GEORGIA DOT RESEARCH PROJECT 23-15

Final Report

EFFECTIVENESS OF AUTOMATED SPEED ENFORCEMENT IN SCHOOL ZONES AND GUIDANCE FOR CONTINUOUS USAGE IN GEORGIA

Georgia Department of Transportation

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16. Abstract
One of the growing concerns for transportation agencies is speed management in school zones, as it is vital to children's safety. Automated Speed Enforcement (ASE) is one of the measures to address speed management concerns. As of January 2024, approximately 286 schools across Georgia were equipped with ASE cameras, aiming to improve traffic safety in school zones. This research project was carried out to quantitatively evaluate the effect of ASE on safety in school zones. A comprehensive crash analysis was performed to estimate Crash Modification Factors (CMFs) using two approaches: (1) a before-and-after study with the EB approach, only considering treated schools and (2) a before-and-after study using the comparison-group method. A speed study was performed to collect speed data at schools with and without ASE, estimate key parameters, determine the percentage of drivers who exceeded school zone speed limits, and perform relevant statistical tests to compare speed variance distributions and speed distributions. A road user survey was conducted, and responses were analyzed through descriptive statistics and cross-classification. The results of the crash study indicated that, after implementing ASE cameras, total crashes have been reduced by 10 percent and 9 percent within the school zones at on-system and off-system treated schools, respectively. Also, speeding-related crashes have been reduced by 35 percent and 54 percent at on-system and off-system schools, respectively. Overall, ASE was found to be effective in reducing total crashes and speeding-related crashes in school zones, resulting in CMFs below 1.0 across all scenarios considered in this study. The results of the speed study indicated that treated schools experienced lower speed variances, higher driver compliance, and lower mean, 50th percentile, and 85th percentile speeds than control schools. At treated schools, the percentage of drivers exceeding school zone speed limits by more than 10 mph was 36 percent lower compared to control schools. At a 95 percent confidence level, the observed speed variance and speed distribution curves at treated schools were significantly lower than that at control schools. In summary, ASE was found to be an effective enforcement practice for speed management, resulting in improved safety in school zones.

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GDOT Research Project 23-15

Final Report

EFFECTIVENESS OF AUTOMATED SPEED ENFORCEMENT IN SCHOOL ZONES AND GUIDANCE FOR CONTINUOUS USAGE IN GEORGIA

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In cooperation with
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January 2026

METRIC CONVERSION CHART

SI* (MODERN METRIC) CONVERSION FACTORS				
APPROXIMATE CONVERSIONS TO SI UNITS				
Symbol	**When You Know**	**Multiply By**	**To Find**	**Symbol**
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
		NOTE: volumes greater than 1000 L shall be shown in m^3		
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa
APPROXIMATE CONVERSIONS FROM SI UNITS				
Symbol	**When You Know**	**Multiply By**	**To Find**	**Symbol**
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
°C	Celsius	1.8C+32	Fahrenheit	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

* SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380. (Revised March 2003)

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LIST OF ABBREVIATIONS AND SYMBOLS

AADT	Average Annual Daily Traffic
ASE	Automated Speed Enforcement
CITI	Collaborative Institutional Training Initiative
CMF	Crash Modification Factor
EB	Empirical Bayes
FHWA	US Federal Highway Administration
GA	Georgia
GDOT	Georgia Department of Transportation
GEARS	Georgia Electronic Accident Reporting System
HSM	Highway Safety Manual
IRB	Institutional Review Board (at Kennesaw State University)
K-S Test	Kolmogorov–Smirnov Test
Lidar	Light Detection and Ranging
Mph	Miles Per Hour
NHTSA	National Highway Traffic Safety Administration
OR	Odds Ratio
PDO	Property Damage Only
Radar	Radio Detection and Ranging
SPF	Safety Performance Function
TADA	Traffic Analysis and Data Application
TRB	Transportation Research Board
TWLTL	Two-Way Left-Turn Lane

US	United States
UK	United Kingdom
WHO	World Health Organization

EXECUTIVE SUMMARY

Georgia (GA) roadways experienced over 1,789 speeding-related traffic fatalities from 2019 to 2023, with 349 such fatalities in 2023 alone, showing a 64 percent increase over the decade. School zones, where there is a high likelihood of vehicle-pedestrian interactions involving adults and children, are among the most critical locations for speeding-related crashes. To address this challenge, Georgia House Bill 978 was passed in 2018, clearing the way for the use of Automated Speed Enforcement (ASE) in school zones. By January 2024, the Georgia Department of Transportation (GDOT) and other regional/local transportation agencies have equipped approximately 286 school zones in GA with ASE.

The main aim of this study was to quantitatively evaluate the effectiveness of ASE on safety and vehicle speeds in school zones. The first objective was to estimate Crash Modification Factors (CMFs) that indicate the change in crash frequency after the treatment. The CMFs were estimated using the Highway Safety Manual (HSM) predictive method through (1) a before-and-after study with Empirical Bayes (EB) approach focusing only on treated schools and (2) a before-and-after study using the comparison-group method. The second objective was to estimate and compare speed parameters in schools with and without ASE cameras. This included collecting speed data, estimating key parameters, and the percentage of drivers who exceeded school zone speed limits, and performing relevant statistical tests. The third objective was to conduct a road-user survey to understand public perceptions on ASE.

The before-and-after crash studies yielded CMFs below 1.0 in all scenarios considered, indicating safety benefits of ASE. The before-and-after study using the comparison-group method found that total crashes were reduced by 10 percent (CMF = 0.90) and 9 percent (CMF =

0.91) and fatal and injury crashes were reduced by 3 percent (CMF=0.97) and 1 percent (CMF=0.99) within the school zones at on-system and off-system treated schools, respectively. Also, speeding-related crashes were reduced by 35 percent (CMF=0.65) and 54 percent (CMF=0.46) at on-system and off-system schools, respectively, after implementing ASE cameras. The results of the speed study indicated that treated schools experienced lower mean, 50th percentile, and 85th percentile speeds than control schools, considering free-flow vehicles during the school-zone hours. At treated schools, the percentage of drivers exceeding school zone speed limits by more than 10 mph was 36 percent lower compared to control schools. The speed variance distribution curve and the speed distribution curve at treated schools were statistically significantly lower than those at control schools at the 95 percent confidence level ($p<0.001$). The road user survey with 502 responses from GA drivers aged 18 or older, indicated that 71 percent of drivers who have driven across school zones with ASE cameras supported the ASE. The cross-classification analysis revealed that respondents' direct connections to schools influenced support for ASE, indicating more support from parents, individuals with school-aged siblings, and school employees. Also, age, driving experience, and whether respondents had previously received a fine also influenced the support for ASE. However, overall, the survey results were to be used with caution because many individuals who opposed ASE declined to participate in the survey.

In summary, ASE was found to be effective in reducing total crashes and speeding-related crashes, lowering speeds, enhancing driver compliance with school zone speed limits, and promoting consistency in driver behavior. These findings may provide transportation agencies with evidence-based guidance to continue using ASE in GA, enabling them to make informed decisions, as long as the concerns raised by Georgians are addressed.

CHAPTER 1. INTRODUCTION

BACKGROUND

Speeding can be defined as exceeding the posted speed limit by driving too fast for the conditions or racing, which is a dangerous driving behavior that has become the norm for many drivers in the United States (US). Speeding can be harmful on all types of roads, but particularly on non-interstate rural and urban roadways (National Highway Traffic Safety Administration [NHTSA] 2025-b). In 2023, speeding was a contributing factor in 29 percent of all traffic fatalities in the US (NHTSA 2025-b). Speeding causes considerable safety issues, leading not only to crashes but to high-severity crashes. Therefore, speed management has become a challenge for transportation agencies nationwide. Figure 1 shows total and speeding-related traffic fatalities in the US for the period from 2014 to 2023 (National Safety Council [NSC] 2025).

In 2023, approximately 2 out of every 10 fatal crashes in Georgia (GA) involved at least one driver who was speeding (Georgia Governor's Office of Highway Safety 2025-a). Among victims fatally or seriously injured in multiple-vehicle speeding-related crashes in GA in 2023, 63 percent were in the speeding vehicle, and 37 percent were occupants of other vehicles or non-motorists. Additionally, 25 percent of speeding drivers had a prior speeding conviction, and 22 percent had a previous suspension or revocation of their driver’s license recorded within the past 5 years. From 2019 to 2023, there were more than 1,700 speeding-related traffic fatalities in GA. Figure 2 shows the number of total and speeding-related traffic fatalities in GA from 2014-2023 (Georgia Governor's Office of Highway Safety 2025-b).

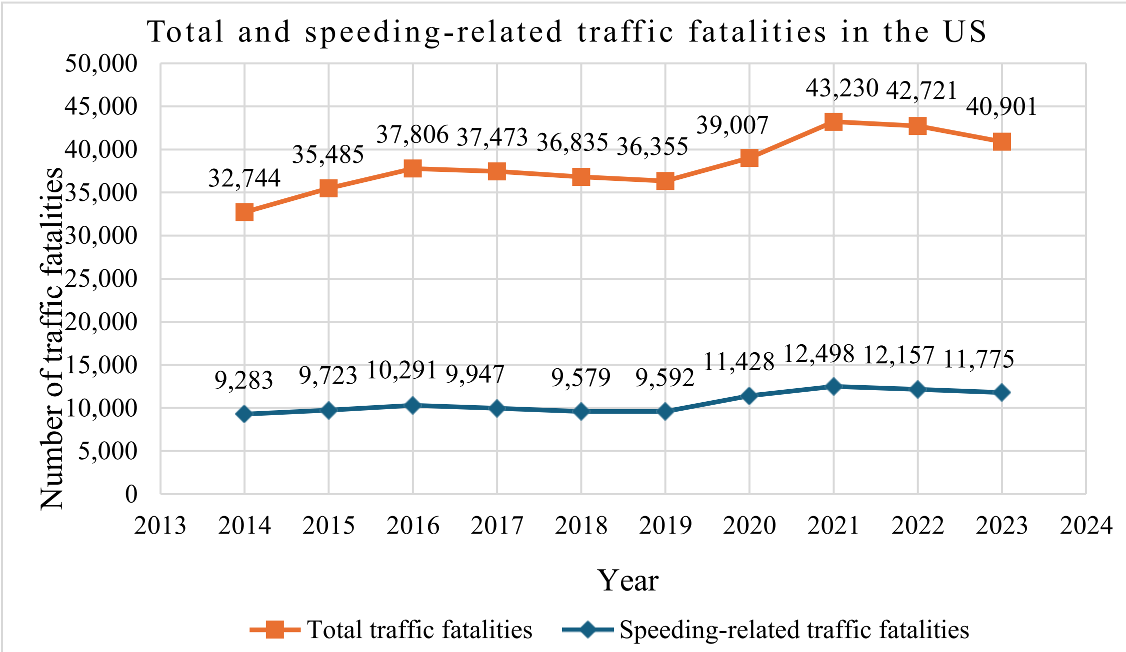


Figure 1. Graph. Total and speeding-related traffic fatalities in the US during the 2014–2023 period.

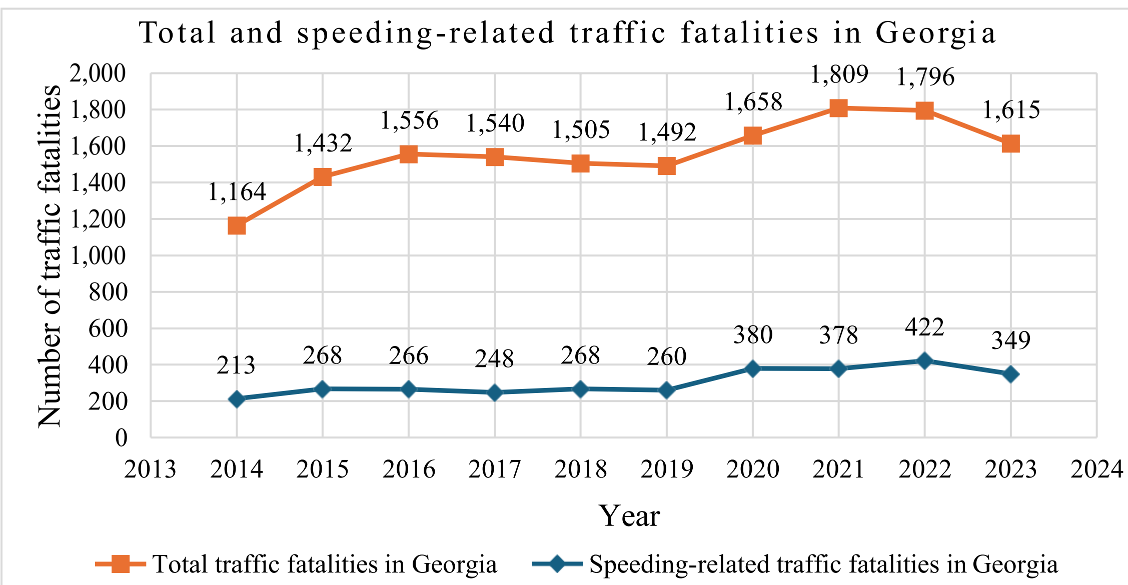


Figure 2. Graph. Total and speeding-related traffic fatalities in GA during the 2014–2023 period.

A growing concern about traffic safety in school zones in GA exists, with speeding being prevalent and thereby compromising the safety of young children. School zones are complex traffic environments with high interaction densities between motorized and non-motorized road users, short-term traffic surges during school opening and dismissal hours, and increased points of traffic conflict. The presence of vulnerable road users, such as children, cyclists, and school bus passengers, requires enhanced attention from drivers and reduced vehicle speeds in school zones. Given these circumstances, Georgia House Bill 978, Motor Vehicles; Automated Speed Enforcement Safety Devices in School Zones; Provisions was passed in 2018, clearing the way for the use of Automated Speed Enforcement (ASE) in school zones (Georgia General Assembly 2018). By January 2024, there were approximately 286 school zones in GA where ASE was in effect. Figure 3 shows the distribution of implemented schools across the state. The counties colored green had at least one school zone with ASE cameras. As of January 2024, there were 2,306 schools across the state, of which 12.4 percent had ASE cameras. County-wise, 30 percent of counties had at least one school with ASE cameras.

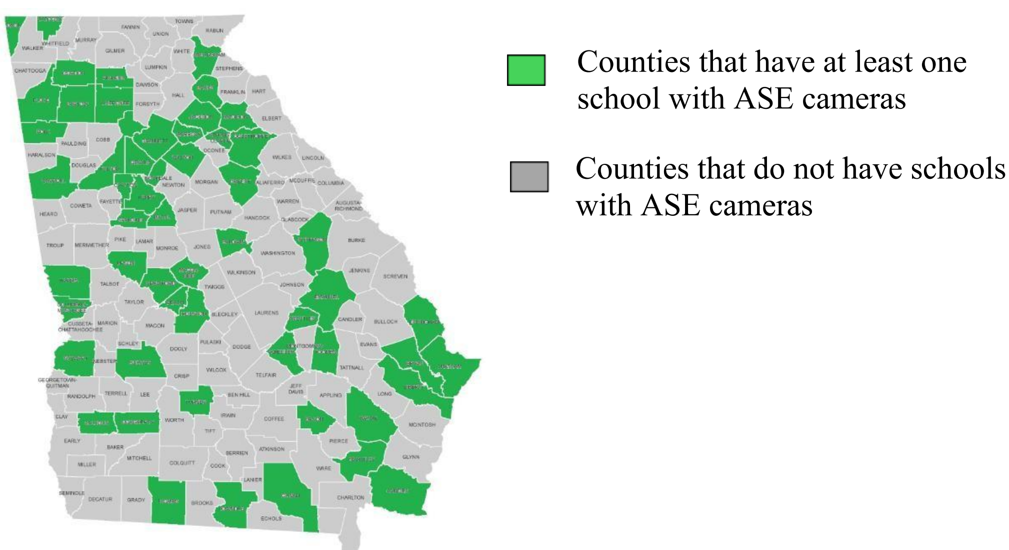


Figure 3. Map. Distribution of ASE-implemented schools across GA in January 2024.

Schools have been chosen to implement ASE cameras by both the local schools and the relevant police departments, after conducting a traffic study (City of Canton, GA 2025). Before implementing ASE cameras in a particular school, the school or the school system should apply for a permit from the Georgia Department of Transportation (GDOT), and approval/denial is at the discretion of the state traffic engineer (GDOT 2025). Figure 4 and Figure 5 illustrate two types of cameras commonly used in schools: pole-mounted cameras and speed cabinets.

Figure 4. Photos. Pole-mounted ASE cameras in school zones.

Figure 5. Photo. Cabinet-type ASE camera in a school zone.

According to the state law, ASE cameras are permitted to operate in school zones only on school days during the time in which instructional classes are taking place, and for 1 hour before such classes are scheduled to begin, and 1 hour after such classes have concluded (Georgia General Assembly 2018). A violation must be more than 10 mph over the posted speed limit in a school zone to warrant the issuance of a citation. In addition, clear and visible warning signs about cameras should be placed within 500 ft before the school zone reduced speed limit sign. These warning signs should be 24 by 30 inches in size and visible to all traffic lanes on the road under all traffic conditions. Figure 6 shows an ASE warning sign installed in a school zone.

Figure 6. Photo. ASE warning sign in a school zone.

After introducing ASE cameras in a particular school zone, drivers receive warnings only during the first 30-day period for exceeding the school zone speed limit. After the warning period, the civil monetary penalty is $75 for the first violation and $125 for any subsequent violation. The citation is issued to the registered vehicle owner via first-class mail, including all details related to the violation, such as the date, location, speed, and photographic evidence. These speed violations are not considered to be moving traffic violations for point assessment or insurance purposes. If the owner of the vehicle is not driving the vehicle at the time of speed violation or the vehicle has been reported stolen at the time of speed violation, the owner can contest the citation by testifying under oath in open court or by submitting to the court a sworn notarized statement or by providing the court a certified copy of a police report showing that the vehicle had been reported stolen before the time of the speed violation. If a person fails to pay the citation or does not file to contest it within 60 days of the law enforcement agency mailing the citation, a second notice and a subsequent final notice are sent, within 30 days for each. If the registered owner of the vehicle disregards the final notice, the record will be sent to the Department of Revenue, which will prevent the vehicle's registration renewal and prohibit the vehicle's title transfer within the state.

ASE cameras use multi-dimensional radio detection and ranging (radar) or light detection and ranging (lidar) technology to detect vehicle speeds. By analyzing the variations in the emitted and returned radio waves, these cameras capture and calculate the speed of a moving vehicle, serving as a reliable method for speed detection. If a vehicle exceeds the posted speed limit by 10 mph, the system triggers, and the camera activates. Simultaneously, the embedded automated license plate recognition system within the camera captures the vehicle's license plate, along with date, time, and location details. The law enforcement agency or the agent operating ASE cameras on behalf of the law enforcement agency should perform a self-test once every 30 days and conduct an independent calibration test at least once every 12 months to verify the accuracy of these devices (Georgia General Assembly 2018).

GOALS AND OBJECTIVES

Although about 286 school zones across the state have been equipped with ASE cameras as of January 2024, their impact on vehicle speeds and crashes, and thereby the safety of school zones, has yet to be evaluated independently. There is also limited guidance on the long-term use of these programs. As driver compliance with posted speed limits has the potential to enhance roadway safety, authorities need to assess ASE as an investment. The effectiveness of ASE also depends on how well the community perceives it. Understanding public perceptions is crucial for making data-driven policy and funding decisions, assessing the long-term feasibility of the camera programs, and promoting compliance. This study aims to quantitatively evaluate the effectiveness of ASE cameras on traffic safety and vehicle speeds in school zones in GA. The study has three main objectives.

