Massachusetts HSIP

Implementation Plan

PREPARED FOR

massDOT
Massachusetts Department of Transportation

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Introduction

The purpose of the Federal Highway Administration (FHWA) Highway Safety Improvement Program (HSIP) is to reduce fatalities and serious injuries on all public roads. This core Federal-aid program distributes funding to the States for them to administer primarily on infrastructure safety projects. Massachusetts receives approximately $45 million in Federal HSIP funds every year, which are administered by the Massachusetts Department of Transportation (MassDOT).

MassDOT first submitted an HSIP Implementation Plan in 2021 by choice in order to reevaluate investment decisions and determine the most effective way to allocate HSIP funds. The Plan was updated in 2023 because MassDOT did not meet or make significant progress towards meeting the annual safety performance targets. These plans included a review of safety trends, historical HSIP project performance, estimation of future HSIP project benefits, and recommendations for improving the HSIP; this version is an update to that plan. The updated plan provides a status on actions recommended in the 2023 plan while identifying additional opportunities for improving the effectiveness of MassDOT's HSIP implementation. The plan begins with a review of recent safety performance to identify where MassDOT could focus their efforts. Following the review of statewide safety performance is a review of recent project effectiveness to determine what types of projects are most and least effective for MassDOT from both a safety performance and cost effectiveness standpoint. The plan then includes a summary of the potential benefits of planned State Transportation Improvement Program (STIP) projects for 2024 and 2025 which will include HSIP dollars, helping to determine what role the HSIP can play in helping MassDOT reach their safety targets. Finally, the plan includes a review of previous recommendations for MassDOT to improve the administration and effectiveness of the HSIP.

Massachusetts completed an update of their Strategic Highway Safety Plan (SHSP) in 2023. In this SHSP, Massachusetts adopted the Safe System Approach to guide transportation decision making. Figure 1 summarizes the principles and elements of the Safe System Approach. The SHSP's six core initiatives and 31 actions align with the approach. As such, the HSIP should be guided by the Safe System Approach as well.

Figure 1. Safe System Approach principles and elements.[1]

[1] https://safety.fhwa.dot.gov/zerodeaths/docs/FHWA_SafeSystem_Brochure_V9_508_200717.pdf

Safety Trends

To guide the Massachusetts HSIP into the future, it is important to look to the past and establish context for recent safety performance in the Commonwealth. The following sections review trends in fatal and suspected serious injuries resulting from traffic crashes in recent years. These measures will serve as a baseline against which MassDOT should consider the distribution of their safety funds. As of the time of this writing, the 2022 and 2023 crash data are not yet finalized and crashes may still be added, removed, or edited. The plots and analysis in this document reflect the current data obtained from MassDOT's Safety Data Tool IMPACT[2] as of August 8th, 2024.

Overall Crashes Per Year

Figure 2 shows the annual and five-year average number of fatal injuries in Massachusetts from 2015 to 2023. The five-year rolling average fatal injuries shown in Figure 2 indicates a recent increasing trend, primarily driven by abnormally high fatal injury frequency in 2021 and 2022; however, the lower number of fatalities observed in 2023 lowered the most recent five-year average, and 2024 year-to-date fatalities indicate a continuing reduction in the fatalities trend. The increase from 2020-2022 aligns with recent national trends, as national fatalities have risen from a recent low of 36,355 fatalities in 2019 to 39,007 in 2020 (7-percent increase), and to 43,230 in 2021 (~11-percent increase)[3]. In 2022, there were 42,514 fatalities, a nominal decrease from 2021. Further, the National Highway Traffic Safety Administration (NHTSA) published a projection of 40,990 fatalities for 2023, a 4-percent decrease from 2022[4]. This aligns with the trends in MA fatalities.

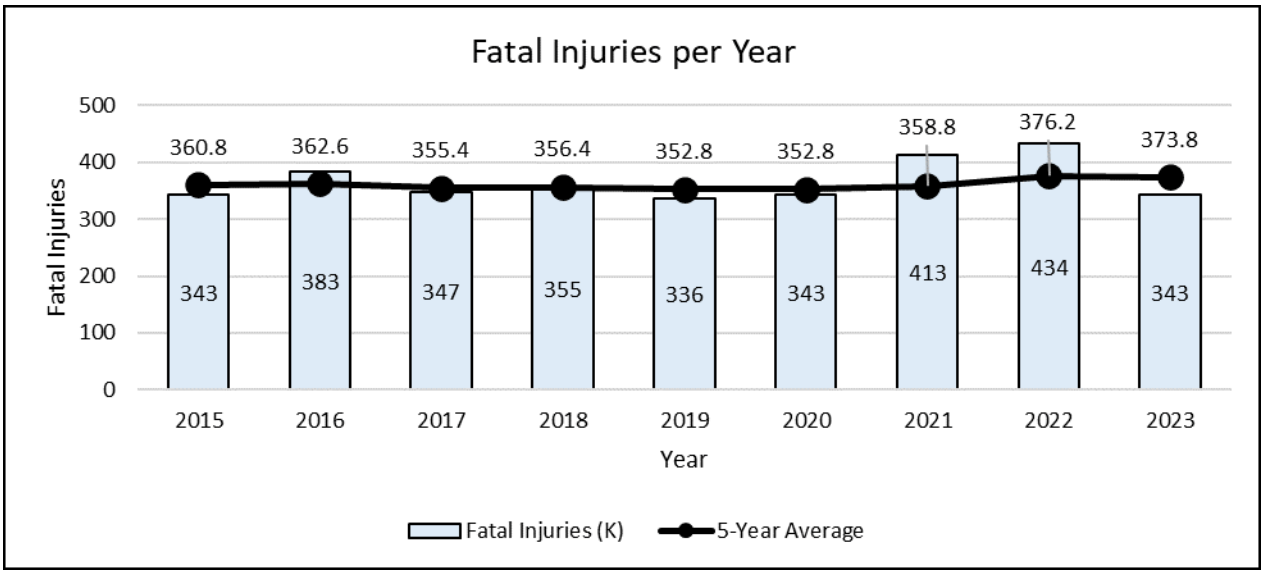

Figure 2. Fatal injury trend for Massachusetts from 2015 to 2023.

Figure 3 shows the annual and 5-year average number of suspected serious injuries in Massachusetts from 2015 to 2023. Massachusetts has seen a reduction in the 5-year average suspected serious injuries

[2] https://apps.impact.dot.state.ma.us/cdp/home
[3] https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/813435
[4] https://www.nhtsa.gov/press-releases/2022-traffic-deaths-2023-early-estimates#

from 3,264.6 in 2015 to 2,772.8 in 2023. However, there has been a recent year-over-year increase in annual suspected serious injuries since 2020, growing from 2,365 in 2020 to 2,903 in 2021, and 3,010 in 2022, which ended in 2023 when 2,850 serious injuries were reported[5]. This increase is also reflected in the increase in the 5-year average in 2022 and 2023, which represent the first increases in a 5-year average in recent years.

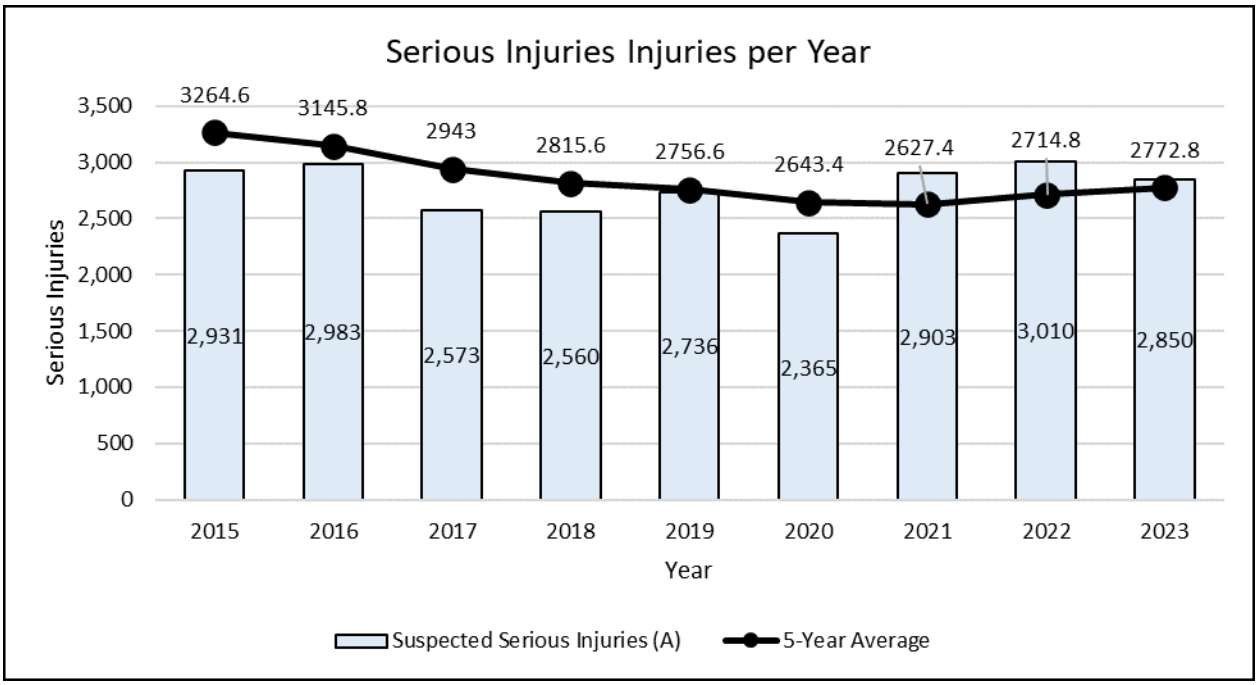

Figure 3. Suspected serious injury trend for Massachusetts from 2015 to 2023.

The recent increase in fatalities and suspected serious injuries indicates there is still much that can be done to improve road user safety. Massachusetts is striving to reverse these trends and produce reductions in fatalities and suspected serious injuries, in pursuit of MassDOT's goal of zero guided by the Safe System Approach. It is worth noting that, as of this writing[6], MassDOT observed reductions in fatal and serious injuries in 2023 and early trends in 2024 are indicating further reductions. Optimistically, this is the start of a trending decrease for those injuries in Massachusetts. The remainder of this section breaks down crash data to begin to identify potential areas of improvement.

[5] Preliminary as of May 29th, 2024.
[6] August 14, 2023

SHSP Emphasis Areas (EAs)

Massachusetts completed the third update of its SHSP in 2023 and is making progress on implementing many of the included strategies.[7] Framed within the context of the Safe System Approach, this SHSP did not explicitly include EAs; however, MassDOT members and stakeholders formed committees and conducted EA-focused meetings. Additionally, the IMPACT dashboard tracks the following EAs from the 2018 SHSP update:

- Lane Departure,
- Impaired Driving,
- Occupant Protection,
- Speeding and Aggressive Driving,
- Intersection Crashes,
- Pedestrians,
- Older Drivers,
- Motorcycle Crashes,
- Younger Drivers,
- Large Truck-Involved Crashes,
- Driver Distraction,
- Bicyclists,
- Safety of Persons Working on Roadways, and
- At-Grade Rail Crossings.

Figure 4 shows the 5-year average number of fatalities by SHSP EA for 2018 through 2022. MassDOT extracted these values from the IMPACT dashboard[8]. Lane departure crashes accounted for the highest average number of fatalities, while rail-highway grade crossings accounted for the fewest. Several factors (lane departure, impaired driving, occupant protection, and speeding related) accounted for more than 100 fatalities per year, while intersection related had an average of 96.0 fatalities. Note that these EAs are not mutually exclusive, so fatalities may be counted in multiple categories. For instance, a lane departure fatality involving an impaired driver who is unbelted would be counted in the "Lane Departure", "Impaired Driving", and "Occupant Protection" EAs.

[7] Massachusetts SHSP (2023 Update): https://www.mass.gov/doc/massachusetts-shsp-2023/download
[8] https://apps.impact.dot.state.ma.us/cdp/dashboard-view/24

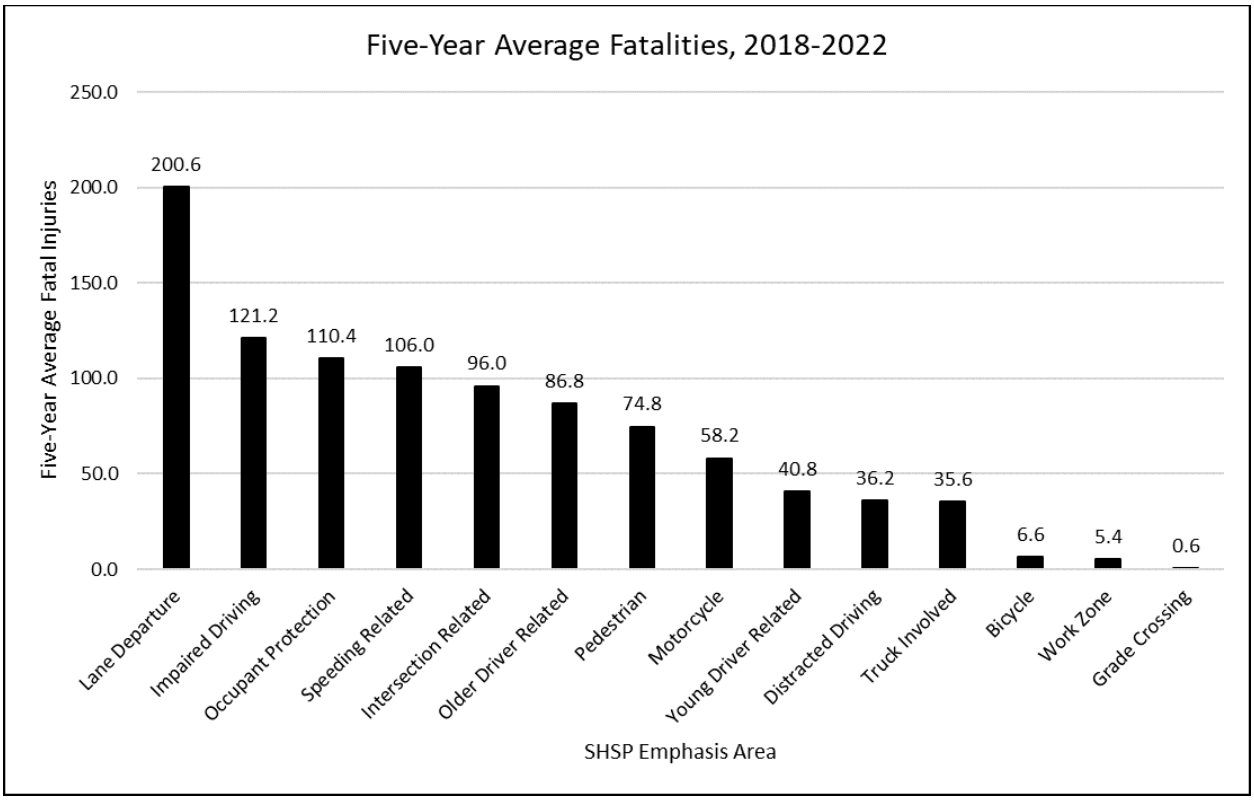

Figure 4. Annual average of fatal injuries from 2018 to 2022 by SHSP EA.

Figure 5 summarizes the 5-year average number of suspected serious injuries for 2018 through 2022—the most recent 5 years of published data on the IMPACT dashboard. Note that lane departure still accounts for a large proportion, but intersection related are the most common crashes. These are followed by older-driver related, occupant protection, and young-driver related crashes. Rail-highway grade crossing crashes account for the fewest suspected serious injuries.

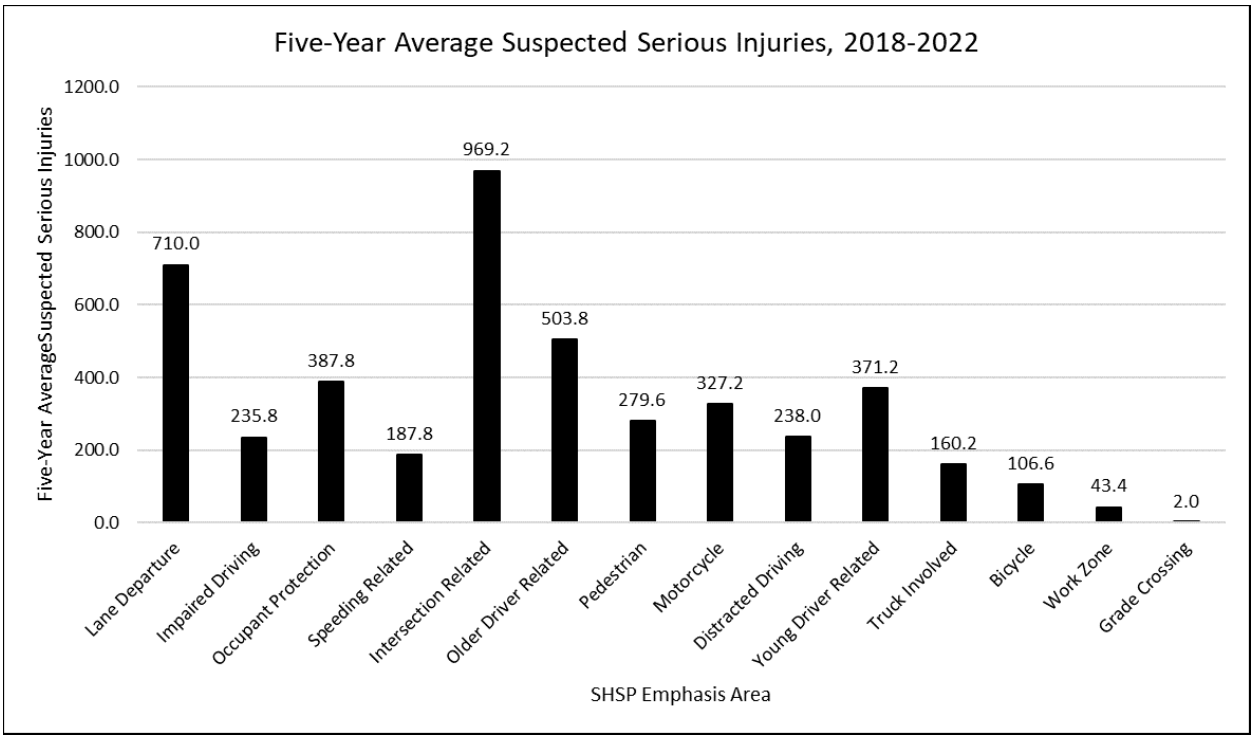

Figure 5. Annual average of suspected serious injuries from 2018 to 2022 by SHSP EA.

For ease of interpreting the annual crash trends associated with each EA, Figure 6 through Figure 14 organize the list of EAs into three groups, based loosely on the magnitude of the fatal injury trends over the 6-year period. The three groups are as follows:

- Group 1: Lane Departure Crashes, Impaired Driving, Intersection Crashes, Speeding and Aggressive Driving, and Occupant Protection.
- Group 2: Pedestrians, Older Drivers, Motorcycle Crashes, Young Drivers, Large Truck-Involved Crashes, and Driver Distraction.
- Group 3: Bicyclists, Safety of Persons Working on Roadways, and At-Grade Rail Crossings.

Note that the EAs are only divided into these groups to improve the ease of reading and interpreting the fatal and suspected serious injury trends in the figures below. It is important to keep in mind the interrelationships between the EAs. For instance, speeding is often a contributing factor in lane departure fatalities, so increases in speeding behaviors may be correlated with increases in fatal lane departure crash frequency. In this vein, note the differences in the scale of the plots when comparing trends for EAs shown in different plots. Additionally, it is important to realize that the suspected serious injury trend may be quite different than the fatal injury trend for the same EA. This may be for several reasons, including the increased randomness that a crash results in a fatality and the absence of a detailed investigation process for serious injury crashes (compared to that which occurs for fatal crashes). As such, the totals were combined in a later table for consideration of the total trends (see Table 1 and Table 2).

The first group of EAs resulted in, on average, the highest numbers of fatal injuries over the study period. Figure 6 shows the 5-year rolling average fatal injuries for each of the EAs in Group 1. Average lane departure crashes represent the leading cause of fatal injuries and unfortunately have shown a

small climb in recent years, from a low of 189.0 in 2019 to 200.6 in 2022. Average impaired driving fatalities have followed a similar trend, initially decreasing from approximately 124.0 in 2016 to approximately 113.4 in 2020, before rising to 121.2 in 2022. Average intersection-related fatalities have increased slightly yet consistently from 87.4 in 2017 to 96 in 2022. Speeding-related fatalities have, on average, remained fairly constant, but have climbed slightly from an average of 99 in 2017 to an average of 106 in 2022. Occupant protection crashes saw an increase in fatalities from 2016 to 2017, but otherwise have remained relatively stable. It is important to note that 2021 and 2022 are not yet closed, so these data are subject to change.

