simulated average speed was captured as part of the travel time calibration process and the visual review of bottleneck locations against speed heat maps.

2. Simulated Queue Length – Queuing within the study area is notably inconsistent and can oscillate numerous times within the peak periods, or be absent altogether on some days. A qualitative subjective assessment was conducted for queue lengths at targeted locations in addition to the review of freeway mainline congestion/queues against the speed heat maps.

Volume Calibration and MOEs (Freeways)

PM Peak Hour (5:00 PM - 6:00 PM)

		Subtotal	Total	Percent	Target	Target Met
Segments (n = 125)	Within ± 20% for < 100 vph	7	108	86%	85%	Yes
	Within ± 15% for ≥ 100 vph to < 300 vph	5				
	Within ± 10% for ≥ 300 vph to < 1,000 vph	36				
	Within ± 5% for ≥ 1,000 vph	60				

Facility	Segment	Type	Balanced Count (vph)	VISSIM Throughput (vph)	Difference (vph)	Difference (%)
Northbound Route 28	Mainline south of Frying Pan Road	Basic	4,971	4,888	-83	-2%
	Mainline south of Frying Pan Road	Diverge	4,971	4,877	-95	-2%
	Between off-ramp to Frying Pan Road and on-ramp from Frying Pan Road	Basic	4,426	4,194	-232	-5%
	Between on-ramp from Frying Pan Road and off-ramp to Route 267 EB/Dulles Airport	Weave	5,339	4,987	-353	-7%
	Between off-ramp to Route 267 EB/Dulles Airport and on-ramp from Route 267 EB	Basic	4,324	3,971	-353	-8%
	Between on-ramp from Route 267 EB and off-ramp to Route 267 WB	Weave	5,082	4,691	-391	-8%
	Between off-ramp to Route 267 WB and on-ramp from Route 267 WB	Basic	4,337	4,004	-332	-8%
	Between on-ramp from Route 267 WB and off-ramp to Innovation Ave	Weave	5,875	5,387	-488	-8%
	Between off-ramp to Innovation Ave and on-ramp from Innovation Ave	Basic	5,707	5,225	-482	-8%
	Between on-ramp from Innovation Ave and off-ramp to Route 606 EB	Weave	5,753	5,222	-531	-9%
	Between off-ramp to Route 606 EB and on-ramp from Route 606 EB	Basic	5,422	4,925	-497	-9%
	Between on-ramp from Route 606 EB and off-ramp to Route 606 WB	Weave	5,798	5,173	-625	-11%
	Between off-ramp to Route 606 WB and on-ramp from Route 606 WB	Basic	5,238	4,781	-457	-9%
	Between on-ramp from Route 606 WB and off-ramp to Sterling Blvd EB	Weave	6,029	5,552	-476	-8%
	Between off-ramp to Sterling Blvd EB and off-ramp to Sterling Blvd WB	Diverge	5,457	4,979	-478	-9%
Between off-ramp to Sterling Blvd WB and on-ramp from Sterling Blvd	Basic	5,387	4,978	-409	-8%	
Mainline north of Sterling Blvd	Weave	6,093	5,664	-430	-7%	
Southbound Route 28	Mainline north of Sterling Blvd	Weave	4,528	4,505	-22	0%
	Between off-ramp to Sterling Blvd and on-ramp from Sterling Blvd WB	Basic	4,205	4,212	7	0%
	Between on-ramp from Sterling Blvd WB and on-ramp from Sterling Blvd EB	Basic	4,892	4,906	14	0%
	Between on-ramp from Sterling Blvd EB and off-ramp to Route 606 WB	Weave	5,230	5,186	-44	-1%
	Between off-ramp to Route 606 WB and on-ramp from Route 606 WB	Basic	4,976	4,981	5	0%
	Between on-ramp from Route 606 WB and off-ramp to Route 606 EB	Weave	5,311	5,165	-146	-3%
	Between off-ramp to Route 606 EB and on-ramp from Route 606 EB	Basic	4,790	4,795	5	0%
	Between on-ramp from Route 606 EB and off-ramp to Innovation Ave	Weave	5,645	5,584	-61	-1%
	Between off-ramp to Innovation Ave and on-ramp from Innovation Ave	Basic	5,570	5,551	-19	0%
	Between on-ramp from Innovation Ave and on-ramp from Route 267	Basic	5,667	5,559	-108	-2%
	Between on-ramp from Route 267 and off-ramp to Dulles Airport	Weave	6,650	6,531	-119	-2%
	Between off-ramp to Dulles Airport and off-ramp to Route 267 EB	Diverge	6,332	6,237	-95	-2%
	Between off-ramp to Route 267 EB and on-ramp from Route 267 EB	Basic	4,952	4,916	-36	-1%
	Between on-ramp from Route 267 EB and off-ramp to Frying Pan Road	Weave	5,961	5,913	-48	-1%
	Between off-ramp to Frying Pan Road and on-ramp from Frying Pan Road	Basic	5,066	5,039	-27	-1%
Mainline south of Frying Pan Road	Merge	6,007	5,955	-52	-1%	
Mainline south of Frying Pan Road	Basic	6,007	5,950	-57	-1%	
Eastbound Route 267	Mainline west of Dulles Greenway Toll Plaza	Basic	810	810	0	0%
	Between Dulles Greenway Toll Plaza and mainline from Route 28/Dulles Airport	Basic	641	640	-2	0%
	Mainline leaving Dulles Airport near Rudder Road	Weave	2,434	2,416	-18	-1%
	Between off-ramp to Rudder Road/Route 267 WB and off-ramp to DAAR EB (west)	Diverge	1,917	1,885	-32	-2%
	Between off-ramp to DAAR EB and on-ramp from Aviation Dr	Basic	1,195	1,218	23	2%
	Between on-ramp from Aviation Dr and off-ramp to Route 28 SB	Weave	2,154	2,131	-23	-1%
	Between off-ramp to Route 28 SB and off-ramp to DAAR EB (east)	Diverge	1,145	1,107	-38	-3%
	Between off-ramp to DAAR EB (east) and on-ramp from Route 28 SB	Basic	810	822	12	2%
	Between on-ramp from Route 28 SB and off-ramp to Route 28 NB	Weave	2,189	2,153	-36	-2%
	Between off-ramp to Route 28 NB and on-ramp from Route 28 NB	Basic	1,431	1,433	2	0%
	Between on-ramp from Route 28 NB and DTR Toll Plaza	Basic	2,088	2,034	-55	-3%
	Between DTR Toll Plaza and on-ramp from DAAR EB (west)	Merge	2,088	2,038	-51	-2%
	Between on-ramp from DAAR EB (west) and mainline from Dulles Greenway	Basic	2,501	2,455	-46	-2%
	Mainline between on-ramps from Dulles Greenway & Route 28/Dulles Airport/DAAR and off-ramp to Centreville Road	Weave	3,142	3,034	-108	-3%
	Between off-ramp to Centreville Road and on-ramp from DAAR EB (east)	Basic	2,872	2,835	-37	-1%
	Between on-ramp from DAAR EB (east) and on-ramp from Centreville Road	Merge	2,968	2,934	-34	-1%
	Mainline east of Centreville Road	Merge	3,998	3,936	-62	-2%
Mainline east of Centreville Road	Basic	3,998	3,901	-97	-2%	

PM Volume Calibration (Freeways)

Facility	Segment	Type	Balanced Count (vph)	VISSIM Throughput (vph)	Difference (vph)	Difference (%)
Westbound Route 267	Mainline east of off-ramp to DAAR WB	Diverge	6,479	6,395	-84	-1%
	Between off-ramp to DAAR WB and off-ramp to Centreville Road	Basic	6,479	6,474	-5	0%
	Between off-ramp to DAAR WB and off-ramp to Centreville Road	Diverge	6,479	6,440	-39	-1%
	Between off-ramp to Centreville Road and on-ramp from Centreville Road	Basic	5,560	5,556	-4	0%
	Between on-ramp from Centreville Road and off-ramp to Dulles Airport	Weave	6,190	6,128	-63	-1%
	Between off-ramp to Dulles Airport and off-ramp to Route 28 NB	Diverge	6,071	5,945	-126	-2%
	Between off-ramp to Route 28 NB and off-ramp to Route 28 SB	Basic	4,532	4,452	-80	-2%
	Between off-ramp to Route 28 NB and off-ramp to Route 28 SB	Diverge	4,532	4,431	-101	-2%
	Between off-ramp to Route 28 SB and Dulles Greenway Toll Plaza	Basic	3,638	3,574	-64	-2%
Mainline west of Dulles Greenway Toll Plaza	Basic	4,829	4,700	-129	-3%	
Eastbound DAAR	Mainline leaving Dulles Airport near Rudder Road	Basic	890	892	2	0%
	Between on-ramp from Route 267 EB (west) and on-ramp from Route 267 EB (east)	Merge	1,612	1,608	-3	0%
	Between on-ramp from Route 267 EB (east) and off-ramp to Route 267 EB (west)	Merge	1,947	1,941	-6	0%
	Between on-ramp from Route 267 EB (east) and off-ramp to Route 267 EB (west)	Diverge	1,947	1,920	-27	-1%
	Between off-ramp to Route 267 EB (west) and off-ramp to Route 267 EB (east)	Basic	1,535	1,529	-6	0%
	Between off-ramp to Route 267 EB (west) and off-ramp to Route 267 EB (east)	Diverge	1,535	1,486	-48	-3%
	Mainline east of Centreville Road	Basic	1,439	1,431	-7	-1%
Westbound DAAR	Mainline east of on-ramp from Route 267 WB	Basic	2,304	2,302	-2	0%
	Between on-ramp from Route 267 WB near Centreville Road and on-ramp from Route 267 WB to Dulles Airport	Merge	2,304	2,299	-5	0%
	Between on-ramp from Route 267 WB near Centreville Road and on-ramp from Route 267 WB to Dulles Airport	Basic	2,304	2,287	-17	-1%
	Between on-ramp from Route 267 WB to Dulles Airport and off-ramp to Rudder Road (Rental Car Return/Economy Parking)	Weave	2,424	2,386	-38	-2%
	Between off-ramp to Rudder Road (Rental Car Return/Economy Parking) and on-ramps from Route 28/Route 267 EB	Basic	1,206	1,185	-21	-2%
	Mainline west of on-ramps from Route 28/Route 267 EB	Basic	1,670	1,620	-51	-3%

PM Volume Calibration (Freeways)

Facility	Segment	Type	Balanced Count (vph)	VISSIM Throughput (vph)	Difference (vph)	Difference (%)
Frying Pan Road Interchange	Route 28 NB to Frying Pan Road EB		545	529	-16	-3%
	Frying Pan Road WB to Route 28 NB		913	886	-27	-3%
	Route 28 SB to Frying Pan Road EB		896	898	3	0%
	Frying Pan Road WB to Route 28 SB		942	917	-25	-3%
Route 267 Interchange	Route 28 NB to Route 267 EB/Dulles Airport (Combined)		1,016	934	-82	-8%
	Route 28 NB to Dulles Airport		358	336	-22	-6%
	Route 28 NB to Route 267 EB		657	600	-57	-9%
	Route 267 EB to Route 28 NB		759	763	4	1%
	Route 28 NB to Route 267 WB		745	695	-50	-7%
	Route 267 WB to Route 28 NB		1,539	1,437	-102	-7%
	Route 267 EB to Route 28 SB		90	92	3	3%
	Route 267 WB to Route 28 SB		894	869	-25	-3%
	Route 267 EB/WB to Route 28 SB (Combined)		984	959	-24	-2%
	Route 28 SB to Dulles Airport		318	316	-3	-1%
	Route 28 SB to Route 267 EB		1,380	1,370	-10	-1%
Route 267 EB to Route 28 SB		1,009	1,024	15	2%	
Innovation Avenue Interchange	Route 28 NB to Innovation Ave EB		169	160	-9	-5%
	Innovation Ave WB to Route 28 NB		46	47	1	2%
	Route 28 SB to Innovation Ave EB		74	83	9	12%
	Innovation Ave WB to Route 28 SB		97	95	-1	-1%
Route 606 / Old Ox Road Interchange	Route 28 NB to Route 606 EB		330	301	-29	-9%
	Route 606 EB to Route 28 NB		376	371	-4	-1%
	Route 28 NB to Route 606 WB		560	508	-52	-9%
	Route 606 WB to Route 28 NB		791	799	8	1%
	Route 28 SB to Route 606 WB		254	257	3	1%
	Route 606 WB to Route 28 SB		336	333	-2	-1%
	Route 28 SB to Route 606 EB		521	517	-4	-1%
Sterling Blvd Interchange	Route 606 EB to Route 28 SB		855	839	-15	-2%
	Route 28 NB to Sterling Blvd EB		572	527	-45	-8%
	Route 28 NB to Sterling Blvd WB		70	62	-8	-11%
	Sterling Blvd to Route 28 NB		706	712	6	1%
	Route 28 SB to Sterling Blvd		322	316	-6	-2%
	Sterling Blvd WB to Route 28 SB		687	692	5	1%
Route 267 / Centreville Road Interchange	Sterling Blvd EB to Route 28 SB		338	340	2	0%
	Route 267 EB to Centreville Road		270	264	-6	-2%
	Centreville Road to Route 267 EB		1,030	1,002	-27	-3%
	Route 267 WB to Centreville Road		919	912	-7	-1%
Various Dulles Airport / DAAR Ramps	Centreville Road to Route 267 WB		631	620	-10	-2%
	Route 267 EB to Dulles Airport		79	78	-1	-1%
	Route 267 WB to Dulles Airport		120	116	-4	-3%
	DAAR WB to Rudder Road		1,218	1,207	-11	-1%
	Ramps from Route 267 EB/Route 28 to Rudder Road		291	279	-12	-4%
	Ramps from Route 267 EB/Route 28 to Dulles Airport		465	450	-14	-3%
	DAAR EB (Outer Lanes) to Rudder Road		518	506	-12	-2%
	Dulles Airport to Route 267 WB		445	444	-1	0%
	Aviation Blvd to Route 267 EB		959	959	0	0%
	Route 267 EB to DAAR EB (west)		722	714	-8	-1%
	Route 267 EB to DAAR EB (east)		335	332	-4	-1%
	DAAR EB to Route 267 EB (west)		413	417	5	1%
DAAR EB to Route 267 EB (east)		96	99	3	3%	

Volume Calibration and MOEs (Intersections)

PM Peak Hour (5:00 PM - 6:00 PM)

	Volume Criteria	Subtotal	Total	Percent	Target	Target Met
Approaches (n = 34)	Within ± 20% for < 100 vph	1	33	97%	85%	Yes
	Within ± 15% for ≥ 100 vph to < 300 vph	4				
	Within ± 10% for ≥ 300 vph to < 1,000 vph	14				
	Within ± 5% for ≥ 1,000 vph	14				

#	Intersection	Approach	Movement	Balanced Count (vph)		VISSIM Throughput (vph)		Difference (vph)		Difference (%)		
1	Route 846 (Sterling Boulevard) and Pacific Boulevard	NB	TH	500	860	495	863	-5	3	-1%	0%	
			RT	360		368		8		2%		
		SB	LT	620	815	616	807	-4	-8	-1%	-1%	
			TH	180		179		-1		-1%		
			RT	15		12		-3		-20%		
		EB	LT	10	45	8	48	-2	3	-20%	7%	
			TH	25		29		4		16%		
			RT	10		11		1		10%		
		WB	LT	140	400	136	385	-4	-15	-3%	-4%	
			TH	15		14		-1		-7%		
			RT	245		235		-10		-4%		
		Intersection				2,120		2,103		-17		-1%
		2	Route 846 (Sterling Boulevard) and Route 28 SB Off-Ramp	SB	LT	255	320	249	313	-6	-7	-2%
RT	65				64	-1		-2%				
EB	TH			670	670	671	671	1	1	0%	0%	
	WB			TH	335	335	320	320	-15	-15	-4%	-4%
Intersection				1,325		1,304		-21		-2%		
3	Route 846 (Sterling Boulevard) and Route 28 NB Ramps	NB	RT	570	570	516	516	-54	-54	-9%	-9%	
			EB	LT		235		930		233		920
		WB	TH	695	687	-8	-1%					
			TH	955	948	-7	-1%					
		RT	470	480	10	2%						
		Intersection				2,925		2,864		-61		-2%
4	Route 846 (Sterling Boulevard) and Shaw Road	NB	LT	275	700	270	702	-5	2	-2%	0%	
			TH	60		59		-1		-2%		
			RT	365		373		8		2%		
		SB	LT	20	155	23	156	3	1	15%	1%	
			TH	25		23		-2		-8%		
			RT	110		110		0		0%		
		EB	U	5	1,265	5	1,205	0	-60	0%	-5%	
			LT	65		61		-4		-6%		
			TH	1,080		1,027		-53		-5%		
			RT	115		112		-3		-3%		
		WB	LT	220	1,270	209	1,265	-11	-5	-5%	0%	
			TH	1,035		1,042		7		1%		
			RT	15		13		-2		-13%		
Intersection				3,390		3,328		-62		-2%		

PM Volume Calibration (Intersections)

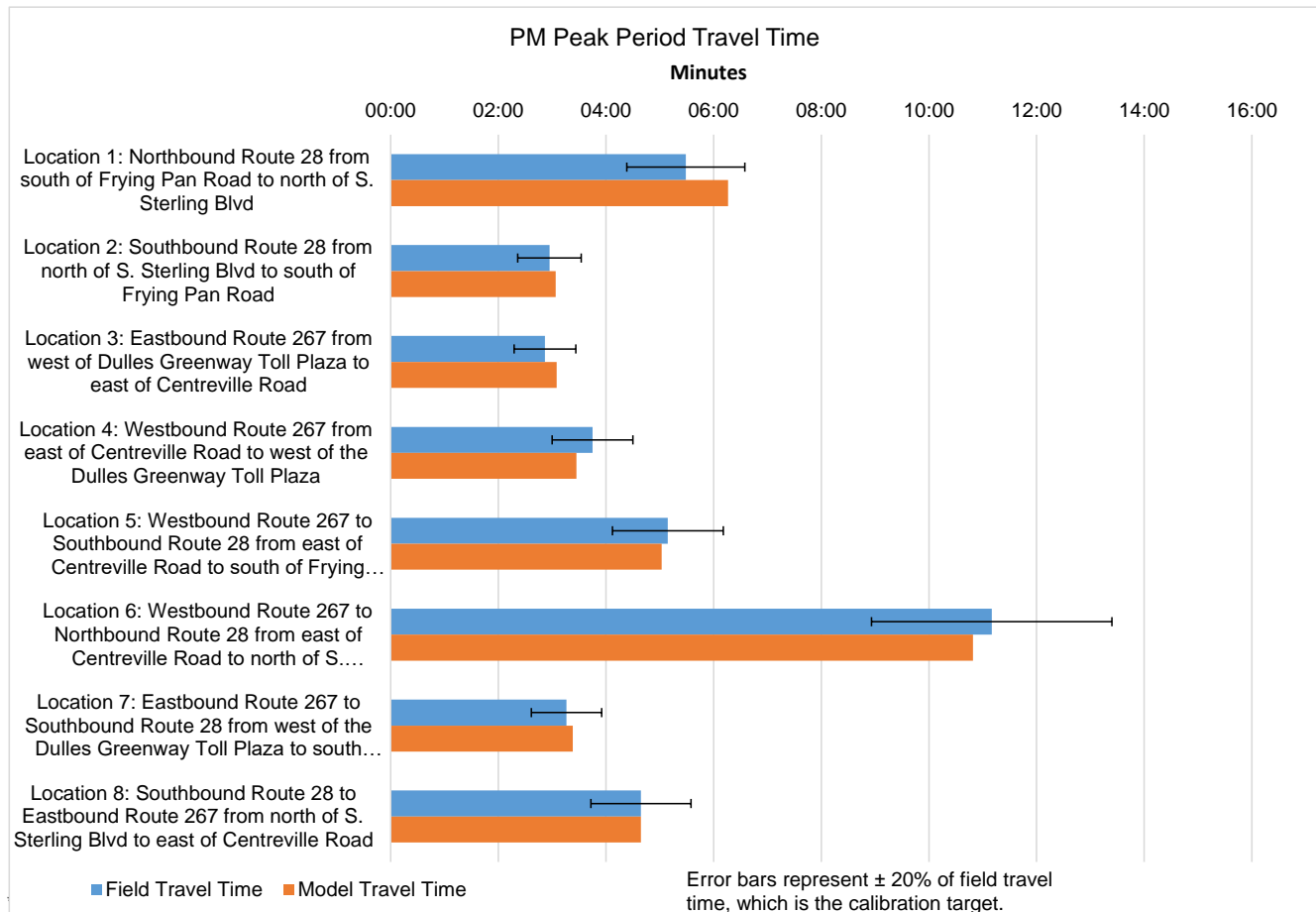
#	Intersection	Approach	Movement	Balanced Count (vph)		VISSIM Throughput (vph)		Difference (vph)		Difference (%)	
5	Route 606 (Old Ox Road) and Pacific Boulevard	NB	LT	45	310	47	305	2	-5	4%	-2%
			TH	50		47		-3		-6%	
			RT	215		211		-4		-2%	
		SB	U	5	805	3	796	-2	-9	-40%	-1%
			LT	500		495		-5		-1%	
			TH	45		44		-1		-2%	
		EB	RT	255	1,520	254	1,519	-1	-1	0%	0%
			LT	220		219		-1		0%	
			TH	1,200		1,197		-3		0%	
		WB	RT	100	1,605	101	1,553	1	-52	1%	-3%
			U	5		4		-1		-20%	
			LT	50		51		1		2%	
			TH	1,245		1,201		-44		-4%	
		Intersection				4,240		4,173		-67	
6	Route 606 (Old Ox Road) and Route 28 NB Off-Ramp	NB	TH	110	110	103	103	-7	-7	-6%	-6%
			EB	TH	1,210	1,210	1,205	1,205	-5	-5	0%
		WB	TH	1,125	1,125	1,133	1,133	8	8	1%	1%
		Intersection				2,445		2,441		-4	
7	Route 606 (Old Ox Road) and Shaw Road	NB	LT	140	230	143	229	3	-1	2%	0%
			TH	45		44		-1		-2%	
			RT	45		42		-3		-7%	
		SB	LT	250	485	248	488	-2	3	-1%	1%
			TH	30		27		-3		-10%	
			RT	205		213		8		4%	
		EB	U	10	1,535	9	1,505	-1	-30	-10%	-2%
			LT	165		155		-10		-6%	
			TH	1,190		1,170		-20		-2%	
		WB	RT	170	1,855	171	1,855	1	0	1%	0%
			U	10		11		1		10%	
			LT	40		34		-6		-15%	
			TH	1,555		1,558		3		0%	
		Intersection				4,105		4,077		-28	
8	Sunrise Valley Drive and Frying Pan Road	SB	LT	35	1,160	35	1,085	0	-75	0%	-6%
			RT	1,125		1,050		-75		-7%	
		EB	U	5	1,440	4	1,441	-1	1	-20%	0%
			LT	705		705		0		0%	
		WB	TH	730	760	732	755	2	-5	0%	-1%
			RT	725		719		-6		-1%	
		Intersection				3,360		3,281		-79	
9	Centreville Road and Dulles Toll Road WB Ramps	NB	LT	355	1,785	335	1,762	-20	-23	-6%	-1%
			TH	1,430		1,427		-3		0%	
		SB	TH	1,325	1,600	1,335	1,611	10	11	1%	1%
			RT	275		276		1		0%	
		WB	LT	525	920	501	885	-24	-35	-5%	-4%
			RT	395		383		-12		-3%	
		Intersection				4,305		4,258		-47	
10	Centreville Road and Dulles Toll Road EB Ramps	NB	TH	1,630	2,410	1,614	2,376	-16	-34	-1%	-1%
			RT	780		762		-18		-2%	
		SB	LT	250	1,845	240	1,834	-10	-11	-4%	-1%
			TH	1,595		1,594		-1		0%	
		EB	LT	155	270	152	258	-3	-12	-2%	-4%
			RT	115		104		-11		-10%	
		Intersection				4,525		4,468		-57	

Travel Time Calibration

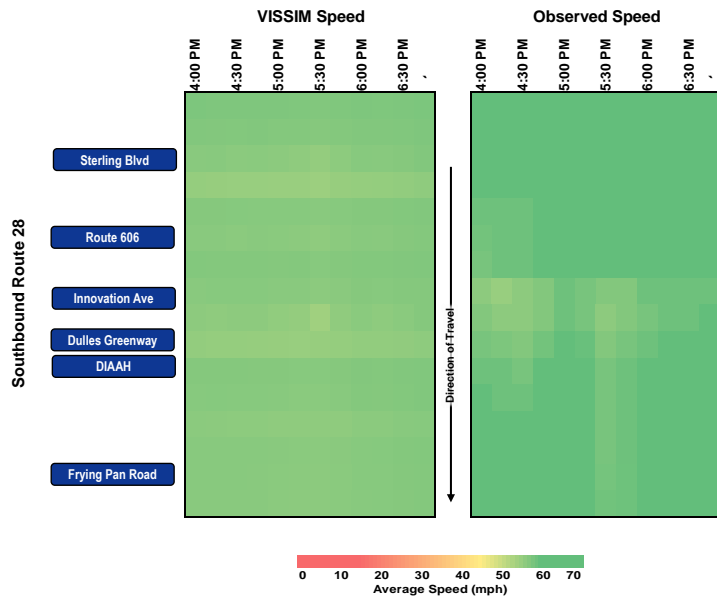
PM Peak Period (4:30 PM - 6:30 PM)*

Routes	Travel Time Criteria	Total	Percent	Target	Target Met
(n = 8)	Within ± 20% for average travel time on freeways	8	100%	85%	Yes

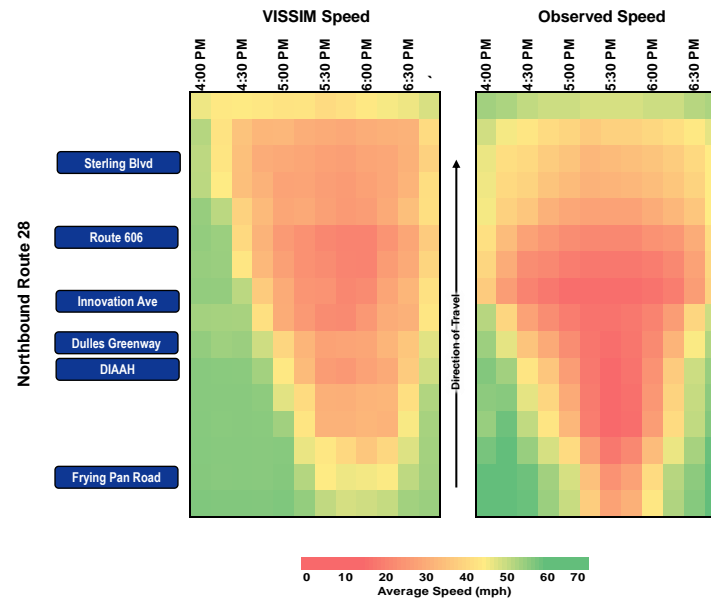
Segment ID	Route	Peak Period Travel Time			
		Field (MM:SS)	VISSIM (MM:SS)	Difference (MM:SS)	Difference (%)
Location 1: Northbound Route 28 from south of Frying Pan Road to north of S. Sterling Blvd		05:29	06:16	00:47	14%
Location 2: Southbound Route 28 from north of S. Sterling Blvd to south of Frying Pan Road		02:57	03:04	00:07	4%
Location 3: Eastbound Route 267 from west of Dulles Greenway Toll Plaza to east of Centreville Road		02:52	03:05	00:13	8%
Location 4: Westbound Route 267 from east of Centreville Road to west of the Dulles Greenway Toll Plaza		03:45	03:27	-00:18	-8%
Location 5: Westbound Route 267 to Southbound Route 28 from east of Centreville Road to south of Frying Pan Road		05:09	05:02	-00:07	-2%
Location 6: Westbound Route 267 to Northbound Route 28 from east of Centreville Road to north of S. Sterling Blvd		11:10	10:49	-00:21	-3%
Location 7: Eastbound Route 267 to Southbound Route 28 from west of the Dulles Greenway Toll Plaza to south of Frying Pan Road		03:16	03:23	00:07	4%
Location 8: Southbound Route 28 to Eastbound Route 267 from north of S. Sterling Blvd to east of Centreville Road		04:39	04:39	00:00	0%