- To evaluate the effectiveness of ASE camera use on school zone safety: The research team conducted two studies (1) before-and-after study with Empirical Bayes (EB) approach considering only treated schools and (2) before-and-after study using the comparison-group method. Both studies were conducted according to the American Association of State Highway Transportation Officials (AASHTO) Highway Safety Manual (HSM) to estimate Crash Modification Factors (CMFs) that reflect the change in crash frequencies after implementing ASE cameras in school zones.
- To evaluate the effectiveness of ASE camera use on vehicle speeds in school zones: The research team collected and analyzed speed data to estimate key speed parameters and percentages of drivers who exceeded the school zone speed limits, and to perform statistical tests comparing variance distributions and speed distributions in school zones with and without ASE cameras.

- To explore public perceptions toward ASE programs through a road user survey: The researchers conducted a road user survey to explore the opinions of GA drivers aged 18 or over regarding ASE camera programs.

ORGANIZATION OF THE REPORT

This document is organized as follows. Chapter 2 provides a comprehensive understanding of the existing body of knowledge on ASE, including speeding as a key contributor to traffic safety; the traffic safety problem in school zones; current speed management practices in school zones; ASE practices; the effectiveness of ASE in terms of the reduction of crashes, vehicle speeds, and public opinion including the methodologies used; challenges of implementing ASE; and future trends. Chapter 3 presents the descriptive methodologies used in this study, including sampling techniques, data collection methods, and analytical procedures. Results of the crash analysis, speed analysis, and road user survey are presented and discussed in detail in Chapter 4. The summary, recommendations, and limitations of the study are provided in Chapter 5. The appendices (Appendix A-Appendix J) and list of references are provided at the end of this report.

CHAPTER 2. LITERATURE REVIEW

This chapter provides a comprehensive understanding of the existing body of knowledge on ASE. It summarizes studies on speeding as a key contributor to traffic safety; the traffic safety problem in school zones; current speed management practices in school zones; ASE practices; the effectiveness of ASE in terms of the reduction of crashes, vehicle speeds, and public opinions, including the methodologies used; challenges of implementing ASE; and future trends as discussed in the literature. By reviewing prior research, this chapter identifies and summarizes the research gap that led to the current study.

SPEEDING AND THE TRAFFIC SAFETY PROBLEM IN SCHOOL ZONES

Speed is recognized as a key contributor to traffic crashes and the severity of crashes (Jurewicz et al. 2016). The leading cause of death among young people aged 15–29 years all over the world is traffic crashes (World Health Organization [WHO] 2025). Children are considered more vulnerable road users due to their small physical size, which makes them less visible to drivers; their unexpected behavior compared to adults; and their limited ability to judge vehicle speed or distance (Kattan et al. 2011). An alarming number of pedestrian fatalities and injuries occurred in school zones in the US during the past decade, and about 25,000 children were injured and 100 were killed annually while walking to school (Colorado Department of Transportation 2024).

Only a few studies have been conducted in the US to examine driver compliance with school zone speed limits. One study found that the mean speed of school zones in the state of Mississippi was higher than the posted speed limit of 35 mph (Rahman and Strawderman 2016). Another study conducted in 2019 at 6 school zones in Alpharetta, GA, found that 3,557 drivers were traveling more than 11 mph over the posted speed limit while the school zones were active

(City of Alpharetta, GA 2025). Additionally, it was discovered that more than 54 percent of violators traveled at least 15 mph over the school zone speed limit, with 14.2 percent exceeding the speed limit by 20–24 mph. Speeding in school zones is also a critical issue in other countries. A study was conducted in Sydney, Australia, to examine speeding behavior in school zones using GPS, spatial, demographic, and psychological data from 147 drivers over a 5-week period (Ellison et al. 2013). The focus was on the duration and the extent to which drivers exceeded the posted speed limits. The main finding of the study was that 23 percent of the distance traveled in school zones exceeded the school zone speed limits, which was a higher rate compared to urban arterials and residential streets.

Another study was conducted in the City of Calgary, Alberta, Canada, to investigate speed compliance, mean speed, and 85th percentile speed at selected school zones and playground zones (Kattan et al. 2011). It was found that the mean speeds and 85th percentile speeds in school zones were lower, and speed compliance was higher in school zones compared to playground zones. However, the mean and 85th percentile speeds were slightly higher than the school zone speed limit of 30 km/h in those school zones. For the study, speed data were collected using laser speed guns during the daytime off-peak period under free-flow conditions. Additionally, another study conducted in Toronto, Canada, examined the relationships between factors related to school location and motor vehicle versus child pedestrian collisions (Warsh et al. 2009). There was a total of 2,717 motor vehicle versus child pedestrian collisions during the 2000–2005 period, and the area density of collisions, specifically fatal collisions, was highest in school zones. The density of collisions decreased as the distance from the school increased.

CURRENT SPEED MANAGEMENT TECHNIQUES IN SCHOOL ZONES

Effective speed management can mitigate traffic crash fatalities and severity (Federal Highway Administration [FHWA] 2023). Even a 5-mph reduction in speed could contribute to a significant reduction in severe injuries or fatalities to children (Tefft 2013). Several countermeasures are in practice to control vehicle speeds in school zones, including traffic calming methods, speed limit signs, flashing beacons, manual enforcement, and ASE (Quistberg et al. 2019). A study conducted about school zone flashers in North Carolina found that both flasher and non-flasher sites had low compliance with the school zone speed limits (Simpson 2007). In Toronto, Canada, school safety zones were created in 2017 under the City of Toronto's Vision Zero Road Safety Plan, and a study was conducted to examine the effect of built environment interventions on driver speeds, active school transportation, and dangerous driving in those school zones (Rothman et al. 2022). The study's results revealed no change in speed metrics at those schools.

The lack of attention to speed limit signs leads to non-compliance with the posted speed limits in school zones when several school speed limit signs are present within a given area or when several school zones are located nearby (Rahman and Strawderman 2016). Additionally, the lack of human resources creates limitations in manual speed enforcement (Tay 2009). For example, it is difficult to enforce speed limits manually in certain situations, such as heavy traffic congestion or adverse weather conditions. Therefore, ASE practices are increasingly used to enforce speeds in school zones.

AUTOMATED SPEED ENFORCEMENT

In ASE, there are mainly three types of cameras utilized: fixed, safety, and mobile (Audit Office of New South Wales 2011). Cameras can detect vehicle speeds using radar, lidar, or loop detectors and capture photos of vehicles that surpass predefined speed thresholds. Fixed cameras are installed in areas that require higher safety measures, such as school zones or work zones, with a focus on speed enforcement to enhance safety in these critical areas. Safety cameras are also deployed at signalized intersections, with the capability to detect drivers exceeding speed limits and running red lights. Mobile cameras are designed to address speeding issues across the entire road network rather than at predetermined locations. Their unpredictability prompts drivers to consistently obey posted speed limits, as they cannot foresee the camera's location, thereby promoting safer driving behavior. In enforced zones, necessary signs, speed limits, and flashing beacons are installed, which remind drivers to comply with the posted speed limits (Quistberg et al. 2019). Drivers found to be speeding more than the threshold speed are issued citations through the mail, and the license plate of the vehicle captured during the violation is attached to the citation.

Different countries and states have varying rules and regulations regarding the implementation of ASE. In South Wales, Australia, specific criteria exist for selecting sites to deploy speed cameras in school zones. These criteria typically include prerequisites such as a minimum traffic flow and at least 10 crashes within 3 years, with at least one occurring during school hours (Audit Office of New South Wales 2011). In GA, schools are required to complete and submit the Automated Traffic Enforcement Safety Device Permit Form to the GDOT. This form provides the necessary information and documentation for the department to evaluate the need for the permit. Details include the location; the specific device, model, or identification; traffic data (such as vehicle count and speeds); a list of all schools within the relevant school zone; and proof that the applicant has obtained all essential permissions, permits, and property rights for installing, maintaining, and operating the device. The approval or denial of an application will be determined at the state traffic engineer's discretion. Several states in the US, including Maine, Mississippi, New Hampshire, New Jersey, South Carolina, Texas, Utah, West Virginia, and Wisconsin, have passed laws prohibiting the use of such cameras for traffic enforcement (Governors Highway Safety Association 2024). ASE implementation across different regions reflects a blend of criteria, community-specific regulations, and varying legislative stances, reflecting the complexity and diversity in achieving road safety measures.

ASE uses a camera for capturing license plate with technology for detecting speed. When the target is not stationary, the radar device detects variations in the transmitted and received signals; this phenomenon is known as the Doppler effect. The change in frequency is accurately measured by speed cameras, enabling them to determine the speed of vehicles effectively. The photo, typically captured from the rear of the vehicle, includes details such as the vehicle and its registration tag, as well as the time, location, and speed, and it serves as evidence for issuing citations to the registered owner. The accuracy of this entire process is rigorously regulated, adhering to specific standards set by the corresponding authorities. Various tests should be conducted by certified personnel to ensure the system's compliance with standards and its precision. Given their exposure to various weather conditions, radar speed cameras may require regular maintenance and calibration to ensure optimal performance. This regular upkeep is essential to ensure the accuracy and reliability of their speed measurements.

These automated systems can have modified configurations and operations based on the location where they are installed. Different regions might have diverse traffic regulations and policies, resulting in adjustments to the system's operational thresholds, tolerances, or even the technology used for detection and identification. For example, in Italy, loop detectors placed underneath the pavement are used to measure the speed of vehicles. As vehicles pass through these detectors, cameras capture the data at a 25 frames per second rate (Montella et al. 2012). These images are analyzed for license plate identification. At exit points, a similar process calculates average speed. If the calculated average travel speed exceeds the posted speed limit, plus a maximum tolerance speed between ~3 mph and 5 percent of the posted speed limit, the system automatically activates and captures the license plate. These variations in regulations reflect the fact that ASE systems are subjected to specific legal and technological requirements, depending on the area in which they are installed.

EFFECTIVENESS OF AUTOMATED SPEED ENFORCEMENT IN TERMS OF REDUCTION OF CRASHES, VEHICLE SPEEDS, AND PUBLIC PERCEPTION

A study conducted on ASE cameras on both residential streets and school zones in Montgomery County, Maryland, found that ASE cameras have directly contributed to reducing vehicle speeds (Hu and McCartt 2016). In the study, free-flow and off-peak vehicle speeds were compared before and 7.5 years after the program's implementation. A sample of 20 camera sites out of 40, which had similar characteristics was selected for analysis. There, 19 camera sites were located on residential streets, and the other camera site was in a school zone. Additionally, 10 control sites were randomly selected, located adjacent to Montgomery County, to examine potential spillover effects. The speed of passenger vehicles was measured using speed cameras at each location from 10:00 a.m. to 4:00 p.m., Monday through Friday. To ensure consistency between the before and after periods, the weighted mean of the statistics for each site in the after period was calculated, using weights equal to the proportion of vehicles observed at each site during the before period.

A linear regression model and a logistic regression model were developed in the study to model the mean speed and the odds of vehicles exceeding the speed limit by 10 mph, respectively. The independent variables in the models were hourly vehicle counts during observation periods, individual site indicators, a study period indicator, and an indicator for camera versus control sites during the after period. Results indicated that ASE cameras caused a 10.2 percent reduction in the mean speed and reduced the probability of exceeding speed limits by 10 mph by 62 percent compared to control sites. Also, the study found a 19.4 percent reduction in the probability of involving an incapacitating or fatal injury at ASE camera sites located in school zones and residential streets. Additionally, a telephone survey was conducted among 900 licensed drivers in Montgomery County to assess their awareness and attitudes toward the ASE program. A chi-squared test was performed to identify significant differences in responses across the age and gender of the respondents. Support for school zone cameras was significantly higher than support for cameras on residential streets.

Another study, conducted in four school zones with ASE cameras in Seattle, Washington, found that speed limit violation rates gradually decreased over time and tended to increase after weekends, school breaks, and summer vacation periods (Quistberg et al. 2019). For the study, hourly vehicle volume, hourly violation rate, mean hourly speed, mean hourly violation speed, and hourly maximum violation speed were evaluated during the warning and citation periods. An interrupted time-series analysis model was developed considering the time of day, day of the week, and quarter of the year. Only the day of the week and the quarter of the year were considered in the final model, as no significant difference was observed between morning and afternoon times. According to the results, the hourly citation rate per 1,000 vehicles decreased by 50 percent in school zones during the citation period compared to the warning period, whereas traffic volumes remained relatively constant during both periods. The overall mean hourly speed decreased by 1 mph during the warning period and remained steady after the introduction of ASE cameras, with drivers traveling 5 mph less during school travel times. When the cameras were not installed, it was common for drivers to travel at speeds exceeding 30 mph beyond the posted speed limit.

A study examined the contribution of ASE to the Vision Zero mission and action plan, which was initiated in 2015 by the District of Columbia, aiming for zero traffic fatalities by 2024 (Abdelhalim et al. 2021). The primary objectives were to evaluate the effectiveness of the ASE system in terms of crash frequency and severity, the percentage of road users who received citations, and the impact on the overall speeding behavior of vehicles along corridors. The study period spanned from 2016 to mid-2019, and 29 locations were selected based on two criteria: availability of crash data from 2016 and installation of ASE during the 2017–2018 period. To determine the area of influence of speed cameras at selected locations, a maximum distance of 750 ft was considered. For locations where the distance to the nearest intersection exceeded this value, a maximum distance of 750 ft was used. Additionally, at locations where traffic signals were nearby, this influencing distance was reduced to minimize the upstream influence of traffic signals. Crash data due to speeding were collected, along with its severity levels, to perform a before-and-after comparative crash analysis. Each location had at least 1 year of crash data for the before-and-after analysis. The Haversine distance equation was used to determine the crashes that fell within the area of influence at each selected location. This was further verified using street identifiers and travel directions of vehicles involved in a crash. Of a total of 92,360 crashes, only 2 percent were reported as being caused by speeding.

Geospatial mapping of crashes and speed camera locations was also conducted. Hourly counts of violators and non-violators, and their respective violating and passing speeds, were collected to analyze trends in citations issued by the ASE cameras. To examine the driver behavior patterns before and after installing ASE cameras, a probe vehicle dataset was collected, which included 1-minute average speeds and travel times of predefined roadway segments. The results of the before-and-after crash analysis revealed that crash statistics at the selected camera locations showed a downward trend across all crash types. Citations were presented as a percentage of passing traffic, and the rate was 1.18 percent for the first month after the cameras were installed, decreasing to 0.79 percent after 12 months. The probability distributions of speeds of the after period illustrated a significant shift toward the defined speed limit.

A study conducted in Minnesota measured public rejection of ASE and the possibility of shifting opinions in a favorable direction through an online survey (Peterson et al. 2017). For the survey, 18 open-ended interviews were conducted with professionals in law enforcement, non-enforcement, government, the judiciary, and public health. The survey began with questions on sociodemographic characteristics, driving experience, and habits, followed by the respondent's opinion on ASE. Based on the respondent's answers on a 5-point scale, the rest of the survey was designed. During the interviews, the following principal reasons for opposing ASE were identified:

- ASE is unconstitutional.

- ASE makes the owner of the car responsible for tickets regardless of who is driving.
- ASE will have a negative impact on law enforcement duties.
- ASE will not work.
- ASE would not be implemented fairly.
- The public does not support ASE.
- ASE is only to make money for the government.
- ASE is an invasion of a driver's privacy.
- ASE expands the reach and control of the government.

These nine issues were incorporated into the survey, and participants who opposed ASE could select two of them. Another series of questions was then based on those selections and pre-identified reasons. The survey was completed by 203 participants, and 100 of them had favorable opinions on ASE when they entered the survey. Their primary focus was on the safety effects of speeding. Participants who opposed ASE held different views on the nine pre-identified issues. Additionally, the survey revealed a lack of public awareness about ASE. For further understanding, the researchers suggested expanding the survey to other states, increasing the sample size and including a control group, and conducting in-person interviews rather than online surveys.

Another online survey was conducted to investigate the level of acceptance and support for different types of speed enforcement, mainly ASE, and the influence of informative statements or suggested ASE policies on levels of acceptance and support among people in British Columbia, Canada (Beaton et al. 2022). To examine public perceptions, an online opinion poll was developed and conducted in 2018. The survey consisted of four main sections, each containing multiple questions. Those sections included sociodemographic information about the respondent, opinions on different types of speed enforcement practices, opinions on pro-ASE and con-ASE statements, various critical elements of support, and additional comments. The survey received 802 responses from adults of driving age, and around one-third of respondents provided additional comments on ASE. Survey results revealed that more than four in five respondents endorsed traditional police enforcement and fixed speed cameras in schools or playground zones. The lowest approval was for point-to-point enforcement. Of 16 pro-ASE and con-ASE statements, most respondents agreed that tickets should be issued to drivers, not vehicle owners, and wanted ASE in places where police officers cannot operate safely. Regarding the informative statements, most respondents rated the selected locations of cameras based on the frequency of road crashes and injuries.

Overall, when evaluating the effectiveness of different interventions, the use of before-and-after methods helps decision-makers monitor and understand the effects of a particular intervention, enabling them to make more informed decisions (Ma et al. 2024). The HSM recommends using the EB method in before-and-after studies when crash data are available for before-and-after periods, as it provides more statistically reliable estimates and CMFs (FHWA 2025-a). It combines observed crash frequencies with predicted crash frequencies derived from safety performance functions (SPFs). The HSM predictive method and SPFs can be used to estimate these predicted crash frequencies at a particular facility, or location-specific SPFs can be developed. Therefore, the EB method is more commonly used for estimating CMFs in traffic safety studies (Park et al. 2016, Gayah et al. 2024, Zlatkovic, and Cameron 2018). In speed studies, the two-sample t-test, Mann–Whitney *U* test, and Kolmogorov–Smirnov (K-S) test are widely used for comparing speeds before and after implementing speed limit changes, as well as with and without specific speed management or enforcement strategies (Abohassan et al. 2024, Shirazinejad and Dissanayake 2020). Regarding the questionnaire surveys, cross-classification analysis using a chi-squared test, logistic regression models, Mann–Whitney *U* test, and several other methods are widely used to understand the variations in responses or opinions of people across different sociodemographic groups (Hu and McCartt 2016, Jevinger and Svensson 2024, Verma and Rastogi 2025, Matz et al. 2018).

CHALLENGES OF IMPLEMENTATION OF ASE

Public Opposition

The implementation of ASE has become challenging due to multiple reasons. It is expected that the public would widely support the installation of these cameras, however, there is significant opposition to this technology. Public opposition remains one of the primary hurdles in implementing ASE. Despite its proven potential to improve road safety, many people and organizations raise objections regarding the necessity of ASE programs. The critics present a variety of arguments, including allegations that ASE does not effectively change driver behavior, fails to prevent crashes, and may not be the most effective way to reduce traffic violations. They also express concerns about the reliability of the equipment, the delayed notification of alleged violators, and the deficiency of public awareness (Farmer 2017). Some individuals even question the motivations behind ASE, suggesting that it may be driven by revenue generation rather than a genuine commitment to safety (Peterson et al. 2017). Critics argue that the locations where ASE is installed may be intentionally selected to catch more violators, and this practice may also be allegedly based on race, raising concerns about fairness (Ralph et al. 2022).

Despite this opposition, a notable portion of the population supports and recognizes the importance of ASE, particularly in school zones (Hu and McCartt 2016). These individuals understand the danger of speeding in these areas and its potential to endanger children and other community members, creating an unsafe environment. Whereas some respondents maintain vague opinions about speeding in school zones, others explicitly endorse the importance of having speed limits in place. This highlights the willingness of a portion of the population to endorse ASE in school zones, even amid the broader challenges and opposition.