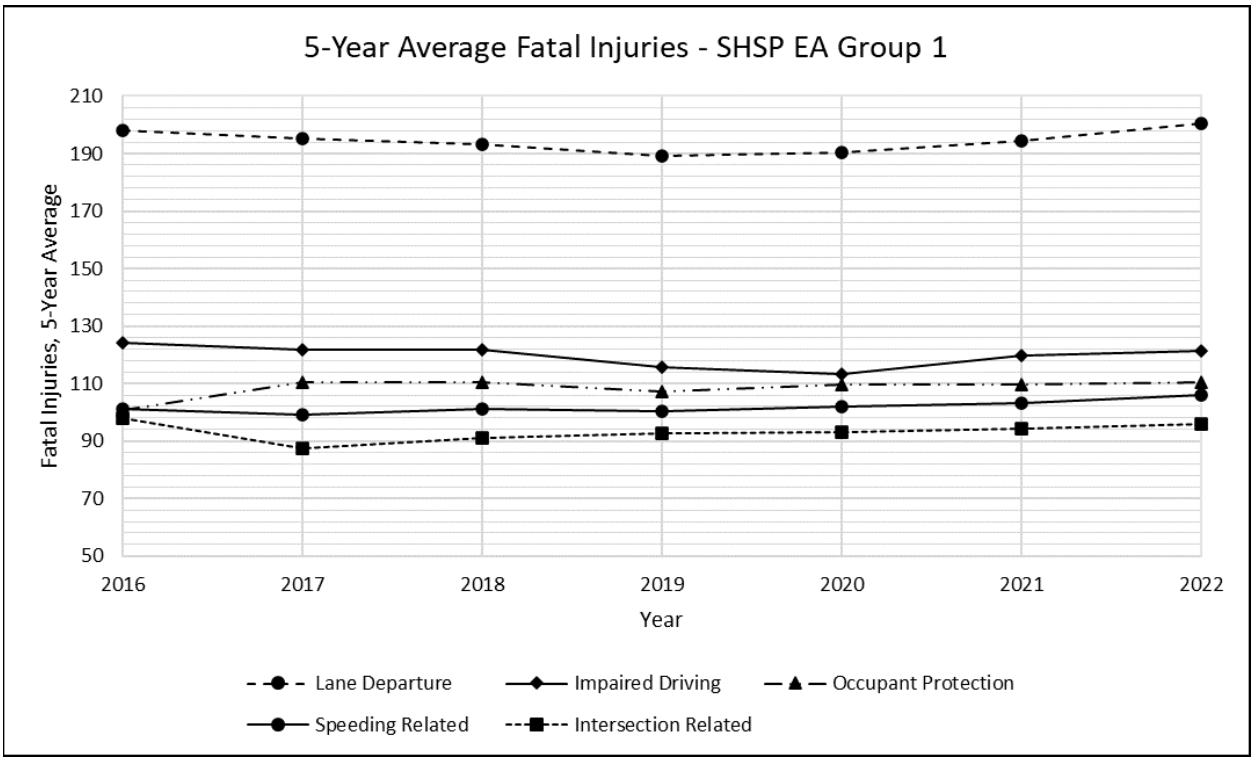

Figure 6. Five-year average fatal injuries by Group 1 Massachusetts SHSP EA.

The Group 1 trends are somewhat different for suspected serious injuries. Figure 7 shows the 5-year rolling average trends, indicating that intersection-related crashes, on average, resulted in the highest numbers of suspected serious injuries each year. This means that, while more of the fatal and suspected serious injuries occurring during this period were intersection-related, lane departure crashes produced a higher proportion of fatalities. While intersection-related suspected serious injuries declined from around 1,200 in 2016 to around 970 in 2022, the five-year average for lane departure jumped in 2021 and 2022 compared to previous years. Occupant protection and speeding-related suspected serious injuries saw slight declines on average, but slight increases in recent years. Impaired driving suspected serious injuries saw an increase since 2016, but this may be related to issues with crash reporting given that "Suspected Alcohol Use" and "Suspected Drug Use" are relatively new crash data fields and not all police use the updated crash reporting form. While the intersection-related trends are desirable, MassDOT would like to turn the other crash trends more downward moving forward.

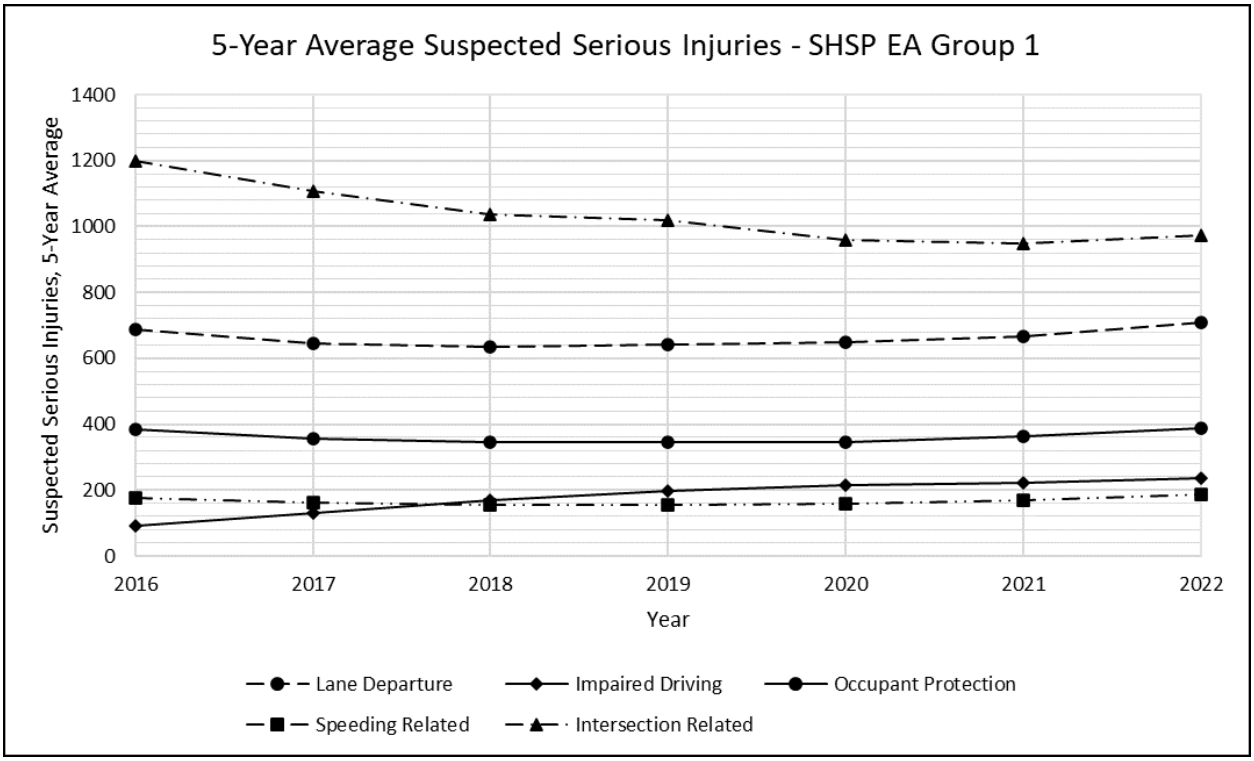

Figure 7. Five-year average suspected serious injuries by Group 1 Massachusetts SHSP EA.

Figure 8 shows the trends when fatalities and serious injuries are combined. These trends are driven primarily by suspected serious injuries, as they account for a large proportion of the total for each EA. Intersection related has largely shown a decreasing trend, while impaired driving has largely shown an increasing trend. The remaining emphasis areas – lane departure, occupant protection, and speeding related – have stayed relatively stable.

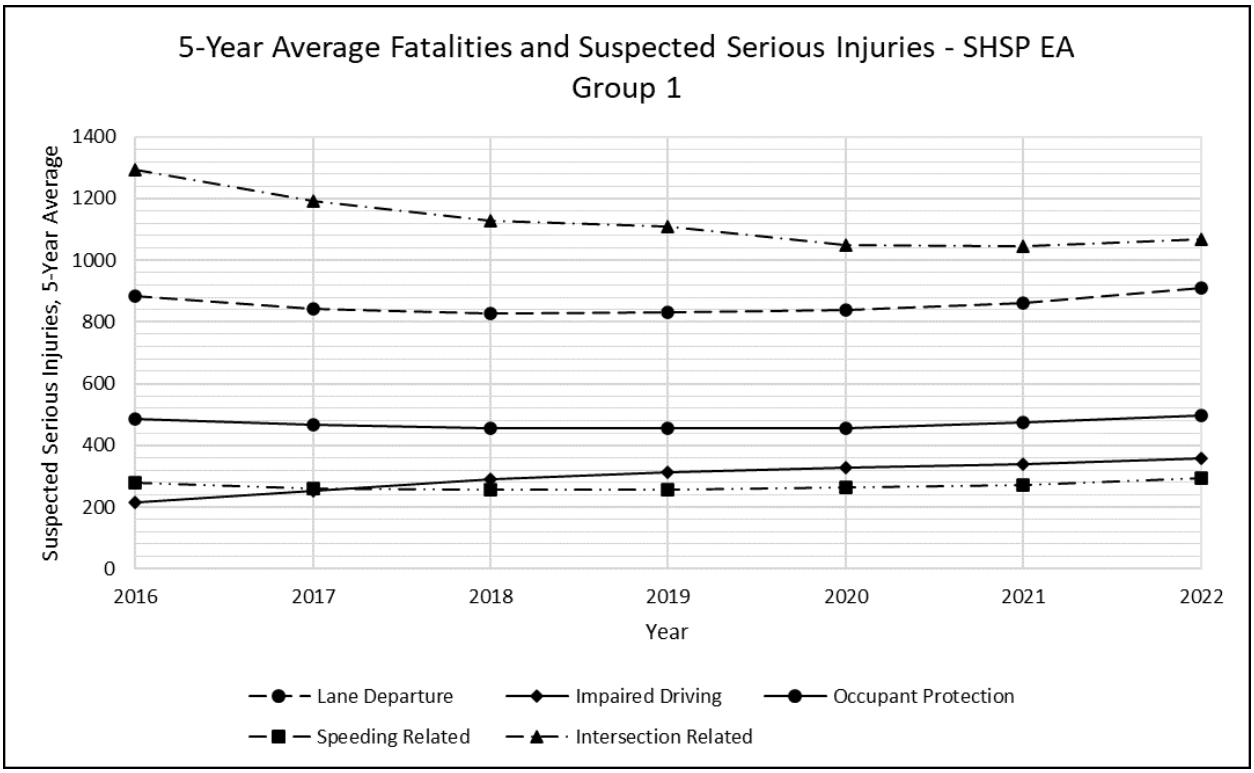

Figure 8. Five-year average fatalities and suspected serious injuries by Group 1 Massachusetts SHSP EA.

Figure 9 and Figure 10 show the 5-year rolling average injury trends for the second group of SHSP EAs (Pedestrians, Older Drivers, Motorcycle Crashes, Young Drivers, Large Truck-Involved Crashes, and Driver Distraction). Average pedestrian fatalities stayed relatively constant from 2016 to 2019, then declined to 71 in 2020 and climbed back toward 2016 levels in 2022. Similarly, average older driver-related fatalities dipped from 2016 to 2018, but then rose sharply in 2019 until 2022 at approximately 87 fatalities per year. Motorcyclist fatalities remained fairly constant over the period shown (around 50 fatalities per year) until 2021 and 2022 when fatalities increased to around 58 per year. Young driver-related crashes have remained fairly constant at around 40 fatalities per year. Truck-involved fatalities show a similar, constant trend from 2016 to 2022. Finally distracted driving fatalities remained relatively consistent until a noted reduction in 2020 to 2022; however, it is unclear how much this relates to changes in reporting processes. Additionally, annual counts for distracted driving fatalities has increased.

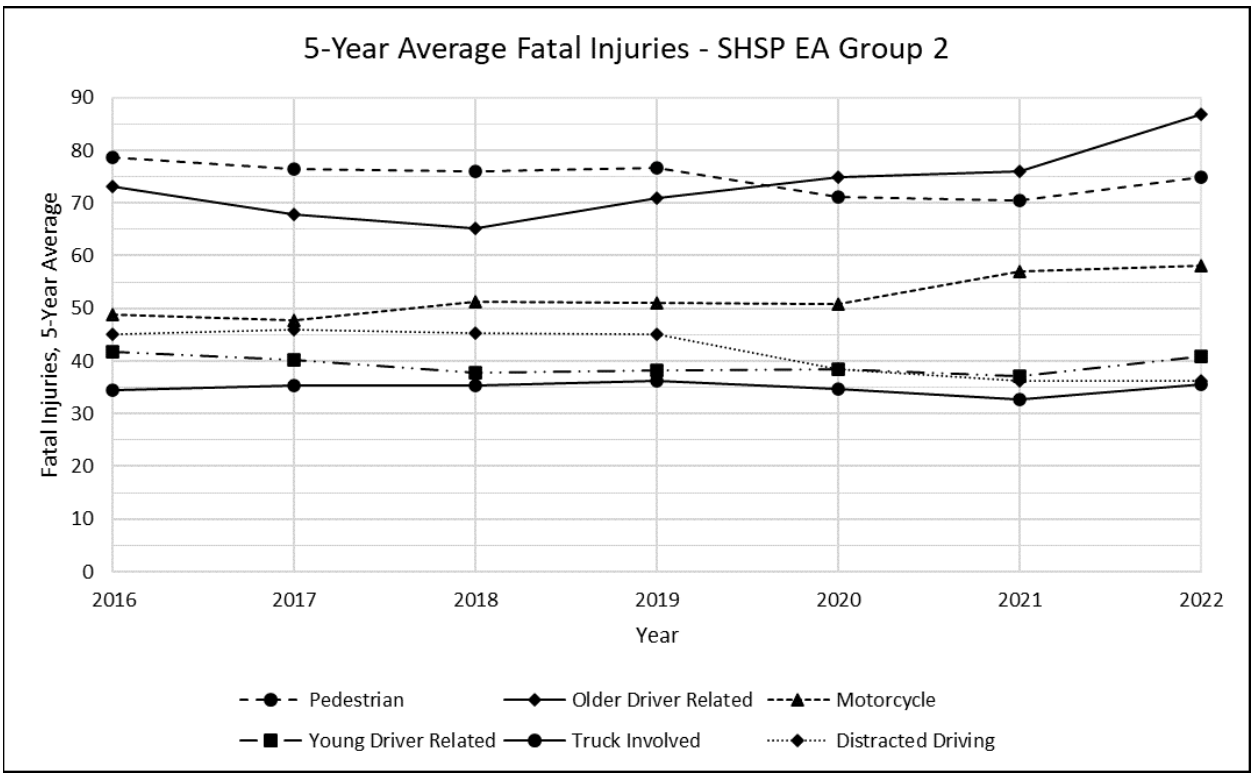

Figure 9. Five-year average fatal injuries by Group 2 Massachusetts SHSP EA.

In terms of suspected serious injury trends for the second group of EAs, average older driver-related suspected serious injuries showed a decreasing trend from 2016 to 2022. Average young driver-related suspected serious injuries showed a significant, consistent decline from approximately 452 in 2016 to approximately 353.6 in 2020, after which it took a slight upturn through 2022. Motorcyclist and pedestrian suspected serious injuries, on average, showed nearly identical trends, remaining fairly constant overall (just over 300 injuries per year) until 2020. In 2020 motorcyclist suspected serious injuries increased while pedestrian suspected serious injuries decreased. Average suspected serious injuries related to truck-involved crashes declined slightly over the period from around 176 in 2016 to around 160.2 in 2022. Distracted driving suspected serious injuries experienced a significant, consistent rise on average from around 133 in 2016 to 238 in 2022, but this is due to increased reporting of the behavior after addition of the field to the crash report, and the frequency remains fairly constant past 2019.

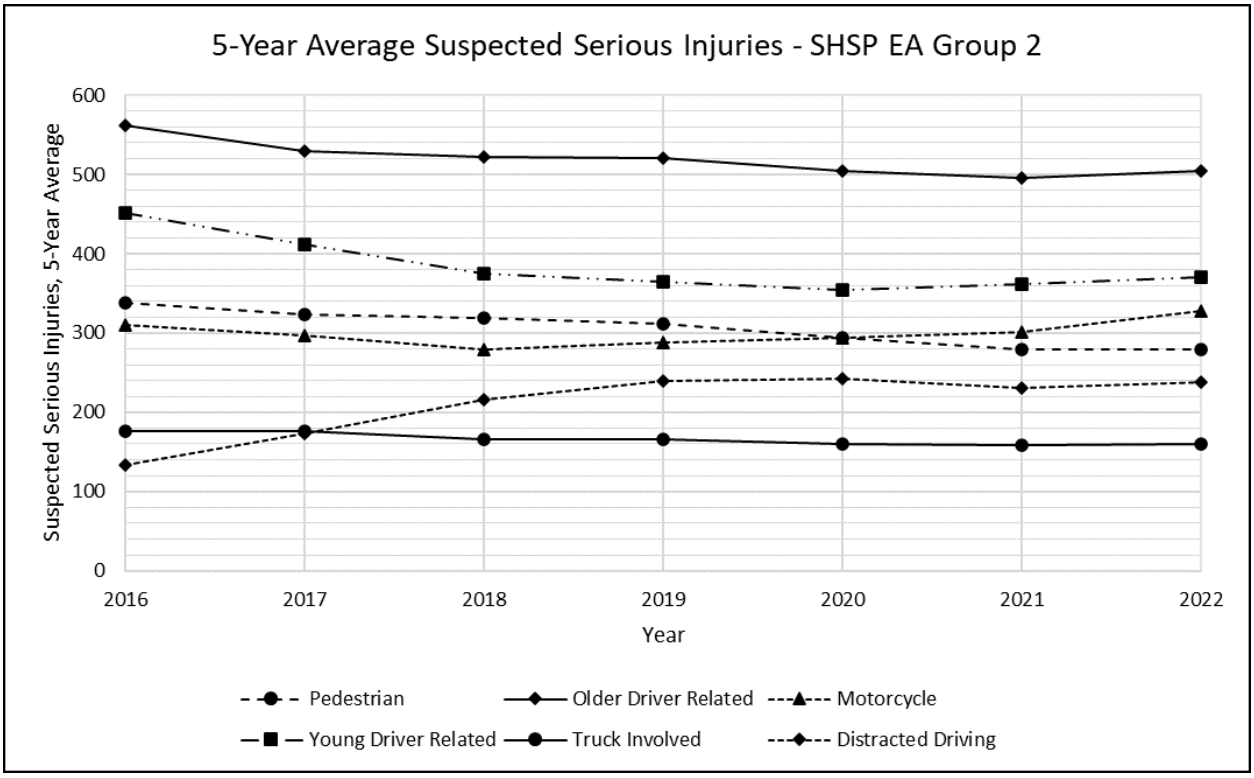

Figure 10. Five-year average suspected serious injuries by Group 2 Massachusetts SHSP EA.

Figure 11 shows the trends for combined fatalities and suspected serious injuries of Group 2 of the SHSP EAs. Overall, most EAs have remained relatively stable. Young-driver related saw a reduction from 2016 through 2020 but has leveled out since. Meanwhile, distracted driving increased from 2016 through 2019 and has stabilized since. Finally, pedestrian has slowly trended downward since 2016.

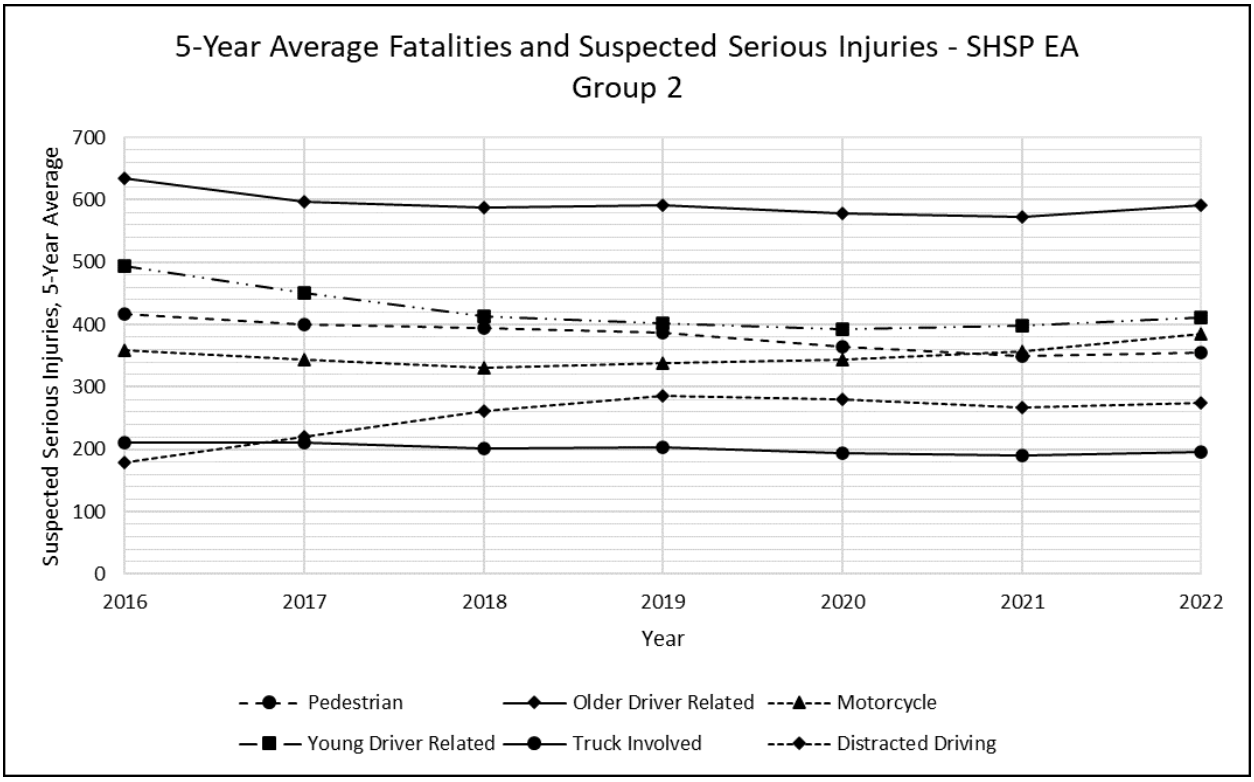

Figure 11. Five-Year average fatalities and suspected serious injuries by Group 2 Massachusetts SHSP EA.

