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Charles D. Baker
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Evaluating the Safety Impacts of Flashing Yellow Permissive Left-Turn Indications in Massachusetts

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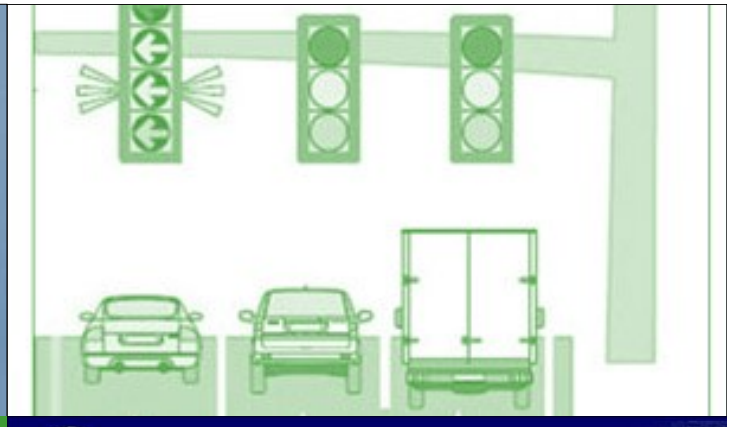

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16. Abstract

The 2009 edition of the *Manual on Uniform Traffic Control Devices (MUTCD)* introduced the flashing yellow arrow (FYA) as a permissive left-turn indication. Massachusetts recently implemented this novel traffic control device through a statewide retrofitting project at over 350 traditional protected-permissive left-turn traffic signals. A before/after implementation safety impact analysis was conducted, including a thorough benefit-to-cost analysis. The analysis evaluated the economic benefits of installing FYA signals, yielding a range of benefit-to-cost ratios across the three FYA treatment intersections (3-way with one FYA, 4-way with one FYA, and 4-way with two-or-more FYAs). Crashes were annualized per year using the FHWA *KABCO* injury scale, with economic costs per injury level calculated using Massachusetts adjusted FHWA costs ("MassDOT Economic Adjusted Costs"). In MassDOT adjusted costs, the 3-way FYA intersections yielded the highest BC ratio range (180:1 to 22:1) and 4-way intersections with multiple FYA approaches yielded the lowest (22:1 to 3:1). The economic benefits suggest that the FYA signal retrofits should be widely implemented, regardless of intersection type. Overall, results provided overwhelming evidence that the FYA reduced the average annual number of injury-related crashes and led to lower economic cost of injuries in all three of the treatment types of intersections investigated.

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Evaluating the Safety Impacts of Flashing Yellow Permissive Left-Turn Indications in Massachusetts

Final Report

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Disclaimer

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Executive Summary

This study of *Evaluating the Safety Impacts of Flashing Yellow Permissive Left-Turn Indications in Massachusetts* was undertaken as part of the Massachusetts Department of Transportation (MassDOT) Research Program. This program is funded with Federal Highway Administration (FHWA) State Planning and Research (SPR) funds. Through this program, applied research is conducted on topics of importance to the Commonwealth of Massachusetts transportation agencies.

The 2009 edition of the *Manual on Uniform Traffic Control Devices* (MUTCD) introduced the flashing yellow arrow (FYA) as a permissive left-turn indication *(1)*. Massachusetts has set out to implement this novel traffic control device at intersections across the Commonwealth. The eligibility criteria for installing an FYA signal at an intersection approach required: 1) Protected-permissive left-turn (PPLT) phasing, and 2) dedicated left-turn lane. Since 2013, MassDOT has begun the implementation process, with contracts set in place to ultimately retrofit over 350 traditional PPLT traffic signals to include the FYA permissive indication. With the completion of the retrofit project in sight, a need exists to investigate the safety impacts of these traffic control devices. Thus, a pre- and post-implementation cost-benefit analysis needs to be evaluated, specifically taking into consideration various metrics such as jurisdiction, treatment type, and infrastructure elements at each respective location throughout the Commonwealth. More so, there is a need for an updated inventory database of all statewide FYA locations.

This research endeavor was conducted across four major tasks, in an effort to evaluate the safety impacts of FYA signals in Massachusetts.

Objectives:

- Develop an FYA inventory database to track and itemize current installations (as of spring 2020).
- Conduct an in-depth before-and-after crash analysis of FY implementation intersections across Massachusetts.
- Perform a cost-benefit analysis for the implementation of the FYA across statewide protected/permissive left-turn indications (exploring both FHWA and MassDOT adjusted injury costs).
- Provide a set of recommendations and prioritization plan for future FYA retrofitting procedures, taking into consideration both the safety assessment and cost-benefit analysis.

While taking into consideration the potential crash data availability of recently installed FYA signals, a threshold of two years before and after implementation was utilized to define a preliminary list of study sites. In addition to these temporal conditions, a spatial review of crash distribution surrounding each FYA intersection was taken into consideration. A 200-foot buffer was selected to identify intersection-related crashes, which was verified through a blind review of crash narratives for several sample sites. More so, volume data (AADT) was

aggregated using both the MS2 Transportation Data Management System and the MassDOT Roadway Inventory to filter out FYA locations with reliable and accurate volume information. The volume data from these sources was adjusted to reflect regionality across Massachusetts and yearly factors based on the before-and-after implementation dates of each FYA location. Ultimately, there were a total of 166 FYA intersections (approx. 83% of crash available locations) selected to be included in the before/after cost-benefit analysis.

The 166 FYA intersections were evaluated in three treatment categories: 3-way intersections with one FYA approach; 4-way intersections with one FYA approach; and 4-way intersections with two or more FYA approaches. Vehicle crashes were aggregated from the intersection-level and characterized into the following: total crashes, injury crashes, property damage only (PDO) crashes, rear-end crashes, angle crashes, single vehicle crashes, head-on crashes, left-turn (LT) crashes, and left-turn-opposing-through (LTOT) crashes. Crash data was analyzed according to average annual before and after by crash type, as well as the KABCO injury scale. Further, in an effort to remain consistent with MassDOT crash reporting methods, the before/after crashes were also reported in equivalent property damage only (EPDO) values.

The FYA installation costs were derived from various sources, such as a combination of previous FYA literature *(8,19),* MassDOT contractual records and construction estimates, and a survey of local transportation consultants. FYA crash injury reduction benefits were calculated using annualized injury costs during the before and after periods using societal economic costs from *(21)* and *(24).* Benefit-to-cost (BC) ratios were calculated using these annualized FYA costs versus the crash severity reduction benefits.

Key Findings:

- Three-way intersections with one FYA had the largest sample of study intersections; however, this treatment category yielded the smallest total number of before/after crashes.
- Treatment Categories #2 and #3 resulted in a significant reduction in injury-related crashes, yet all three categories had significant increases in rear-end crashes, suggesting the potential for stronger yield perception from drivers (e.g., fewer head-on and angle crashes).
- LTOT-related crash rates were only significantly reduced in Treatment Category #3.
- Treatment Categories #2 and #3 significantly reduced EPDO crashes; however, Treatment Category #1 resulted in a slight increase of EPDO crashes.
- In MassDOT adjusted costs: Treatment Category #1 yielded the highest BC ratio range (180:1 to 22:1) and Treatment Category #3 yielding the lowest (22:1 to 3:1).
- The economic benefits suggest that the FYA signal retrofits should be widely implemented, regardless of intersection type.
- Overall, results provided overwhelming evidence that the FYA reduced the average annual number of injury-related crashes, and ultimately led to a lower economic cost of injuries at all three of the treatment types investigated in this study.

Recommendations:

- Given the challenges in assessing approach-level crashes for each FYA installation, further research should be conducted to assess the efficacy of using crash reports/diagrams to assess approach-level safety benefits.
- Results from this study suggest further investigation into the performance of FYAs at 3-way intersections across Massachusetts, especially focusing on the safety impacts of the variety of traffic signal phasing schemes.
- Prioritize the installation of FYAs based on cost and not on intersection type, ultimately leading to widespread implementation.
- Evaluate more efficient intersection volume data collection strategies to better assess future safety impacts.
- Continue to research the impacts of intersection infrastructure elements and its impact on driver behavior, particularly with left-turn maneuvers with the FYA.

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Table of Contents

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List of Tables

List of Figures

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List of Acronyms

Acronym	Expansion
AADT	Annual Average Daily Traffic
BC	Benefit-to-Cost
CG	Circular Green
EB	Empirical-Bayes
EPDO	Equivalent Property Damage Only
FHWA	Federal Highway Administration
FYA	Flashing Yellow Arrow
GIS	Geographic Information System
HSM	Highway Safety Manual
LOC	Level of Confidence
LT	Left-Turn
LTOT	Left-Turn-Opposing-Through
MassDOT	Massachusetts Department of Transportation
MEV	Million Entering Vehicles
MPO	Metropolitan Planning Organizations
MUTCD	Manual on Uniform Traffic Control Devices
NCHRP	National Cooperative Highway Research Program
PDO	Property Damage Only
PPLT	Protected-Permissive Left-Turn
RPA	Regional Planning Agencies
SGA	Solid Green Arrow
SPF	Safety Performance Functions
SRA	Solid Red Arrow
SYA	Solid Yellow Arrow
TEV	Total Entering Vehicles per Day
VMT	Vehicle Miles Traveled

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1.0 Introduction

This study of *Evaluating the Safety Impacts of Flashing Yellow Permissive Left-Turn Indications in Massachusetts* was undertaken as part of the Massachusetts Department of Transportation (MassDOT) Research Program. This program is funded with Federal Highway Administration (FHWA) State Planning and Research (SPR) funds. Through this program, applied research is conducted on topics of importance to the Commonwealth of Massachusetts transportation agencies.

In 2013, the Massachusetts Department of Transportation (MassDOT) began installing the flashing yellow arrow (FYA) as a permissive left-turn indication at intersections across the Commonwealth. Since then, there has been evidence to suggest that this new permissive indication has lowered left-turn crash rates at their respective locations. This study aims to quantitatively evaluate the safety impact of these FYAs in recent years. The FYA has been proven effective in other states around the country; however, there remains a need to evaluate its worth here in Massachusetts. This research focuses on conducting a thorough cost-benefit analysis for the implementation of this indication, specifically taking into consideration the phase scheme, jurisdiction, and infrastructure elements of each respective location.

1.1 Background

1.1.1. Implementation of the Flashing Yellow Arrow

The flashing yellow arrow (FYA) was introduced in the 2009 edition of the *Manual on Uniform Traffic Control Devices (1)* as a recommended permissive left-turn indication, as displayed in Figure 1. Following a number of research initiatives, the culminating National Cooperative Highway Research Program (NCHRP) work completed in *NCHRP Report 493* led to the proposal of this recommendation based on the significant anticipated benefits from this novel traffic control device *(2).* Since the FYA's adoption into national standards, agencies across the country have begun implementing the FYA as a permissive left-turn indication. As of 2013, there were approximately 31 states that had already implemented the FYA *(3)*. Notably, this list of state agencies has since grown since then, including states such as Massachusetts and Wisconsin.

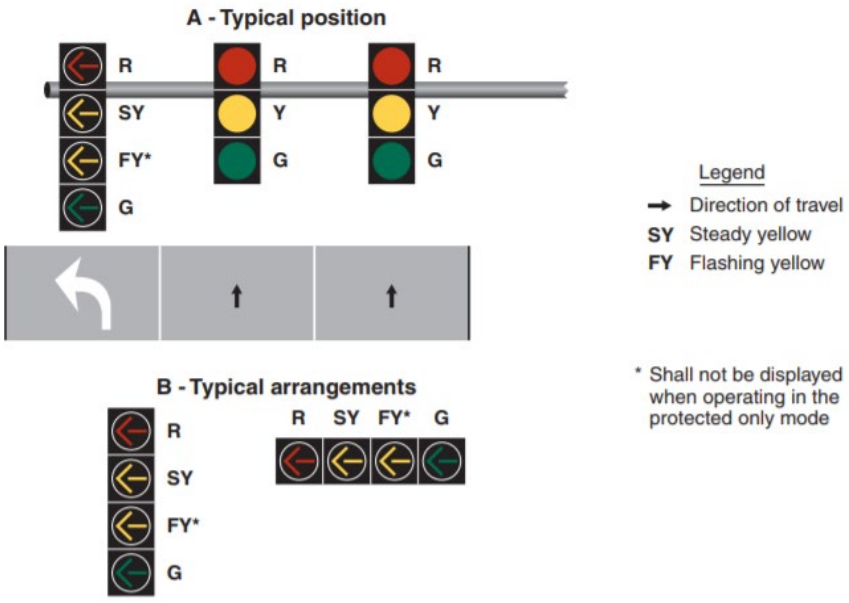

Figure 1: Typical position and arrangements of FYA signal for left turns

Several studies in recent years have investigated the driver comprehension of these novel traffic control devices. As the application of FYAs became prevalent across the country, Knodler et al. conducted studies that evaluated the exposure impacts on other similar signal indications. Through extensive driver comprehension survey studies, they found that the exposure to the FYA permissive indication did not have a negative impact on the driver comprehension of the solid yellow arrow (SYA) indication *(4).* In addition to this, Knodler et al. conducted various comprehension-based studies that evaluated the comprehension of FYA indications against the existing circular green (CG) permissive indications. Through both dynamic driving simulator environments and static evaluations, they determined that there was insignificant driver comprehension impacts of the CG indication, as compared to the novel alternative *(5, 6).* These studies have developed a foundation for evaluating driver comprehension, particularly with the FYA permissive indication.

In addition to evaluating the driver comprehension of the FYA indication, researchers have also investigated the various infrastructure elements that pair with this signal implementation. For instance, supplementary signage has been studied in various aspects, namely assessing the effect on driver behavior. The impacts of supplementary signage with regards to the FYA indication have been evaluated in recent years, as displayed with an example in Figure 2. Schattler et al. conducted a naïve before-and-after study of crash frequencies, which provided evidence to suggest safety improvements from implementing FYAs for left turns *(7, 8)*. More so, additional studies have found that the overall comprehension, and ultimately driver behavior with the FYA indication, benefited from the introduction of supplementary signage *(9)*. Aside from evaluating the impacts of supplementary signage, there exist several concerns with the implementation of multiple permissive indications within certain jurisdictions or municipalities. However, Rietgraf and Schattler *(10)* found that there was no significant difference in safety impacts, given multiple forms of permissive left-turn indications (i.e., FYA and CG). That said, this study provided evidence to suggest that consistency in

permissive left-turn indications would yield higher driver comprehension. These research studies remain important in progressing toward consistency in the FYA permissive left-turn implementation. Specifically, both the integration of supplementary signage infrastructure and consistency of permissive indications ultimately reinforce the decision making for statewide retrofitting procedures.

Source: Schattler et al. *(7)*

Figure 2: Examples of FYA supplementary signage

The FYA has been studied in a multitude of ways over the years, specifically with regards to the NCHRP community. Following the recommendations made from *NCHRP Report 493 (2),* several researchers continued to investigate the implementation impacts of the FYA permissive left-turn indication. A field assessment of the FYA indication across the United States was conducted as part of *NCHRP Web-Only Document 123 (11).* This analysis was conducted to evaluate the existing safety improvements that resulted from converting to the FYA permissive-only left-turn indication. Following this study, an additional initiative was pursued in *NCHRP Web-Only Document 207*, which specifically focused on bimodal signal indication displays *(12).* Through both a computer-based static evaluation and full-scale driving simulator study, this research evaluated the efficacy of integrating the FYA indication through a bimodal fashion within a three-section traffic signal display. Ultimately, it was found that the FYA was best fit as a bimodal display with the SYA indication (middle section). More so, Hurwitz et al. conducted a driving simulator experiment to evaluate the comprehension impacts on vertical positioning of three- and four-section vertical signal displays. This resulted in insignificant driver fixation durations on the FYA indication comparing the three- versus four-section signal displays *(13).* That said, the results from these studies were not found to be significant in identifying recommendations for retrofitting procedures, and therefore further research was recommended.

There still exists a need to implement consistent recommendations for standardizing the protected/permissive phasing with respect to the FYA nationwide. Studies in recent years have investigated the impacts of various phase sequences, when transitioning between the protected and permissive left-turn movements. Appiah and Cottrell evaluated this transition period as the "FYA delay," which represents the solid red arrow (SRA) indication that appears in the transition between the protected solid green arrow (SGA) movements and the FYA movements *(14).* Through microsimulation analyses, this study revealed that there were significant safety impacts with the inclusion of the FYA delay. More recently, Tainter et al.

conducted a driver comprehension and field study to evaluate the impacts of various protected/permissive left-turn (PPLT) phase schemes in a real-world environment *(15)*. In this study, drivers were found to anticipate the all-red clearance interval (i.e. FYA delay) during the protected/permissive transition period. Empirical field analysis found that drivers performed more risky maneuvers when the all-red clearance interval was not present. An example of the trajectory data collected during the field study is shown in Figure 3.

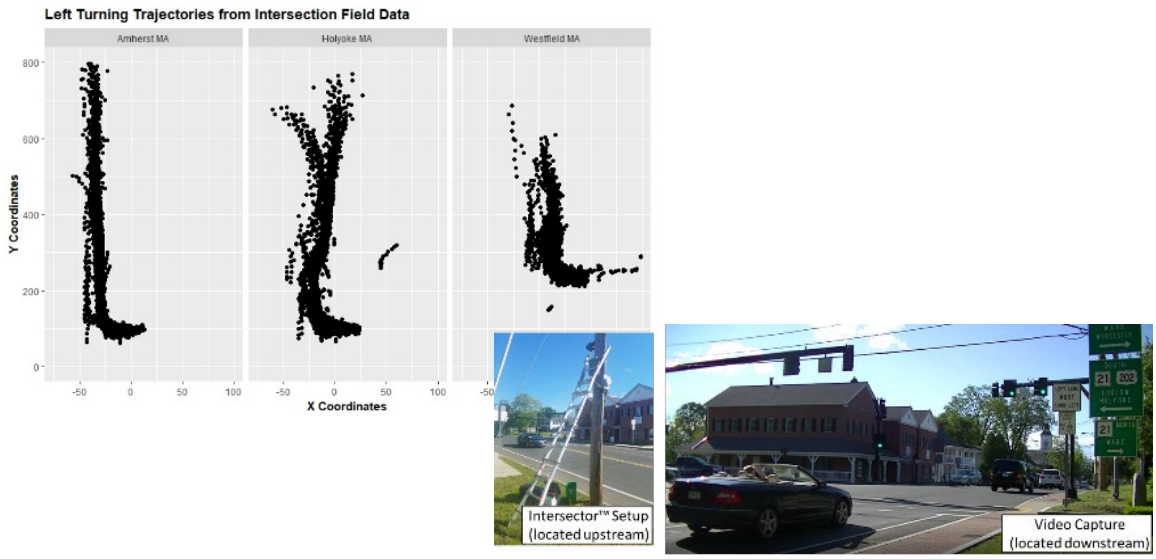

Figure 3: Example of field data collection procedure and trajectory output

In addition to this previous field study, Figure 4 presents results from the driver comprehension surveys of various PPLT phasing schemes that were conducted in *(15)*. Further, it is important to note that a current NCHRP project (NCHRP 03-125) remains in progress to develop FYA-based recommendations for practitioners and agencies with respect to the use of the all-red clearance interval when transitioning between protected and permissive indications.

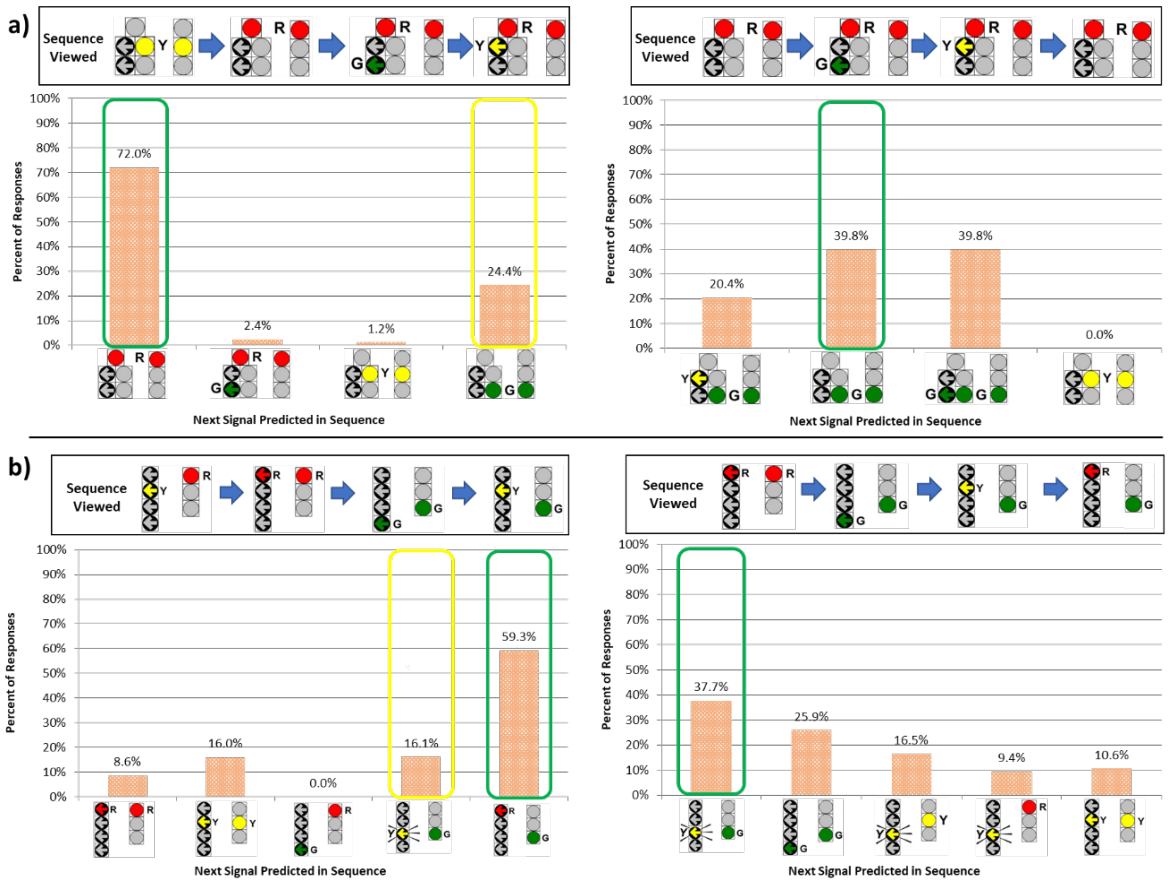

Figure 4: Nationwide FYA driver comprehension survey results

Other states across the country have investigated the implementation impacts of the FYA permissive indication. For instance, there have been recent initiatives to evaluate the potential of a dynamic left-turn control phasing, particularly emphasizing the application of the FYA *(16)*. Minnesota also pursued the development of guidelines for time-of-day left-turn permissive phasing, particularly for the FYA. In this system, researchers developed an interactive tool that could evaluate the potential impact for implementing this strategy at various candidate intersection approaches *(17)*. More so, researchers in North Carolina evaluated the impact in converting to FYA PPLT phasing from various previous phasing schemes, such as permissive-only and protected-only. The results from this study found significant evidence to suggest a reduction in target crashes (e.g., left-turn (LT) and left-turn-opposing-through (LTOT), angle, head-on, etc.) for directly converting from the CG permissive indication to the FYA left-turn permissive indications *(18)*. Further, Srinivasan et al. developed and calibrated safety performance functions (SPFs) to assess the FYA impacts in North Carolina, Oregon, Nevada, and Oklahoma *(19)*. The previous studies evaluating the potential variations of FYA phasing have established unique perspectives into the analysis of the specific FYA phase schemes and their safety benefits.

1.1.2. Massachusetts Crash Data Resources

Historical crash data in Massachusetts was collected from the University of Massachusetts Traffic Safety Research Program (UMassSafe) Data Warehouse *(20)*. UMassSafe provided

secure access to the Massachusetts Crash Worthiness Data System (CDS), which contains historical crash information and over 20 years of crash-related data. It is important to note that this research was conducted using "open" years of reported data for the years 2018–2019. Traffic volume data in Massachusetts was collected using the MassDOT MS2 Transportation Data Management System and the MassDOT Roadway Inventory. These data sources were mined for realistic and accurate historical traffic count data; however, it should be pointed out that null and default values in these respective systems were not included in this study.

1.2 Objectives and Project Motivation

The 2009 edition of the *Manual on Uniform Traffic Control Devices* (MUTCD) introduced the FYA as a permissive left-turn indication *(1).* Massachusetts has set out to implement this novel traffic control device at intersections across the Commonwealth. The eligibility criteria for installing a FYA signal at an intersection approach required: 1) Protected-permissive left-turn (PPLT) phasing and 2) dedicated left-turn lane. Since 2013, MassDOT has begun the implementation process, with contracts set in place to ultimately retrofit over 350 traditional PPLT traffic signals to include the FYA permissive indication. However, with the completion of the retrofit project in sight, a need exists to investigate the safety impacts of these traffic control devices that have now been installed. Thus, a pre- and post-implementation cost-benefit analysis of the FYA signals was initiated, specifically taking into consideration various metrics such as jurisdiction, treatment type, and infrastructure elements at each of respective location throughout the Commonwealth. Finally, there is a need for an updated inventory database of all statewide FYA locations.

Task 1 – Before/After Crash and Volume Acquisition. The research team developed an FYA inventory database to track and itemize the current installations to date and those that had not been retrofitted as of February 2020. Based on this inventory, study locations were filtered based on available years of post-installation crash data. The research team also worked to obtain realistic and accurate volume data for the study intersections, derived from various MassDOT resources.

Task 2 – Safety Assessment of FYA Intersections. The research team conducted an in-depth crash analysis of pre-and post-implementation periods for the FYA signal indication at all of the acceptable study intersections with a permissive left-turn FYA indication installed across Massachusetts.

Task 3 – FYA Cost-Benefit Analysis. The research team conducted a cost-benefit analysis for the implementation of the FYA at statewide protected/permissive left-turn indications. The FYA implementation costs were derived from MassDOT contract information and strategic interviews with local consultants.

Task 4 – MassDOT FYA Prioritization Plan. The research team provided a prioritization plan moving forward in future MassDOT retrofitting procedures, taking into consideration the results of both the safety assessment and cost-benefit analysis. The guidance provided in

this plan will promote effective and safe implementation of the FYA left-turn signals in future projects.

1.3 Organization of Report

This report is organized as follows. Chapter 1 introduces the derivation of the FYA, previous literature evaluating its efficacy, research motivation, and detailed objectives and tasks for this research project. Chapter 2 presents the methodology, including an in-depth explanation of the before/after FYA safety assessment, and cost-benefit analysis. Chapter 3 presents the results from this study, Chapter 4 presents implementation and technology transfer, and Chapter 5 summarizes the findings of this project, including the proposed prioritization plan for future FYA installations in Massachusetts.

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2.0 Research Methodology

This research endeavor was conducted across four major tasks, in an effort to evaluate the safety impacts of FYA signals in Massachusetts. First, a statewide inventory was developed, including all of the existing FYA left-turn signal installations at both rural and urban 3- and 4-leg intersections. Next, a before/after safety assessment was conducted to evaluate the overall crash impacts at the study intersections, followed by a cost-benefit analysis to quantify the safety benefits of FYA installations. Lastly, these results were compiled and reported to provide an overview of FYA signal safety impacts in Massachusetts.

2.1 Developing the FYA Inventory

To begin the process of verifying and updating the FYA locations in Massachusetts, MassDOT provided the research team with a skeleton database of 379 FYA locations included within seven recently completed and existing statewide retrofit contracts. Initially, only the signal coordinates, signal ID, town/municipality, and intersection street names were provided. The following section discusses the methodological approach taken in an effort to build out the MassDOT FYA signal inventory database across the entire Commonwealth of Massachusetts.

First, utilizing the intersection street names and XY coordinate information provided in the initial FYA database, an in-depth review of all intersections was required. More so, each of the 379 intersections were investigated using Google Maps Street View to identify the following characteristics:

- FYA Present (Yes/No/Uncertain)
- FYA Approach (Including travel direction and street name)
- If not FYA, existing LT signal phasing
- Supplementary Signage (Yes/No)
- Intersection Type (3-way/4-way)
- Multiple FYAs at location (including number)

With these intersection characteristics included in the database, the FYA locations were then filtered out, resulting in a total of 248 signalized intersections where an FYA signal was present. The 248 FYA locations were mapped out using ArcMap GIS software, as shown in Figure 5. In addition to these basic characteristics, the locations were cross-matched with the MassDOT contracts associated with them. From there, the inclusion of contracted work was included in the spreadsheet, such as cabinet work upgrades, signal mount installation information, and contract closeout dates. That said, certain installation elements such as retroreflective backplates were not taken into consideration for this study but may have an impact on the post-implementation analysis.

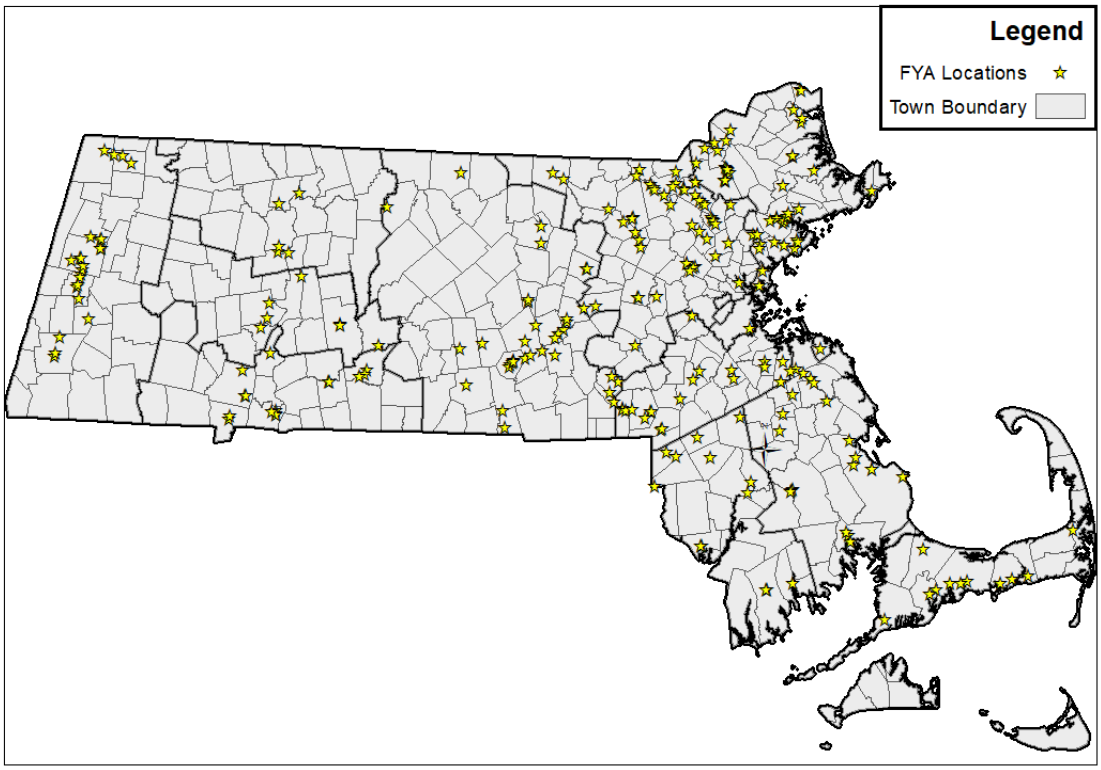


Figure 5: GIS map of confirmed FYA locations in Massachusetts

Lastly, given the difficult circumstances within this project scope, it was determined that the installation dates of each FYA location would be determined through Google Street View imagery. For instance, a thorough review of historical imagery was viewed to determine the latest imagery for each location with a circular green left-turn indication. In addition, the earliest known imagery of the FYA was included and served as the earliest post-implementation date. It is important to note that the post-installation dates were cross-referenced with the contract closeout dates. If the contract closeout occurred before the earliest known post-implementation imagery, then the contract closeout date was selected for this study. More so, given the novelty of the FYA signal in Massachusetts, it was understood that the first application took place on January 15, 2013, in Lenox, Massachusetts. Therefore, this date was also cross-referenced with the before-implementation and the latest date between the two was selected for this study. Additionally, a link to the Google Street View imagery was included in the database, along with any noteworthy comments for any unique characteristics or intersection attributes. The FYA inventory database is presented in Appendix A, and an explanation of each column from the database is presented in Table 1.