Legislation and Regulations

Challenges in the legislation and regulation of ASE programs in the US revolve around complicated issues, encompassing constitutional, legislative, and probative concerns. Although the primary purpose of these programs is to reduce speeding-related crashes and fatalities, their execution is significantly affected by legal restrictions and perceived violations of constitutional rights (Shaheen et al. 2007). One important challenge is rooted in the potential violation of rights, such as the right to privacy, freedom of association, and protection against illegal search and seizure, as outlined in the First, Fourth, Fifth, and Fourteenth Amendments to the US Constitution. Although legal scholars oppose ASE programs that do not actually violate constitutional rights, the potential for these programs to face constitutional challenges persists.

In GA, ASE began with the 2018 law (House Bill 978), which first authorized the use of automated traffic enforcement safety devices in school zones (Georgia General Assembly 2018). This law allowed local governments to install cameras that detect vehicles exceeding the posted school-zone speed limit and issue citations based on recorded images, with specific requirements for warning signs and camera operation times. Later, House Bill 225 in 2025 sought to repeal these provisions entirely, proposing to ban the use of ASE cameras in school zones and to prohibit local governments and law enforcement agencies from entering or renewing related contracts (Georgia General Assembly 2025-a). However, another 2025 proposal, House Bill 651, aimed to reform rather than repeal the system (Georgia General Assembly 2025-b). The amendment AM 39 0495 to HB 651 refined its scope, limiting camera operation strictly to school days and specific instructional hours, setting a 10-mph threshold over the posted limit for violations, prohibiting late fees or surcharges, requiring clearer warning signage, and mandating that collected funds be used exclusively for school safety purposes such as surveillance systems, crossing guards, or safety training. Finally, Senate Bill 172 in 2025 reversed the approach of HB 651 by proposing a complete repeal of all GA laws authorizing ASE in school zones, taking effect on July 1, 2026, and a prohibition on entering or renewing ASE contracts effective immediately (Georgia General Assembly 2025-c).

Therefore, enabling legislation is crucial for establishing the legal framework necessary for the effective operation of these programs.

Future Trends of ASE

Many researchers have provided recommendations to overcome challenges faced when implementing and operating ASE programs. ASE programs can be integrated into comprehensive road safety initiatives, and a long-term safety goal can be established to enhance public confidence (Farmer 2017). Additionally, the transparency of the program can be improved by publicizing the site selection process, the vendors involved, changes and updates to the program, procedures available for contesting citations, revenue generated, and how it is utilized (Farmer 2017). Public campaigns can be organized to emphasize the risks of speeding and the importance of adhering to speed thresholds (Fleiter and Watson 2012). Like drunk driving, speeding should be framed as a socially unacceptable behavior (Beaton et al. 2022). Key stakeholders of these ASE programs include the public, special interest groups, elected officials, and governmental agencies (Shaheen et al. 2007). The design of the program should be a collaborative effort among representatives of all those stakeholders (Farmer 2017). Additionally, statistics on speed and citations should be collected continuously to demonstrate the program's effectiveness, and calibration test results for cameras should be made publicly available. Rules and regulations should be updated to assign liability to the driver, not the vehicle owner, when citations are issued (Beaton et al. 2022).

ASE programs are expected to be expanded in the future in various ways. In terms of technology, ASE camera systems will be integrated with smart city infrastructure in the future. The infrastructure of smart cities can be integrated to create a connected network that adapts to real-time traffic conditions (Sadaf et al. 2023). Artificial Intelligence (AI) algorithms will be used to enhance the capabilities of speed cameras. For example, it will be important to take a frontal photograph of the driver, in addition to the photograph of the vehicle's license plate (Beaton et al. 2022). The use of mobile cameras is more effective than fixed cameras, as they are less predictable to the driver (Shaaban et al. 2023). Therefore, more mobile speed cameras will be used to enforce speed limits in the future. Currently, different countries and states have their own laws and regulations regarding ASE systems (NHTSA 2025-a). However, universal laws and protocols for ASE systems will be established in the future. Additionally, public acceptance is expected to improve gradually with increased transparency of such programs, and privacy concerns will be addressed in the future.

IDENTIFICATION OF THE RESEARCH GAP

There have been only a few studies on school zone–related ASE practices in the US. As previously described in the literature review, the study conducted to examine the effectiveness of ASE cameras in four elementary schools in Seattle, Washington, concluded that ASE was effective in reducing vehicle speeds in school zones (Quistberg et al. 2019). Another study conducted in Montgomery County, Maryland, evaluated the effectiveness of ASE, considering 19 camera sites located on residential streets and one camera site in a school zone (Hu and McCartt 2016). That study found that ASE was effective in reducing crashes and speeding in those camera sites. Although a few more studies have been conducted in the US in other contexts, such as residential streets, freeways, and work zones, no studies have been conducted in GA, where the implementation of ASE in school zones is relatively new.

Additionally, the driving culture in GA differs from that in other geographical areas, making this research project unique in nature. More importantly, this study adheres to the HSM predictive method and EB method in developing CMFs for ASE in school zones. The HSM provides CMFs for ASE in the general context. However, CMFs for ASE in school zones are not available in the current literature, and this is a novel contribution to the field of traffic safety. The study focused on conducting an in-depth analysis to develop CMFs across multiple categories, using different analysis methods, distances measured from the cameras, crash types, crash severity levels, and other factors. Additionally, many studies currently available in the literature have collected speed data directly from ASE cameras themselves. This study focused on collecting speed data in school zones independently. Overall, this research has extensive potential to yield significant benefits for residents of GA.

CHAPTER 3. METHODOLOGY

This chapter presents the methodologies employed in this study, including sampling techniques, data collection methods, and analytical procedures, as illustrated in Figure 7.

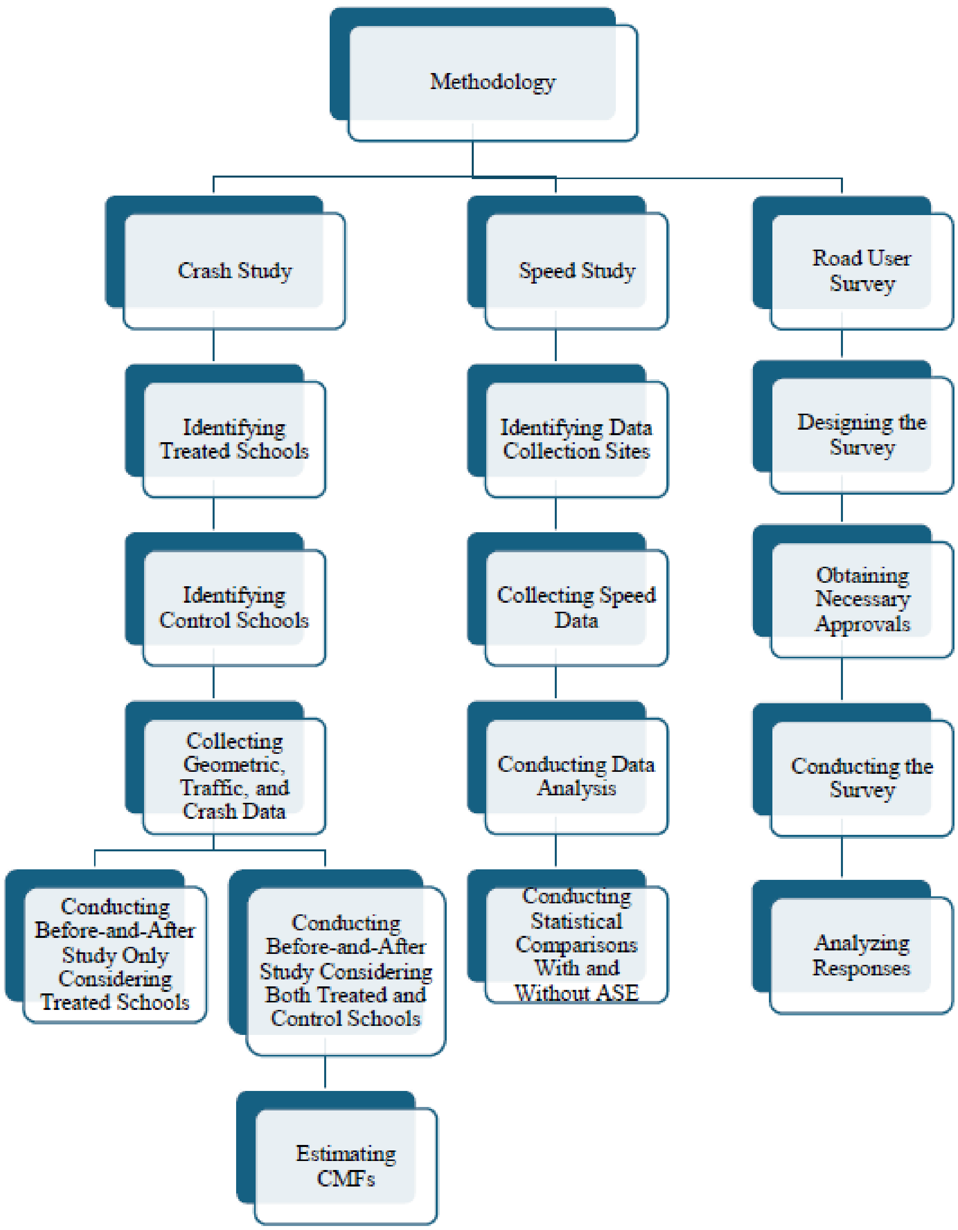


Figure 7. Flowchart. Overview of study methodology.

CRASH STUDY

Treated Schools

As of January 2024, ASE had been implemented in 286 schools across 54 school districts in GA. At the time, there were total of 181 school districts across the state, containing 2,306 schools (Georgia Department of Education 2025). Approximately 12.5 percent of schools had already been equipped with ASE cameras, and 30 percent of school districts in GA had at least one school with ASE cameras. Table 1 presents the number of schools with ASE cameras by school type as of January 2024.

Table 1. Distribution of schools with ASE in GA based on the type of school.

School Type	Number of Schools with ASE
Elementary Schools	130
Middle Schools	53
High Schools	68
Other Schools	35

To have a better understanding of the geographical distribution of treated schools and corresponding ASE camera locations, they were mapped on Google Earth. Figure **8** shows a portion of the map, and Figure 9 shows a specific school and the corresponding camera locations on the map.

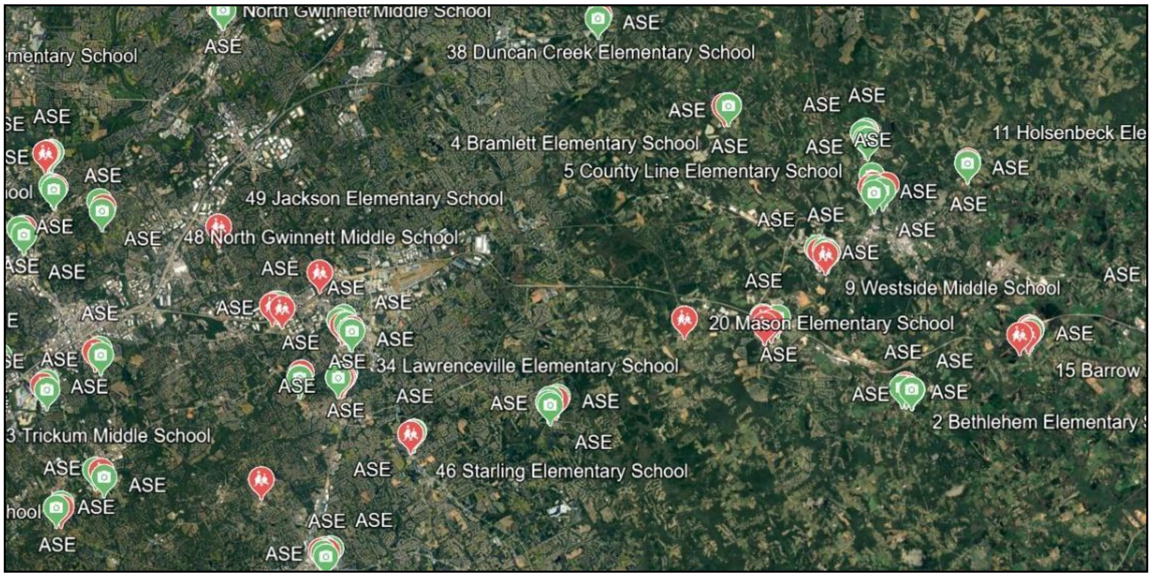


Figure 8. Map. Google Earth map with treated schools and ASE camera locations.

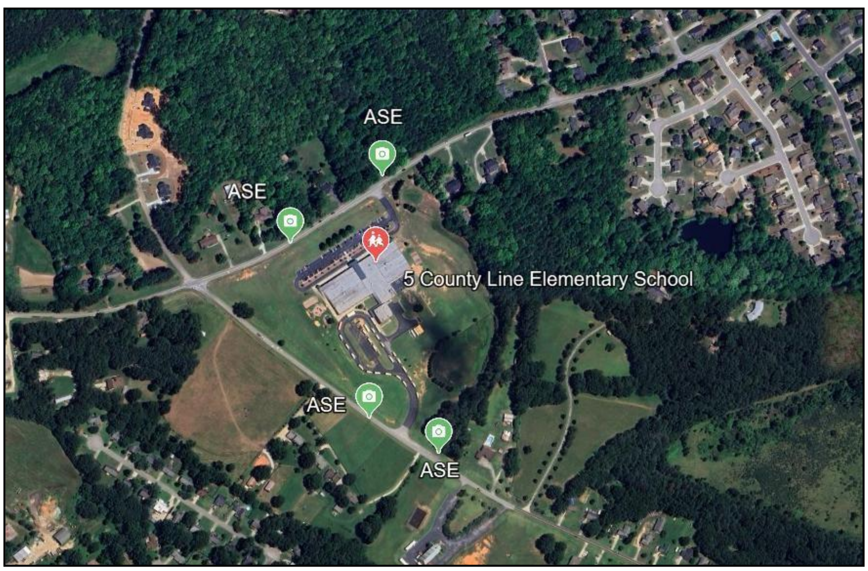


Figure 9. Map. A treated school and corresponding ASE camera location.

Sample Size

Out of 286 school zones with ASE cameras, some schools had two sets of ASE cameras on different roads, resulting in 295 camera sites in total. Schools that fell into one of the following categories were excluded from the population:

- Schools with limitations of information (e.g., date of implementation of ASE programs, timely updated Google Street View, etc.)
  Regarding the implementation date, attempts were made to contact ASE camera vendors in GA; however, several were unresponsive. Consequently, reliable secondary sources, including police department and municipal websites, and news articles, were used to collect this information. Due to these constraints, the sample was restricted to locations with confirmed implementation dates.
- Combined school zones (i.e., school zones with two or more schools, such as middle school together with high school)

This resulted in 187 potential camera sites in the population. For the crash analysis, the minimum required sample sizes were determined using Cochran's formula for an infinite population (Ahmed 2024), as follows:

$$n = \frac{Z^2.P.(1-P)}{E^2} \quad (1)$$

Where,

n = Sample size

Z = Z-score corresponding to the confidence level

P = Estimated proportion of an attribute that is present in the population

E = Desired level of precision

Assuming the maximum variability, which is equal to 50 percent (P = 0.5) and considering a 95 percent confidence level with ±5 percent precision,

$$n = \frac{1.96^2 . 0.5 . (1-0.5)}{0.05^2}$$

$$n = 384.16$$

Because the population was finite, the following correction formula was necessary:

$$n = \frac{n_O}{1 + \frac{(n_O - 1)}{N}} \quad (2)$$

Where,

n = Final sample size

n_0 = Sample size obtained from equation 1

N = Population size

For better approximation and understanding, the population of treated schools was divided into two groups: on-system schools and off-system schools. On-system schools refer to schools located on state-maintained highways, whereas off-system schools refer to schools located on locally maintained roads. There were 55 on-system schools and 132 off-system schools, that met the eligibility criteria mentioned earlier.

Minimum sample size determination for on-system schools was as follows:

$$n = \frac{384.16}{1 + \frac{(384.16 - 1)}{55}}$$

$$n = 48.22 \text{ or } \sim 49 \text{ schools}$$

Minimum sample size determination for off-system schools was as follows:

$$n = \frac{384.16}{1 + \frac{(384.16 - 1)}{132}}$$

$$n = 98.43 \text{ or } \sim 99 \text{ schools}$$

Based on this minimum sample size requirement, all 55 on-system schools and 99 off-system schools were selected for the crash analysis in this study.

Control Schools

Control schools refer to schools where ASE is not in place and schools that are comparable to the treated sites to the extent realistically possible. When selecting the control group, priority was given to schools in the same school district/county as the treated school to provide a better approximation of all other geometric and traffic conditions. The following characteristics were collected at treated schools and nearby potential control schools.

- Type of school (i.e., elementary, middle, or high schools)
- Type of road (i.e., on-system and off-system)
- Posted school zone speed limit
- Approach speed limits
- Traffic volumes
- Presence of traffic control mechanisms (e.g., traffic signal lights, flashing beacons)
- School enrollment
- Geometric characteristics of the school zone (e.g., number of lanes, presence of sidewalks, presence of crosswalks, presence of bicycle lanes, etc.)

If there were no schools that matched a particular treated school within a district/county, schools in nearby counties were considered. Based on the above features and visual inspections via

Google Street View, the selection of control schools was conducted manually and systematically, using engineering judgment, as school zones across the state are notably diverse. This manual selection helped capture qualitative and contextual features to better match control schools. Similar to the sample sizes of the on-system and off-system treated school groups, 55 on-system and 99 off-system control schools were selected.

Crash, Geometric, and Traffic Data Collection

Crash data for the before-and-after periods were collected from the Georgia Electronic Accident Reporting System (GEARS), and traffic volumes were extracted at each location for each year from the Traffic Analysis and Data Application (TADA), which are maintained by GDOT. All geometry-related data and measurements were collected at each selected school using Google Street View and the Google Earth Measure Tool.

In the study, CMFs were calculated for several crash types, severities, and boundaries.

Different Crash Types

All crashes, irrespective of the contributing cause and speeding-related crashes, were considered separately in estimating CMFs. Although the research team intended to incorporate pedestrian-involved crashes into the analysis, developing CMFs was not feasible due to the limited number of such crashes. There were only five pedestrian-involved crashes across all on-system schools, three during the before period, and two during the after period. There were 10 pedestrian-involved crashes observed during the before period at off-system schools, and nine were observed during the after period within the school zones. These crash numbers were insufficient to apply the study methodology reliably.

Different Crash Severity Levels

Two severity levels were considered in estimating CMFs: Property Damage Only (PDO) crashes and injury/fatal crashes. These severity levels were considered for all crashes, regardless of the contributing cause, and for speeding-related crashes.

Different Boundaries

In addition to the designated school zone boundary, this study examined the variation of CMFs under five other boundaries. The primary objective behind selecting multiple boundaries was to determine the impact of ASE cameras on reducing crashes over varying distances measured from the cameras. In the literature, there is no clear guidelines for setting up a boundary where ASE cameras are effective. A study conducted on ASE practices in Chicago used 250 m because Chicago's speed cameras are placed on urban streets, which mostly follow a grid pattern (Tilahun 2023). Longer-distance choices incorporated multiple intersections whose operation and crash outcomes might not be related to the speed cameras. As a result, it was assumed that the safety impacts of the cameras would be proximate to the camera locations. Another study conducted in the United Kingdom (UK) used four different catchment areas for each ASE camera, comprising crashes within a distance of 250 m, 500 m, 1,000 m, and 2,000 m, respectively, from the camera (Hess 2004). Especially in the two wider catchment areas, 1,000 m and 2,000 m, there was some overlapping of the catchment areas for cameras positioned close to each other.