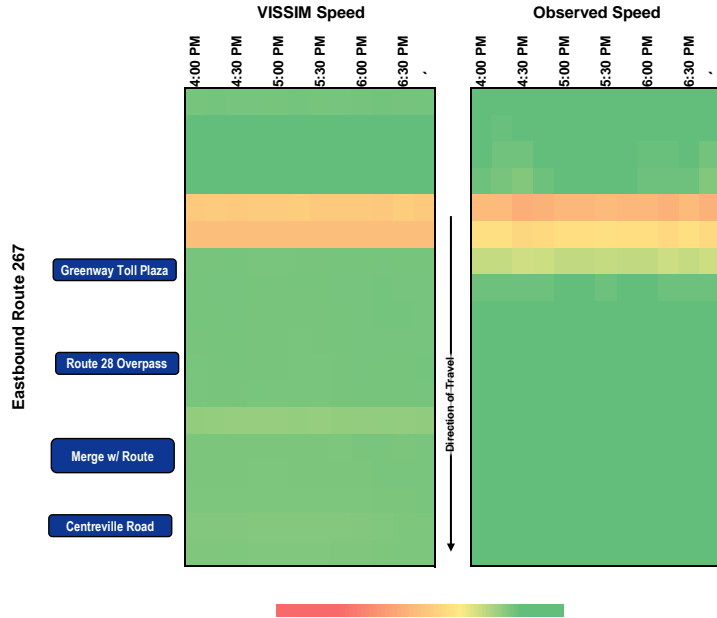
Freeway Average Speed Comparison: Route 28 SB



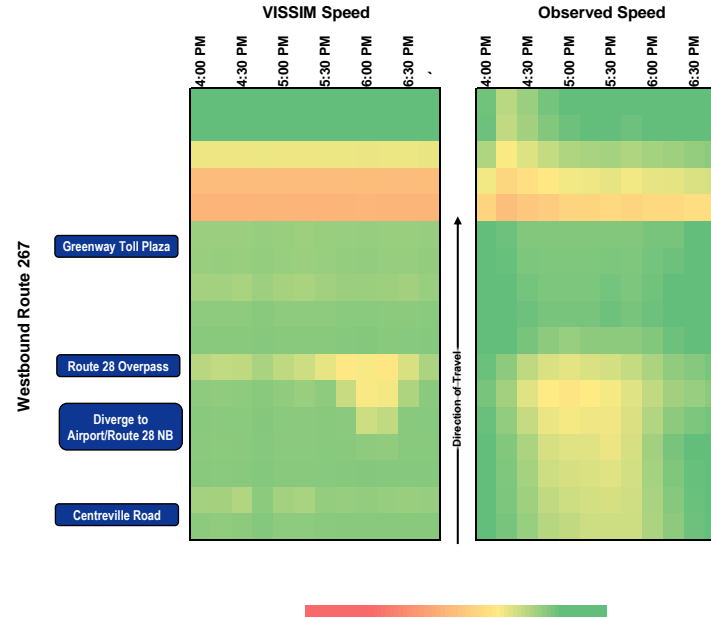
Freeway Average Speed Comparison: Route 28 NB



Freeway Average Speed Comparison: Route 267 (Dulles Toll Road/Dulles Greenway) EB



Freeway Average Speed Comparison: Route 267 (Dulles Toll Road/Dulles Greenway) WB



Queue Length Calibration

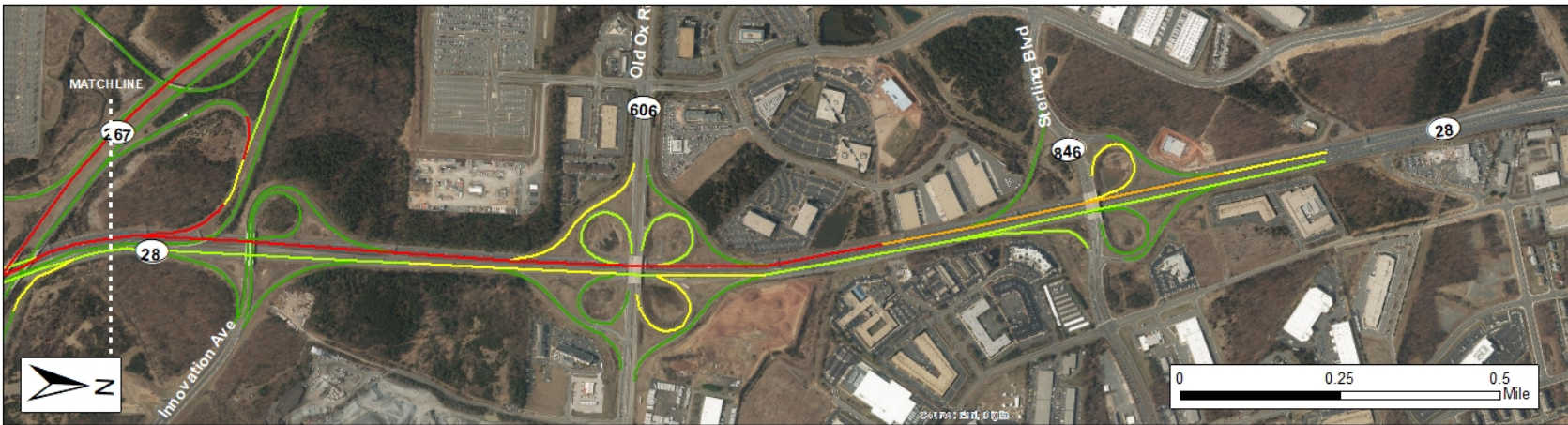
PM Peak Period (4:00 PM - 7:00 PM)

	Queue Criteria	Total	Percent	Target	Target Met
Approaches (n = 8)	Modeled queues qualitatively reflect the impacts of observed queues (e.g., spillback from ramp intersections, turn bay, or downstream intersection)	8	100%	85%	Yes

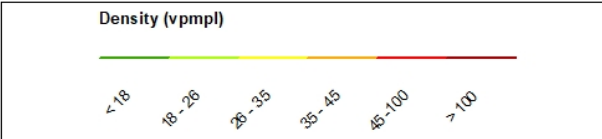
Interchange	Location	Observed Max Queue (feet)	VISSIM Max Queue (feet)	Max Queue Difference (feet)	Max Queue Difference (%)	Field Conditions Represented (Yes/No)	Field-Observed Queue Description	VISSIM Queue Description
Route 28 / Route 267 Interchange	Ramp from Route 267 WB to Route 28 NB	3,000	3,438	438	15%	Y	Queues in field should spill back to Route 267 WB mainline	Queues in VISSIM spill back onto Route 267 westbound mainline for a short distance upstream of the off-ramp gore.
	Ramp from Route 267 EB/WB (Combined) to Route 28 SB	0	0	0	-	Y	No observed queue in PM peak.	
	Ramp from Route 28 NB to Route 267 EB	0	29	29	-	Y	No observed queue in PM peak.	
Route 28 / Frying Pan Road Interchange	Frying Pan Rd EBL approaching Sunrise Valley Dr	350	436	86	25%	Y	Queues in field observed to be contained within EBL turn bay.	Queues in VISSIM contained within EBL turn bays
	Route 28 SB off-ramp to Frying Pan Road	0	0	0	-	Y	No observed queue in PM peak.	
	Route 28 NB off-ramp to Frying Pan Road	0	0	0	-	Y	No observed queue in PM peak.	
	Ramp from Frying Pan Road to Route 28 NB	1,000	999	-1	0%	Y	Queues in field should spill back approximately to Frying Pan mainline.	Queues in VISSIM spill back, occasionally nearly extending half to three-quarters of the length of the on-ramp.
Route 267 / Centreville Road Interchange	Route 267 WB off-ramp to Centreville Rd	1,500	1,526	26	2%	Y	Queues in field observed to spill back to almost reach the Route 267 WB mainline.	Queues in VISSIM on the off-ramp spill back to approximately the Route 267 mainline but do not create queuing on the mainline itself.

APPENDIX E – EXISTING CONDITIONS OPERATIONAL ANALYSIS RESULTS

Existing AM Peak Hour Freeway and Ramp Density – Route 28 Corridor

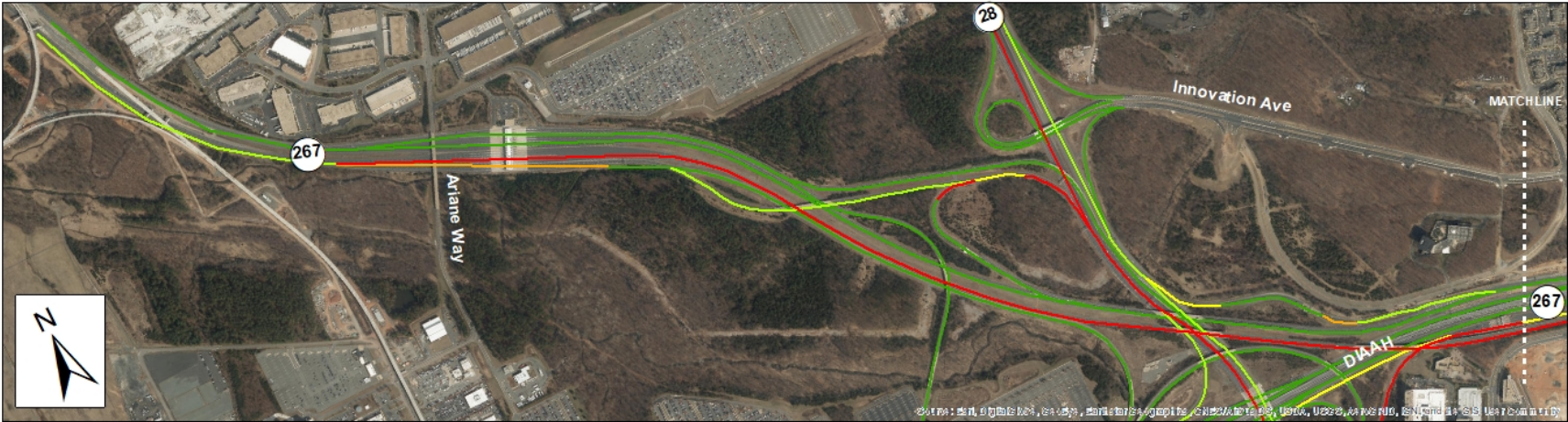


**Route 28 Corridor
Mainline and Ramp Densities
Existing AM Peak Hour**

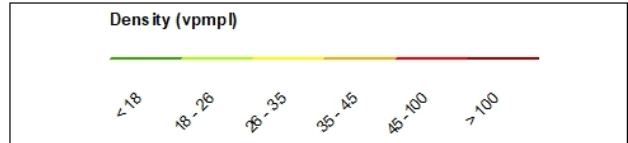


Existing AM Peak Hour Freeway and Ramp Density – Route 267 Corridor

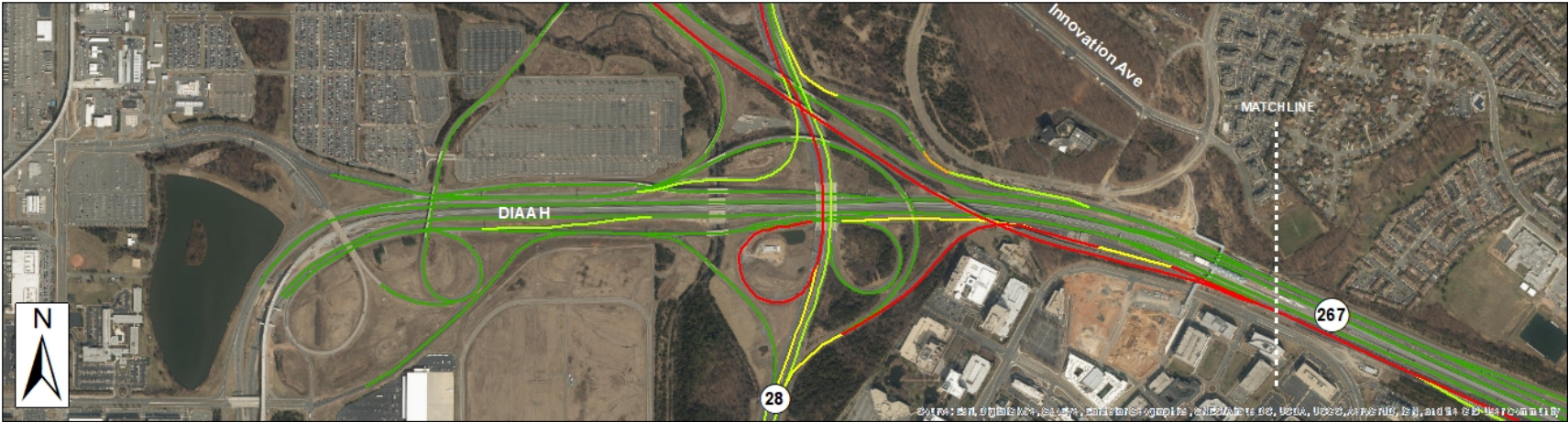
ROUTE 28 AND DULLES TOLL ROAD/DULLES GREENWAY STUDY



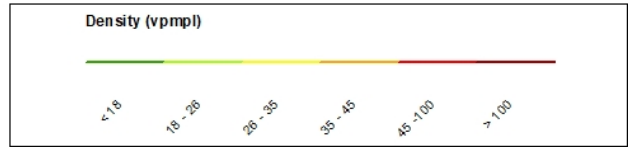
**Route 267 Corridor
Mainline and Ramp Density
Existing AM Peak Hour**



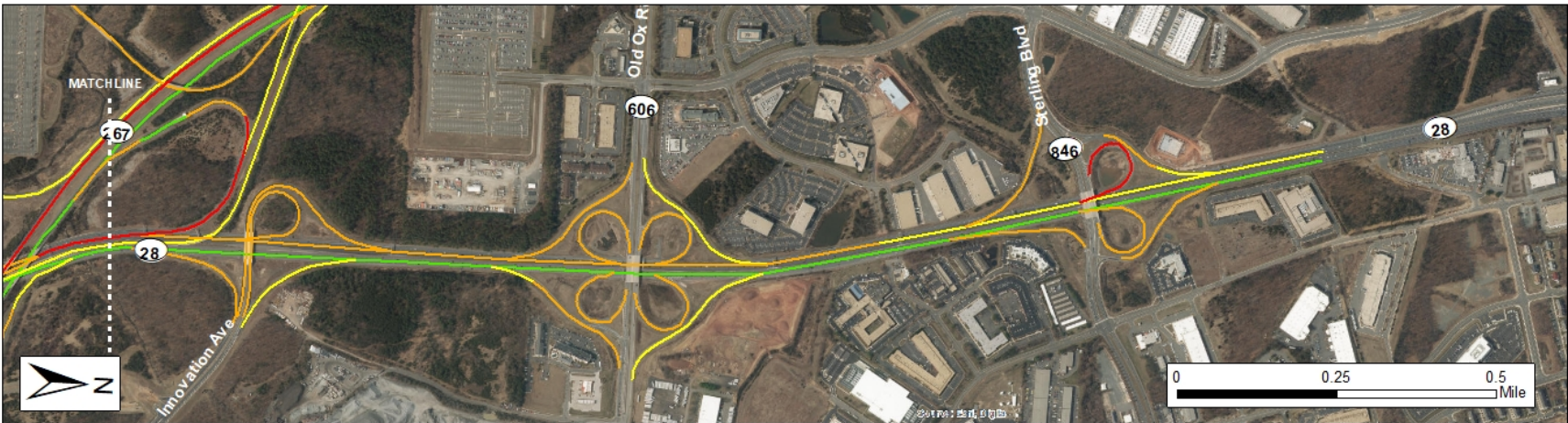
Existing AM Peak Hour Freeway and Ramp Density – DIAAH Corridor



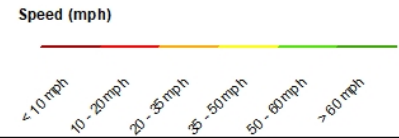
**DIAAH Corridor
Mainline and Ramp Density
Existing AM Peak Hour**



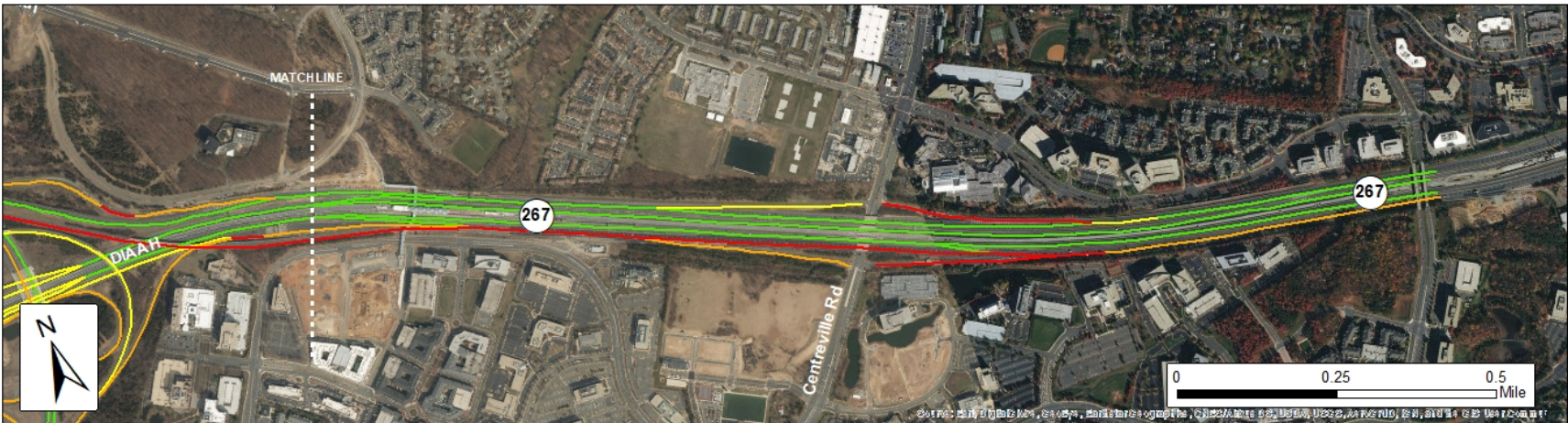
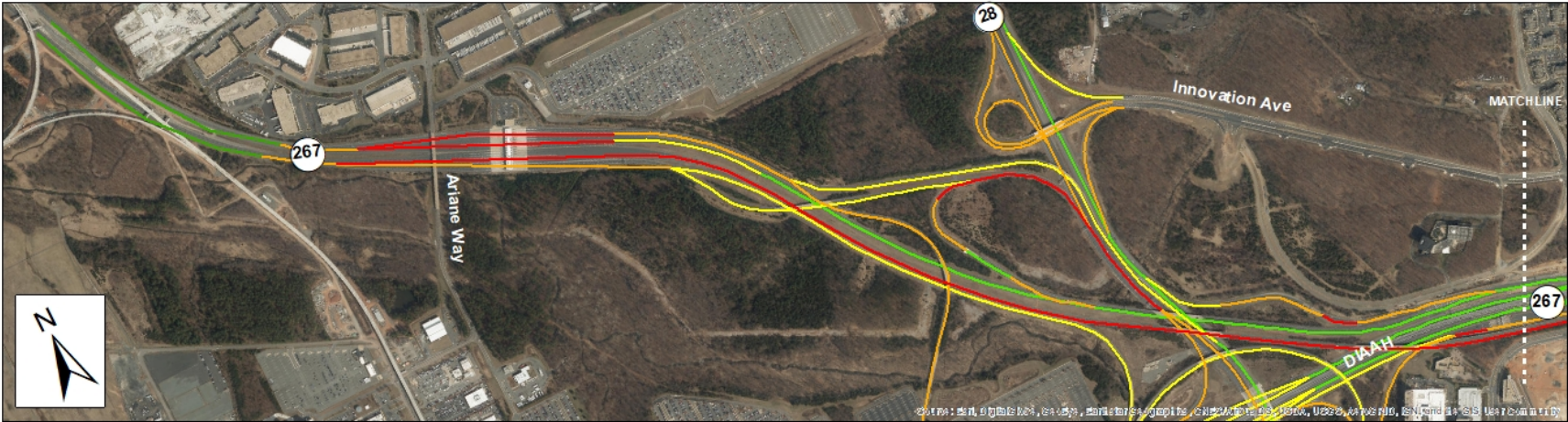
Existing AM Peak Hour Freeway and Ramp Speeds – Route 28 Corridor



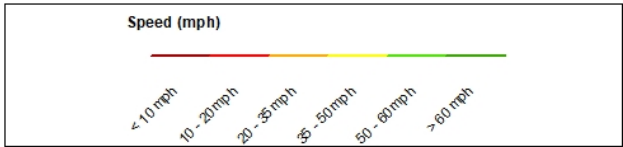
**Route 28 Corridor
Mainline and Ramp Speeds
Existing AM Peak Hour**



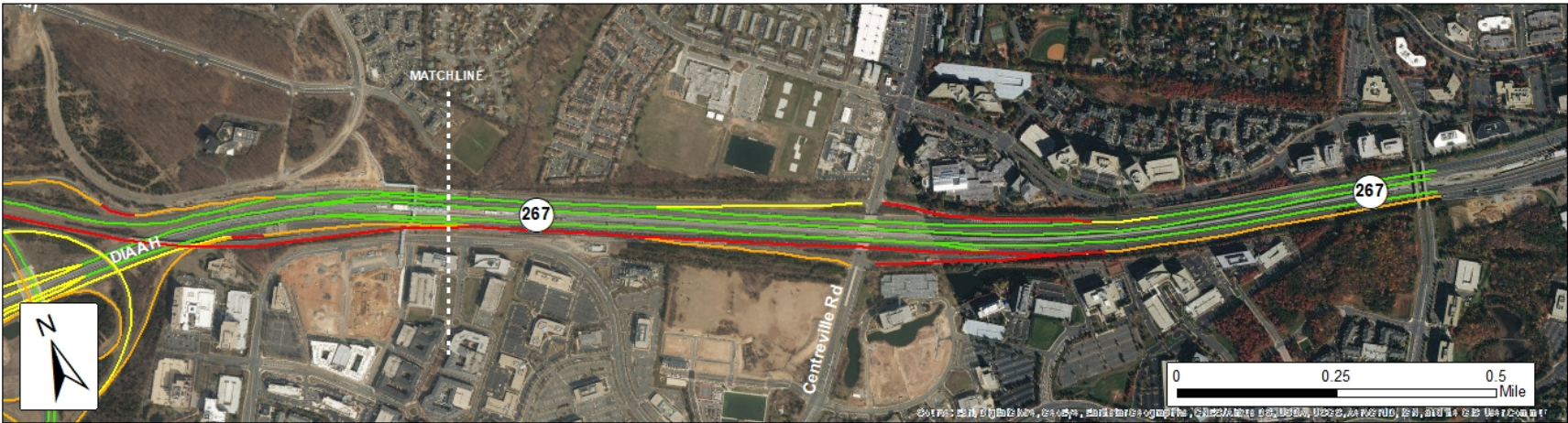
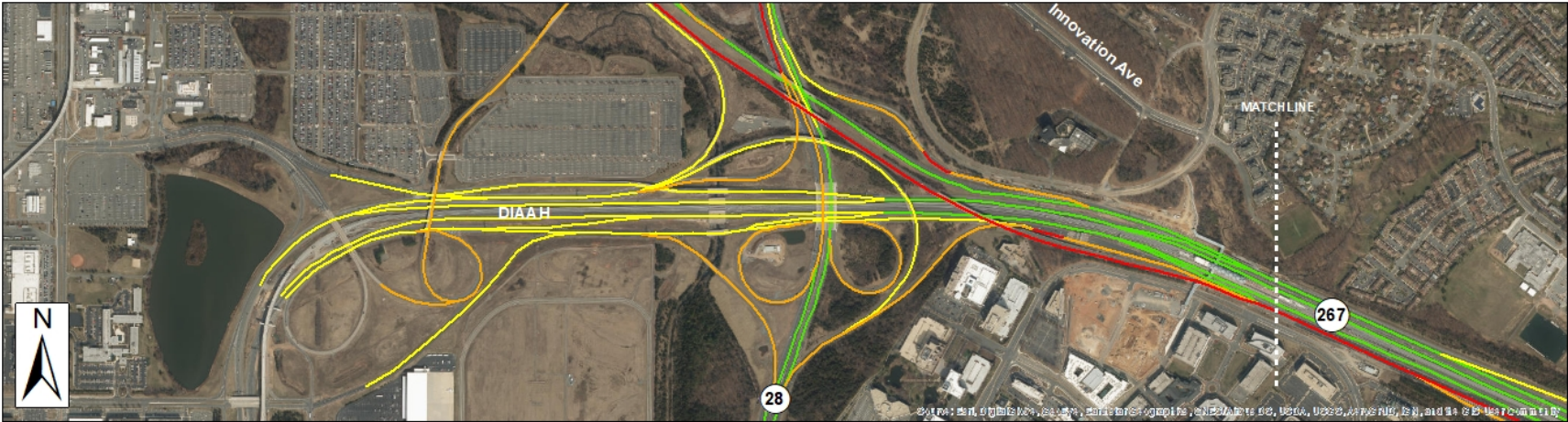
Existing AM Peak Hour Freeway and Ramp Speeds – Route 267 Corridor



**Route 267 Corridor
Mainline and Ramp Speeds
Existing AM Peak Hour**

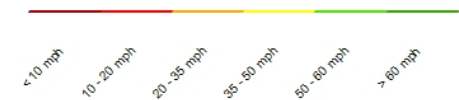


Existing AM Peak Hour Freeway and Ramp Speeds – DIAAH Corridor



**DIAAH Corridor
Mainline and Ramp Speed
Existing AM Peak Hour**

Speed (mph)