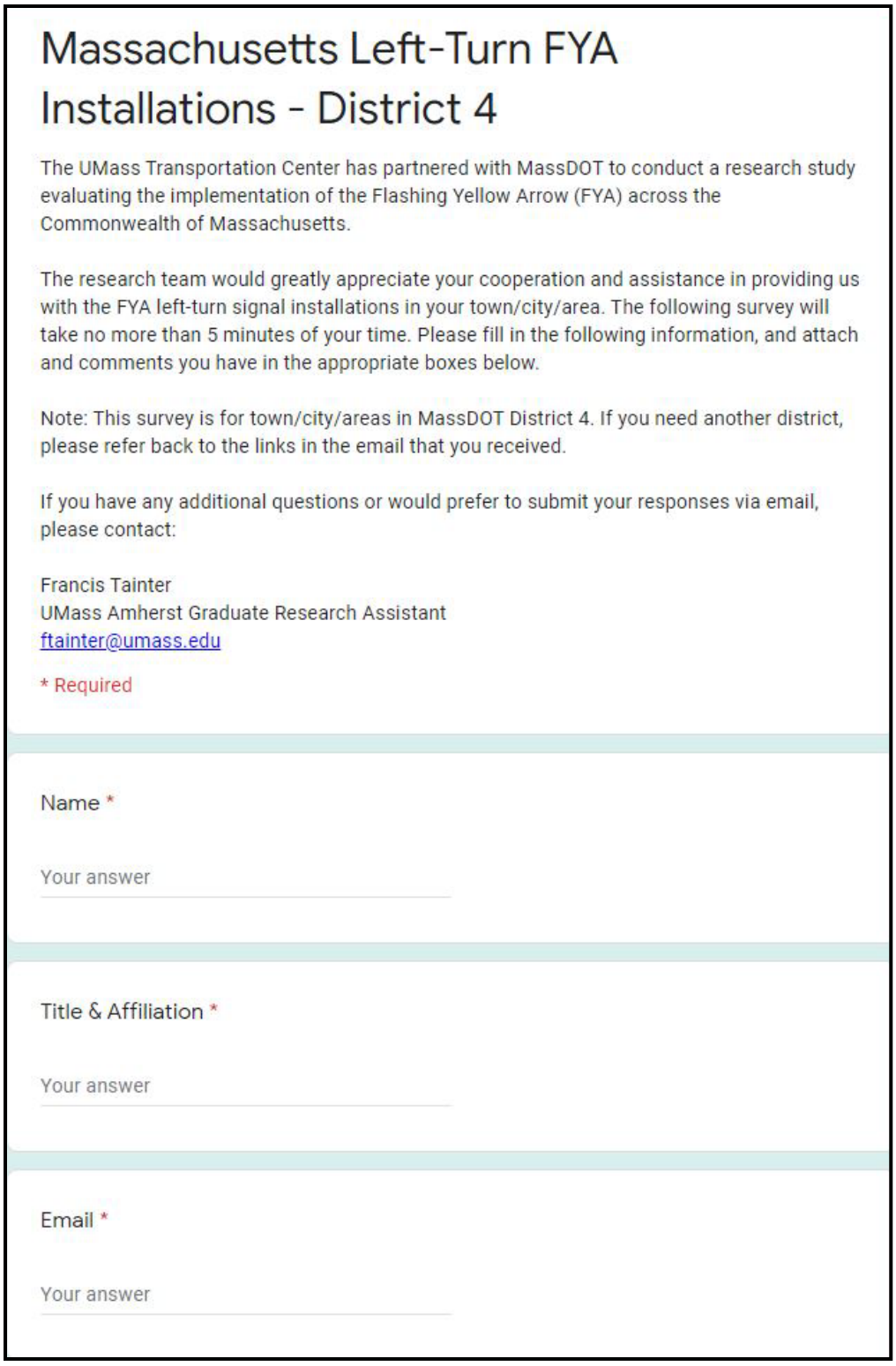
In addition to conducting a review of historical roadway imagery, a survey was developed in order to assist with verification of the FYA locations in Massachusetts. The survey was disseminated across Massachusetts, using the listserv associated with the UMass Transportation Center and Baystate Roads organizations. Through these respective listservs, the intent was to reach out to all cities, towns, municipalities, Metropolitan Planning Organizations (MPOs), and Regional Planning Agencies (RPAs) in Massachusetts. The screenshot provided in Figure 7 displays the general format of the survey that was provided

to all recipients, and the complete survey results can be found in Appendix A. The survey was broken down by MassDOT districts for simplicity's sake. The recipients were instructed to complete the survey for their respective municipalities, towns, etc. Once selected on their respective area, they were provided with a list of MassDOT–operated FYA locations in that town or city, according to the inventory database that was established. The survey takers were instructed to confirm whether these intersections did or did not have an FYA signal and then were asked to provide any additional intersections where they could confirm an FYA signalized approach. These additional FYA locations were assumed to be municipally owned/operated and therefore were categorized as such in a separate database.

The inventory verification was conducted via survey; however, it remained nearly impossible to receive feedback from all 351 towns and cities in the Commonwealth of Massachusetts. As a result, there were over 150 survey verifications of the 248 confirmed FYA locations statewide. Although the survey was unable to cover all cities and towns, there were over 50 FYA locations that were verified as having an FYA signal, even though the preliminary Street View imagery provided an "uncertain" confirmation. Over 115 towns and cities provided a response to this survey, including over 30 secondary verifications in certain towns and cities. It is important to note that over 65 additional town- or city-owned and/or operated FYA signals were imputed from this survey. These locations were not included in this MassDOT intersection safety analysis; however, a secondary research project has been initiated to further analyze these specific municipally owned or operated locations.

Table 1: FYA inventory database data dictionary

Column Identifier	Description
FID	The ID assigned to the FYA intersection, which was utilized to track throughout the crash/volume data process
Signal_ID	MassDOT assigned ID, which represents the cabinet number for the FYA intersection
Dist_ID	MassDOT District assigned ID, representing the intersection ID associated within that respective district
District	The MassDOT District where the FYA intersection is located
Location 1 & 2	Location 1 represents the primary roadway and Location 2 represents the secondary roadway of the FYA intersection
Latitude/Longitude	The geographic coordinates representing the centroid of each FYA intersection
FYA Approach	Identifies the approach within the intersection where the primary FYA signal was implemented
Supp. Signage (Yes/No)	Indicates whether there is a supplementary "Left Turn Yield on FYA" sign present on the FYA approach
Intersection Legs	Represents the total of number of intersection approaches for each FYA intersection
Multiple FYA Approaches	Identifies whether there are multiple FYA approaches at the intersection, and if so, include the total number of FYA signals present
Latest Before Installation Imagery	Indicates the latest known pre-implementation Google Street View imagery that depicts the circular green indication (or previous permissive left-turn indication)
Earliest After Installation Imagery	Indicates the earliest known post-implementation Google Street View imagery that depicts the circular green indication (or previous permissive left-turn indication)
Link to Street View	Provides the link to the geographic coordinates presented above, also with Google Street View imagery of the FYA signal approach



Massachusetts Left-Turn FYA Installations - District 4

The UMass Transportation Center has partnered with MassDOT to conduct a research study evaluating the implementation of the Flashing Yellow Arrow (FYA) across the Commonwealth of Massachusetts.

The research team would greatly appreciate your cooperation and assistance in providing us with the FYA left-turn signal installations in your town/city/area. The following survey will take no more than 5 minutes of your time. Please fill in the following information, and attach and comments you have in the appropriate boxes below.

Note: This survey is for town/city/areas in MassDOT District 4. If you need another district, please refer back to the links in the email that you received.

If you have any additional questions or would prefer to submit your responses via email, please contact:

Francis Tainter
UMass Amherst Graduate Research Assistant
ftainter@umass.edu

* Required

Name *

Your answer

Title & Affiliation *

Your answer

Email *

Your answer

Figure 6: Sample of statewide disseminated FYA inventory survey

2.2 Before/After Crash and Volume Data Acquisition

With the statewide FYA inventory database finalized, the next step was to identify the locations that could be included in the before-and-after safety analysis. The main objective of this task was to develop a crash registry for the FYA installations across Massachusetts, both before and after the signals were implemented. First, the research team obtained the statewide crash data from 2011 to 2019 through the UMassSafe Traffic Safety Data Warehouse. The processing and compiling of crash data were done primarily in R, a statistical computing programming language. The graphic presented in Figure 8 displays a screenshot of the interface utilized in this data compilation.

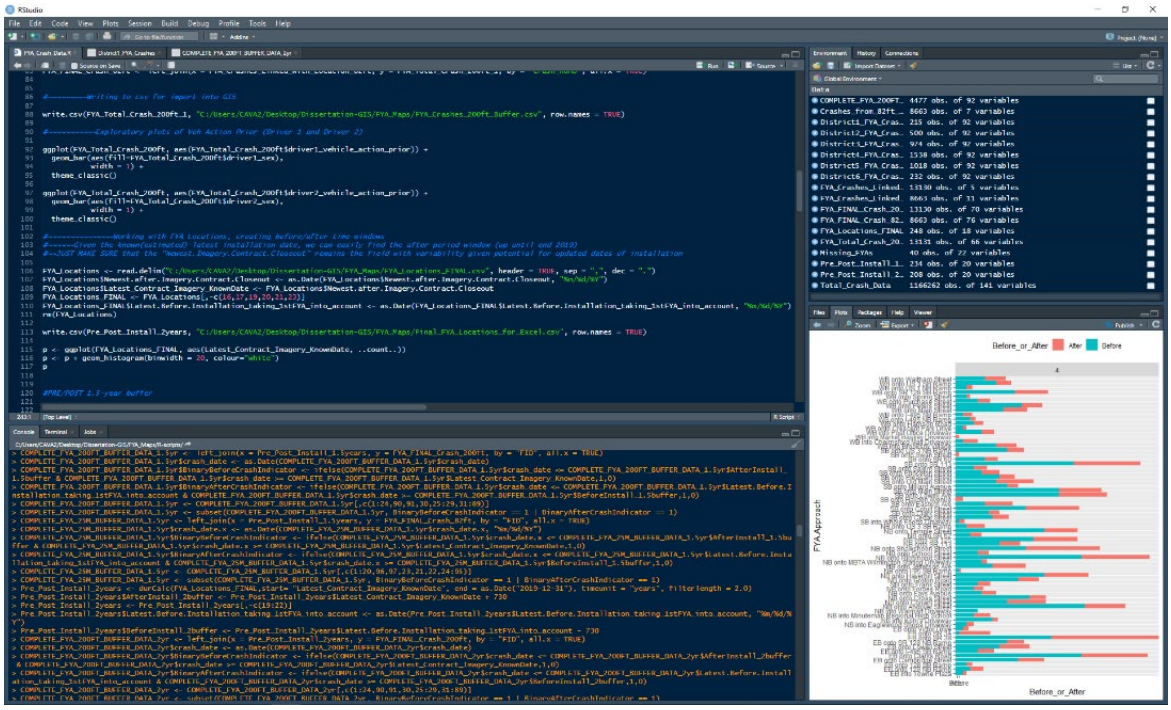


Figure 7: Example of RStudio Interface

As previously mentioned, in order to accurately assign crash data to each of the FYA intersections, there was a need to define the implementation period of each FYA signal. In this case, Google Street View imagery dates were utilized to determine the most recent confirmed "before" period (i.e., with a circular green indication instead of an FYA indication), and the earliest "after" period (i.e., with an FYA indication). This imagery was compiled and thoroughly quality checked. Once the before and after dates were determined, an appropriate crash year sample needed to be defined. Given the novelty of FYA signals in Massachusetts, with the first signal implemented in early 2013, the after dates were utilized as a design barrier to ensure quality and, more importantly, an adequate sample size of post-implementation crash data. As displayed in Figure 9, both a 1.5- and 2-year pre/post-implementation timespan were considered. The 1.5-year dataset provided the potential for monthly bias, particularly not including a yearly representative sample. More so, the bias

could represent alternative calendar months during the after period, as compared to the before period. With this anticipated bias, the 2-year dataset was determined as appropriate for the final analysis. While a longer pre- and post-implementation time period would typically be preferred in conducting a cost-benefit analysis, the decision was made to maximize the number of FYA site locations using the 2-year periods.

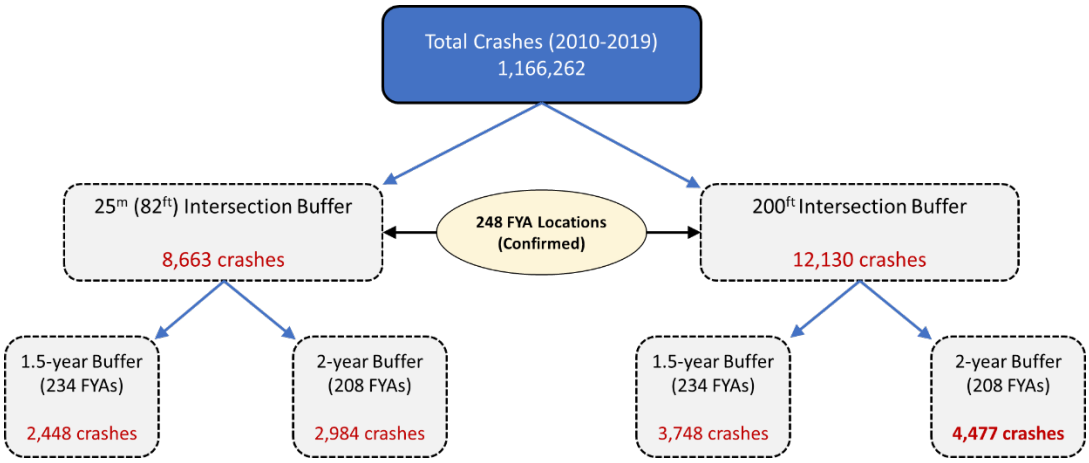


Figure 8: Crash dataset breakdown for FYA locations

In addition to identifying the before and after analysis periods, the team needed to evaluate an appropriate intersection buffer from which to extract crash data. In an effort to remain consistent with previous crash cluster research from MassDOT, the team investigated the utilization of 25-meter (82-foot) cluster buffers around each FYA location *(21)*. More so, previous literature specifically pertaining to safety analyses with respect to FYA implementation has considered intersection buffers between 150 and 250 feet *(7, 9)*. That said, the 200-foot buffer was selected initially for preliminary analysis. A spot-check quality assurance against the two aforementioned buffers was conducted to ensure that the 200-foot buffer did not lead to the inclusion of non-intersection-related crashes. A blind review of several crash narratives was conducted using the reported Roadway Junction type field to confirm the outcome between intersection and non-intersection-related crashes within the two distance buffers from the centroids of each intersection. As a result, there was no apparent impact from using a 200-foot intersection crash buffer as compared to previous literature. That said, the 200-foot buffer provided a sufficient sample of potential location-based crash data. The GIS map provided in Figure 10 displays two sample locations in Auburn, Massachusetts, with the 200-foot buffer depicted, including the red crash markers for each respective intersection.

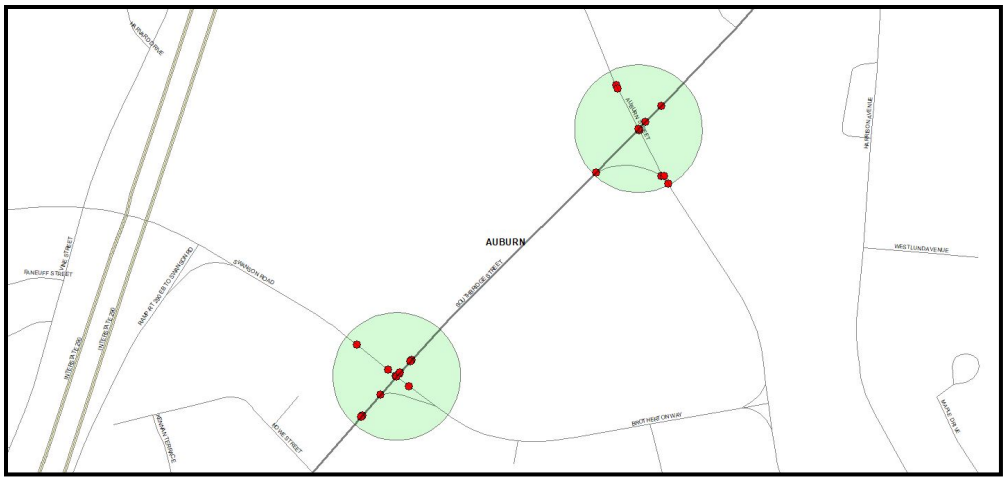


Figure 9: Example of 200-foot intersection buffer at FYA locations in Auburn, MA

Ultimately, at this stage, there were 201 FYA locations that were selected for inclusion in the analysis, based solely on the prevalence of two years of before/after crash data. Figure 11 represents the FYAs in District 2 and their respective before/after crash study periods, as well as the unknown gaps of time in between, as determined from historical Google Street View imagery (also presented in Appendix B). The following section discusses the methods utilized to filter these potential locations based on the availability of reliable volume data. The before crash period is designated in orange, the after in green and the uncertainty time is shown in gray between the two.

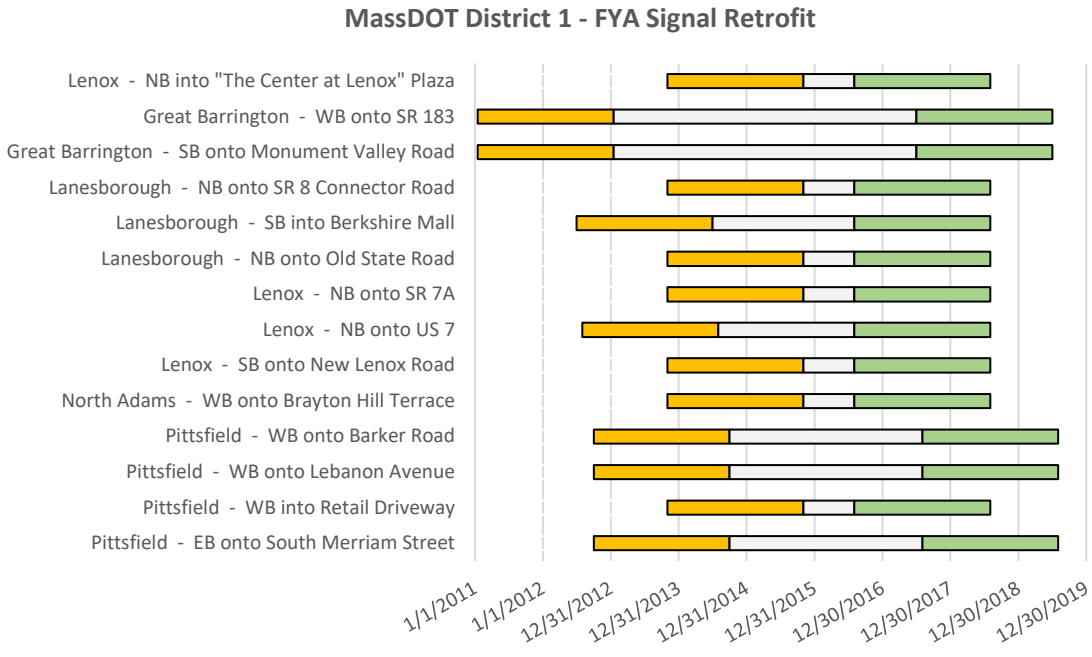


Figure 10: FYA retrofits: Before and After Crash Periods, including uncertainty time

2.3 Identifying Available AADT Volumes for FYA locations

Upon selecting the 201 FYA intersections based on before/after crash criteria, the locations were split into three main categories or treatment types, to be assessed in the safety and cost-benefit analysis. Figure 12 depicts the breakdown of treatments: 3-way intersection with FYA; 4-way intersection with one FYA approach; and 4-way intersection with two or more FYA approaches. Before the filtering of sites based on their available volume data, there were 81, 66, and 54 locations within the 3-way intersection with FYA, 4-way intersection with one FYA approach, and 4-way intersection with two or more FYA approach categories, respectively. In order to evaluate the benefit of the FYA signal, volume data from each of the intersections was necessary to measure the before/after crash data. Given the challenges associated with volume data collection during the COVID-19 pandemic, data mining efforts were conducted to extract measurable volume data from two MassDOT resources: the MassDOT MS2 Transportation Data Management System and the MassDOT Roadway Inventory. These volume mining techniques will explained in the following sections.

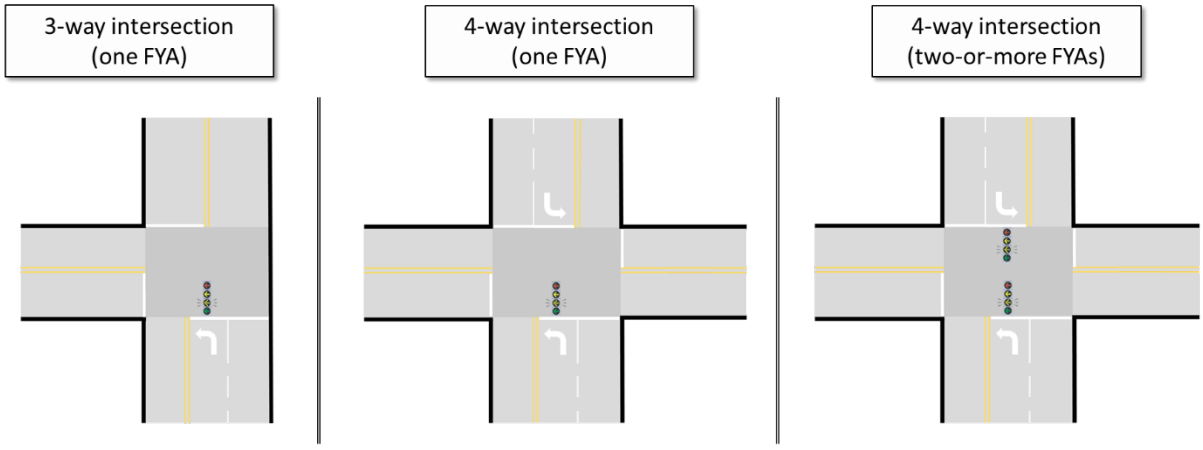


Figure 11: Three studied FYA treatment categories

The procedure to extract and utilize volumes from both of the aforementioned resources is depicted in Figure 13. First, volume data was extracted within close proximity to each FYA. Then, major and minor approaches were determined based on count location. Each of the average annual daily traffic (AADT) volumes was then retroactively adjusted, based on previous yearly regionality volume data.

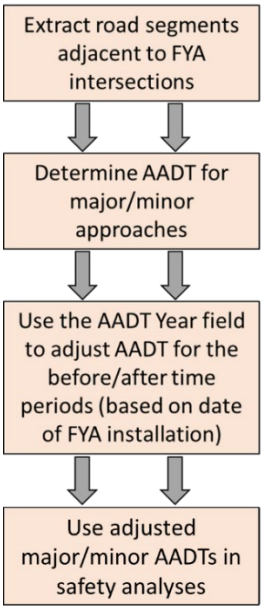


Figure 12: Procedure to adapt volume data from MassDOT sources

2.3.1. MS2 Volume Data Extraction

Web-scraping tools were written to automate the extraction of data from each of the 201 FYA intersections. Given the adaptation of the MS2 database in previous projects, this was the resource first utilized to extract volume data. For MS2, this required a search via the spatial coordinates of each intersection, followed by a selection of the closest volume counts available using a narrow search radius by proximity. The graphic displayed in Figure 14 presents the user interface of the MS2 database. The web-scraped volume count stations were tabulated, and a database of AADT volume history at each intersection was established.

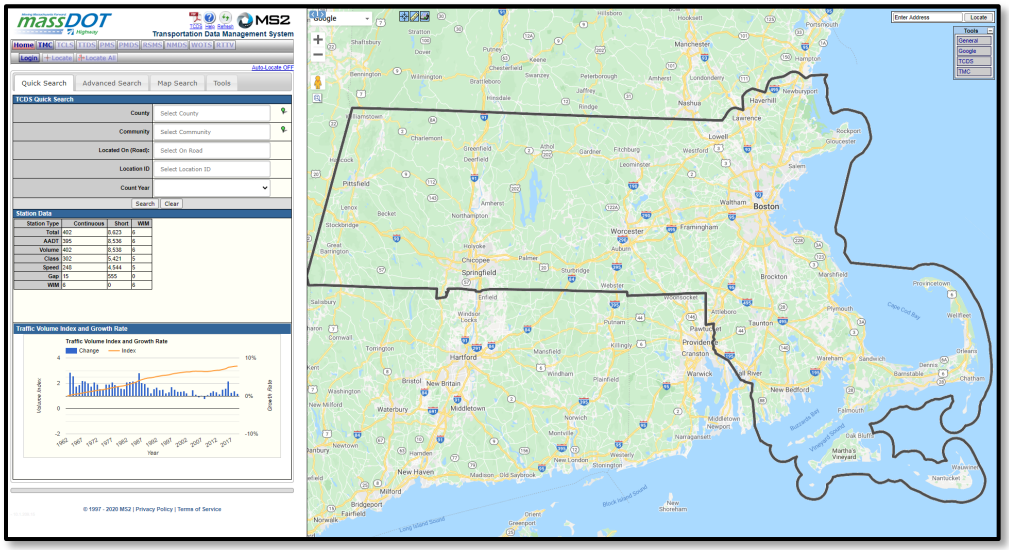


Figure 13: MassDOT MS2 Transportation Data Management System

Following this round of volume extraction, the major and minor AADT volumes were determined based on the proximity of each count station and their respective volume output. While the team anticipated finding the majority of location volume data through the MS2 database, this did not end up being the case (for both the major and minor approaches). In this search, there were only paired volumes for:

- 3-way intersections: 22
- 4-way intersections (1 FYA): 17
- 4-way intersections (2 or more FYAs): 26

Given the small sample (~31% of total) yielded from this first volume extraction in MS2, further investigation into volume data mining was adapted. The MassDOT Roadway Inventory database was utilized to locate and extract volume data from the remaining FYA intersections.

2.3.2. MassDOT Roadway Inventory Database

Similar to the procedure conducted with the MS2 database, the FYA intersection coordinates were utilized to web-scrape and tabulate the roadway inventory volume data from each of the remaining FYAs. The user interface for the MassDOT Roadway Inventory GIS database is presented in Figure 15. In this iteration, each of the unique FYA intersections was examined to identify AADT volumes closest in proximity to the intersections for each of the approaching roadway legs. Following this AADT extraction, the database was cleaned, removing any zero or default volumes or missing data year information.

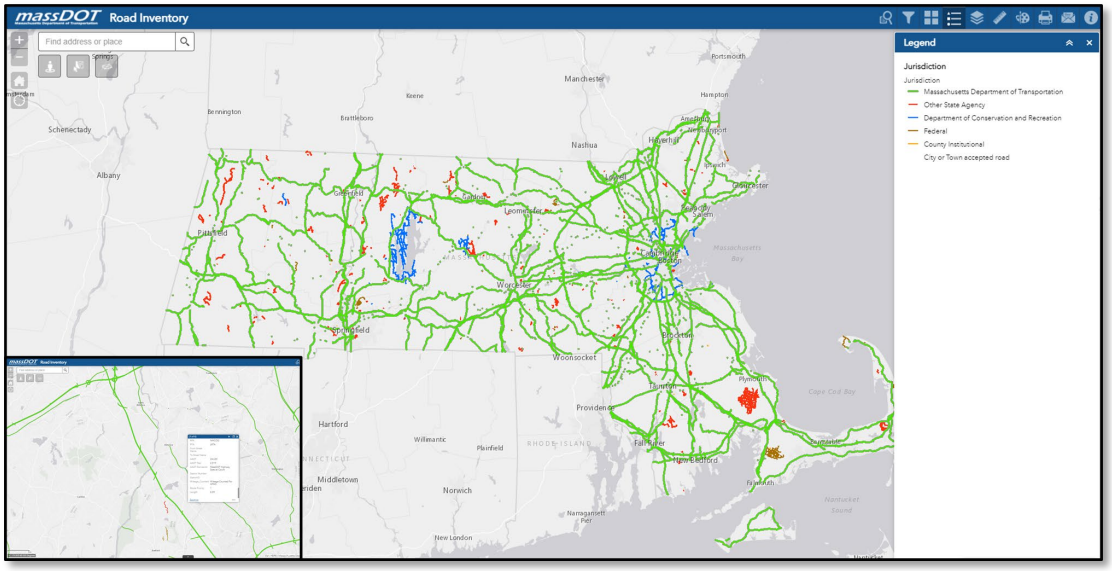


Figure 14: MassDOT Roadway Inventory Database

In the first effort to utilize the MassDOT Roadway Inventory (RI) data, unmatched major/minor pairs from the first iteration were addressed (e.g., intersections that either had MS2 major AADT or minor AADT, but not both). An in-depth review of the missing major and minor AADTs from the RI were extracted through engineering judgment, evaluating the

missing approach based on its depicted AADT output and count source. As a result, the following were added to the existing list of FYA intersections with volume data:

- 3-way intersections: 22
- 4-way intersections (1 FYA): 26
- 4-way intersections (2 or more FYAs): 9

This second iteration resulted in a total of 121 FYA intersections (~60% of total); however, the sample size still remained too small for a thorough analysis, especially given the three treatment categories. Again, additional extraction through the RI was necessary to include more FYA intersections.

Finally, an additional extraction using the RI database was conducted to find remaining missing intersections, particularly those with AADT major and minor volumes from the RI database. Again, an in-depth review of these remaining intersections was completed in an effort to extract reasonable and accurate major and minor AADT volumes. As a result of this final iteration, there were a total of 166 FYA intersections (~83% of total) with reliable and accurate AADT data to be included in the cost-benefit analysis. The breakdown of volume source by intersection type is presented in Table 2. The adaptation of this volume data, with respect to the FYA implementation dates, is explained in the following section.

Table 2: AADT volumes by data source and treatment type

3-way with one FYA				4-way with one FYA				4-way with two-or-more FYAs			
Major	**Minor**	**#**	**% total**	**Major**	**Minor**	**#**	**% total**	**Major**	**Minor**	**#**	**% total**
MS2	MS2	22	27%	MS2	MS2	17	26%	MS2	MS2	25	46%
MS2/RI	MS2/RI	22	27%	MS2/RI	MS2/RI	26	39%	MS2/RI	MS2/RI	9	17%
RI	RI	18	22%	RI	RI	17	26%	RI	RI	10	20%
	TOTAL	62	77%		**TOTAL**	60	91%		**TOTAL**	44	83%

In an effort to evaluate the accuracy of the volume data being integrated to the database, a simple statistical test was conducted using the values from each iteration as provided in Table 3. As a result, there were no statistically significant differences between the first iteration of the mean major/minor AADT volumes and the third iteration of volumes. Therefore, it was determined that this inventory of volumes was acceptable in further analysis of the FYA intersections.

Table 3: Iterative AADT volume analysis

First Iteration		**Mean Values by Treatment Category**			**Percent Change (before/after)**		
		1	**2**	**3**			
AADT Major	*before*	17220	19245	18056	0.55%	0.98%	1.09%
	after	17314	19434	18253			
AADT Minor	*before*	6704	9943	9349	1.36%	1.07%	1.24%
	after	6795	10049	9465			

Second Iteration		**Mean Values by Treatment Category**			**Percent Change (before/after)**		
		1	**2**	**3**			
AADT Major	*before*	17408	18211	18121	1.10%	0.94%	0.86%
	after	17600	18382	18276			
AADT Minor	*before*	6842	8673	8780	0.82%	1.27%	0.89%
	after	6898	8783	8858			

Third Iteration		**Mean Values by Treatment Category**			**Percent Change (before/after)**		
		1	**2**	**3**			
AADT Major	*before*	17434	17835	17627	1.28%	1.16%	1.02%
	after	17657	18042	17807			
AADT Minor	*before*	6861	7106	8196	1.01%	1.34%	0.99%
	after	6930	7201	8277			

The description and characteristics of the 166 intersections where an FYA signal was implemented are shown in Table 4. This table provides information regarding the location of the FYA intersection, intersection geometry, FYA supplementary signage, and before/after installation AADT volume years.