The distances measured in this study were 250 ft, 500 ft, 1,000 ft, 2,000 ft, and 4,000 ft from the camera location and the designated school zone boundary. Figure 10 illustrates the method used to define the boundaries. "D" refers to the distance between two cameras that face each driving direction at a particular school zone. The minimum “D” value is zero when cameras face each other and are at the same location. The selection of a 250 ft distance was intended to capture the immediate influence of the ASE cameras on the driver’s behavior within the visible range of the cameras from the driver’s perspective. According to state law, ASE warning signs should be posted within 500 ft prior to the reduced speed limit signs (Georgia General Assembly 2018). Given this, a distance of 500 ft was selected. In Georgia, a school zone is defined as the area within 1,000 ft measured from the property line (Georgia General Assembly 2018). However, this is not consistent and depends on factors such as location geometry, land use, school type, and numerous other practical scenarios. Therefore, a consistent 1,000 ft distance measured from the camera location was selected as one of the boundaries, in addition to the designated school zone.

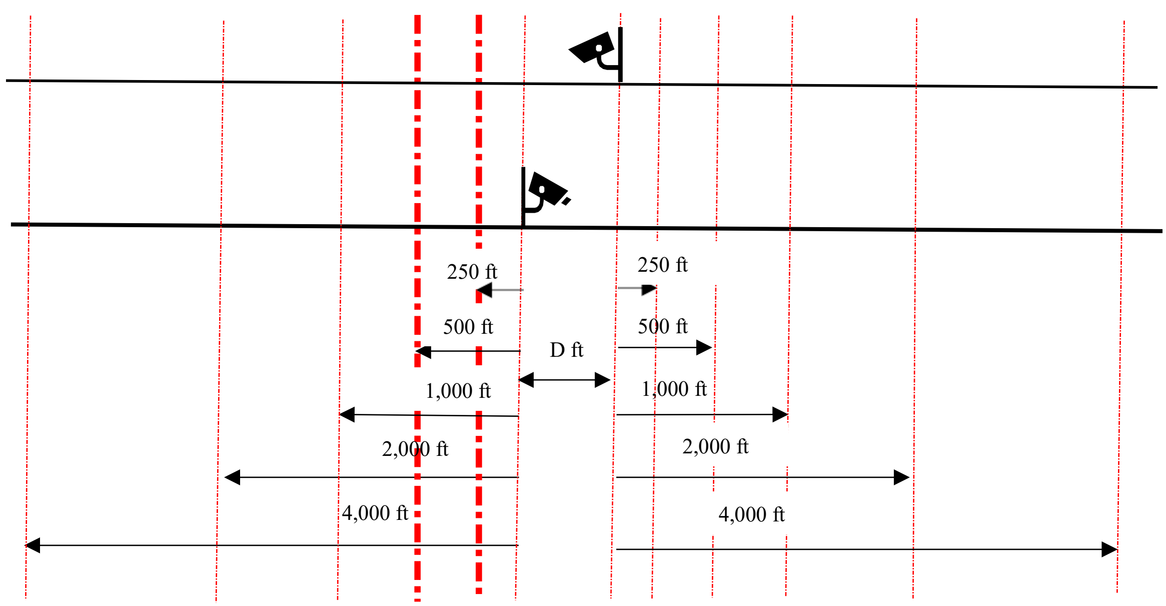


Figure 10. Diagram. Different boundaries considered in estimating CMFs.

Boundary 1: (D + 250 + 250) ft

Boundary 2: (D + 500 + 500) ft

Boundary 3: (D + 1,000 + 1,000) ft

Boundary 4: (D + 2,000 + 2,000) ft

Boundary 5: (D + 4,000 + 4,000) ft

Boundary 6: Existing school zone boundary

The 2,000 ft and 4,000 ft distances were selected to assess the medium and long-range spillover effects, representing areas where drivers may still adjust their speeds due to awareness of ASE cameras. The spillover effect is a phenomenon in which drivers' behavioral changes due to ASE cameras extend beyond enforcement zones, affecting traffic safety in upstream and downstream areas (Romo et al. 2024). This could create both positive and negative impacts. For example, due to increased awareness and frequent travel through school zones equipped with cameras, drivers tend to slow down even before entering the school zone and maintain lower speeds even after leaving it. On the other hand, drivers slow down only within the enforcement zone and then tend to accelerate after passing the school zone, or they make aggressive maneuvers, such as sudden braking near cameras, to comply with the speed limit. Therefore, these 2,000 ft and 4,000 ft distances were selected to examine the safety benefits of ASE cameras beyond the immediate vicinity of cameras and school zones. Additionally, it helps determine whether the presence of ASE has a sustained effect on crash reduction as vehicles continue along the roadway.

When defining the boundaries for control schools, the average segment length of all treated schools in a given category was used, and distances were measured from the entrances of control schools in each direction.

Period of Interest

It is necessary to consider the coronavirus disease 2019 (COVID-19) pandemic period in the analysis because most of the ASE cameras were installed between 2018 and 2023, and schools were either fully or partially closed during this period. To identify the effects of the COVID-19 pandemic on traffic volumes at schools, traffic volume data were collected from the GDOT TADA at selected schools and plotted over time to detect any changes in traffic flow. For example, Figure 11 demonstrates the Annual Average Daily Traffic (AADT) over time for 10 randomly selected schools from the sample.

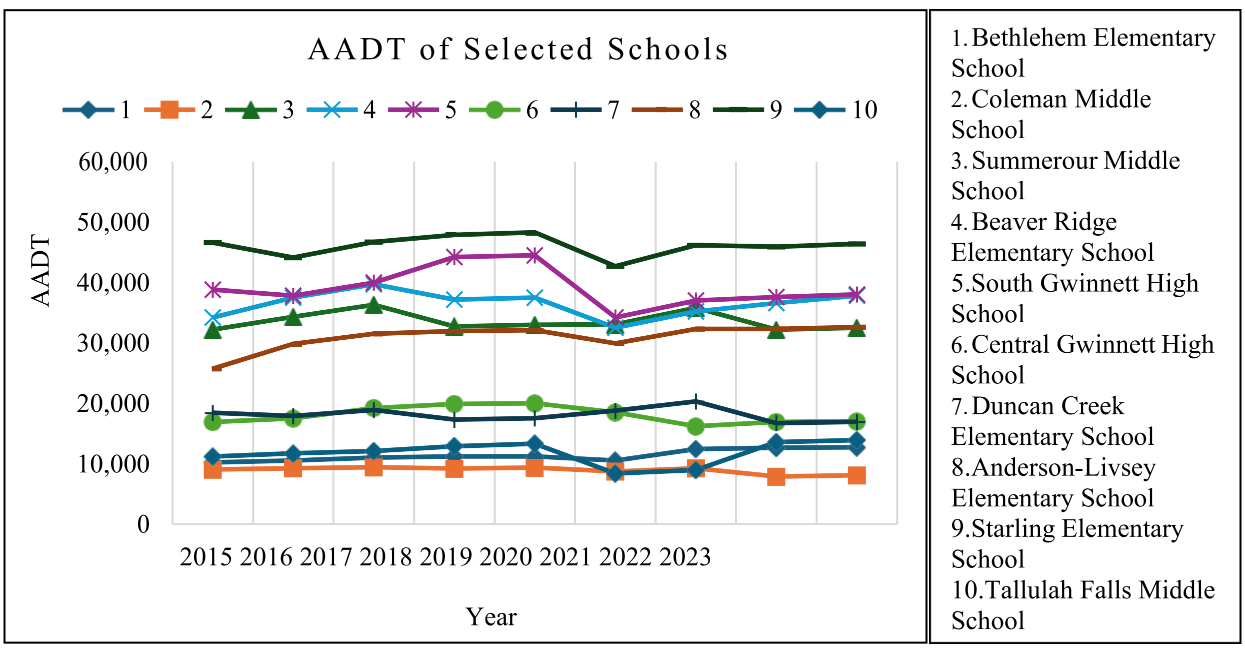


Figure 11. Graph. Traffic volumes over time at selected schools.

In mid-March 2020, all schools in GA closed, and instruction shifted to fully remote learning. During the Fall 2020 and Spring 2021 semesters, schools adopted a hybrid learning model that combined remote learning with limited in-person classes. By Fall 2021, most schools in GA had returned to in-person learning. Considering all these scenarios, this study defined the pandemic period as March 1, 2020, to July 31, 2021, and excluded this period from the crash analysis.

Based on the date of implementation of ASE programs at treated schools, before and after periods were defined for each school. The before period and after period were equal in duration at each school to control for temporal variations, for the consistency of data, and for accurate estimation of effects as suggested in the HSM (FHWA 2025-a). Table 2 provides the summary of the durations of the before-and-after periods for on-system and off-system school groups, and Appendix A provides detailed information about each location. In the table, "D" refers to the duration of the period before and after.

Table 2. Summary of before and after durations.

Before and After Durations in Years	Number of Schools	
	On-System Schools	Off-System Schools
$0 < D \leq 2$	33	32
$2 < D \leq 4$	22	67
Total Schools	55	99

For each control school, the same before-and-after period as that of the corresponding treated school was used. Hence, on-system and off-system control schools have the same before and after durations as the treated schools, as shown in Table 2.

Before-and-After Study with EB Approach Only Considering Treated Schools

CMFs quantify the change in expected average crash frequency at a site caused by implementing a particular treatment (FHWA 2025-a). CMF can be expressed as,

CMF = Ratio between expected and observed crash frequency ± Standard error

Application of the HSM Predictive Method

The steps used for the application of the HSM predictive method are as follows:

1. Identifying treated schools and collecting required data for the before period, such as crash data, traffic data, and geometry-related data at each school zone.
2. Identifying the correct SPF from the HSM to calculate the predicted average crash frequency at each treated school zone for the before period.

   Here, the correct SPF was selected from Chapters 10, 11, or 12 of the HSM Volume 02 based on the road classification. According to the HSM, the definitions of "urban" and "rural" areas are based on the FHWA guidelines, which classify "urban" areas as places inside urban boundaries where the population is greater than 5,000 persons, and define "rural" areas as places outside urban areas where the population is less than 5,000 (FHWA 2025-a). Applicable road categories in the HSM were rural two-way two-lane highways, rural multilane highways, and urban and suburban arterials. Even though the HSM uses the term "suburban" to refer to outlying portions of an urban area, the predictive method does not distinguish between urban and suburban portions of a developed area. For example, if the selected school zone is located on a rural multilane highway, the SPF for base conditions is:

$$N_{spf} = e^{(a+b\times ln(AADT)+ln(L))} \quad (3)$$

   Where,

   $AADT$ = Average Annual Daily Traffic

   L = Length of the road segment

   a, b = Regression coefficients derived in the HSM

3. Adjusting the SPF if the actual road conditions deviate from the base conditions.

   The corresponding CMFs for the adjustments are provided in the HSM and were estimated accordingly. All geometry-related data required to estimate these CMFs were collected at each school. Table 3 and Table 4 provide the required CMFs for adjusting the given SPFs in each chapter for each facility type. In each chapter of the HSM, ASE is one of the factors already considered in developing SPFs using the predictive method. However, those values were derived from general conditions rather than tailored explicitly to school zones. Since the objective of this crash study was to develop CMFs for school zones by fully capturing and isolating the effects of ASE on crash frequency, CMFs for ASE were set at 1.0 for all HSM SPFs adopted under each chapter.

4. Using the selected SPF and the estimated applicable CMFs, the predicted average crash frequency is calculated for each treated school zone for the before period as follows:

$$N_{predicted} = N_{spf} \times (CMF_{1x} \times CMF_{2x} \times \ldots \ldots . \times CMF_{yx}) \quad (4)$$

Table 3. CMFs for adjustments of the SPFs for rural divided multilane highways, rural undivided multilane highways, and urban and suburban arterials.

CMF*	Adjustment		
	Rural Divided Multilane Highways	Rural Undivided Multilane Highways	Urban and Suburban Arterials
CMF_1	Lane width	Lane width	On-street parking
CMF_2	Shoulder type and width	Shoulder type and width	Roadside fixed objects
CMF_3	Median width	Side slope	Median width
CMF_4	Lighting	Lighting	Lighting
CMF_5	ASE	ASE	ASE

* These CMFs are from Chapters 11 and 12 of the HSM Volume 02.

Table 4. CMFs for adjustments of the SPFs for rural two-way two-lane roads.

CMF*	Adjustment
CMF_1	Lane width
CMF_2	Shoulder type and width
CMF_3	Horizontal curves
CMF_4	Horizontal curves-superelevation
CMF_5	Grades
CMF_6	Driveway density
CMF_7	Centerline rumble strips
CMF_8	Passing lanes
CMF_9	Two-way left-turning lanes (TWLTL)
CMF_{10}	Roadside design
CMF_{11}	Lighting
CMF_{12}	Automated speed enforcement

* These CMFs are from Chapter 10 of the HSM Volume 02.

Application of the EB Method

After calculating predicted crash frequency for the before period, the weighted-adjustment factor ($w_{i,B}$) was estimated for the before period for each treated school as follows:

$$w_{i,B} = \frac{1}{1+k\sum_{\substack{Before\\years}} N_{predicted}} \tag{5}$$

Where *k* is the over-dispersion parameter for the applied SPF and is available on the HSM.

Then, the expected average crash frequency was calculated over the entire before period at each treated school as follows:

$$N_{expected,\mathrm{B}} = w_{i,B} \times N_{predicted} + (1 - w_{i,B}) \times N_{observed,B} \tag{6}$$

The previous steps 1-4 were repeated to calculate the predicted average crash frequency for the after period at each treated school.

After calculating the predicted crash frequency for the after period, the adjustment factor, r_i, was calculated as follows:

$$r_i = \frac{\sum_{\substack{After \\ years}} N_{predicted,A}}{\sum_{\substack{Before \\ years}} N_{predicted,B}} \tag{7}$$

The expected average crash frequency was calculated over the entire after period at each treated school as follows:

$$N_{expected,A} = N_{expected,B} \times r_i \tag{8}$$

The overall effectiveness of all combined treated schools was calculated using the odds ratio (OR') as follows:

$$OR' = \frac{\sum_{ALl\ sites} N_{observed,A}}{\sum_{All\, sites} N_{expected,A}} \tag{9}$$

As the overall effectiveness is biased due to the variability in effectiveness at individual sites, the adjusted OR was calculated as follows:

$$OR = \frac{OR'}{1 + \frac{Var(\sum_{All\, sites} N_{expected,A})}{[\sum_{All\ sites} N_{expected,A}]^2}} \tag{10}$$

Where,

$$Var(\textstyle\sum_{All\ sites} N_{expected,A}) = \sum_{All\ sites}(r_i^2 \times N_{expected,B} \times (1 - w_{i,B})) \tag{11}$$

And,

$w_{i,B}$ = weighted factor of treated sites in the before period.

The overall unbiased safety effectiveness was computed as a percentage of change in crash frequency across all treated sites as follows:

$$Safety\ Effectiveness = 100 \times (1 - OR) \quad (12)$$

The variance of the unbiased estimated safety effectiveness was computed as follows:

$$Var(OR) = \frac{OR'^2 \times \left[\frac{1}{N_{observed,A}} + \frac{Var\{\sum_{All\ sites} N_{expected,A}\}}{[\sum_{All\ sites} N_{expected,A}]^2}\right]}{1 + \frac{Var\{\sum_{All\ sites} N_{expected,A}\}}{[\sum_{All\ sites} N_{expected,A}]^2}} \quad (13)$$

Then, the standard error of unbiased safety effectiveness was estimated as follows:

$$SE(OR) = \sqrt{Var(OR)} \quad (14)$$

$$SE(Safety\ Effectiveness) = 100 \times SE(OR) \quad (15)$$

If,

$$Abs\left|\frac{Safety\ Effectiveness}{SE(Safety\ Effectiveness)}\right| < 1.7$$

then the treatment effect is not significant at the 90 percent confidence level.

If,

$$Abs\left|\frac{Safety\ Effectiveness}{SE(Safety\ Effectiveness)}\right| \geq 1.7$$

then the treatment effect is significant at the 90 percent confidence level.

If,

$$Abs\left|\frac{Safety\ Effectiveness}{SE(Safety\ Effectiveness)}\right| \geq 2.0$$

then the treatment effect is significant at the 95 percent confidence level.

Before-and-After Study Using the Comparison-Group Method

All steps of the HSM predictive method were conducted to estimate the predicted average crash frequency for the before and after periods at each treated and control school.

Then, the adjustment factor for the before period at each treated school *i* and control site *j* combination was calculated as follows:

$$Adj_{i,j,B} = \frac{N_{predicted,T,B}}{N_{predicted,C,B}} \times \frac{Y_{BT}}{Y_{BC}} \tag{16}$$

Where Y_{BT} and Y_{BC} are the years of the before period of the treated school and the corresponding control school.

Then, the adjustment factor for the after period at each treated school *i* and control site *j* combination was calculated as follows:

$$Adj_{i,j,A} = \frac{N_{predicted,T,A}}{N_{predicted,C,A}} \times \frac{Y_{AT}}{Y_{AC}} \tag{17}$$

Where Y_{AT} and Y_{AC} are the years of the after period of the treated school and the corresponding control school.

The expected average crash frequency for each control school was calculated for the before period as follows:

$$N_{expected,C,B} = \sum N_{observed,C,B} \times Adj_{i,j,B} \tag{18}$$

The expected average crash frequency for each control school was calculated for the after period as follows:

$$N_{expected,C,A} = \sum N_{observed,C,A} \times Adj_{i,j,A} \tag{19}$$

For each treatment site i, the total control group expected average crash frequency in the before period was calculated as follows:

$$N_{expected,C,B,total} = \sum_{All\ control\ sites} N_{expected,C,B} \tag{20}$$

For each treatment site i, the total control group expected average crash frequency in the after period was calculated as follows:

$$N_{expected,C,A,total} = \sum_{All\ control\ sites} N_{expected,C,A} \tag{21}$$

For each of the treated schools, the comparison ratio was calculated as follows:

$$r_{ic} = \frac{N_{expected,C,A,total}}{N_{expected,C,B,total}} \tag{22}$$

The expected average crash frequency of treated schools was estimated if the treatment was not in place as follows:

$$N_{expected,T,A} = \sum N_{observed,T,B} \times r_{ic} \tag{23}$$

The safety effectiveness of an individual treated school was estimated as follows:

$$OR_i = \frac{N_{observed,T,A}}{N_{expected,T,A}} \tag{24}$$

The weighted-adjustment factor for each treated school was calculated as follows:

$$w_i = \frac{1}{R_{iSE}^2} \tag{25}$$

Where,

$R_i = \ln (OR_i)$

R^2_{iSE} is the squared standard error of log ORs.

$$R^2_{i(SE)} = \frac{1}{N_{observed,T,B,total}} + \frac{1}{N_{observed,T,A,total}} + \frac{1}{N_{expected,C,B,total}} + \frac{1}{N_{expected,C,A,total}} \tag{26}$$

The weighted average log OR for all treated sites *n* was calculated as follows:

$$R = \frac{\sum_n w_i R_i}{\sum_n w_i} \tag{27}$$

The overall effectiveness or the CMF can be calculated as follows using the OR.

$$OR = e^R \tag{28}$$

$$\text{Safety Effectiveness} = 100 \times (1 - \text{OR}) \tag{29}$$

Where,

OR = Overall CMF across all treated sites

$$\text{SE (Safety Effectiveness)} = 100 \times \frac{\text{OR}}{\sqrt{\sum_n w_i}} \tag{30}$$

Where,

$$\Sigma_n w_i = the\ total\ weighted\ adjustment\ factor\ across\ all\ treated\ sites$$

If,

$$\text{Abs}\left|\frac{\text{Safety Effectiveness}}{\text{SE(Safety Effectiveness)}}\right| < 1.7$$

then the treatment effect is not significant at the 90 percent confidence level.