Volume Calibration and MOEs (Freeways)

AM Peak Hour (8:00 AM - 9:00 AM)

Facility	Segment	Type	VISSIM Throughput (vph)	Average Speed (mph)	Average Density (vp/ml)
Northbound Route 28	Mainline south of Frying Pan Road	Basic	6,082	56	26.9
	Mainline south of Frying Pan Road	Diverge	6,079	55	24.5
	Between off-ramp to Frying Pan Road and on-ramp from Frying Pan Road	Basic	4,994	56	22.0
	Between on-ramp from Frying Pan Road and off-ramp to Route 267 EB/Dulles Airport	Weave	5,739	55	21.0
	Between off-ramp to Route 267 EB/Dulles Airport and on-ramp from Route 267 EB	Basic	4,039	56	24.0
	Between on-ramp from Route 267 EB and off-ramp to Route 267 WB	Weave	4,256	53	20.2
	Between off-ramp to Route 267 WB and on-ramp from Route 267 WB	Basic	4,135	55	24.9
	Between on-ramp from Route 267 WB and off-ramp to Innovation Ave	Weave	5,538	56	24.7
	Between off-ramp to Innovation Ave and on-ramp from Innovation Ave	Basic	5,431	57	23.8
	Between on-ramp from Innovation Ave and off-ramp to Route 606 EB	Weave	5,453	54	23.9
	Between off-ramp to Route 606 EB and on-ramp from Route 606 EB	Basic	5,192	54	31.9
	Between on-ramp from Route 606 EB and off-ramp to Route 606 WB	Weave	5,260	52	25.2
	Between off-ramp to Route 606 WB and on-ramp from Route 606 WB	Basic	4,566	55	27.3
	Between on-ramp from Route 606 WB and off-ramp to Sterling Blvd EB	Weave	5,040	55	23.1
	Between off-ramp to Sterling Blvd EB and off-ramp to Sterling Blvd WB	Diverge	4,259	56	22.4
Between off-ramp to Sterling Blvd WB and on-ramp from Sterling Blvd	Basic	3,968	56	23.4	
Mainline north of Sterling Blvd	Basic	4,284	57	18.9	
Southbound Route 28	Mainline north of Sterling Blvd	Basic	6,965	48	31.9
	Between off-ramp to Sterling Blvd and on-ramp from Sterling Blvd WB	Basic	6,433	43	44.1
	Between on-ramp from Sterling Blvd WB and on-ramp from Sterling Blvd EB	Basic	7,009	40	43.4
	Between on-ramp from Sterling Blvd EB and off-ramp to Route 606 WB	Weave	7,010	36	46.3
	Between off-ramp to Route 606 WB and on-ramp from Route 606 WB	Basic	6,756	31	62.2
	Between on-ramp from Route 606 WB and off-ramp to Route 606 EB	Weave	7,046	24	68.8
	Between off-ramp to Route 606 EB and on-ramp from Route 606 EB	Basic	6,691	26	71.8
	Between on-ramp from Route 606 EB and off-ramp to Innovation Ave	Weave	7,538	21	76.2
	Between off-ramp to Innovation Ave and on-ramp from Innovation Ave	Basic	7,452	34	54.3
	Between on-ramp from Innovation Ave and on-ramp from Route 267	Basic	7,469	26	60.8
	Between on-ramp from Route 267 and off-ramp to Dulles Airport	Weave	8,604	20	73.1
	Between off-ramp to Dulles Airport and off-ramp to Route 267 EB	Diverge	8,034	27	58.9
	Between off-ramp to Route 267 EB and on-ramp from Route 267 EB	Basic	6,194	55	28.1
	Between on-ramp from Route 267 EB and off-ramp to Frying Pan Road	Weave	6,587	52	25.4
	Between off-ramp to Frying Pan Road and on-ramp from Frying Pan Road	Basic	5,368	56	23.4
Mainline south of Frying Pan Road	Merge	5,881	56	22.5	
Mainline south of Frying Pan Road	Basic	5,887	56	26.3	
Eastbound Route 267	Mainline west of Dulles Greenway Toll Plaza	Basic	4,225	62	22.5
	Between Dulles Greenway Toll Plaza and mainline from Route 28/Dulles Airport	Basic	3,272	17	95.2
	Mainline leaving Dulles Airport near Rudder Road	Weave	1,738	47	9.2
	Between off-ramp to Rudder Road/Route 267 WB and off-ramp to DAAR EB (west)	Diverge	1,630	42	12.9
	Between off-ramp to DAAR EB and on-ramp from Aviation Dr	Basic	736	44	8.1
	Between on-ramp from Aviation Dr and off-ramp to Route 28 SB	Weave	1,135	44	8.6
	Between off-ramp to Route 28 SB and off-ramp to DAAR EB (east)	Diverge	699	44	7.9
	Between off-ramp to DAAR EB (east) and on-ramp from Route 28 SB	Basic	347	45	3.8
	Between on-ramp from Route 28 SB and off-ramp to Route 28 NB	Weave	2,212	43	17.2
	Between off-ramp to Route 28 NB and on-ramp from Route 28 NB	Basic	2,002	36	29.0
	Between on-ramp from Route 28 NB and DTR Toll Plaza	Basic	3,114	22	50.7
	Between DTR Toll Plaza and on-ramp from DAAR EB (west)	Merge	3,107	31	44.6
	Between on-ramp from DAAR EB (west) and mainline from Dulles Greenway	Basic	3,240	26	38.9
	Mainline between on-ramps from Dulles Greenway & Route 28/Dulles Airport/DAAR and off-ramp to Centreville Road	Weave	6,387	17	84.8
	Between off-ramp to Centreville Road and on-ramp from DAAR EB (east)	Basic	5,903	19	77.1
Between on-ramp from DAAR EB (east) and on-ramp from Centreville Road	Merge	6,006	18	63.9	
Mainline east of Centreville Road	Merge	6,911	18	89.1	
Mainline east of Centreville Road	Basic	6,861	26	66.7	

AM Freeway MOEs

Facility	Segment	Type	VISSIM Throughput (vph)	Average Speed (mph)	Average Density (vpmp)
Westbound Route 267	Mainline east of off-ramp to DAAR WB	Diverge	3,461	58	15.0
	Between off-ramp to DAAR WB and off-ramp to Centreville Road	Basic	3,503	57	15.3
	Between off-ramp to DAAR WB and off-ramp to Centreville Road	Diverge	3,480	47	19.0
	Between off-ramp to Centreville Road and on-ramp from Centreville Road	Basic	2,433	58	10.5
	Between on-ramp from Centreville Road and off-ramp to Dulles Airport	Weave	2,622	57	9.1
	Between off-ramp to Dulles Airport and off-ramp to Route 28 NB	Diverge	2,430	52	11.6
	Between off-ramp to Route 28 NB and off-ramp to Route 28 SB	Basic	980	58	5.6
	Between off-ramp to Route 28 NB and off-ramp to Route 28 SB	Diverge	976	58	5.7
Eastbound DAAR	Between off-ramp to Route 28 SB and Dulles Greenway Toll Plaza	Basic	481	56	4.0
	Mainline west of Dulles Greenway Toll Plaza	Basic	675	61	3.7
	Mainline leaving Dulles Airport near Rudder Road	Basic	494	45	5.4
	Between on-ramp from Route 267 EB (west) and on-ramp from Route 267 EB (east)	Merge	1,432	44	13.9
	Between on-ramp from Route 267 EB (east) and off-ramp to Route 267 EB (west)	Merge	1,831	55	12.7
	Between on-ramp from Route 267 EB (east) and off-ramp to Route 267 EB (west)	Diverge	1,811	54	11.1
	Between off-ramp to Route 267 EB (west) and off-ramp to Route 267 EB (east)	Basic	1,703	57	14.9
	Between off-ramp to Route 267 EB (west) and off-ramp to Route 267 EB (east)	Diverge	1,656	56	14.0
Westbound DAAR	Mainline east of Centreville Road	Basic	1,606	56	14.2
	Mainline east of on-ramp from Route 267 WB	Basic	752	58	6.4
	Between on-ramp from Route 267 WB near Centreville Road and on-ramp from Route 267 WB to Dulles Airport	Merge	755	58	6.1
	Between on-ramp from Route 267 WB near Centreville Road and on-ramp from Route 267 WB to Dulles Airport	Basic	761	58	6.6
	Between on-ramp from Route 267 WB to Dulles Airport and off-ramp to Rudder Road (Rental Car Return/Economy Parking)	Weave	927	57	5.4
	Between off-ramp to Rudder Road (Rental Car Return/Economy Parking) and on-ramps from Route 28/Route 267 EB	Basic	589	39	5.8
	Mainline west of on-ramps from Route 28/Route 267 EB	Basic	1,616	44	7.4

AM Freeway MOEs

Facility	Segment	Type	VISSIM Throughput (vph)	Average Speed (mph)	Average Density (vpmp)
Frying Pan Road	Route 28 NB to Frying Pan Road EB		1,078	24	46.6
	Frying Pan Road WB to Route 28 NB		768	39	9.9
	Route 28 SB to Frying Pan Road EB		1,255	16	84.7
	Frying Pan Road WB to Route 28 SB		503	24	20.4
Route 267	Route 28 NB to Route 267 EB/Dulles Airport (Combined)		1,723	32	31.9
	Route 28 NB to Dulles Airport		605	40	7.6
	Route 28 NB to Route 267 EB		1,112	23	59.6
	Route 267 EB to Route 28 NB		245	25	9.6
	Route 28 NB to Route 267 WB		152	39	3.8
	Route 267 WB to Route 28 NB		1,447	42	33.4
	Route 267 EB to Route 28 SB		667	36	18.2
	Route 267 WB to Route 28 SB		494	23	20.9
	Route 267 EB/WB to Route 28 SB (Combined)		1,158	19	61.9
	Route 28 SB to Dulles Airport		574	22	25.3
	Route 28 SB to Route 267 EB		1,901	23	81.9
	Route 267 EB to Route 28 SB		418	26	15.8
Innovation Avenue	Route 28 NB to Innovation Ave EB		144	33	4.3
	Innovation Ave WB to Route 28 NB		60	36	1.6
	Route 28 SB to Innovation Ave EB		143	29	4.9
	Innovation Ave WB to Route 28 SB		149	25	6.0
Route 606 / Old Ox Road	Route 28 NB to Route 606 EB		296	46	6.4
	Route 606 EB to Route 28 NB		191	26	7.3
	Route 28 NB to Route 606 WB		816	25	31.8
	Route 606 WB to Route 28 NB		499	36	13.9
	Route 28 SB to Route 606 WB		295	36	8.1
	Route 606 WB to Route 28 SB		494	21	23.7
	Route 28 SB to Route 606 EB		550	24	22.8
	Route 606 EB to Route 28 SB		923	32	28.7
Sterling Blvd	Route 28 NB to Sterling Blvd EB		745	31	23.7
	Route 28 NB to Sterling Blvd WB		345	21	16.0
	Sterling Blvd to Route 28 NB		331	31	10.4
	Route 28 SB to Sterling Blvd		488	47	10.1
	Sterling Blvd WB to Route 28 SB		606	20	30.6
	Sterling Blvd EB to Route 28 SB		129	32	4.0
Route 267 / Centreville Road	Route 267 EB to Centreville Road		618	27	23.1
	Centreville Road to Route 267 EB		910	15	65.5
	Route 267 WB to Centreville Road		1,046	11	98.1
	Centreville Road to Route 267 WB		205	50	4.1
Various Dulles Airport / DAAR Ramps	Route 267 EB to Dulles Airport		450	46	9.7
	Route 267 WB to Dulles Airport		172	57	3.0
	DAAR WB to Rudder Road		353	40	4.4
	Ramps from Route 267 EB/Route 28 to Rudder Road		584	38	14.8
	Ramps from Route 267 EB/Route 28 to Dulles Airport		1,046	39	13.2
	DAAR EB (Outer Lanes) to Rudder Road		88	27	3.2
	Dulles Airport to Route 267 WB		45	34	1.3
	Aviation Blvd to Route 267 EB		424	45	9.4
	Route 267 EB to DAAR EB (west)		934	43	21.4
	Route 267 EB to DAAR EB (east)		396	44	8.9
	DAAR EB to Route 267 EB (west)		134	56	2.4
DAAR EB to Route 267 EB (east)		101	55	1.8	

Volume Calibration and MOEs (Intersections)

AM Peak Hour (8:00 AM - 9:00 AM)

#	Intersection	Approach	Movement	VISSIM Throughput (vph)		Average Delay (sec/veh)		Average Queue Length (feet)		Max Queue Length (feet)			
1	Route 846 (Sterling Boulevard) and Pacific Boulevard	NB	LT	10	247	40.6	20.6	2	15	40	98		
			TH	148		28.0		15		98			
			RT	89		6.0		4		86			
		SB	LT	334	782	35.4	24.9	42	42	189	215		
			TH	427		17.6		24		215			
			RT	21		4.7		1		68			
		EB	LT	10	42	45.8	42.2	9	9	97	132		
			TH	24		47.5		9		97			
			RT	8		21.7		6		132			
		WB	LT	246	836	24.6	16.9	23	35	142	365		
			TH	53		25.7		7		94			
			RT	537		12.5		35		365			
		Intersection				1,907		21.2					
2	Route 846 (Sterling Boulevard) and Route 28 SB Off-Ramp	SB	LT	307	487	28.3	21.2	25	25	143	143		
			RT	180		9.0		0		0			
		EB	TH	319	319	6.1	6.1	5	5	126	126		
			TH	651		6.9		10		137			
		Intersection				1,457		11.5					
3	Route 846 (Sterling Boulevard) and Route 28 NB Ramps	NB	RT	745	745	6.1	6.1	0	0	0	0		
			RT	54		17.9		5		91			
		EB	TH	573	627	0.5	2.0	0	5	0	91		
			TH	907		2.8		6		204			
		WB	RT	278	1,185	3.1	2.9	0	6	98	204		
			RT	278		3.1		0		98			
Intersection				2,557		3.6							
4	Route 846 (Sterling Boulevard) and Shaw Road	NB	LT	103	341	57.9	28.6	35	35	201	201		
			TH	24		64.2		8		77			
			RT	213		10.3		12		134			
		SB	LT	16	131	63.3	10.8	6	6	62	85		
			TH	52		0.3		0		0			
			RT	63		6.2		3		85			
		EB	U	13	1,316	15.0	12.6	3	46	72	391		
			TH	79		16.3		3		72			
			TH	909		14.9		46		391			
		WB	RT	315	1,231	4.8	11.5	4	44	133	410		
			LT	205		14.5		10		288			
			TH	1,003		10.9		35		378			
		Intersection				3,019		13.9					
		5	Route 606 (Old Ox Road) and Pacific Boulevard	NB	LT	76	260	68.9	42.6	40	40	167	167
					TH	44		71.7		40		167	
RT	139				18.8	13		159					
SB	U			3	550	64.7	46.5	86	86	311	311		
	LT			287		66.0		86		311			
	TH			68		67.1		86		311			
EB	RT			192	1,837	9.9	38.0	14	238	177	1,203		
	LT			170		86.6		196		1,185			
	TH			1,561		34.4		238		1,203			
WB	RT			105	1,579	13.4	33.9	2	125	76	603		
	U			10		76.0		29		118			
	LT			89		78.2		29		118			
Intersection				4,226		37.9							
6	Route 606 (Old Ox Road) and Route 28 NB Off-Ramp	NB	TH	79	79	39.0	39.0	16	16	136	136		
			TH	1,413		11.8		21		387			
		WB	TH	955	955	1.4	1.4	0	0	0	0		
			TH	955		1.4		0		0			
Intersection				2,447		8.6							

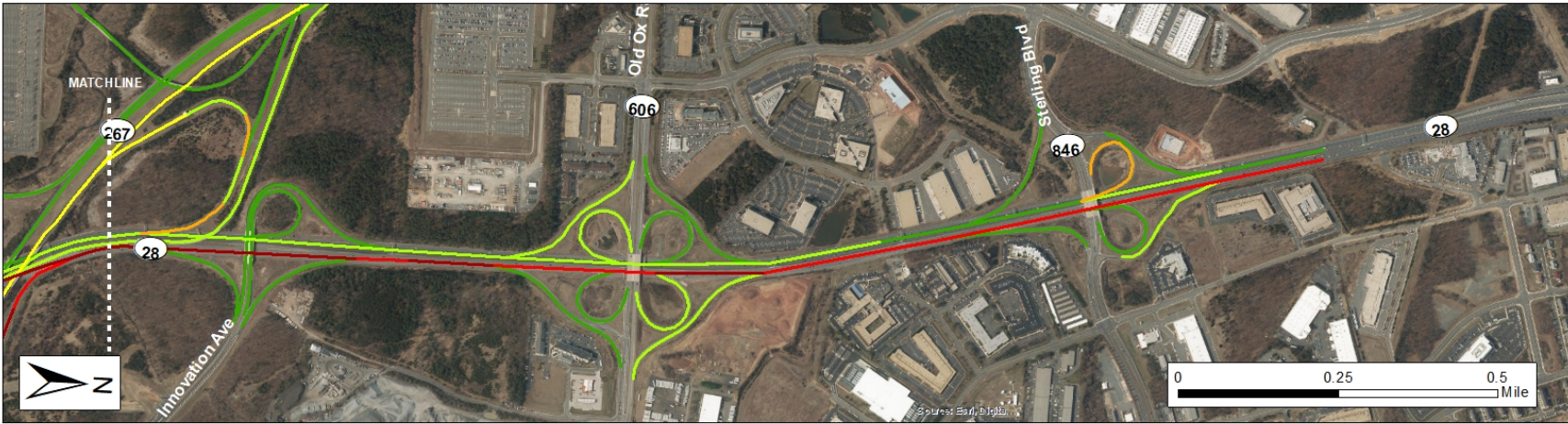
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AM Intersection MOEs

#	Intersection	Approach	Movement	VISSIM Throughput (vph)		Average Delay (sec/veh)		Average Queue Length (feet)		Max Queue Length (feet)		
7	Route 606 (Old Ox Road) and Shaw Road	NB	LT	151	237	68.5	54.9	59	59	247	247	
			TH	27		69.4		59		247		
			RT	59		13.5		3		72		
		SB	LT	203	380	66.3	44.3	55	55	275	275	
			TH	22		67.9		55		275		
			RT	155		12.1		13		137		
		EB	LT	167	1,732	71.4	27.4	74	123	308	614	
			TH	1,429		23.7		123		614		
			RT	134		11.0		4		127		
		WB	U	10	1,400	106.5	30.1	18	134	191	646	
			LT	23		110.1		18		191		
			TH	1,150		33.0		134		646		
			RT	217		2.8		0		28		
		Intersection				3,749		31.8				
8	Sunrise Valley Drive and Frying Pan Road	SB	LT	15	689	73.5	6.4	6	6	60	60	
			RT	673		4.8		0		0		
		EB	LT	1,518	2,335	109.2	99.4	1,784	1,784	4,258	4,258	
			TH	817		81.1		2		184		
		WB	TH	597	664	152.7	147.4	957	957	1,566	1,566	
			RT	67		100.6		0		0		
		Intersection				3,688		90.6				
		9	Centreville Road and Dulles Toll Road WB Ramps	NB	LT	85	1,276	27.7	12.3	12	33	278
TH	1,191				11.2	33		348				
SB	TH			1,005	1,123	20.7	19.3	69	69	444	444	
	RT			118		7.5		3		155		
WB	LT			683	995	149.6	136.1	1,032	1,032	2,526	2,526	
	RT			311		106.6		1,013		2,506		
Intersection				3,394		50.9						
10	Centreville Road and Dulles Toll Road EB Ramps	NB	TH	986	1,687	19.7	22.8	48	106	375	590	
			RT	701		27.1		106		590		
		SB	LT	227	1,525	59.3	16.7	69	69	479	500	
			TH	1,298		9.3		45		500		
		EB	LT	294	626	147.4	115.1	127	127	701	701	
			RT	332		86.4		0		106		
		Intersection				3,838		35.4				

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Existing PM Peak Hour Freeway and Ramp Density – Route 28 Corridor

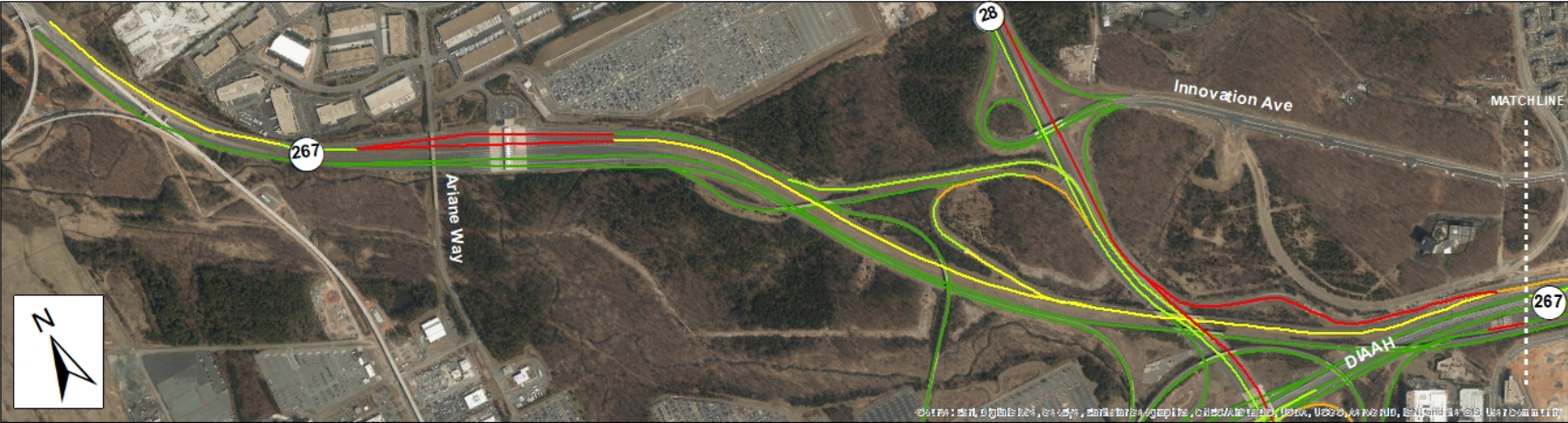


**Route 28 Corridor
Mainline and Ramp Densities
Existing PM Peak Hour**

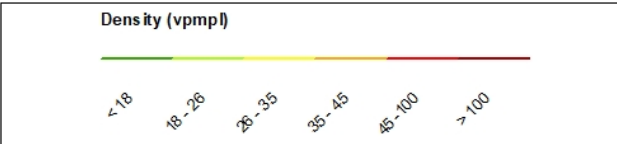
Density (vp/ml)



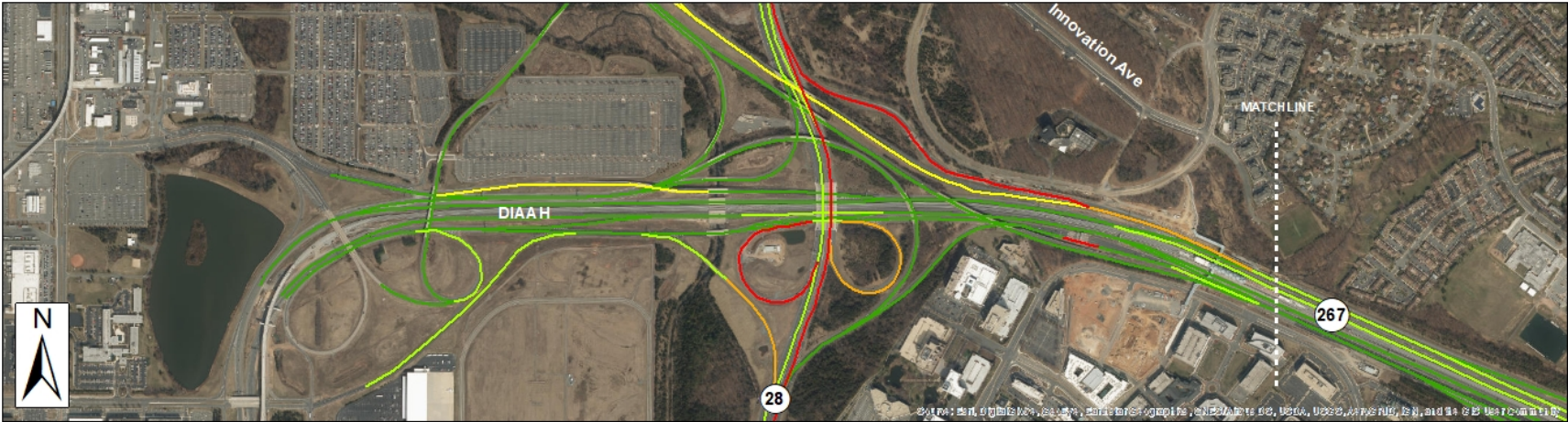
Existing PM Peak Hour Freeway and Ramp Density – Route 267 Corridor



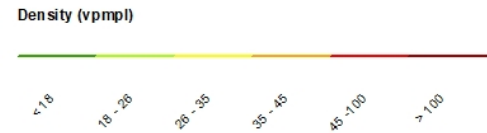
**Route 267 Corridor
Mainline and Ramp Density
Existing PM Peak Hour**



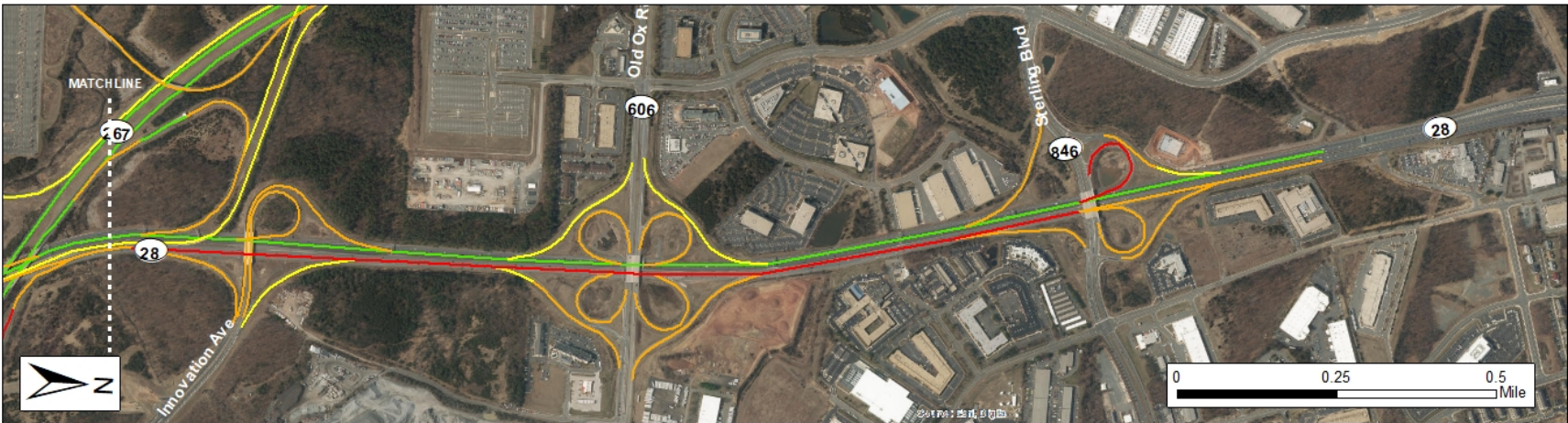
Existing PM Peak Hour Freeway and Ramp Density – DIAAH Corridor