Table 4: FYA study intersection characteristics

ID	Intersection Name	City/Town	RPA	Intersection Type	FYA Supp. Signage	Multiple FYAs	FYA Before Install Volume Year	FYA After Install Volume Year
1	SR 2A & Nagog Park	ACTON	MAPC	3-way	No	No	2014	2018
2	SR 159 (Main Street) & School Street	AGAWAM	PVPC	3-way	Yes	No	2014	2018
3	SR 159 (Main Street) & Elm Street	AGAWAM	PVPC	4-way	Yes	Yes	2014	2018
4	SR 28 (South Main Street) & Salem Street	ANDOVER	MVPC	3-way	Yes	No	2012	2018
5	SR 28 (Main Street) & School Street	ANDOVER	MVPC	4-way	Yes	No	2012	2017
6	US 7 & The Center at Lenox	LENOX	BCRPC	4-way	Yes	Yes	2014	2017
7	SR 126 (Pond Street) & Eliot Street	ASHLAND	MAPC	4-way	No	No	2012	2017
8	SR 2A (South Main Street) & Daniel Shays Highway	ATHOL	MRPC	3-way	Yes	No	2012	2018
9	US 1 (Washington Street) & East Bacon Street	ATTLEBORO	SRPEDD	4-way	Yes	No	2012	2018
10	SR 12 (Southbridge Street) & Auburn Street	AUBURN	CMRPC	4-way	No	No	2012	2017
11	SR 12 (Southbridge Street) & Church Street	AUBURN	CMRPC	3-way	Yes	No	2012	2017
12	SR 12 (Southbridge Street) & Swanson Road	AUBURN	CMRPC	4-way	No	No	2015	2018
13	SR 12 (Southbridge Street) & Oxford Street N	AUBURN	CMRPC	4-way	Yes	No	2012	2017
14	SR 28 (Falmouth Road) & SR 130 (Main Street)	BARNSTABLE	CCC	3-way	Yes	No	2014	2018
15	SR 28 (Falmouth Road) & Old Stage Road	BARNSTABLE	CCC	4-way	Yes	No	2014	2018
16	SR 28 (Falmouth Road) & Lumbert Mill Road	BARNSTABLE	CCC	4-way	Yes	Yes	2014	2018
17	SR 28 (Falmouth Road) & South County Road	BARNSTABLE	CCC	4-way	Yes	Yes	2014	2018
18	SR 9 (Federal Street) & US 202 (North Main Street)	BELCHERTOWN	PVPC	4-way	Yes	No	2012	2018
19	SR 9 (Federal Street) & George Hannum Street	BELCHERTOWN	PVPC	3-way	Yes	No	2012	2017
20	SR 126 (North Main Street) & SR 140 (Mechanic St)	BELLINGHAM	MAPC	3-way	Yes	No	2014	2018
21	SR 126 & SR 140 (Mechanic Street)	BELLINGHAM	MAPC	4-way	Yes	No	2014	2018
22	SR 140 (Mechanic Street) & Blackstone Street	BELLINGHAM	MAPC	3-way	No	No	2014	2018
23	SR 1A (Dodge Street) & Conant Street	BEVERLY	MAPC	3-way	Yes	Yes	2014	2018

ID	Intersection Name	City/Town	RPA	Intersection Type	FYA Supp. Signage	Multiple FYAs	FYA Before Install Volume Year	FYA After Install Volume Year
24	SR 117 (Main Street) & I-495 SB Ramps	BOLTON	MAPC	4-way	Yes	Yes	2012	2017
25	SR 37 (Washington Street) & SR 37 (Franklin Street)	BRAINTREE	MAPC	3-way	Yes	No	2012	2017
26	SR 37 (Washington Street) & Braxton Street	BRAINTREE	MAPC	3-way	Yes	No	2012	2018
27	SR 3A (Cambridge Street) & Bedford Street	BURLINGTON	MAPC	4-way	Yes	Yes	2012	2018
28	SR 3A (Cambridge Street) & SR 62 (Francis Wyman Road)	BURLINGTON	MAPC	3-way	Yes	No	2012	2018
29	SR 4 (North Road) & SR 3A (Princeton Street)	CHELMSFORD	NMCOG	3-way	Yes	No	2012	2018
30	SR 3A (Tyngsboro Road) & SR 40 (Groton Road)	CHELMSFORD	NMCOG	3-way	Yes	No	2014	2018
31	SR 129 (Billerica Road) & US 3 SB Ramps	CHELMSFORD	NMCOG	3-way	No	No	2012	2018
32	SR 4 (North Road) & Technology Drive	CHELMSFORD	NMCOG	4-way	Yes	Yes	2012	2018
33	SR 3A (Cushing Highway) & King Street	COHASSET	MAPC	4-way	Yes	No	2012	2018
34	Endicott Street & SR 128 SB Ramps	DANVERS	MAPC	3-way	Yes	No	2014	2018
35	Endicott Street & SR 128 NB Ramps	DANVERS	MAPC	4-way	Yes	No	2014	2017
36	SR 2A & SR 110 (King Street)	LITTLETON	MAPC	4-way	Yes	Yes	2012	2018
37	SR 35 (High Street) & SR 128 NB Ramps	DANVERS	MAPC	4-way	No	No	2014	2018
38	SR 35 (High Street) & SR 128 SB Ramps	DANVERS	MAPC	4-way	Yes	No	2014	2018
39	SR 35 (High Street) & Purchase Street	DANVERS	MAPC	3-way	Yes	No	2012	2018
40	SR 2A (Great Road) & SR 27 (Main Street)	ACTON	MAPC	4-way	Yes	Yes	2014	2018
41	US 6 (State Road) & Cross Road	DARTMOUTH	SRPEDD	4-way	Yes	Yes	2012	2018
42	SR 5 & SR 116 (Conway Road)	DEERFIELD	FCDP	4-way	Yes	Yes	2012	2018
43	SR 28 (Main Street) & SR 134 (E-W Dennis Road)	DENNIS	CCC	4-way	Yes	Yes	2013	2018
44	SR 10 (Northampton Street) & Florence Road	EASTHAMPTON	PVPC	4-way	Yes	No	2014	2018
45	SR 138 (Washington Street) & Main Street	EASTON	OCPC	4-way	No	Yes	2015	2018
46	SR 140 (West Central Street) & Forge Parkway West	FRANKLIN	MAPC	3-way	Yes	No	2012	2018
47	King Street & I-495 NB Ramps	FRANKLIN	MAPC	3-way	Yes	No	2014	2018
48	SR 2 & Montague-Gill Bridge	GILL	FCDP	4-way	Yes	Yes	2014	2017
49	SR 128 & SR 127 (Eastern Avenue)	GLOUCESTER	MAPC	4-way	Yes	Yes	2012	2018
50	US 7 & SR 183 (Stockbridge Rd)	GREAT BARRINGTON	BCRPC	3-way	Yes	No	2012	2018

ID	Intersection Name	City/Town	RPA	Intersection Type	FYA Supp. Signage	Multiple FYAs	FYA Before Install Volume Year	FYA After Install Volume Year
51	US 7 & Monument Valley Road	GREAT BARRINGTON	BCRPC	3-way	Yes	No	2012	2018
52	SR 2A (Mohawk Trail) & Shelburne Road	GREENFIELD	FCDP	4-way	Yes	Yes	2014	2017
53	SR 53 (Washington Street) & SR 3 SB Ramps	HANOVER	OCPC	4-way	Yes	No	2012	2018
54	SR 110 & SR 113 (River Street) & Lowell Avenue	HAVERHILL	MVPC	4-way	Yes	No	2014	2018
55	SR 53 (Whiting Street) & Cushing Street	HINGHAM	MAPC	4-way	Yes	No	2014	2018
56	SR 141 (Easthampton Road) & I-91 SB Ramps	HOLYOKE	PVPC	4-way	Yes	No	2014	2018
57	SR 8 (Cheshire Road) & Berkshire Mall Road	LANESBOROUGH	BCRPC	3-way	Yes	No	2014	2017
58	US 7 (South Main Street) & Berkshire Mall Road	LANESBOROUGH	BCRPC	3-way	Yes	No	2013	2017
59	SR 8 (Cheshire Road) & Old State Road	LANESBOROUGH	BCRPC	3-way	Yes	No	2014	2017
60	US 7 & SR 7A (Main Street)	LENOX	BCRPC	3-way	Yes	No	2014	2017
61	US 20 (Lee Road) & US 7	LENOX	BCRPC	3-way	Yes	No	2013	2017
62	US 7 & New Lenox Road	LENOX	BCRPC	4-way	Yes	No	2014	2017
63	SR 13 (Main Street) & Hawes Street	LEOMINSTER	MRPC	3-way	Yes	No	2014	2018
64	SR 12 (Central Street) & Willard Street	LEOMINSTER	MRPC	4-way	Yes	No	2012	2018
65	SR 2A (Marrett Road) & Waltham Street	LEXINGTON	MAPC	4-way	No	No	2012	2018
66	SR 2A (Marrett Road) & Massachusetts Avenue	LEXINGTON	MAPC	4-way	Yes	No	2014	2017
67	SR 2A (Marrett Road) & Spring Street	LEXINGTON	MAPC	3-way	Yes	No	2012	2018
68	Spring Street & Hayden Avenue	LEXINGTON	MAPC	4-way	Yes	Yes	2012	2018
69	SR 2A (Marrett Road) & Forbes Road	LEXINGTON	MAPC	4-way	Yes	No	2014	2017
70	SR 38 (Nesmith Street) & SR 133 (Andover Street)	LOWELL	NMCOG	4-way	Yes	No	2012	2017
71	SR 107 (Highland Avenue) & Fays Avenue	LYNN	MAPC	3-way	Yes	No	2012	2018
72	SR 140 (Commercial Street) & School Street	MANSFIELD	SRPEDD	4-way	Yes	No	2012	2018
73	US 20 (West Main Street) & US 20 (Lakeside Avenue)	MARLBOROUGH	MAPC	3-way	No	No	2014	2017
74	US 20 (Boston Post Road) & Boundary Street	MARLBOROUGH	MAPC	4-way	Yes	No	2012	2017
75	SR 28 (Falmouth Road) & Asher's Path East	MASHPEE	CCC	4-way	Yes	Yes	2014	2018
76	SR 140 (Cape Road) & Hartford Avenue	MENDON	CMRPC	4-way	Yes	No	2012	2018
77	SR 110 (Jackson Street) & Swan Street	METHUEN	MVPC	4-way	Yes	No	2012	2017

ID	Intersection Name	City/Town	RPA	Intersection Type	FYA Supp. Signage	Multiple FYAs	FYA Before Install Volume Year	FYA After Install Volume Year
78	SR 113 (Pleasant Valley Street) & Howe Street	METHUEN	MVPC	4-way	Yes	No	2015	2018
79	SR 38 (Mystic Avenue) & Temple Street	SOMERVILLE	MAPC	4-way	Yes	No	2015	2018
80	SR 110 (Merrimack Street) & SR 113 (Pleasant Valley St)	METHUEN	MVPC	4-way	Yes	Yes	2014	2018
81	SR 28 (East Grove Street) & SR 28 (West Grove Street)	MIDDLEBOROUGH	SRPEDD	4-way	Yes	Yes	2014	2018
82	SR 105 (South Main Street) & I-495 NB Ramps	MIDDLEBOROUGH	SRPEDD	3-way	Yes	No	2013	2018
83	SR 105 (South Main Street) & I-495 SB Ramps	MIDDLEBOROUGH	SRPEDD	3-way	Yes	No	2013	2018
84	SR 140 (South Main Street) & Cape Road	MILFORD	MAPC	4-way	Yes	Yes	2012	2018
85	SR 16 (East Main Street) & Fortune Blvd.	MILFORD	MAPC	4-way	Yes	No	2014	2018
86	SR 122 (Grafton Road) & Mass Turnpike Ramps	MILLBURY	CMRPC	3-way	Yes	No	2014	2018
87	Coggeshall Street & I-195 WB Ramps	NEW BEDFORD	SRPEDD	4-way	Yes	Yes	2014	2018
88	SR 2 (Mohawk Trail) & Barbour Street	NORTH ADAMS	BCRPC	3-way	Yes	No	2014	2017
89	SR 114 (Salem Turnpike) & SR 125 (Andover Street)	NORTH ANDOVER	MVPC	4-way	Yes	Yes	2014	2017
90	SR 114 (Salem Turnpike) & SR 125 (Andover Bypass)	NORTH ANDOVER	MVPC	4-way	Yes	No	2014	2017
91	SR 114 (Salem Turnpike) & SR 133 (Haverhill Street)	NORTH ANDOVER	MVPC	4-way	No	Yes	2014	2017
92	US 1 (East Washington Street) & Elm Street	NORTH ATTLEBORO	SRPEDD	4-way	Yes	Yes	2012	2018
93	SR 28 (Main Street) & North Street	NORTH READING	MAPC	4-way	Yes	Yes	2012	2018
94	SR 10 (South Street) & Earle Street	NORTHAMPTON	PVPC	3-way	No	No	2012	2018
95	SR 5 & Big Y Driveway	NORTHAMPTON	PVPC	3-way	Yes	No	2014	2018
96	US 20 (Southwest Cutoff) & SR 9 EB Ramps	NORTHBOROUGH	CMRPC	3-way	Yes	No	2014	2017
97	US 20 (Southwest Cutoff) & Davis Street	NORTHBOROUGH	CMRPC	4-way	No	No	2014	2017
98	US 20 (Southwest Cutoff) & US 20 (West Main Street)	NORTHBOROUGH	CMRPC	3-way	Yes	No	2014	2017
99	SR 53 (Washington Street) & Grove Street	NORWELL	MAPC	4-way	Yes	No	2014	2018
100	SR 53 (Washington Street) & Jacobs Trail	NORWELL	MAPC	4-way	Yes	No	2014	2018
101	SR 6A (Cranberry Highway) & Eldridge Parkway	ORLEANS	CCC	4-way	Yes	No	2014	2018
102	US 20 (North Main Street) & US 20 (Wilbraham Street)	PALMER	PVPC	4-way	Yes	No	2012	2018

ID	Intersection Name	City/Town	RPA	Intersection Type	FYA Supp. Signage	Multiple FYAs	FYA Before Install Volume Year	FYA After Install Volume Year
103	SR 32 (Thorndike Street) & High Street	PALMER	PVPC	4-way	Yes	No	2014	2017
104	SR 32 (Thorndike Street) & Mass Turnpike Ramps	PALMER	PVPC	3-way	Yes	No	2012	2017
105	SR 114 (Andover Street) & Cross Street	PEABODY	MAPC	3-way	Yes	No	2015	2018
106	Lowell Street & US 1 SB Ramps	PEABODY	MAPC	4-way	Yes	No	2014	2018
107	SR 53 (Columbia Road) & SR 53 (Washington Street)	PEMBROKE	OCPC	4-way	Yes	No	2014	2018
108	US 20 (West Housatonic Street) & Barker Road	PITTSFIELD	BCRPC	4-way	Yes	No	2013	2018
109	US 20 (West Housatonic Street) & Lebanon Avenue	PITTSFIELD	BCRPC	4-way	Yes	No	2013	2018
110	SR 9 (Dalton Avenue) & Meadowview Drive	PITTSFIELD	BCRPC	4-way	Yes	No	2014	2017
111	US 20 (West Housatonic Street) & South Merriam Street	PITTSFIELD	BCRPC	4-way	Yes	No	2013	2018
112	SR 80 (Plympton Road) & Commerce Way	PLYMOUTH	OCPC	4-way	Yes	Yes	2014	2018
113	SR 60 (Squire Road) & Charger Street	REVERE	MAPC	4-way	Yes	No	2015	2018
114	SR 123 (Market Street) & Highland Street	ROCKLAND	MAPC	4-way	Yes	Yes	2014	2018
115	US 1 (Newburyport Turnpike) & SR 133 (Haverhill Street)	ROWLEY	MVPC	4-way	Yes	Yes	2012	2016
116	SR 1A (Loring Avenue) & Jefferson Avenue	SALEM	MAPC	3-way	Yes	No	2012	2018
117	SR 1A (Loring Avenue) & Harrison Road	SALEM	MAPC	3-way	No	No	2012	2018
118	Toll Road & Main Street	SALISBURY	MVPC	4-way	Yes	No	2014	2018
119	Lynn Fells Parkway & US 1 NB Ramps	SAUGUS	MAPC	3-way	Yes	No	2014	2018
120	US 20 (Hartford Tpk.) & South Street	SHREWSBURY	CMRPC	4-way	No	No	2014	2018
121	US 20 (Hartford Tpk.) & Cherry Street	SHREWSBURY	CMRPC	4-way	No	Yes	2014	2018
122	SR 10 & SR 57 (Granville Road)	SOUTHWICK	PVPC	4-way	No	Yes	2014	2018
123	SR 10 & SR 57 (Feeding Hill Road)	SOUTHWICK	PVPC	3-way	No	No	2014	2018
124	US 20 (Boston Post Road) & Union Avenue	SUDBURY	MAPC	4-way	No	Yes	2014	2018
125	US 20 (Boston Post Road) & Nobscott Road	SUDBURY	MAPC	3-way	No	No	2014	2017
126	SR 47 (North Main Street) & SR 116 (Amherst Road)	SUNDERLAND	FCDP	4-way	No	Yes	2014	2017
127	US 6 (Grand Army Highway) & I-195 WB Ramps	SWANSEA	SRPEDD	3-way	Yes	No	2014	2017
128	US 6 (Grand Army Highway) & I-195 EB Ramps	SWANSEA	SRPEDD	3-way	Yes	No	2014	2017

ID	Intersection Name	City/Town	RPA	Intersection Type	FYA Supp. Signage	Multiple FYAs	FYA Before Install Volume Year	FYA After Install Volume Year
129	SR 38 (Main Street) & Shawsheen Street	TEWKSBURY	NMCOG	4-way	No	Yes	2012	2018
130	SR 38 (Main Street) & Pleasant Street	TEWKSBURY	NMCOG	4-way	Yes	No	2014	2017
131	SR 38 (Main Street) & I-495 SB Ramps	TEWKSBURY	NMCOG	4-way	No	No	2012	2017
132	SR 133 (Andover Street) & I-495 SB Ramps	TEWKSBURY	NMCOG	4-way	Yes	Yes	2012	2017
133	SR 133 (Andover Street) & I-495 NB Ramps	TEWKSBURY	NMCOG	4-way	Yes	No	2013	2017
134	SR 38 (Main Street) & Clarks Road	TEWKSBURY	NMCOG	3-way	Yes	No	2014	2017
135	SR 38 (Main Street) & Old Main Street	TEWKSBURY	NMCOG	3-way	Yes	No	2012	2017
136	SR 38 (Main Street) & Victor Drive	TEWKSBURY	NMCOG	4-way	Yes	Yes	2012	2018
137	SR 113 (Pawtucket Blvd.) & SR 3A (Frost Road)	TYNGSBOROUGH	NMCOG	3-way	Yes	No	2012	2017
138	Westford Road & US 3 NB Ramps	TYNGSBOROUGH	NMCOG	3-way	Yes	No	2014	2018
139	Audubon Road & I-95 SB Ramps	WAKEFIELD	MAPC	4-way	Yes	No	2014	2018
140	SR 28 (Cranberry Highway) & Rosebrook Way	WAREHAM	SRPEDD	3-way	Yes	No	2013	2018
141	SR 28 (Cranberry Highway) & Tobey Road	WAREHAM	SRPEDD	4-way	Yes	No	2013	2018
142	US 20 (Boston Post Road) & SR 27	WAYLAND	MAPC	4-way	Yes	Yes	2014	2017
143	Cedar Street & SR 9 EB Ramps	WELLESLEY	MAPC	4-way	Yes	No	2012	2018
144	Long Pond Road & SR 3 SB Ramps	PLYMOUTH	OCPC	3-way	Yes	No	2015	2018
145	Long Pond Road & SR 3 NB Ramps	PLYMOUTH	OCPC	3-way	Yes	No	2015	2018
146	US 20 (East Main Street) & Little River Road	WESTFIELD	PVPC	4-way	Yes	No	2014	2018
147	US 20 (Springfield Road) & Union Street	WESTFIELD	PVPC	3-way	Yes	No	2014	2018
148	SR 10 & Summit Lock Road	WESTFIELD	PVPC	4-way	Yes	Yes	2014	2018
149	SR 110 (Littleton Road) & Powers Road	WESTFORD	NMCOG	3-way	No	No	2014	2018
150	SR 18 (Main Street) & Trotter Road	WEYMOUTH	MAPC	3-way	Yes	No	2014	2018
151	SR 18 (Main Street) & SR 58 (Pond Street)	WEYMOUTH	MAPC	4-way	No	Yes	2014	2018
152	SR 5 & SR 10 (State Road) & SR 116 (Sunderland Road)	WHATELY	FCDP	4-way	Yes	Yes	2014	2017
153	US 20 (Boston Road) & Post Office Park	WILBRAHAM	PVPC	4-way	No	No	2012	2018
154	US 20 (Boston Road) & Post Office Park	WILBRAHAM	PVPC	4-way	No	Yes	2012	2018

ID	Intersection Name	City/Town	RPA	Intersection Type	FYA Supp. Signage	Multiple FYAs	FYA Before Install Volume Year	FYA After Install Volume Year
155	SR 38 (Main Street) & SR 129 (Richmond Street)	WILMINGTON	MAPC	4-way	Yes	No	2014	2018
156	SR 38 (Main Street) & Clark Street	WILMINGTON	MAPC	3-way	Yes	No	2014	2018
157	SR 38 (Main Street) & SR 129 (Lowell Street)	WILMINGTON	MAPC	3-way	Yes	No	2014	2018
158	SR 12 (Spring Street) & SR 140 (Gardner Road)	WINCHENDON	MRPC	3-way	Yes	No	2012	2017
159	Washington Street & Cedar Street	WOBURN	MAPC	4-way	No	No	2012	2018
160	US 3 (Cambridge Street) & Country Club Road	WOBURN	MAPC	4-way	No	No	2014	2018
161	US 20 (SW Cutoff) & Greenwood Street	WORCESTER	CMRPC	4-way	Yes	No	2014	2017
162	SR 138 (Turnpike Street) & Randolph Street	CANTON	MAPC	4-way	Yes	Yes	2013	2017
163	Plantation Street & I-90 EB Off-Ramp	WORCESTER	CMRPC	4-way	Yes	No	2015	2018
164	SR 1A (South Street) & I-495 SB Ramps	WRENTHAM	MAPC	3-way	Yes	No	2014	2018
165	SR 28 & Berry Avenue	YARMOUTH	CCC	4-way	Yes	Yes	2013	2018
166	SR 203 (Gallivan Boulevard) & Granite Avenue	BOSTON	MAPC	4-way	Yes	Yes	2015	2018

2.3.3. Adjusting VMT by Region and Year

Now that the FYA inventory was filtered to include only locations with valid AADT data for both the major and minor approaches, there was a need to adjust these compiled volumes to reflect the before/after implementation periods of each FYA intersection. In order to understand the yearly volume trends in Massachusetts, volume was aggregated to present the vehicle miles traveled (VMT) data across all of the Metropolitan Planning Organizations (MPOs) and Regional Planning Agencies (RPAs) across the Commonwealth (as presented in Appendix C).

More so, the data presented in Table 5 identified the regions of Massachusetts that had larger or smaller VMT increases between 2011 and 2019. It is important to note that the shaded cells in this table represent the yearly percentage increases by region (blue = lowest increase of that year; red = highest increase of that year). The percentages in this table represent the percentage change from the baseline year of 2011. Further, the VMT data collected in 2012 through 2014 were reported to have consistent increases across all regions. While this data presents potential bias against both the larger metropolitan regions and smaller rural regions, the consistent VMT approach was deemed acceptable in this research scope.

Table 5: MassDOT percentage change in VMT, since 2011

Region \ Year	2011	2012	2013	2014	2015	2016	2017	2018	2019
Berkshire	-	1.78%	2.70%	4.80%	3.93%	4.42%	4.87%	5.31%	5.75%
Cape Cod	-	1.78%	2.70%	4.80%	4.10%	4.25%	4.09%	3.94%	3.78%
Central Mass.	-	1.78%	2.70%	4.80%	4.16%	4.19%	4.93%	5.66%	6.38%
Franklin	-	1.78%	2.70%	4.80%	4.21%	4.14%	4.33%	4.51%	4.69%
Boston	-	1.78%	2.70%	4.80%	4.05%	4.30%	4.53%	4.76%	4.99%
Montachusett	-	1.78%	2.70%	4.80%	3.99%	4.36%	4.91%	5.45%	5.98%
Martha's Vineyard	-	1.78%	2.70%	4.80%	3.54%	4.80%	5.14%	5.48%	5.81%
Merrimack Valley	-	1.78%	2.70%	4.80%	4.10%	4.25%	4.40%	4.54%	4.68%
Northern Middlesex	-	1.78%	2.70%	4.80%	4.06%	4.29%	4.46%	4.62%	4.78%
Nantucket	-	1.78%	2.70%	4.80%	4.61%	3.73%	4.29%	4.84%	5.39%
Old Colony	-	1.78%	2.70%	4.80%	4.10%	4.26%	4.45%	4.64%	4.84%
Pioneer Valley	-	1.78%	2.70%	4.80%	4.19%	4.17%	4.59%	5.02%	5.44%
Southeastern Mass.	-	1.78%	2.70%	4.80%	4.15%	4.20%	4.60%	4.99%	5.38%
Grand Total	-	1.78%	2.70%	4.80%	4.09%	4.26%	4.56%	4.87%	5.16%

Note: Shaded cells represent yearly percentage increases by region (Blue = lowest, Red = highest).

In order to adjust the volumes according to the before and after FYA installation years, a ratio of VMT data was developed for each specific intersection, comparing against the baseline of 2019 VMT. For instance, FYA ID #1 was located in the Boston Region (MAPC) with the before and after volume years being 2014 and 2018, respectively. Subsequently, "Before Adjustment" and "After Adjustment" ratios were created based on the specific region VMT and the years of before and after volume. Lastly, these adjustment ratios were multiplied against the compiled major and minor AADT to volume to result in adjusted before and after volumes for each of the FYA intersections. This adjustment method was applied to take into consideration the inflation of traffic volumes over recent years, combatting the anticipated rise in the number of crashes per region in recent years.

2.4 Conducting the Cost-Benefit Analysis

To evaluate the economic impact of the FYA implementation across Massachusetts, both the cost (e.g., FYA installation) and benefit (e.g., net monetary benefit value) needed to be taken into consideration. The following sections present the methods utilized to derive these outputs.

2.4.1. Calculating FYA Crash Frequencies/Rates

As previously mentioned, this study employed an FYA analysis procedure that evaluated the three treatment categories of implementation in Massachusetts. However, in an effort to assess the impacts of the FYA, it was important to conduct a before/after crash analysis of both the treatment categories and the aggregated 166 FYA intersections combined. In doing so, the crashes were aggregated from the intersection level and characterized into the following:

- Total Crashes
- Injury Crashes
- Property Damage Only (PDO) Crashes
- Rear-End Crashes
- Angle Crashes
- Single Vehicle Crashes
- Head-On Crashes
- Left-Turn (LT) Crashes
- Left-Turn-Opposing-Through (LTOT) Crashes

This aforementioned crash data aggregation was completed for the total FYA intersections, as well as for each of the three treatment categories. It is important to note that both LT and LTOT crashes were included, as these remain the primary crash types that FYA installations aim to mitigate in the after period. Lastly, in order to remain consistent with previous MassDOT crash reporting literature *(21),* the raw before/after crashes at each intersections were adjusted to report equivalent property damage only (EPDO) values. The aggregated injury crashes for each FYA intersection are presented in Appendix D.

Given the challenges of data reliability and accessibility as mentioned in previous sections, as well as the large quantity of FYA installations in the dataset, an Empirical Bayes method was not considered in this analysis. Instead, an alternative assessment was developed to take into consideration for volume and crash inflation across the FYA implementation study years. While many previous studies have derived FYA-specific safety performance functions (SPFs) to consider the expected value of after-period crashes, the volume/crash data was not deemed justifiable in applying to specific FYA approaches. Alternatively, this study employed a methodology to inflate regional volumes per their yearly VMT data. The before and after adjusted AADT volumes, as mentioned in previous sections, were applied to calculate intersection-level crash rates before and after FYA implementation. In doing so, the intersection crash rates were calculated using equations from the *Highway Safety Manual (22).* First, the number of million entering vehicles was calculated for each intersection,

$$MEV = \frac{TEV}{1{,}000{,}000} \cdot (n) \cdot (365)$$

where, MEV refers to the million entering vehicles, calculated by taking into consideration the total entering vehicles per day (TEV) and the number of years of crash data (n). And lastly, the observed crash rate at each intersection was calculated,

$$R_i = \frac{N_{observed,i(total)}}{MEV_i} \cdot$$

where, R_i refers to the observed crash rate at intersection *i*, calculated by dividing the total observed crashes at intersection *i* through the MEV. It is important to note that the crash rates

were calculated for the 166 aggregated FYA intersections first and then calculated for each of the three treatment categories.

2.4.2. Calculating FYA Installation Costs

The FYA installation costs were derived from various sources, such as a combination of previous FYA literature *(8,19),* MassDOT contractual records and construction estimates, and a survey of local transportation consultants. Table 6 and Table 7 present an example of a breakdown of the specific line-item costs included in an FYA signal installation. These values were collected from local transportation consultants to provide an initial breakdown of FYA line-item costs and the rough estimate of FYA retrofitting based on the degree of signal upgrades required.

Table 6: Example of FYA installation line-item costs

Modification	Description	Cost
Parts	4 section head, 4"-12" LED's, 4 Visors, 1 RR Backplate	$2,000
Labor	1 electrician and 1 laborer for 8 hours	$1,700
Other Equipment	1 bucket truck for 8 hours	$450
Police Detail	At least 4 hours	$280
Cabinet Update	Assuming completion within 8-hour timeframe	$0
New Controller	*Only if current controller cannot perform FYA operations	$5,000
New Cabinet with Controller and MMU	*Only if controller is outdated and does not support FYA wiring	$25,000

Table 7: FYA installations by manner of retrofit

Manner of Retrofit	Total Costs (approx.)
Signal Replacement w/ no additional cabinet upgrades	$4,500
Signal Replacement w/ new controller	$9,500
Signal Replacement w/ new cabinet	$30,000

Ultimately, the FYA costs were divided into thresholds ranging from lowest anticipated installation cost to highest anticipated installation cost. The levels of FYA installation costs and their descriptions are provided in Table 8. Lastly, benefit-cost (BC) ratios were derived by taking into consideration the expected lifespan of the FYA installations and their expected annual cost. Methodologies from previous FYA literature were adapted to calculate a range of BC ratios, as presented in greater detail within the results section.

Table 8: FYA costs used to calculate benefit/cost ratios, per approach

Installation Cost (per FYA approach)	Source
$6,000	Schattler et al. 2016 *(8)* & Srinivasan et al. 2020 *(19)*
$10,000	MassDOT Contract Estimate (lower threshold,)
$50,000	MassDOT (upper threshold) and Local Consultants Estimate

3.0 Results

The following section presents the results from the before-and-after FYA installation crash analysis and discusses the significant findings.

3.1 Total Crashes and Crash Frequencies by Treatment Type

As previously mentioned, the FYA implementation was recently installed across Massachusetts at various 3-way and 4-way intersections. An FYA was only retrofitted for existing protected-permissive left-turn (PPLT) signal phasing, with an existing dedicated left-turn lane. Given the expectation of crash variance between 3-way and 4-way intersections, this study aimed to analyze the FYA impact across three main category types: 3-way intersection with one FYA; 4-way intersection with one FYA; and 4-way intersection with two or more FYAs. Additionally, in an effort to holistically assess the overall statewide impact of the FYA with regards to before/after crashes, a separate analysis was conducted using all three categories aggregated together. Table 9 presents the overall number of studied intersections and crashes by treatment type.

Table 9: Total crashes by treatment type

Treatment Category	Description	Number of Treatment Sites	Total Number of Crashes
1	3-way with 1 FYA Approach	62	1047
2	4-way with 1 FYA Approach	60	1611
3	4-way with 2 or more FYA Approaches	44	1245
Total	All FYA Intersections	166	3903

In order to evaluate the before/after conditions of each FYA treatment category, the crash data were aggregated by characteristics (as explained in 2.4.1). Figure 16 presents the aggregated average annual FYA intersection crashes by crash type. Injury and Property Damage Only (PDO)–related crashes were taken into consideration with the expectation that an FYA would reduce severe injury crashes and increase PDO crashes. While the aggregated FYA intersection data paralleled these hypothesized trends, further investigation into FYA treatment categories remained warranted. More so, it is important to note that rear-end, left-turn (LT), and left-turn-opposing-through (LTOT) crashes were all taken into consideration, given their anticipated correlation with FYA implementation.

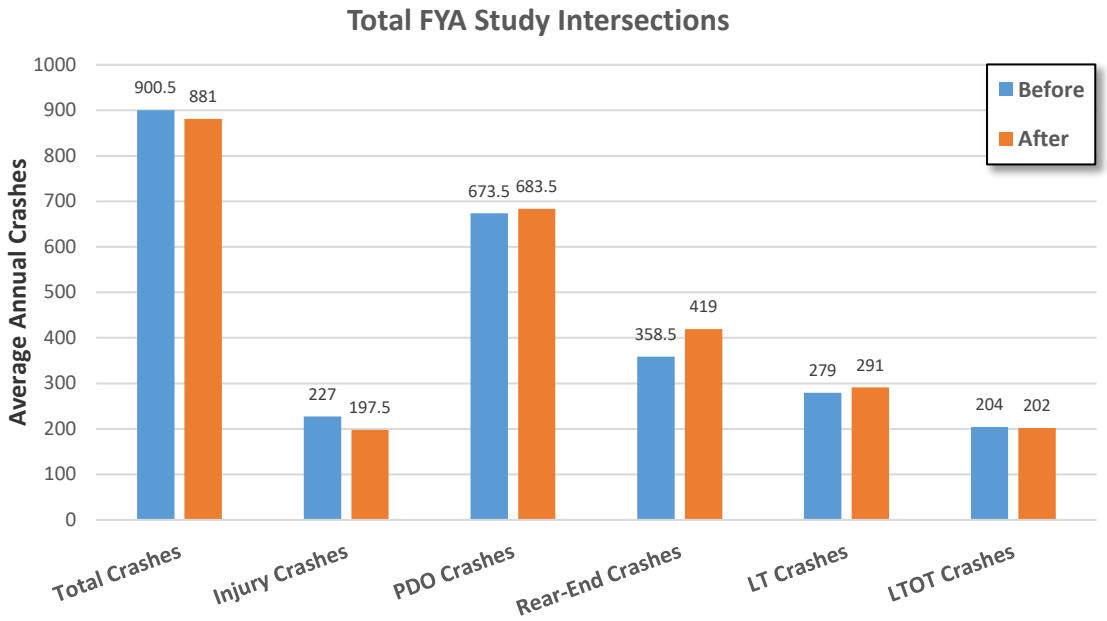
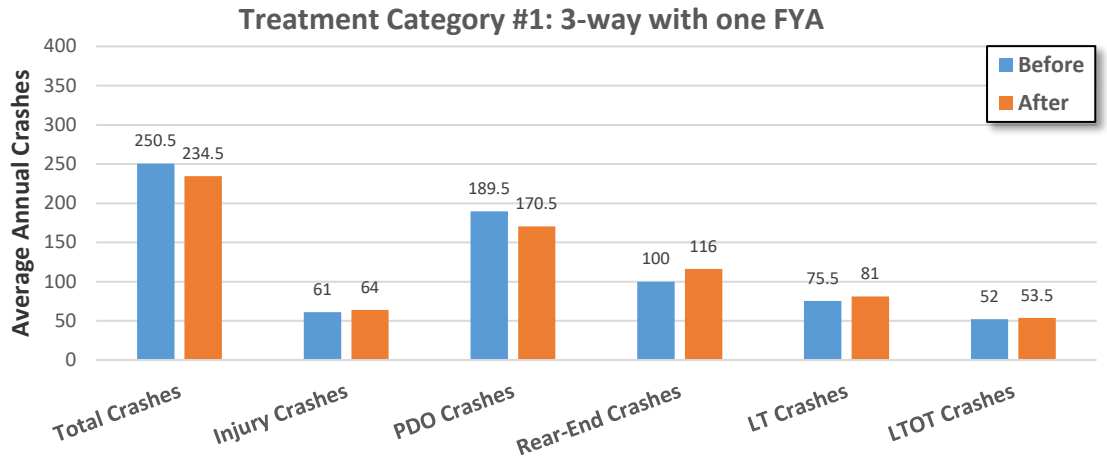


Figure 15: Total FYA intersections before/after crashes

Figure 17 presents the average annual before/after crashes across the three FYA treatment categories, in three separate bar charts. The values presented in these graphics depict the raw number of crashes (on average) that occurred before and after the FYA was installed. Although Treatment Category #1 comprised the highest total number of intersections, the fewest crashes occurred at these locations. Also, this was the only treatment to result in an increase in LT crashes. Further, Treatment Category #2 resulted in the highest number of crashes during both the before and after periods; however, there was a slightly larger number of total crashes during the after period at these intersections.