If,

$$\text{Abs}\left|\frac{\text{Safety Effectiveness}}{\text{SE(Safety Effectiveness)}}\right| \geq 1.7$$

then the treatment effect is significant at the 90 percent confidence level.

If,

$$\text{Abs}\left|\frac{\text{Safety Effectiveness}}{\text{SE(Safety Effectiveness)}}\right| \geq 2.0$$

then the treatment effect is significant at the 95 percent confidence level.

Example calculations for both methods: before-and-after study with EB approach only considering treated schools, and before-and-after study using the comparison group method, are presented in Appendix B.

SPEED STUDY

The objective of the speed study was to observe vehicle speeds of comparable groups of treated and control schools and make meaningful comparisons. Data were collected from multiple school zones in GA, including both schools with ASE cameras and those without, during active enforcement periods. For collecting speed data, a JAMAR Technologies Black Cat II radar device was used. The device is capable of collecting speed data over multiple days continuously. It collects the speed of individual vehicles that pass through its detection zone, along with the date, time, headway, gap, and vehicle length, which can later be downloaded in the laboratory.

Speed Data Collection

Table 5 presents the schools selected for speed data collection. School zones were selected based on a combination of enforcement, operational, and location-specific criteria to ensure representative and meaningful analysis. Table 6 presents the criteria used to select the school locations.

Table 5. Selected schools for collecting speed data.

School Group	School Name	School District	School Category
Treated	Church Street Elementary School	Clayton County Public Schools	Off-system
	Duncan Creek Elementary School	Gwinnett County Public Schools	On-system
	Coleman Middle School	Gwinnett County Public Schools	On-system
	Griffin High School	Griffin-Spalding County Schools	On-system
	Riverdale High School	Clayton County Public Schools	Off-system
Control	Powers Ferry Elementary School	Cobb County School District	Off-system
	Milford Elementary School	Cobb County School District	On-system
	Sutton Middle School	Atlanta Public Schools	On-system
	Marietta High School	Marietta City Schools	On-system
	Salem High School	Rockdale County School District	Off-system

Table 6. School selection criteria for collecting speed data.

Criterion	Description
Presence of ASE cameras	• A group of schools with ASE cameras • A group of schools without ASE cameras
Clearly defined school zones	• Schools with clearly defined school zones with signage • Presence of flashing beacons • Presence of school zone speed limit signs
Road classification	• Similar road classification in both school groups • Representative sample for on-system and off-system schools
Feasibility of data collection	• Availability of suitable mounting locations for the radar device • Safety of the data collection device and researchers • Coordination with the local law enforcement authorities

The radar device mentioned previously was used to collect speed data. The device was mounted beside the road at each school zone to collect speeds of individual vehicles continuously over multiple days, as shown in Figure 12. Proper installation, including the correct distance from the edge of the roadway, correct mounting height, and angle, was required for reliable speed measurements.

Figure 12. Photos. Speed data collection at selected school zones.

Estimation of Key Speed Parameters

From the collected data at each treated school, speeds recorded during camera active hours were filtered out. For control schools, a similar time window to that of the treated schools was considered. The period of interest at each school is given in Table 7. During camera active hours of treated schools and similar hours in control schools, free-flow vehicles were identified.

Table 7. Period of interest for speed data analysis.

School Name	School Zone Speed Limit	School Operating Hours	Period of Interest
Church Street Elementary School	25 mph	7:45 AM–2:15 PM	7:00 AM–2:45 PM
Duncan Creek Elementary School	35 mph	8:50 AM–3:20 PM	7:50 AM–4:20 PM
Coleman Middle School	25 mph	9:20 AM–4:00 PM	8:20 AM–5:00 PM
Griffin High School	35 mph	8:45 AM–3:15 PM	7:45 AM–4:15 PM
Riverdale High School	25 mph	8:15 AM–3:15 PM	7:35 AM–4:15 PM
Powers Ferry Elementary School	25 mph	7:15 AM–3:00 PM	6.15 AM–4.00 PM
Milford Elementary School	25 mph	7:15 AM–3:00 PM	6:30 AM–3.30 PM
Sutton Middle School	25 mph	7:30 AM–5:00 PM	6:30 AM–6:00 PM
Marietta High School	35 mph	7:45 AM–2:30 PM	6:45 AM–3:30 PM
Salem High School	25 mph	7:30 AM–3:30 PM	6:50 AM–4:30 PM

In this study, free-flow vehicles were identified according to the definition in the Highway Capacity Manual, 6th Edition; thus, all vehicles with a headway of 5 s or greater were identified as free-flow vehicles (Transportation Research Board [TRB] 2016). For the analysis, free-flow vehicle speeds during camera-active hours at treated schools and free-flow vehicle speeds at control schools within a similar time window to that of the treated schools were considered. Table 8 presents the total number of vehicles, number of free-flow vehicles, and number of vehicles observed during the period of interest: camera operating hours at treated schools and similar time windows at control schools.

Table 8. Total vehicles, total free-flow vehicles, and free-flow vehicles observed during the period of interest at each treated and control school.

School Name	Total Vehicles	Total Free-Flow Vehicles	Free-Flow Vehicles during the Period of Interest
Church Street Elementary School	19,861	6,663	2,701
Duncan Creek Elementary School	98,962	21,912	7,090
Coleman Middle School	40,619	12,301	4,745
Griffin High School	74,235	19,231	7,103
Riverdale High School	8,245	3,272	1,913
Powers Ferry Elementary School	34,074	9,016	4,987
Milford Elementary School	92,600	18,610	6,222
Sutton Middle School	67,603	15,802	7,476
Marietta High School	50,737	9,661	5,126
Salem High School	31,242	11,112	5,167
Total Observations	518,178	127,580	52,530

Considering free-flow vehicle speeds during camera-active hours at treated schools and free-flow vehicle speeds at control schools within a similar time window to treated schools, key speed parameters, such as the 50th percentile speed, 85th percentile speed, mean speed, speed variance, and standard deviation, were estimated at each school. Percentile speeds that play an important role in traffic engineering can be defined as follows (FHWA 2025-b):

- 50th Percentile Speed: The speed at or below which 50 percent of the drivers travel on a road segment.
- 85th Percentile Speed: The speed at or below which 85 percent of the drivers travel on a road segment.

These percentile speeds were obtained from the graphical method: a histogram of vehicle speeds versus cumulative frequency (Texas Department of Transportation [TxDOT] 2015). The desired percentile value was obtained by locating the percentage on the vertical axis, drawing a horizontal line to intersect with the cumulative curve, and then dropping a vertical line to the horizontal axis.

- Mean Speed: The arithmetic average speed of all observed vehicles at a particular location during a particular period:

$$\tilde{v} = \frac{\sum_{i=1}^{n} v_i}{n} \tag{31}$$

Where v_i is the speed of the i^{th} vehicle and n is the total number of vehicles.

- Speed Variance: Variance measures the extent to which individual vehicle speeds deviate from the mean speed:

$$\sigma^2 = \frac{1}{n} \sum_{i=1}^{n} (v_i - \tilde{v})^2 \tag{32}$$

- Speed Standard Deviation: Standard deviation is the square root of the speed variance:

$$\sigma = \sqrt{\frac{1}{n} \sum_{i=1}^{n} (v_i - \tilde{v})^2} \tag{33}$$

Additionally, the percentages of drivers who exceeded the school zone speed limits by more than 5 mph and 10 mph at each school zone were calculated.

Performance of Statistical Tests

The objective of this task was to statistically compare the speed distribution and variance distribution at treated schools and control schools to evaluate whether ASE has a significant impact on reducing speeds and speed variance, improving compliance with school zone speed limits. For the Levene's test, Mann–Whitney *U* test, and K-S test, schools with a school zone speed limit of 25 mph were selected from the initial list for a reliable and valid comparison.

Table 9 shows those schools selected for statistical analysis. The total number of free-flow vehicles observed at treated and control schools was 9,359 and 23,852, respectively.

Table 9. Schools selected for the statistical comparisons in the speed analysis.

School Group	School Name	School Zone Speed Limit
Treated	Church Street Elementary School	25 mph
	Coleman Middle School	25 mph
	Riverdale High School	25 mph
Control	Powers Ferry Elementary School	25 mph
	Milford Elementary School	25 mph
	Sutton Middle School	25 mph
	Salem High School	25 mph

To identify appropriate statistical test methods and assess the validity of assumptions, the speed distributions for each group were tested for normality using the one-sample K-S test.

One-Sample Kolmogorov–Smirnov Test for Normality

The K-S test was used to assess the distribution of the data and to identify the appropriate statistical test. Checking data distributions for normality is one application of the K-S test. The test hypothesis can be defined as follows (National Institute of Standards and Technology [NIST] 2025):

- Null Hypothesis (H_0): The sample data follow a normal distribution
- Alternative Hypothesis (Ha): The sample data do not follow a normal distribution

The Empirical Cumulative Distribution Function gives the proportion of vehicles that are traveling at or below a certain speed x for a sample of n observations in ascending order (Cardoso and Galeno 2023):

$$F_n(x) = \frac{Number\ of\ observations \leq x}{n} \tag{34}$$

The Theoretical Cumulative Distribution Function for Normal Distribution can be defined as follows:

$$F(x) = P(X \leq x) = \ \phi\,(\frac{x-\mu}{\sigma}) \tag{35}$$

Where,

μ = Mean of the normal distribution

σ = Standard deviation of the normal distribution

ϕ = Standard Normal Cumulative Distribution Function

The K-S statistic, *D,* measures the maximum absolute difference between the empirical distribution and the theoretical distribution as follows:

$$D = {}^{sup}{}_{x}|F_n(x) - F(x)| \tag{36}$$

For a large sample of data, this K-S statistic is compared with the critical *D* value at the level of confidence α (Marks 2007):

$$D_\propto \approx \frac{c(\propto)}{\sqrt{n}} \tag{37}$$

This approximation applies only to larger samples, *n* > 40. For small samples, the exact critical *D* value should be obtained from the one-sample K-S critical values tables. Here, *c(α)* is a constant depending on the level of significance *α*, where *α* = 0.05 (95 percent level of significance). The *c*(*α*) values can be obtained from Table 10 (Fabbri and De León 2017).

Table 10. Constants corresponding to the different significant levels in estimating the critical K-S statistic.

α	**0.1**	**0.05**	**0.025**	**0.01**	**0.005**	**0.001**
c(α)	1.22	1.36	1.48	1.63	1.73	1.95

If the observed D, which is the maximum absolute difference between the empirical distribution and the theoretical distribution, is greater than $D\alpha$ $(D > D\alpha)$, the null hypothesis is rejected, indicating that the sample likely does not follow the normal distribution. If $D \leq D\alpha$, the alternative hypothesis is rejected, indicating that the sample likely follows the normal distribution. In the p-value approach, a p-value ≤ 0.05 indicates that the observed test statistic D is unlikely to occur under the null hypothesis, suggesting the rejection of the null hypothesis. If the p-value > 0.05, it indicates the rejection of the alternative hypothesis. In this study, IBM SPSS software was used to perform the test, which used a p-value-based approach.

Based on the results of the normality test, it was found that speeds were not normally distributed in each group. Therefore, it was decided to perform nonparametric statistical tests, including Levene's test, the two-tailed Mann–Whitney *U* test, and the two-sample K-S test. Table 11 shows the objectives of the selected statistical tests.

Table 11. Objectives of performing each statistical test in the speed study.

Test	**Objective**
Levene's Test	To examine whether the variance distribution of treated schools significantly differs from that of the control schools
Two-Tailed Mann–Whitney *U* Test	To evaluate whether two independent speed samples, treated and control schools, originate from populations with the same central tendency, typically the median
Two-Sample K-S Test	To determine whether the distribution of speeds in treated schools differs significantly from the distribution of speeds in control schools

Levene's Test

Average speed and speed variance are two key characteristics that could affect the frequency and severity of traffic crashes (Alomari et al. 2023, Xu et al. 2019). Speed variance represents the inconsistency of speeds along a road segment, and the speed variance has a strong relationship with the crash frequency at a particular road segment (Wang et al. 2018). Therefore, it is essential to examine the variance distributions at treated and control schools in order to determine the effectiveness of ASE in improving safety in school zones. Levene's test is a robust parametric test that can be used to compare variance distributions of two or more groups, when the data are not normally distributed. The test assesses the distribution of deviations of individual observations from group means to determine whether group variances are statistically equal. The test hypotheses can be defined as follows (Gastwirth et al. 2009):

- Null Hypothesis (H_0:) The speed variance distribution of treated schools is the same as the speed variance distribution of control schools.
- Alternative Hypothesis (H_a): The speed variance distributions of the treated and control schools differ.

First, the test computes absolute deviations of each group from its center as follows:

$$Z_{ij} = |Y_{ij} - C_i| \tag{38}$$

Where,

Z_{ij} = Absolute deviation of the group

Y_{ij} = Observation j in the group i

C_i = Central value of group i

Then, the group mean is calculated as follows:

$$\bar{Z}_i = \frac{1}{n_i} \sum_{j=1}^{n_i} Z_{ij} \quad (39)$$

Where n_i is the number of observations in group i.

Then, the grand mean is estimated as follows:

$$\bar{Z} = \frac{1}{N} \sum_{i=1}^{k} \sum_{j=1}^{n_i} Z_{ij} = \frac{1}{N} \sum_{i=1}^{k} n_i \bar{Z}_i \quad (40)$$

Where N refers to the total number of observations across all groups.

Then, the Between-group Sum of Squares (SS_B) and Within-group Sum of Squares (SS_W) are estimated as follows:

$$SS_B = \sum_{i=1}^{k} n_i (\bar{Z}_i - \bar{Z})^2 \quad (41)$$

$$SS_W = \sum_{i=1}^{k} \sum_{j=1}^{n_i} (Z_{ij} - \bar{Z}_i)^2 \quad (42)$$

Using SS_B and SS_W, the Between-group Mean Squares (MS_B) and Within-group Mean Squares (MS_W) are calculated as follows:

$$MS_B = \frac{SS_B}{k-1} \quad (43)$$

$$MS_W = \frac{SS_W}{N-k} \quad (44)$$

Here, k refers to the number of groups. Then, Levene's statistic W is estimated as follows:

$$W = \frac{MS_B}{MS_W} \quad (45)$$

Under the null hypothesis, the test statistic follows an F distribution with $k - 1$ degrees of freedom in the numerator and $N - k$ degrees of freedom in the denominator as follows:

$$p = P(F_{k-1,N-k} \geq W) \tag{46}$$

The p-value is the probability of observing a larger F statistic than W. It rejects the null hypothesis if the W is greater than the upper critical value of the F distribution.

Two-Tailed Mann–Whitney U Test

The two-tailed Mann–Whitney U test is a nonparametric statistical test used to compare two independent data distributions when the assumption of normality is not valid. The hypotheses of the test can be defined as follows (Nachar 2008):

- Null Hypothesis (H_0): The two independent speed distributions originate from populations with the same central tendency.
- Alternative Hypothesis (H_a): The two independent speed distributions originate from populations with different central tendencies.

The two-tailed Mann–Whitney U test initially requires estimating the U statistic for each group as in the following equations:

$$U_1 = n_1 n_2 + n_1 \frac{(n_1+1)}{2} - R_1 \tag{47}$$

$$U_2 = n_1 n_2 + n_2 \frac{(n_2+1)}{2} - R_2 \tag{48}$$

$$U = \min(U_1, U_2) \tag{49}$$

Where,

n_1 = Number of vehicles sampled in treated schools

n_2 = Number of vehicles sampled in control schools

R_1 = Sum of ranks for all speeds in treated schools

R_2 = Sum of ranks for all speeds in control schools

From U_1 and U_2, the smaller value is considered the *U s*tatistic in the test.

The mean (μ) and standard deviation (σ) of *U* are calculated as follows:

$$\mu_U = \frac{n_1 n_2}{2} \tag{50}$$

$$\sigma_U = \sqrt{\frac{n_1 n_2 (n_1 + n_2 + 1)}{12}} \tag{51}$$

Using the mean and the standard deviation, the *U* statistic is converted into a *z*-score as follows:

$$Z_{observed} = \frac{U - \mu_U}{\sigma_U} \tag{52}$$

The *p*-value of the test can be calculated as follows:

$$p = 2 \times P(Z > |Z_{observed}|) \tag{53}$$

Where the *Z* value is obtained from the standard normal distribution table, if the p-value ≤ 0.05, the null hypothesis is rejected; otherwise, the alternative hypothesis is rejected.

Two-Sample Kolmogorov–Smirnov Test

Similar to the two-tailed Mann–Whitney *U* test, the two-sample K-S test is also a nonparametric test used to compare two independent distributions. The hypotheses of the test are the following (Metchev and Grindlay 2002):

- Null Hypothesis (H_0): The two independent speed samples come from the same continuous distribution.
- Alternative Hypothesis (H_a): The two independent speed samples come from different distributions.

The empirical distribution functions for vehicles that are traveling at or below a certain speed *x* for samples of n_1 and n_2 observations in ascending order are as follows (Büning 2002):

$$F_{n1}(x) = \frac{Number\ of\ X_i \leq x}{n_1} \tag{54}$$

$$G_{n2}(x) = \frac{Number\ of\ Y_i \leq x}{n_2} \tag{55}$$

The K-S statistic, *D*, is the maximum absolute difference between two empirical distribution functions, as shown by the following:

$$D_{n_1,n_2} = \sup_x |F_{n1}(x) - G_{n2}(x)| \tag{56}$$

For large n_1 and n_2, the K-S statistic is scaled as follows:

$$\lambda = D_{n_1,n_2} \cdot \sqrt{\frac{n_1 n_2}{n_1+n_2}} \tag{57}$$

For a large sample of data, the *p*-value can be approximated using the following formula (Metchev and Grindlay 2002):

$$p \approx Q_{KS}(\lambda) = 2 \sum_{j=1}^{\infty} (-1)^{j-1} e^{-2j^2\lambda^2} \tag{58}$$

Where,

$Q_{KS}(\lambda)$ = Asymptotic distribution function of the K-S statistic for two-sample tests

j = Index of the observations in the combined ordered sample from both groups

If the *p*-value ≤ 0.05, it suggests rejecting the null hypothesis. If the *p*-value > 0.05, it indicates the rejection of the alternative hypothesis. In this study, IBM SPSS software was used to perform all statistical tests.

ROAD USER SURVEY

The objective of the road user survey was to gather public opinions about ASE programs in school zones across GA. The questionnaire was designed based on the insights and methodologies identified in existing literature to ensure the validity and relevance of the questions (Beaton et al. 2022, Peterson et al. 2017, Farmer 2017). The questionnaire was designed using Qualtrics and consisted of multiple-choice, scale-based, and open-ended questions. The questionnaire consisted of three main sections, as presented in Table 12.

The survey materials were reviewed and approved by the Institutional Review Board (IRB) of Kennesaw State University to ensure ethical conduct involving human subjects. The research team underwent the Collaborative Institutional Training Initiative (CITI) training on human subjects-related research to ensure all federal and institutional regulations were met (CITI Program 2025). The target population of the survey consisted of licensed drivers in GA aged 18 years or older, and participation was voluntary.

Table 12. The structure of the road user questionnaire.