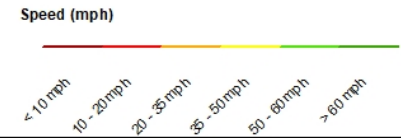
**DIAAH Corridor
Mainline and Ramp Density
Existing PM Peak Hour**



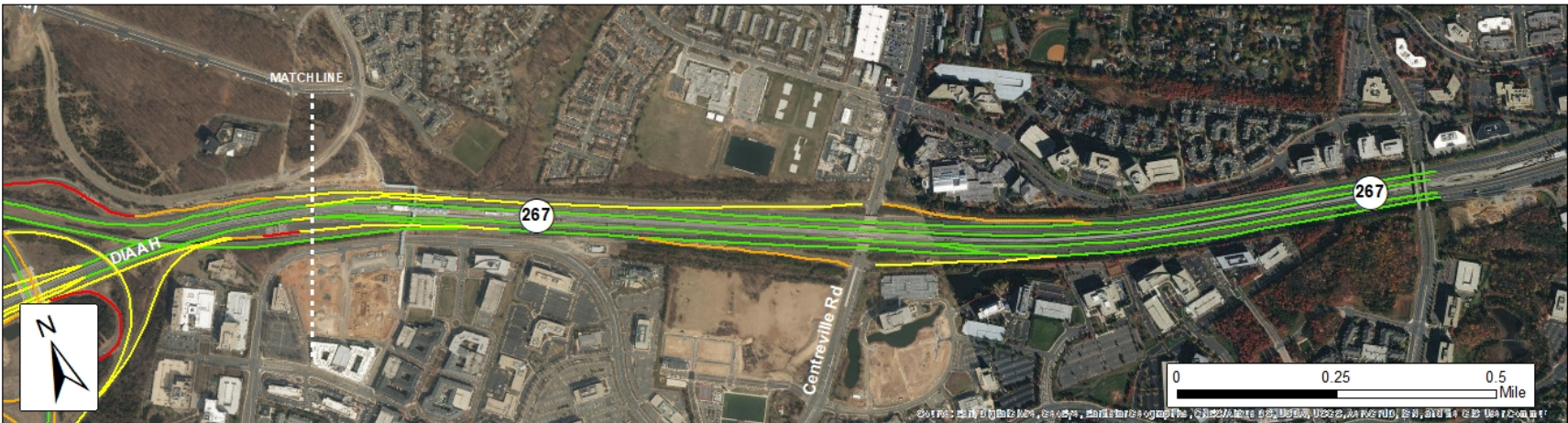
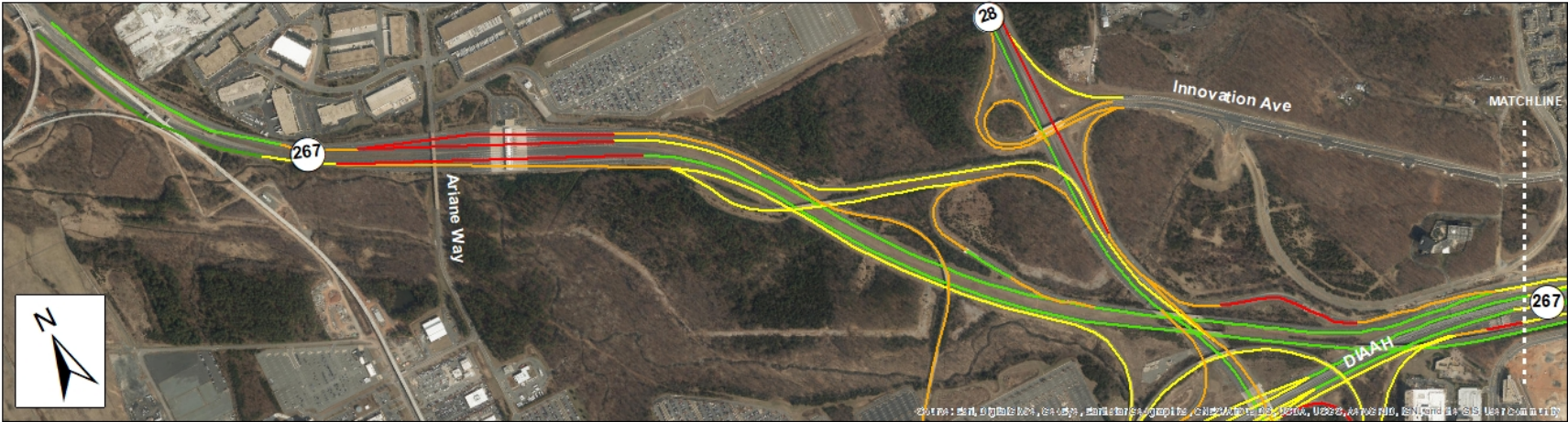
Existing PM Peak Hour Freeway and Ramp Speeds – Route 28 Corridor



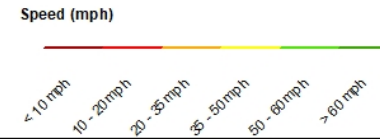
**Route 28 Corridor
Mainline and Ramp Speeds
Existing PM Peak Hour**



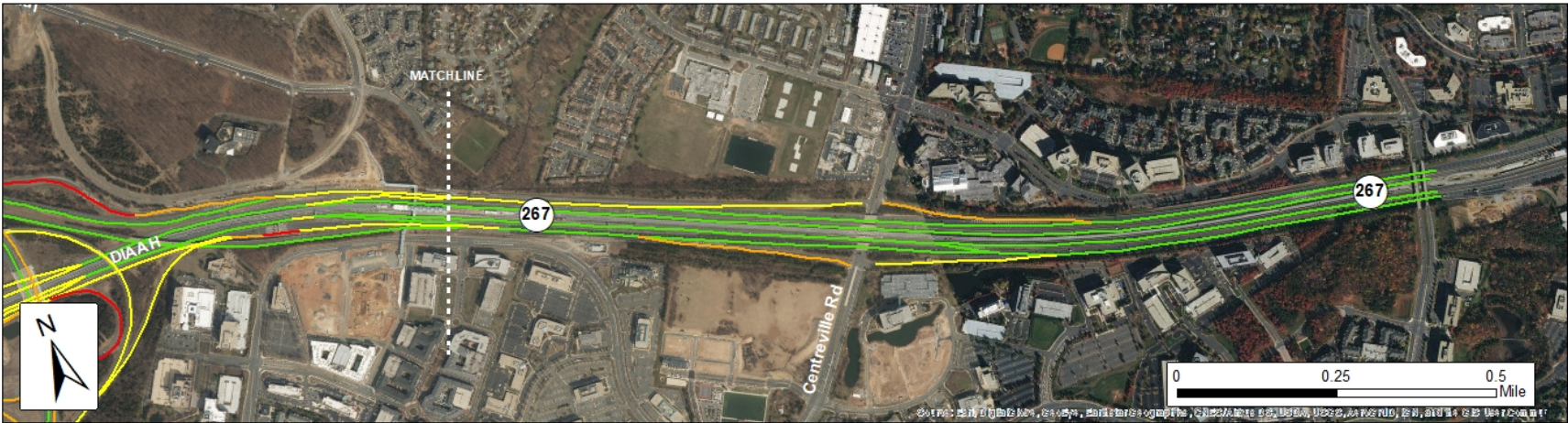
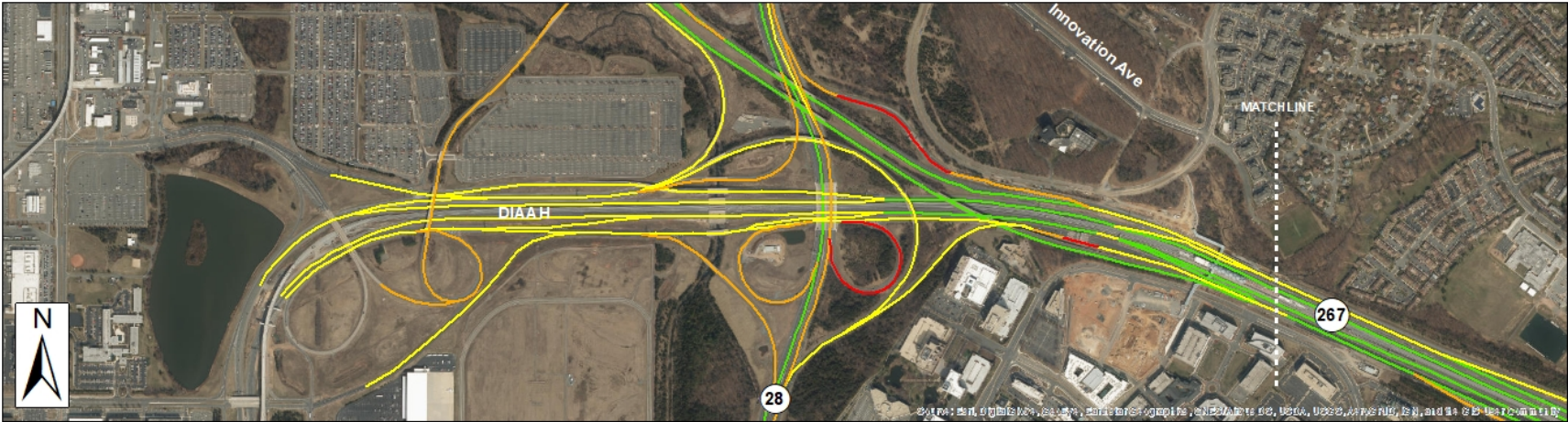
Existing PM Peak Hour Freeway and Ramp Speeds – Route 267 Corridor



**Route 267 Corridor
Mainline and Ramp Speeds
Existing PM Peak Hour**

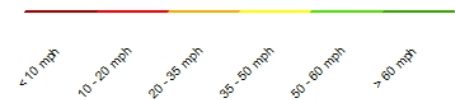


Existing PM Peak Hour Freeway and Ramp Speeds – DIAAH Corridor



**DIAAH Corridor
Mainline and Ramp Speed
Existing PM Peak Hour**

Speed (mph)



Volume Calibration and MOEs (Freeways)

PM Peak Hour (5:00 PM - 6:00 PM)

Facility	Segment	Type	VISSIM Throughput (vph)	Average Speed (mph)	Average Density (vp/mpi)
Northbound Route 28	Mainline south of Frying Pan Road	Basic	4,888	46	34.5
	Mainline south of Frying Pan Road	Diverge	4,877	42	40.3
	Between off-ramp to Frying Pan Road and on-ramp from Frying Pan Road	Basic	4,194	27	63.9
	Between on-ramp from Frying Pan Road and off-ramp to Route 267 EB/Dulles Airport	Weave	4,987	20	83.9
	Between off-ramp to Route 267 EB/Dulles Airport and on-ramp from Route 267 EB	Basic	3,971	19	98.4
	Between on-ramp from Route 267 EB and off-ramp to Route 267 WB	Weave	4,691	14	112.2
	Between off-ramp to Route 267 WB and on-ramp from Route 267 WB	Basic	4,004	13	109.8
	Between on-ramp from Route 267 WB and off-ramp to Innovation Ave	Weave	5,387	13	110.0
	Between off-ramp to Innovation Ave and on-ramp from Innovation Ave	Basic	5,225	13	106.6
	Between on-ramp from innovation Ave and off-ramp to Route 606 EB	Weave	5,222	12	102.9
	Between off-ramp to Route 606 EB and on-ramp from Route 606 EB	Basic	4,925	17	98.3
	Between on-ramp from Route 606 EB and off-ramp to Route 606 WB	Weave	5,173	14	90.9
	Between off-ramp to Route 606 WB and on-ramp from Route 606 WB	Basic	4,781	15	106.7
	Between on-ramp from Route 606 WB and off-ramp to Sterling Blvd EB	Weave	5,552	19	72.3
	Between off-ramp to Sterling Blvd EB and off-ramp to Sterling Blvd WB	Diverge	4,979	18	82.0
Between off-ramp to Sterling Blvd WB and on-ramp from Sterling Blvd	Basic	4,978	25	66.3	
Mainline north of Sterling Blvd	Weave	5,664	30	48.0	
Southbound Route 28	Mainline north of Sterling Blvd	Weave	4,505	57	15.9
	Between off-ramp to Sterling Blvd and on-ramp from Sterling Blvd WB	Basic	4,212	57	18.3
	Between on-ramp from Sterling Blvd WB and on-ramp from Sterling Blvd EB	Basic	4,906	57	17.2
	Between on-ramp from Sterling Blvd EB and off-ramp to Route 606 WB	Weave	5,186	54	18.0
	Between off-ramp to Route 606 WB and on-ramp from Route 606 WB	Basic	4,981	55	22.2
	Between on-ramp from Route 606 WB and off-ramp to Route 606 EB	Weave	5,165	50	20.6
	Between off-ramp to Route 606 EB and on-ramp from Route 606 EB	Basic	4,795	56	21.2
	Between on-ramp from Route 606 EB and off-ramp to Innovation Ave	Weave	5,584	55	20.1
	Between off-ramp to Innovation Ave and on-ramp from Innovation Ave	Basic	5,551	56	24.6
	Between on-ramp from Innovation Ave and on-ramp from Route 267	Basic	5,559	56	19.7
	Between on-ramp from Route 267 and off-ramp to Dulles Airport	Weave	6,531	55	19.6
	Between off-ramp to Dulles Airport and off-ramp to Route 267 EB	Diverge	6,237	55	22.6
	Between off-ramp to Route 267 EB and on-ramp from Route 267 EB	Basic	4,916	56	21.6
	Between on-ramp from Route 267 EB and off-ramp to Frying Pan Road	Weave	5,913	55	21.4
	Between off-ramp to Frying Pan Road and on-ramp from Frying Pan Road	Basic	5,039	56	22.1
Mainline south of Frying Pan Road	Merge	5,955	55	23.1	
Mainline south of Frying Pan Road	Basic	5,950	56	26.5	
Eastbound Route 267	Mainline west of Dulles Greenway Toll Plaza	Basic	810	65	4.2
	Between Dulles Greenway Toll Plaza and mainline from Route 28/Dulles Airport	Basic	640	56	5.7
	Mainline leaving Dulles Airport near Rudder Road	Weave	2,416	46	13.2
	Between off-ramp to Rudder Road/Route 267 WB and off-ramp to DAAR EB (west)	Diverge	1,885	42	15.0
	Between off-ramp to DAAR EB and on-ramp from Aviation Dr	Basic	1,218	44	13.4
	Between on-ramp from Aviation Dr and off-ramp to Route 28 SB	Weave	2,131	42	16.8
	Between off-ramp to Route 28 SB and off-ramp to DAAR EB (east)	Diverge	1,107	44	12.6
	Between off-ramp to DAAR EB (east) and on-ramp from Route 28 SB	Basic	822	44	9.0
	Between on-ramp from Route 28 SB and off-ramp to Route 28 NB	Weave	2,153	35	20.3
	Between off-ramp to Route 28 NB and on-ramp from Route 28 NB	Basic	1,433	42	16.7
	Between on-ramp from Route 28 NB and DTR Toll Plaza	Basic	2,034	41	15.1
	Between DTR Toll Plaza and on-ramp from DAAR EB (west)	Merge	2,038	42	21.4
	Between on-ramp from DAAR EB (west) and mainline from Dulles Greenway	Basic	2,455	44	17.7
	Mainline between on-ramps from Dulles Greenway & Route 28/Dulles Airport/DAAR and off-ramp to Centreville Road	Weave	3,034	55	12.3
	Between off-ramp to Centreville Road and on-ramp from DAAR EB (east)	Basic	2,835	57	12.2
Between on-ramp from DAAR EB (east) and on-ramp from Centreville Road	Merge	2,934	57	9.8	
Mainline east of Centreville Road	Merge	3,936	57	15.9	
Mainline east of Centreville Road	Basic	3,901	57	17.1	

PM Freeway MOEs

Facility	Segment	Type	VISSIM Throughput (vph)	Average Speed (mph)	Average Density (vpmpi)
Westbound Route 267	Mainline east of off-ramp to DAAR WB	Diverge	6,395	56	28.4
	Between off-ramp to DAAR WB and off-ramp to Centreville Road	Basic	6,474	56	28.6
	Between off-ramp to DAAR WB and off-ramp to Centreville Road	Diverge	6,440	55	27.9
	Between off-ramp to Centreville Road and on-ramp from Centreville Road	Basic	5,556	56	24.7
	Between on-ramp from Centreville Road and off-ramp to Dulles Airport	Weave	6,128	49	25.7
	Between off-ramp to Dulles Airport and off-ramp to Route 28 NB	Diverge	5,945	43	37.1
	Between off-ramp to Route 28 NB and off-ramp to Route 28 SB	Basic	4,452	56	26.4
	Between off-ramp to Route 28 NB and off-ramp to Route 28 SB	Diverge	4,431	54	27.4
	Between off-ramp to Route 28 SB and Dulles Greenway Toll Plaza	Basic	3,574	52	32.0
Mainline west of Dulles Greenway Toll Plaza	Basic	4,700	59	26.4	
Eastbound DAAR	Mainline leaving Dulles Airport near Rudder Road	Basic	892	45	9.9
	Between on-ramp from Route 267 EB (west) and on-ramp from Route 267 EB (east)	Merge	1,608	44	15.7
	Between on-ramp from Route 267 EB (east) and off-ramp to Route 267 EB (west)	Merge	1,941	54	13.6
	Between on-ramp from Route 267 EB (east) and off-ramp to Route 267 EB (west)	Diverge	1,920	48	13.4
	Between off-ramp to Route 267 EB (west) and off-ramp to Route 267 EB (east)	Basic	1,529	57	13.4
	Between off-ramp to Route 267 EB (west) and off-ramp to Route 267 EB (east)	Diverge	1,486	57	12.5
	Mainline east of Centreville Road	Basic	1,431	57	12.6
Westbound DAAR	Mainline east of on-ramp from Route 267 WB	Basic	2,302	57	20.1
	Between on-ramp from Route 267 WB near Centreville Road and on-ramp from Route 267 WB to Dulles Airport	Merge	2,299	57	19.2
	Between on-ramp from Route 267 WB near Centreville Road and on-ramp from Route 267 WB to Dulles Airport	Basic	2,287	56	20.5
	Between on-ramp from Route 267 WB to Dulles Airport and off-ramp to Rudder Road (Rental Car Return/Economy Parking)	Weave	2,386	56	14.2
	Between off-ramp to Rudder Road (Rental Car Return/Economy Parking) and on-ramps from Route 28/Route 267 EB	Basic	1,185	39	11.9
	Mainline west of on-ramps from Route 28/Route 267 EB	Basic	1,620	44	7.4

PM Freeway MOEs

Facility	Segment	Type	VISSIM Throughput (vph)	Average Speed (mph)	Average Density (vpmpi)
Frying Pan Road Interchange	Route 28 NB to Frying Pan Road EB		529	37	14.3
	Frying Pan Road WB to Route 28 NB		886	32	15.8
	Route 28 SB to Frying Pan Road EB		898	30	30.0
	Frying Pan Road WB to Route 28 SB		917	24	37.9
Route 267 Interchange	Route 28 NB to Route 267 EB/Dulles Airport (Combined)		934	42	10.9
	Route 28 NB to Dulles Airport		336	40	4.2
	Route 28 NB to Route 267 EB		600	38	15.7
	Route 267 EB to Route 28 NB		763	21	36.6
	Route 28 NB to Route 267 WB		695	37	18.5
	Route 267 WB to Route 28 NB		1,437	21	68.3
	Route 267 EB to Route 28 SB		92	39	2.4
	Route 267 WB to Route 28 SB		869	22	37.7
	Route 267 EB/WB to Route 28 SB (Combined)		959	24	38.9
	Route 28 SB to Dulles Airport		316	26	12.3
	Route 28 SB to Route 267 EB		1,370	27	51.3
	Route 267 EB to Route 28 SB		1,024	25	40.3
Innovation Avenue Interchange	Route 28 NB to Innovation Ave EB		160	30	5.2
	Innovation Ave WB to Route 28 NB		47	36	1.3
	Route 28 SB to Innovation Ave EB		83	31	2.7
	Innovation Ave WB to Route 28 SB		95	25	3.8
Route 606 / Old Ox Road Interchange	Route 28 NB to Route 606 EB		301	34	8.7
	Route 606 EB to Route 28 NB		371	25	14.5
	Route 28 NB to Route 606 WB		508	24	20.5
	Route 606 WB to Route 28 NB		799	35	22.8
	Route 28 SB to Route 606 WB		257	36	7.2
	Route 606 WB to Route 28 SB		333	26	12.5
	Route 28 SB to Route 606 EB		517	25	20.2
Sterling Blvd Interchange	Route 606 EB to Route 28 SB		839	36	23.3
	Route 28 NB to Sterling Blvd EB		527	31	16.9
	Route 28 NB to Sterling Blvd WB		62	23	2.7
	Sterling Blvd to Route 28 NB		712	31	22.6
	Route 28 SB to Sterling Blvd		316	47	6.6
	Sterling Blvd WB to Route 28 SB		692	19	35.5
Route 267 / Centreville Road Interchange	Sterling Blvd EB to Route 28 SB		340	31	10.8
	Route 267 EB to Centreville Road		264	26	10.8
	Centreville Road to Route 267 EB		1,002	39	25.2
	Route 267 WB to Centreville Road		912	27	33.7
Various Dulles Airport / DAAR Ramps	Centreville Road to Route 267 WB		620	49	12.5
	Route 267 EB to Dulles Airport		78	48	1.6
	Route 267 WB to Dulles Airport		116	49	2.4
	DAAR WB to Rudder Road		1,207	38	15.9
	Ramps from Route 267 EB/Route 28 to Rudder Road		279	39	6.9
	Ramps from Route 267 EB/Route 28 to Dulles Airport		450	39	5.6
	DAAR EB (Outer Lanes) to Rudder Road		506	26	19.2
	Dulles Airport to Route 267 WB		444	32	13.6
	Aviation Blvd to Route 267 EB		959	44	21.7
	Route 267 EB to DAAR EB (west)		714	43	16.3
	Route 267 EB to DAAR EB (east)		332	44	7.4
	DAAR EB to Route 267 EB (west)		417	55	7.6
DAAR EB to Route 267 EB (east)		99	56	1.8	

Volume Calibration and MOEs (Intersections)

PM Peak Hour (5:00 PM - 6:00 PM)

#	Intersection	Approach	Movement	VISSIM Throughput (vph)		Average Delay (sec/veh)		Average Queue Length (feet)		Max Queue Length (feet)			
1	Route 846 (Sterling Boulevard) and Pacific Boulevard	NB	TH	495	863	24.1	19.1	39	39	242	263		
			RT	368		12.5		31		263			
		SB	LT	616	807	34.9	28.5	72	72	301	301		
			TH	179		8.2		4		79			
			RT	12		4.1		0		71			
		EB	LT	8	48	41.2	36.8	9	9	106	141		
			TH	29		43.5		9		106			
			RT	11		16.1		6		141			
		WB	LT	136	385	33.0	17.7	19	19	114	168		
			TH	14		34.2		2		41			
			RT	235		7.9		10		168			
		Intersection				2,103		22.9					
		2	Route 846 (Sterling Boulevard) and Route 28 SB Off-Ramp	SB	LT	249	313	23.4	19.1	22	22	124	124
RT	64				2.4	0		0					
EB	TH			671	671	6.2	6.2	11	11	190	190		
	TH			320		6.1		5		95			
Intersection				1,304		9.2							
3	Route 846 (Sterling Boulevard) and Route 28 NB Ramps	NB	RT	516	516	61.2	61.2	0	0	0	0		
			LT	233		30.0		41		266			
		EB	TH	687	920	0.9	8.3	0	41	0	266		
			TH	948		6.9		18		290			
		WB	RT	480	1,428	9.3	7.7	13	18	350	350		
			RT	480		9.3		13		350			
Intersection				2,864		17.5							
4	Route 846 (Sterling Boulevard) and Shaw Road	NB	LT	270	702	72.5	46.6	158	158	776	776		
			TH	59		72.9		23		370			
			RT	373		23.7		55		527			
		SB	LT	23	156	61.1	13.9	8	8	74	106		
			TH	23		0.2		0		0			
			RT	110		7.0		6		106			
		EB	U	5	1,205	27.9	20.1	3	83	89	506		
			LT	61		21.2		3		89			
			TH	1,027		21.8		83		506			
		WB	RT	112	1,265	4.1	17.9	1	73	64	522		
			LT	209		23.5		31		474			
			TH	1,042		16.8		62		490			
		Intersection				3,328		24.6					
5	Route 606 (Old Ox Road) and Pacific Boulevard	NB	LT	47	305	66.3	30.7	32	32	153	192		
			TH	47		65.0		32		153			
			RT	211		15.1		18		192			
		SB	U	3	796	80.8	49.2	124	124	483	483		
			LT	495		65.0		124		483			
			TH	44		65.7		124		483			
		EB	RT	254	1,519	15.0	35.9	26	164	313	906		
			LT	219		80.4		164		906			
			TH	1,197		30.0		135		878			
		WB	RT	101	1,553	8.5	34.4	2	183	69	872		
			U	4		93.4		19		90			
			LT	51		86.3		19		90			
		Intersection				4,173		37.5					
6	Route 606 (Old Ox Road) and Route 28 NB Off-Ramp	NB	TH	103	103	228.6	228.6	19	19	171	171		
			TH	1,205		8.1		13		260			
		WB	TH	1,133	1,133	2.1	2.1	0	0	0	0		
			TH	1,133		2.1		0		0			
Intersection				2,441		14.6							

LOS	
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PM Intersection MOEs

#	Intersection	Approach	Movement	VISSIM Throughput (vph)		Average Delay (sec/veh)		Average Queue Length (feet)		Max Queue Length (feet)			
7	Route 606 (Old Ox Road) and Shaw Road	NB	LT	143	229	68.0	56.5	63	63	242	242		
			TH	44		62.3		63		242			
			RT	42		11.6		2		68			
		SB	LT	248	488	62.3	46.7	67	67	431	67	431	431
			TH	27		63.6		67		431			
			RT	213		26.4		37		308			
		EB	U	9	1,505	65.3	25.8	76	91	326	91	326	499
			LT	155		75.0		76		326			
			TH	1,170		21.6		91		499			
			RT	171		8.0		6		135			
		WB	U	11	1,855	205.0	126.8	685	1,250	1,597	1,250	1,597	2,599
			LT	34		202.1		685		1,597			
			TH	1,558		133.2		1,250		2,599			
			RT	252		73.6		0		29			
Intersection				4,077		76.0							
8	Sunrise Valley Drive and Frying Pan Road	SB	LT	35	1,085	192.3	173.5	11	23	96	144		
			RT	1,050		172.9		23		144			
		EB	U	4	1,441	41.9	30.9	85	85	427	85	427	
			LT	705		47.0		85		427			
			TH	732		15.3		9		329			
		WB	TH	719	755	23.6	22.8	119	119	770	119	770	
			RT	36		5.6		0		0			
Intersection				3,281		76.2							
9	Centreville Road and Dulles Toll Road WB Ramps	NB	LT	335	1,762	82.5	28.4	206	206	524	536		
			TH	1,427		15.7		142		536			
		SB	TH	1,335	1,611	34.4	31.9	170	170	648	170	648	
			RT	276		19.6		42		561			
		WB	LT	501	885	94.7	71.0	217	217	1,272	217	1,272	
			RT	383		39.9		197		1,253			
Intersection				4,258		38.6							
10	Centreville Road and Dulles Toll Road EB Ramps	NB	TH	1,614	2,376	39.1	42.3	256	274	928	939		
			RT	762		49.1		274		939			
		SB	LT	240	1,834	98.4	16.3	97	97	460	97	470	
			TH	1,594		4.0		18		470			
		EB	LT	152	258	114.5	74.1	114	114	461	114	461	
			RT	104		13.5		0		16			
Intersection				4,468		33.5							