The third group of EAs includes Bicyclists, Safety of Persons Working on Roadways, and At-Grade Rail Crossings. Figure 12 shows the 5-year rolling average fatalities for these three EAs. Average bicyclist fatalities have declined from around 10 fatalities in 2016 to around 7 fatalities in 2022. Work zone fatalities dipped substantially from 2016 to 2017 and then began to rise again from around three in 2017 to almost six in 2020 and they have stayed relatively constant through 2022. At-grade rail crossing fatalities remained very low, less than one per year on average, and fairly constant over the entire period.

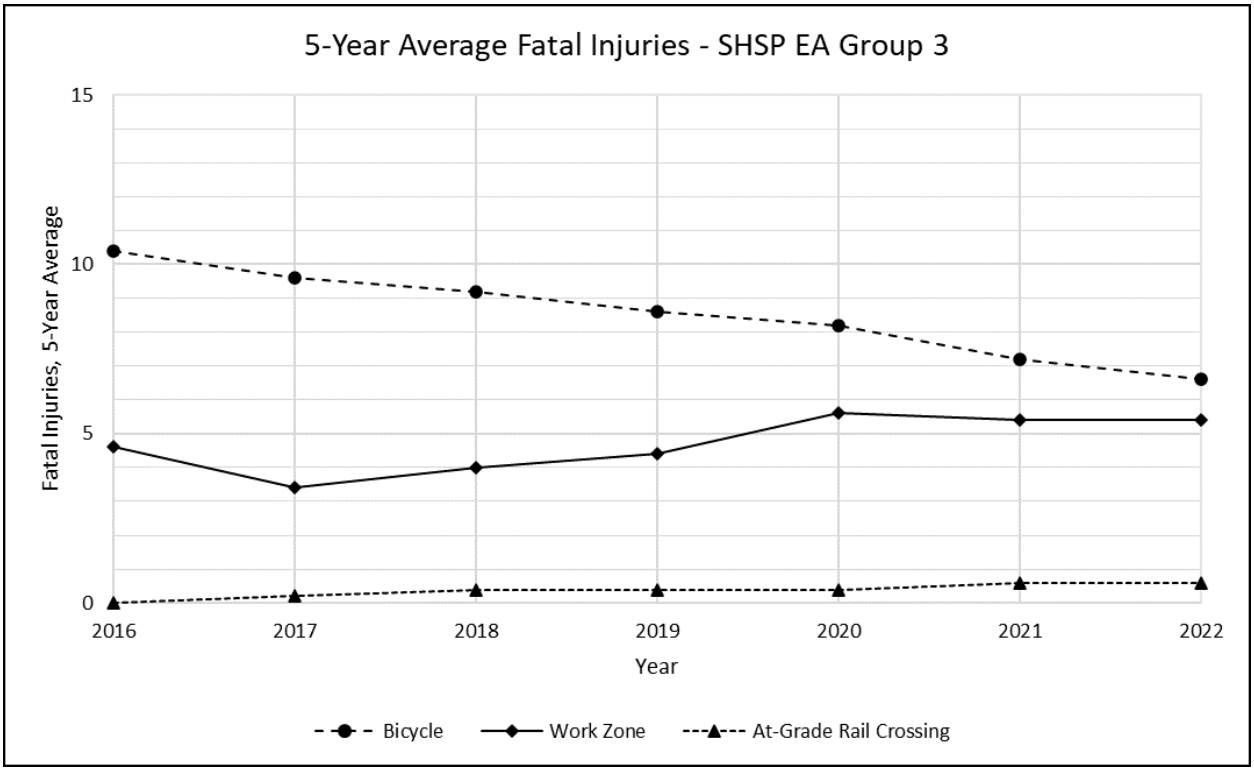

Figure 12. Five-year average fatal injuries by Group 3 Massachusetts SHSP EA.

Figure 13 shows the rolling average trends for suspected serious injuries for this third group of EAs. On average, suspected serious injuries for bicyclists began to steadily decrease from about 113 suspected injuries in 2016 to less than 100 in 2020 before rising again to about 106.6 in 2022. Work zone suspected serious injuries saw a similar decline on average, from around 66 in 2016 to around 43 in 2022. As with the fatality trend, at-grade rail crossing suspected serious injuries remained low and fairly constant, at around one to two injuries per year on average over the period shown.

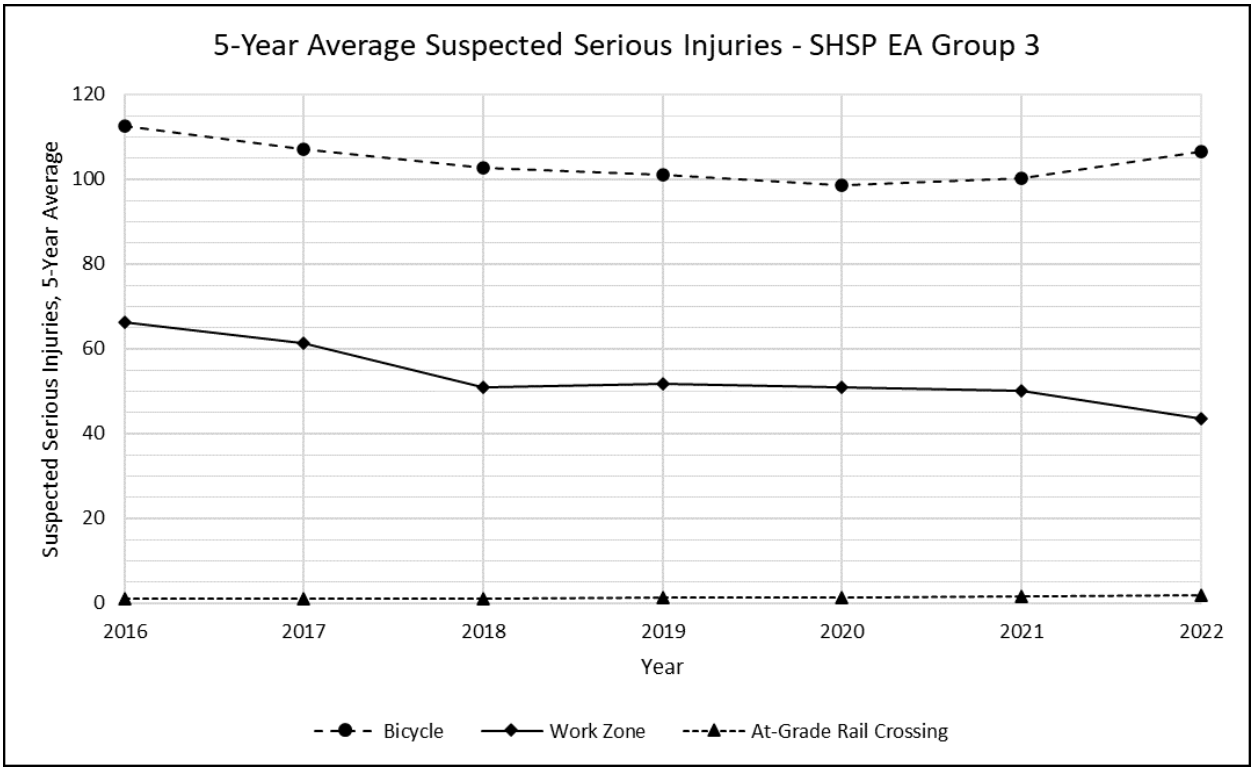

Figure 13. Five-year average suspected serious injuries by Group 3 Massachusetts SHSP EA.

Figure 14 shows the combined trends for fatalities and suspected serious injuries for EA Group 3. Note that bicycle fatalities and suspected serious injuries had been trending downwards before an uptick in 2022. Work zone fatalities and suspected serious injuries has consistently trended downward. The rail-crossing EA has too small of a sample to have a meaningful trend.

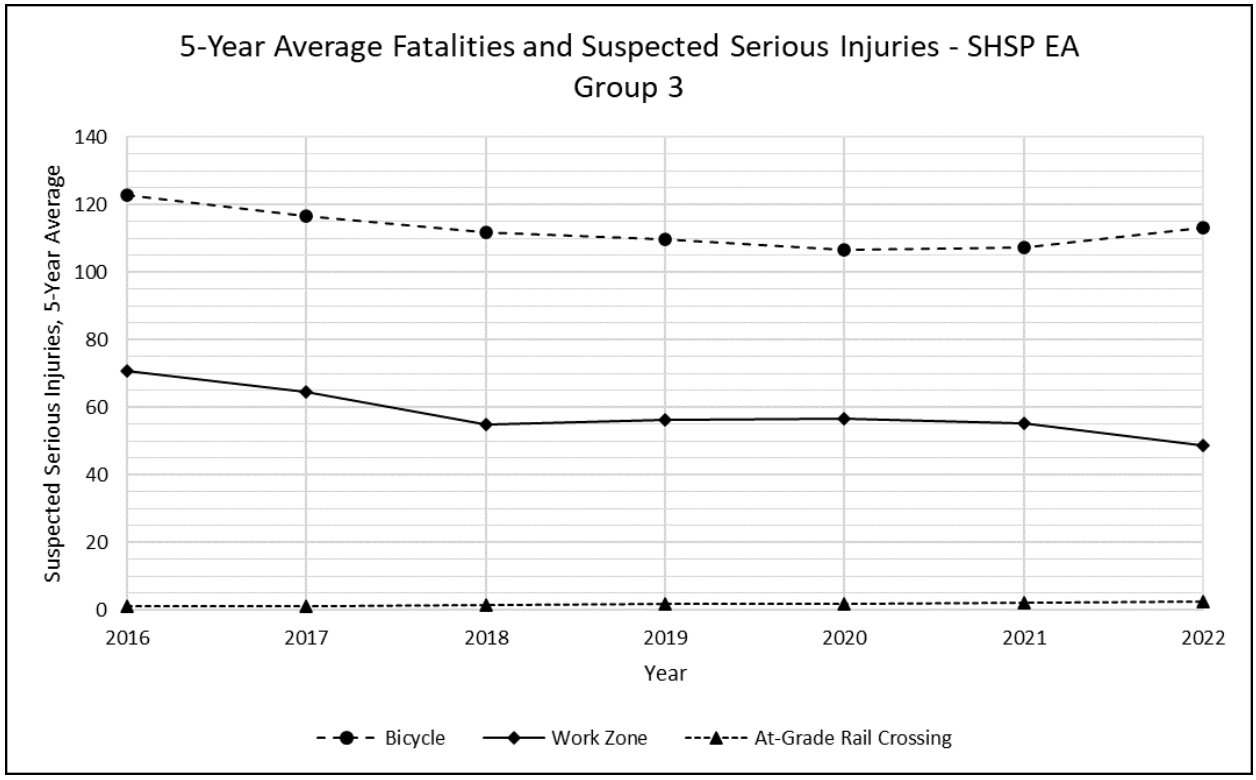

Figure 14. Five-year average fatalities and suspected serious injuries by Group 3 Massachusetts SHSP EA.

Table 1 shows a breakdown of the aggregate fatal and suspected serious injury distributions across all EAs from 2018 through 2022. Note that EAs are not mutually exclusive. For example, a given fatality could result from a crash that involved both speeding and lane departure. Therefore, the columns in Table 1 sum to more than 100 percent. The three EAs accounting for the highest proportions of fatalities and suspected serious injuries are intersection related, lane departure, and older driver related; this result is consistent with previous years.

Table 1. Percent of fatalities and suspected serious injuries for each Massachusetts SHSP EA for the period from 2018 to 2022.

SHSP EA	Percent Fatal Injuries	Percent Suspected Serious Injuries	Percent Fatal + Suspected Serious Injuries
Intersection Related	26%	36%	34%
Lane Departure	53%	26%	29%
Older Driver Related	23%	19%	19%
Occupant Protection	29%	14%	16%
Young Driver Related	11%	14%	13%
Impaired Driving	32%	9%	12%
Motorcyclist	15%	12%	12%
Pedestrian	20%	10%	11%
Speeding-Related	28%	7%	10%
Distracted Driving	10%	9%	9%
Truck Involved	9%	6%	6%
Bicyclist	2%	4%	4%
Work Zone	1%	2%	2%
At-Grade Rail Crossing	<1%	<1%	<1%

Table 2 summarizes the trends for fatalities and suspected serious injuries for each EA, focused primarily on 2020 through 2022 compared to previous years dating back to 2016. Fatalities and suspected serious injuries increased for several EAs compared to previous years, including lane departure, young driver, impaired driving, motorcycle, and bicyclist. On the other hand, pedestrian and work zone fatalities and suspected serious injuries have decreased from previous years. The remaining EAs have remained relatively flat.

Table 2. Summary of EA trends.

EA	Fatal and Suspected Serious Injury Trend
Intersection Related	Flat
Lane Departure	Increasing
Older Driver Related	Flat
Occupant Protection	Flat
Young Driver Related	Increasing
Impaired Driving	Increasing
Motorcyclist	Increasing
Pedestrian	Decreasing
Speeding-Related	Flat
Distracted Driving	Flat
Truck Involved	Flat
Bicyclist	Increasing
Work Zone	Decreasing
At-Grade Rail Crossing	Flat

There are three key takeaways from these results:

1. MassDOT has seen increasing trends in fatalities and suspected serious injuries for lane departure, young driver, impaired driving, motorcycle, and bicycle crashes. These are concerning trends that MassDOT should focus on reversing. There is likely correlation between lane departure and impaired driving, so addressing one should address the other.
2. MassDOT has observed decreasing trends in fatalities and suspected serious injuries for pedestrian and work zone crashes. MassDOT should review programs used to address these crashes to determine if similar strategies can be applied to other EAs.
3. The Infrastructure Investment and Jobs Act (IIJA) broadened the list of projects eligible for HSIP funds to include non-infrastructure projects, such as education and enforcement campaigns. This means that MassDOT will be able to use HSIP funds to support campaigns targeting behavioral crashes, such as impaired driving and distracted driving crashes. MassDOT can work with their partners at the Governor's Highway Safety Bureau to determine how to optimize funding for such campaigns. However, based on the distribution of fatal and suspected serious injuries by EA, MassDOT should focus HSIP funds on intersection, lane departure, speeding, and non-motorist crashes.

Geographic and Jurisdictional Distribution

One way to examine the geographic distribution of fatal and suspected serious injuries is to examine the jurisdiction responsible for the roads where the crashes occurred. As a comparison, MassDOT included the average distribution of vehicle miles traveled (VMT) based on the years 2019, 2020, 2021, and 2022, (available at MassDOT's VMT Data Viewer[9]). Where the proportion of fatal and/or suspected serious injuries was notably higher than the proportion of VMT, MassDOT considers those features overrepresented and thus should be considered for focused safety campaigns.

Jurisdiction

Figure 15 compares the 5-year average proportion of fatalities for 2019 through 2023 to the average proportional distribution of VMT for 2019 through 2022. The figure shows that City or Town roadways accounted for about half of the fatalities in the study period, which is overrepresented compared to the 44 percent distribution of VMT for which those roads account.

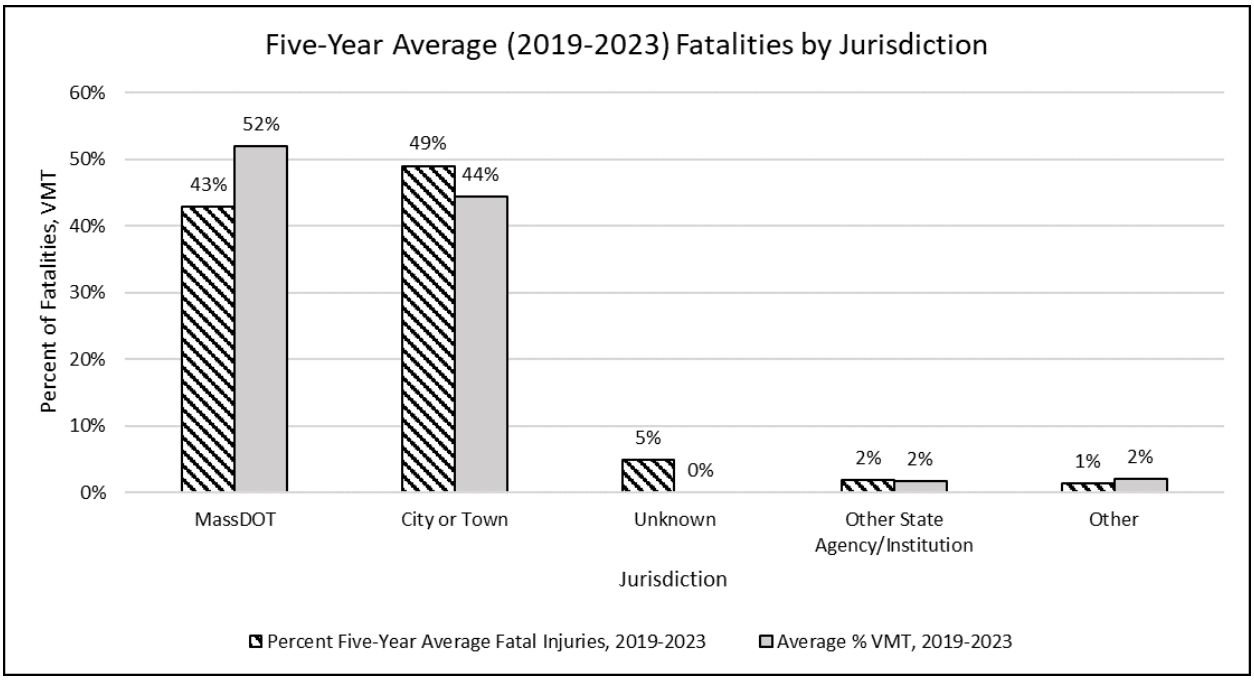

Figure 15. Five-year annual average fatal injuries by Massachusetts jurisdiction.

[9] https://gis.massdot.state.ma.us/dataviewers/vmt/

Similarly, Figure 16 summarizes the distribution of suspected serious injuries by jurisdiction compared to the VMT distribution. This plot also shows City or Town roads accounting for the majority of suspected serious injuries, though in this case, the overrepresentation is even more pronounced, as those roads account for 63 percent of suspected serious injuries compared to just 44 percent of VMT.

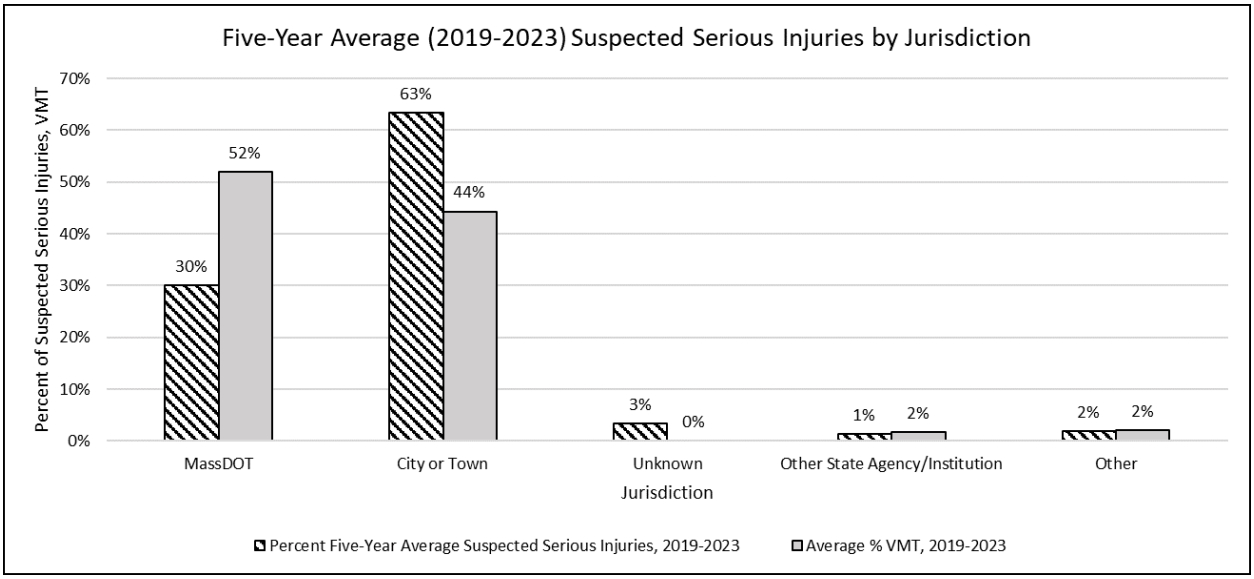

Figure 16. Five-year annual average suspected serious injuries by Massachusetts jurisdiction.

Table 3 shows a breakdown of the aggregate fatal and suspected serious injury distributions across the different jurisdiction types for 2019 through 2023. Cities and towns account for the majority of fatal and suspected serious injuries, with MassDOT coming in second highest. All other jurisdictions make up a very small percentage of fatalities and suspected serious injuries. When compared to VMT, it is noteworthy that the proportion of fatalities and suspected serious injuries on City or Town roads is 18-percent higher than the proportion of VMT, indicating overrepresentation on those roadways. These results reinforce the need for MassDOT to address safety on all public roads, not just those under MassDOT's jurisdiction.