Section	Content
User awareness and level of agreement or disagreement	• Awareness of ASE in school zones in GA • Frequency of driving through treated schools • Impact of ASE on slowing down the vehicle • History of receiving citations from ASE cameras • Agreement or disagreement for positive and negative statements on ASE
Additional comments and suggestions about the ASE program	• Opinions on improving transparency • Opinions on improving trustworthiness • Opinions on making the program fairer for drivers • Additional comments/suggestions
Sociodemographic information of the respondent	• Information on affiliation to a school • Level of education, employment status, age group, and experience in driving

Survey Administration

The survey was widely distributed online through multiple channels, including direct sharing, social media, the GDOT Safe Routes to School Program, and professional organizations, to reach a diverse sample of participants. The survey was available to any GA driver who was 18 years or older, regardless of any other characteristic. The research team visited public places in various counties, including parks, libraries, and shopping malls, to distribute the questionnaire directly. Several practical challenges were encountered during the survey administration. Some people who opposed these ASE cameras refused to take the survey, potentially limiting the diversity of perspectives. Additionally, some respondents started the survey but did not complete it, resulting in partially completed or unusable responses. Furthermore, access restrictions to specific populations and locations, such as contacting parents through schools or school districts, or reaching out to people at public libraries or shopping malls, limited the outreach opportunities. Responses were collected over 7 months from February 2025 to September 2025, and the survey received a total of 502 responses.

Data Analysis

The responses collected were exported from Qualtrics to Microsoft Excel and IBM SPSS software for further analysis. Descriptive data analysis was conducted to determine frequency distributions and percentages of positive and negative statements regarding ASE cameras, as well as the level of agreement or disagreement. In addition to the descriptive analysis, a cross-classification analysis, also known as contingency table analysis, was conducted to investigate whether statistically significant relationships exist between opinions on ASE and selected sociodemographic factors, as well as driving frequencies, across schools equipped with ASE cameras. Chi-squared test performed for this purpose is a nonparametric statistical test used to examine the relationship between two categorical variables in a cross-classification table. The hypotheses of the test can be defined as follows (McHugh 2013):

- Null Hypothesis (H_0): The two variables are independent, and there is no statistically significant relationship between the variables.
- Alternative Hypothesis (H_a): The two variables are not independent, and there is a statistically significant relationship between the variables.

The chi-squared statistic in the test is calculated as follows:

$$\mathcal{X}^2 = \sum \frac{(O_{ij} - E_{ij})^2}{E_{ij}} \tag{59}$$

Where,

O_{ij} = Observed frequency in cell *i,j* in the contingency table

E_{ij} = Expected frequency in cell *i,j*

E_{ij} and the degrees of freedom are calculated as follows:

$$E_{ij} = \frac{(Row\ Total_i)(Column\ Total_j)}{Grand\ Total} \tag{60}$$

$$df = (r - 1)(c - 1) \tag{61}$$

Where,

r = Number of rows

c = Number of columns in the contingency table

After estimating the chi-squared statistic and degrees of freedom, the *p*-value is found by comparing the test statistic to the chi-squared distribution with the same degrees of freedom. If the *p*-value is less than 0.05 (95 percent level of confidence), the null hypothesis is rejected.

OBSERVING TRAFFIC CONFLICTS AT SCHOOL ZONES

This study examined traffic conflicts at selected schools for a minimal period, as a surrogate safety measure for crash frequencies. Two treated and two control schools were selected for observing traffic conflicts. The selected schools were Duncan Creek Elementary School, Beaver Ridge Elementary School, Roberts Elementary School, and Fort Daniel Elementary School. When choosing schools, school zone speed limits, approach speed limits, road classifications, and other geometric and traffic characteristics were considered to perform a valid and reasonable comparison. Elementary schools were selected for this study because younger children have comparatively less ability to judge vehicle speeds, especially when crossing roads, making them one of the most vulnerable road users, and these school zones experience substantial traffic activity during arrival and dismissal times, as many parents drive to drop off and pick up their children. This combination of activities increases the likelihood of traffic conflicts in school zones, which may not be reflected in crash data.

As shown in Figure 13, video cameras were installed at the school entrances of each selected school to capture traffic operations and pedestrian movements. Traffic operations were video-recorded over a 4-hour window, consisting of 2 hours in the morning (1 hour before and after school opening time) and 2 hours in the evening (1 hour before and after school dismissal time), at each school. The collected video recordings were reviewed in the laboratory to identify conflicts and categorize them according to their type. Manual observations were also conducted on-site to verify the recorded data.

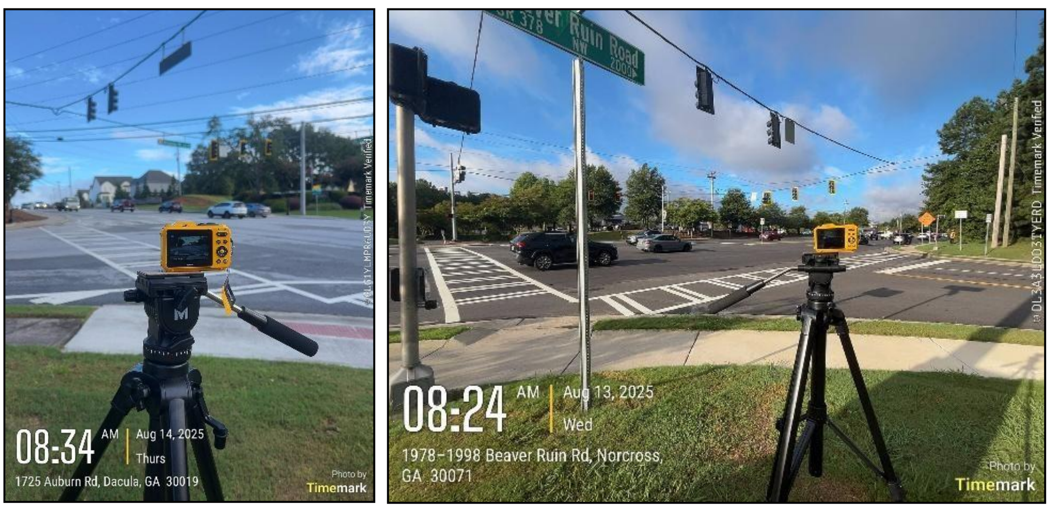


Figure 13. Photos. Video recording of traffic operations at selected school zones.

CHAPTER 4. RESULTS AND DISCUSSION

This chapter presents and discusses the results obtained from all the methodologies applied in this study. The results of the before-and-after study with the EB approach, only considering treated schools, and the before-and-after study using the comparison group method are presented first. The results of the speed study include key speed parameters and the percentages of drivers who exceeded school zone speed limits at treated and control schools, along with the results of Levene's test, the Mann–Whitney *U* test, and the K-S test. Finally, the results of the road user survey and traffic conflict observational study are presented and discussed in the last two subsections of this chapter.

RESULTS OF THE CRASH STUDY

CMFs: Before-and-After Study with EB Approach Only Considering Treated Schools

This study initially estimated CMFs, considering only treated schools. The HSM predictive method and the EB approach were used in estimating CMFs.

On-System Schools: All Crashes

Table 13 presents CMFs estimated for on-system schools considering all crashes regardless of the contributing cause. The CMFs for total crashes ranged from 0.92 to 0.97, depending on the boundaries considered in this study. For PDO crashes and fatal and injury crashes, the CMFs ranged from 0.95 to 0.98 and 0.96 to 0.99, respectively. Under the fatal and injury crash category, the CMFs have been estimated by removing outliers of crash frequencies. No clear pattern was observed among the CMFs estimated under different boundaries.

Table 13. Treated sites only: CMFs estimated for on-system schools, considering all crashes.

Parameter	Total Crashes	PDO Crashes	Fatal & Injury Crashes
Boundary 1 (250 ft measured from each camera)			
CMF	0.94	0.95	0.96*
Variance	0.004	0.007	0.025
Statistical significance	>2.0	>2.0	<1.7
Boundary 2 (500 ft measured from each camera)			
CMF	0.92	0.97	0.99*
Variance	0.003	0.004	0.011
Statistical significance	>2.0	>2.0	>2.0
Boundary 3 (1,000 ft measured from each camera)			
CMF	0.95	0.98	0.99*
Variance	0.001	0.002	0.006
Statistical significance	>2.0	>2.0	>2.0
Boundary 4 (School zone)			
CMF	0.95	0.96	0.98*
Variance	0.002	0.004	0.009
Statistical significance	>2.0	>2.0	>2.0
Boundary 5 (2,000 ft measured from each camera)			
CMF	0.97	0.97	0.98*
Variance	0.001	0.002	0.005
Statistical significance	>2.0	>2.0	>2.0
Boundary 6 (4,000 ft measured from each camera)			
CMF	0.96	0.98	0.99*
Variance	0.0004	0.0005	0.004
Statistical significance	>2.0	>2.0	>2.0

* CMFs estimated after removing outliers.

Statistical significance of the estimated CMFs was calculated as described in the methodology section: if the statistical significance is greater than 2.0, the CMF is statistically significant at the 95 percent confidence level, if the statistical significance is greater than 1.7, the CMF is statistically significant at the 90 percent confidence level, and if the statistical significance is less than 1.7, the estimated CMF is not statistically significant at the 90 percent confidence level. Here, except for the CMF for fatal and injury crashes under the 250 ft boundary, all other CMFs were statistically significant at the 95 percent confidence level. Overall, all the CMFs indicated a reduction in crashes at school zones after the implementation of ASE cameras, as all values were less than 1.0.

On-System Schools: Speeding-Related Crashes

Table 14 presents CMFs estimated for on-system schools considering only speeding-related crashes. For total speeding-related crashes, the CMFs varied from 0.09 to 0.37, while the CMFs for speeding-related PDO crashes varied between 0.13 and 0.34. For speeding-related fatal and injury crashes, the CMF under Boundary 1 was not applicable as the observed crash frequency was zero during the before and after periods. For the other boundaries of that crash category, the CMFs varied from 0.18 to 0.29. All CMFs were statistically significant at the 95 percent confidence level (statistical significance>2.0). All CMFs indicate a significant reduction in speeding-related crashes at school zones following the implementation of ASE cameras. However, the frequency of speeding-related crashes at school zones was relatively low compared to all observed crashes, regardless of the contributing cause. Therefore, these CMFs may be less reliable compared to the CMFs developed for total crashes, even though they were statistically significant.

Table 14. Treated sites only: CMFs estimated for on-system schools, considering speeding-related crashes.

Parameter	Total Crashes	PDO Crashes	Fatal & Injury Crashes
Boundary 1 (250 ft measured from each camera)			
CMF	0.09	0.13	NA
Variance	0.003	0.006	-
Statistical significance	>2.0	>2.0	-
Boundary 2 (500 ft measured from each camera)			
CMF	0.32	0.27	0.23
Variance	0.009	0.01	0.01
Statistical significance	>2.0	>2.0	>2.0
Boundary 3 (1,000 ft measured from each camera)			
CMF	0.37	0.34	0.24
Variance	0.007	0.01	0.007
Statistical significance	>2.0	>2.0	>2.0
Boundary 4 (School zone)			
CMF	0.34	0.26	0.29
Variance	0.007	0.007	0.01
Statistical significance	>2.0	>2.0	>2.0
Boundary 5 (2,000 ft measured from each camera)			
CMF	0.32	0.26	0.23
Variance	0.004	0.005	0.005
Statistical significance	>2.0	>2.0	>2.0
Boundary 6 (4,000 ft measured from each camera)			
CMF	0.33	0.33	0.18
Variance	0.003	0.004	0.003
Statistical significance	>2.0	>2.0	>2.0

Off-System Schools: All Crashes

Table 15 presents CMFs estimated for off-system schools considering all crashes regardless of the contributing cause. Since no pattern was observed in the CMFs for on-system schools across multiple boundaries, only two boundaries were considered for off-system schools. According to the state law, ASE cameras should be placed within the school zone, and warning signs should be placed within a 500 ft distance ahead of the cameras (Georgia General Assembly 2018). Considering those criteria, the legally designated school zone boundary and 500 ft distance measured from the camera locations were selected for estimating CMFs. The CMFs indicated a 10 percent reduction in total crashes for both boundaries. For PDO crashes, there was an 11 percent and 10 percent reduction, respectively. For fatal and injury crashes, there was an 8 percent and 7 percent reduction, respectively, after implementing ASE cameras. The CMFs estimated for total crashes were statistically significant at a 95 percent confidence level (statistical significance>2.0), while CMFs for PDO crashes were statistically significant at a 90 percent confidence level (statistical significance>1.7).

Table 15. Treated sites only: CMFs estimated for off-system schools, considering all crashes.

Parameter	Total Crashes	PDO Crashes	Fatal & Injury Crashes
Boundary 1 (500 ft measured from each camera)			
CMF	0.90	0.89	0.92
Variance	0.002	0.003	0.01
Statistical significance	>2.0	>1.7	<1.7
Boundary 2 (School zone)			
CMF	0.90	0.90	0.93
Variance	0.002	0.003	0.009
Statistical significance	>2.0	>1.7	<1.7

Off-System Schools: Speeding-Related Crashes

Table 16 presents CMFs estimated for off-system schools considering speeding-related crashes. Compared to the CMFs estimated for off-system schools by considering all crashes, the CMFs estimated for speeding-related crashes were low, indicating that ASE is highly effective in reducing speeding-related crashes in school zones. All CMFs were statistically significant at the 95 percent confidence level (statistical significance>2.0). However, the small sample size of speeding-related crashes makes these CMFs less reliable compared to the CMFs estimated for total crashes.

Table 16. Treated sites only: CMFs estimated for off-system schools, considering speeding-related crashes.

Parameter	Total Crashes	PDO Crashes	Fatal & Injury Crashes
Boundary 1 (500 ft measured from each camera)			
CMF	0.32	0.23	0.24
Variance	0.006	0.006	0.007
Statistical Significance	>2.0	>2.0	>2.0
Boundary 2 (School zone)			
CMF	0.27	0.23	0.17
Variance	0.004	0.005	0.004
Statistical Significance	>2.0	>2.0	>2.0

CMFs: Before-and-After Study Using the Comparison-Group Method

The estimation of CMFs was conducted in this part of the study by considering both treated and control schools.

On-System Schools: All Crashes

Table 17 presents CMFs estimated for on-system schools considering all crashes regardless of the contributing cause. For total crashes, the CMFs varied from 0.84 to 0.92, while the CMFs ranged between 0.86–0.93 and 0.78–0.98 for PDO and fatal and injury crashes, respectively. All the CMFs were less than 1.0, which indicated a reduction in crashes at schools after the implementation of ASE cameras. All CMFs estimated for total crashes and PDO crashes were statistically significant at a 95 percent confidence level (statistical significance>2.0) or a 90 percent confidence level (statistical significance>1.7). However, CMFs estimated for fatal and injury crashes were not statistically significant at a 90 percent confidence level (statistical significance<1.7), except for Boundary 3. Additionally, it was observed that the estimated CMFs did not exhibit a distinct pattern based on the boundary or the crash severity level.

Table 17. Treated and control sites: CMFs estimated for on-system schools, considering all crashes.

Parameter	Total Crashes	PDO Crashes	Fatal & Injury Crashes
Boundary 1 (250 ft measured from each camera)			
CMF	0.89	0.88	0.98
Statistical significance	>2.0	>1.7	<1.7
Boundary 2 (500 ft measured from each camera)			
CMF	0.92	0.90	0.97
Statistical significance	>1.7	>1.7	<1.7
Boundary 3 (1,000 ft measured from each camera)			
CMF	0.84	0.93	0.78
Statistical significance	>2.0	>1.7	>2.0
Boundary 4 (School zone)			
CMF	0.90	0.90	0.97
Statistical significance	>2.0	>1.7	<1.7
Boundary 5 (2,000 ft measured from each camera)			
CMF	0.92	0.91	0.91
Statistical significance	>2.0	>2.0	<1.7
Boundary 6 (4,000 ft measured from each camera)			
CMF	0.88	0.86	0.91
Statistical significance	>2.0	>2.0	<1.7

On-System Schools: Speeding-Related Crashes

Table 18 presents all the CMFs estimated for speeding-related total crashes, speeding-related PDO crashes, and speeding-related fatal and injury crashes under different boundaries. The observed speeding-related crash frequencies were low at treated and control schools, compared to all crashes observed at those locations. For Boundary 1, the CMFs could not be defined because the crash counts were zero for at least one of the treated and control schools in each sample pair. For speeding-related total crashes, the CMFs ranged from 0.60 to 0.65, while the CMFs ranged from 0.20 to 0.67 and 0.17 to 0.55 for speeding-related PDO and fatal and injury crashes, respectively. All the CMFs indicated that ASE was highly effective in reducing speeding-related crashes in school zones. However, some of the CMFs estimated were not statistically significant at 95 percent or 90 percent confidence levels (statistical significance<1.7). Overall, these CMFs are less reliable than those developed for total crashes, as the sample sizes are relatively small.

Table 18. Treated and control sites: CMFs estimated for on-system schools, considering speeding-related crashes.

Parameter	Total Crashes	PDO Crashes	Fatal & Injury Crashes
Boundary 1 (250 ft measured from each camera)			
CMF	NA	NA	NA
Statistical significance	-	-	-
Boundary 2 (500 ft measured from each camera)			
CMF	0.65	0.59	0.43
Statistical significance	<1.7	<1.7	<1.7
Boundary 3 (1,000 ft measured from each camera)			
CMF	0.62	0.20	0.55
Statistical significance	>1.7	>2.0	<1.7
Boundary 4 (School zone)			
CMF	0.65	0.67	0.18
Statistical significance	<1.7	<1.7	>2.0
Boundary 5 (2,000 ft measured from each camera)			
CMF	0.60	0.62	0.49
Statistical significance	>1.7	<1.7	<1.7
Boundary 6 (4,000 ft measured from each camera)			
CMF	0.60	0.67	0.17
Statistical significance	>2.0	<1.7	>2.0

Off-System Schools: All Crashes

Table 19 presents CMFs estimated for off-system schools considering all crashes regardless of the contributing cause. All CMFs were lower than 1.0, indicating that all crashes, PDO crashes, and fatal and injury crashes have been reduced after implementing ASE cameras in school zones. The CMFs estimated for total and PDO crashes were statistically significant at the 95 percent confidence level (statistical significance>2.0); however, the CMFs for fatal and injury crashes were not statistically significant at the 90 percent confidence level (statistical significance<1.7).

Table 19. Treated and control sites: CMFs estimated for off-system schools, considering all crashes.

Parameter	Total Crashes	PDO Crashes	Fatal & Injury Crashes
Boundary 1 (500 ft measured from each camera)			
CMF	0.81	0.89	0.98
Statistical significance	>2.0	>2.0	<1.7
Boundary 2 (School zone)			
CMF	0.91	0.90	0.99
Statistical significance	>2.0	>2.0	<1.7

Off-System Schools: Speeding-Related Crashes

Table 20 presents CMFs estimated for off-system schools considering speeding-related crashes. All CMFs estimated under different boundaries and crash severity levels indicated that speeding-related crashes have decreased at school zones after the implementation of ASE cameras, even though the frequencies of speeding-related crashes observed during the before and after periods at treated and control schools were low, compared to all crashes observed at those schools.

Table 20. Treated and control sites: CMFs estimated for off-system schools, considering speeding-related crashes.

Parameter	Total Crashes	PDO Crashes	Fatal & Injury Crashes
Boundary 1 (500 ft measured from each camera)			
CMF	0.51	0.43	0.69
Statistical significance	<1.7	>1.7	<1.7
Boundary 2 (School zone)			
CMF	0.46	0.73	0.62
Statistical significance	>2.0	<1.7	<1.7

Overall, the before-and-after study using the comparison-group method provided more reliable CMFs compared to the before-and-after study that considered only treated schools. This approach enabled the isolation and quantification of the safety effect of ASE cameras by controlling factors such as changes in traffic patterns, extreme weather conditions, law enforcement changes in school zones, and socioeconomic changes, if any. These broad and system-wide changes cannot be accommodated in the before-and-after study, which only considers treated sites, thereby limiting the ability to quantify the actual and isolated effectiveness of ASE cameras. In summary, the CMFs presented in Table 21, which were obtained from the before-and-after study using the comparison-group method, can be recommended for future use.