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APPENDIX F – CRASH DATA COLLECTION

Route 28 - Crash Analysis

Crash Dates: January 1, 2014 to December 31, 2018

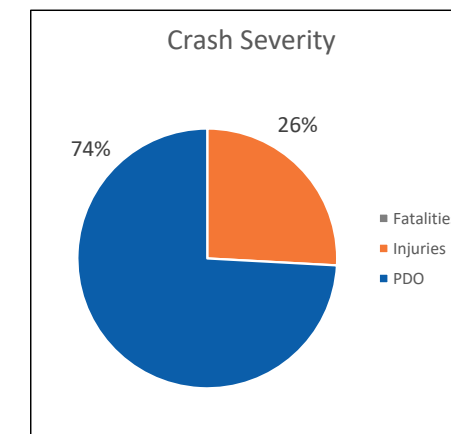
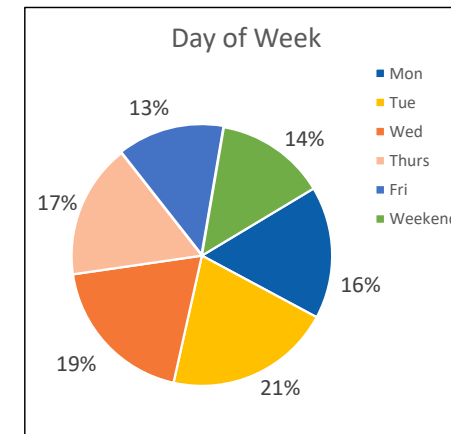
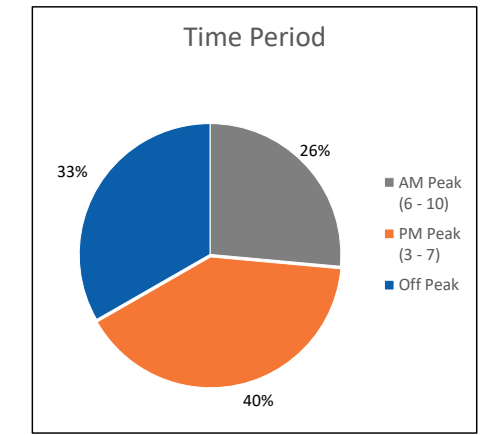
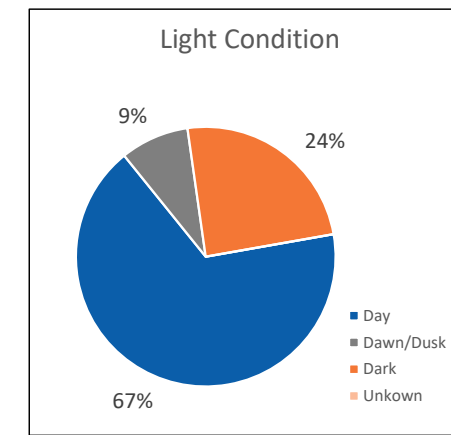
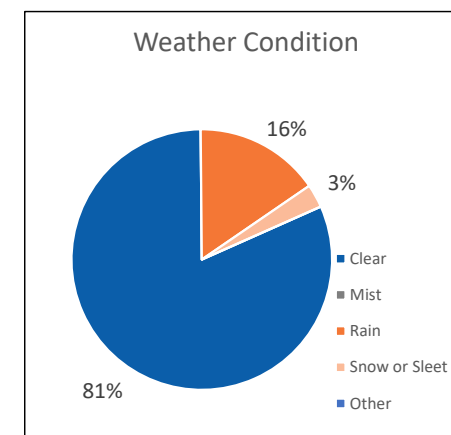
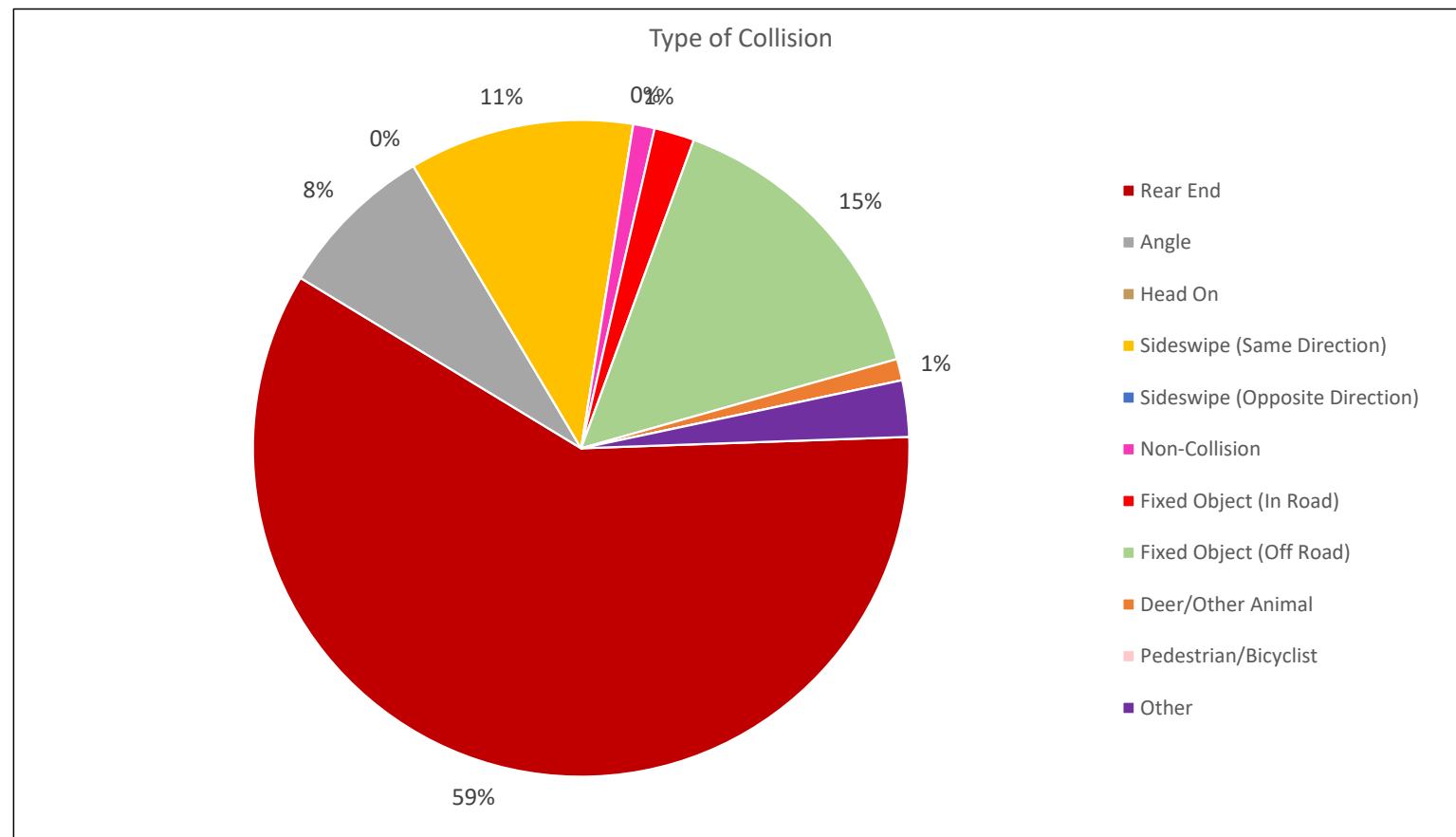
Total Comparison

YEAR	SEVERITY			WEEKDAY					WEEKEND	TIME PERIOD			LIGHT CONDITION				WEATHER CONDITION					TYPE OF COLLISION											TOTAL		
	Fatalities	Injuries	PDO	Mon	Tue	Wed	Thurs	Fri	Weekend	AM Peak (6 - 10)	PM Peak (3 - 7)	Off Peak	Day	Dawn/ Dusk	Dark	Unknown	Clear	Fog	Rain or Mist	Snow or Sleet	Other	Rear End	Angle	Head On	Side-swipe (Same)	Side-swipe (Opp.)	Non-Collision	Fixed Object (In Road)	Fixed Object (Off Road)	Deer/ Other Animal	Ped/ Bike	Backed Into		Other	
2014	0	42	87	18	27	25	27	17	15	34	53	42	84	14	31	0	108	0	16	5	0	76	8	0	14	0	1	4	23	2	0	0	0	1	129
2015	1	37	115	33	25	36	22	22	15	28	77	48	101	12	40	0	122	0	25	5	1	97	7	0	13	0	4	5	21	1	0	0	5	153	
2016	0	57	130	26	37	41	31	30	22	49	76	62	129	16	42	0	163	0	20	4	0	119	10	0	24	0	2	4	19	3	0	0	6	187	
2017	1	24	101	22	37	19	20	11	17	40	48	38	87	9	30	0	108	0	16	2	0	81	14	0	10	0	0	0	17	1	0	0	3	126	
2018	0	36	129	26	31	25	27	21	35	50	52	63	108	14	43	0	117	0	41	6	1	76	20	1	23	0	1	2	34	1	1	0	6	165	
TOTAL	2	196	562	125	157	146	127	101	104	201	306	253	509	65	186	0	618	0	118	22	2	449	59	1	84	0	8	15	114	8	1	0	21	760	

Crash summaries do not include toll booth crashes. Toll booth crashes analyzed separately.

Percentage Comparison

YEAR	SEVERITY			WEEKDAY					WEEKEND	TIME PERIOD			LIGHT CONDITION				WEATHER CONDITION					TYPE OF COLLISION											TOTAL	
	Fatalities	Injuries	PDO	Mon	Tue	Wed	Thurs	Fri	Weekend	AM Peak (6 - 10)	PM Peak (3 - 7)	Off Peak	Day	Dawn/ Dusk	Dark	Unknown	Clear	Mist	Rain	Snow or Sleet	Other	Rear End	Angle	Head On	Side-swipe (Same)	Side-swipe (Opp.)	Non-Collision	Fixed Object (In Road)	Fixed Object (Off Road)	Deer/ Other Animal	Ped/ Bike	Backed Into		Other
2014	0%	33%	67%	14%	21%	19%	21%	13%	12%	26%	41%	33%	65%	11%	24%	0%	84%	0%	12%	4%	0%	59%	6%	0%	11%	0%	<1%	3%	18%	2%	0%	0%	<1%	17%
2015	<1%	24%	75%	22%	16%	24%	14%	14%	10%	18%	50%	31%	66%	8%	26%	0%	80%	0%	16%	3%	<1%	63%	5%	0%	8%	0%	3%	3%	14%	<1%	0%	0%	3%	20%
2016	0%	30%	70%	14%	20%	22%	17%	16%	12%	26%	41%	33%	69%	9%	22%	0%	87%	0%	11%	2%	0%	64%	5%	0%	13%	0%	1%	2%	10%	2%	0%	0%	3%	25%
2017	<1%	19%	80%	17%	29%	15%	16%	9%	13%	32%	38%	30%	69%	7%	24%	0%	86%	0%	13%	2%	0%	64%	11%	0%	8%	0%	0%	0%	13%	<1%	0%	0%	2%	17%
2018	0%	22%	78%	16%	19%	15%	16%	13%	21%	30%	32%	38%	65%	8%	26%	0%	71%	0%	25%	4%	<1%	46%	12%	<1%	14%	0%	<1%	1%	21%	<1%	<1%	0%	4%	22%
TOTAL	<1%	26%	74%	16%	21%	19%	17%	13%	14%	26%	40%	33%	67%	9%	24%	0%	81%	0%	16%	3%	<1%	59%	8%	<1%	11%	0%	1%	2%	15%	1%	<1%	0%	3%	100%



Northbound Route 28 - Crash Analysis

Crash Dates: January 1, 2014 to December 31, 2018

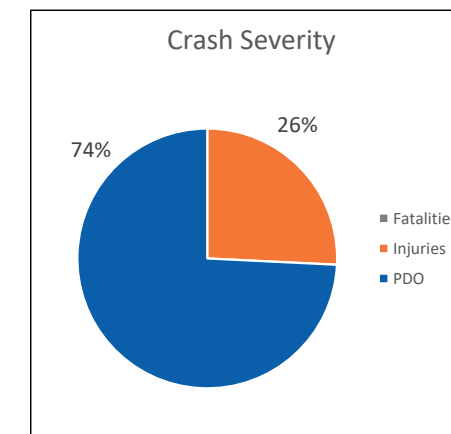
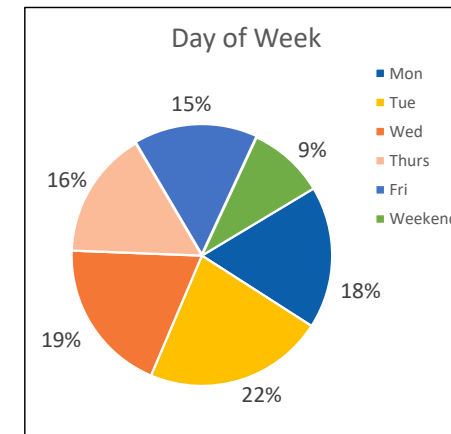
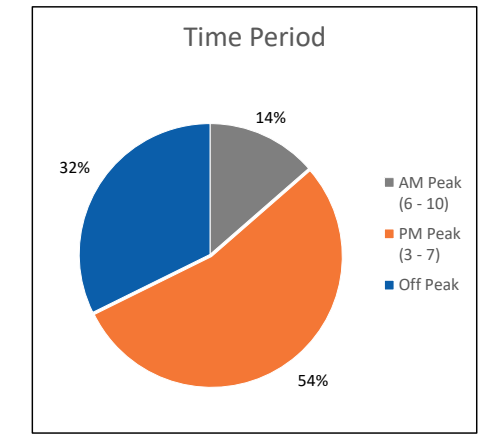
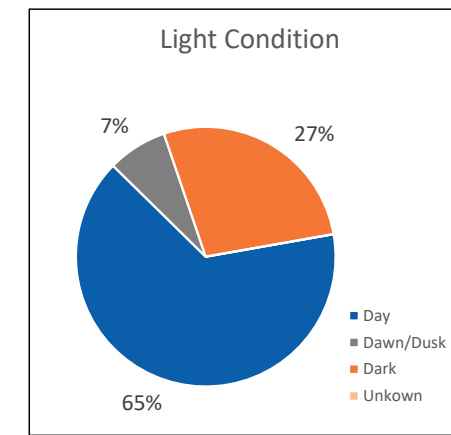
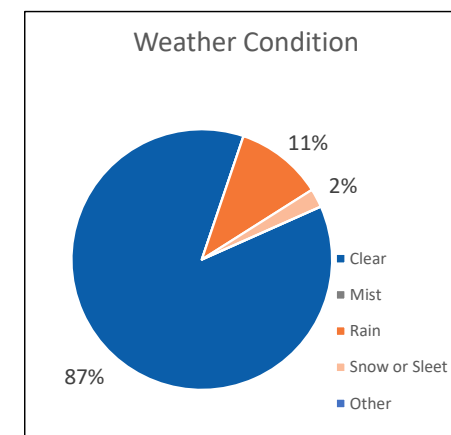
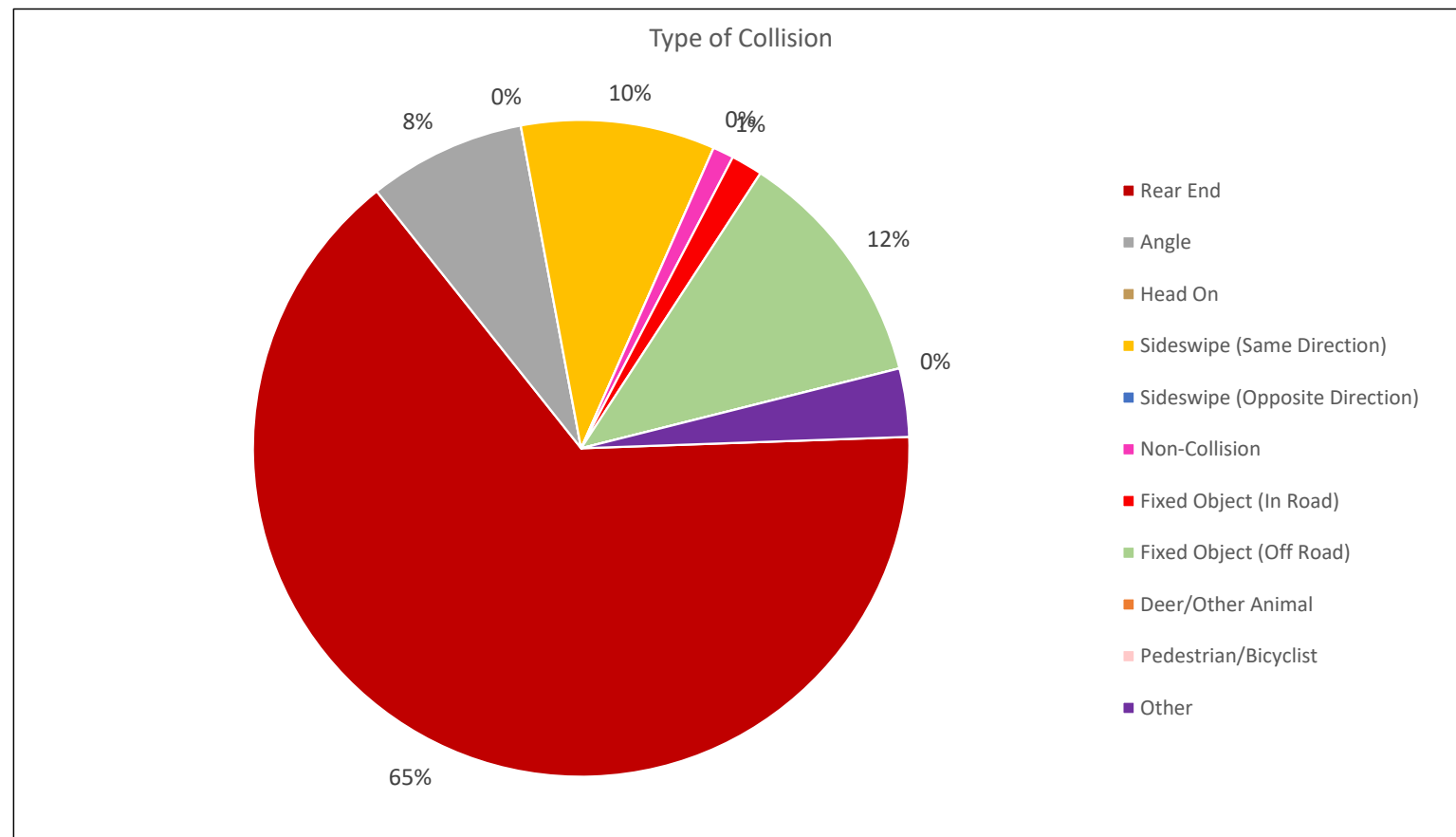
Total Comparison

YEAR	SEVERITY			WEEKDAY					WEEKEND	TIME PERIOD				LIGHT CONDITION				WEATHER CONDITION					TYPE OF COLLISION											TOTAL	
	Fatalities	Injuries	PDO	Mon	Tue	Wed	Thurs	Fri	Weekend	AM Peak (6 - 10)	PM Peak (3 - 7)	Off Peak	Day	Dawn/ Dusk	Dark	Unknown	Clear	Fog	Rain or Mist	Snow or Sleet	Other	Rear End	Angle	Head On	Side-swipe (Same)	Side-swipe (Opp.)	Non-Collision	Fixed Object (In Road)	Fixed Object (Off Road)	Deer/ Other Animal	Ped/ Bike	Backed Into	Other		
2014	0	24	53	13	15	14	17	11	7	12	39	26	50	6	21	0	71	0	4	2	0	49	4	0	6	0	0	3	13	1	0	0	0	1	77
2015	1	22	57	20	14	16	13	12	5	7	55	18	53	8	19	0	62	0	13	4	1	52	3	0	6	0	2	3	11	0	0	0	3	80	
2016	0	24	55	13	20	19	8	15	4	9	45	25	58	5	16	0	74	0	4	1	0	61	4	0	5	0	2	0	4	0	0	0	3	79	
2017	1	12	64	10	22	15	11	7	12	12	38	27	47	6	24	0	70	0	7	0	0	49	9	0	7	0	0	0	9	1	0	0	2	77	
2018	0	18	59	13	16	11	13	15	9	13	34	30	46	4	27	0	60	0	14	2	1	40	10	0	13	0	0	0	9	1	0	0	4	77	
TOTAL	2	100	288	69	87	75	62	60	37	53	211	126	254	29	107	0	337	0	42	9	2	251	30	0	37	0	4	6	46	3	0	0	13	390	

Crash summaries do not include toll booth crashes. Toll booth crashes analyzed separately.

Percentage Comparison

YEAR	SEVERITY			WEEKDAY					WEEKEND	TIME PERIOD				LIGHT CONDITION				WEATHER CONDITION					TYPE OF COLLISION											TOTAL
	Fatalities	Injuries	PDO	Mon	Tue	Wed	Thurs	Fri	Weekend	AM Peak (6 - 10)	PM Peak (3 - 7)	Off Peak	Day	Dawn/ Dusk	Dark	Unknown	Clear	Mist	Rain	Snow or Sleet	Other	Rear End	Angle	Head On	Side-swipe (Same)	Side-swipe (Opp.)	Non-Collision	Fixed Object (In Road)	Fixed Object (Off Road)	Deer/ Other Animal	Ped/ Bike	Backed Into	Other	
2014	0%	31%	69%	17%	19%	18%	22%	14%	9%	16%	51%	34%	65%	8%	27%	0%	92%	0%	5%	3%	0%	64%	5%	0%	8%	0%	0%	4%	17%	1%	0%	0%	1%	20%
2015	1%	28%	71%	25%	18%	20%	16%	15%	6%	9%	69%	23%	66%	10%	24%	0%	78%	0%	16%	5%	1%	65%	4%	0%	8%	0%	3%	4%	14%	0%	0%	0%	4%	21%
2016	0%	30%	70%	16%	25%	24%	10%	19%	5%	11%	57%	32%	73%	6%	20%	0%	94%	0%	5%	1%	0%	77%	5%	0%	6%	0%	3%	0%	5%	0%	0%	0%	4%	20%
2017	1%	16%	83%	13%	29%	19%	14%	9%	16%	16%	49%	35%	61%	8%	31%	0%	91%	0%	9%	0%	0%	64%	12%	0%	9%	0%	0%	0%	12%	1%	0%	0%	3%	20%
2018	0%	23%	77%	17%	21%	14%	17%	19%	12%	17%	44%	39%	60%	5%	35%	0%	78%	0%	18%	3%	1%	52%	13%	0%	17%	0%	0%	0%	12%	1%	0%	0%	5%	20%
TOTAL	<1%	26%	74%	18%	22%	19%	16%	15%	9%	14%	54%	32%	65%	7%	27%	0%	86%	0%	11%	2%	<1%	64%	8%	0%	9%	0%	1%	2%	12%	<1%	0%	0%	3%	100%