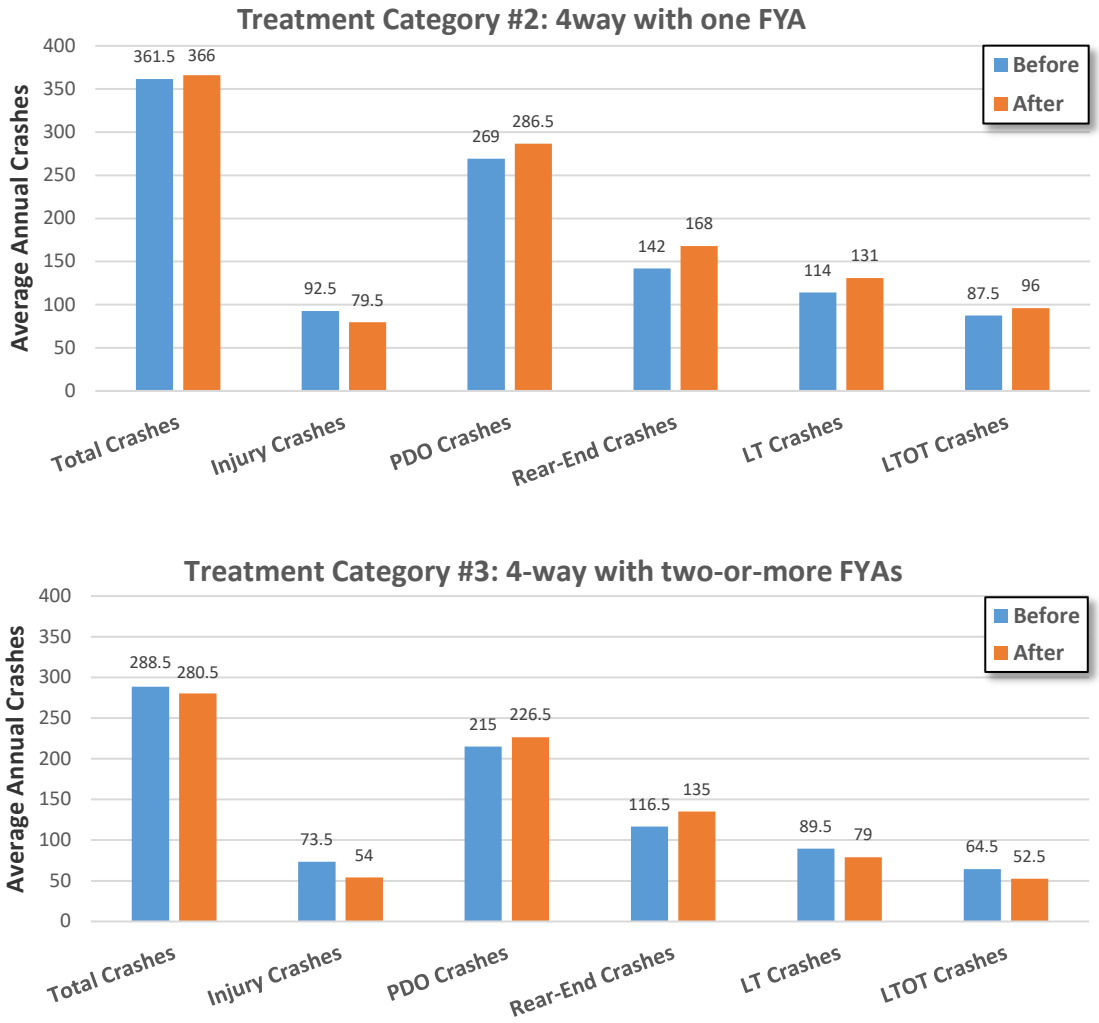


Figure 16: Before/after crashes by treatment type

The three treatment categories, in addition to the aggregated total, were normalized to account for the discrepancy between total number of treatment sites. The crash frequencies presented in Table 10 display each crash type, normalized per site, per year for each of the treatment categories. The mean values within each of the categories were presented during the before and after FYA period.

Table 10: Crash frequencies by treatment type

Crash Type (crashes/site-year)		Mean Values by Treatment Category			Total (mean value)
		1	2	3	
Total Crashes	*before*	4.0	6.0	6.6	5.4
	after	3.8	6.1	6.4	5.3
Injury Crashes	*before*	1.0	1.5	1.7	1.4
	after	1.0	1.3	1.2	1.2
PDO Crashes	*before*	3.1	4.5	4.9	4.1
	after	2.8	4.8	5.1	4.1
Rear-End Crashes	*before*	1.6	2.4	2.6	2.2
	after	1.9	2.8	3.1	2.5
Angle Crashes	*before*	1.4	2.3	2.3	2.0
	after	1.3	2.5	2.5	2.1
S.V Crashes	*before*	0.4	0.6	0.6	0.5
	after	0.3	0.5	0.6	0.5
Head-On Crashes	*before*	0.2	0.3	0.3	0.3
	after	0.2	0.3	0.3	0.3
LT Crashes	*before*	1.2	1.9	2.0	1.7
	after	1.3	2.2	1.8	1.8
LTOT Crashes	*before*	0.8	1.5	1.5	1.2
	after	0.9	1.6	1.2	1.2

3.2 Crash Rates – Using Before/After Volume Adjustments

The before/after results show promising results with respect to a reduction of the target crash types; however, these values do not take into consideration the increase or decrease of traffic volumes during the before and after periods. As explained in Section 2.3.3, volumes were adjusted across 2011–2019 regionally across Massachusetts. These adjusted VMT ratios were then applied to determine more precise AADT volumes at each of the FYA intersections during the before and after FYA periods. Typically, crash rates remain crucial in the transportation industry when conducting a traffic impact study; however, they have not been applied for infrastructure improvements, such as the FYA signal, before.

Table 11 presents the aggregated crash rates, calculated across all 166 FYA intersections. In doing so, crash rates were initially calculated for each intersection with the mean values presented herein. Injury crashes were reduced in the after period by nearly 8%, while rear-end crashes increased by 18%. LT crashes increased by 9% in the after period; however, LTOT crashes remained approximately similar during the after period.

Table 11: Crash rates of combined FYA intersections, including percentage change

Crash Type (crashes/MEV)		Mean Values	Percent Change (before/after)
Total Crashes	*before*	0.640	12.81%
	after	0.722	
Injury Crashes	*before*	0.169	-7.69%
	after	0.156	
PDO Crashes	*before*	0.473	0.42%
	after	0.475	
Rear-End Crashes	*before*	0.267	17.98%
	after	0.315	
Angle Crashes	*before*	0.230	8.26%
	after	0.249	
S.V Crashes	*before*	0.077	0.00%
	after	0.077	
Head-On Crashes	*before*	0.055	-1.82%
	after	0.054	
LT Crashes	*before*	0.200	9.00%
	after	0.218	
LTOT Crashes	*before*	0.161	0.62%
	after	0.162	

Note: Shading presents variance from highest increase (red) to highest decrease (green).
MEV: Million entering vehicles.

Table 12 presents the crash rates by crash type, calculated within the three treatment categories. Again, crash rates were initially calculated for each intersection with the mean values aggregated and averaged by treatment type. Treatment Category #1 resulted in an increase in injury-related crash rates (7%), while treatment categories #2 and #3 resulted in large decreases (-16.8% and -9%, respectively). With respect to rear-end crashes, all three categories resulted in large increases in crash rates during the after period (#1: 19%, #2: 12%, #3: 24%). Treatment Category #2 resulted in the highest increase in LT-related crash rates; however, the remaining treatment categories resulted in relatively low LT-related crash rate increases. Lastly, LTOT-related crash rates were reduced in both Treatment Category #1 and #3 yet were increased in category #2.

Table 12: Crash rates by treatment type, including percentage change

Crash Type (crashes/MEV)		Mean Values by Treatment Category			Percent Change (before/after)		
		1	2	3			
Total Crashes	*before*	0.501	0.751	0.684	5.19%	11.85%	22.08%
	after	0.527	0.840	0.835			
Injury Crashes	*before*	0.142	0.197	0.166	7.04%	-16.75%	-9.04%
	after	0.152	0.164	0.151			
PDO Crashes	*before*	0.375	0.544	0.513	-10.67%	1.47%	9.75%
	after	0.335	0.552	0.563			
Rear-End Crashes	*before*	0.216	0.305	0.284	18.98%	12.13%	23.94%
	after	0.257	0.342	0.352			
Angle Crashes	*before*	0.184	0.271	0.238	-9.78%	12.92%	19.33%
	after	0.166	0.306	0.284			
S.V Crashes	*before*	0.076	0.083	0.072	-7.89%	-8.43%	20.83%
	after	0.07	0.076	0.087			
Head-On Crashes	*before*	0.056	0.065	0.041	-8.93%	-9.23%	19.51%
	after	0.051	0.059	0.049			
LT Crashes	*before*	0.174	0.229	0.208	6.90%	15.72%	0.96%
	after	0.186	0.265	0.210			
LTOT Crashes	*before*	0.139	0.182	0.16	-4.32%	10.44%	-6.25%
	after	0.133	0.201	0.15			

Note: Shading presents variance from highest increase (red) to highest decrease (green).
MEV: Million entering vehicles.

Given the challenges with aggregating both FYA implementation dates, as well as uniform traffic volume data, it was ultimately decided to refrain from applying an Empirical-Bayes (EB) method through the use of safety performance functions (SPFs). The simple retrofit of FYA installations included within this study provided confidence that regression-to-the-mean would not need to be considered. More so, a naïve before/after analysis was considered to provide preliminary evidence into FYA safety benefits.

3.3 Naïve Before/After Crash Analysis

Ultimately, a naïve before/after crash analysis was conducted in this study to evaluate the safety benefits of the FYA left-turn signal indication. While previous literature on FYA safety benefits has utilized a multitude of methods, Schattler et al. (2016) found that the naïve before/after results compared similarly to the results from their EB analysis *(8)*.

The results in Table 13 present the percentage reduction of each crash type within the three treatment categories and the aggregated total intersections, in four separate tables. The average annual before and average annual after crashes were taken into consideration using the two years before and after FYA implementation. The overall effectiveness of the FYA across the treatment categories was assessed based on overall significance between before

and after crashes. Given that traffic crashes remain discrete with a non-normal distribution, a Poisson test was assumed in determining statistical significance between the before and after average annual crashes. A one-tailed test with (up to) 90% level of confidence (LOC) was utilized to evaluate these differences, with $p<0.10$ yielding statistical significance. The results in Table 13 present those crash types that resulted in a significant difference with both 90% and 95% confidence.

Table 13: Naïve before/after analysis of all FYA treatment categories

Total FYA Study Intersections				
Crash Type	**Avg Annual before**	**Avg Annual After**	**% Reduction**	**Significant? (p-value)**
Total Crashes	900.5	881	2.2%	0.264
Injury Crashes	227	197.5	13.0%	**0.023****
PDO Crashes	673.5	683.5	-1.5%	0.652
Rear-End Crashes	358.5	419	-16.9%	0.999
LT Crashes	279	291	-4.3%	0.774
LTOT Crashes	204	202	1.0%	0.463

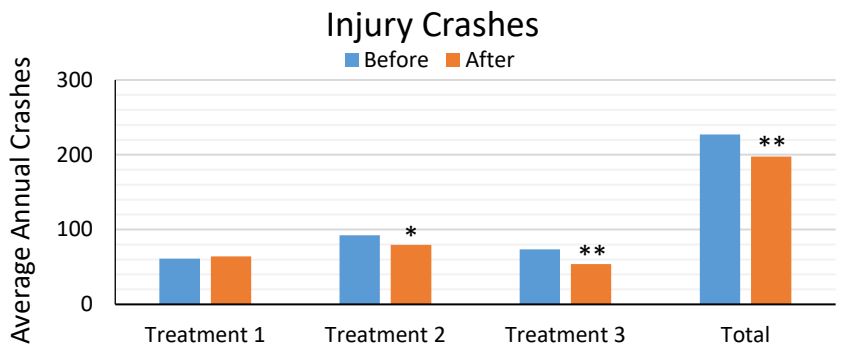
Treatment Category #1: 3-way with 1 FYA				
Crash Type	**Avg Annual before**	**Avg Annual After**	**% Reduction**	**Significant? (p-value)**
Total Crashes	250.5	234.5	6.4%	0.156
Injury Crashes	61	64	-4.9%	0.679
PDO Crashes	189.5	170.5	10.0%	**0.082***
Rear-End Crashes	100	116	-16.0%	0.948
LT Crashes	75.5	81	-7.3%	0.758
LTOT Crashes	52	53.5	-2.9%	0.591

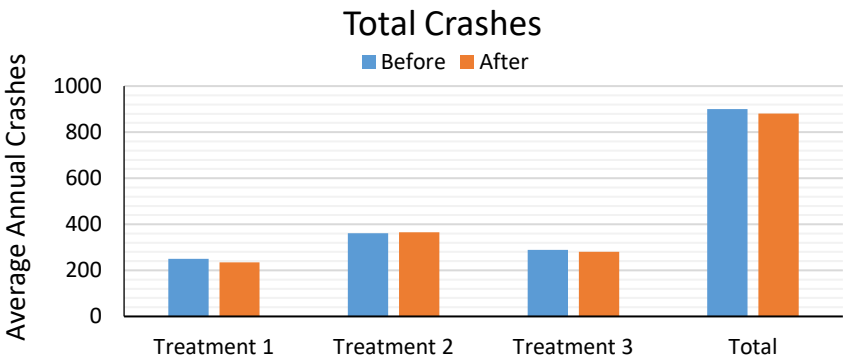
Treatment Category #2: 4way with 1 FYA				
Crash Type	**Avg Annual before**	**Avg Annual After**	**% Reduction**	**Significant? (p-value)**
Total Crashes	361.5	366	-1.2%	0.607
Injury Crashes	92.5	79.5	14.1%	**0.086***
PDO Crashes	269	286.5	-6.5%	0.857
Rear-End Crashes	142	168	-18.3%	0.985
LT Crashes	114	131	-14.9%	0.947
LTOT Crashes	87.5	96	-9.7%	0.832

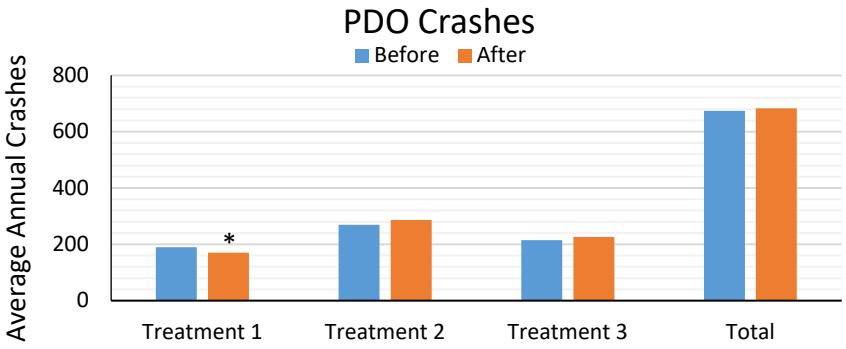
Treatment Category #3: 4-way with 2-or-more FYAs				
Crash Type	**Avg Annual before**	**Avg Annual After**	**% Reduction**	**Significant? (p-value)**
Total Crashes	288.5	280.5	2.8%	0.322
Injury Crashes	73.5	54	26.5%	**0.011****
PDO Crashes	215	226.5	-5.3%	0.785
Rear-End Crashes	116.5	135	-15.9%	0.958
LT Crashes	89.5	79	11.7%	0.145
LTOT Crashes	64.5	52.5	18.6%	**0.064***

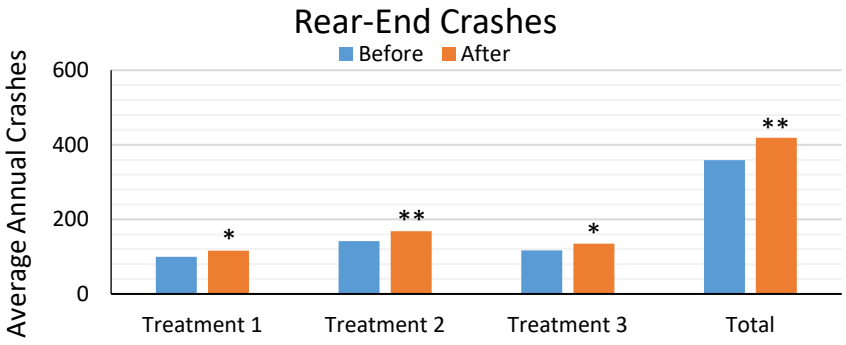
Note: (*) statistically significant at 90% (p<0.10); (**) statistically significant at 95% (p<0.05)

Given the results from the naïve before/after analysis, there was a significant reduction of injury-related crashes at all of the 4-way FYA intersections; however, there was a slight increase in injury-related crashes at 3-way intersections with the FYA implementation. Further, Treatment Category #3 (4-way intersection with two-or-more FYAs) was the only category to have a significant reduction in LTOT-related crashes. It is also important to note that there was a statistically significant increase in rear-end-related crashes across all three treatment categories. Albeit a net increase in crashes, the introduction of more rear-end crashes at these intersections suggests that the FYA was introducing a stronger yield perception to drivers and resulting in fewer head-on or angle crashes with the opposing through movements. The data presented in Figure 18 (using six separate bar charts) depict the significant differences of before/after crashes by crash type (*statistically significant at 90% [p<0.10], **statistically significant at 95% [0<0.05]).


Injury Crashes
Before
After
Average Annual Crashes
300
200
100
0
*
**
**
Treatment 1
Treatment 2
Treatment 3
Total


Total Crashes
Before
After
Average Annual Crashes
1000
800
600
400
200
0
Treatment 1
Treatment 2
Treatment 3
Total


PDO Crashes
Before
After
Average Annual Crashes
800
600
400
200
0
*
Treatment 1
Treatment 2
Treatment 3
Total


Rear-End Crashes
Before
After
Average Annual Crashes
600
400
200
0
*
**
*
**
Treatment 1
Treatment 2
Treatment 3
Total

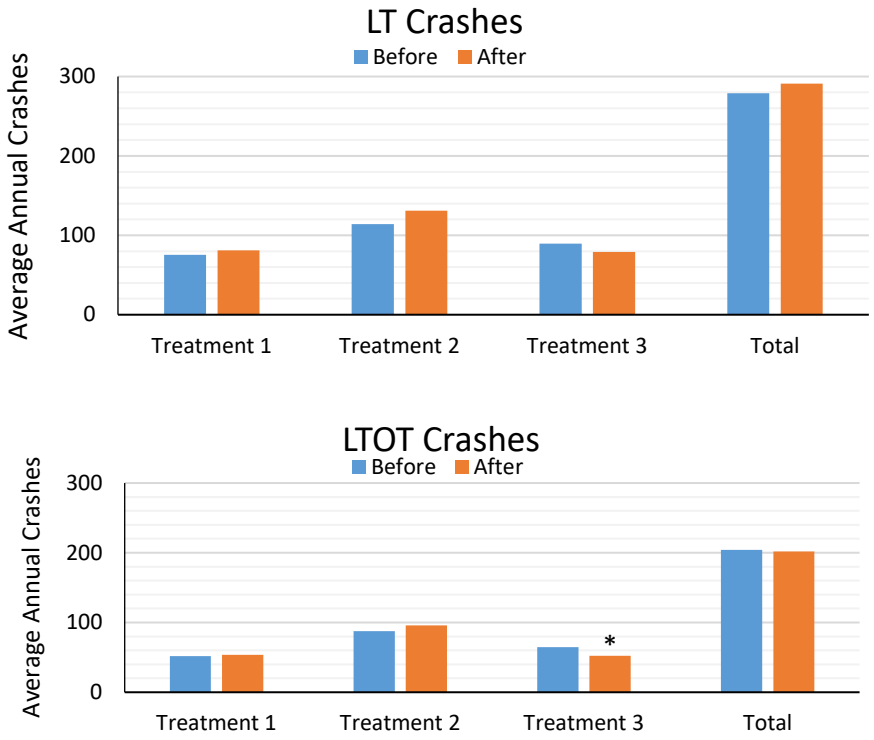


Figure 17: Before/after crashes by crash and injury type

The results from the naïve before/after analysis provide unique insight into the impacts on specific target crash types from the FYA implementation. However, it was important to evaluate these crashes in coordination with previous MassDOT safety analyses *(21)*. Table 14 presents the equivalent property damage only (EPDO) crashes for the before and after periods, by treatment category. In an effort to limit the monetary weight of fatal crashes, these EPDO crashes equally weighted the injury-related crashes (e.g. fatal, incapacitating, non-incapacitating, and possible injury) by a factor of 21:1. Again, statistical tests revealed significant reductions across Treatment Categories #2 and #3; however, Treatment Category #1 resulted in an increase in EPDO crashes.

Table 14: Equivalent PDO (EPDO) crashes by treatment type

	EPDO Crashes			
Treatment Type	**Avg Annual before**	**Avg Annual After**	**% Reduction**	**Significant? (p-value)**
1	1470.5	1514.5	-3.0%	0.874
2	2211.5	1953	11.7%	**0.000****
3	1746.5	1360.5	22.1%	**0.000****
Total	5440.5	4831	11.2%	**0.000****

Note: (**) statistically significant at 95% ($p<0.05$)

3.4 Cost-Benefit Analysis

A thorough cost-benefit analysis was conducted to determine the economic impacts of installing a FYA at the 166 study intersections across Massachusetts. An equivalency of economic costs and benefits of the FYA were derived and annualized to establish a benefit-to-cost (BC) ratio of the overall FYA implementation.

The benefits from the FYA implementation were determined by calculating the crash costs allocated during the before and after periods. Table 15 presents the overall injury cost calculations by treatment type, in addition to the aggregated total FYA study intersection assessment. Again, crashes were annualized per year during the before/after period across the five levels of Injury Status *(23).* Societal economic costs per injury level were calculated based on the most recent FHWA report *(24)* and have been normalized to represent Massachusetts dollars *(25),* which is referred to as "MassDOT Economic Costs (Adjusted)" in the table below. Ultimately, these crash costs were calculated across each injury type during the before/after period within all of the FYA treatment categories to establish a net benefit of FYA implementation.

Table 15: Injury cost calculations by treatment type

Total FYA Study Intersections				
	Average Annual Crashes (Before)	**Average Annual Crashes (After)**	**MassDOT Economic Costs (Adjusted)**	**Annual Monetary Benefit (MassDOT)**
Fatal	1	0.5	$16,257,800	$8,128,900
Incap.	12.5	8	$941,300	$4,235,850
Non-Incap.	87	78	$284,600	$2,561,400
Possible	126.5	111	$179,600	$2,783,800
PDO	673.5	683.5	$16,700	-$167,000

Treatment Category #1: 3-way with 1 FYA				
	Average Annual Crashes (Before)	**Average Annual Crashes (After)**	**MassDOT Economic Costs (Adjusted)**	**Annual Monetary Benefit (MassDOT)**
Fatal	1	0	$16,257,800	$16,257,800
Incap.	4	2	$941,300	$1,882,600
Non-Incap.	24	28	$284,600	-$1,138,400
Possible	32	34	$179,600	-$359,200
PDO	189.5	170.5	$16,700	$317,300

Treatment Category #2: 4way with 1 FYA				
	Average Annual Crashes (Before)	Average Annual Crashes (After)	MassDOT Economic Costs (Adjusted)	Annual Monetary Benefit (MassDOT)
Fatal	0	0	$16,257,800	$0
Incap.	4	7.5	$941,300	-$3,294,550
Non-Incap.	53.5	40.5	$284,600	$3,699,800
Possible	89	68	$179,600	$3,771,600
PDO	398	418	$16,700	-$334,000

Treatment Category #3: 4-way with 2-or-more FYAs				
	Average Annual Crashes (Before)	Average Annual Crashes (After)	MassDOT Economic Costs (Adjusted)	Annual Monetary Benefit (MassDOT)
Fatal	0	0.5	$16,257,800	-$8,128,900
Incap.	9	1	$941,300	$7,530,400
Non-Incap.	43	31.5	$284,600	$3,272,900
Possible	56.5	46	$179,600	$1,885,800
PDO	304.5	327.5	$16,700	-$384,100

In order to calculate the annualized expected cost of installing the FYA, the costs (as presented in Section 2.4.2) were utilized to approximate the annual economic cost. Annualized yearly costs of the FYA implemented required several assumptions, such as:

- Economic expected lifespan of improvement: 20 years
- Interest Rate *(8,19)*: 5%
- Annual Maintenance of FYA installation: $0

These assumptions were utilized to derive an annualized Capital Recovery Factor,

$$CR = \frac{i(1+i)^n}{(1+i)^n - 1}$$

where, i represents the interest rate and n represents the expected lifespan of the improvement. Thus, a Capital Recovery factor of 0.0963 was multiplied against the FYA treatment costs to calculate an annualized treatment cost per intersection.

Table 16 presents a range of BC ratios across all three of the FYA treatment categories. In Treatment Categories #1 and #2, a range of $6,000–$50,000 cost per FYA treatment was utilized, while with Treatment Category #3 a range of $12,000–$100,000 was utilized to

establish a wide-range of annualized treatment costs. By establishing a selection of FYA treatment costs, this study was able to calculate a range of BC ratios referring to the established MassDOT adjusted costs.

Table 16: Cost-benefit ratios by FYA treatment type

Treatment Category	FYA Treatment Cost	Annualized Treatment Cost (per intersection)	Crash Reduction Benefits (MassDOT Cost)	Benefit to Cost Ratio
1	$6,000	$94,015	$16,960,100	180.4
	$10,000	$156,692		108.2
	$50,000	$783,461		21.6
2	$6,000	$94,015	$3,842,850	40.9
	$10,000	$156,692		24.5
	$50,000	$783,461		4.9
3	$12,000	$188,031	$4,176,100	22.2
	$20,000	$313,385		13.3
	$100,000	$1,566,923		2.7
Total	$6,000	$94,015	$17,542,950	186.6
	$10,000	$156,692		112.0
	$100,000	$1,566,923		11.2

The MassDOT costs resulted in a range of BC ratios of 180:1 to 22:1, 41:1 to 5:1, and 22:1 to 3:1 for Treatment Categories 1, 2, and 3, respectively. Overall, the aggregated FYA BC ratios using the MassDOT adjusted costs ranged from 187:1 to 11:1. Using this cost breakdown, there was a significant benefit from the implementation of a FYA indication at these intersections, with regards to the crash quantity and injury-severity of the crashes during the before/after periods. It is important to note, a significant benefit may be met through very few fatal crashes given the large economic cost value for fatal crashes in the adjusted cost breakdown. This outcome provided evidence to suggest that the existing MassDOT injury-severity weighting system may have a large impact in assessing infrastructure safety impact. Overall, the results provide overwhelming evidence that the implementation of the FYA reduced the average annual number of injury-related crashes, and Treatment Category #3 provided the most promising results with respect to improving safety.

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4.0 Implementation and Technology Transfer

This research project developed the foundation for future safety analysis studies on traffic signal infrastructure, given the holistic assessment of before/after FYA crashes. The FYA inventory established through this project will provide MassDOT with a working database to continue monitoring and assessing the installation of FYA signals across Massachusetts. With refined traffic volume data collection, further studies could evaluate a larger sample of FYAs using the methodologies established within this research project.

In this research project, FYAs were evaluated from an intersection level, given the restrictions of crash data availability from the approach level. While the research conducted herein provided significant insight into the safety impacts of the FYA signal, given the majority of simple retrofit locations, future work could build on adapting methodologies of assessing approach-level safety impacts at signalized intersections across Massachusetts. With the availability of crash reports and crash diagrams, this future work could entail an in-depth analysis of signalized intersections to evaluate the reliability of crashes by approach, as well as evaluating the accuracy of intersection crash-types using visualizations such as crash diagram modeling.

There were a few limitations that were presented in this study, most of which provide unique insight into potential future research. The exact dates of installation for each of the FYA intersections were difficult to determine; however, this study utilized Google Street View imagery to determine before and after dates of implementation. While this method still yielded the appropriate before and after study period, there is a need to have a statewide database of signalized intersection improvements and their respective dates of improvement. Additionally, the FYAs evaluated in this study were strictly Massachusetts-owned and/or -operated signals, and therefore future research should include signals from the municipality level to evaluate any potential discrepancy in safety benefits. Lastly, the majority of FYA intersections in this study utilized "open" years of crash data from 2018 to 2019. That said, there might exist a need to revisit this analysis in future years to evaluate the FYAs based on "closed" years of crash data in the post-implementation period.

Given the findings of this study, which revealed a significant benefit-to-cost ratio for all of the treatment intersection types, efforts should be made to highlight the benefits of the flashing yellow arrow at protected-permissive left turn locations statewide, particularly when implementing locally owned-operated FYA signals.

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5.0 Conclusions

This study sought to evaluate the efficacy of the flashing yellow arrow (FYA) left-turn permissive indication in Massachusetts, which was introduced to the 2009 edition of the *Manual on Uniform Traffic Control Devices* (MUTCD). Since 2013, MassDOT has begun the implementation process of FYAs, with contracts set in place to retrofit over 350 traditional protected-permissive left-turn (PPLT) traffic signals to include the FYA permissive indication. Given the near-completion of this retrofit project, a need existed to investigate the safety impacts of these traffic control devices across the Commonwealth. Thus, a pre- and post-implementation cost-benefit analysis of FYA signals was conducted, specifically taking into consideration various metrics such as jurisdiction, treatment type, and infrastructure elements at each of the FYA intersections. Ultimately, this research study was conducted across four main tasks, with their respective results explained as follows.

A statewide inventory of FYA installations was created, resulting in a database that included metrics such as before/after installation dates, intersection characteristics (e.g., number of FYAs, presence of supplementary signage, and geometric design elements), and links to updated Google Street View imagery. This evolving database may be utilized by MassDOT to continue tracking FYA installations in Massachusetts, with additional understanding of existing infrastructure characteristics from previous designs.

In conducting a before/after safety impact analysis, 166 FYA intersections were selected based on the availability of before/after crash data and reliable traffic volume information. Traffic volumes were collected from MassDOT-approved resources and adjusted for each FYA intersection to consider regionality and yearly volume trends. FYA intersections were evaluated based on intersection and treatment type (3-way intersection with one FYA approach, 4-way intersection with one FYA approach, and 4-way intersection with two or more FYA approaches). Overall, the 3-way intersections with one FYA approach yielded the largest sample size; however, these 3-way intersections experienced the fewest before/after crashes. The 4-way intersection treatment types both showed a significant reduction of injury-related crashes, yet all three categories had significant increases in rear-end crashes, which suggested the potential for a stronger yield perception from drivers (e.g., fewer head-on and angle crashes). More so, left-turn-opposing-through (LTOT) crash rates were only significantly reduced in 4-way intersections with two or more FYA approaches. Lastly, the 4-way intersection FYA treatment categories significantly reduced the total number of equivalent property damage only (EPDO) crashes, while 3-way FYA intersections resulted in a slight increase in EPDO crashes.

A cost-benefit analysis was conducted to evaluate the economic benefits of installing FYA signals at the aforementioned locations in Massachusetts, yielding a range of benefit-to-cost (BC) ratios. The crash reduction benefits from FYA implementation were determined by calculating crash costs during the before/after periods. Crashes were annualized per year across the FHWA defined five-level KABCO scale of injury status. Societal economic costs per injury level were calculated using the Massachusetts adjusted FHWA costs ("MassDOT Economic Costs Adjusted"). This crash cost method was applied to assess the range of crash

cost reduction benefits across the three FYA treatment types. In MassDOT adjusted costs, the 3-way FYA intersections yielded the highest BC ratio range (180:1 to 22:1) and 4-way intersections with multiple FYA approaches yielded the lowest (22:1 to 3:1). The economic benefit results suggest that the FYA signal retrofits should be widely implemented, prioritizing only for cost of installation. While the overwhelmingly positive results from the BC ratios suggest that FYA signals be installed at all intersection treatment types across Massachusetts, follow-up studies are anticipated to be conducted in the coming years to further evaluate the safety impacts of these traffic control devices. The FYA signal for left-turn permissive movements provided a significant reduction in the average number of injury-related crashes, and ultimately led to a lower economic cost of injuries at all three of the treatment types investigated in this study.

Future work should focus on the intersection infrastructure elements and their respective impacts on driver behavior, particularly with left-turn maneuvers at intersections involving the FYA. More so, the results from this study suggest further investigation into the performance of FYAs at 3-way intersections across Massachusetts, specifically focusing on the potential safety impact from FYA traffic signal phase schemes. Additionally, given the challenges incurred with assessing approach-level crashes, further research should be conducted to assess the efficacy of using crash reports and diagrams to verify approach-level safety benefits in Massachusetts. The data collection methodologies and applications to assess traffic safety will continue to remain important in the coming years, and therefore procedures for adapting volume, crash, and injury costs should remain critical in future research endeavors.