Table 21. Recommended CMFs from the crash study.

Boundary	**Crash Type**	**CMF for On-System Schools**	**CMF for Off-System Schools**
School zone	Total crashes	0.90	0.91
School zone	Speeding-related total crashes	0.65	0.46

However, the results of both the before and after methods indicated that ASE is effective in reducing all crashes, speeding-related crashes, as well as fatal, injury, and PDO crashes at treated schools.

Generally, the overall crash reduction between the before and after periods across all sites differed from the average per-site reduction. This arises due to the varying durations of the before and after periods at each study site. Some sites were observed for longer periods, while others were observed for shorter periods, depending on when the camera programs were implemented. As a result, sites with longer durations contribute more crashes to the total counts, which can inflate the overall reduction when calculated from raw crash data. In contrast, when calculating the average reduction per site, each site is given equal weight regardless of its observation period or traffic exposure. This approach produces a smaller, but more representative, estimate of the treatment effect at the site level. Accordingly, the CMFs derived using the EB method reflect this average site-level reduction, accounting for regression-to-the-mean effects and differences in expected crash frequencies, rather than the total systemwide crash reduction. Total raw crash counts for before-and-after periods, and average crash reduction per site for each category are presented in Appendix C.

RESULTS OF THE SPEED STUDY

This section presents the results of the speed analysis, including key speed parameters and the percentages of drivers who exceeded the posted speed limits at treated and control schools, along with the results of the Levene's test, Mann–Whitney *U* test, and K-S test.

Key Speed Parameters

Table 22 presents the speed parameters estimated for each treated school during camera-active hours, considering free-flow vehicles. Mean speed, speed variance, standard deviation, and percentile speeds were estimated for each treated school. Among schools with a 25-mph school zone speed limit, the highest mean, 50th percentile, and 85th percentile speeds recorded were 26.9 mph, 27 mph, and 34 mph, respectively. Among schools with a 35-mph school zone speed limit, the highest mean, 50th percentile, and 85th percentile speeds recorded were 39.3 mph, 39.9 mph, and 48 mph, respectively.

Table 22. Speed parameters at each treated school.

School Name	School Zone Speed Limit (mph)	50th Percentile Speed (mph)	85th Percentile Speed (mph)	Mean Speed (mph)	Variance (mph)	Standard Deviation (mph)
Church Street Elementary School	25	27.0	34.0	26.9	28.0	5.3
Coleman Middle School	25	20.5	26.0	20.9	28.4	5.3
Riverdale High School	25	23.3	32.0	24.5	46.9	6.8
Duncan Creek Elementary School	35	37.2	43.6	35.2	76.9	8.8
Griffin High School	35	39.9	48.0	39.3	65.7	8.1

Table 23 presents speed parameters estimated for each control school within a window similar to the active hours of the camera at treated schools, considering free-flow vehicles. Among the control schools with a 25 mph school zone speed limit, the highest mean, 50th percentile, and 85th percentile speeds were 41.9 mph, 42.2 mph, and 49.1 mph.

Table 23. Speed parameters at each control school.

School Name	School Zone Speed Limit (mph)	50th Percentile Speed (mph)	85th Percentile Speed (mph)	Mean Speed (mph)	Variance (mph)	Standard Deviation (mph)
Powers Ferry Elementary School	25	37.9	44.0	36.1	54.4	7.4
Milford Elementary School	25	42.2	49.1	41.9	60.8	7.8
Sutton Middle School	25	34.1	42.0	33.5	57.9	7.6
Salem High School	25	29.6	37.5	29.7	54.4	7.4
Marietta High School	35	36.4	44.4	32.2	167.1	12.9

Table 24 and Table 25 present speed parameters estimated separately for treated and control schools with 25-mph and 30-mph school zone speed limits, respectively. As 25-mph and 35-mph school zones represent two distinct speed distributions, they were analyzed separately to ensure the validity of the resulting speed parameters.

Table 24. Speed parameters estimated for treated and control schools with a 25-mph school zone speed limit.

Group	Total Vehicles	50th Percentile Speed (mph)	85th Percentile Speed (mph)	Mean Speed (mph)	Variance (mph)	Standard Deviation (mph)
Treated	9,359	23.0	29.8	31.8	39.0	6.2
Control	23,852	36.0	44.1	34.8	74.9	8.7

Table 25. Speed parameters estimated for treated and control schools with a 35-mph school zone speed limit

Group	Total Vehicles	50th Percentile Speed (mph)	85th Percentile Speed (mph)	Mean Speed (mph)	Variance (mph)	Standard Deviation (mph)
Treated	14,193	37.9	44.7	37.3	75.5	8.7
Control	5,126	36.0	44.7	32.3	167.1	12.9

Overall, the mean, 50th percentile, and 85th percentile speeds, and the speed variance and standard deviation were lower at treated schools than at control schools. Therefore, it can be concluded that ASE is effective in reducing speeds in school zones.

Percentages of Drivers Exceeding School Zone Speed Limits

Table 26 shows the percentages of drivers who exceeded the school zone speed limits by 5 mph and 10 mph at each treated school, under free-flow conditions. The highest percentages observed were 46.3 percent and 20.6 percent, exceeding the school zone speed limits by 5 mph and 10 mph, respectively.

Table 27 shows the percentages of drivers who exceeded the school zone speed limits by 5 mph and 10 mph at each control school. Among the selected control schools, the highest percentages observed were 94 percent and 86.1 percent exceeding the school zone speed limits by 5 mph and 10 mph, respectively. Table 28 presents the percentages of drivers who exceeded school zone speed limits, estimated separately for the treated group and control group.

Table 26. Percentages of drivers who exceeded school zone speed limits at treated schools.

School Name	School Zone Speed Limit (mph)	Total Vehicles	Percentage of Drivers Exceeded School Zone Speed Limit	Percentage of Drivers Exceeded School Zone Speed Limit by 5 mph	Percentage of Drivers Exceeded School Zone Speed Limit by 10 mph
Church Street Elementary School	25	2,701	61.6	27.5	5.1
Coleman Middle School	25	4,745	19.6	3.3	0.1
Riverdale High School	25	1,913	40.6	19.1	6.0
Duncan Creek Elementary School	35	7,090	60.5	29.1	5.4
Griffin High School	35	7,103	70.3	46.3	20.6

Table 27. Percentages of drivers who exceeded school zone speed limits at control schools.

School Name	School Zone Speed Limit (mph)	Total Vehicles	Percentage of Drivers Exceeded School Zone Speed Limit	Percentage of Drivers Exceeded School Zone Speed Limit by 5 mph	Percentage of Drivers Exceeded School Zone Speed Limit by 10 mph
Powers Ferry Elementary School	25	4,987	91.1	80.3	59.3
Milford Elementary School	25	6,222	97.4	94.0	86.1
Sutton Middle School	25	7,476	88.1	73.0	41.0
Salem High School	25	5,167	70.1	46.0	19.9
Marietta High School	35	5,126	52.9	35.8	11.5

Table 28. Percentages of drivers exceeded school zone speed limits at treated and control schools.

Group	Total Vehicles	Percentage of Drivers Exceeded School Zone Speed Limit	Percentage of Drivers Exceeded School Zone Speed Limit by 5 mph	Percentage of Drivers Exceeded School Zone Speed Limit by 10 mph
Treated	23,552	53.7	28.1	8.9
Control	28,978	81.2	67.4	44.9

The percentages of drivers who exceeded the school zone speed limits by 5 mph and 10 mph were considerably lower at the treated schools compared to the control schools. The percentages of drivers who exceeded the school zone speed limit by 10 mph were 8.9 percent and 44.9 percent at treated and control schools, respectively, showing a 36 percent lower percentage at treated schools. Therefore, it can be concluded that ASE is effective in improving driver compliance with the posted speed limits in school zones.

Statistical Comparisons

This section presents the results obtained from statistical tests conducted to compare the variance distributions and speed distributions at treated and control schools. Table 29 presents a summary of the results from Levene's test, which was conducted to compare the variance distributions between treated and control schools. The test assesses the distribution of deviations of individual observations from group means to determine whether group variances are statistically equal. For all categories considered, the *p*-value was less than 0.05 (at a 95 percent level of significance), indicating that the variance distribution curves of all treated schools-elementary, middle, and high schools-were statistically significantly lower compared to the control schools.

Table 29. Results of Levene's test for comparing speed variances.

Comparison (Treated vs. Control)	Variance of the Treated Group	Variance of the Control Group	Levene Statistic	*p*-Value
All treated schools vs. all control schools	39.0	74.9	1,100.56	<0.001
Elementary Schools vs. Elementary Schools	28.0	61.4	224.81	<0.001
Middle Schools vs. Middle Schools	28.5	57.9	337.11	<0.001
High Schools vs. High Schools	46.9	54.5	29.38	<0.001

These results demonstrate that ASE was associated with significantly lower variance distribution in school zones under free-flow conditions, and this observation was consistent across all school types. Overall, the speed variances at treated and control schools were 39.0 and 74.9, respectively, indicating lower variance at the treated schools. This effect was more pronounced at elementary schools, indicating greater driver sensitivity to ASE and increased compliance with school zone speed limits. Compared to control schools, lower speed variances at treated schools imply that ASE may lead to reduce traffic conflicts and crashes in school zones, thereby improving safety.

Overall, the results suggest that ASE promotes more consistent driving behavior and driver compliance with school zone speed limits. However, it is also essential to examine the speed distribution curves at both treated and control schools, as this provides a comprehensive picture of the overall driver response to ASE, beyond mean speeds or percentile speeds. Table 30 shows the results of the Mann–Whitney *U* test and the K-S test. A two-tailed Mann–Whitney *U* test was conducted for the speed distribution curves at treated and control schools, as well as for the site-level 85th percentile speeds. A two-sample K-S test was conducted for the two speed distribution curves at treated and control schools, as the test is only capable of comparing the data distributions.

Table 30. Results of Mann–Whitney *U* test and K-S test for comparing speed distributions.

Comparison (Treated vs Control)	Mann–Whitney *U* Test Asymp.Sig.(2-tailed)	K-S Test Asymp.Sig.(2-tailed)
Speed distribution	<0.001	<0.001
Site-level 85th percentile speed	0.034	-

Asymptotic significance or the *p*-values of the tests were lower than 0.05, suggesting rejection of the null hypothesis of both tests. Specifically, the two-tailed Mann–Whitney *U* test results indicated that independent speed samples from both treated and control schools originated from populations with different central tendencies, typically the median of the data. This was applied to the speed distribution, as well as to the site-level 85th percentile speeds estimated under free-flow conditions. Rejecting the null hypothesis of the two-sample K-S test indicated that the speed distribution curves at treated schools were significantly lower from those at control schools, with lower mean and percentile speeds.

Table 31 presents the results of the two-tailed Mann–Whitney *U* test and the two-sample K-S test, considering different school types. Results indicated that, for each school category-wise comparison, the asymptotic significance, or the *p*-value, was lower than 0.05. Like the previous observations, it suggested rejecting the null hypothesis. For each school category, independent speed samples from both treated and control schools originated from populations with different central tendencies, typically the median of the data. Additionally, the speed distribution curves at treated schools within each category were significantly lower than those at control schools under the same category, with lower mean and percentile speeds.

Table 31. Results of the Mann–Whitney *U* test and the K-S test for different school categories for comparing speed distributions.

Comparison (Treated vs Control)	Mann–Whitney *U* Test Asymp.Sig.(2-tailed)	K-S Test Asymp.Sig.(2-tailed)
Speed distribution-Elementary Schools vs Elementary Schools	<0.001	<0.001
Speed distribution-Middle Schools vs Middle Schools	<0.001	<0.001
Speed distribution -High Schools vs High Schools	<0.001	<0.001

Therefore, it can be concluded that there is a statistically significant difference in vehicle speeds in treated and control school zones, since both the Mann–Whitney *U* test and K-S test indicated that the speed distribution curve at treated schools was significantly lower compared to the speed distribution curve of the control schools. Furthermore, ASE promotes driver compliance with posted speed limits and uniform speeds across school zones.

RESULTS OF THE ROAD USER SURVEY

This section presents and discusses the results of the road user survey conducted to understand drivers' perceptions of ASE in school zones in GA. A total of 502 responses were received for the survey, and the target population consisted of GA drivers aged 18 years or older. The survey included screening questions to identify students, parents, and respondents with school-age siblings who have direct relationships with the school environment. The IRB approval letter, recruitment flyer, questionnaire form, and informed consent form are provided in Appendix D, Appendix E, Appendix F, and Appendix G, respectively.

The sample consisted of 3 percent high school students and 44 percent parents/respondents with school-age siblings. Additionally, the sample comprised of respondents from diverse sociodemographic categories and varied driving experiences. Of the respondents, 39 percent held a graduate degree, 37 percent held a bachelor's degree, 23 percent had completed a high school degree or an equivalent qualification, and 1 percent reported having less than a high school degree. Regarding the employment status of the respondents, 83 percent were employed, while 17 percent were not employed. Most respondents were aged between 35 and 64 years, representing 52 percent of the total. Respondents aged 18–34 accounted for 41 percent, those aged 65 years or older made-up 6 percent, and 1 percent preferred not to disclose their age range. Of the respondents, 39 percent had more than 25 years of driving experience, 18 percent had 15–25 years, 26 percent had 5–15 years, and 17 percent had less than 5 years of driving experience.

First, the respondents were asked several questions to understand their awareness of ASE cameras, as shown in Figure 14. Of the total respondents, 76 percent had heard about ASE cameras before participating in the survey, and among those, 74 percent had driven through a school zone with ASE cameras. Of those who have driven through school zones with ASE cameras, 22 percent drive every day, 5 percent drive on all weekdays, 24 percent drive at least three or four times per week, 16 percent drive less than three times per week, and 33 percent drive occasionally.

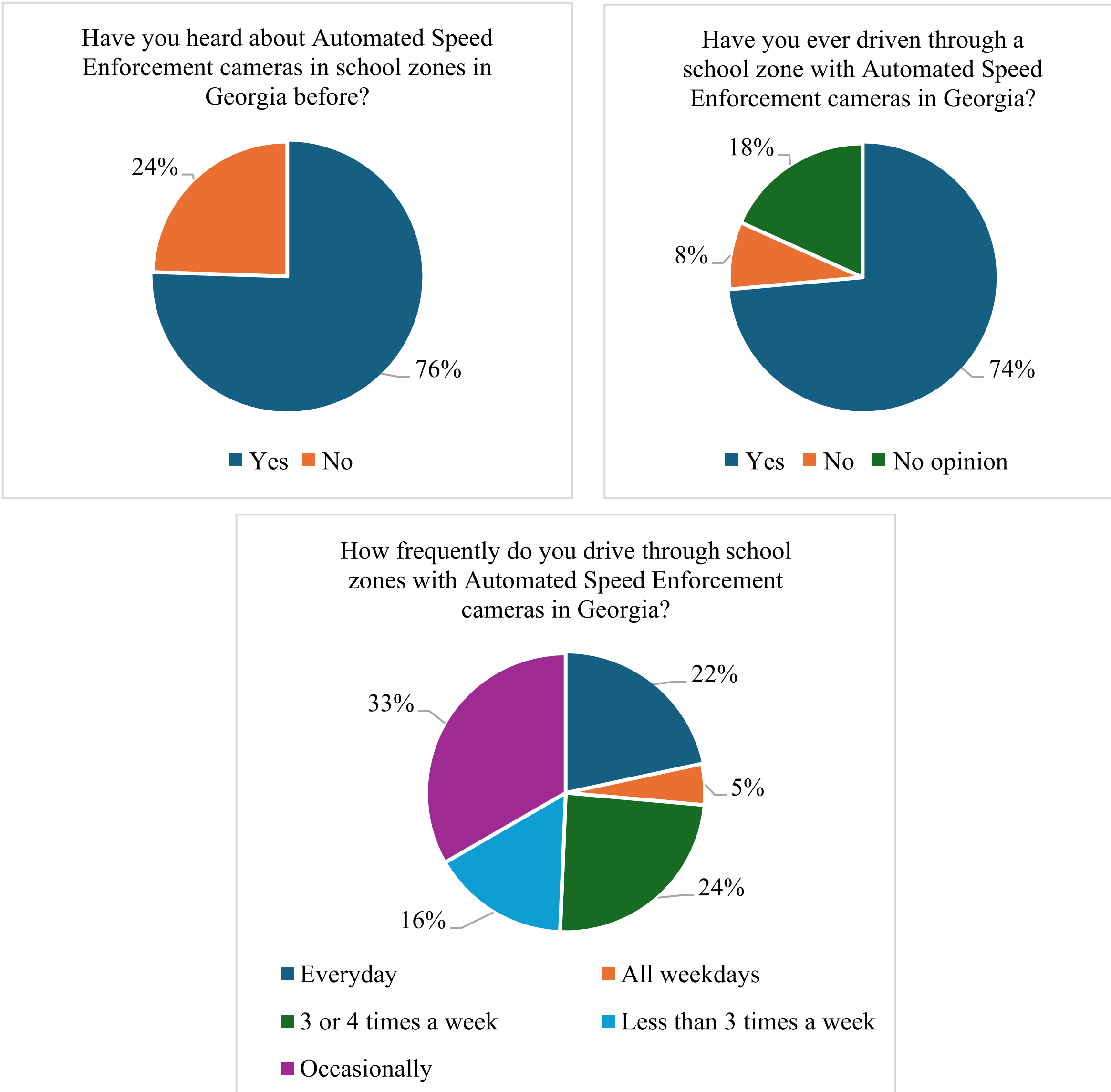


Figure 14. Pie Charts. Respondents' awareness of ASE cameras.

From drivers who have driven across school zones with ASE cameras, 81 percent agreed that ASE caused them to slow down, as shown in Figure 15.

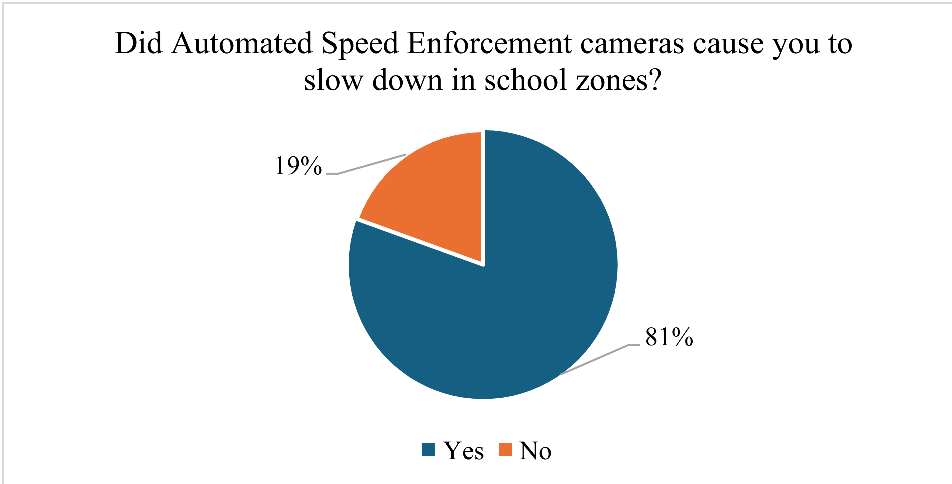
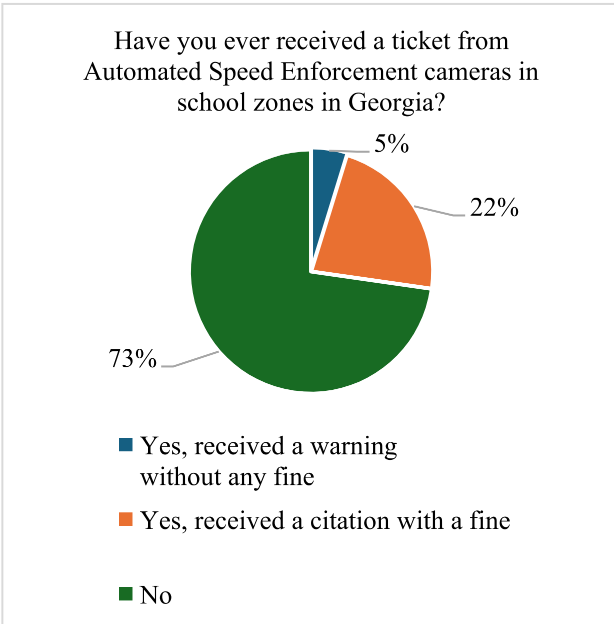


Figure 15. Pie Chart. Opinions of the respondents about the effect of ASE cameras on slowing down in school zones.