Southbound Route 28 - Crash Analysis

Crash Dates: January 1, 2014 to December 31, 2018

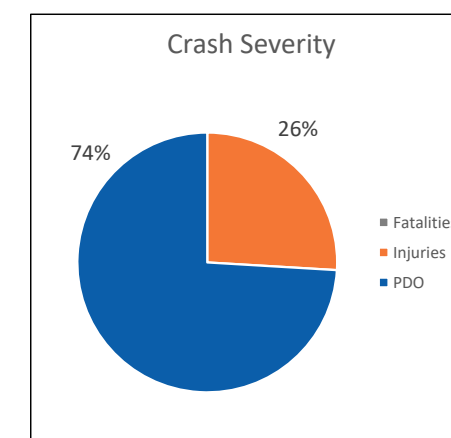
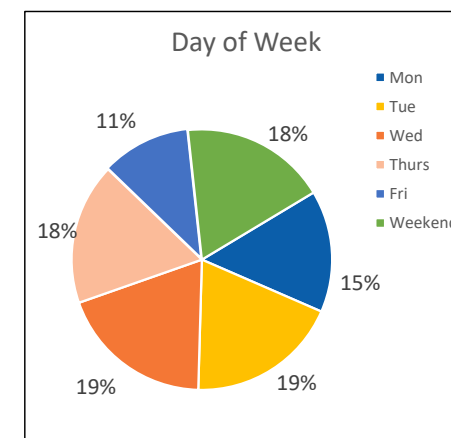
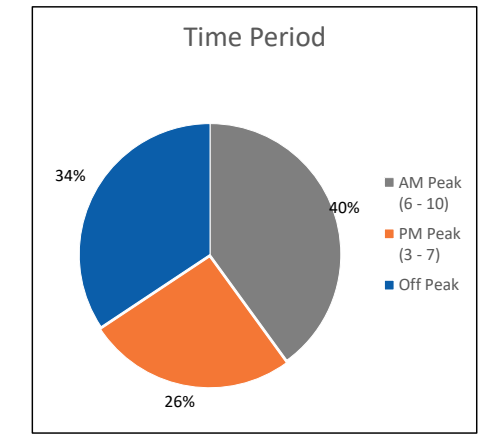
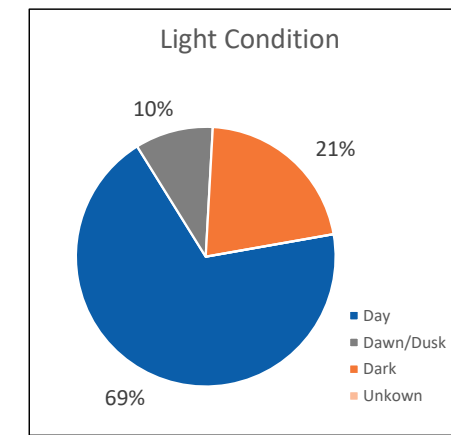
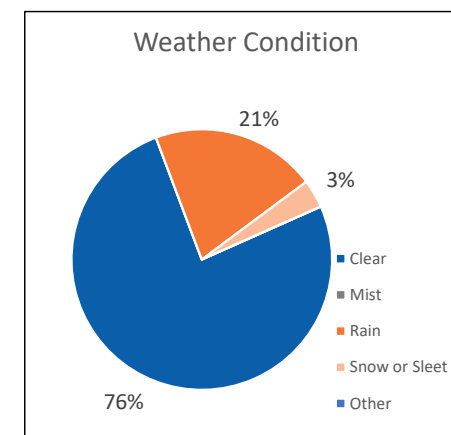
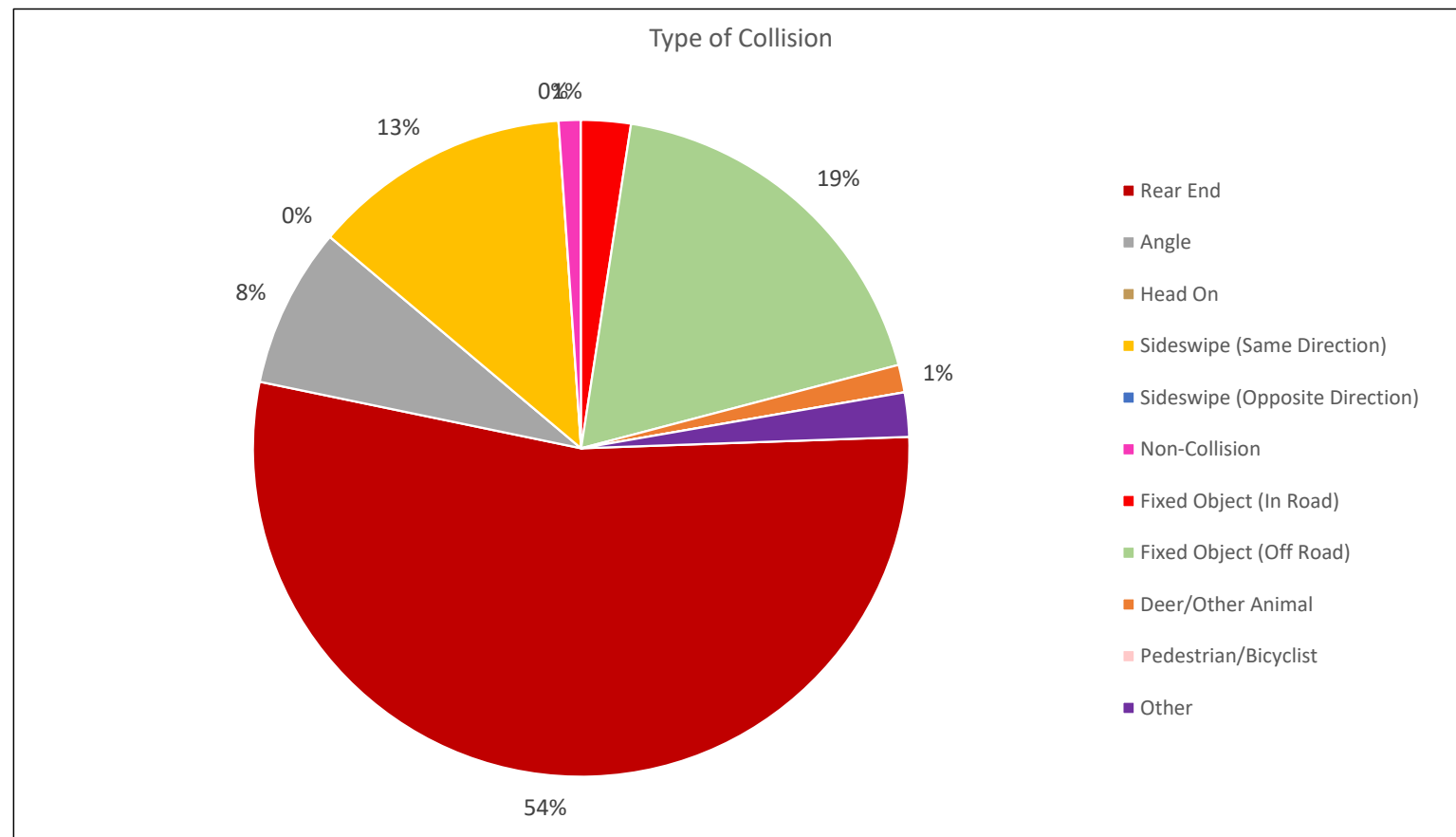
Total Comparison

YEAR	SEVERITY			WEEKDAY					WEEKEND	TIME PERIOD			LIGHT CONDITION				WEATHER CONDITION					TYPE OF COLLISION										TOTAL			
	Fatalities	Injuries	PDO	Mon	Tue	Wed	Thurs	Fri	Weekend	AM Peak (6 - 10)	PM Peak (3 - 7)	Off Peak	Day	Dawn/ Dusk	Dark	Unknown	Clear	Fog	Rain or Mist	Snow or Sleet	Other	Rear End	Angle	Head On	Side-swipe (Same)	Side-swipe (Opp.)	Non-Collision	Fixed Object (In Road)	Fixed Object (Off Road)	Deer/ Other Animal	Ped/ Bike		Backed Into	Other	
2014	0	18	34	5	12	11	10	6	8	22	14	16	34	8	10	0	37	0	12	3	0	27	4	0	8	0	1	1	10	1	0	0	0	0	52
2015	0	15	58	13	11	20	9	10	10	21	22	30	48	4	21	0	60	0	12	1	0	45	4	0	7	0	2	2	10	1	0	0	2	73	
2016	0	33	75	13	17	22	23	15	18	40	31	37	71	11	26	0	89	0	16	3	0	58	6	0	19	0	0	4	15	3	0	0	3	108	
2017	0	12	37	12	15	4	9	4	5	28	10	11	40	3	6	0	38	0	9	2	0	32	5	0	3	0	0	0	8	0	0	0	1	49	
2018	0	18	70	13	15	14	14	6	26	37	18	33	62	10	16	0	57	0	27	4	0	36	10	1	10	0	1	2	25	0	1	0	2	88	
TOTAL	0	96	274	56	70	71	65	41	67	148	95	127	255	36	79	0	281	0	76	13	0	198	29	1	47	0	4	9	68	5	1	0	8	370	

Crash summaries do not include toll booth crashes. Toll booth crashes analyzed separately.

Percentage Comparison

YEAR	SEVERITY			WEEKDAY					WEEKEND	TIME PERIOD			LIGHT CONDITION				WEATHER CONDITION					TYPE OF COLLISION										TOTAL			
	Fatalities	Injuries	PDO	Mon	Tue	Wed	Thurs	Fri	Weekend	AM Peak (6 - 10)	PM Peak (3 - 7)	Off Peak	Day	Dawn/ Dusk	Dark	Unknown	Clear	Mist	Rain	Snow or Sleet	Other	Rear End	Angle	Head On	Side-swipe (Same)	Side-swipe (Opp.)	Non-Collision	Fixed Object (In Road)	Fixed Object (Off Road)	Deer/ Other Animal	Ped/ Bike		Backed Into	Other	
2014	0%	35%	65%	10%	23%	21%	19%	12%	15%	42%	27%	31%	65%	15%	19%	0%	71%	0%	23%	6%	0%	52%	8%	0%	15%	0%	2%	2%	19%	2%	0%	0%	0%	0%	14%
2015	0%	21%	79%	18%	15%	27%	12%	14%	14%	29%	30%	41%	66%	5%	29%	0%	82%	0%	16%	1%	0%	62%	5%	0%	10%	0%	3%	3%	14%	1%	0%	0%	3%	20%	
2016	0%	31%	69%	12%	16%	20%	21%	14%	17%	37%	29%	34%	66%	10%	24%	0%	82%	0%	15%	3%	0%	54%	6%	0%	18%	0%	0%	4%	14%	3%	0%	0%	3%	29%	
2017	0%	24%	76%	24%	31%	8%	18%	8%	10%	57%	20%	22%	82%	6%	12%	0%	78%	0%	18%	4%	0%	65%	10%	0%	6%	0%	0%	0%	16%	0%	0%	0%	2%	13%	
2018	0%	20%	80%	15%	17%	16%	16%	7%	30%	42%	20%	38%	70%	11%	18%	0%	65%	0%	31%	5%	0%	41%	11%	1%	11%	0%	1%	2%	28%	0%	1%	0%	2%	24%	
TOTAL	0%	26%	74%	15%	19%	19%	18%	11%	18%	40%	26%	34%	69%	10%	21%	0%	76%	0%	21%	4%	0%	54%	8%	<1%	13%	0%	1%	2%	18%	1%	<1%	0%	2%	100%	



Route 267 (Dulles Toll Road/Dulles Greenway) - Crash Analysis Crash Dates: January 1, 2014 to December 31, 2018

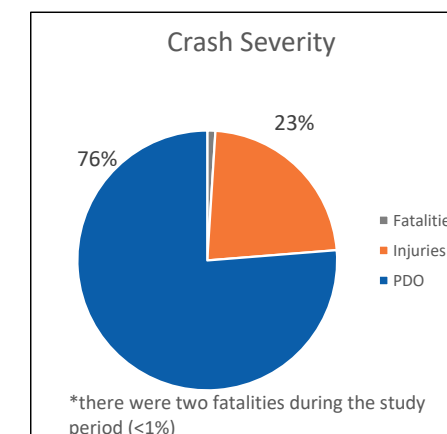
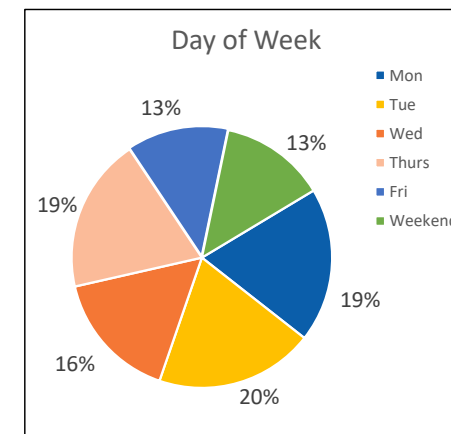
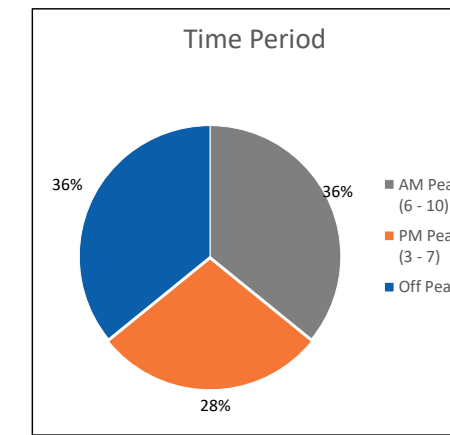
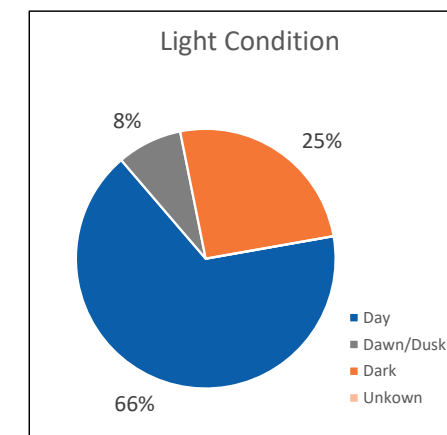
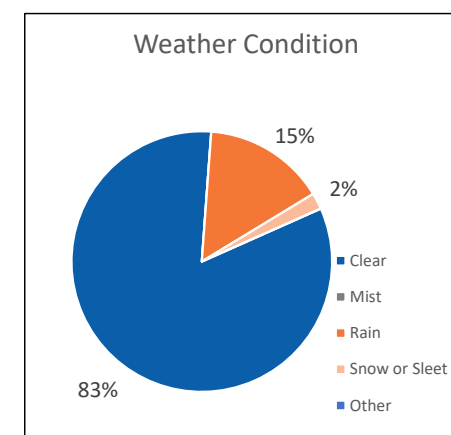
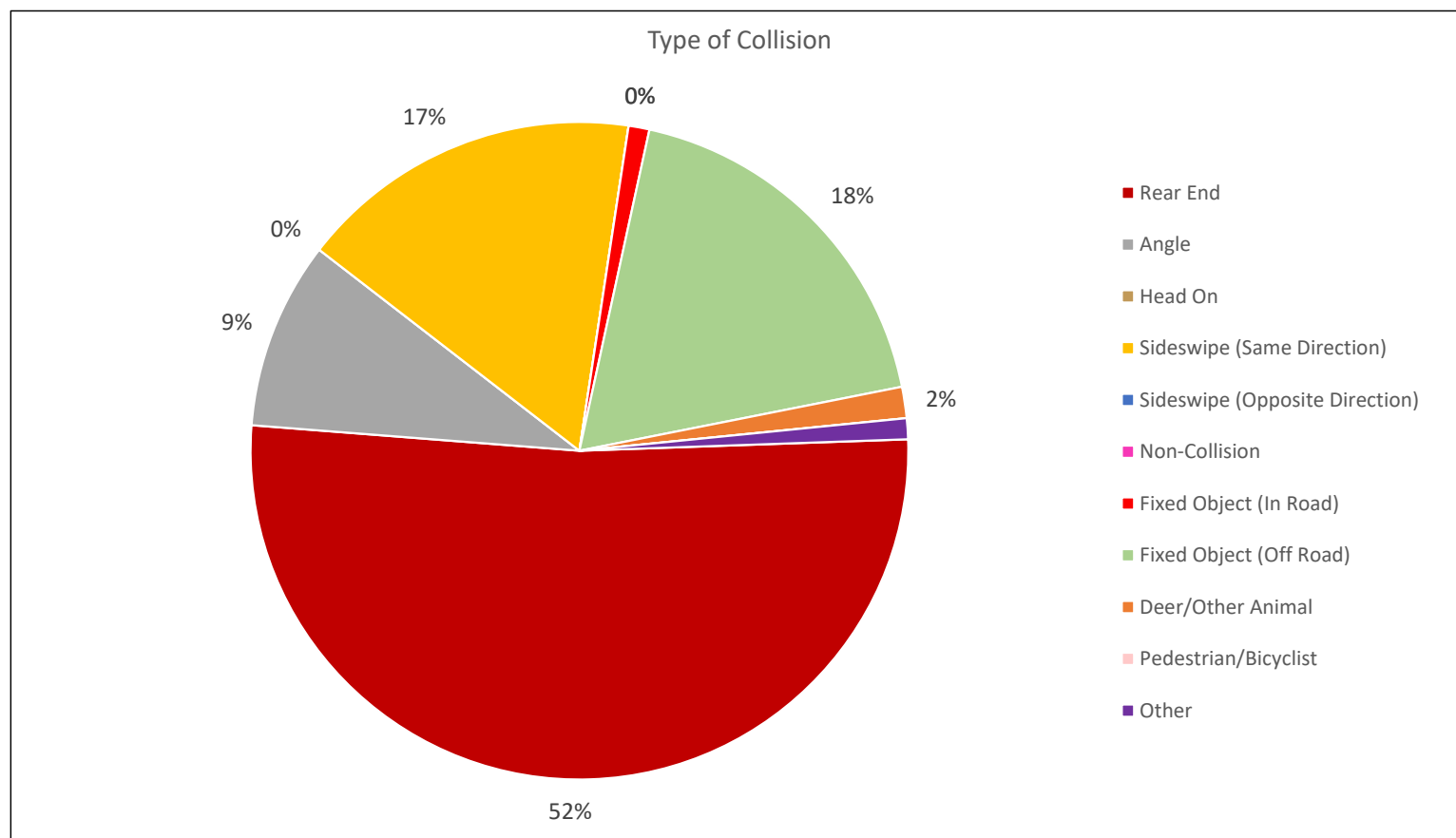
Total Comparison

YEAR	SEVERITY			WEEKDAY					WEEKEND	TIME PERIOD				LIGHT CONDITION					WEATHER CONDITION					TYPE OF COLLISION										TOTAL		
	Fatalities	Injuries	PDO	Mon	Tue	Wed	Thurs	Fri	Weekend	AM Peak (6 - 10)	PM Peak (3 - 7)	Off Peak	Day	Dawn/ Dusk	Dark	Unknown	Clear	Fog	Rain or Mist	Snow or Sleet	Other	Rear End	Angle	Head On	Side-swipe (Same)	Side-swipe (Opp.)	Non-Collision	Fixed Object (In Road)	Fixed Object (Off Road)	Deer/ Other Animal	Ped/ Bike	Backed Into	Other			
2014	0	9	33	13	8	7	6	5	3	16	7	19	31	1	10	0	32	0	7	3	0	16	5	0	9	1	0	0	10	0	0	0	0	0	1	42
2015	1	7	28	5	4	12	4	5	6	17	8	11	23	6	6	1	30	0	6	0	0	20	4	0	4	0	0	1	7	0	0	0	0	0	36	
2016	0	11	29	5	9	8	7	6	5	11	11	18	25	1	14	0	33	0	7	0	0	23	1	1	7	0	0	0	7	1	0	0	0	40		
2017	0	9	33	8	9	2	12	3	8	12	13	17	24	5	13	0	38	0	3	1	0	18	4	0	10	0	1	1	6	1	0	0	1	42		
2018	1	9	28	7	9	3	9	6	4	15	17	6	28	3	7	0	31	0	7	0	0	24	4	0	3	0	0	6	1	0	0	0	0	38		
TOTAL	2	45	151	38	39	32	38	25	26	71	56	71	131	16	50	1	164	0	30	4	0	101	18	1	33	1	1	2	36	3	0	0	2	198		

Crash summaries do not include toll booth crashes. Toll booth crashes analyzed separately.

Percentage Comparison

YEAR	SEVERITY			WEEKDAY					WEEKEND	TIME PERIOD				LIGHT CONDITION					WEATHER CONDITION					TYPE OF COLLISION										TOTAL	
	Fatalities	Injuries	PDO	Mon	Tue	Wed	Thurs	Fri	Weekend	AM Peak (6 - 10)	PM Peak (3 - 7)	Off Peak	Day	Dawn/ Dusk	Dark	Unknown	Clear	Mist	Rain	Snow or Sleet	Other	Rear End	Angle	Head On	Side-swipe (Same)	Side-swipe (Opp.)	Non-Collision	Fixed Object (In Road)	Fixed Object (Off Road)	Deer/ Other Animal	Ped/ Bike	Backed Into	Other		
2014	0%	21%	79%	31%	19%	17%	14%	12%	7%	38%	17%	45%	74%	2%	24%	0%	76%	0%	17%	7%	0%	38%	12%	0%	21%	2%	0%	0%	24%	0%	0%	0%	0%	2%	21%
2015	3%	19%	78%	14%	11%	33%	11%	14%	17%	47%	22%	31%	64%	17%	17%	3%	83%	0%	17%	0%	0%	56%	11%	0%	11%	0%	0%	3%	19%	0%	0%	0%	0%	0%	18%
2016	0%	28%	73%	13%	23%	20%	18%	15%	13%	28%	28%	45%	63%	3%	35%	0%	83%	0%	18%	0%	0%	58%	3%	3%	18%	0%	0%	0%	18%	3%	0%	0%	0%	0%	20%
2017	0%	21%	79%	19%	21%	5%	29%	7%	19%	29%	31%	40%	57%	12%	31%	0%	90%	0%	7%	2%	0%	43%	10%	0%	24%	0%	2%	2%	14%	2%	0%	0%	2%	21%	
2018	3%	24%	74%	18%	24%	8%	24%	16%	11%	39%	45%	16%	74%	8%	18%	0%	82%	0%	18%	0%	0%	63%	11%	0%	8%	0%	0%	16%	3%	0%	0%	0%	0%	0%	19%
TOTAL	1%	23%	76%	19%	20%	16%	19%	13%	13%	36%	28%	36%	66%	8%	25%	<1%	83%	0%	15%	2%	0%	51%	9%	<1%	17%	<1%	<1%	1%	18%	2%	0%	0%	1%	100%	



Eastbound Route 267 (Dulles Toll Road/Dulles Greenway) - Crash Analysis Crash Dates: January 1, 2014 to December 31, 2018

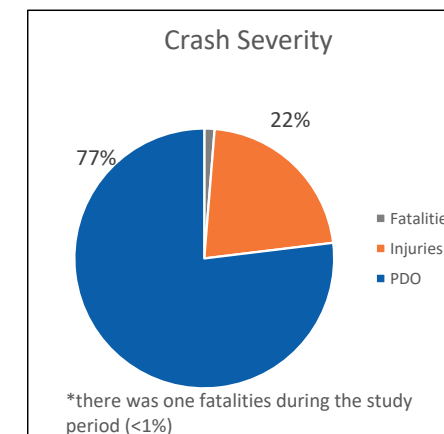
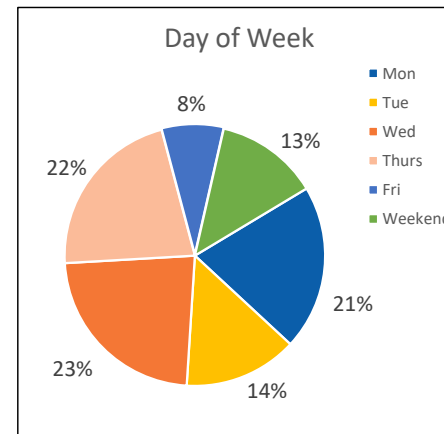
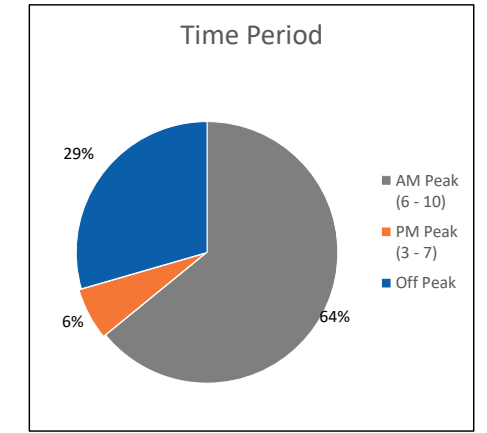
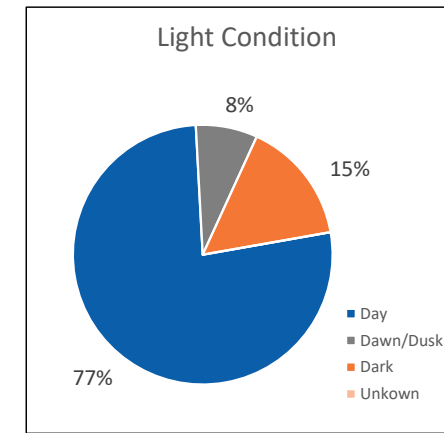
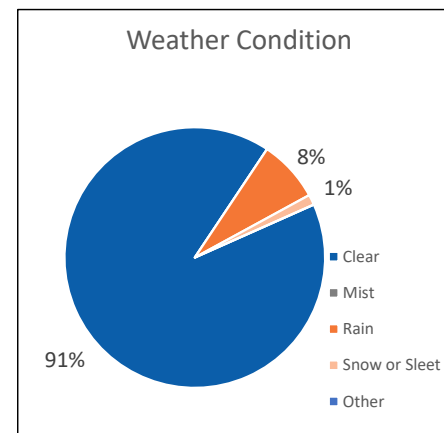
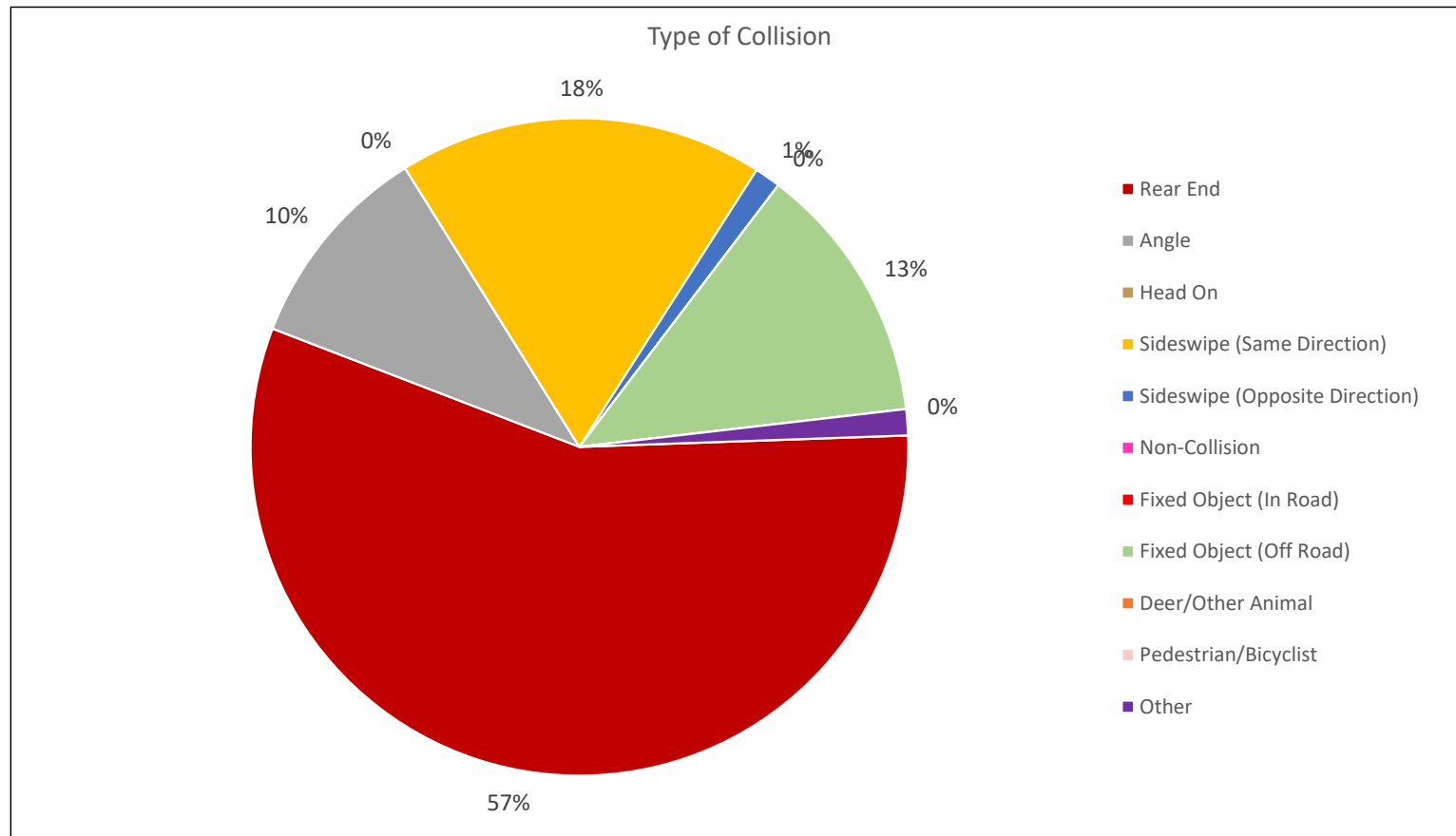
Total Comparison

YEAR	SEVERITY			WEEKDAY					WEEKEND	TIME PERIOD			LIGHT CONDITION				WEATHER CONDITION					TYPE OF COLLISION										TOTAL							
	Fatalities	Injuries	PDO	Mon	Tue	Wed	Thurs	Fri	Weekend	AM Peak (6 - 10)	PM Peak (3 - 7)	Off Peak	Day	Dawn/ Dusk	Dark	Unknown	Clear	Fog	Rain or Mist	Snow or Sleet	Other	Rear End	Angle	Head On	Side-swipe (Same)	Side-swipe (Opp.)	Non-Collision	Fixed Object (In Road)	Fixed Object (Off Road)	Deer/ Other Animal	Ped/ Bike		Backed Into	Other					
2014	0	5	14	6	3	4	2	2	2	9	0	10	15	0	4	0	16	0	3	0	0	7	3	0	5	1	0	0	3	0	0	0	0	0	0	0	0	0	19
2015	0	2	14	2	1	7	4	1	1	12	1	3	13	2	1	0	15	0	1	0	0	14	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	16
2016	0	6	9	1	2	5	1	3	3	8	2	5	11	0	4	0	14	0	1	0	0	9	1	0	2	0	0	0	3	0	0	0	0	0	0	0	0	0	15
2017	0	2	11	4	2	1	4	0	2	8	0	5	7	3	3	0	12	0	0	1	0	4	3	0	3	0	0	0	2	0	0	0	0	0	0	1	0	13	
2018	1	2	12	3	3	1	6	0	2	13	2	0	14	1	0	0	14	0	1	0	0	10	0	0	3	0	0	0	2	0	0	0	0	0	0	0	0	15	
TOTAL	1	17	60	16	11	18	17	6	10	50	5	23	60	6	12	0	71	0	6	1	0	44	8	0	14	1	0	0	10	0	0	0	0	0	0	1	78		

Crash summaries do not include toll booth crashes. Toll booth crashes analyzed separately.