6.0 References

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7.0 Appendices

7.1 Appendix A: Flashing Yellow Arrow Inventory

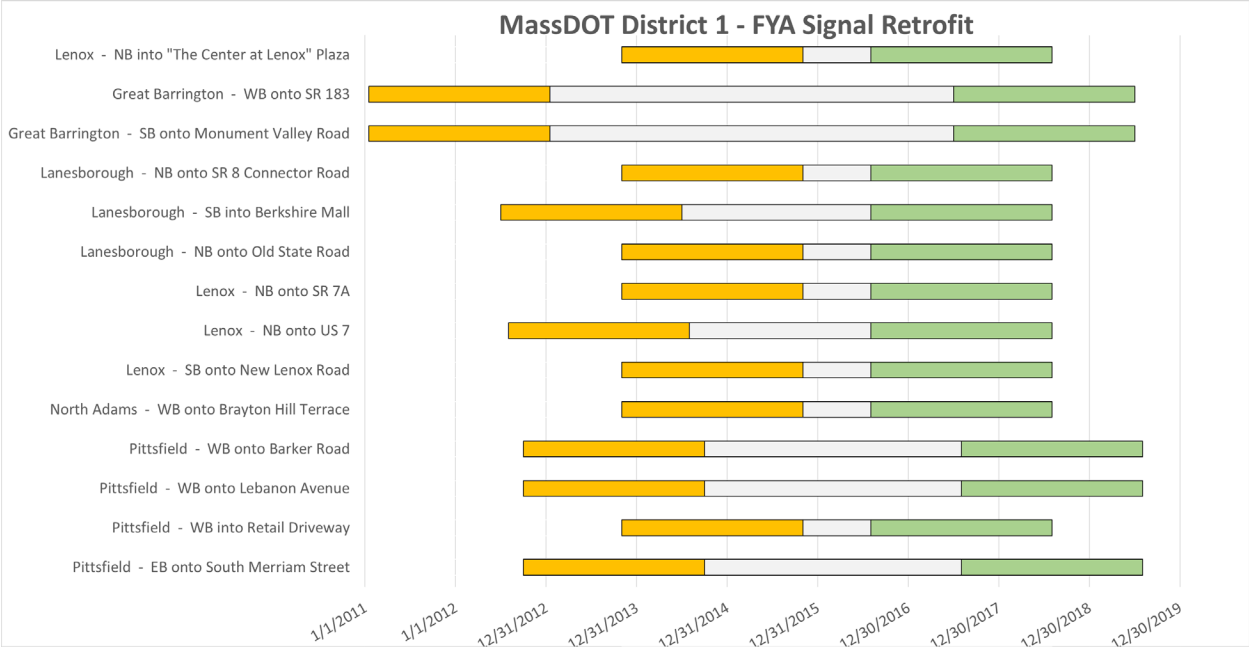
FID	Signal ID	Dist_ID	District	Municipality	Location 1	Location 2	Latitude	Longitude	FYA Approach	Supp. Signage (Yes/No)	Intersection Legs	Multiple FYA/CG Approaches?	Structure (Post/Mast-arm/Span Wire)	Second Structure	Pedestrian Signal (Yes/No)	Activation Button (Yes/No)	Opposing Right Turn Lane (Yes/No)	Right Turn on Red (Yes/No)	Taper (ft.)	Turn Bay (ft.)	Width of FYA/CG Approach (ft.)	Width of Opposing Approach (ft.)	Width of Perpendicular Approach (ft.)	Latest Before Installation Imagery	Earliest After Installation Imagery	Link to Streetview
0	10322	31377	3	ACTON	SR 2A & SR 119 (Great Road)	Nagog Park	42.5216	-71.4336	SB onto Nagog Park	No	3-way	No	Mast-arm	-	No	N/A	Yes	Yes	187	150	54	54	106	Nov-15	Aug-17	https://www.google.c
1	10366	31772	3	ACTON	SR 2A & SR 119 (Great Road)	Brookside Shops Driveway	42.4830	-71.4157	SB into Trader Joe's/Staples Plaza	Yes	3-way	No	Mast-arm	-	Yes	Yes	No	Yes	151	181	34	42	48	Nov-15	Nov-17	https://www.google.c
2	10401	20426	2	AGAWAM	SR 159 (Main Street)	School Street	42.0696	-72.6152	SB onto School Street	Yes	3-way	No	Mast-arm	-	Yes	Yes	No	No	86	224	35	32	39	Nov-15	Aug-18	https://www.google.c
3	10671	20902	2	AGAWAM	SR 159 (Main Street)	Elm Street	42.0679	-72.6156	NB onto Elm Street	Yes	4-way	2	Mast-arm	-	Yes	Yes	No	Yes	145	181	37	35	37	Nov-15	Aug-18	https://www.google.c
5	11297	21515	2	AGAWAM	SR 75 (Suffield Street)	SR 57 WB Ramps	42.0748	-72.6304	NB onto Route 57	No	4-way	No	Mast-arm	-	No	N/A	Yes	Yes (yield)	172	376	53	51	17	Nov-15	Aug-18	https://www.google.c
6	11483	21748	2	AGAWAM	SR 159 (Main Street)	Meadow Street	42.0776	-72.6146	NB onto Meadow Street	Yes	4-way	2	Mast-arm	-	No	N/A	No	Yes	158	67	92	80	41	Oct-16	Aug-18	https://www.google.c
7	11484	41045	4	AMESBURY	Main Street	Merrill Street	42.8369	-70.9080	NB onto Main Street	Yes	3-way	No	Mast-arm	-	No	N/A	No	Yes	100	103	37	39	56	Oct-15	Oct-17	https://www.google.c
8	11486	20594	2	AMHERST	SR 116	SR 63 (Meadow Street)	42.4090	-72.5381	NB onto Route 63	Yes	4-way	2	Span Wire	-	No	N/A	Yes	Yes (yield)	192	87	48	38	26	Oct-13	Aug-17	https://www.google.c
9	11487	40450	4	ANDOVER	SR 28 (South Main Street)	Salem Street	42.6461	-71.1334	SB onto Salem Street	Yes	3-way	No	Mast-arm	Post	Yes	Yes	Yes	No	61	187	54	55	59	Oct-12	Nov-17	https://www.google.c
10	11488	40888	4	ANDOVER	SR 28 (Main Street)	School Street	42.6494	-71.1357	NB onto School Street	Yes	4-way	No	Mast-arm	Post	Yes	Yes	no	No	69	88	63	51	38	Oct-12	Nov-16	https://www.google.c
11	11489	11490	1	LENOX	US 7 & 20 (Pittsfield Road)	Price Chopper/The Center at Lenox/Homeswood Ter	42.4048	-73.2652	NB into "The Center at Lenox" Plaza	Yes	4-way	2	Span Wire	Post	Yes	Yes	Yes	Yes	52	97	59	69	92	Nov-15	Aug-16	https://www.google.c
13	11491	41052	4	ANDOVER	SR 28 (Main Street)	Chapel Avenue	42.6487	-71.1352	SB onto Chapel Ave	Yes	3-way	No	Mast-arm	Post	Yes	Yes	No	No	48	77	61	53	38	Oct-12	Nov-16	https://www.google.c
14	11492	30513	3	ASHLAND	SR 126 (Pond Street)	Eliot Street	42.2419	-71.4313	NB onto Eliot Street	No	4-way	3	Mast-arm	-	No	N/A	Yes	Yes	133	142	39	66	42	Oct-13	Nov-16	https://www.google.c
16	11494	21556	2	ATHOL	SR 2A (South Main Street)	Daniel Shays Highway	42.5821	-72.2552	WB onto Brookside Road	Yes	3-way	No	Mast-arm	-	No	N/A	No	Yes	80	180	50	34	99	Oct-11	Oct-18	https://www.google.c
17	11496	51056	5	ATTLEBORO	US 1 (Washington Street)	East Bacon Street	41.8962	-71.3704	NB onto Bacon Street	Yes	4-way	No	Span Wire	-	Yes	Yes	No	Yes	67	96	60	66	61	Oct-13	Aug-17	https://www.google.c
18	11498	30119	3	AUBURN	SR 12 (Southbridge Street)	Auburn Street	42.2064	-71.8337	WB onto Auburn Street	No	4-way	2	Mast-arm	-	Yes	Yes	Yes	Yes (yield(	162	116	62	58	54	Aug-11	Nov-16	https://www.google.c
19	11502	30242	3	AUBURN	SR 12 (Southbridge Street)	Church Street	42.1951	-71.8440	SB onto Church Street	Yes	3-way	No	Mast-arm	-	Yes	Yes	No	Yes	126	99	56	53	34	Aug-11	Nov-16	https://www.google.c
20	11504	30779	3	AUBURN	SR 12 (Southbridge Street)	Swanson Road	42.2042	-71.8364	NB onto Swanson Road	No	4-way	No	Mast-arm	-	Yes	Yes	No	Yes	55	270	56	61	72	Nov-16	Sep-17	https://www.google.c
21	11581	30848	3	AUBURN	Auburn Street	Vine Street	42.2099	-71.8385	NB onto I-290 WB Ramp	No	4-way	No	Mast-arm	-	No	N/A	Yes	Yes (yield)	216	124	53	44	150	No imagery o	No imagery of	https://www.google.c
22	11622	31381	3	AUBURN	SR 12 (Southbridge Street)	Oxford Street North	42.1889	-71.8489	EB onto Oxford Street North	Yes	4-way	No	Mast-arm	-	No	N/A	Yes	Yes (yield)	70	111	64	59	111	Aug-11	Nov-16	https://www.google.c
23	11623	31382	3	AUBURN	SR 12 (Southbridge Street)	Auburn Mall Driveway	42.2010	-71.8395	NB into Retail Driveway	Yes	4-way	2	Span Wire	-	Yes	Yes	No	Yes	124	145	54	56	69	Aug-11	Nov-16	https://www.google.c
24	11624	50471	5	BARNSTABLE	SR 28 (Falmouth Road)	SR 130 (Main Street)	41.6376	-70.4518	EB onto SR 130	Yes	3-way	No	Mast-arm	-	No	N/A	No	Yes	89	169	46	33	81	Oct-15	Sep-17	https://www.google.c
26	20355	50547	5	BARNSTABLE	SR 28 (Falmouth Road)	Old Stage Road	41.6569	-70.3499	SB onto Falmouth Road	Yes	4-way	No	Mast-arm	-	Yes	Yes	No	Yes	101	134	99	47	56	Oct-15	Sep-17	https://www.google.c
27	20363	51377	5	BARNSTABLE	SR 28 (Falmouth Road)	Lumbert Mill Road	41.6523	-70.3715	WB onto Lumbert Mill Road	Yes	4-way	2	Mast-arm	-	No	N/A	No	Yes	128	108	42	57	51	Oct-15	Sep-17	https://www.google.c
28	20370	51378	5	BARNSTABLE	SR 28 (Falmouth Road)	South County Road	41.6523	-70.4045	EB onto Main Street	Yes	4-way	2	Span Wire	-	Yes	Yes	Yes	Yes	126	103	38	49	37	Oct-15	Sep-17	https://www.google.c
29	20381	20355	2	BELCHERTOWN	SR 9 (Federal Street & Sargent Street)	US 202 (North Main Street & Daniel Shays Highway)	42.2893	-72.4067	NB onto SR 9	Yes	4-way	No	Span Wire	-	Yes	Yes	No	Yes	111	92	41	27	41	Oct-13	Oct-18	https://www.google.c
30	20397	21557	2	BELCHERTOWN	SR 9 (Federal Street)	George Hannum Street	42.2912	-72.4091	NB onto George Hannum Street	Yes	3-way	No	Mast-arm	-	No	N/A	No	Yes	95	75	52	37	39	Oct-13	Nov-16	https://www.google.c
31	20426	31384	3	BELLINGHAM	SR 126 (North Main Street)	SR 126 & SR 140 (Mechanic Street)	42.0873	-71.4748	NB onto SR 140	Yes	3-way	No	Mast-arm	Post	Yes	Yes	No	Yes	75	170	46	42	30	Oct-15	Aug-17	https://www.google.c
32	20457	31830	3	BELLINGHAM	SR 126 & SR 140 (Mechanic Street)	SR 140 (Mechanic Street)	42.0864	-71.4741	SB onto Common Street	Yes	4-way	No	Mast-arm	-	No	N/A	No	Yes	47	60	34	37	62	Oct-15	Aug-17	https://www.google.c
33	20512	31831	3	BELLINGHAM	SR 140 (Mechanic Street)	Blackstone Street	42.0816	-71.4643	WB onto Blackstone Street	No	3-way	No	Mast-arm	-	No	N/A	No	Yes	126	113	41	37	55	Oct-15	Aug-17	https://www.google.c
34	20518	40805	4	BEVERLY	SR 1A (Dodge Street)	Conant Street	42.5771	-70.8906	NB onto Conant Street	Yes	3-way	No	Mast-arm	-	Yes	Yes	No	Yes	116	104	65	60	86	Jul-15	Sep-17	https://www.google.c
36	20594	41066	4	BILLERICA	SR 3A (Boston Road)	Towne Plaza Driveway	42.5380	-71.2438	EB into Towne Plaza	Yes	3-way	No	Mast-arm	-	Yes	Yes	No	Yes	133	129	42	43	80	Oct-13	Nov-17	https://www.google.c
38	20834	31388	3	BOLTON	SR 117 (Main Street)	I-495 SB Ramps	42.4312	-71.5950	WB onto I-495 SB Ramp	Yes	4-way	2	Mast-arm	-	No	N/A	Yes	Yes (yield)	108	148	56	48	52	Oct-11	Nov-16	https://www.google.c
39	20844	31832	3	BOLTON	SR 117 (Main Street)	I-495 NB Ramps	42.4305	-71.5906	EB onto I-495 NB Ramp	Yes	3-way	No	Mast-arm	-	No	N/A	Yes	Yes (yield)	136	149	39	41	49	Oct-11	Oct-18	https://www.google.c
40	20850	50653	5	BOURNE	SR 6A (Sandwich Road)	Mid-Cape Connector	41.7743	-70.5476	WB onto Mid-Cape Connector	No	3-way	No	Mast-arm	-	No	N/A	Yes	Yes (yield)	61	49	39	31	53	Oct-15	Sep-17	https://www.google.c
42	20902	51387	5	BOURNE	Meetinghouse Lane	State Road	41.7823	-70.5410	EB onto State Road	No	4-way	2	Span Wire	-	No	N/A	No	Yes	284	189	59	52	45	Sep-17	Oct-19	https://www.google.c
43	21505	61078	6	BRAINTREE	SR 37 (Washington Street)	SR 37 (Franklin Street)	42.2018	-71.0072	SB onto Washington Street	Yes	3-way	No	Mast-arm	-	Yes	Yes	Yes	Yes	95	65	48	36	75	Oct-13	Oct-16	https://www.google.c
44	21509	61736	6	BRAINTREE	SR 37 (Washington Street)	Braxton Street	42.1884	-71.0075	NB onto Braxton Street	Yes	3-way	No	Mast-arm	-	Yes	Yes	No	Yes	65	150	36	36	44	Oct-13	Jul-17	https://www.google.c
46	21515	40492	4	BURLINGTON	SR 3A (Cambridge Street)	Bedford Street	42.5050	-71.1959	EB onto Cambridge Street	Yes	4-way	No	Mast-arm	-	Yes	Yes	No	Yes	97	161	39	45	42	Oct-13	Nov-17	https://www.google.c
48	21520	41083	4	BURLINGTON	SR 3A (Cambridge Street)	SR 62 (Francis Wyman Road)	42.5241	-71.2198	NB onto SR 62	Yes	3-way	No	Mast-arm	-	Yes	Yes	No	Yes	192	103	52	53	55	Oct-13	Nov-17	https://www.google.c
49	21522	61095	6	CANTON	SR 138 (Turnpike Street)	Dan Road	42.1606	-71.1092	NB onto Dan Road	Yes	3-way	No	Mast-arm	-	No	N/A	No	Yes	201	117	49	43	64	Oct-07	Nov-16	https://www.google.c
51	21556	31549	3	CHARLTON	US 20 (Worcester Road)	Stafford Street	42.1451	-71.9904	EB onto Stafford Street	No	3-way	No	Span Wire	-	No	N/A	Yes	Yes	150	288	45	51	61	Sep-14	Oct-18	https://www.google.c
52	21557	40213	4	CHELMSFORD	SR 4 (North Road)	SR 3A (Princeton Street)	42.6312	-71.3736	SB onto Princeton Street	Yes	3-way	No	Mast-arm	-	No	N/A	Yes	Yes (yield)	154	149	59	56	52	Aug-12	Nov-17	https://www.google.c
53	21558	40390	4	CHELMSFORD	SR 3A (Tyngsboro Road)	SR 40 (Groton Road)	42.6396	-71.3836	NB onto Groton Road	Yes	3-way	No	Span Wire	-	Yes	Yes	No	Yes	45	135	50	33	53	Oct-15	Nov-17	https://www.google.c
55	21561	41097	4	CHELMSFORD	SR 110 (Chelmsford Street)	Chelmsford Mall Driveway	42.6114	-71.3357	WB into Chelmsford Mall Driveway	Yes	3-way	No	Mast-arm	Post	Yes	Yes	Yes	No	202	107	43	47	69	Nov-16	Nov-17	https://www.google.c
56	21740	41100	4	CHELMSFORD	SR 129 (Billerica Road)	US 3 SB Ramps	42.5893	-71.3145	NB onto US 3 SB Ramp	No	3-way	No	Mast-arm	-	No	N/A	Yes	Yes (yield)	169	218	72	77	52	Oct-12	Nov-17	https://www.google.c
57	21744	41105	4	CHELMSFORD	SR 4 (North Road)	Technology Drive	42.6268	-71.3691	NB onto Frank Street	Yes	4-way	2	Mast-arm	-	No	N/A	No	Yes	122	62	43	44	73	Aug-12	Nov-17	https://www.google.c
60	21748	51105	5	COHASSET	SR 3A (Cushing Highway)	King Street	42.2335	-70.8220	SB into Stop & Shop Driveway	Yes	4-way	No	Mast-arm	-	No	N/A	No	Yes	87	149	42	46	95	Aug-12	Nov-17	https://www.google.c
61	21751	41043	4	DANVERS	SR 114 (Andover Street)	Garden Street	42.5569	-70.9684	WB into Supercuts Plaza	No	4-way	2	Span Wire	-	No	N/A	No	Yes	186	104	60	81	64	Jul-15	Nov-16	https://www.google.c
62	21752	41111	4	DANVERS	Endicott Street	SR 128 SB Ramps	42.5488	-70.9382	EB onto 128 SB Ramp	Yes	3-way	No	Mast-arm	-	Yes	Yes	Yes	Yes (yield)	186	194	58	54	56	Jul-15	Nov-17	https://www.google.c
63	30034	41112	4	DANVERS	Endicott Street	SR 128 NB Ramps	42.5493	-70.9343	EB onto 128 NB Ramp	Yes	4-way	No	Mast-arm	-	No	N/A	Yes	Yes (yield)	145	93	66	61	62	Jul-15	Nov-16	https://www.google.c
64	30035	30035	3	LITTLETON	SR 2A & SR 119 (Great Road)	SR 110 (King Street)	42.5465	-71.4729	SB onto SR 2A	Yes	4-way	4	Mast-arm	Post	Yes	Yes	No	Yes	79	189	35	47	33	Nov-12	Nov-17	https://www.google.c
65	30036	41114	4	DANVERS	SR 114 (Andover Street)	Wal-Mart West Driveway	42.5555	-70.9657	WB into Brooksby Village Drive	Yes	3-way	2	Mast-arm	-	No	N/A	No	Yes	63	119	61	61	94	Jul-15	Nov-16	https://www.google.c
66	30112	41115	4	DANVERS	SR 114 (Andover Street)	Brooksby Village Drive	42.5547	-70.9640	EB into Car Dealership	Yes	4-way	-	Mast-arm	-	Yes	No	Yes	Yes	118	128	-	-	-	Oct-08	Nov-16	https://www.google.c
67	30119	41833	4	DANVERS	SR 35 (High Street)	SR 128 NB Ramps	42.5578	-70.9284	EB onto SR 128 NB Ramp	No	4-way	No	Mast-arm	-	No	N/A	Yes	Yes (yield)	56	140	48	46	50	Jul-15	Nov-17	https://www.google.c
68	30182	41834	4	DANVERS	SR 35 (High Street)	SR 128 SB Ramps	42.5583	-70.9295	WB onto SR 128 SB Ramp	Yes	4-way	No	Mast-arm	Post	No	N/A	Yes	Yes (yield)	75	139	48	46	37	Jul-15	Nov-17	https://www.google.c
69	30189	41835	4	DANVERS	SR 35 (High Street)	Purchase Street	42.5585	-70.9299	WB onto Purchase Street	Yes	3-way	No	Mast-arm	-	Yes	Yes	No	Yes	71	66	47	43	39	Aug-13	Nov-17	https://www.google.c
70	30198	30198	3	ACTON	SR 2A (Great Road)	SR 27 (Main Street)	42.5019	-71.4195	NB onto Main Street	Yes	4-way	3	Mast-arm	-	Yes	Yes	No	No*	145	76	32	32	43	Aug-15	Aug-17	https://www.google.c
73	30309	41837	4	DANVERS	SR 62 (Elliot Street)	SR 128 SB Ramps	42.5655	-70.9233	WB onto SR 128 SB Ramp	Yes	4-way	No	Mast-arm	Post	No	N/A	Yes	Yes (yield)	100	139	50	46	27	Aug-13	Sep-18	https://www.google.c
74	30321	50904	5	DARTMOUTH	US 6 (State Road)	Cross Road	41.6409	-71.0064	SB onto State Road	Yes	4-way	2	Mast-arm	-	Yes	Yes	No	Yes	172	107	61	51	86	Aug-12	Aug-17	https://www.google.c
75	30347	51398	5	DARTMOUTH	US 6 (State Road)	Target Driveway	41.6408	-71.0040	WB into Target Driveway	Yes	3-way	No	Mast-arm	-	No	N/A	Yes	Yes	187	285	71	86	67	Sep-15	Aug-17	https://www.google.c
76	30408	21505	2	DEERFIELD	SR 5 & SR 10 (South Deerfield Bypass)	SR 116 (Conway Road)	42.4826	-72.6127	NB onto SR 116	Yes	4-way	2	Span Wire	Post	No	N/A	Yes	Yes	62	226	43	64	69	Sep-13	Oct-18	https://www.google.c
78	30479	50617	5	DENNIS	SR 28 (Main Street)	SR 134 (E-W Dennis Road)	41.6675	-70.1480	WB onto Swan River Road	Yes	4-way	3	Mast-arm	-	Yes	Yes	No	Yes	34	104	45	41	66	Aug-14	Sep-17	https://www.google.c
79	30513	41121	4	DRACUT	SR 113 (Arlington Street)	SR 113 (Broadway Road)	42.6704	-71.2964	SB onto Arlington Street	Yes	4-way	2	Mast-arm	-	Yes	Yes	No	Yes	76	169	37	27	45	Nov-17	Oct-18	https://www.google.c
80	30668	50022	5	EAST BRIDGEWATER	SR 18 (Bedford Street)	Central Street	42.0319	-70.9585	SB onto Central Street	No	4-way	No	Span Wire	-	No	N/A	Yes	Yes (yield)	96	62	40	49	41	Sep-15	Nov-18	https://www.google.c
81	30721	21558	2	EASTHAMPTON	SR 10 (Northampton Street)	Florence Road	42.2812	-72.6696	NB onto Florence Road	Yes	4-way	No	Mast-arm	-	Yes	Yes	Yes	Yes	90	149	42	48	58	Oct-15	Aug-17	https://www.google.c
82	30779	50010	5	EASTON	SR 138 (Washington Street)	Main Street	42.0667	-71.0873	SB onto Main Street	No	4-way	3	Span Wire	-	Yes	Yes	No	Yes	198	117	65	61	65	Nov-16	Aug-17	https://www.google.c
83	30820	50709	5	FALMOUTH	SR 28 (Palmer Avenue)	Terrace Heun Drive	41.5640	-70.6188	SB onto Jones Road	Yes	4-way	No	Mast-arm	-	Yes	Yes	No	Yes	179	339	42	42	55	Oct-15	Nov-18	https://www.google.c
86	30961	31551	3	FRANKLIN	SR 140 (West Central Street)	Forge Parkway West	42.0865	-71.4442	WB onto Forge Parkway	Yes	3-way	No	Mast-arm	-	No	N/A	No	Yes	91	198	91	82	92	Oct-13	Aug-17	https://www.google.c
88	31377	31773	3	FRANKLIN	King Street	I-495 NB Ramps	42.0656	-71.4003	NB onto I-495 NB Ramp	Yes	3-way	No	Mast-arm	-	No	N/A	Yes	Yes (yield)	N/A	171	49	51	25	Oct-15	Nov-17	https://www.google.c
89	31378	31821	3	FRANKLIN	SR 140 (E. Central Street)	Big Y Driveway	42.0800	-71.3805	WB into Big Y Driveway	No	4-Way	2	Mast-arm	-	No	N/A	No	Yes	237	148	44	34	65	Sep-13	Aug-17	https://www.google.c
90	31381	31833	3	FRANKLIN	SR 140 (E. Central Street)	Horace Mann Plaza	42.0803	-71.3846	WB into CVS Driveway	No	4-way	2	Span Wire	Post	Yes	Yes	Yes	Yes	101	75	45	51	53	Sep-13	Oct-15	https://www.google.c
91	31382	51416	5	FREETOWN	Innovation Way	SR 24 & SR 79 SB Ramps	41.7670	-71.0978	WB onto SR 24 SB Ramp	No	4-way	No	Mast-arm	-	No	N/A	Yes	Yes (yield)	121	298	78	74	25	Sep-12	Sep-19	https://www.google.c
92	31384	20520	2	GILL	SR 2 & SR 2A (Mohawk Trail & French King H	Montague-Gill Bridge	42.6131	-72.5488	WB onto Main Road	Yes	4-way	2	Mast-arm	-	Yes	Yes	No	Yes	99	68	42	41	67	Nov-15	Nov-16	https://www.google.c
94	31388	40524	4	GLOUCESTER	SR 128	SR 127 (Eastern Avenue)	42.6196	-70.6488	SB onto Eastern Ave	Yes	4-way	2	Span Wire	-	Yes	Yes	Yes	Yes (yield)	160	233	46	59	47	Aug-13	Nov-17	https://www.google.c
95	31398	31407	3	GRAFTON	SR 122 & SR 140 (Worcester Street)	Stop & Shop Driveway	42.2192	-71.6977	SB into Stop & Shop Driveway	Yes	3-way	No	Span Wire	Post	Yes	Yes	No	Yes	94	147	52	53	70	Nov-15	Oct-18	https://www.google.c
96	31407	11483	1	GREAT BARRINGTON	US 7 & SR 183 (Stockbridge Road)	Barrington Plaza Driveway	42.2107	-73.3455	SB into Barrington Plaza Driveway	Yes	4-way	2	Span Wire	Post	No	N/A	Yes	Yes	42	110	41	55	61	Sep-11	Aug-18	https://www.google.c
97	31414	11484	1	GREAT BARRINGTON	US 7 & SR 23 (State Road)	US 7 & SR 183 (Stockbridge Road)	42.2015	-73.3491	WB onto SR 183	Yes	3-way	No	Mast-arm	Post	No	N/A	Yes	Yes	107	148	35	44	97	Sep-11	Jul-17	https://www.google.c
98	31429	11581	1	GREAT BARRINGTON	US 7 & SR 183 (Stockbridge Road)	Monument Valley Road	42.2486	-73.3316	SB onto Monument Valley Road	Yes	3-way	No	Mast-arm	Post	No	N/A	No	Yes	132	174	51	44	97	Sep-09	Jul-17	https://www.google.c
99	31432	20381	2	GREENFIELD	SR 2A (Mohawk Trail)	Shelburne Road	42.5855	-72.6127	WB onto River Street	Yes	4-way	2	Mast-arm	-	Yes	Yes	Yes	Yes	74	69	48	52	59	Nov-15	Nov-16	https://www.google.c
103	31447	31835	3	GROTON	SR 119 (Boston Road)	SR 225 (Forge Village Road)	42.5789	-71.5207	EB onto Boston Road	Yes	4-way	No	Span Wire	-	Yes	Yes	Yes	Yes	91	155	39	44	61	Aug-15	Sep-18	https://www.google.c