Table 3. Percent of fatalities and suspected serious injuries for each jurisdiction for the period from 2019 to 2023.

Jurisdiction of Roadway	Percent Fatal Injuries	Percent Suspected Serious Injuries	Percent Fatal + Suspected Serious Injuries	Percent VMT[10]
City or Town	49%	63%	62%	44%
MassDOT	43%	30%	32%	52%
Unknown	5%	3%	4%	0%
Other State Agency	2%	1%	1%	2%
Other	1%	2%	2%	2%

[10] https://gis.massdot.state.ma.us/dataviewers/vmt/

MassDOT Districts

One can also view the distribution of severe crashes by MassDOT's six Districts, shown geographically in Figure 17.

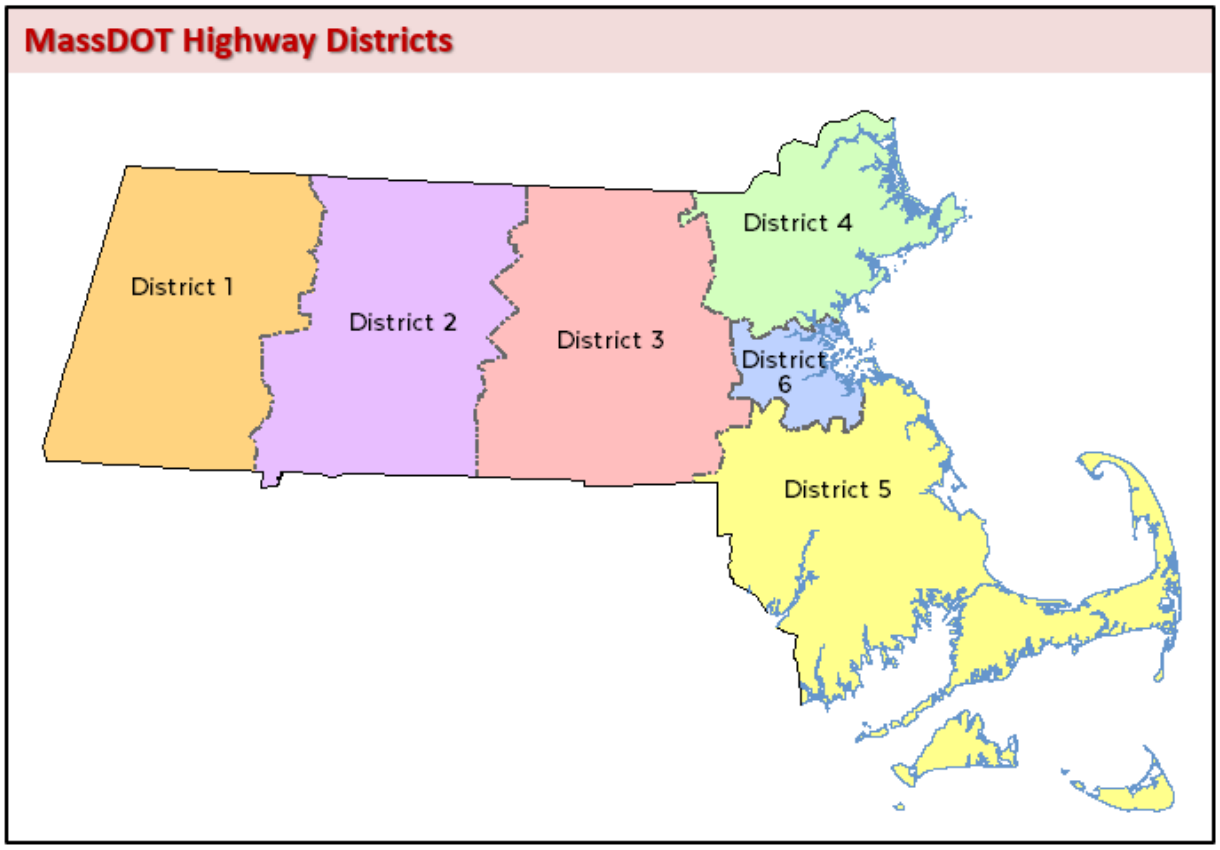

Figure 17. Map displaying MassDOT's highway districts. Source: Massachusetts Bureau of Geographic Information.[11]

Figure 18 and Figure 19 illustrate the five-year average fatal and suspected serious injury distributions across each of the Districts from 2019 through 2023. For both measures, District 5 (southeastern Massachusetts) has the largest proportion of injuries, while District 1 has the lowest. Two additional noteworthy findings are that District 2 accounts for 17 percent of fatalities, but only 12 percent of suspected serious injuries; while District 4 accounts for 19 percent of fatalities but 26 percent of suspected serious injuries. Generally, the proportional distribution of injuries and VMT are similar, but the proportion of fatalities in District 2 is 7-percent higher than the proportion of VMT.

[11] https://www.mass.gov/info-details/massgis-data-massdot-highway-districts

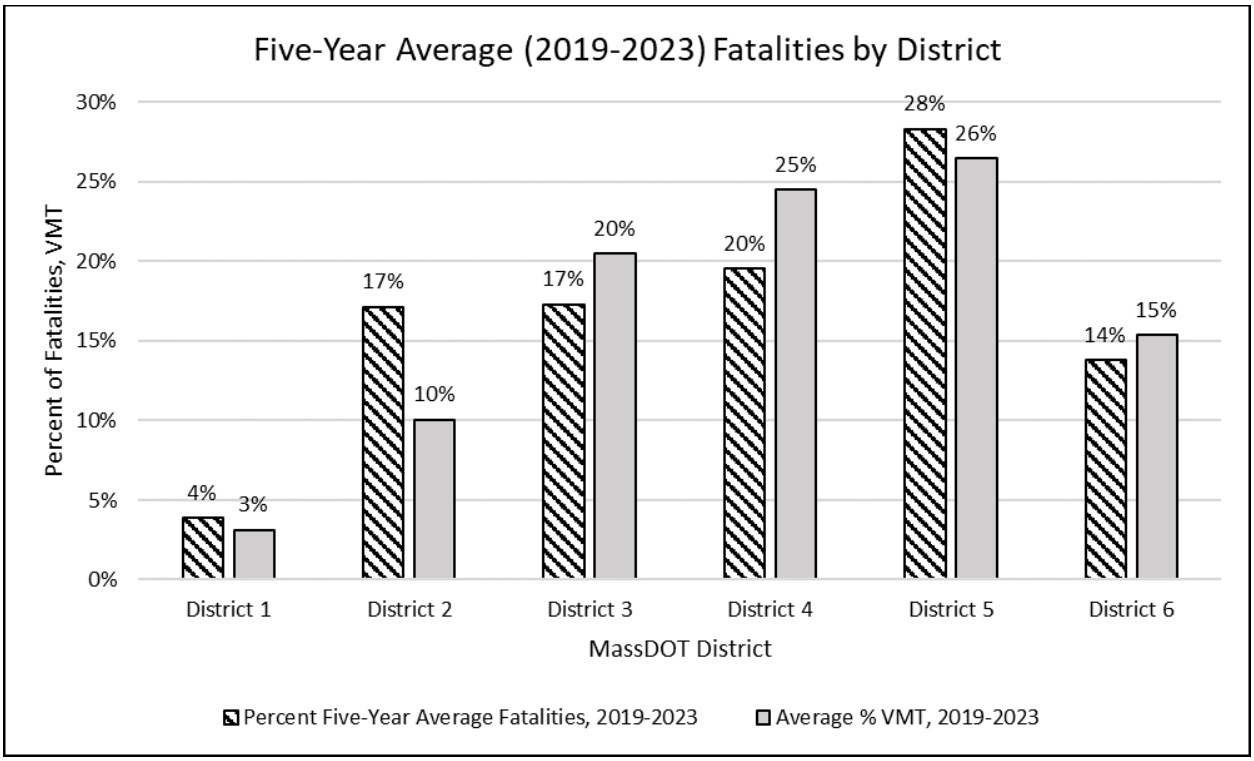

Figure 18. Five-year annual average fatal injuries by MassDOT District.

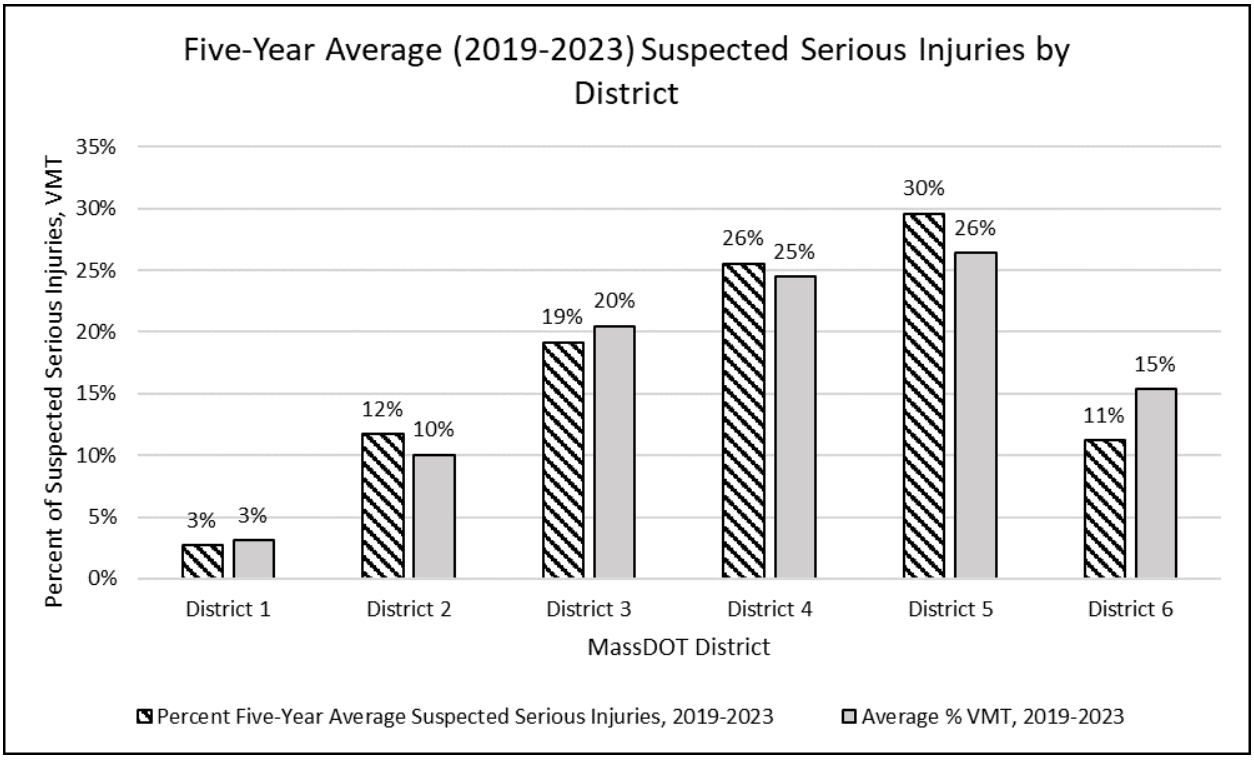

Figure 19. Five-year annual average suspected serious injuries by MassDOT District.

Table 4 shows a breakdown of the aggregate fatal and suspected serious injury distributions across the Districts for the 5-year period (2019-2023). District 5 accounts for the highest proportion of fatal and suspected serious injuries (29 percent), District 4 the second highest (25 percent), while District 1 accounts for the lowest proportion (3 percent). There is little discordance between the distribution of fatalities and serious injuries and VMT, with the largest difference between the two being 3 percent (Districts 5 and 6). As such, no districts are notably overrepresented with regards to the combined sum of fatal and suspected serious injuries.

Table 4. Percent of fatalities and suspected serious injuries for each MassDOT District for the period from 2019 to 2023.

MassDOT District	Percent Fatal Injuries	Percent Suspected Serious Injuries	Percent Fatal + Suspected Serious Injuries	Percent of VMT (2019-2023)
District 1	4%	3%	3%	3%
District 2	17%	12%	12%	10%
District 3	17%	19%	19%	20%
District 4	20%	26%	25%	25%
District 5	28%	30%	29%	26%
District 6	14%	11%	12%	15%

Regional Planning Agencies

Massachusetts has 13 regional planning agencies (RPAs), which are multi-jurisdictional regional planning organizations. The RPAs, shown in Figure 20, are:

- Berkshire Regional Planning Commission (BRPC).
- Cape Cod Commission (CCC).
- Central Massachusetts Regional Planning Commission (CMRPC).
- Franklin Regional Council of Governments (FRCOG).
- Metropolitan Area Planning Council (MAPC).
- Montachusett Regional Planning Commission (MRPC).
- Martha's Vineyard Commission (MVC).
- Merrimack Valley Planning Commission (MVPC).
- Northern Middlesex Council of Governments (NMCOG).
- Nantucket Planning and Economic Development Commission (NPEDC).
- Old Colony Planning Council (OCPC).
- Pioneer Valley Planning Commission (PVPC).
- Southeastern Regional Planning and Economic Development District (SRPEDD).

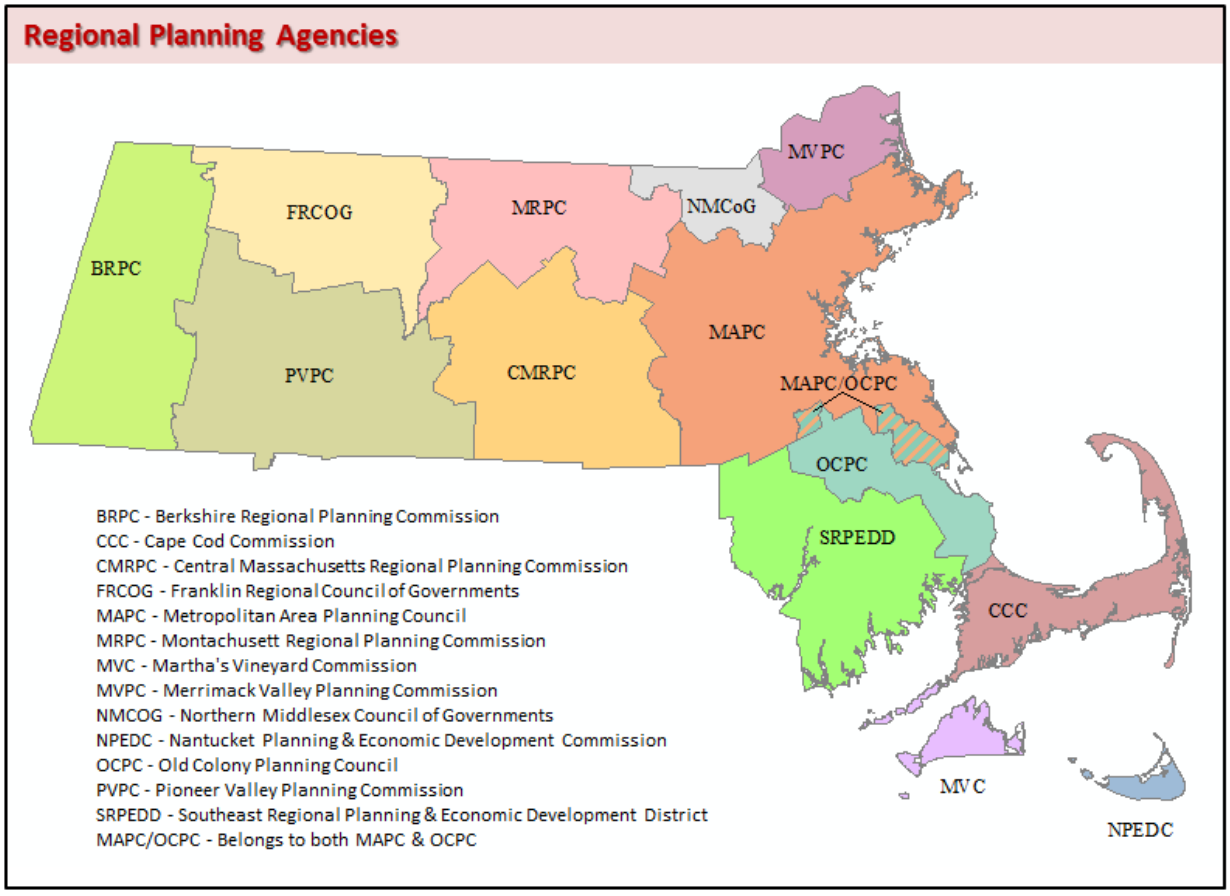

Figure 20. Map displaying Massachusetts RPAs.

Figure 21 shows the distribution of the 5-year average number of fatalities for 2019 through 2023 by RPA; VMT is included as a comparison. The MAPC accounts for the highest proportion of fatalities (32 percent), while the MVC and NPEDC account for the lowest (less than 1 percent). Notably, the PVPC was overrepresented, accounting for 15 percent of fatalities compared to just 9 percent of VMT.

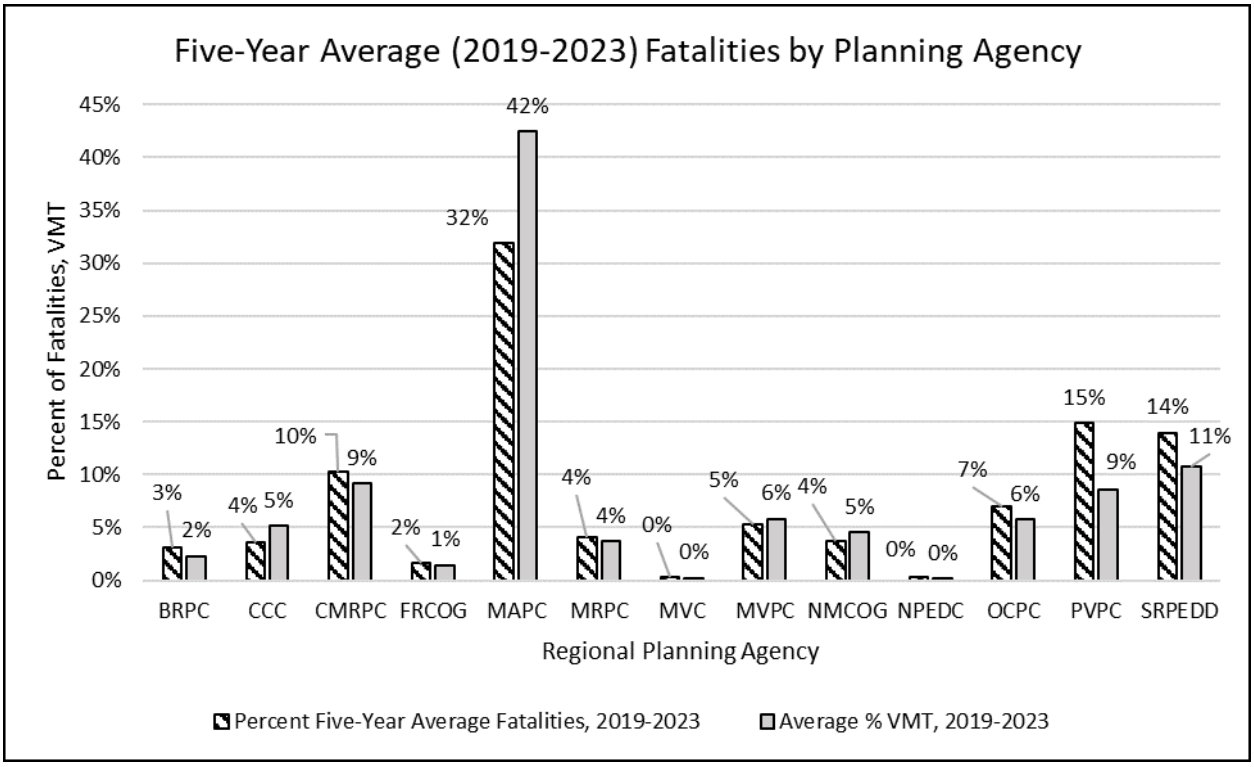

Figure 21. Five-year annual average of fatal injuries from 2019 to 2023 by regional planning agency.

Similarly, Figure 22 summarizes the distribution of suspected serious injuries and VMT by RPA. Again, the MAPC accounts for the highest proportion of injuries (36 percent) while the MVC and NRPED account for the lowest (less than 1 percent). No RPAs were notably overrepresented compared to VMT.