Percentage Comparison

YEAR	SEVERITY			WEEKDAY					WEEKEND	TIME PERIOD			LIGHT CONDITION				WEATHER CONDITION					TYPE OF COLLISION										TOTAL						
	Fatalities	Injuries	PDO	Mon	Tue	Wed	Thurs	Fri	Weekend	AM Peak (6 - 10)	PM Peak (3 - 7)	Off Peak	Day	Dawn/ Dusk	Dark	Unknown	Clear	Mist	Rain	Snow or Sleet	Other	Rear End	Angle	Head On	Side-swipe (Same)	Side-swipe (Opp.)	Non-Collision	Fixed Object (In Road)	Fixed Object (Off Road)	Deer/ Other Animal	Ped/ Bike		Backed Into	Other				
2014	0%	26%	74%	32%	16%	21%	11%	11%	11%	47%	0%	53%	79%	0%	21%	0%	84%	0%	16%	0%	0%	37%	16%	0%	26%	5%	0%	0%	16%	0%	0%	0%	0%	0%	0%	0%	0%	24%
2015	0%	13%	88%	13%	6%	44%	25%	6%	6%	75%	6%	19%	81%	13%	6%	0%	94%	0%	6%	0%	0%	88%	6%	0%	6%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	21%	
2016	0%	40%	60%	7%	13%	33%	7%	20%	20%	53%	13%	33%	73%	0%	27%	0%	93%	0%	7%	0%	0%	60%	7%	0%	13%	0%	0%	0%	20%	0%	0%	0%	0%	0%	0%	0%	19%	
2017	0%	15%	85%	31%	15%	8%	31%	0%	15%	62%	0%	38%	54%	23%	23%	0%	92%	0%	0%	8%	0%	31%	23%	0%	23%	0%	0%	15%	0%	0%	0%	0%	0%	8%	0%	17%		
2018	7%	13%	80%	20%	20%	7%	40%	0%	13%	87%	13%	0%	93%	7%	0%	0%	93%	0%	7%	0%	0%	67%	0%	0%	20%	0%	0%	13%	0%	0%	0%	0%	0%	0%	0%	0%	19%	
TOTAL	1%	22%	77%	21%	14%	23%	22%	8%	13%	64%	6%	29%	77%	8%	15%	0%	91%	0%	8%	1%	0%	56%	10%	0%	18%	1%	0%	0%	13%	0%	0%	0%	0%	1%	100%			



Westbound Route 267 (Dulles Toll Road/Dulles Greenway) - Crash Analysis

Crash Dates: January 1, 2014 to December 31, 2018

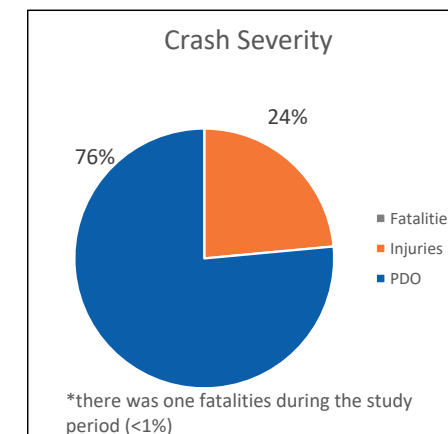
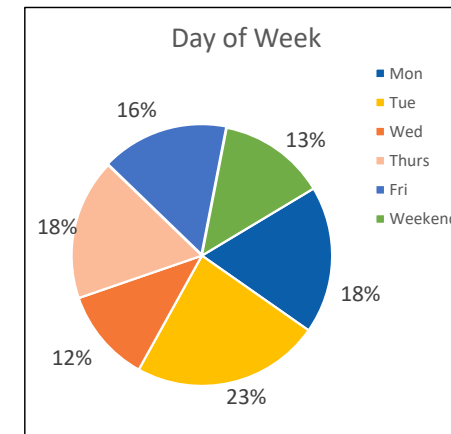
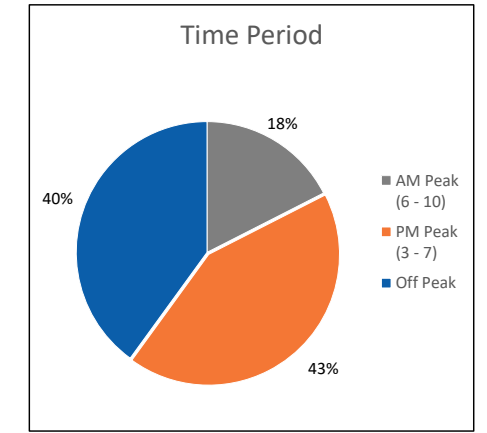
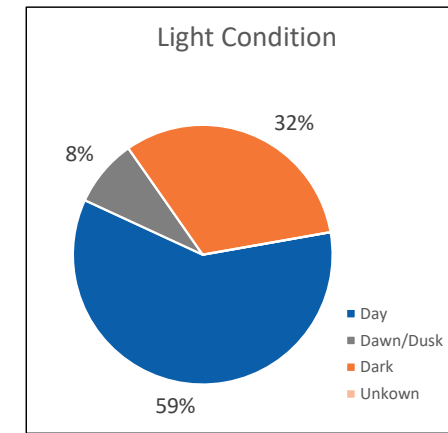
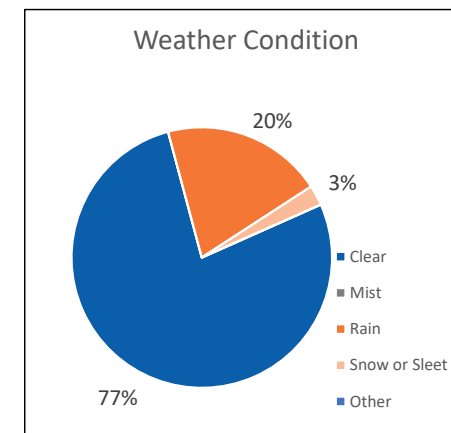
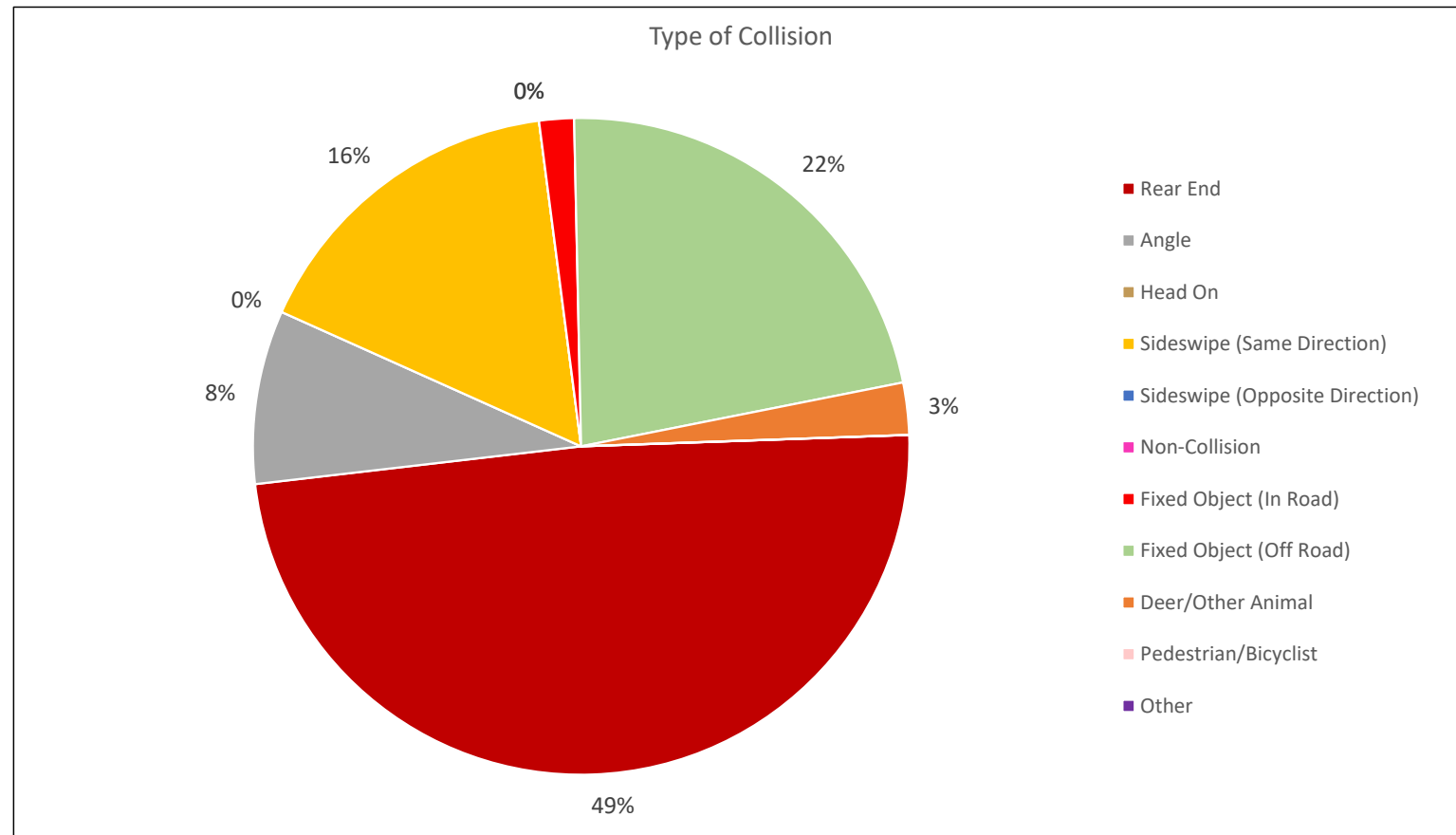
Total Comparison

YEAR	SEVERITY			WEEKDAY					WEEKEND	TIME PERIOD			LIGHT CONDITION				WEATHER CONDITION					TYPE OF COLLISION										TOTAL				
	Fatalities	Injuries	PDO	Mon	Tue	Wed	Thurs	Fri	Weekend	AM Peak (6 - 10)	PM Peak (3 - 7)	Off Peak	Day	Dawn/ Dusk	Dark	Unknown	Clear	Fog	Rain or Mist	Snow or Sleet	Other	Rear End	Angle	Head On	Side-swipe (Same)	Side-swipe (Opp.)	Non-Collision	Fixed Object (In Road)	Fixed Object (Off Road)	Deer/ Other Animal	Ped/ Bike		Backed Into	Other		
2014	0	4	19	7	5	3	4	3	1	7	7	9	16	1	6	0	16	0	4	3	0	9	2	0	4	0	0	0	7	0	0	0	0	0	1	23
2015	1	5	14	3	3	5	0	4	5	5	7	8	10	4	5	1	15	0	5	0	0	6	3	0	3	0	0	1	7	0	0	0	0	0	20	
2016	0	5	20	4	7	3	6	3	2	3	9	13	14	1	10	0	19	0	6	0	0	14	0	1	5	0	0	4	1	0	0	0	0	25		
2017	0	7	22	4	7	1	8	3	6	4	13	12	17	2	10	0	26	0	3	0	0	14	1	0	7	0	1	1	4	1	0	0	0	29		
2018	0	7	16	4	6	2	3	6	2	2	15	6	14	2	7	0	17	0	6	0	0	14	4	0	0	0	0	4	1	0	0	0	0	23		
TOTAL	1	28	91	22	28	14	21	19	16	21	51	48	71	10	38	1	93	0	24	3	0	57	10	1	19	0	1	2	26	3	0	0	1	120		

Crash summaries do not include toll booth crashes. Toll booth crashes analyzed separately.

Percentage Comparison

YEAR	SEVERITY			WEEKDAY					WEEKEND	TIME PERIOD			LIGHT CONDITION				WEATHER CONDITION					TYPE OF COLLISION										TOTAL			
	Fatalities	Injuries	PDO	Mon	Tue	Wed	Thurs	Fri	Weekend	AM Peak (6 - 10)	PM Peak (3 - 7)	Off Peak	Day	Dawn/ Dusk	Dark	Unknown	Clear	Mist	Rain	Snow or Sleet	Other	Rear End	Angle	Head On	Side-swipe (Same)	Side-swipe (Opp.)	Non-Collision	Fixed Object (In Road)	Fixed Object (Off Road)	Deer/ Other Animal	Ped/ Bike		Backed Into	Other	
2014	0%	17%	83%	30%	22%	13%	17%	13%	4%	30%	30%	39%	70%	4%	26%	0%	70%	0%	17%	13%	0%	39%	9%	0%	17%	0%	0%	0%	30%	0%	0%	0%	0%	4%	19%
2015	5%	25%	70%	15%	15%	25%	0%	20%	25%	25%	35%	40%	50%	20%	25%	5%	75%	0%	25%	0%	0%	30%	15%	0%	15%	0%	0%	5%	35%	0%	0%	0%	0%	0%	17%
2016	0%	20%	80%	16%	28%	12%	24%	12%	8%	12%	36%	52%	56%	4%	40%	0%	76%	0%	24%	0%	0%	56%	0%	4%	20%	0%	0%	16%	4%	0%	0%	0%	0%	21%	
2017	0%	24%	76%	14%	24%	3%	28%	10%	21%	14%	45%	41%	59%	7%	34%	0%	90%	0%	10%	0%	0%	48%	3%	0%	24%	0%	3%	3%	14%	3%	0%	0%	0%	24%	
2018	0%	30%	70%	17%	26%	9%	13%	26%	9%	9%	65%	26%	61%	9%	30%	0%	74%	0%	26%	0%	0%	61%	17%	0%	0%	0%	0%	17%	4%	0%	0%	0%	0%	0%	19%
TOTAL	<1%	23%	76%	18%	23%	12%	18%	16%	13%	18%	43%	40%	59%	8%	32%	<1%	78%	0%	20%	3%	0%	48%	8%	<1%	16%	0%	<1%	2%	22%	3%	0%	0%	<1%	100%	



Dulles International Airport Access Highway - Crash Analysis

Crash Dates: January 1, 2014 to December 31, 2018

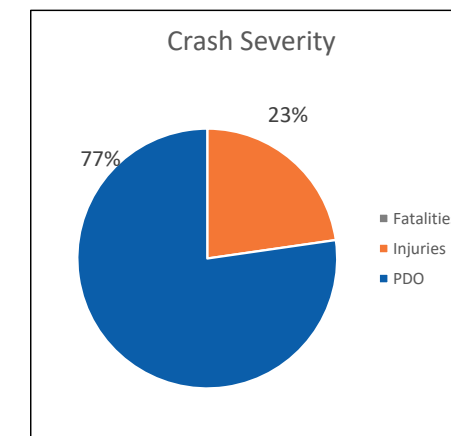
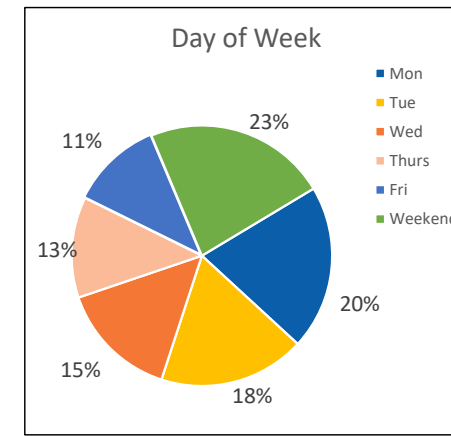
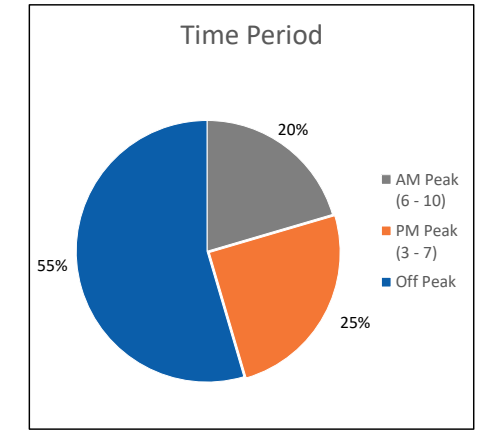
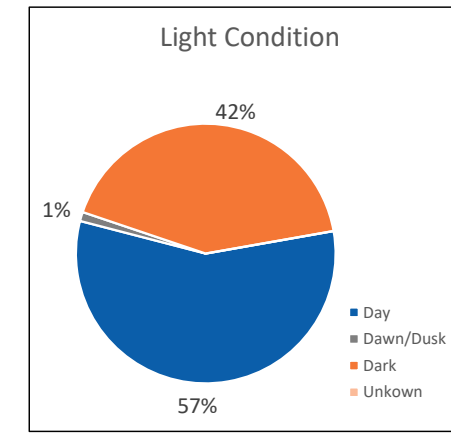
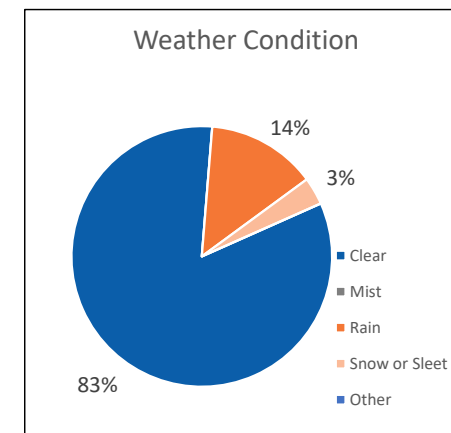
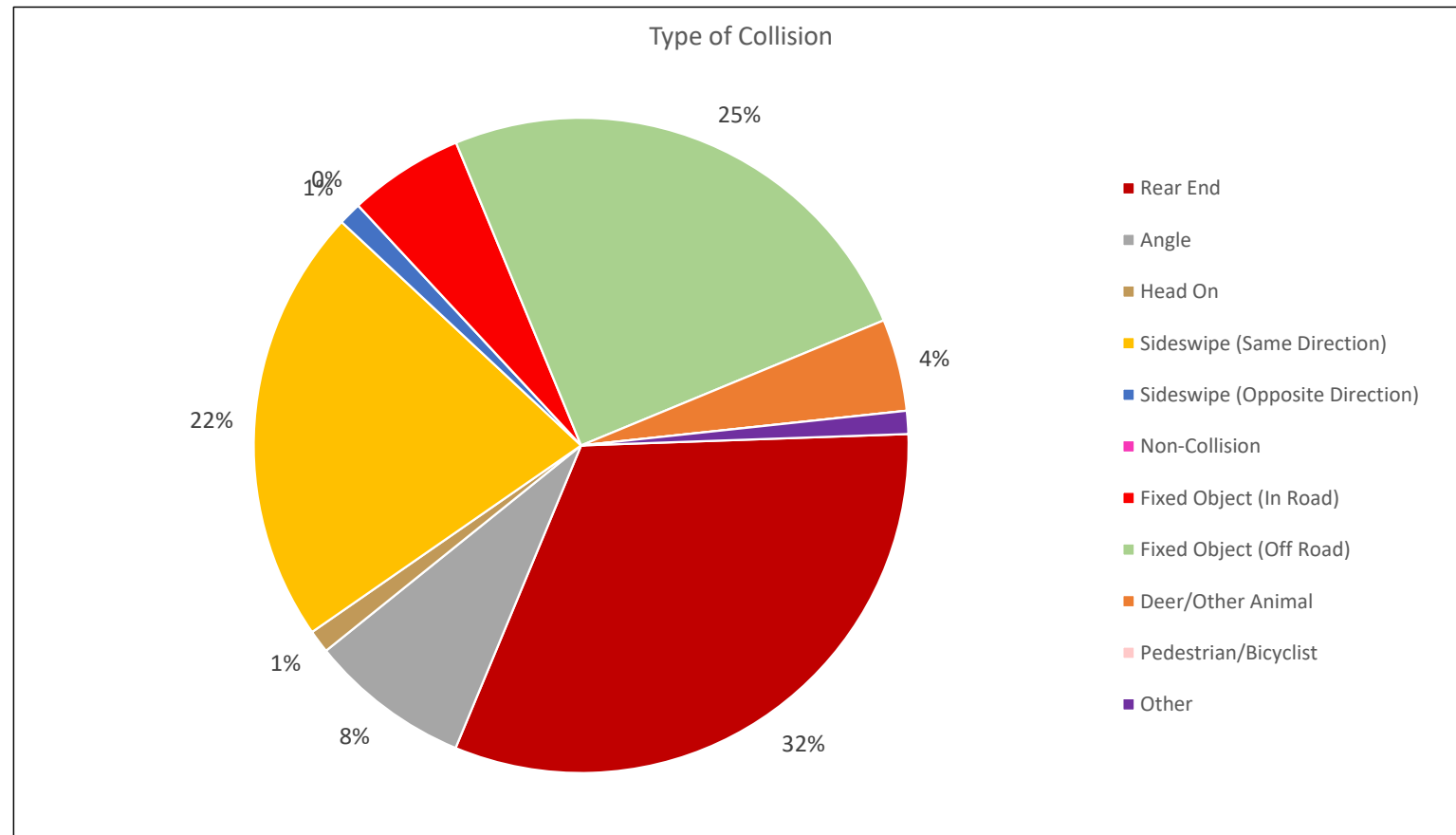
Total Comparison

YEAR	SEVERITY			WEEKDAY					WEEKEND	TIME PERIOD			LIGHT CONDITION				WEATHER CONDITION					TYPE OF COLLISION										TOTAL			
	Fatalities	Injuries	PDO	Mon	Tue	Wed	Thurs	Fri	Weekend	AM Peak (6 - 10)	PM Peak (3 - 7)	Off Peak	Day	Dawn/ Dusk	Dark	Unknown	Clear	Fog	Rain or Mist	Snow or Sleet	Other	Rear End	Angle	Head On	Side-swipe (Same)	Side-swipe (Opp.)	Non-Collision	Fixed Object (In Road)	Fixed Object (Off Road)	Deer/ Other Animal	Ped/ Bike		Backed Into	Other	
2014	0	6	14	5	7	2	3	0	3	3	5	12	6	0	14	0	17	0	1	2	0	7	0	1	2	0	0	2	5	3	0	0	0	0	20
2015	0	6	18	8	2	5	2	3	4	5	5	14	15	1	8	0	19	0	4	1	0	12	1	0	3	0	0	1	7	0	0	0	0	24	
2016	0	3	15	2	0	3	3	4	6	3	5	10	11	0	7	0	16	0	2	0	0	3	3	0	7	0	0	1	4	0	0	0	0	18	
2017	0	2	12	2	4	2	1	2	3	2	4	8	10	0	4	0	12	0	2	0	0	2	3	0	4	1	0	1	1	1	0	1	14		
2018	0	3	9	1	3	1	2	1	4	5	3	4	8	0	4	0	9	0	3	0	0	4	0	0	3	0	0	0	5	0	0	0	0	12	
TOTAL	0	20	68	18	16	13	11	10	20	18	22	48	50	1	37	0	73	0	12	3	0	28	7	1	19	1	0	5	22	4	0	0	1	88	

Crash summaries do not include toll booth crashes. Toll booth crashes analyzed separately.