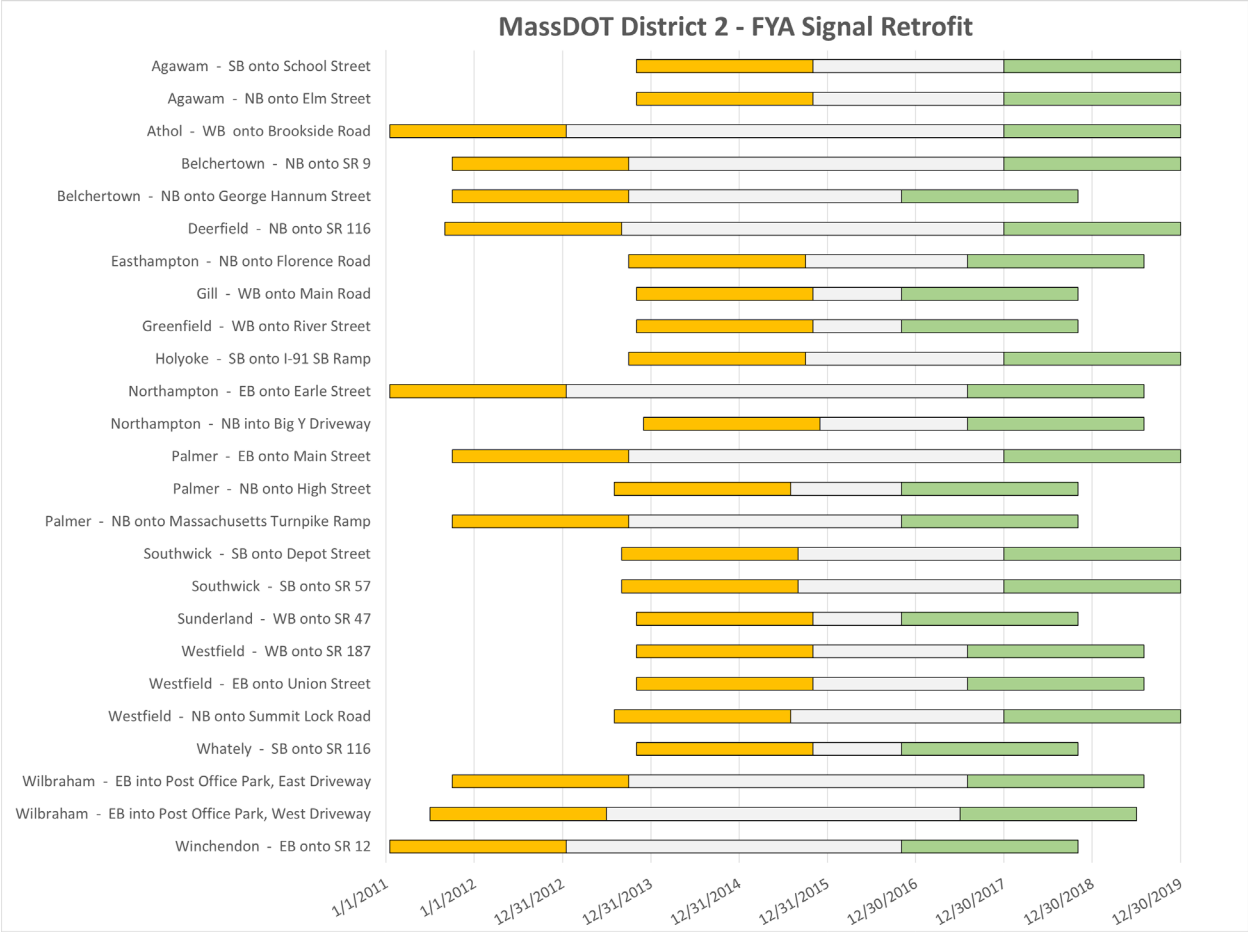
FID	Signal ID	Dist_ID	District	Municipality	Location 1	Location 2	Latitude	Longitude	FYA Approach	Supp. Signage (Yes/No)	Intersection Legs	Multiple FYA/CG Approaches?	Structure (Post/Mast-arm/Span Wire)	Second Structure	Pedestrian Signal (Yes/No)	Activation Button (Yes/No)	Opposing Right Turn Lane (Yes/No)	Right Turn on Red (Yes/No)	Taper (ft.)	Turn Bay (ft.)	Width of FYA/CG Approach (ft.)	Width of Opposing Approach (ft.)	Width of Perpendicular Approach (ft.)	Latest Before Installation Imagery	Earliest After Installation Imagery	Link to Streetview
107	31459	51302	5	HANOVER	SR 53 (Washington Street)	SR 3 SB Ramps	42.1494	-70.8455	EB onto Washington Street	Yes	4-way	No	Mast-arm	-	No	N/A	Yes	Yes	182	126	84	74	50	Jun-12	Sep-17	https://www.google.c
108	31460	51414	5	HANOVER	SR 53 (Washington Street)	SR 3 NB Ramps	42.1525	-70.8457	SB onto SR 3 NB Ramp	Yes	4-way	No	Mast-arm	-	Yes	Yes	Yes	Yes (yield)	65	205	53	53	67	Sep-17	Oct-19	https://www.google.c
109	31461	41122	4	HAVERHILL	SR 110 & SR 113 (River Street)	Lowell Avenue	42.7727	-71.1163	SB onto Lowell Ave	Yes	4-way	No	Span Wire	Post	Yes	Yes	Yes	Yes (yield)	99	182	64	56	62	Jul-15	Nov-17	https://www.google.c
110	31463	50745	5	HINGHAM	SR 53 (Whiting Street)	Cushing Street	42.1827	-70.9034	SB onto Whiting Street	Yes	4-way	2	Mast-arm	-	Yes	Yes	No	Yes	153	76	45	53	50	Jul-15	Sep-17	https://www.google.c
112	31469	51420	5	HINGHAM	Derby Street	Pond Park Road	42.1785	-70.9207	WB onto Pond Park Road	No	4-way	No	Mast-arm	Post	No	N/A	No	Yes	113	231	53	43	63	Aug-13	Sep-17	https://www.google.c
115	31478	21517	2	HOLYOKE	SR 141 (Easthampton Road)	I-91 SB Ramps	42.2175	-72.6374	SB onto I-91 SB Ramp	Yes	4-way	No	Span Wire	-	No	N/A	No	Yes	131	240	38	34	65	Oct-15	Oct-18	https://www.google.c
116	31549	41850	4	IPSWICH	SR 1A & SR 133 (County Road)	Agawam Village	42.6709	-70.8371	NB into Agawam Village	Yes	3-way	2	Mast-arm	-	No	N/A	No	Yes	273	58	38	35	38	Sep-08	Oct-18	https://www.google.c
117	31551	51136	5	KINGSTON	SR 3A (Summer Street)	Tremont Street	42.0071	-70.7306	NB onto Keith Ave	Yes	4-way	No	Mast-arm	Post	Yes	Yes	Yes	Yes	191	60	44	69	80	Sep-15	Sep-17	https://www.google.c
119	31745	11486	1	LANESBOROUGH	SR 8 (Cheshire Road)	Berkshire Mall Road	42.4888	-73.2028	NB onto SR 8 Connector Road	Yes	3-way	No	Mast-arm	Post	No	N/A	Yes	Yes	166	208	53	49	77	Nov-15	Aug-16	https://www.google.c
120	31751	11487	1	LANESBOROUGH	US 7 (South Main Street)	Berkshire Mall Road	42.4964	-73.2374	SB into Berkshire Mall	Yes	3-way	No	Mast-arm	-	No	N/A	Yes	Yes (yield)	111	241	47	35	47	Jul-14	Aug-16	https://www.google.c
123	31765	11488	1	LANESBOROUGH	SR 8 (Cheshire Road)	Old State Road	42.4937	-73.2018	NB onto Old State Road	Yes	3-way	No	Mast-arm	Post	No	N/A	Yes	Yes	83	214	46	49	45	Nov-15	Aug-16	https://www.google.c
124	31768	11623	1	LEE	SR 102 (Pleasant Street)	Tyringham Road	42.2952	-73.2393	NB into Big Y	Yes	4-way	2	Span Wire	Post	Yes	Yes	No	Yes	115	145	47	39	48	No imagery p	Aug-16	https://www.google.c
125	31772	30309	3	LEICESTER	SR 9 (Main Street)	SR 56 (Pleasant Street)	42.2458	-71.9080	NB onto SR 56	No	4-way	No	Span Wire	-	Yes	Yes	No	Yes	241	193	49	49	42	Aug-11	Oct-18	https://www.google.c
126	31773	31837	3	LEICESTER	SR 9 (Main Street)	Wal-Mart Driveway	42.2475	-71.9375	EB into Wal-Mart Driveway	No	3-way	No	Mast-arm	-	No	N/A	Yes	Yes (yield)	320	104	53	51	117	Aug-11	Sep-19	https://www.google.c
128	31787	10322	1	LENOX	US 7 & 20 (Veterans Memorial Highway)	SR 7A (Main Street)	42.3723	-73.2774	NB onto SR 7A	Yes	3-way	No	Mast-arm	Post	No	N/A	No	Yes	168	464	63	61	136	Nov-15	Aug-16	https://www.google.c
129	31789	10671	1	LENOX	US 20 (Lee Road)	US 7	42.3433	-73.2706	NB onto US 7	Yes	3-way	No	Span Wire	-	No	N/A	Yes	Yes (yield)	268	361	64	65	46	Aug-14	Aug-16	https://www.google.c
130	31821	11491	1	LENOX	US 7 & 20 (Pittsfield Road)	New Lenox Road	42.3971	-73.2698	SB onto New Lenox Road	Yes	4-way	No	Span Wire	Post	No	N/A	Yes	Yes	182	150	72	78	37	Nov-15	Aug-16	https://www.google.c
131	31830	11492	1	LENOX	US 20 (West Housatonic Street)	Aspinwell/Shops at Brushwood/Lenox House Rest	42.3774	-73.2770	NB into Lenox Commons	Yes	4-way	2	Span Wire	Post	No	N/A	Yes	Yes	212	397	96	76	60	Aug-14	Aug-16	https://www.google.c
133	31832	31414	3	LEOMINSTER	SR 13 (Main Street)	Hawes Street	42.5372	-71.7444	WB onto Haws Street	Yes	3-way	No	Mast-arm	Post	Yes	Yes	Yes	Yes (yield)	-	-	42	34	33	Nov-15	Oct-17	https://www.google.c
134	31833	31840	3	LEOMINSTER	SR 12 (Central Street)	Willard Street	42.4936	-71.7452	SB onto Willard Street	Yes	4-way	No	Mast-arm	-	Yes	Yes	No	No	74	121	35	35	44	Jul-11	Oct-17	https://www.google.c
135	31835	40207	4	LEXINGTON	SR 2A (Marrett Road)	Waltham Street	42.4359	-71.2346	WB onto Waltham Street	No	4-way	2	Mast-arm	-	Yes	Yes	No	Yes	83	130	47	39	48	Oct-12	Sep-17	https://www.google.c
136	31837	41126	4	LEXINGTON	SR 2A (Marrett Road)	Massachusetts Avenue	42.4457	-71.2630	NB into Minuteman Regional High Schoo	Yes	4-way	No	Span Wire	-	No	N/A	No	Yes	75	216	49	38	56	Aug-15	Nov-16	https://www.google.c
137	31840	41767	4	LEXINGTON	SR 2A (Marrett Road)	Spring Street	42.4343	-71.2417	WB onto Spring Street	Yes	3-way	No	Mast-arm	Post	Yes	Yes	No	No	129	107	36	27	39	Oct-12	Sep-17	https://www.google.c
138	31841	41820	4	LEXINGTON	Spring Street	Hayden Avenue	42.4251	-71.2504	SB onto Hayden Avenue	Yes	4-way	4	Mast-arm	-	Yes	Yes	No	Yes	98	81	50	40	40	Oct-12	Sep-17	https://www.google.c
139	31842	41852	4	LEXINGTON	SR 2A (Marrett Road)	Forbes Road	42.4447	-71.2615	NB onto Forbes Road	Yes	4-way	No	Span Wire	Post	No	N/A	No	Yes	85	194	62	49	49	Aug-15	Nov-16	https://www.google.c
140	31843	40324	4	LOWELL	VFW Highway	Aiken Street	42.6558	-71.3141	SB onto VFW Highway	No	4-way	No	Mast-arm	Post	Yes	Yes	No	Yes	N/A	90	55	59	115	Oct-18	Sep-19	https://www.google.c
141	31844	40326	4	LOWELL	SR 113 (Varnum Avenue)	SR 113 (Riverside Street)	42.6502	-71.3315	WB onto Varnum Ave	Yes	4-way	2	Mast-arm	Post	Yes	Yes	No	Yes	154	115	45	45	72	Oct-18	Sep-19	https://www.google.c
142	31845	40458	4	LOWELL	SR 38 (Nesmith Street)	SR 133 (Andover Street)	42.6422	-71.2976	SB onto Andover Street	Yes	4-way	No	Mast-arm	-	Yes	Yes	No	Yes	N/A	56	47	71	55	Aug-13	Nov-16	https://www.google.c
143	31846	41766	4	LOWELL	SR 3A (Thorndike Street)	Gorham Street	42.6331	-71.3095	SB onto Gorham Street	No	3-way	No	Span Wire	-	Yes	Yes	Yes	Yes (yield)	47	80	80	80	47	Nov-17	Oct-18	https://www.google.c
144	31848	40727	4	LYNN	SR 107 (Highland Avenue)	Fays Avenue	42.4875	-70.9387	NB onto Fays Avenue	Yes	3-way	No	Mast-arm	-	No	No	No	Yes	66	91	39	38	29	Oct-12	Nov-17	https://www.google.c
145	31850	41790	4	LYNN	SR 129 (Lynnfield Street)	Millard Avenue & Parker Hill Avenue	42.4964	-70.9700	SB onto Millard Avenue	Yes	5-way	No	Mast-arm	Post	No	No	No	Yes	59	244	40	37	32	Jul-15	Nov-17	https://www.google.c
146	40004	41828	4	LYNNFIELD	Walnut Street	I-95 SB Ramps	42.5151	-71.0297	WB onto Walnut Street	Yes	4-way	No	Mast-arm	-	Yes	Yes	Yes	Yes	117	186	60	67	40	Aug-15	Sep-18	https://www.google.c
147	40020	41829	4	LYNNFIELD	Walnut Street	I-95 NB Ramps	42.5133	-71.0285	SB onto I-95 NB Ramp	Yes	4-way	No	Mast-arm	-	No	No	Yes	Yes (yield)	74	179	56	36	42	Jul-15	Nov-16	https://www.google.c
149	40063	50936	5	MANSFIELD	SR 140 (Commercial Street)	School Street	42.0173	-71.2275	WB onto Commercial Street	Yes	4-way	No	Mast-arm	-	No	No	Yes	Yes (yield)	233	101	60	70	96	Sep-13	Aug-17	https://www.google.c
150	40090	31841	3	MARLBOROUGH	US 20 (West Main Street)	US 20 (Lakeside Avenue)	42.3396	-71.5620	WB onto Williams Street	No	3-way	No	Mast-arm	-	Yes	Yes	Yes	No	108	134	45	52	58	Jul-15	Oct-16	https://www.google.c
154	40178	31842	3	MARLBOROUGH	US 20 (Boston Post Road)	Boundary Street	42.3356	-71.6021	WB onto Hayes Memorial Drive	Yes	4-way	No	Span Wire	-	No	No	No	Yes	122	89	68	54	71	Aug-11	Oct-16	https://www.google.c
155	40197	51431	5	MASHPEE	SR 28 (Falmouth Road)	Asher's Path East	41.6282	-70.4725	EB onto Asher's Path E	Yes	4-way	3	Mast-arm	-	No	No	No	Yes	156	124	45	49	53	Oct-15	Sep-17	https://www.google.c
156	40207	30820	3	MENDON	SR 140 (Cape Cod)	Hartford Avenue	42.1029	-71.5042	SB onto Hartford Avenue E	Yes	4-way	No	Mast-arm	-	Yes	Yes	No	Yes	89	260	43	45	52	Oct-13	Aug-17	https://www.google.c
157	40213	41137	4	METHUEN	SR 110 (Jackson Street)	Swan Street	42.7225	-71.1587	SB onto Swan Street	Yes	4-way	No	Mast-arm	-	Yes	Yes	No	Yes	-	-	34	35	50	Aug-12	Nov-16	https://www.google.c
159	40319	41138	4	METHUEN	SR 110 (Lowell Street)	Griffin Brook Park Drive	42.6905	-71.2289	NB onto Griffin Brook Park Drive	No	4-way	No	Span Wire	-	No	No	Yes	Yes	208	101	70	67	69	Jul-12	Oct-18	https://www.google.c
162	40326	41145	4	METHUEN	SR 113 (Pleasant Valley Street)	Howe Street	42.7411	-71.1681	SB onto SR 113	Yes	4-way	No	Span Wire	-	Yes	Yes	Yes	Yes (yield)	39	149	53	60	67	Nov-16	Nov-17	https://www.google.c
163	40330	41151	4	METHUEN	Pelham Street	I-93 SB Ramps	42.7289	-71.2077	NB onto Pelham Street	Yes	4-way	No	Span Wire	-	No	N/A	No	Yes	102	119	51	70	59	Oct-18	Sep-19	https://www.google.c
165	40338	40338	4	SOMERVILLE	SR 38 (Mystic Avenue)	Temple Street	42.3956	-71.0891	NB onto Temple Street	Yes	4-way	No	Mast-arm	-	Yes	Yes	No	Yes	53	146	54	53	49	Apr-16	Oct-17	https://www.google.c
166	40345	41152	4	METHUEN	Pelham Street	I-93 NB Ramps	42.7278	-71.2028	WB onto I-93 NB Ramp	Yes	4-way	2	Span Wire	-	No	No	Yes	Yes (yield)	108	145	43	37	72	Oct-12	Nov-17	https://www.google.c
167	40390	41154	4	METHUEN	SR 110 (Merrimack Street)	SR 113 (Pleasant Valley Street)	42.7460	-71.1298	NB onto SR 113	Yes	4-way	2	Span Wire	-	Yes	Yes	No	Yes (yield)	57	103	41	45	42	Oct-15	Nov-17	https://www.google.c
169	40450	50027	5	MIDDLEBOROUGH	SR 28 (East Grove Street)	SR 28 (West Grove Street)	41.8860	-70.9171	NB onto W. Grove Street	Yes	4-way	4	Mast-arm	-	Yes	Yes	No	No	55	85	53	45	44	Sep-15	Aug-17	https://www.google.c
170	40458	51434	5	MIDDLEBOROUGH	SR 105 (South Main Street)	I-495 NB Ramp	41.8837	-70.9196	NB onto I-495 NB Ramp	Yes	3-way	No	Mast-arm	Post	No	No	Yes	Yes (yield)	63	95	59	55	71	Jul-14	Aug-17	https://www.google.c
171	40473	51435	5	MIDDLEBOROUGH	SR 105 (South Main Street)	I-495 SB Ramps	41.8812	-70.9227	NB onto I-495 SB Ramp	Yes	3-way	No	Mast-arm	Post	Yes	Yes	Yes	Yes (yield)	117	322	56	44	49	Jul-14	Aug-17	https://www.google.c
172	40492	30840	3	MILFORD	SR 140 (South Main Street)	Cape Road	42.1272	-71.5182	NB into CVS/Papa Ginos's Plaza	Yes	4-way	2	Mast-arm	-	No	No	Yes	Yes (yield)	61	67	38	40	36	Sep-13	Aug-17	https://www.google.c
173	40524	31429	3	MILFORD	SR 16 (East Main Street)	Fortune Blvd.	42.1534	-71.4895	EB onto East Main Street	Yes	4-way	No	Span Wire	-	Yes	Yes	No	Yes	246	151	67	49	57	Oct-15	Aug-17	https://www.google.c
176	40585	31432	3	MILLBURY	SR 122 (Grafton Road)	Massachusetts Turnpike Ramps	42.2303	-71.7386	WB onto I-90 Ramp	Yes	3-way	No	Span Wire	-	No	No	Yes	Yes	192	112	36	58	53	Nov-15	Oct-17	https://www.google.c
180	40682	51318	5	NEW BEDFORD	King's Highway	Mt. Pleasant Street	41.6756	-70.9455	SB onto Kings Highway	Yes	4-way	No	Mast-arm	-	No	N/A	Yes	Yes (yield)	41	134	49	38	66	Sep-15	Sep-19	https://www.google.c
181	40727	51440	5	NEW BEDFORD	Coggeshall Street	I-195 WB Ramps	41.6561	-70.9196	EB onto Sawyer Street	Yes	4-way	3	Mast-arm	Post	No	No	No	Yes	484	199	82	49	90	Sep-15	Aug-17	https://www.google.c
182	40772	41725	4	NEWBURY	US 1 (Newburyport Turnpike)	Middle Road	42.7897	-70.8786	WB onto US 1	No	4-way	No	Mast-arm	-	No	No	No	Yes	92	41	74	43	72	Oct-15	Oct-18	https://www.google.c
186	40805	41025	4	NEWBURYPORT	SR 113 (Storey Avenue)	Port Plaza Driveway	42.8213	-70.9057	WB into Port Plaza Driveway	Yes	3-way	No	Mast-arm	-	No	No	No	Yes	154	87	49	46	87	Oct-15	Oct-17	https://www.google.c
187	40878	41026	4	NEWBURYPORT	SR 113 (Storey Avenue)	Market Basket Driveway	42.8221	-70.9034	WB into Market Baskey Driveway	Yes	3-way	No	Mast-arm	-	Yes	Yes	No	Yes	134	127	64	50	66	Jul-15	Oct-17	https://www.google.c
188	40888	41162	4	NEWBURYPORT	US 1 (Newburyport Turnpike)	Hill Street	42.8008	-70.8775	NB onto Hill Street	Yes	4-way	No	Span Wire	-	No	No	No	Yes	167	181	67	74	26	Oct-12	Oct-18	https://www.google.c
190	40951	11493	1	NORTH ADAMS	SR 2 (Mohawk Trail)	Barbour Street	42.6984	-73.1370	WB onto Brayton Hill Terrace	Yes	3-way	No	Mast-arm	Post	Yes	No	No	Yes	110	88	45	42	44	Nov-15	Aug-16	https://www.google.c
191	40965	11494	1	NORTH ADAMS	SR 2 (Mohawk Trail)	Airport Road	42.7001	-73.1643	WB onto Airport Road	Yes	3-way	No	Mast-arm	Post	No	No	No	Yes	104	178	43	40	55	Nov-15	Aug-16	https://www.google.c
194	41018	11496	1	NORTH ADAMS	SR 8 (Curran Highway)	Wal-Mart Driveway	42.6802	-73.1065	SB into Ocean State Job Lot Parking Lot	Yes	3-way	No	Mast-arm	Post	No	No	Yes	Yes	145	132	43	55	70	Nov-15	Aug-16	https://www.google.c
195	41025	40004	4	NORTH ANDOVER	SR 114 (Salem Turnpike)	SR 125 (Andover Street)	42.6733	-71.1259	NB onto Andover Street	Yes	4-way	2	Span Wire	-	No	No	No	Yes	132	272	66	65	54	Oct-15	Nov-16	https://www.google.c
196	41026	40020	4	NORTH ANDOVER	SR 114 (Salem Turnpike)	SR 125 (Andover Bypass)	42.6676	-71.1180	NB onto SR 125	Yes	4-way	No	Span Wire	-	No	No	Yes	Yes (yield)	83	155	63	60	67	Oct-15	Nov-16	https://www.google.c
197	41032	40090	4	NORTH ANDOVER	SR 114 (Salem Turnpike)	SR 133 (Haverhill Street)	42.6749	-71.1281	WB onto Peters Street	No	4-way	2	Span Wire	-	No	No	No	Yes	162	198	62	60	73	Oct-15	Nov-16	https://www.google.c
198	41043	41165	4	NORTH ANDOVER	SR 114 (Salem Turnpike)	Waverly Road	42.6794	-71.1336	SB onto Cotuit Street	Yes	5-way	No	Span Wire	Post	No	No	No	Yes	191	167	52	53	105	Oct-15	Nov-16	https://www.google.c
200	41051	41731	4	NORTH ANDOVER	SR 114 (Salem Turnpike)	Eaglewood Shops Driveway	42.6763	-71.1302	NB into Eaglewood Shops Driveway	Yes	3-way	No	Mast-arm	-	Yes	Yes	Yes	Yes	136	166	66	69	47	Oct-12	Nov-16	https://www.google.c
201	41052	50148	5	NORTH ATTLEBORO	US 1 (East Washington Street)	Elm Street	41.9813	-71.3297	NB onto Elm Street	Yes	4-way	2	Mast-arm	-	Yes	Yes	No	No	123	66	77	69	38	Aug-12	Aug-17	https://www.google.c
203	41066	51438	5	NORTH ATTLEBORO	Robert F. Toner Boulevard	I-95 SB Ramps	41.9691	-71.2984	EB onto I-95 SB Ramp	Yes	3-way	No	Mast-arm	-	No	No	Yes	Yes (yield)	124	111	58	55	100	Aug-12	Sep-17	https://www.google.c
204	41083	40772	4	NORTH READING	SR 28 (Main Street)	North Street	42.5891	-71.1163	WB onto Main Street	Yes	4-way	2	Span Wire	-	Yes	Yes	No	Yes	125	79	46	46	55	Oct-13	Oct-17	https://www.google.c
207	41100	21740	2	NORTHAMPTON	SR 10 (South Street)	Earle Street	42.3062	-72.6472	EB onto Earle Street	No	3-way	No	Mast-arm	-	No	No	Yes	Yes	229	124	39	47	57	Oct-07	Aug-17	https://www.google.c
210	41105	21747	2	NORTHAMPTON	SR 5 & SR 10 (North King Street)	Big Y Driveway	42.3416	-72.6410	NB into Big Y Driveway	Yes	3-way	No	Mast-arm	Post	No	No	Yes	Yes	322	156	46	44	73	Dec-15	Aug-17	https://www.google.c
211	41111	31768	3	NORTHBOROUGH	US 20 (Southwest Cutoff)	SR 9 EB Ramps	42.2813	-71.6708	SB onto SR 9 EB Ramp	Yes	3-way	No	Mast-arm	-	No	N/A	Yes	Yes (yield)	166	96	46	46	44	Nov-15	Oct-16	https://www.google.c
212	41112	31844	3	NORTHBOROUGH	US 20 (Southwest Cutoff)	Davis Street	42.3006	-71.6573	SB onto Davis Street	No	4-way	No	Mast-arm	-	No	N/A	Yes	Yes (yield)	189	250	37	39	41	Jul-15	Oct-16	https://www.google.c
213	41114	31845	3	NORTHBOROUGH	US 20 (Southwest Cutoff)	US 20 (West Main Street)	42.3074	-71.6576	NB onto W. Main Street	Yes	3-way	No	Span Wire	-	Yes	Yes	Yes	No	135	82	39	47	37	Jul-15	Oct-16	https://www.google.c
214	41115	30479	3	NORTHBRIDGE	SR 122 (Providence Road)	Church Street	42.1241	-71.6453	SB onto SR 122	No	4-way	No	Span Wire	-	Yes	Yes	No	Yes	155	67	39	36	41	Oct-15	Oct-19	https://www.google.c
215	41121	51320	5	NORTON	SR 123 (West Main Street)	SR 140 (Mansfield Avenue)	41.9668	-71.1882	NB onto SR 140	Yes	3-way	No	Mast-arm	Post	No	N/A	No	Yes	167	72	38	47	67	Oct-12	Oct-18	https://www.google.c
216	41122	50925	5	NORWELL	SR 53 (Washington Street)	Grove Street	42.1721	-70.8788	NB onto Washington Street	Yes	4-way	No	Post	-	Yes	Yes	Yes	Yes (yield)	215	70	76	59	47	Jul-15	Sep-17	https://www.google.c
217	41126	51321	5	NORWELL	SR 53 (Washington Street)	Jacobs Trail	42.1595	-70.8538	WB into Stop and Shop Driveway	Yes	4-way	No	Mast-arm	-	Yes	Yes	No	Yes	70	116	50	48	58	Jul-15	Sep-17	https://www.google.c
218	41137	51188	5	NORWOOD	SR 1A (Walpole Street)	Hannaford Driveway	42.1798	-71.2210	SB into Big Y Driveway	No	3-way	No	Mast-arm	-	Yes	Yes	No	Yes	158	78	45	67	110	Jul-15	Aug-17	https://www.google.c
219	41138	50527	5	ORLEANS	SR 6A (Cranberry Highway)	Eldridge Parkway	41.7803	-69.9999	NB onto Old Kings Highway	Yes	4-way	No	Mast-arm	-	Yes	Yes	Yes	Yes	190	90	48	59	62	Oct-15	Sep-17	https://www.google.c
220	41144	31789	3	OXFORD	SR 12 (Main Street)	Cudworth Road	42.0814	-71.8695	SB onto Cudworth Road	Yes	3-way	No	Mast-arm	-	No	N/A	Yes	Yes	53	164	51	56	69	Oct-15	Oct-18	https://www.google.c
221	41145	20363	2	PALMER	US 20 (North Main Street)	US 20 (Wilbraham Street)	42.1632	-72.3434	EB onto Main Street	Yes	4-way	No	Span Wire	-	No	N/A	No	No	268	63	45	52	39	Oct-13	Oct-18	https://www.google.c
222	41151	21520	2	PALMER	SR 32 (Thorndike Street & Ware Road)	High Street	42.1787	-72.3194	NB onto High Street	Yes	4-way	No	Mast-arm	-	No	N/A	Yes	Yes	162	85	50	53	47	Aug-15	Nov-16	https://www.google.c
223	41152	21752	2	PALMER	SR 32 (Thorndike Street)	Massachusetts Turnpike Ramps	42.1689	-72.3263	NB onto Massachusetts Turnpike Ramp	Yes	3-way	No	Span Wire	Post	No	N/A	Yes	Yes (yield)	143	78	47	35	48	Oct-13	Nov-16	https://www.google.c
224	41154	41178	4	PEABODY	SR 114 (Andover Street)	Cross Street	42.5439	-70.9425	NB onto Cross Street	Yes	3-way	No	Mast-arm	-	No	N/A	No	Yes	103	100	84	79	94	Nov-16	Nov-17	https://www.google.c
225	41162	41181	4	PEABODY	Lowell Street	US 1 SB Ramps	42.5490	-70.9851	WB onto US 1 SB Ramp	Yes	4-way	No	Mast-arm	-	No	N/A	Yes	Yes (yield)	92	65	60	55	55	Aug-15	Nov-17	https://www.google.c
227	41167	51197	5	PEMBROKE	SR 53 (Columbia Road)	SR 53 (Washington Street)	42.1040	-70.8037	SB onto Schoosett Street	Yes	4-way	No	Span Wire	-	No	N/A	No	Yes	345	340	53	45	57	Jul-15	Sep-17	https://www.google.c
228	41178	51329	5	PEMBROKE	SR 139 (Church Street)	Old Oak Street	42.1080	-70.7634	EB onto Old Oak Street	No	4-way	2	Span Wire	-	Yes	Yes	No	Yes	119	122	62	61	42	Jul-15	Sep-17	https://www.google.c
229	41181	10366	1	PITTSFIELD	US 20 (West Housatonic Street)	Barker Road	42.4436	-73.2698	WB onto Barker Road	Yes	4-way	No	Mast-arm	Post	No	N/A	No	Yes	55	135	38	34	37	Oct-14	Aug-17	https://www.google.c
230	41182	10401	1	PITTSFIELD	US 20 (West Housatonic Street)	Lebanon Avenue	42.4396	-73.2983	WB onto Lebanon Avenue	Yes	4-way	No	Mast-arm	-	No	N/A	No	Yes	91	100	40	40	80	Oct-14	Aug-17	https://www.google.c