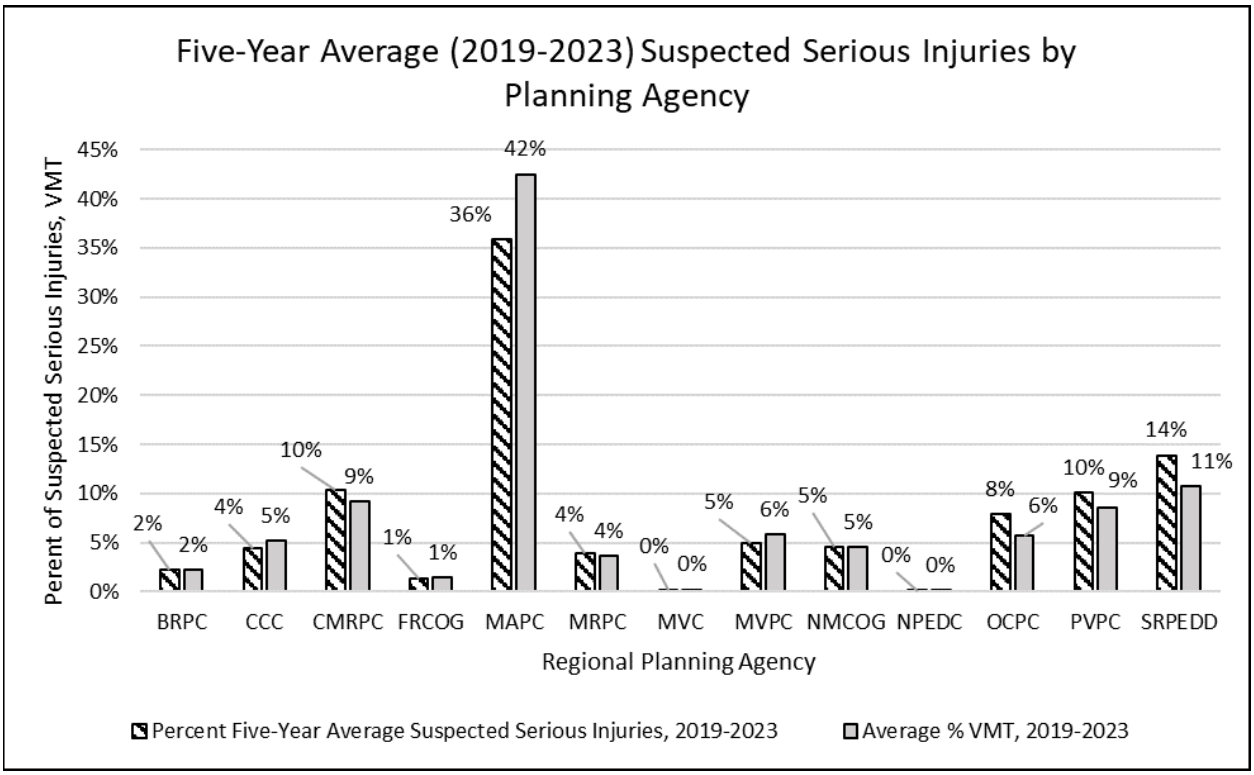

Figure 22. Five-year annual average of suspected serious injuries from 2019 to 2023 by regional planning agency.

Table 5 shows a breakdown of the aggregate fatal and suspected serious injury distributions across the RPAs for 2019 through 2023. Combined, the MAPC accounts for the largest proportion of fatal and suspected serious injuries (35 percent), while the MVC and NPEDC account for the lowest proportion (less than 1 percent). The SRPEDD is the only MPO notably overrepresented, accounting for 14 percent of fatal and suspected serious injury crashes compared to 11 percent of VMT. The proportion of injuries in the MAPC is underrepresented with 7 percent fewer suspected serious injuries than the proportion of VMT.

Table 5. Percent of fatalities and suspected serious injuries for each Massachusetts RPA for the period from 2019 to 2023.

Massachusetts RPA	Percent Fatal Injuries	Percent Suspected Serious Injuries	Percent Fatal + Suspected Serious Injuries	Percent of VMT
BRPC	3%	2%	2%	2%
CCC	4%	4%	4%	5%
CMRPC	10%	10%	10%	9%
FRCOG	2%	1%	1%	1%
MAPC	32%	36%	35%	42%
MRPC	4%	4%	4%	4%
MVC	<1%	<1%	<1%	<1%
MVPC	5%	5%	5%	6%
NMCOG	4%	5%	4%	5%
NPEDC	<1%	<1%	<1%	<1%
OCPC	7%	8%	8%	6%
PVPC	15%	10%	11%	9%
SRPEDD	14%	14%	14%	11%

Area Type

One final way to look at the geographic distribution of fatal and suspected serious injuries in Massachusetts is to examine the split between crashes in urban areas and rural areas. Figure 23 compares the distribution of the 5-year average fatalities for 2019 through 2023 by area type to the distribution of VMT. The overwhelming majority of fatalities occurred on urban roads (90 percent), though this proportion is underrepresented compared to the proportion of VMT (95 percent). Note that 2022 and 2023 are not closed years of crash data. As such, several crashes are still not geocoded leading to them being classified as "Unknown" for area type.

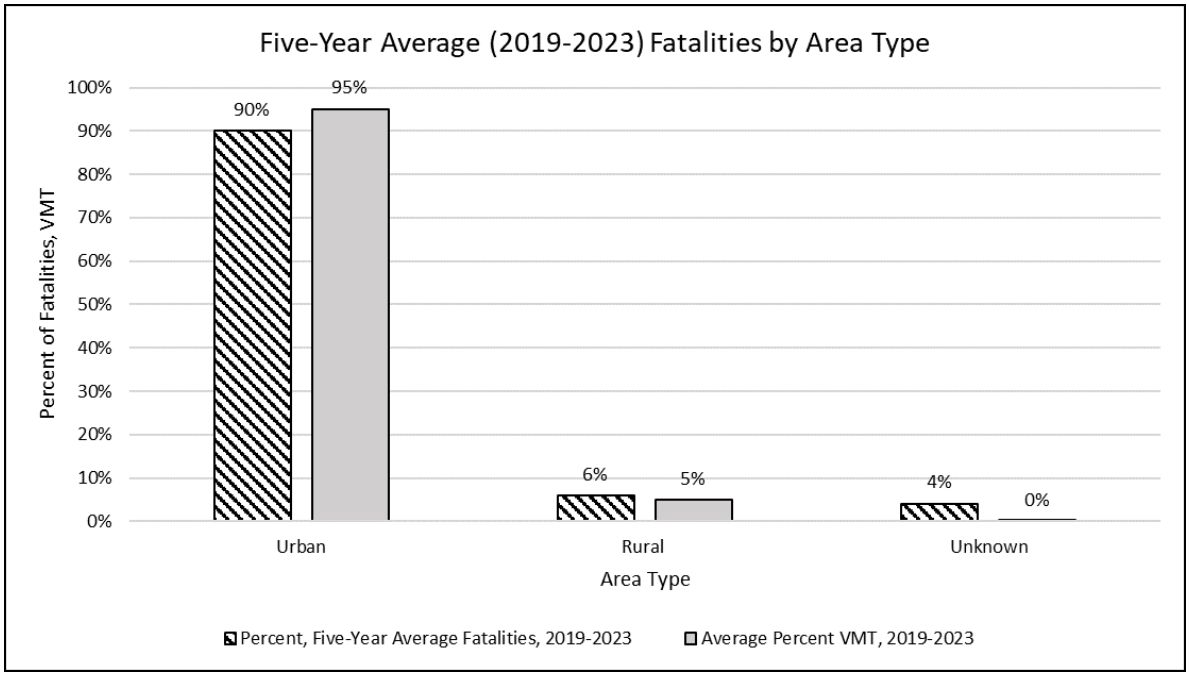

Figure 23. Five-year annual average fatal injuries by area type, 2019-2023.

Figure 24 compares the distribution of suspected serious injuries by area type to the distribution of VMT for the years 2019 through 2023. Note that the distributions are nearly identical, with 93 percent of suspected serious injuries occurring on urban roadways compared to 95 percent of VMT.

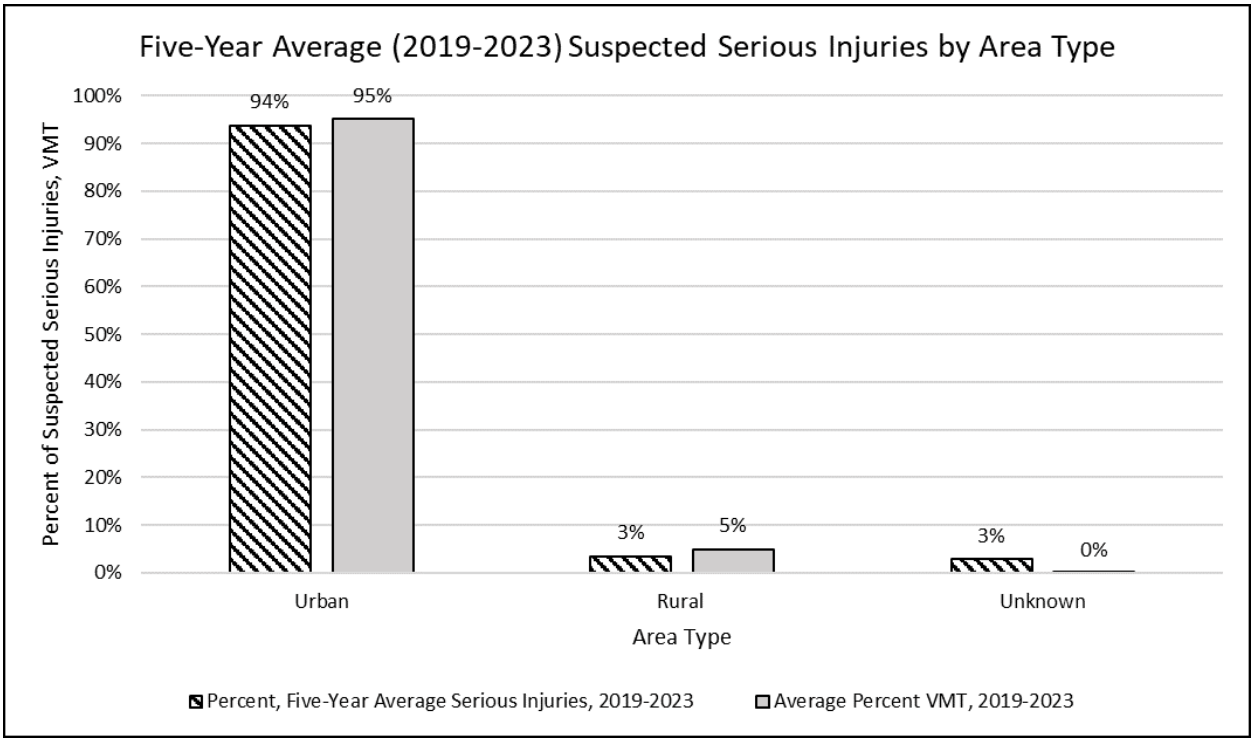

Figure 24. Five-year annual average suspected serious injuries by area type.

Table 6 shows a breakdown of the aggregate fatal and suspected serious injury distributions for rural and urban area types for 2019 through 2023. The distribution of injuries and VMT by area type are nearly identical, with 93 percent of injuries and 95 percent of VMT occurring on urban roads, and 4 percent of injuries and 5 percent of VMT on rural roads.

Table 6. Percent of fatalities and suspected serious injuries by area type for the period from 2019 to 2023.[12]

Area Type	Percent Fatal Injuries	Percent Suspected Serious Injuries	Percent Fatal + Suspected Serious Injuries	Percent of VMT
Rural	6%	3%	4%	5%
Urban	90%	94%	93%	95%
Unknown	4%	3%	3%	0%

[12] This table presents absolute totals and is not normalized against area type mileage.

Manner of Collision

The "Manner of Collision" field provides detail on the type of crash and can help to identify potential mitigation strategies. Figure 25 and Figure 26 present the annual breakdown by manner of collision for both fatal and suspected serious injuries in Massachusetts. In both figures, single-vehicle crashes represent the highest number of injuries, though this is somewhat more pronounced for the fatal injuries shown in Figure 25. Note that in MassDOT crash data, single-vehicle crashes include a wide range of crashes, including those involving lane departures, striking fixed objects, as well as collisions in which vehicles strike vulnerable road users.

For fatal injuries, head-on crashes result in the second-highest number of fatalities, followed closely by angle crashes, then rear-end, other/unknown, and sideswipe crashes. Most of these crash types have stayed relatively consistent in terms of fatal injuries over the study period.

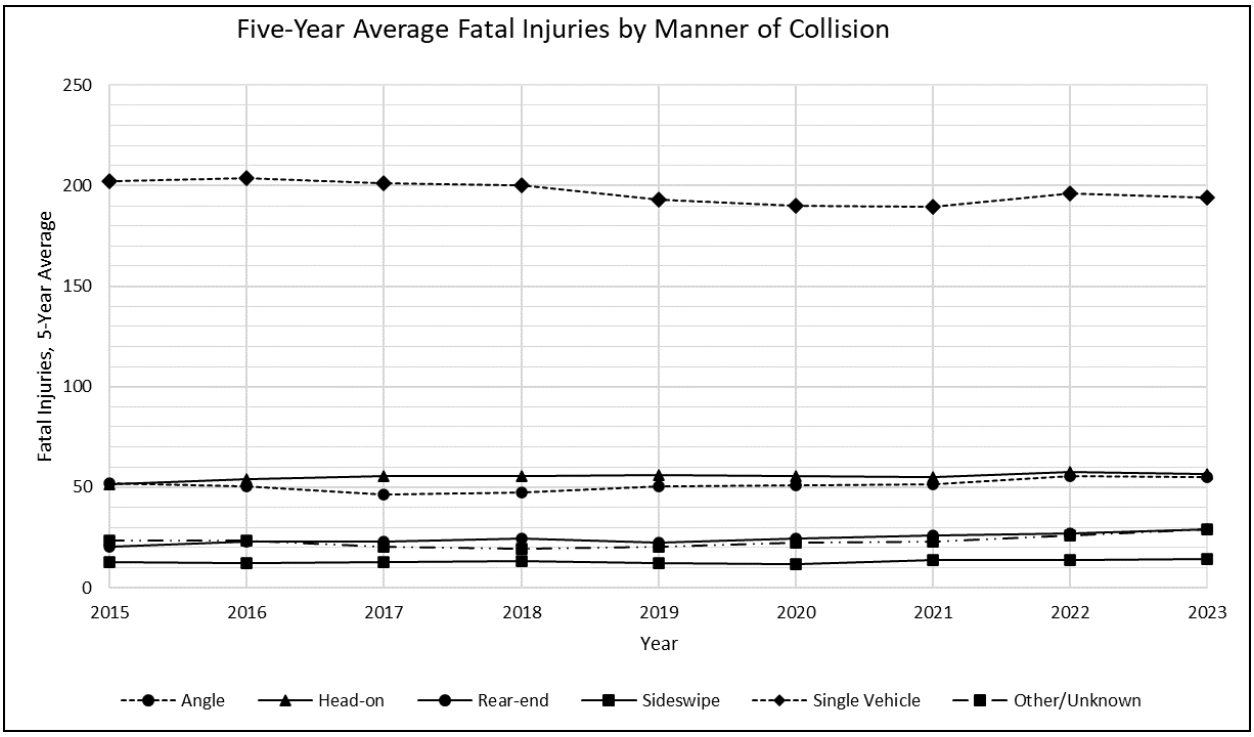

Figure 25. Five-year annual average of Massachusetts fatal injuries by manner of collision.

After single-vehicle crashes, angle crashes result in the second-highest number of suspected serious injuries, followed by rear-end crashes, then head-on crashes, sideswipe crashes, and other/unknown crashes. The two highest categories of crash types—single-vehicle and angle—steadily decreased from 2015 to 2020 before leveling out and then increasing through 2023. Notably, there was a significant decrease in suspected serious injuries for rear-end crashes since 2015. Suspected serious injuries for head-on, sideswipe, and other/unknown crashes have remained relatively constant for the study period.

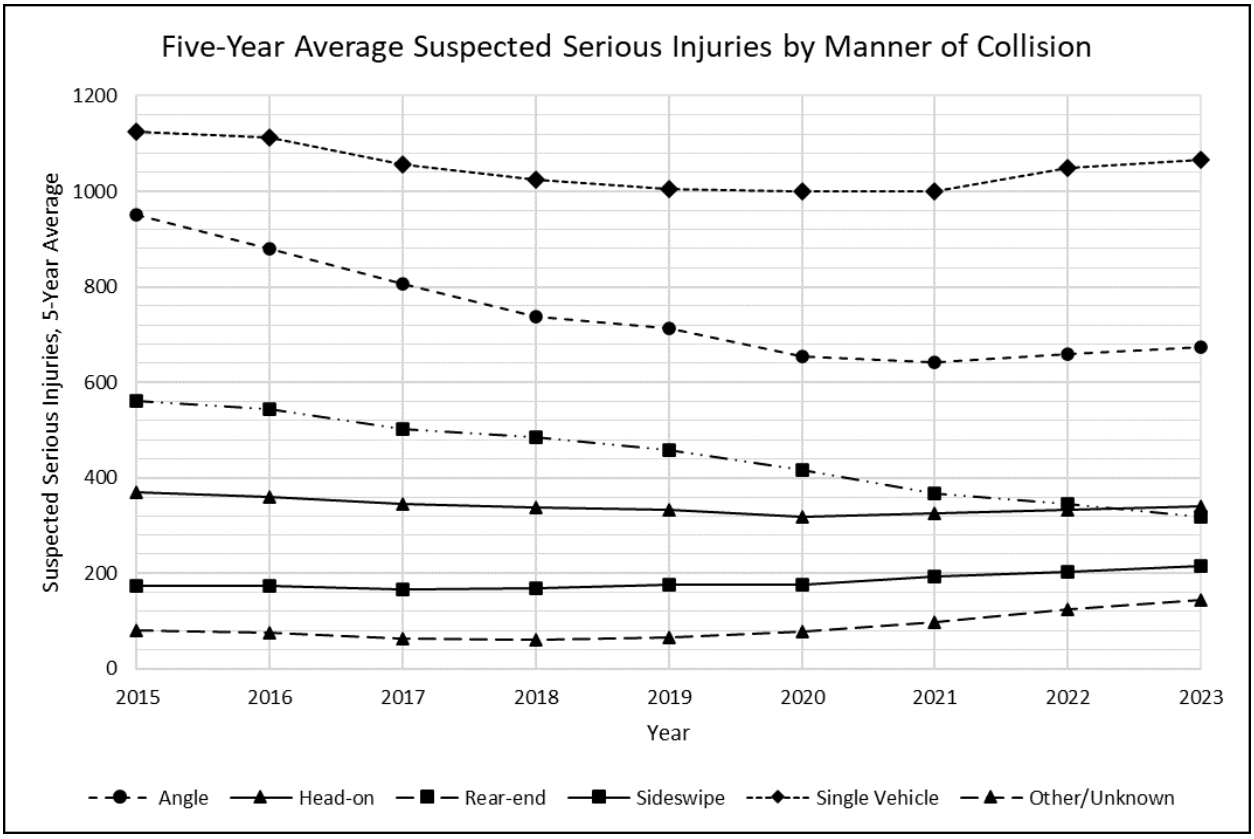

Figure 26. Five-year annual average of Massachusetts suspected serious injuries by manner of collision.

Table 7 shows a breakdown of the aggregate fatal and suspected serious injury distributions for manner of collision for 2019 through 2023. Single-vehicle crashes account for the plurality of fatalities and suspected serious injuries, with angle crashes accounting for the second-highest proportion.

Table 7. Percent of fatalities and suspected serious injuries by manner of collision for the period from 2019 to 2023.

Manner of Collision	Percent Fatal Injuries	Percent Suspected Serious Injuries	Percent Fatal + Suspected Serious Injuries
Single vehicle	52%	39%	40%
Angle	15%	25%	23%
Head-on	15%	12%	13%
Rear-end	8%	12%	11%
Sideswipe	4%	8%	7%
Other/Unknown	6%	4%	6%

Equity

The Massachusetts 2023 SHSP introduced a focus on equity in highway safety. Data included in the SHSP and the completed Vulnerable Road User (VRU) Safety Assessment[13] reveal racial disparities in motor vehicle and pedestrian deaths[14]. While Black people account for only 6.5 percent of the population in Massachusetts, they account for 7.8 percent of pedestrian deaths and 8.4 percent of motor vehicle fatalities in the State. Further, Black pedestrians had rates of injury-related hospital stays 3-times higher, on average, than White pedestrians[13]. The overrepresentation of the Black populace in fatal crashes may be linked to the ways infrastructure was designed and invested (or underinvested) historically, especially in Black communities. This correlates with larger issues related to health equity investigated by the Massachusetts Health Policy Commission (HPC). The HPC considers transportation a social determinant of health[15]. As such, MassDOT strives to produce more equitable health outcomes through addressing transportation issues, identified using data, in historically underserved communities.