Percentage Comparison

YEAR	SEVERITY			WEEKDAY					WEEKEND	TIME PERIOD			LIGHT CONDITION				WEATHER CONDITION					TYPE OF COLLISION										TOTAL			
	Fatalities	Injuries	PDO	Mon	Tue	Wed	Thurs	Fri	Weekend	AM Peak (6 - 10)	PM Peak (3 - 7)	Off Peak	Day	Dawn/ Dusk	Dark	Unknown	Clear	Mist	Rain	Snow or Sleet	Other	Rear End	Angle	Head On	Side-swipe (Same)	Side-swipe (Opp.)	Non-Collision	Fixed Object (In Road)	Fixed Object (Off Road)	Deer/ Other Animal	Ped/ Bike		Backed Into	Other	
2014	0%	30%	70%	25%	35%	10%	15%	0%	15%	15%	25%	60%	30%	0%	70%	0%	85%	0%	5%	10%	0%	35%	0%	5%	10%	0%	0%	10%	25%	15%	0%	0%	0%	0%	23%
2015	0%	25%	75%	33%	8%	21%	8%	13%	17%	21%	21%	58%	63%	4%	33%	0%	79%	0%	17%	4%	0%	50%	4%	0%	13%	0%	0%	4%	29%	0%	0%	0%	0%	0%	27%
2016	0%	17%	83%	11%	0%	17%	17%	22%	33%	17%	28%	56%	61%	0%	39%	0%	89%	0%	11%	0%	0%	17%	17%	0%	39%	0%	0%	6%	22%	0%	0%	0%	0%	0%	20%
2017	0%	14%	86%	14%	29%	14%	7%	14%	21%	14%	29%	57%	71%	0%	29%	0%	86%	0%	14%	0%	0%	14%	21%	0%	29%	7%	0%	7%	7%	0%	0%	7%	0%	16%	
2018	0%	25%	75%	8%	25%	8%	17%	8%	33%	42%	25%	33%	67%	0%	33%	0%	75%	0%	25%	0%	0%	33%	0%	0%	25%	0%	0%	0%	42%	0%	0%	0%	0%	0%	14%
TOTAL	0%	23%	77%	20%	18%	15%	13%	11%	23%	20%	25%	55%	57%	1%	42%	0%	83%	0%	14%	3%	0%	32%	8%	1%	22%	1%	0%	6%	25%	5%	0%	0%	1%	100%	



Eastbound Dulles International Airport Access Highway - Crash Analysis

Crash Dates: January 1, 2014 to December 31, 2018

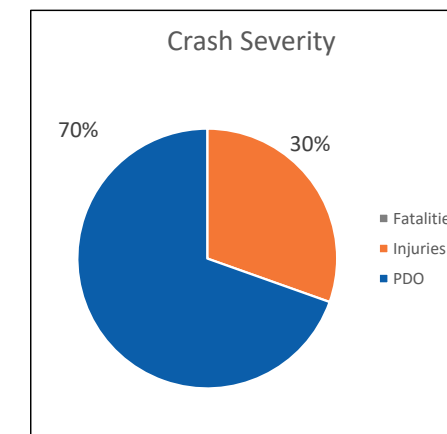
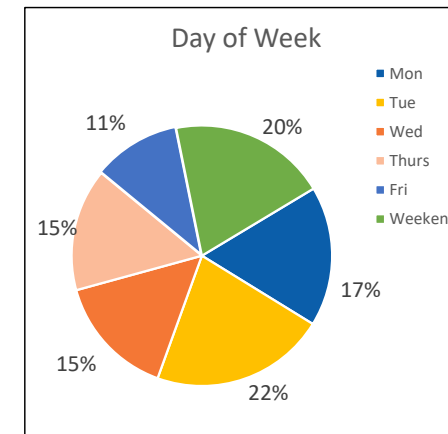
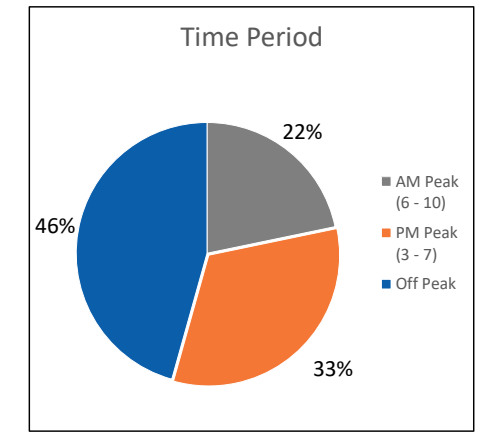
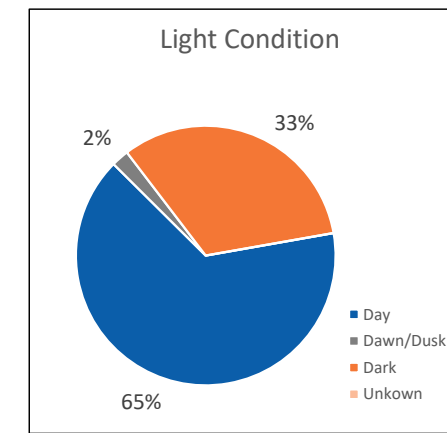
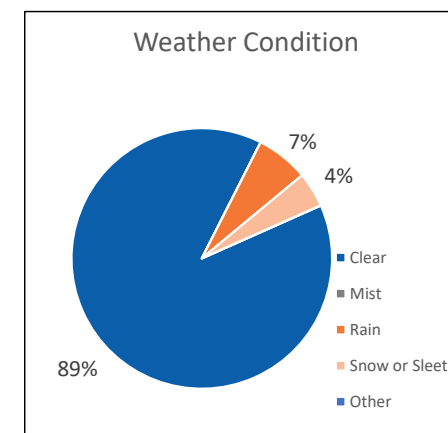
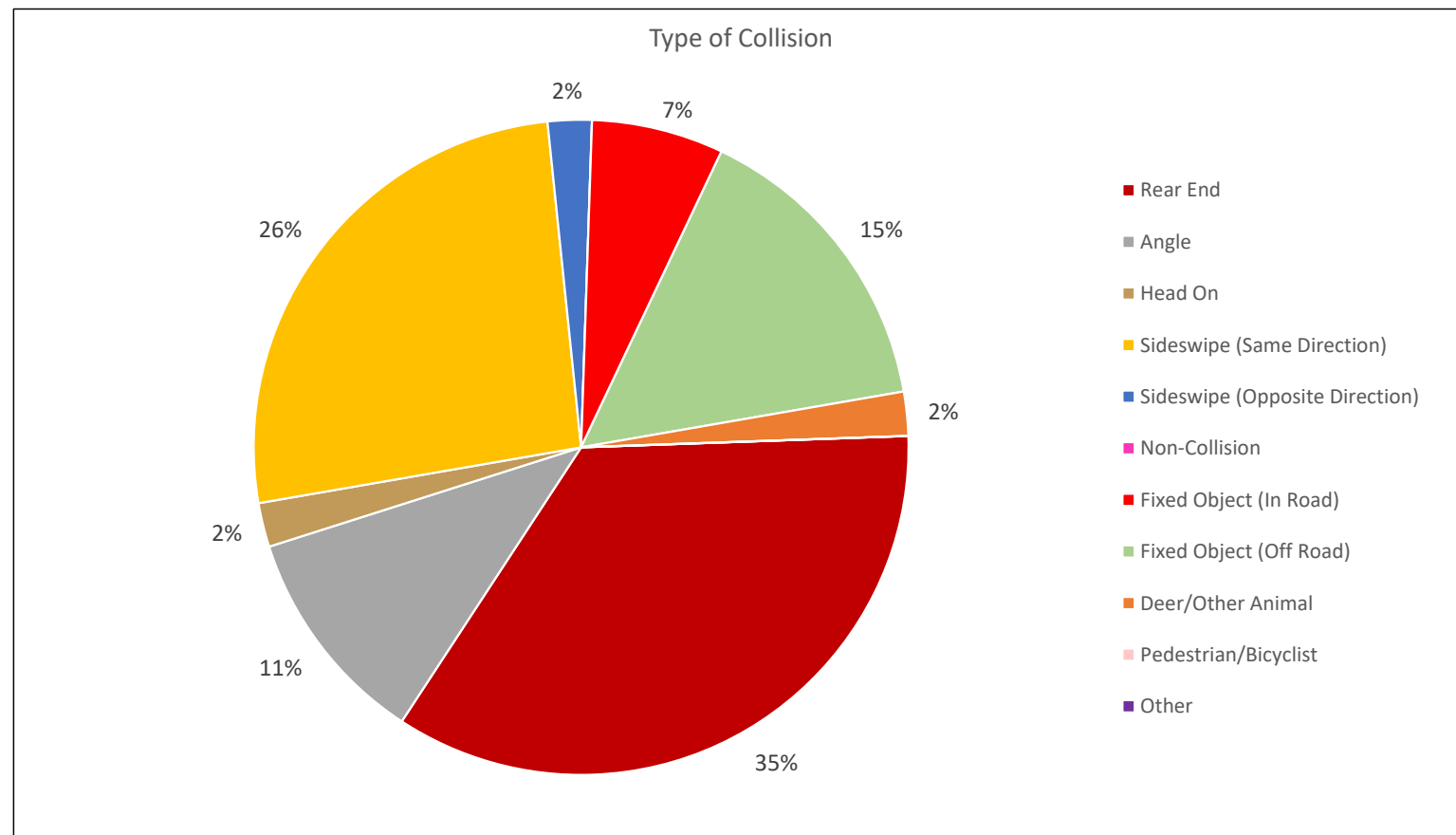
Total Comparison

YEAR	SEVERITY			WEEKDAY					WEEKEND	TIME PERIOD			LIGHT CONDITION				WEATHER CONDITION					TYPE OF COLLISION										TOTAL					
	Fatalities	Injuries	PDO	Mon	Tue	Wed	Thurs	Fri	Weekend	AM Peak (6 - 10)	PM Peak (3 - 7)	Off Peak	Day	Dawn/ Dusk	Dark	Unknown	Clear	Fog	Rain or Mist	Snow or Sleet	Other	Rear End	Angle	Head On	Side-swipe (Same)	Side-swipe (Opp.)	Non-Collision	Fixed Object (In Road)	Fixed Object (Off Road)	Deer/ Other Animal	Ped/ Bike		Backed Into	Other			
2014	0	4	6	2	6	0	1	0	1	2	3	5	4	0	6	0	8	0	0	2	0	5	0	1	1	0	0	0	0	2	1	0	0	0	0	0	10
2015	0	3	8	3	1	3	1	2	1	2	4	5	9	1	1	0	10	0	1	0	0	7	0	0	2	0	0	1	1	0	0	0	0	0	0	11	
2016	0	2	9	1	0	3	2	2	3	2	5	4	8	0	3	0	10	0	1	0	0	1	3	0	5	0	0	1	1	0	0	0	0	0	0	11	
2017	0	2	7	1	3	1	1	1	2	2	2	5	6	0	3	0	9	0	0	0	0	1	2	0	3	1	0	1	1	0	0	0	0	0	0	9	
2018	0	3	2	1	0	0	2	0	2	2	1	2	3	0	2	0	4	0	1	0	0	2	0	0	1	0	0	0	2	0	0	0	0	0	0	5	
TOTAL	0	14	32	8	10	7	7	5	9	10	15	21	30	1	15	0	41	0	3	2	0	16	5	1	12	1	0	3	7	1	0	0	0	0	46		

Crash summaries do not include toll booth crashes. Toll booth crashes analyzed separately.

Percentage Comparison

YEAR	SEVERITY			WEEKDAY					WEEKEND	TIME PERIOD			LIGHT CONDITION				WEATHER CONDITION					TYPE OF COLLISION										TOTAL					
	Fatalities	Injuries	PDO	Mon	Tue	Wed	Thurs	Fri	Weekend	AM Peak (6 - 10)	PM Peak (3 - 7)	Off Peak	Day	Dawn/ Dusk	Dark	Unknown	Clear	Mist	Rain	Snow or Sleet	Other	Rear End	Angle	Head On	Side-swipe (Same)	Side-swipe (Opp.)	Non-Collision	Fixed Object (In Road)	Fixed Object (Off Road)	Deer/ Other Animal	Ped/ Bike		Backed Into	Other			
2014	0%	40%	60%	20%	60%	0%	10%	0%	10%	20%	30%	50%	40%	0%	60%	0%	80%	0%	0%	20%	0%	50%	0%	10%	10%	0%	0%	0%	20%	10%	0%	0%	0%	0%	0%	0%	22%
2015	0%	27%	73%	27%	9%	27%	9%	18%	9%	18%	36%	45%	82%	9%	9%	0%	91%	0%	9%	0%	0%	64%	0%	0%	18%	0%	0%	9%	9%	0%	0%	0%	0%	0%	0%	0%	24%
2016	0%	18%	82%	9%	0%	27%	18%	18%	27%	18%	45%	36%	73%	0%	27%	0%	91%	0%	9%	0%	0%	9%	27%	0%	45%	0%	0%	9%	9%	0%	0%	0%	0%	0%	0%	0%	24%
2017	0%	22%	78%	11%	33%	11%	11%	11%	22%	22%	56%	67%	0%	33%	0%	100%	0%	0%	0%	0%	11%	22%	0%	33%	11%	0%	11%	11%	0%	0%	0%	0%	0%	0%	0%	20%	
2018	0%	60%	40%	20%	0%	0%	40%	0%	40%	40%	20%	40%	60%	0%	40%	0%	80%	0%	20%	0%	0%	40%	0%	0%	20%	0%	0%	40%	0%	0%	0%	0%	0%	0%	0%	0%	11%
TOTAL	0%	30%	70%	17%	22%	15%	15%	11%	20%	22%	33%	46%	65%	2%	33%	0%	89%	0%	7%	4%	0%	35%	11%	2%	26%	2%	0%	7%	15%	2%	0%	0%	0%	0%	0%	100%	



Westbound Dulles International Airport Access Highway - Crash Analysis

Crash Dates: January 1, 2014 to December 31, 2018

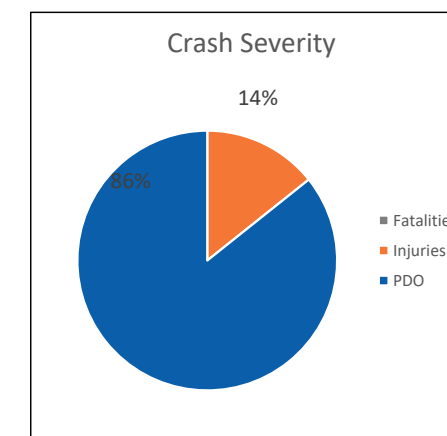
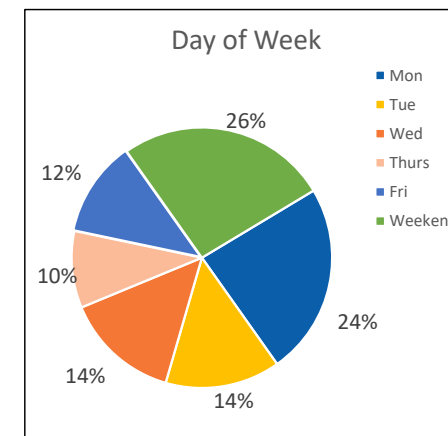
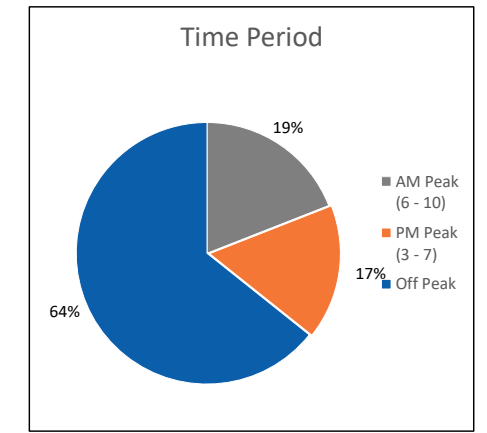
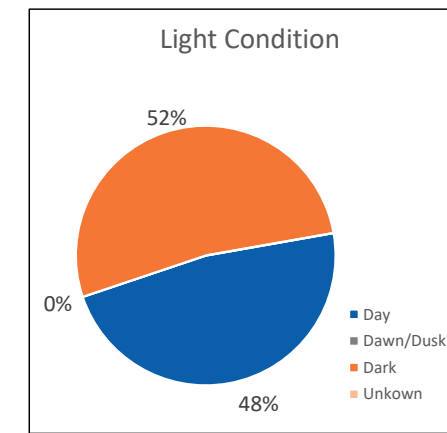
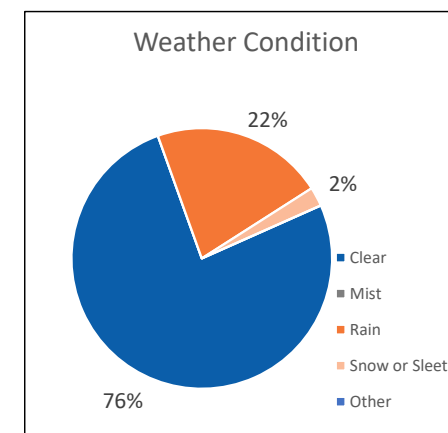
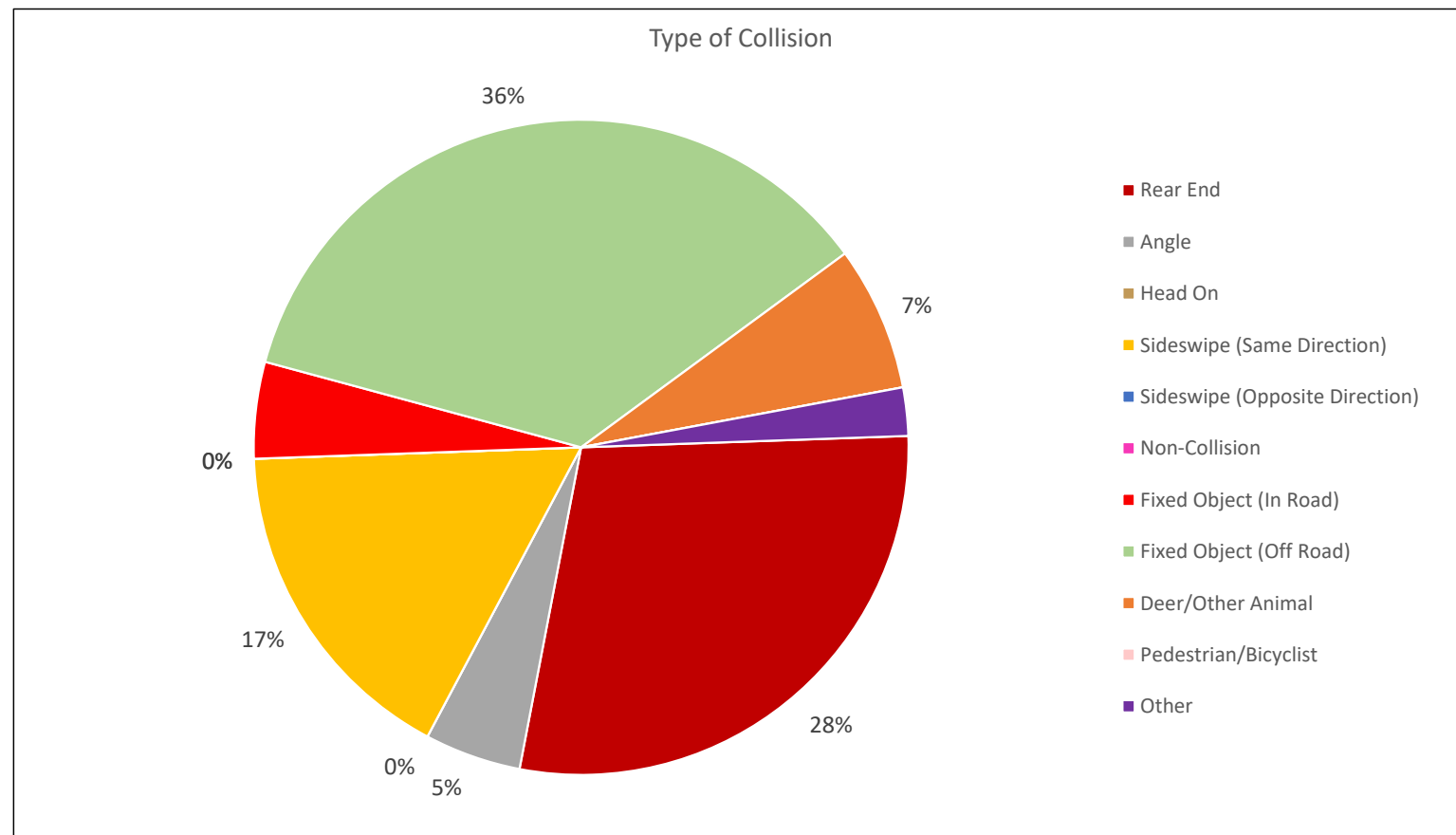
Total Comparison

YEAR	SEVERITY			WEEKDAY					WEEKEND	TIME PERIOD			LIGHT CONDITION				WEATHER CONDITION					TYPE OF COLLISION										TOTAL				
	Fatalities	Injuries	PDO	Mon	Tue	Wed	Thurs	Fri	Weekend	AM Peak (6 - 10)	PM Peak (3 - 7)	Off Peak	Day	Dawn/ Dusk	Dark	Unknown	Clear	Fog	Rain or Mist	Snow or Sleet	Other	Rear End	Angle	Head On	Side-swipe (Same)	Side-swipe (Opp.)	Non-Collision	Fixed Object (In Road)	Fixed Object (Off Road)	Deer/ Other Animal	Ped/ Bike		Backed Into	Other		
2014	0	2	8	3	1	2	2	0	2	1	2	7	2	0	8	0	9	0	1	0	0	2	0	0	1	0	0	2	3	2	0	0	0	0	0	10
2015	0	3	10	5	1	2	1	1	3	3	1	9	6	0	7	0	9	0	3	1	0	5	1	0	1	0	0	0	6	0	0	0	0	0	13	
2016	0	1	6	1	0	0	1	2	3	1	0	6	3	0	4	0	6	0	1	0	0	2	0	0	2	0	0	0	3	0	0	0	0	0	7	
2017	0	0	5	1	1	1	0	1	1	0	2	3	4	0	1	0	3	0	2	0	0	1	1	0	1	0	0	0	1	0	0	1	0	0	5	
2018	0	0	7	0	3	1	0	1	2	3	2	2	5	0	2	0	5	0	2	0	0	2	0	0	2	0	0	0	3	0	0	0	0	0	7	
TOTAL	0	6	36	10	6	6	4	5	11	8	7	27	20	0	22	0	32	0	9	1	0	12	2	0	7	0	0	2	15	3	0	0	1	42		

Crash summaries do not include toll booth crashes. Toll booth crashes analyzed separately.

Percentage Comparison

YEAR	SEVERITY			WEEKDAY					WEEKEND	TIME PERIOD			LIGHT CONDITION				WEATHER CONDITION					TYPE OF COLLISION										TOTAL			
	Fatalities	Injuries	PDO	Mon	Tue	Wed	Thurs	Fri	Weekend	AM Peak (6 - 10)	PM Peak (3 - 7)	Off Peak	Day	Dawn/ Dusk	Dark	Unknown	Clear	Mist	Rain	Snow or Sleet	Other	Rear End	Angle	Head On	Side-swipe (Same)	Side-swipe (Opp.)	Non-Collision	Fixed Object (In Road)	Fixed Object (Off Road)	Deer/ Other Animal	Ped/ Bike		Backed Into	Other	
2014	0%	20%	80%	30%	10%	20%	20%	0%	20%	10%	20%	70%	20%	0%	80%	0%	90%	0%	10%	0%	0%	20%	0%	0%	10%	0%	0%	20%	30%	20%	0%	0%	0%	0%	24%
2015	0%	23%	77%	38%	8%	15%	8%	8%	23%	23%	8%	69%	46%	0%	54%	0%	69%	0%	23%	8%	0%	38%	8%	0%	8%	0%	0%	0%	46%	0%	0%	0%	0%	0%	31%
2016	0%	14%	86%	14%	0%	0%	14%	29%	43%	14%	0%	86%	43%	0%	57%	0%	86%	0%	14%	0%	0%	29%	0%	0%	29%	0%	0%	0%	43%	0%	0%	0%	0%	0%	17%
2017	0%	0%	100%	20%	20%	20%	0%	20%	20%	0%	40%	60%	80%	0%	20%	0%	60%	0%	40%	0%	0%	20%	20%	0%	20%	0%	0%	0%	20%	0%	0%	20%	0%	0%	12%
2018	0%	0%	100%	0%	43%	14%	0%	14%	29%	43%	29%	29%	71%	0%	29%	0%	71%	0%	29%	0%	0%	29%	0%	0%	29%	0%	0%	43%	0%	0%	0%	0%	0%	0%	17%
TOTAL	0%	14%	86%	24%	14%	14%	10%	12%	26%	19%	17%	64%	48%	0%	52%	0%	76%	0%	21%	2%	0%	29%	5%	0%	17%	0%	0%	5%	36%	7%	0%	0%	2%	100%	



Route 267 (Dulles Toll Road/Dulles Greenway) Toll Plazas - Crash Analysis Crash Dates: January 1, 2014 to December 31, 2018

Total Comparison

YEAR	SEVERITY			WEEKDAY					WEEKEND	TIME PERIOD			LIGHT CONDITION				WEATHER CONDITION					TYPE OF COLLISION										TOTAL			
	Fatalities	Injuries	PDO	Mon	Tue	Wed	Thurs	Fri	Weekend	AM Peak (6 - 10)	PM Peak (3 - 7)	Off Peak	Day	Dawn/ Dusk	Dark	Unknown	Clear	Fog	Rain or Mist	Snow or Sleet	Other	Rear End	Angle	Head On	Side-swipe (Same)	Side-swipe (Opp.)	Non-Collision	Fixed Object (In Road)	Fixed Object (Off Road)	Deer/ Other Animal	Ped/ Bike		Backed Into	Other	
2014	0	4	19	1	8	2	4	2	6	6	5	12	19	0	4	0	21	0	2	0	0	10	1	0	4	0	0	2	2	0	0	0	4	0	23
2015	0	2	24	4	3	5	8	2	4	8	4	14	17	1	7	1	16	0	7	2	1	9	5	0	3	0	0	4	2	0	0	3	0	26	
2016	0	3	21	0	8	3	5	4	4	9	4	11	17	2	5	0	19	0	5	0	0	6	7	0	5	0	0	3	0	1	0	2	0	24	
2017	0	0	33	7	6	2	4	5	9	8	5	20	29	0	4	0	28	0	4	1	0	6	5	0	5	0	0	7	8	0	0	2	0	33	
2018	0	2	33	5	3	8	5	5	9	9	8	18	28	0	7	0	31	0	4	0	0	4	7	0	8	0	0	10	1	0	0	5	0	35	
TOTAL	0	11	130	17	28	20	26	18	32	40	26	75	110	3	27	1	115	0	22	3	1	35	25	0	25	0	0	26	13	1	0	16	0	141	

Percentage Comparison

YEAR	SEVERITY			WEEKDAY					WEEKEND	TIME PERIOD			LIGHT CONDITION				WEATHER CONDITION					TYPE OF COLLISION										TOTAL		
	Fatalities	Injuries	PDO	Mon	Tue	Wed	Thurs	Fri	Weekend	AM Peak (6 - 10)	PM Peak (3 - 7)	Off Peak	Day	Dawn/ Dusk	Dark	Unknown	Clear	Mist	Rain	Snow or Sleet	Other	Rear End	Angle	Head On	Side-swipe (Same)	Side-swipe (Opp.)	Non-Collision	Fixed Object (In Road)	Fixed Object (Off Road)	Deer/ Other Animal	Ped/ Bike		Backed Into	Other
2014	0%	17%	83%	4%	35%	9%	17%	9%	26%	26%	22%	52%	83%	0%	17%	0%	91%	0%	9%	0%	0%	43%	4%	0%	17%	0%	0%	9%	9%	0%	0%	17%	0%	16%
2015	0%	8%	92%	15%	12%	19%	31%	8%	15%	31%	15%	54%	65%	4%	27%	4%	62%	0%	27%	8%	4%	35%	19%	0%	12%	0%	0%	15%	8%	0%	0%	12%	0%	18%
2016	0%	13%	88%	0%	33%	13%	21%	17%	17%	38%	17%	46%	71%	8%	21%	0%	79%	0%	21%	0%	0%	25%	29%	0%	21%	0%	0%	13%	0%	4%	0%	8%	0%	17%
2017	0%	0%	100%	21%	18%	6%	12%	15%	27%	24%	15%	61%	88%	0%	12%	0%	85%	0%	12%	3%	0%	18%	15%	0%	15%	0%	0%	21%	24%	0%	0%	6%	0%	23%
2018	0%	6%	94%	14%	9%	23%	14%	14%	26%	26%	23%	51%	80%	0%	20%	0%	89%	0%	11%	0%	0%	11%	20%	0%	23%	0%	0%	29%	3%	0%	0%	14%	0%	25%
TOTAL	0%	8%	92%	12%	20%	14%	18%	13%	23%	28%	18%	53%	78%	2%	19%	<1%	82%	0%	16%	2%	<1%	25%	18%	0%	18%	0%	0%	18%	9%	<1%	0%	11%	0%	100%