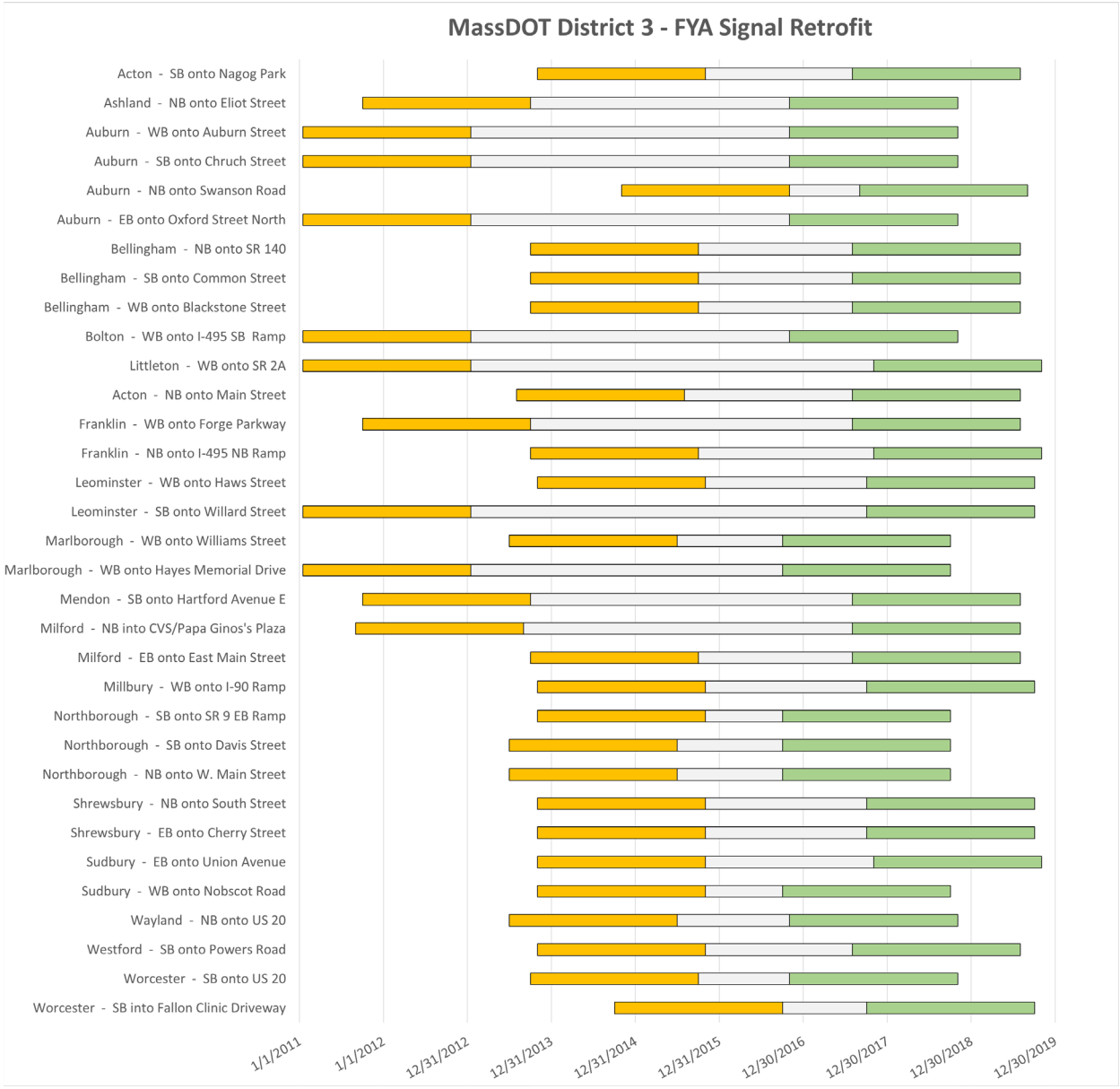
FID	Signal ID	Dist_ID	District	Municipality	Location 1	Location 2	Latitude	Longitude	FYA Approach	Supp. Signage (Yes/No)	Intersection Legs	Multiple FYA/CG Approaches?	Structure (Post/Mast-arm/Span Wire)	Second Structure	Pedestrian Signal (Yes/No)	Activation Button (Yes/No)	Opposing Right Turn Lane (Yes/No)	Right Turn on Red (Yes/No)	Taper (ft.)	Turn Bay (ft.)	Width of FYA/CG Approach (ft.)	Width of Opposing Approach (ft.)	Width of Perpendicular Approach (ft.)	Latest Before Installation Imagery	Earliest After Installation Imagery	Link to Streetview
231	41194	11297	1	PITTSFIELD	SR 9 (Dalton Avenue)	Meadowview Drive	42.4689	-73.2005	WB into Retail Driveway	Yes	4-way	No	Span Wire	Post	No	N/A	Yes	Yes (stop sign	160	220	58	55	85	Nov-15	Aug-16	https://www.google.c
232	41198	11498	1	PITTSFIELD	SR 7 & 20 (South St)	Guardian Life Driveway	42.4166	-73.2609	NB into Hillcrest Driveway	No	4-way	2	Span Wire	-	No	N/A	No	Yes	141	133	58	55	57	Nov-15	Aug-16	https://www.google.c
233	41199	11502	1	PITTSFIELD	SR 8 (Cheshire Road)	Allendale Shopping Center Driveway	42.4701	-73.2038	NB into Allendale Shopping Center Drw	Yes	3-way	No	Span Wire	Post	No	N/A	No	Yes	195	242	76	53	63	Nov-15	Aug-17	https://www.google.c
234	41208	11622	1	PITTSFIELD	US 20 (West Housatonic Street)	South Merriam Street	42.4432	-73.2681	EB onto South Merriam Street	Yes	4-way	No	Mast-arm	Post	Yes	Yes	No	Yes	57	213	35	35	37	Oct-14	Aug-17	https://www.google.c
235	41210	11624	1	PITTSFIELD	SR 7 & 20 (South St)	Guardian Life Driveway	42.4263	-73.2597	NB into Guardian Life Driveway	Yes	4-way	2	Span Wire	Post	Yes	Yes	No	Yes	106	185	55	44	35	Aug-16	Aug-17	https://www.google.c
237	41213	51451	5	PLYMOUTH	Commerce Way	Enterprise Drive (Cherry Street)	41.9644	-70.7083	WB onto Commerce Way	Yes	3-way	No	Mast-arm	Post	Yes	Yes	No	Yes	157	184	41	38	53	Sep-15	Sep-17	https://www.google.c
238	41215	51454	5	PLYMOUTH	SR 80 (Plympton Road)	Commerce Way	41.9468	-70.7162	WB onto Commerce Way	Yes	4-way	2	Mast-arm	-	Yes	Yes	No	Yes	98	99	52	37	89	Oct-15	Sep-17	https://www.google.c
241	41218	51456	5	PLYMOUTH	SR 3A (State Road)	Manomet Point Road	41.9154	-70.5551	EB onto Manomet Point Road	Yes	4-way	No	Mast-arm	-	Yes	Yes	No	No	70	224	41	32	47	Oct-15	Nov-18	https://www.google.c
242	41219	51015	5	RAYNHAM	US 44 (Cape Highway)	Retail Driveway	41.9056	-71.0546	EB into Retail Driveway	Yes	3-way	No	Mast-arm	-	Yes	Yes	No	Yes	199	130	58	59	63	Apr-12	Nov-16	https://www.google.c
243	41220	51208	5	RAYNHAM	SR 138 (Broadway)	Elm Street East	41.9632	-71.0679	WB onto SR 138	No	4-way	No	Mast-arm	-	No	N/A	No	Yes	268	143	68	55	53	Sep-14	Oct-18	https://www.google.c
244	41235	40659	4	REVERE	SR 60 (Squire Road)	Charger Street	42.4250	-71.0114	SB onto SR 60	Yes	4-way	No	Mast-arm	Post	Yes	Yes	No	Yes	N/A	N/A	39	25	84	Sep-16	Oct-17	https://www.google.c
246	41242	51465	5	ROCKLAND	SR 123 (Market Street)	Highland Street	42.1211	-70.9165	NB onto Highland Street	Yes	4-way	2	Mast-arm	-	No	N/A	No	Yes	93	103	43	36	33	Jul-15	Sep-17	https://www.google.c
247	41244	40319	4	ROWLEY	US 1 (Newburyport Turnpike)	SR 133 (Haverhill Street)	42.7052	-70.9091	NB onto Haverhill Street	Yes	4-way	4	Mast-arm	-	No	N/A	Yes	Yes (yield)	67	73	53	48	64	Oct-12	Oct-15	https://www.google.c
248	41725	41194	4	ROWLEY	US 1 (Newburyport Turnpike)	Market Basket Driveway	42.7087	-70.9082	SB into Market Basket Driveway	Yes	3-way	No	Mast-arm	-	No	N/A	Yes	Yes	82	226	53	49	71	Oct-15	Oct-18	https://www.google.c
250	41733	40682	4	SALEM	SR 1A (Loring Avenue)	Jefferson Avenue	42.5005	-70.8960	NB onto Jefferson Ave	Yes	3-way	No	Mast-arm	-	Yes	Yes	Yes	Yes	191	171	47	50	61	Aug-12	Oct-17	https://www.google.c
251	41766	41198	4	SALEM	SR 1A (Loring Avenue)	Harrison Road	42.4944	-70.8937	WB onto Harrison Road	No	3-way	No	Mast-arm	-	No	N/A	Yes	Yes	46	169	53	45	26	Oct-12	Nov-17	https://www.google.c
252	41767	40330	4	SALISBURY	Toll Road	Main Street	42.8697	-70.8829	SB onto Main Street	Yes	4-way	No	Mast-arm	-	No	N/A	No	Yes	204	110	67	55	53	Oct-15	Oct-17	https://www.google.c
254	41820	41018	4	SALISBURY	Toll Road	SR 286 (Forest Street)	42.8679	-70.8806	SB onto SR 286	Yes	4-way	No	Mast-arm	-	No	N/A	No	Yes	111	67	38	40	38	Oct-15	Oct-17	https://www.google.c
255	41828	51470	5	SANDWICH	SR 130 (Forestdale Road)	US 6 EB Ramps	41.7382	-70.4927	NB onto US 6 EB Ramps	Yes	3-way	No	Mast-arm	-	No	N/A	Yes	Yes (yield)	105	141	30	29	54	Nov-16	Nov-18	https://www.google.c
256	41829	41208	4	SAUGUS	SR 129 (Walnut Street)	Walgreens Driveway	42.4906	-71.0187	NB into Kohl's Driveway	Yes	4-way	No	Mast-arm	-	Yes	Yes	No	Yes	77	190	44	35	66	Jul-15	Nov-17	https://www.google.c
257	41830	41733	4	SAUGUS	Lynn Fells Parkway	US 1 NB Ramps	42.4808	-71.0232	WB onto US 1 NB Ramp	Yes	3-way	No	Mast-arm	-	No	N/A	Yes	Yes (yield)	116	192	38	38	54	Jul-15	Nov-17	https://www.google.c
259	41834	31447	3	SHREWSBURY	US 20 (Hartford Tpk.)	South Street	42.2708	-71.6864	NB onto South Street	No	4-way	No	Span Wire	-	No	N/A	No	Yes	89	149	48	46	38	Nov-15	Oct-17	https://www.google.c
260	41835	31850	3	SHREWSBURY	US 20 (Hartford Tpk.)	Cherry Street	42.2621	-71.6958	EB onto Cherry Street	No	4-way	2	Mast-arm	-	No	N/A	No	Yes	152	188	53	49	49	Nov-15	Oct-17	https://www.google.c
261	41836	20370	2	SOUTHWICK	SR 10 & US 202 (College Highway)	SR 57 (Granville Road)	42.0549	-72.7701	SB onto Depot Street	No	4-way	2	Span Wire	Post	Yes	Yes	No	Yes	53	145	51	68	32	Sep-15	Aug-18	https://www.google.c
262	41837	20850	2	SOUTHWICK	SR 10 & US 202 (College Highway)	SR 57 (Feeding Hill Road)	42.0624	-72.7652	SB onto SR 57	No	3-way	No	Mast-arm	Post	Yes	Yes	Yes	Yes	35	159	55	52	80	Sep-15	Aug-18	https://www.google.c
263	41848	31451	3	SPENCER	SR 9 (Dewey Street)	West Main Street	42.2336	-72.0119	EB onto Meadow Road	No	4-way	No	Mast-arm	-	Yes	Yes	No	Yes	201	236	54	50	65	Nov-15	Oct-18	https://www.google.c
264	41850	31459	3	SUDBURY	US 20 (Boston Post Road)	Union Avenue	42.3607	-71.4221	EB onto Union Avenue	No	4-way	2	Span Wire	-	No	N/A	No	Yes	101	239	37	41	76	Nov-15	Nov-17	https://www.google.c
265	41852	31460	3	SUDBURY	US 20 (Boston Post Road)	Nobscott Road	42.3603	-71.4247	WB onto Nobscot Road	No	3-way	No	Mast-arm	-	Yes	Yes	Yes	Yes	308	63	38	46	83	Nov-15	Oct-16	https://www.google.c
266	41855	20512	2	SUNDERLAND	SR 47 (North Main Street & South Main Stree	SR 116 (Amherst Road)	42.4664	-72.5795	WB onto SR 47	No	4-way	2	Mast-arm	-	Yes	Yes	No	Yes	115	94	49	44	50	Nov-15	Nov-16	https://www.google.c
268	41857	41199	4	SWAMPSCOTT	SR 1A (Paradise Road)	Whole Foods/Vinnin Liquors Driveway	42.4801	-70.9045	SB into Whole Foods Driveway	Yes	3-way	No	Mast-arm	Post	Yes	Yes	No	Yes	48	75	35	29	59	Jul-15	Oct-17	https://www.google.c
269	41861	51825	5	SWANSEA	US 6 (Grand Army Highway)	I-195 WB Ramps	41.7498	-71.2165	EB onto I-195 WB Ramp	Yes	3-way	No	Mast-arm	Post	No	N/A	Yes	Yes (yield)	462	91	56	56	54	Sep-15	Oct-16	https://www.google.c
270	41862	51826	5	SWANSEA	US 6 (Grand Army Highway)	I-195 EB Ramps	41.7508	-71.2204	WB onto I-195 EB Ramp	Yes	3-way	No	Mast-arm	Post	No	N/A	Yes	Yes (yield)	438	133	56	57	56	Sep-15	Oct-16	https://www.google.c
271	50010	51366	5	TAUNTON	SR 140 (County Street)	Erika Drive (Home Depot Driveway)	41.8791	-71.0639	NB onto Taunton Depot Drive	Yes	4-way	No	Span Wire	-	No	N/A	Yes	Yes	212	310	59	72	84	Aug-17	Nov-18	https://www.google.c
272	50022	40556	4	TEWKSBURY	SR 38 (Main Street)	Shawsheen Street	42.5894	-71.2025	NB onto Shawsheen Street	No	4-way	4	Span Wire	-	No	N/A	No	Yes	155	208	51	48	46	Nov-12	Nov-17	https://www.google.c
273	50027	41210	4	TEWKSBURY	SR 38 (Main Street)	Pleasant Street	42.6118	-71.2329	EB onto Pleasant Street	Yes	4-way	No	Span Wire	Post	Yes	Yes	No	Yes	256	201	54	36	37	Aug-15	Nov-16	https://www.google.c
274	50075	41212	4	TEWKSBURY	SR 38 (Main Street)	I-495 SB Ramps	42.6282	-71.2732	WB onto I-495 SB Ramp	No	4-way	No	Span Wire	-	No	N/A	Yes	Yes (yield)	148	140	58	76	47	Aug-13	Nov-16	https://www.google.c
277	50174	41215	4	TEWKSBURY	SR 133 (Andover Street)	I-495 SB Ramps	42.6428	-71.2338	EB onto I-495 SB Ramp	Yes	4-way	2	Span Wire	Post	No	N/A	Yes	Yes (yield)	80	249	44	37	74	Sep-13	Nov-16	https://www.google.c
279	50471	41216	4	TEWKSBURY	SR 133 (Andover Street)	I-495 NB Ramps	42.6427	-71.2297	WB onto I-495 NB Ramp	Yes	4-way	No	Mast-arm	Post	No	N/A	Yes	Yes (yield)	149	99	46	35	63	Sep-14	Nov-16	https://www.google.c
280	50527	41218	4	TEWKSBURY	SR 38 (Main Street)	Heathbrook Plaza Driveway	42.5936	-71.2101	WB into Post Office Driveway	No	4-way	No	Span Wire	-	No	N/A	Yes	Yes	70	120	49	46	67	Nov-12	Nov-17	https://www.google.c
281	50547	41219	4	TEWKSBURY	SR 38 (Main Street)	Clarks Road	42.6286	-71.2741	EB onto Clarks Road	Yes	3-way	No	Mast-arm	-	No	N/A	Yes	Yes	103	191	64	74	56	Aug-15	Nov-16	https://www.google.c
282	50565	50565	5	TAUNTON	US 44 (Winthrop Street)	Warner Boulevard	41.8890	-71.1207	WB onto Warner Blvd	Yes	4-way	No	Mast-arm	Post	Yes	Yes	No	Yes	58	298	36	46	50	Nov-18	Sep-19	https://www.google.c
284	50617	41220	4	TEWKSBURY	SR 38 (Main Street)	Old Main Street	42.6257	-71.2682	EB onto Old Main Street	Yes	3-way	No	Span Wire	-	Yes	Yes	No	Yes	211	102	57	55	44	Nov-12	Nov-16	https://www.google.c
285	50653	41855	4	TEWKSBURY	SR 38 (Main Street)	Victor Drive	42.5984	-71.2187	EB onto Victor Drive	Yes	4-way	2	Mast-arm	-	No	N/A	No	Yes	99	156	41	36	39	Nov-12	Nov-17	https://www.google.c
287	50709	40178	4	TOPSFIELD	US 1 (Newburyport Turnpike)	SR 97 (High Street)	42.6361	-70.9421	SB onto High Street	Yes	4-way	No	Mast-arm	Post	No	N/A	No	Yes	87	214	45	41	80	Oct-12	Oct-18	https://www.google.c
288	50745	40345	4	TOPSFIELD	US 1 (Newburyport Turnpike)	Ipswich Road	42.6505	-70.9355	WB onto US 1	Yes	4-way	No	Span Wire	-	No	N/A	No	Yes	177	113	56	49	43	Oct-12	Oct-18	https://www.google.c
291	50845	30321	3	TOWNSEND	SR 119 (Main Street)	SR 13 (Elm Street)	42.6670	-71.7058	WB onto Elm Street	Yes	4-way	No	Mast-arm	-	Yes	Yes	No	No	56	74	49	39	31	Sep-11	Sep-18	https://www.google.c
293	50904	31461	3	TOWNSEND	SR 119 (Main Street)	South Street	42.6529	-71.6719	WB onto South Street	Yes	4-way	No	Mast-arm	-	Yes	Yes	No	Yes	133	99	34	34	29	Sep-11	Sep-18	https://www.google.c
294	50923	40063	4	TYNGSBOROUGH	SR 3A (Middlesex Road)	SR 113 (Kendall Road)	42.6762	-71.4229	WB onto SR 3A	No	4-way	No	Mast-arm	-	No	N/A	Yes	Yes	120	36	42	52	61	Oct-15	Nov-17	https://www.google.c
295	50925	41856	4	TYNGSBOROUGH	SR 113 (Pawtucket Blvd.)	SR 3A (Frost Road)	42.6757	-71.4182	EB onto SR 3A	Yes	3-way	No	Mast-arm	-	No	N/A	Yes	Yes (yield)	222	221	44	47	26	Aug-12	Oct-16	https://www.google.c
297	50936	41857	4	TYNGSBOROUGH	Westford Road	US 3 NB Ramps	42.6600	-71.4272	SB onto US 3 NB Ramp	Yes	3-way	No	Span Wire	-	No	N/A	Yes	Yes (yield)	N/A	228	48	48	58	Oct-15	Nov-17	https://www.google.c
298	51015	41830	4	WAKEFIELD	Audubon Road	I-95 SB Ramps	42.5140	-71.0414	NB onto I-95 SB Ramp	Yes	4-way	No	Mast-arm	-	No	N/A	Yes	Yes (yield)	86	93	55	54	16	Jul-15	Nov-17	https://www.google.c
301	51087	51252	5	WALPOLE	SR 1A (Main Street)	Stop & Shop Driveway	42.1580	-71.2430	SB into Stop and Shop Driveway	No	4-way	No	Mast-arm	-	Yes	Yes	Yes	Yes (yield)	57	57	46	43	46	Jul-15	Aug-17	https://www.google.c
302	51105	51488	5	WALPOLE	SR 1A (Main Street)	Winter Street	42.1121	-71.2840	NB onto Winter Street	Yes	5-way	2	Mast-arm	-	No	N/A	No	No	204	67	40	36	50	Aug-13	Nov-16	https://www.google.c
303	51132	21522	2	WARE	SR 32 (Palmer Road)	Wal-Mart Driveway	42.2395	-72.2808	WB into Wal-Mart Driveway	Yes	4-way	No	Mast-arm	Post	Yes	Yes	Yes	Yes	169	128	53	56	72	Oct-13	Nov-16	https://www.google.c
305	51139	51490	5	WAREHAM	SR 28 (Cranberry Highway)	Rosebrook Way (Lou Avenue)	41.7730	-70.7360	SB into Rosebrook Way	Yes	3-way	No	Mast-arm	-	No	N/A	No	Yes	323	200	66	61	74	Sep-14	Sep-17	https://www.google.c
307	51188	51491	5	WAREHAM	SR 28 (Cranberry Highway)	Tobey Road	41.7811	-70.7439	NB onto Tobey Road	Yes	4-way	No	Mast-arm	Post	Yes	Yes	Yes	Yes (yield)	N/A	200	43	56	66	Sep-14	Sep-17	https://www.google.c
308	51197	51494	5	WAREHAM	US 6 (Marion Road)	Wareham Plaza Driveway (Shaw's)	41.7586	-70.7283	EB into Wareham Plaza Driveway	Yes	3-way	No	Mast-arm	Post	Yes	Yes	No	Yes	69	178	48	53	52	Oct-12	Sep-17	https://www.google.c
309	51208	30347	3	WAYLAND	US 20 (Boston Post Road)	SR 27 & SR 126 (Cochituate Road)	42.3630	-71.3601	NB onto US 20	Yes	4-way	4	Mast-arm	-	Yes	Yes	No	Yes	208	190	58	41	57	Jul-15	Nov-16	https://www.google.c
310	51252	31563	3	WEBSTER	SR 193 (Thompson Road)	I-395 SB Off-Ramp	42.0414	-71.8613	NB onto Lake Parkway	Yes	4-way	No	Span Wire	-	No	N/A	Yes	Yes	71	96	42	93	93	Oct-08	Oct-18	https://www.google.c
311	51254	61227	6	WELLESLEY	Cedar Street	SR 9 EB Ramps	42.3154	-71.2466	SB onto Worcester Street	Yes	4-way	No	Mast-arm	Post	Yes	Yes	No	No	71	186	36	35	33	Sep-13	Jun-17	https://www.google.c
312	51302	30961	3	WEST BOYLSTON	SR 12 (West Boylston Street)	Wal-Mart Driveway	42.3562	-71.7846	SB into Wal-Mart Driveway	No	3-way	No	Span Wire	-	No	N/A	Yes	Yes	310	147	37	49	96	Oct-17	Oct-18	https://www.google.c
313	51318	31846	3	WEST BOYLSTON	SR 12 (West Boylston Street)	Wachusett Plaza Driveway	42.3504	-71.7854	NB into Wachusett Plaza Driveway	Yes	4-way	2	Mast-arm	-	No	N/A	Yes	Yes	85	121	70	59	101	Oct-16	Oct-17	https://www.google.c
316	51329	20397	2	WESTFIELD	US 20 (Springfield Road)	East Mountain Road	42.1078	-72.7042	EB onto East Mountain Road	Yes	3-way	No	Mast-arm	-	No	N/A	No	Yes	238	104	57	60	59	Nov-15	Jul-17	https://www.google.c
317	51335	51335	5	PLYMOUTH	Long Pond Road	SR 3 SB Ramps	41.9347	-70.6571	NB onto SR 3 SB Ramp	Yes	3-way	No	Mast-arm	Post	No	N/A	Yes	Yes (yield)	291	159	57	58	52	Nov-16	Sep-17	https://www.google.c
318	51336	51336	5	PLYMOUTH	Long Pond Road	SR 3 NB Ramps	41.9366	-70.6563	SB onto SR 3 NB Ramp	Yes	3-way	No	Mast-arm	-	No	N/A	Yes	Yes (yield)	123	144	45	44	49	Nov-16	Sep-17	https://www.google.c
319	51366	20518	2	WESTFIELD	US 20 (East Main Street)	Little River Road	42.1125	-72.7187	WB onto SR 187	Yes	4-way	No	Span Wire	-	No	N/A	Yes	Yes (yield)	229	593	68	79	46	Nov-15	Aug-17	https://www.google.c
321	51371	20834	2	WESTFIELD	US 20 (Springfield Road)	Union Street	42.1125	-72.7134	EB onto Union Street	Yes	3-way	No	Mast-arm	Post	No	N/A	Yes	Yes (yield)	135	520	59	60	34	Nov-15	Aug-17	https://www.google.c
322	51377	21529	2	WESTFIELD	SR 10 & US 202 (Southampton Road)	Summit Lock Road	42.1753	-72.7272	NB onto Summit Lock Road	Yes	4-way	2	Span Wire	-	No	N/A	Yes	Yes	120	191	74	73	55	Aug-15	Aug-18	https://www.google.c
325	51393	51393	5	BRIDGEWATER	SR 18 & SR 28 (Bedford Street)	Winter Street	41.9683	-70.9735	NB onto Winter Street	Yes	4-way	2	Mast-arm	-	Yes	Yes	No	Yes	125	148	45	43	53	Aug-17	Oct-19	https://www.google.c
326	51398	31765	3	WESTFORD	SR 110 (Littleton Road)	Powers Road	42.5569	-71.4387	SB onto Powers Road	No	3-way	No	Mast-arm	-	Yes	Yes	No	Yes	41	148	45	44	76	Nov-15	Aug-17	https://www.google.c
327	51414	31787	3	WESTFORD	SR 110 (Littleton Road)	Office Driveway	42.5552	-71.4446	WB into Office Driveway	Yes	4-way	No	Mast-arm	-	No	N/A	No	Yes	58	197	59	59	85	Aug-15	Nov-17	https://www.google.c
328	51416	31848	3	WESTFORD	Boston Road	I-495 SB Ramps	42.5705	-71.4266	NB onto I-495 SB Ramp	No	3-way	No	Mast-arm	-	No	N/A	Yes	Yes (yield)	116	59	54	54	29	Nov-15	Aug-17	https://www.google.c
330	51420	60253	6	WEYMOUTH	SR 53 (Washington Street)	Middle Street	42.2014	-70.9455	WB onto Middle Street	Yes	4-way	3	Mast-arm	-	Yes	Yes	No	No	79	177	54	54	88	Sep-17	Nov-18	https://www.google.c
331	51431	61233	6	WEYMOUTH	SR 18 (Main Street)	Trotter Road	42.1533	-70.9552	SB onto Trotter Road	Yes	3-way	No	Span Wire	-	Yes	Yes	No	Yes	171	166	67	61	58	Jul-15	Sep-17	https://www.google.c
334	51434	61234	6	WEYMOUTH	SR 18 (Main Street)	SR 58 (Pond Street)	42.1524	-70.9552	NB onto Pond Street	No	4-way	2	Span Wire	-	No	N/A	Yes	Yes (yield)	165	111	59	50	41	Jul-15	Sep-17	https://www.google.c
335	51435	21514	2	WHATELY	SR 5 & SR 10 (State Road)	SR 116 (Sunderland Road)	42.4691	-72.6147	SB onto SR 116	Yes	4-way	2	Mast-arm	Post	No	N/A	Yes	Yes	134	317	43	51	51	Nov-15	Nov-16	https://www.google.c
336	51438	51571	5	WHITMAN	SR 18 (Bedford Street)	Stop & Shop Driveway	42.0738	-70.9474	SB into Stop and Shop Driveway	No	3-way	No	Mast-arm	-	Yes	Yes	Yes	Yes	56	325	43	49	66	Jul-15	Sep-17	https://www.google.c
337	51440	21744	2	WILBRAHAM	US 20 (Boston Road)	Post Office Park, East Driveway	42.1487	-72.4413	EB into Post Office Park, East Driveway	No	4-way	No	Span Wire	-	No	N/A	Yes	Yes	95	52	38	49	71	Oct-13	Aug-17	https://www.google.c
338	51451	21745	2	WILBRAHAM	US 20 (Boston Road)	Post Office Park, West Driveway	42.1489	-72.4435	WB onto White Street	No	4-way	2	Span Wire	-	No	N/A	No	No	50	126	38	42	72	Jul-13	Jul-17	https://www.google.c
339	51454	11504	1	WILLIAMSTOWN	SR 2 (Mohawk Trail)	Cole Avenue	42.7108	-73.1972	EB onto Cole Avenue	No	3-way	No	Span Wire	Post	No	N/A	No	Yes	207	58	47	73	78	uncertain	uncertain	https://www.google.c
341	51456	41032	4	WILMINGTON	SR 38 (Main Street)	SR 129 (Richmond Street)	42.5581	-71.1820	NB onto Richmond Street	Yes	4-way	No	Span Wire	-	Yes	Yes	Yes	Yes (yield)	N/A	90	46	39	61	Aug-15	Oct-17	https://www.google.c
342	51465	41235	4	WILMINGTON	SR 38 (Main Street)	MBTA Wilmington Station Driveway	42.5485	-71.1749	NB onto MBTA Wilmington Station Drive	No	3-way	No	Mast-arm	-	Yes	Yes	No	Yes	100	66	43	44	42	Aug-15	Nov-17	https://www.google.c
343	51470	41236	4	WILMINGTON	SR 38 (Main Street)	Clark Street	42.5518	-71.1781	SB onto Clark Street	Yes	3-way	No	Span Wire	-	Yes	Yes	No	Yes	122	155	43	44	37	Aug-15	Oct-17	https://www.google.c
345	51476	51476	5	SOMERSET	US 6 (Grand Army Highway)	Stop & Shop Driveway	41.7308	-71.1698	WB into Stop and Shop Driveway	Yes	3-way	No	Mast-arm	Post	No	N/A	No	Yes	123	148	61	70	64	Nov-18	Sep-19	https://www.google.c
347	51490	41861	4	WILMINGTON	SR 38 (Main Street)	SR 129 (Lowell Street)	42.5423	-71.1678	EB onto Lowell Street	Yes	3-way	No	Mast-arm	-	Yes	Yes	No	Yes	85	223	45	33	63	Aug-15	Nov-17	https://www.google.c
348	51491	41862	4	WILMINGTON	SR 125 (Ballardvale Street)	I-93 SB Ramps	42.5827	-71.1583	NB onto I-93 SB Ramp	Yes	3-way	No	Mast-arm	-	No	N/A	Yes	Yes (yield)	204	66	35	36	61	Oct-13	Oct-18	https://www.google.c
349	51494	21561	2	WINCHENDON	SR 12 (Spring Street)	SR 140 (Gardner Road)	42.6660	-72.0104	EB onto SR 12	Yes	3-way	No	Mast-arm	-	No	N/A	No	Yes	142	86	39	40	38	Sep-08	Nov-16	https://www.google.c
350	51497	51497	5	WRENTHAM	SR 1A (South Street)	SR 121 (West Street)	42.0505	-71.3460	NB onto SR 121	Yes	3-way	No	Mast-arm	Post	No	N/A	Yes	No	173	166	44	49	63	Aug-17	Sep-19	https://www.google.c

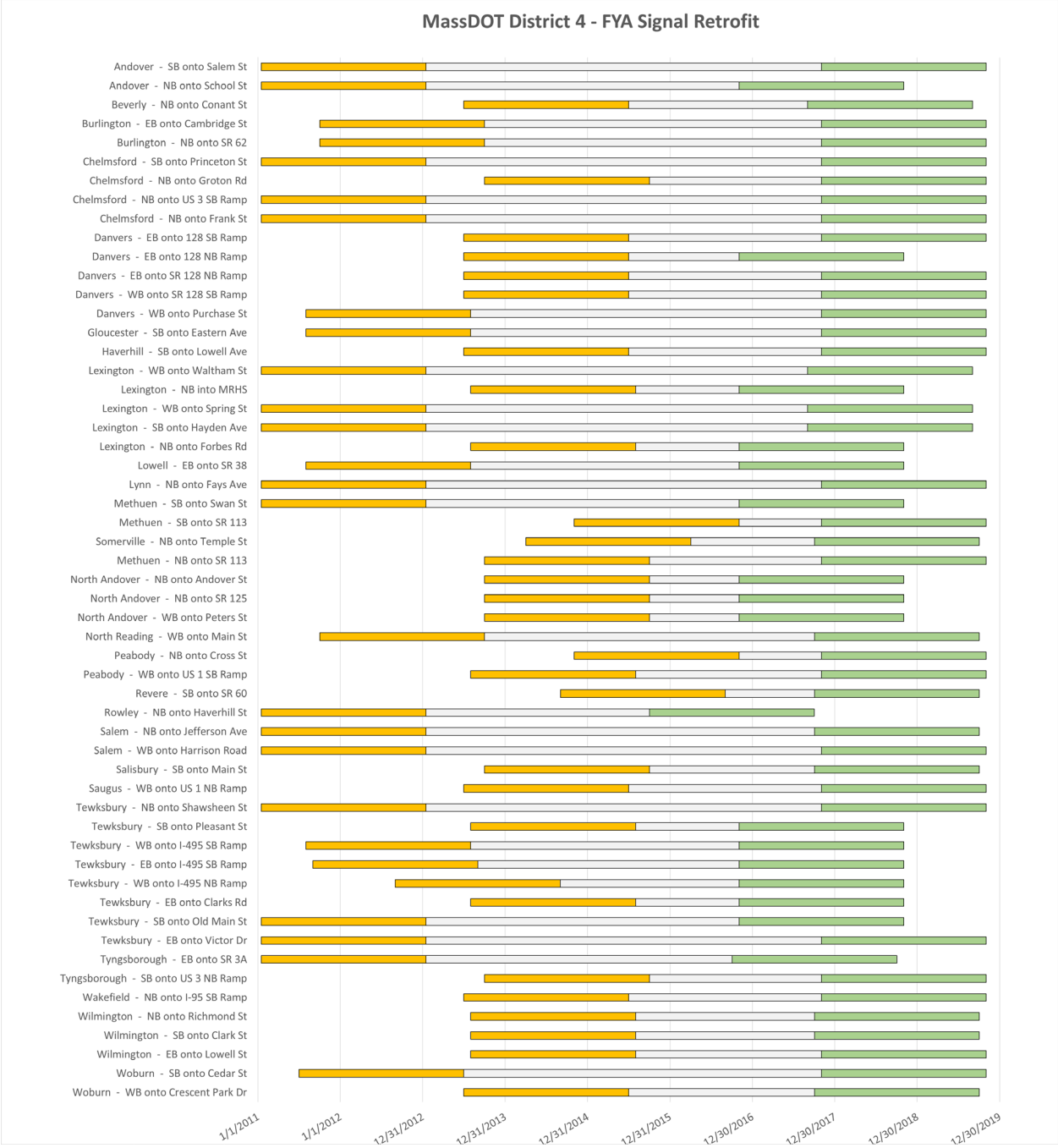
FID	Signal ID	Dist_ID	District	Municipality	Location 1	Location 2	Latitude	Longitude	FYA Approach	Supp. Signage (Yes/No)	Intersection Legs	Multiple FYA/CG Approaches?	Structure (Post/Mast-arm/Span Wire)	Second Structure	Pedestrian Signal (Yes/No)	Activation Button (Yes/No)	Opposing Right Turn Lane (Yes/No)	Right Turn on Red (Yes/No)	Taper (ft.)	Turn Bay (ft.)	Width of FYA/CG Approach (ft.)	Width of Opposing Approach (ft.)	Width of Perpendicular Approach (ft.)	Latest Before Installation Imagery	Earliest After Installation Imagery	Link to Streetview
351	51498	40878	4	WOBURN	Washington Street	Cedar Street	42.4952	-71.1244	SB onto Cedar Street	No	4-way	2	Span Wire	-	No	N/A	No	Yes	N/A	148	53	37	52	Jul-13	Nov-17	https://www.google.c
353	51505	41244	4	WOBURN	US 3 (Cambridge Street)	Country Club Road	42.4614	-71.1678	WB onto Crescent Park Drive	No	4-way	No	Mast-arm	-	No	N/A	Yes	Yes (yield)	96	133	76	66	42	Jul-15	Oct-17	https://www.google.c
354	51825	30112	3	WORCESTER	US 20 (SW Cutoff)	Greenwood Street	42.2117	-71.7954	SB onto US 20	Yes	4-way	No	Span Wire	-	No	N/A	No	Yes	463	79	52	69	72	Oct-15	Nov-16	https://www.google.c
355	51826	30408	3	WORCESTER	US 20 (SW Cutoff)	Park Hill Avenue	42.2178	-71.7799	SB onto US 20	Yes	4-way	No	Span Wire	-	No	N/A	No	Yes	193	92	36	56	84	Jul-11	Oct-18	https://www.google.c
356	60051	60051	6	CANTON	SR 138 (Turnpike Street)	Randolph Street	42.1815	-71.1140	SB onto Randolph Street	Yes	4-way	3	Mast-arm	Post	Yes	Yes	No	Yes	60	271	51	46	60	Sep-14	Nov-16	https://www.google.c
360	60253	31478	3	WORCESTER	Plantation Street	I-90 EB Off-Ramp	42.2923	-71.7606	SB into Fallon Clinic Driveway	Yes	4-way	No	Span Wire	-	No	N/A	Yes	Yes	113	92	77	79	70	Oct-16	Oct-17	https://www.google.c
364	60446	60446	6	CHELSEA	Eastern Avenue & Marginal Street	Central Avenue	42.3877	-71.0236	SB onto Chelsea Street	Yes	4-way	3	Mast-arm	Post	Yes	Yes	Yes	Yes (yield)	N/A	260	44	59	39	Aug-17	Sep-18	https://www.google.c
365	60665	31690	3	WORCESTER	SR 122A (Vernon Street)	I-290 EB Ramps	42.2537	-71.7970	SB onto Jefferson Street	Yes	5-way	No	Mast-arm	-	No	N/A	No	No	33	106	43	25	27	Nov-16	Oct-17	https://www.google.c
368	61095	31751	3	WORCESTER	Millbury Street	Blackstone River Road	42.2279	-71.7859	NB onto Blackstone River Road	No	3-way	No	Mast-arm	-	No	N/A	No	Yes	136	250	35	37	54	Jun-11	Nov-16	https://www.google.c
369	61227	51498	5	WRENTHAM	SR 1A (South Street)	I-495 SB Ramps	42.0385	-71.3460	NB onto I-495 SB Ramp	Yes	3-way	No	Mast-arm	-	No	N/A	Yes	Yes (yield)	109	460	56	54	65	Oct-15	Sep-17	https://www.google.c
370	61233	51501	5	WRENTHAM	SR 1A (South Street)	Premium Outlet Boulevard	42.0362	-71.3470	NB onto Outlet Blvd	Yes	4-way	No	Span Wire	-	No	N/A	Yes	Yes (yield)	93	191	55	61	49	Oct-15	Aug-17	https://www.google.c
371	61234	50923	5	YARMOUTH	SR 28	Berry Avenue	41.6506	-70.2421	WB onto Berry Avenue	Yes	4-way	2	Mast-arm	-	No	N/A	No	Yes	73	77	51	39	63	Jul-14	Sep-17	https://www.google.c
374	61736	51505	5	YARMOUTH	SR 28	Shaw's/RMV Driveway	41.6619	-70.2014	NB into Shaw's/RMW Driveway	Yes	4-way	No	Mast-arm	-	Yes	Yes	Yes	Yes	222	158	51	45	58	Jul-14	Sep-17	https://www.google.c
375	61801	61801	6	BOSTON	SR 203 (Gallivan Boulevard)	Granite Avenue	42.2828	-71.0561	EB onto Adams Street	Yes	4-way	2	Mast-arm	Post	Yes	Yes	No	Yes	98	142	57	60	60	Nov-16	Jul-17	https://www.google.c

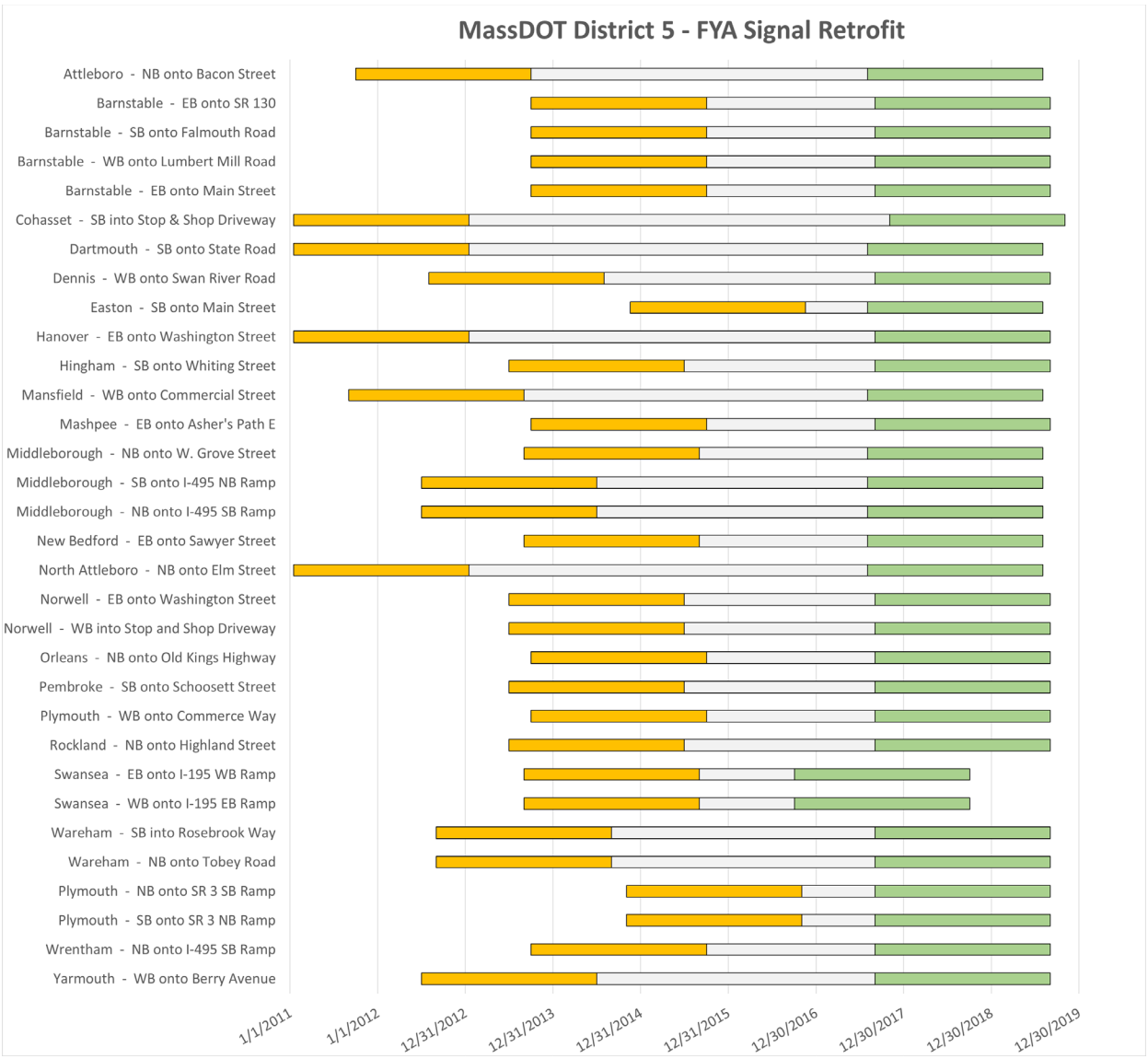
7.2 Appendix B: FYA Signal Retrofit Timeline by District

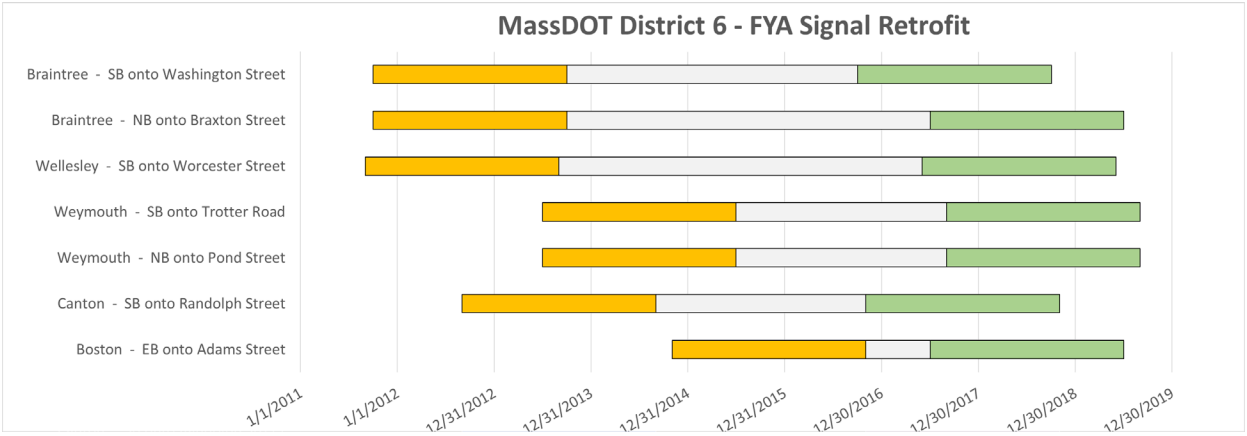



MassDOT District 2 - FYA Signal Retrofit
Agawam - SB onto School Street
Agawam - NB onto Elm Street
Athol - WB onto Brookside Road
Belchertown - NB onto SR 9
Belchertown - NB onto George Hannum Street
Deerfield - NB onto SR 116
Easthampton - NB onto Florence Road
Gill - WB onto Main Road
Greenfield - WB onto River Street
Holyoke - SB onto I-91 SB Ramp
Northampton - EB onto Earle Street
Northampton - NB into Big Y Driveway
Palmer - EB onto Main Street
Palmer - NB onto High Street
Palmer - NB onto Massachusetts Turnpike Ramp
Southwick - SB onto Depot Street
Southwick - SB onto SR 57
Sunderland - WB onto SR 47
Westfield - WB onto SR 187
Westfield - EB onto Union Street
Westfield - NB onto Summit Lock Road
Whately - SB onto SR 116
Wilbraham - EB into Post Office Park, East Driveway
Wilbraham - EB into Post Office Park, West Driveway
Winchendon - EB onto SR 12
1/1/2011
1/1/2012
12/31/2012
12/31/2013
12/31/2014
12/31/2015
12/30/2016
12/30/2017
12/30/2018
12/30/2019