This is especially relevant for vulnerable user safety. Figure 27 shows that more than 80 percent of vulnerable user fatalities and suspected serious injuries occur within 5 miles of home. Further, more than half of pedestrian fatal and suspected serious injuries (KA) occur within a mile of home. Additionally, 50 percent of KA pedestrian crashes occurred in a racial and environmental justice plus (REJ+) community.[13]

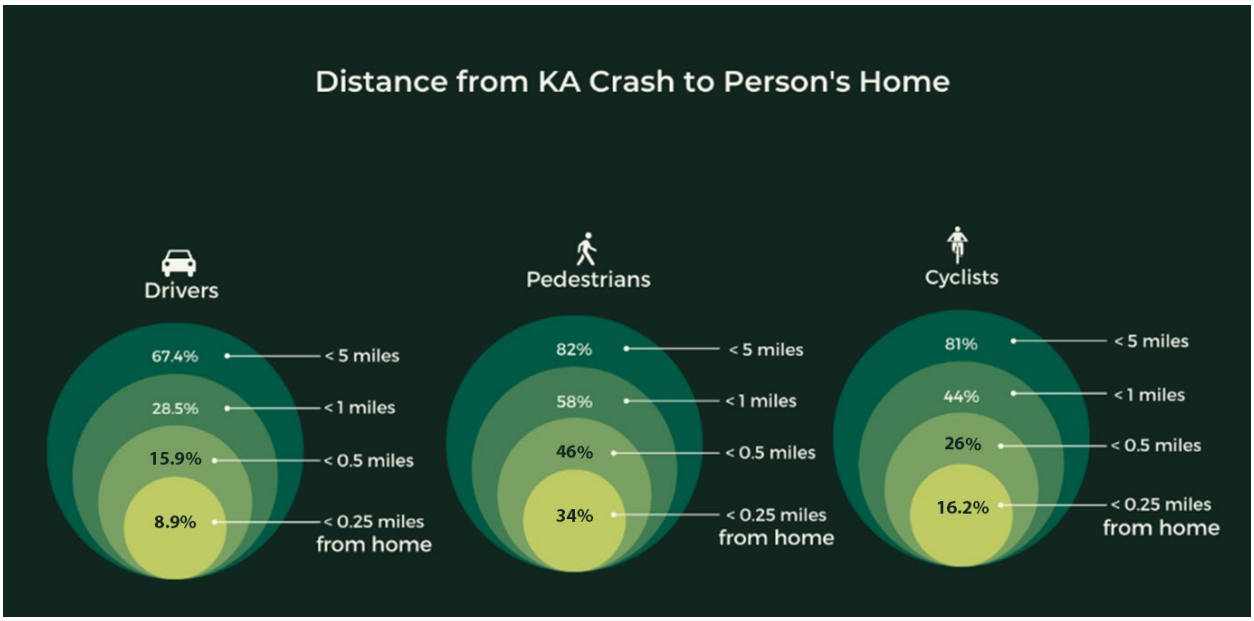

Figure 27. Distribution of persons involved in KA crashes by distance from home.[13]

[13] MassDOT Vulnerable Road User Safety Assessment (arcgis.com)
[14] https://www.mass.gov/doc/massachusetts-shsp-2023/download
[15] https://www.mass.gov/info-details/health-equity

Summary of Crash Trends

The purpose of this section was to summarize recent severe crash trends in Massachusetts. MassDOT can review this section and consider the distribution of severe injury crashes, particularly across geographic regions and by SHSP EA, when programming safety improvement projects in the State. Note again that some of the data discussed in this section, including many of the fatality trends, are from before and the beginning of the COVID-19 pandemic and therefore do not reflect the changes in highway safety outcomes since the pandemic. Based on the crash statistics from 2015 to 2023 presented in this section, the following are prominent trends and crash types related to fatal and suspected serious injury crashes:

- Lane departure crashes produce the highest number of fatalities of any Massachusetts SHSP EA, but intersection-related crashes produce the highest number of suspected serious injuries.
- No specific emphasis area has seen a consistent decline in both fatalities and serious injuries.
- The increasing fatalities and serious injuries due to impaired driving crashes is concerning. Massachusetts should work to reverse this trend. Addressing trends in other EAs, including lane departure and speeding, should also reverse the impaired driving trend.
- City and Town maintained roads experience a significantly higher proportion of fatalities and suspected serious injuries compared to the proportion of VMT.
- Proportional distribution of fatalities and suspected serious injuries are generally in line for Districts, planning agencies, and area type.
- The Black populace, those living in REJ+ communities, and non-motorists appear to have less equitable transportation outcomes than the rest of the State.

Ultimately, these trends and distributions can guide MassDOT's HSIP priorities and funding decisions.

Historical Project Evaluation

To increase the effectiveness of Massachusetts's HSIP, it is important for MassDOT to understand what types of projects have and have not been effective at providing safety benefits and reducing fatal injury and suspected serious injury crashes. To do this, MassDOT aggregated HSIP project evaluation results included in HSIP reports from 2017 to 2024[16,17,18,19,20,21,22,23] – a total of 95 evaluated projects. For evaluation purposes, MassDOT reports projects only when 3 years of crash data are "closed" after the completion of the project. For instance, the projects reported in the 2022 HSIP report were those completed in 2017, as the 2020 crash data were closed in 2022. MassDOT reported 3 years of before crashes and 3 years of after crashes for each project. As part of each HSIP report, MassDOT estimates annual benefits, converts those benefits to a service life benefit in dollars, and compares the benefits to costs for a benefit-cost ratio (B/C). MassDOT omitted 3 projects from the 2024 evaluation process because less than 10 percent of the project received HSIP funds.

This section describes evaluation results at the project level and the countermeasure level.

Project Evaluations

The costs of the projects discussed in this section include all costs, not just HSIP dollars. While an ideal approach would isolate the effects of the HSIP dollars only, this is not feasible, as the other changes in the projects also affect safety performance. This gives a general sense of the ratio of benefits to cost for the program, but unfairly evaluates split-funded projects, which often include significant operational and other components to the project. As such, MassDOT also includes HSIP B/C ratio calculations – comparing the safety benefits to the HSIP funds for the project. Note the HSIP B/C ratio also somewhat misrepresents the efficiency of the HSIP, as there are safety benefits from other components included in the projects, regardless of whether they were funded using the HSIP.

For this report, MassDOT assigned projects into the following general categories based on the improvement(s):

- Cross-section modifications – adjusting lane width, shoulder width, and lane assignments.
- Delineation – signage and pavement marking additions or improvements.
- Flashing yellow arrow (FYA) – reconfiguration of the signal to include FYA on at least one approach.
- Guardrail installation – installation of or upgrades to roadside barrier along at least one side of the roadway.
- High-friction surface treatment (HFST) – installation of specialized HFST friction improvements.
- Intersection geometry improvements – redesigning an intersection to address skew and other geometric issues.

[16] https://safety.fhwa.dot.gov/hsip/reports/pdf/2017/ma.pdf
[17] https://safety.fhwa.dot.gov/hsip/reports/pdf/2018/ma.pdf
[18] https://safety.fhwa.dot.gov/hsip/reports/pdf/2019/ma.pdf
[19] https://safety.fhwa.dot.gov/hsip/reports/pdf/2020/ma.pdf
[20] https://highways.dot.gov/sites/fhwa.dot.gov/files/2021_MA_HSIP_Report.pdf
[21] https://highways.dot.gov/sites/fhwa.dot.gov/files/2023-08/MA-HSIP-2022.pdf
[22] https://highways.dot.gov/sites/fhwa.dot.gov/files/2024-04/HSIP%28Massachusetts%29%202023%20Report.pdf.
[23] MA's 2024 HSIP Report is under development.

- Median barrier – installation of or upgrades to median barrier.
- Ramp and interchange improvements – projects including improvements to access control ramps or interchanges.
- Roundabout – installation of a roundabout intersection.
- Signalized intersection improvements – changes and improvements at signalized intersections, including adding turn lanes, updating signal equipment, and modifying signal timing.
- Two-way stop control (TWSC) to signalized intersection – traffic control conversions from minor stop-control intersections to signalized intersections.
- VRU projects – projects in which the primary focus is on pedestrian and bicycle infrastructure improvements.

Table 8 lists the number of projects, project costs, fatal and suspected serious injury (KA) crashes, and fatal and all injury (KABC) crashes per year for the 3 years before and 3 years after. Note this table provides naïve data – a simple way of reporting the changes in safety performance from a safety project using crashes before and after implementation of the project. Naïve analyses do not account for changes in traffic volume, regression to the mean, and other factors which may affect safety performance over time. Later tables provide more statistically rigorous results based on more reliable methods to account for other factors over time. A review of the naïve data in Table 8 shows that all project categories except for HFST[24] had either no change in or a decrease in the frequency of KA crashes. However, when looking at all injury (KABC) crashes, fewer (7 of 12) project categories produced naïve reductions in KABC crash frequency, including:

- Delineation.
- FYA.
- HFST.
- Roundabout.
- Signalized Intersection Improvements.
- TWSC to Signalized Intersection.
- VRU Projects.

[24] While HFST had an increase in KA crashes, there were so few crashes observed the result it not statistically significant.

Table 8. Summary of HSIP project evaluations for projects.

Project Type	Number of Projects	Total Cost (HSIP funds) of Projects	KA Crashes per year, Before	KA Crashes per year, After	Percent Reduction of KA Crashes	KABC Crashes per year, Before	KABC Crashes per year, After	Percent Reduction of KABC Crashes
Cross-Section Modifications	8	$25,801,547 ($10,551,547)	2.7	2.3	12.5%	28.7	35.0	-22.1%
Delineation	6	$5,655,251 ($5,655,251)	88.7	76.7	13.5%	1073.0	930.0	13.3%
FYA	1	$377,587 ($377,587)	1.0	0.3	66.7%	15.3	8.3	45.7%
Guardrail Installation	1	$468,903 ($468,903)	2.3	1.0	57.1%	9.3	11.0	-17.9%
HFST	1	$2,816,357 ($2,816,357)	0.0	1.0	n/a	4.7	1.3	71.4%
Intersection Geometry Improvements	7	$10,106,562 ($4,065,722)	1.3	1.0	25.0%	11.3	12.0	-5.9%
Median Barrier	14	$33,185,009 ($18,677,171)	14.7	12.3	15.9%	99.3	115.0	-15.8%
Ramp and Interchange Improvements	2	$34,125,608 ($33,959,699)	1.7	1.7	0.0%	22.7	25.3	-11.8%
Roundabout	9	$22,475,802 ($11,488,228)	2.3	0.0	100.0%	28.7	11.7	59.3%
Signalized Intersection Improvements	31	$103,571,618 ($39,747,086)	16.3	8.7	46.9%	230.0	184.0	20.0%
TWSC to Signalized Intersection	9	$16,908,648 ($9,856,966)	3.3	2.0	40.0%	30.3	15.0	50.5%
VRU Projects	6	$14,172,742 ($5,150,664)	8.0	7.0	12.5%	120.0	77.3	35.6%
All Projects	**95**	**$369,665,633 ($142,815,179)**	**142.3**	**114.0**	**19.9%**	**1,673.3**	**1,426.0**	**14.8%**

MassDOT also evaluates HSIP projects using methods to estimate the expected number of crashes in the after period. Where possible, MassDOT uses Empirical Bayes (EB) to estimate the expected number of crashes in the after period. If EB could not be used, MassDOT used the before crash rate and after period AADT to estimate the number of expected crashes in the after period. Table 9 summarizes the comparison of expected (or estimated) and observed crashes per year by project type. In the case of median barrier improvements, this focuses on cross-median crashes, while VRU projects focus on pedestrian or bicycle crashes. Benefit calculations were done on an individual project level, so the crash costs used may vary within the category. For instance, a project type may show an overall increase in KABC crashes, yet still represent a positive benefit because the increase in KABC crashes on one project within the category may have a lower average severity than reductions observed in other projects in the category.

Delineation improvements, FYA, and VRU projects were the most cost efficient with regard to the HSIP B/C ratio; these are also the most efficient with regard to total B/C ratio. In terms of percent reduction, HFST produced the largest reduction in KABC crashes (67 percent), followed by roundabouts (58 percent), and FYA (46 percent). Unfortunately, cross-section improvements, guardrail installation, intersection geometry improvements, and ramp and interchange improvements produced increases in KABC crashes, though this may be due to the fact that there were so few of these projects. Additionally, these categories include several projects that were not primarily safety projects; rather HSIP funds were included to incorporate targeted safety improvements as part of a larger capital project.

Table 10 summarizes effectiveness by annual reduction per million dollars. Most project categories expect a reduction of more than 1 KABC crash per year per $1 million in HSIP dollars, which works out to a BCR north of 5.0. Those that did not meet that threshold include cross-section modifications, guardrail installation, intersection geometry improvements, median barrier, and ramp and interchange improvements.

Table 9. Summary of HSIP project types comparing expected with observed after period crashes.

Project Type	Number of Projects	Expected KABC Crashes per Year, After	Observed KABC Crashes per Year, After	Reduced KABC Crashes per Year	Expected Crashes per Year, After	Observed Crashes per Year, After	Reduced Crashes per Year	Service Life Benefits	B/C	HSIP B/C
Cross-Section Modifications[25]	8	28.5	32.3	-3.8	109.9	127.7	-17.7	-$17,796,529	-0.7	-1.7
Delineation Improvements	6	1,038.5	883.3	155.2	4,030.3	3,470.2	560.2	$800,785,696	141.6	141.6
FYA	1	15.3	8.3	7.0	71.7	47.3	24.3	$19,913,203	52.7	52.7
Guardrail Installation	1	9.8	11.0	-1.2	21.2	28.0	-6.8	-$7,953,556	-17.0	-17.0
HFST	1	5.1	1.7	3.4	14.7	8.0	6.7	$10,814,809	3.8	3.8
Intersection Geometry Improvements	7	9.6	10.0	-0.4	77.9	48.8	29.1	$4,422,217	0.4	1.1
Median Barrier	14	19.5	11.8	7.7	81.6	48.4	33.2	$54,594,401	1.6	2.9
Geometric Ramp and Interchange Improvements[26]	2	22.9	26.0	-3.1	84.4	101.2	-16.8	-$11,406,693	-0.3	-0.3
Roundabout	9	25.8	10.8	14.9	92.6	58.1	34.6	$105,646,224	4.7	9.2
Signalized Intersection Improvements	31	211.5	166.5	45.1	806.2	697.8	109.4	$182,652,555	1.8	4.6
TWSC to Signalized Intersection	9	26.9	15.9	11.0	83.3	62.3	21.0	$39,353,110	2.3	4.0
VRU Projects	6	107.7	77.0	30.7	327.7	274.6	53.0	$155,313,329	11.0	30.2
Total	**95**	**1,521.2**	**1,254.7**	**266.4**	**5,801.6**	**4,972.4**	**830.0**	**$1,336,338,766**	**5.0**	**9.4**

[25] These projects include pavement widening, lane widening, shoulder widening, modifications to auxiliary lanes, and centerline buffer areas; the B/C is representative of total cost.

[26] Projects were primarily operational improvements with some safety funding; only safety benefits are included in B/C calculations.

Table 10. Summary of HSIP project type reductions from expectation per project.

Project Type	Number of Projects	Total Cost	HSIP Cost	Reduced KABC Crashes per Year	Reduced KABC Crashes per Year per Million HSIP Dollars	Reduced All Severity Crashes per Year	Reduced All Severity Crashes per Year per Million HSIP Dollars
Cross-Section Modifications	8	$25,801,547	$10,551,547	-3.8	-0.4	-17.7	-1.7
Delineation Improvements	6	$5,655,251	$5,655,251	155.2	27.4	560.2	99.1
FYA	1	$377,587	$377,587	7.0	18.6	24.3	64.5
Guardrail Installation	1	$468,903	$468,903	-1.2	-2.6	-6.8	-14.5
HFST	1	$2,816,357	$2,816,357	3.4	1.2	6.7	2.4
Intersection Geometry Improvements	7	$10,106,562	$4,065,722	-0.4	-0.1	29.1	7.2
Median Barrier	14	$33,185,009	$18,677,171	7.7	0.4	33.2	1.8
Ramp and Interchange Improvements	2	$34,125,608	$33,959,699	-3.1	-0.1	-16.8	-0.5
Roundabout	9	$22,475,802	$11,488,228	14.9	1.3	34.6	3.0
Signalized Intersection Improvements	31	$103,571,618	$39,747,086	45.1	1.1	109.4	2.8
TWSC to Signalized Intersection	9	$16,908,648	$9,856,966	11.0	1.1	21.0	2.1
VRU Projects	6	$14,172,742	$5,150,664	30.7	6.0	53.0	10.3
Total	**95**	**$269,665,633**	**$142,815,179**	**266.4**	**1.9**	**830.0**	**5.8**

Overall, the evaluated HSIP projects return a B/C of 5.0, meaning every $1 spent towards an HSIP project in Massachusetts returns an estimated $5.00 in societal benefits from crash reductions. For comparison, FHWA estimated a national B/C for the HSIP to be between 4.78 and 6.92 in 2019[27]. When focusing solely on HSIP dollars, the return on investment is even better, producing a B/C ratio of 9.4, meaning every $1 of HSIP dollars produces $9.4 in societal benefits from crash reductions.

MassDOT is always striving to increase the effectiveness of the program. The purpose of this plan is to help MassDOT achieve such a goal. MassDOT has been taking steps along these lines in the form of programming more cost-efficient systemic safety projects and verifying that in mixed-fund projects, HSIP funds are only used for proven safety improvements.

Note that Table 9Table 8 and Table 10 do not account for all HSIP expenditures, only those that could be evaluated at the project level. Some expenditures, such as those for signage improvements and safety data improvements, were not evaluated by MassDOT. However, data improvements are known to provide significant benefits, as more accurate safety data and analysis methods improve MassDOT's ability to provide targeted safety improvements. While MassDOT has not evaluated the effectiveness of these projects, they are eligible for HSIP funds per the United States Code (U.S.C.) to maintain minimum retroreflectivity standards, regardless of whether these projects fall under an SHSP EA[28].

Countermeasure Evaluations

MassDOT has also developed crash modification factors (CMFs) for five common countermeasures, which have been documented in previous HSIP reports:

- TWSC conversions to roundabouts – a CMF of 0.16 for KABC multi-vehicle crashes and a CMF of 0.48 for all-severity multi-vehicle crashes, resulting in a B/C of 8.0.
- TWSC conversions to signalized intersections – a CMF of 0.57 for all-severity multi-vehicle crashes, a CMF of 0.46 for KABC multi-vehicle crashes, and a CMF of 0.64 for property damage-only (PDO) multi-vehicle crashes, resulting in a B/C of 2.3.
- Median cable barrier – a CMF of 0.28 for cross-median crashes, resulting in a B/C of 5.23.
- Hot-spot signalized intersection improvements – a CMF of 0.81 for all-severity multi-vehicle crashes and a CMF of 0.67 for KABC multi-vehicle crashes, resulting in a B/C of 4.0.
- FYA – several CMFs were estimated using a before-after analysis with comparison groups[29]. This included separate CMFs by severity for crashes involving left-turning vehicles (LT) and left-turning and opposing-through vehicles (LTOT). Table 11 summarizes the CMF results. Additionally, the study developed B/C ratios using the before-after results. Nearly all tested scenarios revealed a B/C greater than 1.0, with some as high as 18.1:1 to 21.2:1 for the lowest-cost FYA treatment.

[27] https://safety.fhwa.dot.gov/hsip/reports/pdf/2019/FHWA-21-005_nsbrpt2019.pdf
[28] https://safety.fhwa.dot.gov/hsip/rulemaking/docs/BIL_HSIP_Eligibility_Guidance.pdf
[29] Tainter, F., Fitzpatrick, C., and Hannon, T. (2023). Evaluating the Safety Impacts of Flashing Yellow Permissive Left-Turn Indications in Massachusetts: Approach-Level Analysis. Report No. 23-036. Massachusetts Department of Transportation, Boston, MA.

Table 11. Summary of FYA CMFs.[29]

Crash Type	Crash Category	Treatment Group, Before	Treatment Group, After	Comparison Group, Before	Comparison Group, After	CMF[30]
LT	All Crashes	387	352	96	88	0.871
LT	KABC Crashes	134	120	30	35	*0.718*
LT	Severe Crash Types	363	321	85	80	0.915
LTOT	All Crashes	318	265	61	64	*0.767*
LTOT	KABC Crashes	116	102	24	33	**0.592**
LTOT	Severe Crash Types	313	262	58	62	*0.755*

Evaluation Takeaways

Based on these evaluation results, the following are key takeaways:

- MassDOT's HSIP has increased in economic effectiveness, now aligning with national experience reported in 2019. MassDOT should continue to look for opportunities to increase the return on investment for HSIP dollars.
- Of the countermeasures evaluated to produce a CMF, roundabouts are the most effective evaluated HSIP projects in Massachusetts, significantly reducing injury crashes where they are installed and producing a high rate of return on safety dollars. MassDOT's Intersection Control Evaluation (ICE) policy encourages the construction of more roundabouts (guided by data-driven analysis), as they provide additional benefits aside from the noted safety benefits. MassDOT's ICE policy is a consistent and data-driven approach to evaluate the potential performance of intersection control strategies[31]. Because of these other benefits, MassDOT should continue to use multiple funding sources for roundabouts, not just HSIP funds. Note that while the B/C ratios documented for these projects are relatively high, other States have seen higher B/C ratios for roundabouts. This is likely due to the high cost of construction in Massachusetts and the fact that the reported B/C ratios in this plan include all costs, not just safety dollars.
- FYA continues to be an economically effective method of reducing injury crashes at signalized intersections. Given MassDOT has implemented FYA in all MassDOT signals where feasible, MassDOT should encourage their adoption by local agencies.
- While converting stop-controlled intersections to signalized intersections has proven to be effective, there are more efficient methods of spending safety dollars in Massachusetts to address safety at those intersections. For example, roundabouts in Massachusetts returned a B/C of 8.0, compared to the B/C of 2.28 for converting to signalization. MassDOT should use the ICE policy to determine the most appropriate alternative when modifying traffic control at a stop-controlled intersection.
- General safety improvements at signalized intersections have proven to be effective at reducing crashes and providing a safety benefit. While effective, their B/C ratios are relatively low due to the expense of the projects and the "hot-spot" nature of the improvement.

[30] *Statistically significant at the 90 percent confidence level.* **Statistically significant at the 95 percent confidence level.**

[31] https://www.mass.gov/info-details/massdot-intersection-control-evaluation-ice

- Though only one evaluated project used HFST, the effectiveness of this project should encourage MassDOT to use HSIP dollars for more of these projects. This is especially effective for locations where wet road crashes are an issue, as FHWA markets a potential 52-percent reduction in wet road crashes with the installation of the treatment[32]. The B/C ratio of 3.89 is lower than the national value of 6.0 for curves and 18.7 for ramps identified by Merritt et al. (2020)[33]. The likely source of this discrepancy is that this was one of the first HFST projects in Massachusetts – such projects will presumably become more efficient in the future as lessons are learned by MassDOT and contractors.
- One notable best practice lacking from the reviewed project list is systemic projects. FHWA encourages agencies to apply low-cost safety countermeasures in a systemic manner, based on risk, to proactively mitigate common high-severity crashes, such as vehicle-pedestrian collisions at mid-block crossings and roadway departures. MassDOT's recent development of risk factor maps for IMPACT provide the ability to prioritize locations for systemic projects[34]. One challenge to MassDOT implementing systemic improvements has been issues related to right-of-way and requiring extensive project planning and design, even for low-cost projects within the existing right-of-way. MassDOT recently identified material procurement contracts as a method of overcoming those challenges and implementing systemic improvements – as these project advance MassDOT should evaluate the success of the projects as well as the process of site identification, distribution, and maintenance. MassDOT has also programmed several lane departure and non-motorist systemic projects for future fiscal years.

[32] https://safety.fhwa.dot.gov/provencountermeasures/enhanced_delineation/
[33] https://www.fhwa.dot.gov/publications/research/safety/20061/20061.pdf
[34] https://apps.impact.dot.state.ma.us/sat/NetworkEmphasisArea

Future Project Benefits

MassDOT HSIP dollars can be spent on projects in three STIP categories: Safety, Intersection, and Vulnerable Road Users. This section describes the anticipated benefits as well as estimated lives saved and serious injuries prevented for programmed HSIP and VRU projects for 2024 and 2025.

Methodology

MassDOT used the methodology in MassDOT's *Safety Alternatives Analysis Guide*[35] to estimate the potential benefits of most HSIP projects for the 2024 and 2025 STIP. The guide follows a three-step procedure to estimating project benefits:

1. Estimate future no-build crash frequency.
2. Estimate the expected change in safety performance.
3. Estimate the monetary value of societal safety benefits which will be gained from the reduction in crashes. Note this does not include operational, environmental, and other non-safety benefits derived from the projects.

Additionally, MassDOT used the following assumptions for this analysis:

- All projects were assumed to have a 20-year analysis period and a 7-percent annual discount factor was applied to convert the annual safety benefits to a total benefit in the present year value.
- MassDOT used average crash costs from Massachusetts for 2019, taken from the *Safety Alternatives Analysis Guide.*
- MassDOT used average severity distributions for crashes from 2019 through 2021 statewide to estimate lives saved and serious injuries prevented. Based on data queried from IMPACT, Massachusetts averaged 0.012 fatalities and 0.091 suspected serious injuries per FI crash.
- The cost reflects the HSIP dollars which are obligated to the project. Importantly, the benefits included in the B/C ratio only include safety benefits – most of these projects were built using a more all-encompassing B/C ratio, including savings from user delay, emissions, and other impacts. To look deeper into split-funding projects, MassDOT also included a B/C ratio comparing safety benefits to total costs.
- In almost all cases, MassDOT used the most recent 3 years of complete crash data (2019, 2020, and 2021) to establish baseline safety performance.
- Where possible, MassDOT applied CMFs from the State-preferred list to estimate the change in safety performance. When no CMF was available, MassDOT referred to FHWA's CMF Clearinghouse or used predictive models from the Highway Safety Manual to estimate future safety performance. Finally, if no research was available to estimate the crash reduction, MassDOT used a conservative estimate of the potential reduction.
- Though programmed, MassDOT did not estimate potential lives saved and serious injuries prevented from guide sign improvement projects. As such, this section only reflects remaining HSIP projects.

For 2024 and 2025, MassDOT has 21 hot-spot and 3 systemic projects programmed which are summarized in this section.

[35] https://www.mass.gov/doc/massdot-safety-alternatives-analysis-guide/download

Hot-Spot Projects

Most of MassDOT's proposed HSIP projects for 2024 and 2025 are hot-spot projects, meaning they address an area with a cluster of historical crashes. The improvements are usually large-scale capital improvement projects with significant equipment upgrades, potential changes to the cross-section, resurfacing, and, in some cases, right-of-way acquisition; often the safety improvements are only a small component of the larger overall project. This means the projects usually cost in the millions of dollars and have mixed sources of funding, including HSIP. For instance, the HSIP hot-spot projects for 2024 and 2025 had an average cost of $11.8 million per project, though only $3.6 million per project of that is funded with the HSIP. Given the methodology only includes the estimation of safety benefits, MassDOT elected to compare those safety benefits to the HSIP component of the project cost.

Table 12 summarizes the analysis results for the 21 proposed hot-spot projects in 2024 and 2025. Again, the methodology used to estimate crash reductions and benefits was based on the MassDOT *Safety Alternatives Analysis Guide*. For each project's service life, MassDOT estimated:

- Total number of crashes reduced.
- Fatal and injury crashes reduced.
- Number of lives saved.
- Number of serious injuries prevented.
- Monetary safety benefits.
- HSIP B/C ratio.

Table 12. Summary of service life benefits and HSIP B/C for hot-spot projects.

Project Number	Project Description	Total Crashes Reduced	Fatal and Injury Crashes Reduced	Lives Saved	Serious Injuries Prevented	Present Value HSIP Cost	Present Value Safety Benefits	HSIP B/C
602202	Salisbury- Reconstruction of Route 1 (Lafayette Road)	845.6	147.4	1.8	13.4	$2,543,975	$37,592,926	14.8
606233	Pittsfield- Intersection & Signal Improvements at First Street & North Street (Near Berkshire Medical Center)	165.6	45.4	0.6	4.1	$500,641	$10,560,754	2.3
606895	Granby- Improvements at 2 Locations on Route 202: School Street & Five Corners	148.0	86.2	1.1	7.9	$1,695,380	$15,068,673	8.9
607397	Wellfleet- Intersection Improvements & Related Work at Route 6 & Main Street	32.8	13.6	0.2	1.2	$2,000,000	$2,538,965	1.3
607777	Watertown- Rehabilitation of Mount Auburn Street (Route 16)	197.0	63.4	0.8	5.8	$2,000,000	$18,986,900	9.5
608051	Wilmington- Reconstruction On Route 38 (Main Street), From Route 62 to the Woburn C.L.	41.0	160.4	2.0	14.6	$1,000,000	$10,178,879	10.2
608095	North Andover- Corridor Improvements on Route 114, Between Waverly Road & Willow/Mill Street	30.8	25.8	0.3	2.4	$3,393,037	$8,077,007	2.4
608414	Greenfield- Intersection Improvements at Two Locations, Route 2 and Colrain Road & Route 2 and Big Y Entrance	40.4	9.6	0.1	0.9	$2,443,256	$1,928,982	0.8
608560	Springfield- Improvements On St. James Avenue at Tapley Street	163.0	117.2	1.5	10.7	$6,076,122	$20,731,984	3.4
608565	Springfield- Improvements On St. James Avenue at St. James Boulevard and Carew Street	319.2	153.0	1.9	14.0	$9,086,046	$28,645,017	3.2

Project Number	Project Description	Total Crashes Reduced	Fatal and Injury Crashes Reduced	Lives Saved	Serious Injuries Prevented	Present Value HSIP Cost	Present Value Safety Benefits	HSIP B/C
608759	Swansea- Traffic Signal and Safety Improvements at Three Intersections on Route 6	170.8	235.8	2.9	21.5	$12,256,504	$31,468,203	2.6
608774	Lowell- Tewksbury- Route 38 Intersection Improvements	103.8	19.4	0.2	1.8	$4,048,499	$4,132,669	1.0
608778	Southbridge- Intersection Improvements at Central Street, Foster Street, Hook Street and Hamilton Street	10.6	49.6	0.6	4.5	$1,000,000	$3,377,239	3.4
608933	Peabody- Rehabilitation of Central Street	81.3	27.3	0.3	2.5	$1,500,000	$6,293,783	4.2
608961	Worcester- Intersection Improvements on Chandler Street and May Street	7.6	4.0	0.0	0.4	$1,000,000	$1,346,229	1.3
609065	Holyoke- Resurfacing and Related Work on Cabot Street and Race Street (Center City Connector)	262.4	105.6	1.3	9.6	$2,909,496	$25,912,581	8.9
609253	Wilmington- Intersection Improvements at Lowell Street (Route 129) and Woburn Street	116.0	40.0	0.5	3.6	$3,041,358	$7,597,116	2.5
609254	Lynn- Intersection Improvements at Two Intersections on Broadway	173.4	48.6	0.6	4.4	$6,059,056	$9,359,209	1.5
609532	Chelsea- Targeted Safety Improvements and Related Work on Broadway, from Williams Street to City Hall Avenue	166.8	246.6	3.1	22.5	$6,315,013	$38,880,928	1.6
610704	Burlington- Billerica- Resurfacing and Related Work on Route 3A	60.8	216.8	2.7	19.8	$2,503,217	$17,302,466	6.9
610919	Lynn- Nahant- Northern Strand Extension	113.0	208.4	2.6	19.0	$3,233,870	$25,938,642	8.0
Total Results		**3,250**	**2,024**	**25**	**185**	**$74,605,470**	**$325,919,152**	**4.4**

The results in Table 12 show that the total number of crashes prevented during the analysis period is estimated to be 3,250, of which 2,024 are fatal or injury crashes. This is an average of 155 all-severity crashes and 96 fatal and injury crashes per project. On a per crash basis, approximately $23,000 in HSIP funds are found to prevent 1 all-severity crash and $37,000 in HSIP funds was found to prevent 1 fatal and injury crash. For comparison, MassDOT's *Safety Alternatives Analysis Guide*[36] lists the average cost of an all-severity crash as $121,400 and the average cost of a fatal-and-injury crash as $441,000.

The proposed individual projects account for $74.6 million in planned HSIP spending for 2024 and 2025. Using data-driven safety analysis, MassDOT expects these projects to produce $325.9 million in safety benefits over the 20-year analysis period, providing an overall HSIP B/C of 4.4 for the hot-spot improvement projects. Of the 21 projects evaluated, 4 were found to produce an HSIP B/C of less than 1.0, 4 were found to have a B/C between 1.0 and 2.0, and none were found to have a negative B/C ratio, indicating MassDOT anticipates all projects will produce some safety benefit. As a reminder, these calculations only consider safety benefits, disregarding benefits from other components of the projects. As such, these projects have lower B/C ratios than those in the HSIP portfolio which are primarily safety projects.

MassDOT used the statewide average injury severity distribution to estimate the number of fatalities and suspected serious injuries for each fatal or injury crash. After applying these proportions to the estimated reduction in fatal and serious injury crashes, and projecting over a 20-year service life, these projects are projected to save a total of 25 lives and prevent 185 suspected serious injuries. Monetarily, this converts to an average of approximately $3.0 million in HSIP funds to save 1 life over 20 years and approximately $400,000 in HSIP funds to prevent 1 suspected serious injury over 20 years. For comparison, MassDOT considers the average cost of a fatal crash at $16.3 million and the average cost of a suspected serious injury crash at $941,300.

Systemic Projects

MassDOT programmed three systemic projects for 2024 and 2025:

- 609433 – Attleboro – Median Cable Barrier Installation on I-95 – 2.6 mile long corridor.
- 610794 – Statewide – Systemic Countermeasures for SHSP Implementation (Pedestrian and Bicycle Safety) – specifically, the implementation of pedestrian signal head displays at 63 signalized intersections in Massachusetts.
- S12750 – Statewide – School Zone Speed Feedback Signage at Various Locations - including 281 signs.

Table 13 summarizes the analysis results for the three systemic projects in 2024 and 2025. In general, these projects are fully funded with HSIP dollars. Previous HSIP Implementation Plans describe the methodologies used to estimate the benefits of these projects.

[36] https://www.mass.gov/doc/massdot-safety-alternatives-analysis-guide/download

Table 13. Summary of service life benefits and HSIP B/C for systemic projects.

STIP Program	Project Number	Project Description	Total Crashes Reduced	Fatal and Injury Crashes Reduced	Lives Saved	Serious Injuries Prevented	Present Value HSIP Cost	Present Value Benefits	HSIP B/C
Safety Improvements	610794	Statewide- Systemic Countermeasures for SHSP Implementation – 63 Intersections (Pedestrian and Bicycle Safety)	10.0	16.4	0.2	1.5	$1,802,860	$2,928,868	1.6
Safety Improvements	609433	Attleboro- North Attleborough - Median Cable Barrier Installation on I-95 – 2.6 MIles	74.8	101.5	1.3	9.3	$2,348,020	$19,706,866	8.4
Safety Improvements	S12750	School Zone Speed Feedback Signage at Various Locations (281 Signs)	326.4	82.9	1.0	7.6	$3,250,000	$22,388,706	6.9
		Total Results	**411**	**201**	**2.5**	**18.3**	**$7,400,880**	**$45,024,440**	**6.1**

The three systemic projects are expected to produce $45.0 million in safety benefits for an HSIP cost of $7.4 million, producing a B/C ratio of 6.1. Economically, the projects will cost approximately $18,000 to reduce one all severity crash, $37,000 to reduce one fatal or injury crash, $3.0 million per life saved, and $400,000 per serious injury prevented. Consider these in the context of the average crash costs referenced previously:

- $121,400 for an all-severity crash.
- $441,000 for a fatal or injury crash.
- $941,300 for a suspected serious injury crash.
- $16,257,800 for a fatal crash.

These projects are expected to produce similar cost effectiveness, with relationship to cost to reduce a KA crash, as hot-spot projects. These results are even more impressive given the CMFs used for these projects – the maximum crash reduction for the countermeasures included was only 5 percent.

Summary of Future Project Benefits

Table 14 summarizes the expected safety benefits of future projects for 2024 and 2025 by project type. As stated previously, the systemic projects are expected to be slightly more economically efficient. When combined, the total effects of STIP projects including HSIP funds are expected to produce a B/C ratio of 4.5, returning $4.50 in safety benefits for every $1 in HSIP funds.

Table 14. Summary of HSIP benefits and HSIP B/C by project type.

Project Type	Total Crashes Reduced	Fatal and Injury Crashes Reduced	Lives Saved	Serious Injuries Prevented	Present Value HSIP Costs	Present Value Benefits	HSIP B/C
Hot-Spot	3,250	2,024	25	185	$74,605,470	$325,919,152	4.4
Systemic	411	201	2.5	18.3	$7,400,880	$45,024,440	6.1
Total	**3,661**	**2,225**	**27.5**	**203.3**	**$82,006,350**	**$370,943,592**	**4.5**

Accounting for All Costs

The above analyses compared the safety benefits to only HSIP funding, assuming that all safety benefits derived from the project came solely from those components funded by the HSIP. A different way of calculating B/C ratio would be to compare the safety benefits to all costs. The following tables describe the results by project type, including:

- Table 15 summarizes total B/C ratio for hot-spot projects.
- Table 16 summarizes total B/C ratio for systemic projects.
- Table 17 summarizes total B/C ratio by project type.

Per the results below, hot-spot projects are expected to return $1.30 in safety benefits for every $1 spent in total funds and systemic projects are expected to return $6.60 in safety benefits for every $1 in total funds. In total, all HSIP projects are expected to return $1.40 in safety benefits for every $1.00 in funds. As expected, this B/C ratio is much lower than when only considering HSIP dollars. Once again, note that this only considers the safety benefits of projects; additional operational, emissions, and other benefits are also generated by these projects, but not quantified in this plan. Additionally, some projects have a small percentage of HSIP compared to total funding to reflect the project is primarily a different type of project.

Table 15. Summary of service life safety benefits and total B/C ratio for hot-spot projects.

Project Number	Project Description	Total Crashes Reduced	Fatal and Injury Crashes Reduced	Lives Saved	Serious Injuries Prevented	Present Value Total Cost	Present Value Safety Benefits	Total B/C
602202	Salisbury- Reconstruction of Route 1 (Lafayette Road)	845.6	147.4	1.8	13.4	$21,970,456	$37,592,926	1.7
606233	Pittsfield- Intersection & Signal Improvements at First Street & North Street (Near Berkshire Medical Center)	165.6	45.4	0.6	4.1	$9,273,140	$10,560,754	1.1
606895	Granby- Improvements at 2 Locations on Route 202: School Street & Five Corners	148.0	86.2	1.1	7.9	$5,590,287	$15,068,673	2.7
607397	Wellfleet- Intersection Improvements & Related Work at Route 6 & Main Street	32.8	13.6	0.2	1.2	$16,681,655	$2,538,965	0.2
607777	Watertown- Rehabilitation of Mount Auburn Street (Route 16)	197.0	63.4	0.8	5.8	$24,405,096	$18,986,900	0.8
608051	Wilmington- Reconstruction on Route 38 (Main Street), from Route 62 to the Woburn C.L.	41.0	160.4	2.0	14.6	$22,818,682	$10,178,879	0.4
608095	North Andover- Corridor Improvements on Route 114, Between Waverly Road & Willow/Mill Street	30.8	25.8	0.3	2.4	$43,500,479	$8,077,007	0.2
608414	Greenfield- Intersection Improvements at Two Locations, Route 2 and Colrain Road & Route 2 and Big Y Entrance	40.4	9.6	0.1	0.9	$2,443,256	$1,928,982	0.8
608560	Springfield- Improvements on St. James Avenue at Tapley Street	163.0	117.2	1.5	10.7	$6,076,122	$20,731,984	3.4
608565	Springfield- Improvements on St. James Avenue at St. James Boulevard and Carew Street	319.2	153.0	1.9	14.0	$9,086,046	$28,645,017	3.2

Project Number	Project Description	Total Crashes Reduced	Fatal and Injury Crashes Reduced	Lives Saved	Serious Injuries Prevented	Present Value Total Cost	Present Value Safety Benefits	Total B/C
608759	Swansea- Traffic Signal and Safety Improvements at Three Intersections on Route 6	170.8	235.8	2.9	21.5	$12,663,827	$31,468,203	2.5
608774	Lowell- Tewksbury- Route 38 Intersection Improvements	103.8	19.4	0.2	1.8	$4,048,499	$4,132,669	1.0
608778	Southbridge- Intersection Improvements at Central Street, Foster Street, Hook Street and Hamilton Street	10.6	49.6	0.6	4.5	$5,893,689	$3,377,239	0.6
608933	Peabody- Rehabilitation of Central Street	81.3	27.3	0.3	2.5	$15,219,860	$6,293,783	0.4
608961	Worcester- Intersection Improvements on Chandler Street and May Street	7.6	4.0	0.0	0.4	$6,000,526	$1,346,229	0.2
609065	Holyoke- Resurfacing and Related Work on Cabot Street and Race Street (Center City Connector)	262.4	105.6	1.3	9.6	$5,493,355	$25,912,581	4.7
609253	Wilmington- Intersection Improvements at Lowell Street (Route 129) and Woburn Street	116.0	40.0	0.5	3.6	$6,441,358	$7,597,116	1.2
609254	Lynn- Intersection Improvements at Two Intersections on Broadway	173.4	48.6	0.6	4.4	$6,059,056	$9,359,209	1.5
609532	Chelsea- Targeted Safety Improvements and Related Work on Broadway, from Williams Street to City Hall Avenue	166.8	246.6	3.1	22.5	$7,320,635	$38,880,928	5.3
610704	Burlington- Billerica- Resurfacing and Related Work on Route 3A	60.8	216.8	2.7	19.8	$7,009,540	$17,302,466	2.5
610919	Lynn- Nahant- Northern Strand Extension	113.0	208.4	2.6	19.0	$10,939,360	$25,938,642	2.4
	Total Results	**3,250**	**2,024**	**25**	**185**	**$248,934,935**	**$325,919,152**	**1.3**

Table 16. Summary of service life benefits and total B/C for systemic projects.

STIP Program	Project Number	Project Description	Total Crashes Reduced	Fatal and Injury Crashes Reduced	Lives Saved	Serious Injuries Prevented	Present Value Total Cost	Present Value Benefits	Total B/C
Safety Improvements	610794	Statewide- Systemic Countermeasures for SHSP Implementation (Pedestrian and Bicycle Safety)	10.0	16.4	0.2	1.5	$1,802,860	$2,928,868	1.6
Safety Improvements	609433	Attleboro- North Attleborough - Median Cable Barrier Installation on I-95	74.8	101.5	1.3	9.3	$2,348,020	$19,706,866	8.4
Safety Improvements	S12750	School Zone Speed Feedback Signage at Various Locations (281 Signs)	326.4	82.9	1.0	7.6	$3,250,000	$22,388,706	6.9
		Total Results	**411**	**201**	**2.5**	**18.3**	**$7,400,880**	**$45,024,440**	**6.1**

Table 17. Summary of expected benefits and total B/C by project type.

Project Type	Total Crashes Reduced	Fatal and Injury Crashes Reduced	Lives Saved	Serious Injuries Prevented	Present Value Total Cost	Present Value Benefits	B/C
Hot-Spot	3,250	2,024	25	185	$248,934,935	$325,919,152	1.3
Systemic	451	206	2.6	20.2	$7,400,880	$45,024,440	6.1
Total	**3,701**	**2,230**	**27.6**	**205.2**	**$256,335,815**	**$370,943,592**	**1.4**

Proposed Distribution of Funds

Finally, MassDOT summarized the distribution of planned HSIP and total funds for the proposed HSIP projects regarding geographic distribution. Note that this only includes years 2024 and 2025 and thus represents a snapshot of funding distribution; proportional distribution fluctuates year-to-year for the MassDOT HSIP. Table 18 summarizes the distribution of HSIP funds by MassDOT District in comparison to the distribution of fatal and suspected serious injuries. Note that as of now, District 3 is expected to receive a much lower proportion of HSIP funds compared to their historical share of fatalities and injuries, while District 2 is expected to receive nearly triple the proportion of HSIP funds compared to the fatal and serious injury distribution.

Table 18. Planned distribution of HSIP funds by MassDOT District.