MassDOT District 3 - FYA Signal Retrofit
Acton - SB onto Nagog Park
Ashland - NB onto Eliot Street
Auburn - WB onto Auburn Street
Auburn - SB onto Chruch Street
Auburn - NB onto Swanson Road
Auburn - EB onto Oxford Street North
Bellingham - NB onto SR 140
Bellingham - SB onto Common Street
Bellingham - WB onto Blackstone Street
Bolton - WB onto I-495 SB Ramp
Littleton - WB onto SR 2A
Acton - NB onto Main Street
Franklin - WB onto Forge Parkway
Franklin - NB onto I-495 NB Ramp
Leominster - WB onto Haws Street
Leominster - SB onto Willard Street
Marlborough - WB onto Williams Street
Marlborough - WB onto Hayes Memorial Drive
Mendon - SB onto Hartford Avenue E
Milford - NB into CVS/Papa Ginos's Plaza
Milford - EB onto East Main Street
Millbury - WB onto I-90 Ramp
Northborough - SB onto SR 9 EB Ramp
Northborough - SB onto Davis Street
Northborough - NB onto W. Main Street
Shrewsbury - NB onto South Street
Shrewsbury - EB onto Cherry Street
Sudbury - EB onto Union Avenue
Sudbury - WB onto Nobscot Road
Wayland - NB onto US 20
Westford - SB onto Powers Road
Worcester - SB onto US 20
Worcester - SB into Fallon Clinic Driveway
1/1/2011
1/1/2012
12/31/2012
12/31/2013
12/31/2014
12/31/2015
12/30/2016
12/30/2017
12/30/2018
12/30/2019


MassDOT District 4 - FYA Signal Retrofit
Andover - SB onto Salem St
Andover - NB onto School St
Beverly - NB onto Conant St
Burlington - EB onto Cambridge St
Burlington - NB onto SR 62
Chelmsford - SB onto Princeton St
Chelmsford - NB onto Groton Rd
Chelmsford - NB onto US 3 SB Ramp
Chelmsford - NB onto Frank St
Danvers - EB onto 128 SB Ramp
Danvers - EB onto 128 NB Ramp
Danvers - EB onto SR 128 NB Ramp
Danvers - WB onto SR 128 SB Ramp
Danvers - WB onto Purchase St
Gloucester - SB onto Eastern Ave
Haverhill - SB onto Lowell Ave
Lexington - WB onto Waltham St
Lexington - NB into MRHS
Lexington - WB onto Spring St
Lexington - SB onto Hayden Ave
Lexington - NB onto Forbes Rd
Lowell - EB onto SR 38
Lynn - NB onto Fays Ave
Methuen - SB onto Swan St
Methuen - SB onto SR 113
Somerville - NB onto Temple St
Methuen - NB onto SR 113
North Andover - NB onto Andover St
North Andover - NB onto SR 125
North Andover - WB onto Peters St
North Reading - WB onto Main St
Peabody - NB onto Cross St
Peabody - WB onto US 1 SB Ramp
Revere - SB onto SR 60
Rowley - NB onto Haverhill St
Salem - NB onto Jefferson Ave
Salem - WB onto Harrison Road
Salisbury - SB onto Main St
Saugus - WB onto US 1 NB Ramp
Tewksbury - NB onto Shawsheen St
Tewksbury - SB onto Pleasant St
Tewksbury - WB onto I-495 SB Ramp
Tewksbury - EB onto I-495 SB Ramp
Tewksbury - WB onto I-495 NB Ramp
Tewksbury - EB onto Clarks Rd
Tewksbury - SB onto Old Main St
Tewksbury - EB onto Victor Dr
Tyngsborough - EB onto SR 3A
Tyngsborough - SB onto US 3 NB Ramp
Wakefield - NB onto I-95 SB Ramp
Wilmington - NB onto Richmond St
Wilmington - SB onto Clark St
Wilmington - EB onto Lowell St
Woburn - SB onto Cedar St
Woburn - WB onto Crescent Park Dr
1/1/2011
1/1/2012
12/31/2012
12/31/2013
12/31/2014
12/31/2015
12/30/2016
12/30/2017
12/30/2018
12/30/2019


MassDOT District 5 - FYA Signal Retrofit
Attleboro - NB onto Bacon Street
Barnstable - EB onto SR 130
Barnstable - SB onto Falmouth Road
Barnstable - WB onto Lumbert Mill Road
Barnstable - EB onto Main Street
Cohasset - SB into Stop & Shop Driveway
Dartmouth - SB onto State Road
Dennis - WB onto Swan River Road
Easton - SB onto Main Street
Hanover - EB onto Washington Street
Hingham - SB onto Whiting Street
Mansfield - WB onto Commercial Street
Mashpee - EB onto Asher's Path E
Middleborough - NB onto W. Grove Street
Middleborough - SB onto I-495 NB Ramp
Middleborough - NB onto I-495 SB Ramp
New Bedford - EB onto Sawyer Street
North Attleboro - NB onto Elm Street
Norwell - EB onto Washington Street
Norwell - WB into Stop and Shop Driveway
Orleans - NB onto Old Kings Highway
Pembroke - SB onto Schoosett Street
Plymouth - WB onto Commerce Way
Rockland - NB onto Highland Street
Swansea - EB onto I-195 WB Ramp
Swansea - WB onto I-195 EB Ramp
Wareham - SB into Rosebrook Way
Wareham - NB onto Tobey Road
Plymouth - NB onto SR 3 SB Ramp
Plymouth - SB onto SR 3 NB Ramp
Wrentham - NB onto I-495 SB Ramp
Yarmouth - WB onto Berry Avenue
1/1/2011
1/1/2012
12/31/2012
12/31/2013
12/31/2014
12/31/2015
12/30/2016
12/30/2017
12/30/2018
12/30/2019


MassDOT District 6 - FYA Signal Retrofit
Braintree - SB onto Washington Street
Braintree - NB onto Braxton Street
Wellesley - SB onto Worcester Street
Weymouth - SB onto Trotter Road
Weymouth - NB onto Pond Street
Canton - SB onto Randolph Street
Boston - EB onto Adams Street
1/1/2011
1/1/2012
12/31/2012
12/31/2013
12/31/2014
12/31/2015
12/30/2016
12/30/2017
12/30/2018
12/30/2019

7.3 Appendix C: MassDOT Annual VMT Data by MPO/RPA

Annual VMT (100,000,000 Vehicle Miles Traveled)	Year									
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Berkshire *(BCRPC)*	13.0	13.1	13.3	13.4	13.7	13.6	13.7	13.7	13.8	13.9
Cape Cod *(CCC)*	28.9	29.1	29.6	29.9	30.6	30.3	30.4	30.3	30.3	30.2
Central Mass. *(CMRPC)*	55.6	56.1	57.1	57.6	58.9	58.5	58.5	59.0	59.4	59.9
Franklin *(FCDP)*	8.8	8.9	9.0	9.1	9.3	9.3	9.3	9.3	9.3	9.3
Boston *(MAPC)*	214.3	243.2	247.6	249.9	255.4	253.4	254.1	254.7	255.3	255.9
Montachusett *(MRPC)*	21.2	21.4	21.8	22.0	22.5	22.3	22.4	22.5	22.6	22.8
Marthas Vineyard *(MVC)*	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Merrimack Valley *(MVPC)*	34.8	35.1	35.7	36.0	36.8	36.6	36.6	36.7	36.7	36.8
Northern Middlesex *(NMCOG)*	26.5	26.7	27.2	27.4	28.0	27.8	27.9	27.9	28.0	28.0
Nantucket *(NPEDC)*	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Old Colony *(OCPC)*	31.3	31.5	32.1	32.4	33.1	32.9	33.0	33.0	33.1	33.2
Pioneer Valley *(PVPC)*	52.3	52.7	53.6	54.1	55.3	55.0	55.0	55.2	55.5	55.7
Southeastern Mass. *(SPREDD)*	60.0	60.5	61.6	62.2	63.6	63.1	63.2	63.4	63.7	64.0
Grand Total	575.3	579.8	590.3	595.9	609.0	604.5	605.6	607.5	609.5	611.4

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7.4 Appendix D: FYA Intersection Crash Database

FID	City/Town	RPA	MassDOT District	Major Street	Minor Street	Intersection Type	Fatal & Injury [before(after)]	PDO [before(after)]	Total Crashes [before(after)]	EPDO Equiv Crashes [before(after)]
0	ACTON	MAPC	3	SR 2A & SR 119 (Great Road)	Nagog Park	3-way	1(1)	2(4)	3(5)	23(25)
2	AGAWAM	PVPC	2	SR 159 (Main Street)	School Street	3-way	3(1)	3(3)	6(4)	66(24)
3	AGAWAM	PVPC	2	SR 159 (Main Street)	Elm Street	4-way	1(1)	3(2)	4(3)	24(23)
9	ANDOVER	MVPC	4	SR 28 (South Main Street)	Salem Street	3-way	2(1)	3(2)	5(3)	45(23)
10	ANDOVER	MVPC	4	SR 28 (Main Street)	School Street	4-way	1(0)	5(6)	6(6)	26(6)
11	LENOX	BCRPC	1	US 7 & 20 (Pittsfield Road)	The Center at Lenox	4-way	1(1)	3(7)	4(8)	24(28)
14	ASHLAND	MAPC	3	SR 126 (Pond Street)	Eliot Street	4-way	3(3)	6(11)	9(14)	69(74)
16	ATHOL	MRPC	2	SR 2A (South Main Street)	Daniel Shays Highway	3-way	2(1)	6(3)	8(4)	48(24)
17	ATTLEBORO	SRPEDD	5	US 1 (Washington Street)	East Bacon Street	4-way	3(7)	4(6)	7(13)	67(153)
18	AUBURN	CMRPC	3	SR 12 (Southbridge Street)	Auburn Street	4-way	1(2)	16(13)	17(15)	37(55)
19	AUBURN	CMRPC	3	SR 12 (Southbridge Street)	Church Street	3-way	0(0)	1(1)	1(1)	1(1)
20	AUBURN	CMRPC	3	SR 12 (Southbridge Street)	Swanson Road	4-way	6(3)	10(10)	16(13)	136(73)
22	AUBURN	CMRPC	3	SR 12 (Southbridge Street)	Oxford Street North	4-way	2(2)	3(7)	5(9)	45(49)
24	BARNSTABLE	CCC	5	SR 28 (Falmouth Road)	SR 130 (Main Street)	3-way	2(2)	10(6)	12(8)	52(48)
26	BARNSTABLE	CCC	5	SR 28 (Falmouth Road)	Old Stage Road	4-way	4(3)	9(7)	13(10)	93(70)
27	BARNSTABLE	CCC	5	SR 28 (Falmouth Road)	Lumbert Mill Road	4-way	5(8)	10(5)	15(13)	115(173)
28	BARNSTABLE	CCC	5	SR 28 (Falmouth Road)	South County Road	4-way	3(4)	12(4)	15(8)	75(88)
29	BELCHERTOWN	PVPC	2	SR 9 (Federal Street)	US 202 (North Main Street)	4-way	1(0)	6(6)	7(6)	27(6)
30	BELCHERTOWN	PVPC	2	SR 9 (Federal Street)	George Hannum Street	3-way	0(3)	4(4)	4(7)	4(67)
31	BELLINGHAM	MAPC	3	SR 126 (North Main Street)	SR 126 & SR 140 (Mechanic St)	3-way	6(8)	21(21)	27(29)	147(189)
32	BELLINGHAM	MAPC	3	SR 126 & SR 140 (Mechanic Street)	SR 140 (Mechanic Street)	4-way	1(2)	14(7)	15(9)	35(49)
33	BELLINGHAM	MAPC	3	SR 140 (Mechanic Street)	Blackstone Street	3-way	2(0)	4(4)	6(4)	46(4)
34	BEVERLY	MAPC	4	SR 1A (Dodge Street)	Conant Street	3-way	3(3)	11(11)	14(14)	74(74)
38	BOLTON	MAPC	3	SR 117 (Main Street)	I-495 SB Ramps	4-way	0(2)	4(11)	4(13)	4(53)
43	BRAINTREE	MAPC	6	SR 37 (Washington Street)	SR 37 (Franklin Street)	3-way	0(3)	4(5)	4(8)	4(68)
44	BRAINTREE	MAPC	6	SR 37 (Washington Street)	Braxton Street	3-way	0(0)	1(1)	1(1)	1(1)
46	BURLINGTON	MAPC	4	SR 3A (Cambridge Street)	Bedford Street	4-way	3(2)	14(11)	17(13)	77(53)
48	BURLINGTON	MAPC	4	SR 3A (Cambridge Street)	SR 62 (Francis Wyman Road)	3-way	1(1)	3(4)	4(5)	24(25)
52	CHELMSFORD	NMCOG	4	SR 4 (North Road)	SR 3A (Princeton Street)	3-way	2(2)	5(8)	7(10)	47(50)

FID	City/Town	RPA	MassDOT District	Major Street	Minor Street	Intersection Type	Fatal & Injury [before(after)]	PDO [before(after)]	Total Crashes [before(after)]	EPDO Equiv Crashes [before(after)]
53	CHELMSFORD	NMCOG	4	SR 3A (Tyngsboro Road)	SR 40 (Groton Road)	3-way	4(4)	11(4)	15(8)	95(88)
56	CHELMSFORD	NMCOG	4	SR 129 (Billerica Road)	US 3 SB Ramps	3-way	1(1)	2(5)	3(6)	23(26)
57	CHELMSFORD	NMCOG	4	SR 4 (North Road)	Technology Drive	4-way	3(3)	3(4)	6(7)	66(67)
60	COHASSET	MAPC	5	SR 3A (Cushing Highway)	King Street	4-way	2(1)	4(4)	6(5)	46(25)
62	DANVERS	MAPC	4	Endicott Street	SR 128 SB Ramps	3-way	0(2)	3(1)	3(3)	3(43)
63	DANVERS	MAPC	4	Endicott Street	SR 128 NB Ramps	4-way	1(3)	3(4)	4(7)	24(67)
64	LITTLETON	MAPC	3	SR 2A & SR 119 (Great Road)	SR 110 (King Street)	4-way	2(3)	9(31)	11(34)	51(94)
67	DANVERS	MAPC	4	SR 35 (High Street)	SR 128 NB Ramps	4-way	1(1)	13(8)	14(9)	34(29)
68	DANVERS	MAPC	4	SR 35 (High Street)	SR 128 SB Ramps	4-way	3(6)	11(8)	14(14)	74(134)
69	DANVERS	MAPC	4	SR 35 (High Street)	Purchase Street	3-way	2(0)	4(5)	6(5)	46(5)
70	ACTON	MAPC	3	SR 2A (Great Road)	SR 27 (Main Street)	4-way	4(0)	23(21)	27(21)	107(21)
74	DARTMOUTH	SRPEDD	5	US 6 (State Road)	Cross Road	4-way	3(3)	6(14)	9(17)	69(77)
76	DEERFIELD	FCDP	2	SR 5 & SR 10 (South Deerfield Byp)	SR 116 (Conway Road)	4-way	1(0)	9(4)	10(4)	30(4)
78	DENNIS	CCC	5	SR 28 (Main Street)	SR 134 (E-W Dennis Road)	4-way	0(0)	14(8)	14(8)	14(8)
81	EASTHAMPTON	PVPC	2	SR 10 (Northampton Street)	Florence Road	4-way	5(2)	10(13)	15(15)	115(55)
82	EASTON	OCPC	5	SR 138 (Washington Street)	Main Street	4-way	6(2)	6(4)	12(6)	132(46)
86	FRANKLIN	MAPC	3	SR 140 (West Central Street)	Forge Parkway West	3-way	1(0)	0(1)	1(1)	21(1)
88	FRANKLIN	MAPC	3	King Street	I-495 NB Ramps	3-way	2(0)	9(2)	11(2)	51(2)
92	GILL	FCDP	2	SR 2 & SR 2A (Mohawk Trail)	Montague-Gill Bridge	4-way	0(4)	0(9)	0(13)	0(93)
94	GLOUCESTER	MAPC	4	SR 128	SR 127 (Eastern Avenue)	4-way	4(2)	3(6)	7(8)	87(48)
97	GREAT BARRINGTON	BCRPC	1	US 7 & SR 23 (State Road)	US 7 & SR 183 (Stockbridge Rd)	3-way	1(3)	4(5)	5(8)	25(68)
98	GREAT BARRINGTON	BCRPC	1	US 7 & SR 183 (Stockbridge Road)	Monument Valley Road	3-way	1(0)	0(3)	1(3)	21(3)
99	GREENFIELD	FCDP	2	SR 2A (Mohawk Trail)	Shelburne Road	4-way	8(1)	11(6)	19(7)	179(27)
107	HANOVER	OCPC	5	SR 53 (Washington Street)	SR 3 SB Ramps	4-way	0(2)	1(2)	1(4)	1(44)
109	HAVERHILL	MVPC	4	SR 110 & SR 113 (River Street)	Lowell Avenue	4-way	5(5)	22(15)	27(20)	127(120)
110	HINGHAM	MAPC	5	SR 53 (Whiting Street)	Cushing Street	4-way	1(3)	12(9)	13(12)	33(72)
115	HOLYOKE	PVPC	2	SR 141 (Easthampton Road)	I-91 SB Ramps	4-way	4(3)	10(11)	14(14)	94(74)
119	LANESBOROUGH	BCRPC	1	SR 8 (Cheshire Road)	Berkshire Mall Road	3-way	0(1)	0(0)	0(1)	0(21)
120	LANESBOROUGH	BCRPC	1	US 7 (South Main Street)	Berkshire Mall Road	3-way	0(0)	0(1)	0(1)	0(1)
123	LANESBOROUGH	BCRPC	1	SR 8 (Cheshire Road)	Old State Road	3-way	0(0)	0(2)	0(2)	0(2)
128	LENOX	BCRPC	1	US 7 & 20 (Veterans Memorial Hwy)	SR 7A (Main Street)	3-way	2(1)	3(9)	5(10)	45(30)
129	LENOX	BCRPC	1	US 20 (Lee Road)	US 7	3-way	1(1)	4(3)	5(4)	25(24)
130	LENOX	BCRPC	1	US 7 & 20 (Pittsfield Road)	New Lenox Road	4-way	2(4)	10(5)	12(9)	52(89)
133	LEOMINSTER	MRPC	3	SR 13 (Main Street)	Hawes Street	3-way	3(6)	11(10)	14(16)	74(136)
134	LEOMINSTER	MRPC	3	SR 12 (Central Street)	Willard Street	4-way	1(2)	6(11)	7(13)	27(53)
135	LEXINGTON	MAPC	4	SR 2A (Marrett Road)	Waltham Street	4-way	3(0)	5(11)	8(11)	68(11)
136	LEXINGTON	MAPC	4	SR 2A (Marrett Road)	Massachusetts Avenue	4-way	0(0)	5(9)	5(9)	5(9)
137	LEXINGTON	MAPC	4	SR 2A (Marrett Road)	Spring Street	3-way	0(0)	3(2)	3(2)	3(2)
138	LEXINGTON	MAPC	4	Spring Street	Hayden Avenue	4-way	0(1)	0(3)	0(4)	0(24)
139	LEXINGTON	MAPC	4	SR 2A (Marrett Road)	Forbes Road	4-way	1(0)	4(5)	5(5)	25(5)

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142	LOWELL	NMCOG	4	SR 38 (Nesmith Street)	SR 133 (Andover Street)	4-way	9(10)	17(44)	26(54)	206(254)
144	LYNN	MAPC	4	SR 107 (Highland Avenue)	Fays Avenue	3-way	2(1)	5(6)	7(7)	47(27)
149	MANSFIELD	SRPEDD	5	SR 140 (Commercial Street)	School Street	4-way	2(6)	19(15)	21(21)	61(141)
150	MARLBOROUGH	MAPC	3	US 20 (West Main Street)	US 20 (Lakeside Avenue)	3-way	1(1)	8(8)	9(9)	29(29)
154	MARLBOROUGH	MAPC	3	US 20 (Boston Post Road)	Boundary Street	4-way	0(2)	2(8)	2(10)	2(50)
155	MASHPEE	CCC	5	SR 28 (Falmouth Road)	Asher's Path East	4-way	2(3)	11(6)	13(9)	53(69)
156	MENDON	CMRPC	3	SR 140 (Cape Road)	Hartford Avenue	4-way	3(2)	9(18)	12(20)	72(60)
157	METHUEN	MVPC	4	SR 110 (Jackson Street)	Swan Street	4-way	0(1)	0(1)	0(2)	0(22)
162	METHUEN	MVPC	4	SR 113 (Pleasant Valley Street)	Howe Street	4-way	6(8)	26(27)	32(35)	152(195)
165	SOMERVILLE	MAPC	4	SR 38 (Mystic Avenue)	Temple Street	4-way	6(3)	18(9)	24(12)	144(72)
167	METHUEN	MVPC	4	SR 110 (Merrimack Street)	SR 113 (Pleasant Valley St)	4-way	2(1)	10(10)	12(11)	52(31)
169	MIDDLEBOROUGH	SRPEDD	5	SR 28 (East Grove Street)	SR 28 (West Grove Street)	4-way	8(3)	42(36)	50(39)	210(99)
170	MIDDLEBOROUGH	SRPEDD	5	SR 105 (South Main Street)	I-495 NB Ramps	3-way	2(5)	9(7)	11(12)	51(112)
171	MIDDLEBOROUGH	SRPEDD	5	SR 105 (South Main Street)	I-495 SB Ramps	3-way	0(0)	7(0)	7(0)	7(0)
172	MILFORD	MAPC	3	SR 140 (South Main Street)	Cape Road	4-way	1(3)	10(18)	11(21)	31(81)
173	MILFORD	MAPC	3	SR 16 (East Main Street)	Fortune Blvd.	4-way	2(6)	13(9)	15(15)	55(135)
176	MILLBURY	CMRPC	3	SR 122 (Grafton Road)	Mass Turnpike Ramps	3-way	1(1)	2(0)	3(1)	23(21)
181	NEW BEDFORD	SRPEDD	5	Coggeshall Street	I-195 WB Ramps	4-way	1(5)	14(6)	15(11)	35(111)
190	NORTH ADAMS	BCRPC	1	SR 2 (Mohawk Trail)	Barbour Street	3-way	2(2)	3(4)	5(6)	45(46)
195	NORTH ANDOVER	MVPC	4	SR 114 (Salem Turnpike)	SR 125 (Andover Street)	4-way	12(6)	23(16)	35(22)	275(142)
196	NORTH ANDOVER	MVPC	4	SR 114 (Salem Turnpike)	SR 125 (Andover Bypass)	4-way	7(6)	11(16)	18(22)	158(142)
197	NORTH ANDOVER	MVPC	4	SR 114 (Salem Turnpike)	SR 133 (Haverhill Street)	4-way	7(0)	11(9)	18(9)	158(9)
201	NORTH ATTLEBORO	SRPEDD	5	US 1 (East Washington Street)	Elm Street	4-way	1(3)	7(13)	8(16)	28(76)
204	NORTH READING	MAPC	4	SR 28 (Main Street)	North Street	4-way	4(4)	9(8)	13(12)	93(92)
207	NORTHAMPTON	PVPC	2	SR 10 (South Street)	Earle Street	3-way	0(0)	1(0)	1(0)	1(0)
210	NORTHAMPTON	PVPC	2	SR 5 & SR 10 (North King Street)	Big Y Driveway	3-way	0(0)	1(1)	1(1)	1(1)
211	NORTHBOROUGH	CMRPC	3	US 20 (Southwest Cutoff)	SR 9 EB Ramps	3-way	2(0)	3(2)	5(2)	45(2)
212	NORTHBOROUGH	CMRPC	3	US 20 (Southwest Cutoff)	Davis Street	4-way	2(1)	8(9)	10(10)	50(30)
213	NORTHBOROUGH	CMRPC	3	US 20 (Southwest Cutoff)	US 20 (West Main Street)	3-way	0(2)	4(2)	4(4)	4(44)
216	NORWELL	MAPC	5	SR 53 (Washington Street)	Grove Street	4-way	9(2)	19(11)	28(13)	208(53)
217	NORWELL	MAPC	5	SR 53 (Washington Street)	Jacobs Trail	4-way	1(0)	3(3)	4(3)	24(3)
219	ORLEANS	CCC	5	SR 6A (Cranberry Highway)	Eldridge Parkway	4-way	5(1)	8(2)	13(3)	113(23)
221	PALMER	PVPC	2	US 20 (North Main Street)	US 20 (Wilbraham Street)	4-way	2(0)	10(5)	12(5)	52(5)
222	PALMER	PVPC	2	SR 32 (Thorndike Street)	High Street	4-way	2(1)	3(13)	5(14)	45(34)
223	PALMER	PVPC	2	SR 32 (Thorndike Street)	Mass Turnpike Ramps	3-way	2(5)	12(10)	14(15)	54(115)
224	PEABODY	MAPC	4	SR 114 (Andover Street)	Cross Street	3-way	5(4)	14(5)	19(9)	119(89)
225	PEABODY	MAPC	4	Lowell Street	US 1 SB Ramps	4-way	2(3)	9(4)	11(7)	51(67)
227	PEMBROKE	OCPC	5	SR 53 (Columbia Road)	SR 53 (Washington Street)	4-way	8(2)	11(11)	19(13)	179(53)
229	PITTSFIELD	BCRPC	1	US 20 (West Housatonic Street)	Barker Road	4-way	4(1)	3(3)	7(4)	87(24)

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230	PITTSFIELD	BCRPC	1	US 20 (West Housatonic Street)	Lebanon Avenue	4-way	0(0)	2(1)	2(1)	2(1)
231	PITTSFIELD	BCRPC	1	SR 9 (Dalton Avenue)	Meadowview Drive	4-way	3(4)	9(5)	12(9)	72(89)
234	PITTSFIELD	BCRPC	1	US 20 (West Housatonic Street)	South Merriam Street	4-way	2(0)	2(3)	4(3)	44(3)
238	PLYMOUTH	OCPC	5	SR 80 (Plympton Road)	Commerce Way	4-way	1(1)	2(8)	3(9)	23(29)
244	REVERE	MAPC	4	SR 60 (Squire Road)	Charger Street	4-way	5(1)	3(3)	8(4)	108(24)
246	ROCKLAND	MAPC	5	SR 123 (Market Street)	Highland Street	4-way	1(3)	2(4)	3(7)	23(67)
247	ROWLEY	MVPC	4	US 1 (Newburyport Turnpike)	SR 133 (Haverhill Street)	4-way	6(9)	18(15)	24(24)	144(204)
250	SALEM	MAPC	4	SR 1A (Loring Avenue)	Jefferson Avenue	3-way	2(4)	8(12)	10(16)	50(96)
251	SALEM	MAPC	4	SR 1A (Loring Avenue)	Harrison Road	3-way	3(2)	2(3)	5(5)	65(45)
252	SALISBURY	MVPC	4	Toll Road	Main Street	4-way	8(5)	19(11)	27(16)	187(116)
257	SAUGUS	MAPC	4	Lynn Fells Parkway	US 1 NB Ramps	3-way	2(2)	1(0)	3(2)	43(42)
259	SHREWSBURY	CMRPC	3	US 20 (Hartford Tpk.)	South Street	4-way	4(2)	7(7)	11(9)	91(49)
260	SHREWSBURY	CMRPC	3	US 20 (Hartford Tpk.)	Cherry Street	4-way	2(1)	4(5)	6(6)	46(26)
261	SOUTHWICK	PVPC	2	SR 10 & US 202 (College Hwy)	SR 57 (Granville Road)	4-way	1(1)	8(5)	9(6)	29(26)
262	SOUTHWICK	PVPC	2	SR 10 & US 202 (College Hwy)	SR 57 (Feeding Hill Road)	3-way	2(2)	13(4)	15(6)	55(46)
264	SUDBURY	MAPC	3	US 20 (Boston Post Road)	Union Avenue	4-way	3(0)	10(9)	13(9)	73(9)
265	SUDBURY	MAPC	3	US 20 (Boston Post Road)	Nobscott Road	3-way	2(0)	8(5)	10(5)	50(5)
266	SUNDERLAND	FCDP	2	SR 47 (North Main Street)	SR 116 (Amherst Road)	4-way	1(1)	10(2)	11(3)	31(23)
269	SWANSEA	SRPEDD	5	US 6 (Grand Army Highway)	I-195 WB Ramps	3-way	3(5)	13(11)	16(16)	76(116)
270	SWANSEA	SRPEDD	5	US 6 (Grand Army Highway)	I-195 EB Ramps	3-way	2(3)	15(12)	17(15)	57(75)
272	TEWKSBURY	NMCOG	4	SR 38 (Main Street)	Shawsheen Street	4-way	4(5)	14(22)	18(27)	98(127)
273	TEWKSBURY	NMCOG	4	SR 38 (Main Street)	Pleasant Street	4-way	5(0)	7(8)	12(8)	112(8)
274	TEWKSBURY	NMCOG	4	SR 38 (Main Street)	I-495 SB Ramps	4-way	1(2)	1(3)	2(5)	22(45)
277	TEWKSBURY	NMCOG	4	SR 133 (Andover Street)	I-495 SB Ramps	4-way	2(0)	4(9)	6(9)	46(9)
279	TEWKSBURY	NMCOG	4	SR 133 (Andover Street)	I-495 NB Ramps	4-way	0(0)	4(3)	4(3)	4(3)
281	TEWKSBURY	NMCOG	4	SR 38 (Main Street)	Clarks Road	3-way	5(6)	28(27)	33(33)	133(153)
284	TEWKSBURY	NMCOG	4	SR 38 (Main Street)	Old Main Street	3-way	1(3)	10(17)	11(20)	31(80)
285	TEWKSBURY	NMCOG	4	SR 38 (Main Street)	Victor Drive	4-way	1(1)	1(1)	2(2)	22(22)
295	TYNGSBOROUGH	NMCOG	4	SR 113 (Pawtucket Blvd.)	SR 3A (Frost Road)	3-way	0(7)	1(10)	1(17)	1(157)
297	TYNGSBOROUGH	NMCOG	4	Westford Road	US 3 NB Ramps	3-way	3(4)	11(2)	14(6)	74(86)
298	WAKEFIELD	MAPC	4	Audubon Road	I-95 SB Ramps	4-way	1(0)	0(1)	1(1)	21(1)
305	WAREHAM	SRPEDD	5	SR 28 (Cranberry Highway)	Rosebrook Way (Lou Avenue)	3-way	0(5)	4(2)	4(7)	4(107)
307	WAREHAM	SRPEDD	5	SR 28 (Cranberry Highway)	Tobey Road	4-way	0(2)	4(5)	4(7)	4(47)
309	WAYLAND	MAPC	3	US 20 (Boston Post Road)	SR 27 & SR 126 (Cochituate Rd)	4-way	6(5)	24(35)	30(40)	150(140)
311	WELLESLEY	MAPC	6	Cedar Street	SR 9 EB Ramps	4-way	1(3)	14(28)	15(31)	35(91)

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317	PLYMOUTH	OCPC	5	Long Pond Road	SR 3 SB Ramps	3-way	5(1)	9(2)	14(3)	114(23)
318	PLYMOUTH	OCPC	5	Long Pond Road	SR 3 NB Ramps	3-way	14(3)	8(8)	22(11)	302(71)
319	WESTFIELD	PVPC	2	US 20 (East Main Street)	Little River Road	4-way	12(5)	13(21)	25(26)	265(126)
321	WESTFIELD	PVPC	2	US 20 (Springfield Road)	Union Street	3-way	5(4)	9(9)	14(13)	114(93)
322	WESTFIELD	PVPC	2	SR 10 & US 202 (Southampton Road)	Summit Lock Road	4-way	0(0)	2(1)	2(1)	2(1)
326	WESTFORD	NMCOG	3	SR 110 (Littleton Road)	Powers Road	3-way	1(2)	4(3)	5(5)	25(45)
331	WEYMOUTH	MAPC	6	SR 18 (Main Street)	Trotter Road	3-way	1(1)	5(12)	6(13)	26(33)
334	WEYMOUTH	MAPC	6	SR 18 (Main Street)	SR 58 (Pond Street)	4-way	11(0)	19(13)	30(13)	250(13)
335	WHATELY	FCDP	2	SR 5 & SR 10 (State Road)	SR 116 (Sunderland Road)	4-way	2(0)	5(6)	7(6)	47(6)
337	WILBRAHAM	PVPC	2	US 20 (Boston Road)	Post Office Park	4-way	3(2)	10(9)	13(11)	73(51)
338	WILBRAHAM	PVPC	2	US 20 (Boston Road)	Post Office Park, West Drwy	4-way	0(3)	1(7)	1(10)	1(70)
341	WILMINGTON	MAPC	4	SR 38 (Main Street)	SR 129 (Richmond Street)	4-way	6(10)	28(18)	34(28)	154(228)
343	WILMINGTON	MAPC	4	SR 38 (Main Street)	Clark Street	3-way	1(2)	8(4)	9(6)	29(46)
347	WILMINGTON	MAPC	4	SR 38 (Main Street)	SR 129 (Lowell Street)	3-way	3(1)	9(9)	12(10)	72(30)
349	WINCHENDON	MRPC	2	SR 12 (Spring Street)	SR 140 (Gardner Road)	3-way	4(3)	7(10)	11(13)	91(73)
351	WOBURN	MAPC	4	Washington Street	Cedar Street	4-way	3(1)	7(6)	10(7)	70(27)
353	WOBURN	MAPC	4	US 3 (Cambridge Street)	Country Club Road	4-way	0(0)	2(2)	2(2)	2(2)
354	WORCESTER	CMRPC	3	US 20 (SW Cutoff)	Greenwood Street	4-way	6(8)	16(32)	22(40)	142(200)
356	CANTON	MAPC	6	SR 138 (Turnpike Street)	Randolph Street	4-way	2(7)	13(24)	15(31)	55(171)
360	WORCESTER	CMRPC	3	Plantation Street	I-90 EB Off-Ramp	4-way	4(5)	12(11)	16(16)	96(116)
369	WRENTHAM	MAPC	5	SR 1A (South Street)	I-495 SB Ramps	3-way	4(2)	5(4)	9(6)	89(46)
371	YARMOUTH	CCC	5	SR 28	Berry Avenue	4-way	3(4)	5(4)	8(8)	68(88)
375	BOSTON	MAPC	6	SR 203 (Gallivan Boulevard)	Granite Avenue	4-way	19(2)	21(11)	40(13)	420(53)