District	Planned Percent of HSIP Dollars	Current Percent of Fatal and Suspected Serious Injuries
1	1%	3%
2	27%	10%
3	2%	20%
4	33%	25%
5	20%	26%
6	10%	15%
Statewide	7%	n/a

Similarly, Table 19 describes the planned distribution of HSIP and total funds by RPA. Regions receiving a notably smaller proportion of HSIP dollars compared to injuries include the CMRPC, MRPC, and OCPC. MassDOT will work to identify opportunities to provide additional HSIP funds to these regions. On the other hand, PVPC is expected to receive a proportion of HSIP funds that is nearly three times as much as the proportional distribution of fatalities and suspected serious injuries. Note that smaller planning agencies (e.g., NPEDC, MVC) have fewer projects, so they may aggregate projects for several years, thus rather than receiving annual funding they fund projects every few years.

Table 19. Planned distribution of HSIP funds by MassDOT region.

Massachusetts RPA	Planned Percent of HSIP Dollars	Current Percent of Fatal and Suspected Serious Injuries
BRPC	1%	2%
CCC	2%	5%
CMRPC	2%	9%
FRCOG	3%	1%
MAPC	31%	42%
MRPC	0%	4%
MVC	0%	<1%
MVPC	7%	6%
NMCOG	5%	5%
NPEDC	0%	<1%
OCPC	0%	6%
PVPC	24%	9%
SRPEDD	17%	11%
Statewide	7%	n/a

Finally, Table 20 summarizes the HSIP projects by SHSP EA. Note that MassDOT associates projects with multiple EAs. For instance, a proposed intersection project to upgrade signal equipment may include the construction of bike boxes, sidewalks, and pedestrian signals at the intersection. As such, MassDOT considers this project for the “Intersection Related”, “Pedestrian”, and “Bicyclist” EAs. This aligns with crashes, which can also be assigned to more than one EA. Additionally, while these EAs are infrastructure focused, the projects often build in forgiveness that will help to address behavioral EAs. For instance, while median cable barrier primarily addresses lane departure crashes, it also prevents impaired or distracted drivers from crossing the median and causing a head-on crash. Further, projects such as enhanced signs, signals, and markings can help older and younger drivers.

Table 20. List of STIP HSIP projects with EAs.

Project Description	EAs
Salisbury- Reconstruction of Route 1 (Lafayette Road)	Lane Departure, Pedestrian
Pittsfield- Intersection & Signal Improvements at First Street & North Street (Near Berkshire Medical Center)	Intersection, Bicycle
Granby- Improvements At 2 Locations on Route 202: School Street & Five Corners	Intersection, Pedestrian
Wellfleet- Intersection Improvements & Related Work at Route 6 & Main Street	Intersection, Pedestrian, Bicycle
Watertown- Rehabilitation of Mount Auburn Street (Route 16)	Speeding, Pedestrian, Bicycle
Wilmington- Reconstruction On Route 38 (Main Street), From Route 62 to the Woburn C.L.	Intersection, Pedestrian, Bicycle
North Andover- Corridor Improvements on Route 114, Between Waverly Road & Willow/Mill Street	Intersection, Pedestrian, Bicycle
Greenfield- Intersection Improvements at Two Locations, Route 2 and Colrain Road & Route 2 And Big Y Entrance	Intersection
Springfield- Improvements on St. James Avenue at Tapley Street	Intersection, Pedestrian, Bicycle
Springfield- Improvements on St. James Avenue at St. James Boulevard and Carew Street	Intersection, Pedestrian, Bicycle
Swansea- Traffic Signal and Safety Improvements at Three Intersections on Route 6	Intersection, Pedestrian, Bicycle
Lowell- Tewksbury- Route 38 Intersection Improvements	Intersection
Southbridge- Intersection Improvements at Central Street, Foster Street, Hook Street and Hamilton Street	Intersection, Pedestrian, Bicycle
Peabody- Rehabilitation of Central Street	Speeding, Pedestrian, Bicycle
Worcester- Intersection Improvements on Chandler Street and May Street	Intersection, Pedestrian, Bicycle
Holyoke- Resurfacing and Related Work at Cabot Street and Race Street (Center City Connector)	Pedestrian, Bicycle
Wilmington- Intersection Improvements at Lowell Street (Route 129) and Woburn Street	Intersection, Pedestrian, Bicycle
Lynn- Intersection Improvements at Two Intersections on Broadway	Intersection, Pedestrian, Bicycle
Attleboro- North Attleborough- Median Cable Barrier Installation on I-95	Lane Departure
Chelsea- Targeted Safety Improvements and Related Work on Broadway, from Williams Street to City Hall Avenue	Speeding, Pedestrian, Bicycle
Burlington- Billerica- Resurfacing and Related Work on Route 3A	Lane Departure, Pedestrian, Speeding
Statewide- Systemic Countermeasures for SHSP Implementation (Pedestrian and Bicycle Safety)	Pedestrian, Bicycle
Lynn- Nahant- Northern Strand Extension	Pedestrian, Bicycle
School Zone Speed Feedback Signage at Various Locations (285 Signs)	Speeding, Lane Departure, Pedestrian, Bicycle

Table 21 summarizes HSIP expenditures by EA in comparison to fatal and suspected serious injuries. Note that because both projects and crashes can be assigned to multiple EAs, the total sum of percentages for each column exceeds 100 percent. Pedestrian projects account for the largest proportion of HSIP funds, followed by bicyclist. This is primarily due to MassDOT's inclusion of pedestrian and bicycle improvements in nearly all projects. Intersection also accounts for a large proportion of HSIP projects. Finally, lane departure and speeding are a small proportion of funds – the proportion of funding spent on lane departure is notably lower than the crash proportion, whereas for speeding the proportion of funds is relatively higher. MassDOT may consider increasing the programming of lane departure projects to bring the program in further alignment with fatalities and suspected serious injuries in Massachusetts.

Table 21. Distribution of HSIP funds by SHSP EA.

SHSP EA	Number of Projects	HSIP Dollars Associated	Percent of Total HSIP Dollars	Percent Fatal + Suspected Serious Injuries
Intersection Related	14	$53,599,899	65%	34%
Lane Departure	4	$10,100,052	12%	29%
Older Driver Related	0	$0	0%	19%
Occupant Protection	0	$0	0%	16%
Young Driver Related	0	$0	0%	13%
Motorcyclist	0	$0	0%	12%
Impaired Driving	0	$0	0%	12%
Pedestrian	20	$73,211,094	89%	11%
Speeding-Related	5	$15,568,230	19%	10%
Distracted Driving	0	$0	0%	9%
Truck Involved	0	$0	0%	6%
Bicyclist	18	$66,969,163	82%	4%
Work Zone	0	$0	0%	2%
At-Grade Rail Crossing	0	$0	0%	1%

Program Status and Future Plans

Ultimately, this HSIP Implementation Plan is being updated to consider how MassDOT can improve the effectiveness of the HSIP and contribute more towards developing a Safe System and meeting safety performance targets. The following is the list of recommendations, primarily from previous plans, with status updates for each recommendation and how the recommendation will be advanced in future program years. In some cases, previous recommendations overlapped so MassDOT looked for opportunities to consolidate similar suggestions.

Safe System Approach and Program Management

- Use the HSIP to champion the Safe System Approach in Massachusetts, highlighting how its principles and elements should be considered in all projects and programs. This includes adding context-based speed limit selection and speed management countermeasures in most if not all projects.
    - **Status Update:** MassDOT adopted the Safe System Approach at an executive level, so this will filter down to the entire project planning and development process. Further, Massachusetts's 2023 SHSP update included the adoption of the Safe System Approach, which will guide all HSIP efforts. MassDOT is also taking efforts to implement speed management and context-based speed decisions in all projects, but especially HSIP projects. MassDOT is increasing proactive safety by programming additional systemic projects. MassDOT's Complete Streets approach considers all users in design. MassDOT released the "Learn about speed management" webpage, which includes information about the role of speed in traffic safety. Additionally, this webpage includes materials related to speed limit setting and selecting target speeds for design.
    - **Moving Forward:**
        - MassDOT should consider implementing new FHWA Safe System tools, including the Roadway Design Hierarchy and the Policy-based and Project-based alignment frameworks, to impact program-level and project-level decisions. These resources will help MassDOT advance their implementation of the Safe System Approach.
- MassDOT should consider identifying opportunities to advance the Safe Speed element of the Safe System approach by integrating target speed setting in HSIP projects (as well as all projects), encouraging use of the Roadway Treatment Technical Toolkit, being consistent with the application of their Complete Streets program, and programming systemic projects focused on speed management.
    - **Status Update**: MassDOT identified rural gateways as a risk factor in speed-related crashes and prioritized five locations to test out a new kind of quick hit project focused on systemic speed management. Additionally, MassDOT has incorporated target speed setting into all projects through their design guidelines.
    - **Moving Forward:**
        - MassDOT should continue ongoing plans to create a new project that will systemically address speed management at five locations in Districts 1, 2, and 3. This project will advertise as a low-cost project in 2025.

        - MassDOT will develop a method to systemically identify areas in need of speed management countermeasures and develop potential guidance on how to plan for and select speed management countermeasures for those locations.
- MassDOT's HSIP should focus on reducing fatal and suspected serious injury crashes. This includes both hot-spot and systemic screening and project selection methods.
    - **Status Update:** Massachusetts's 2023 SHSP update included the adoption of the Safe System Approach, which prioritizes a proactive approach to reducing fatalities and serious injuries. MassDOT has also recently updated their network screening models for fatal and serious crashes and now focuses their systemic projects on these models' outputs.
    - **Moving Forward:**
        - Guided by the new 2023 SHSP, MassDOT should continue to focus on reducing fatalities and serious injuries in a proactive manner, programming more and more systemic projects.
        - MassDOT should also seek to develop a methodology for identifying priority locations along freeways.
        - MassDOT should review resources from NCHRP 22-45 to improve the RSA and diagnosis process to better identify solutions targeting fatal and serious injury crashes.
- MassDOT's HSIP should focus on lane departure crashes, intersection crashes, and pedestrian crashes. Infrastructure improvements for these EAs should have carryover effects on other EAs in Massachusetts such as impaired driving, speeding, and occupant protection.
    - **Status Update:** MassDOT's Complete Streets policy encourages the consideration of all users in each transportation project, resulting in pedestrian and bicycle improvements in most projects. Complete Streets and the MassDOT Speed Management policy also encourage the selection of context-sensitive speeds to govern design. Further, MassDOT completed their VRU Safety Assessment in 2023 and now have dedicated funding for VRU safety projects. Additionally, the risk-based network screening maps in the IMPACT tool provide sites to originate systemic projects for these EAs. MassDOT has also expanded their ongoing Focus on Reducing Rural Roadway Departures (FoRRRwD) program to cover 20 additional communities in District 3 using leftover program funds from Districts 1 and 2.
    - **Moving Forward:**
        - MassDOT will continue to program new rounds of pedestrian crossing improvements adjacent to bus stops and pedestrian signal projects for high priority communities. MassDOT will also consider material procurement projects for local agencies to address pedestrian safety (e.g., RRFBs).
        - MassDOT should use the updated risk-based network screening maps to prioritize communities for specified safety projects under each 2023 SHSP emphasis area.
- MassDOT should work closely with MPOs to identify projects/programs to reduce both infrastructure and behavioral risk factors. Consider opportunities to fund behavioral safety projects and programs in the future to target issues such as impaired driving, speeding, and

occupant protection. The IIJA now allows HSIP funds to be used for "specified safety projects" (e.g., non-infrastructure projects which support the SHSP).

- **Status Update:** MassDOT updated the risk-based network screening maps to prioritize communities for specified safety projects under each 2023 SHSP emphasis area. With the enactment of IIJA and allowance of HSIP funding for non-infrastructure projects, MassDOT programs speed feedback and other such projects using HSIP funds. Using state funds, MassDOT is piloting a large-scale citywide seat belt awareness and educational campaign with Brockton on the dangers of being unrestrained.
- **Moving Forward:**
  - MassDOT should work closely with MPOs to identify projects and programs to address risks.
  - MassDOT should evaluate the state-funded public awareness campaign on seat belt use in Brockton to determine the impact of the program. Using the conclusions of this evaluation, MassDOT should replicate this public awareness campaign elsewhere using HSIP funds for top risk communities.

- In an effort to use the HSIP to advance safety across the State, MassDOT should identify opportunities to support local agencies interested in pursuing Safe Streets and Roads for All (SS4A) grants, as well as other State and Federal grants.
  - **Status Update:** All planning agencies have received SS4A grants. MassDOT's IMPACT tool provides ready access to safety data for agencies preparing their grants.
  - **Moving Forward:**
    - MassDOT should work with local agencies to determine if additional improvements in IMPACT may help better facilitate SS4A (and similar) grant application development.

Geography and Jurisdiction

- MassDOT's HSIP should include projects for both MassDOT- and locally-maintained roads.
  - **Status Update:** MassDOT continues using HSIP funds for material procurement projects to support systemic projects on local roads. MassDOT is also working with their regional planning partners to address safety concerns on local roads. For example, MassDOT's FoRRRwD program specifically targets rural locally-owned roads and MassDOT has an upcoming program that will provide pedestrian crossing enhancements at bus stops along municipality-owned roads.
  - **Moving Forward:**
    - MassDOT developed *A Safety Action planning Primer for Massachusetts Communities*[37] to assist MPOs and local communities in developing local road safety plans. MassDOT should continue to market this resource so local agencies are aware.
- Given the large proportion of severe crashes in urban areas, MassDOT's HSIP should prioritize urban areas, but should provide an annual set-aside of funding for rural road safety projects. Additionally, MassDOT should consider distributing HSIP funds by District based on the number of fatal and suspected serious injuries, or at least work with the Districts with the most fatal and suspected serious injuries to understand what challenges they are facing.

[37] https://www.mass.gov/doc/safety-action-planning-primer-for-massachusetts-communities/download

- **Status Update:** MassDOT distributed regional HSIP funds throughout the State and by RPA using the STIP.
- **Moving Forward:**
  - MassDOT should continue to distribute HSIP funds throughout the State and by RPA using the STIP.

Countermeasures

- MassDOT should continue to encourage the use of innovative intersections to address traffic safety issues, particularly at stop-controlled intersections. MassDOT's ICE policy will help determine the most appropriate alternative.
  - **Status Update:** The adoption of MassDOT's ICE policy encourages the consideration of roundabouts and other reduced conflict intersections in nearly all intersection projects.
  - **Moving Forward:**
    - MassDOT's ICE policy should encourage the consideration of all-way stop-control (AWSC) as an interim treatment prior to installation of a roundabout, or in lieu of a roundabout, where total approaching vehicle volumes allow (typically under 15,000 vehicles per day or 7,500 vehicles from the major and minor approaches). Several States, including Delaware, Maine, and North Carolina, have demonstrated the effectiveness of AWSC as a safety countermeasure, virtually eliminating fatal crashes at intersections at which it is installed. MassDOT is now considering a systemic TWSC to AWSC conversion project which will be informed by ICE.
- The sole HSIP-funded HFST project showed that HFST has the potential to improve safety performance in certain conditions. MassDOT should explore opportunities to develop a systemic or systematic HFST project, as these projects tend to be cost-effective, particularly when addressing multiple sites at once.
  - **Status Update:** MassDOT encountered issues related to immediate post-installation care of HFST installations.
  - **Moving Forward:**
    - MassDOT should work with FHWA to revise HFST contracts to support post-installation maintenance.
    - MassDOT should review and document noteworthy practices for longer-term maintenance of HFST installations.

Project Programming, Delivery, and Evaluation

- Systemic safety projects show the potential for substantial returns on investment. As such, MassDOT should continue the use of systemic projects in the HSIP. MassDOT's risk-based network screening maps in IMPACT will help users identify sites for such projects.
  - **Status Update:** MassDOT has increased their systemic project programming, most recently launching a project enhancing VRU facilities adjacent to high-risk bus stops, expanding their four-foot bike passing buffer sign program, and adding District 3 to their roadway departure systemic initiative. Additionally, MassDOT identified material procurement as a method to overcome obstacles to implementing systemic projects on the local system. MassDOT has an ongoing effort to use HSIP funds in 20 communities in District 3 using HSIP funds for procurement.

    - **Moving Forward**:
        - MassDOT should continue its plans to systemically address pedestrian enhancements at locally-maintained signals within the top communities for VRUs. If successful, expand the program to additional communities.
- Continue to pilot and experiment with material procurement projects to increase local road systemic safety projects.
    - **Status Update:** As mentioned earlier, MassDOT programmed and delivered a material procurement project, providing local agencies with speed feedback signs on high-risk rural roads and in school zones.
    - **Moving Forward:**
        - MassDOT should continue its plans to expand this program. With funds already in place within contracts, potential projects include a planned rectangular rapid flashing beacon (RRFB) distribution project in 2025, as well as a potential AWSC project in the next few years.
- MassDOT should look for opportunities to incorporate low-cost safety countermeasures and Safe System concepts in other STIP projects. The example rumble strip addition showed that the addition of low-cost safety countermeasures to already planned projects can produce significant returns on investment for the small additional cost. Alternatively, allow for flexibility of the use of HSIP funds in the STIP so HSIP funds can be used outside of the Intersection and Safety categories. Additionally, continue to use the IMPACT risk-based network screening maps to incorporate low-cost targeted countermeasures in all projects, not just safety projects.
    - **Status Update:** MassDOT has worked with the Pavement division to encourage the review of IMPACT risk-based network screening maps to identify opportunities to incorporate targeted low-cost countermeasures into already programmed pavement and other projects. Additionally, the results in Table 12 suggest that the HSIP components of larger transportation projects are producing highly cost-effective safety benefits. MassDOT updated their network screening maps for posting to IMPACT, which should be live in late summer or early fall of 2024. To promote FHWA's Proven Safety Countermeasures (PSCs), MassDOT includes related information in all RSAs data packages.
    - **Moving Forward:**
        - MassDOT should complete its effort to create a master map which overlays risk-based and crash-based network screening results with crash clusters, equity data, and other data sources to make it easier to identify opportunities to incorporate systemic improvements in other programs.
- Implement relevant recommendations and findings from the 2023 VRU Safety Assessment. This includes considering equity for all users and communities in project programming and programming more proactive, systemic VRU projects.
    - **Status Update:** MassDOT completed the VRU Safety Assessment in 2023. A key finding of the VRU Safety Assessment was the increased risk present for vulnerable road users adjacent to bus stops.
    - **Moving Forward:**
        - MassDOT should continue its development of a systemic project that includes improvements to pedestrian and bicycle facilities adjacent to bus stops along

high-risk corridors. If these prove to be successful, expand the approach to develop additional projects.
        - Additionally, though not using HSIP funds, MassDOT is addressing pedestrian safety at locally owned signalized intersections in top risk VRU communities. MassDOT should continue to enhance pedestrian safety systemically for VRU top risk pedestrian communities.
- Analysis of future projects suggested most hot-spot projects selected for 2024 and 2025 are expected to be economically efficient, producing B/C ratios greater than 1.0.
    - **Status Update:** MassDOT has developed and established the use of the Safety Alternatives Analysis Guide in practice.
    - **Moving Forward:**
        - MassDOT should use the Safety Alternatives Analysis Guide to verify hot-spot projects are expected to produce sufficient safety returns.
        - MassDOT should continue to split fund projects with HSIP and other funds. MassDOT should invest the HSIP portion for the safety component of projects while recognizing there are other purposes and needs for projects.

Conclusion

MassDOT continues to administer their HSIP with the goal of achieving zero fatalities and serious injuries in Massachusetts. This HSIP Implementation Plan helps MassDOT continue to improve the HSIP through providing an overview of recent safety trends, a summary of historic project evaluations, a review of future project benefits, an update on program status, and recommending strategies and actions to increase program efficiency and effectiveness.

Key takeaways from this plan include:

- Massachusetts has seen an increase in fatalities and serious injuries in recent years which MassDOT is coordinating with their partners to address.
- Increase reliance on data-driven safety analysis has led to the selection and implementation of more effective projects for MassDOT's completed HSIP projects, as the total BCR for evaluated projects increased from 2.5 in the 2021 HSIP Implementation Plan to 5.0 in this plan.
- MassDOT continues to program systemic and hot-spot projects where BCR suggests the projects will be effective. While this plan shows only three systemic and material procurement projects are programmed, MassDOT recently programmed and completely several more (as documented in the 2023 HSIP Implementation Plan), compared to three such preliminary projects documented in the 2021 HSIP Implementation Plan. Projects programmed for 2024 and 2025 are project to save 27 lives over their service lives.
- While MassDOT listed several strategies and recommendations moving forward, key actions include:
    - Delivering proposed systemic and material procurement projects, learning from those projects, and refining the programming and delivery of future similar projects.
    - Continuing to develop and program projects addressing VRU safety. The systemic approach and material procurement will be useful as MassDOT expands their VRU safety focus.
    - Expanding the consideration of safety in all projects, especially through encouraging the installation of low-cost safety countermeasures in infrastructure improvements.
    - Identifying opportunities to expand the Safe System Approach in Massachusetts, especially through the implementation of Safe Speeds on the roadway system.
    - Supporting local agencies in their development of safety action plans and pursuit of grant funding to make roadways in their jurisdiction safer for all users. Continuing to support local road safety projects through material procurement, technical support, and other means.

MassDOT's Highway Safety Department will work with their partners and stakeholders to perform the actions and implement the strategies identified in this plan, refining their HSIP processes to continue on the road to zero fatalities.