Among those respondents, 22 percent had received citations with fines, and 5 percent had received warnings without fines. No respondent had received both a warning and a citation with fines. These percentages are presented in Figure 16. Additionally, 52 percent of respondents reported knowing others who had received citations from school zone ASE cameras. This captures the indirect social influence of ASE cameras, which may affect an individual's perceptions. Of the respondents who participated in the survey, 71 percent supported these ASE programs in school zones, as shown in Figure 17. All results presented in this section, including pie charts, tables, and graphs, are based on the complete responses, and incomplete responses were excluded from the analysis.



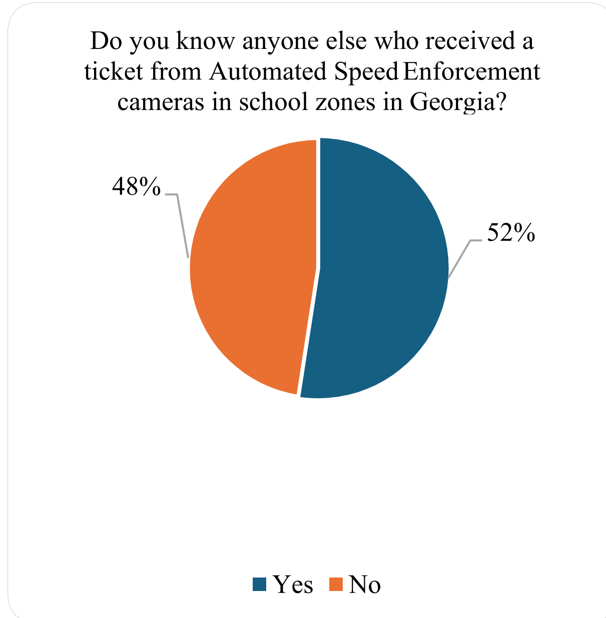


Figure 16. Pie Charts. Respondents' experience in receiving citations.

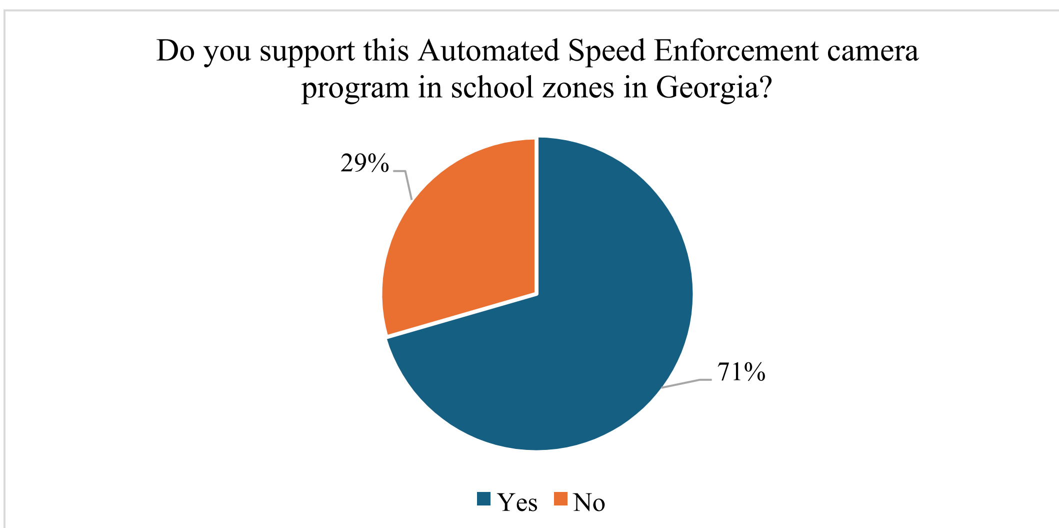


Figure 17. Pie Chart. Respondents' opinions on their support for ASE in GA.

Table 32 shows the level of agreement and disagreement with positive and negative statements about the cameras of all respondents who participated in the survey.

Table 32. Opinions of respondents on different statements regarding ASE.

No.	Statement	Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree	No opinion
1	The sole purpose of ASE cameras is to reduce vehicle speeds and crashes.	14%	12%	6%	32%	32%	4%
2	ASE cameras are effective in reducing vehicle speeds and crashes.	9%	8%	11%	35%	31%	6%
3	ASE is a creative trap that is motivated by revenue generation rather than safety.	16%	18%	16%	22%	22%	5%
4	School zones are selected for camera installation to maximize violation rates and revenue.	24%	20%	13%	23%	16%	4%
5	It is unclear how citation revenue is distributed and utilized.	4%	3%	16%	24%	37%	15%
6	ASE cameras at school zones only benefit private companies.	18%	18%	23%	12%	10%	20%
7	The authorities use these cameras to control the public in an indirect way.	13%	18%	19%	24%	20%	6%
8	ASE fines are too high and it's not fair to pay that much money for exceeding the speed limit by 10 mph.	14%	20%	18%	15%	19%	14%
9	This 10-mph speeding threshold is too low; it should be increased.	23%	24%	25%	11%	11%	6%
10	I do not trust the technology used in these cameras.	19%	22%	19%	18%	17%	4%
11	ASE citations should be issued to the driver, not to the registered owner.	5%	4%	11%	18%	60%	3%
12	These cameras are a threat to my privacy.	24%	20%	22%	17%	14%	3%
13	ASE cameras are not required since school speed limits are always low, and drivers obey.	38%	27%	15%	10%	7%	3%
14	ASE cameras should be installed only in school zones where police officers cannot safely operate.	17%	21%	19%	23%	16%	4%
15	ASE cameras help to ensure fair and unbiased traffic law enforcement.	14%	13%	17%	34%	18%	5%
16	ASE cameras are not supported by the public; therefore, I also do not want to support.	24%	21%	25%	8%	11%	11%
17	I believe these cameras should be implemented in all school zones in Georgia to improve safety.	19%	14%	12%	27%	25%	3%

Notably, 37 percent of respondents strongly agreed that it is unclear how citation revenue is distributed and utilized. Additionally, 60 percent of respondents strongly agreed that citations should be mailed to the driver, rather than to the registered owner of the vehicle. While 38 percent disagreed that ASE is unnecessary because drivers obey school speed limits, 25 percent of respondents strongly agreed that ASE should be expanded to all school zones in GA. In addition to these statements, respondents were asked to provide open-ended comments, and all those comments written by the respondents are provided in Appendix H. Furthermore, the respondents provided their opinions on improving the transparency and trustworthiness of the camera program, as shown in Figure 18 through Figure 20.

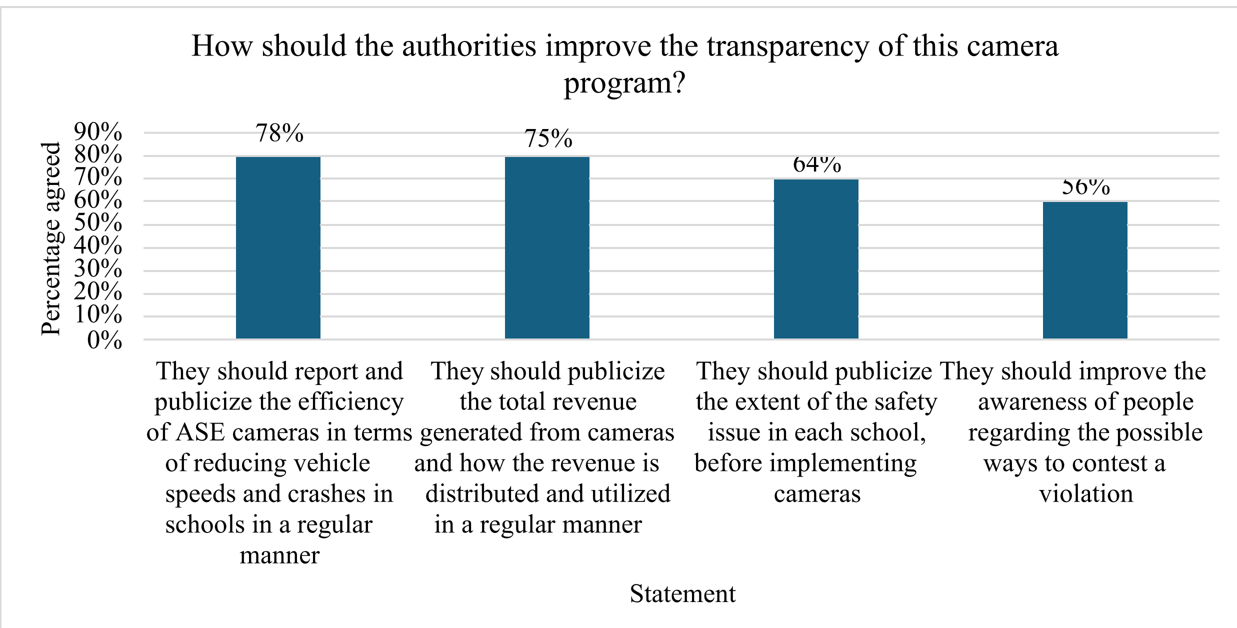


Figure 18. Chart. Views on improving the transparency of the camera program.

Most respondents agreed that the authorities should regularly publicize the efficiency of the ASE cameras and the distribution and utilization of revenue. Regarding the trustworthiness of the program, the primary concern was that the authorities should clearly publish speed limits and hours being evaluated in school zones. Additionally, 63 percent of respondents agreed that authorities should limit the use of ASE cameras to only school zones and work zones.

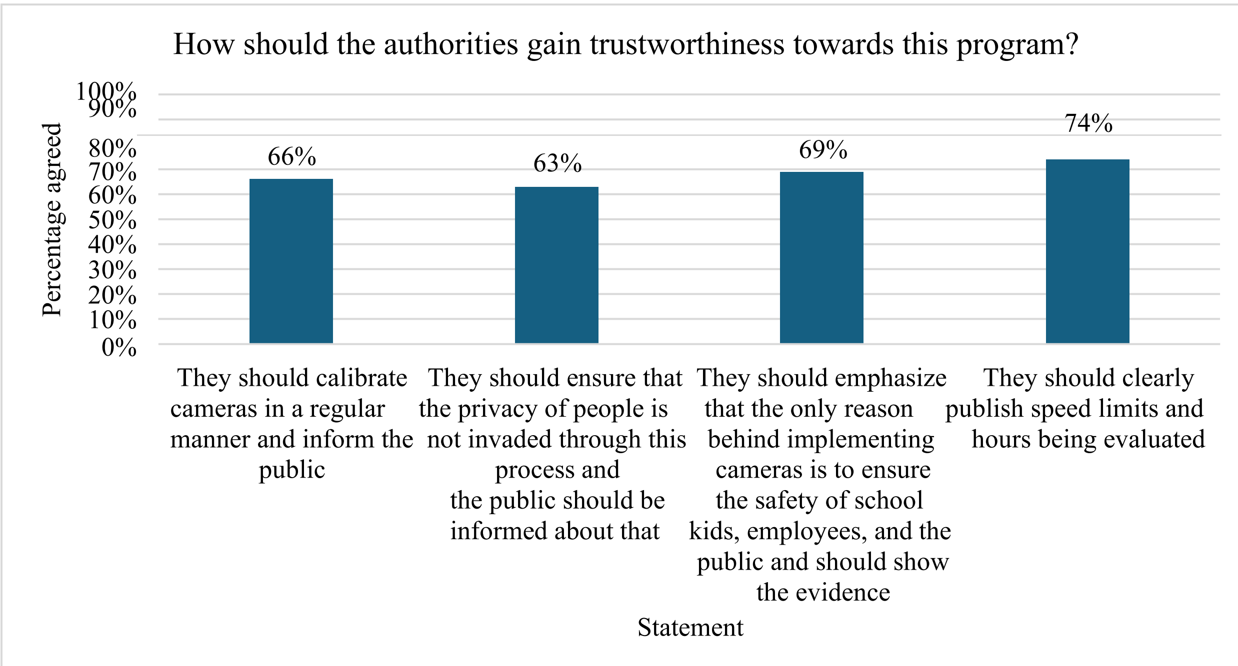


Figure 19. Chart. Views on improving the trustworthiness of the camera program.

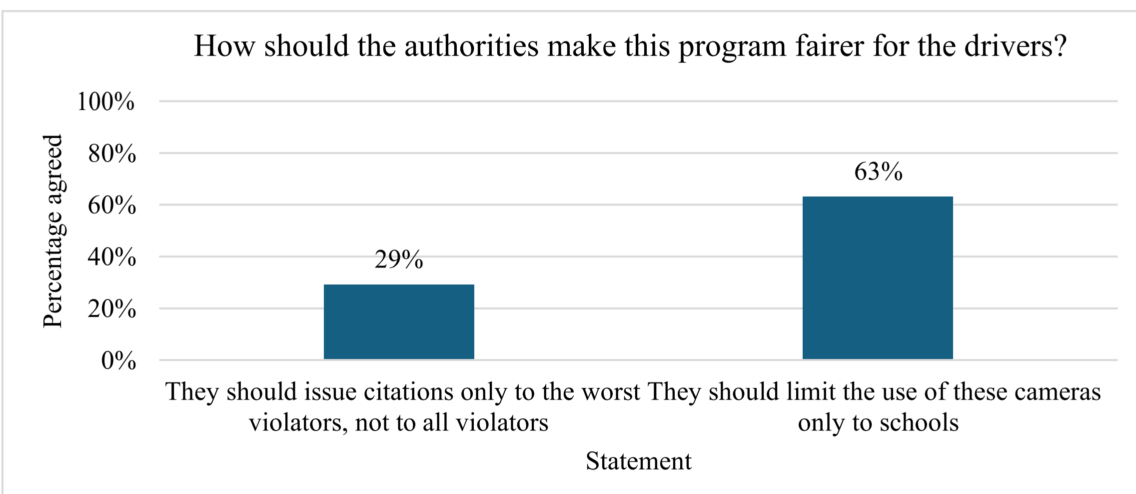


Figure 20. Chart. Views on making the program fairer for the drivers.

Table 33 presents a summary of the results from the cross-classification analysis conducted to examine variations in opinions on ASE across different sociodemographic categories of respondents and their driving frequencies. All contingency tables are presented in Appendix I. A statistically significant relationship was found between support for ASE cameras and the respondent's status as a parent, high school student, or having a school-age sibling. While the majority of respondents who supported ASE did not have a direct school connection, the test results indicate that the respondents with a school connection were more likely to support ASE. Also, the support for the ASE cameras depends on the age of the respondent, driving experience of the respondent, and whether the respondent has previously received a fine. Among the age groups, the 18–34 age group showed relatively strong support for ASE compared to the others. Regarding the driving experience, 83 percent of respondents with less than 5 years of driving experience showed relatively higher support for ASE compared to the other categories of driving experience. Additionally, respondents who had not received a fine supported ASE more than those who had already received a fine. Furthermore, it was found that the perception of ASE as a revenue-motivated practice rather than a safety measure depends on whether the respondent has previously received a fine. Even though the survey received 502 responses, the opinions of people who oppose these ASE cameras may not be represented in these outcomes, as many of them refused to participate in the survey during in-person interactions. As a result, the findings may overrepresent positive perceptions and could underestimate negative opinions toward ASE, highlighting a potential bias in the collected data. Some news articles published about ASE programs in GA are included in Appendix J as a snapshot of opinions available in the public domain.

Table 33. Results of the cross-classification analysis for the road user survey.

Category 1	Category 2	Chi-Squared Statistic	*p*-Value
Support for ASE in School zones (Yes/No)	Respondent is a parent, a high school student, or has a school-aged sibling	6.4	0.01*
	Respondent is not a parent, a high school student, or does not have a school-aged sibling		
Support for ASE in School zones (Yes/No)	Every weekday and every day, travelers through school zones with ASE cameras	0.9	0.34
	Other travelers		
Support for ASE in School zones (Yes/No)	Employed respondents	0.6	0.42
	Unemployed respondents		
Support for ASE in School zones (Yes/No)	Bachelor's or graduate degree holders	0.0	1.0
	High school degree or equivalent qualification holders or less		
Support for ASE in School zones (Yes/No)	18–34 years old respondents	10.1	0.01*
	35–64 years old respondents		
	Respondents 65+ years old		
Support for ASE in School zones (Yes/No)	Respondents with <5 years of driving experience	18.3	0.00*
	Respondents with 5–15 years of driving experience		
	Respondents with 15–25 years of driving experience		
	Respondents with >25 years of driving experience		
Support for ASE in School zones (Yes/No)	Respondents who have received citations with a fine	21.8	<0.00*
	Respondents who have not received any warning or a citation with a fine		
ASE is a creative trap that is motivated by revenue generation rather than safety (Agree/Disagree/Neutral or have no idea)	Respondents who have received citations with a fine	10.2	0.01*
	Respondents who have not received any warning or a citation with a fine		
The sole purpose of ASE cameras is to reduce vehicle speeds and crashes (Agree/Disagree/Neutral or have no idea)	Bachelor's or graduate degree holders	3.1	0.21
	High school degree or equivalent qualification holders or less		
ASE cameras should be implemented in all school zones in GA to improve safety	Every weekday and every day, travelers through school zones with ASE cameras	1.4	0.50
	Other travelers		

*Statistically significant at 95% confidence level.

RESULTS OF TRAFFIC CONFLICT OBSERVATIONS

This section presents the results of the observational study of traffic conflicts. Table 34 presents the summary of conflicts observed at selected treated and control schools. Conflicts were recorded at each school during two consecutive 2-hour windows, one in the morning and one in the evening, encompassing school opening and dismissal times.

Table 34. Different conflict types observed at treated and control schools.

Conflict Type	Treated Schools	Control Schools
Left-turn same direction	3	2
Right-turn same direction	6	2
Slow vehicle	5	3
Lane change	7	5
Opposing left-turn	13	12
Left-turn from right	4	0
Right-turn from-left	1	0
Through from-left	1	0
Sudden braking	4	2
Total Conflicts	44	26

According to the results, more conflicts were observed at the treated schools. It is essential to note that the duration and sample size of the observed conflicts are insufficient to conduct a meaningful, in-depth conflict analysis. For a more accurate analysis, data collection would need to be conducted over a much longer period at multiple locations, which was beyond the scope of this study.

However, the crash analysis and speed analysis revealed that the total number of crashes, speeding-related crashes, mean, and percentile speeds have been significantly reduced after implementing ASE cameras. Conflicts reflect behavioral tendencies and interactions during highdemand periods, while crashes reflect long-term outcomes of a particular countermeasure, making them more reliable. These limited observations suggest that while ASE cameras may not necessarily reduce the frequency of specific driver maneuvers that lead to conflicts, they significantly reduce speed and speed violations, thereby reducing the probability of conflicts escalating into crashes. Additionally, the higher number of conflicts observed at treated schools may be due to behavioral adjustments by drivers, such as sudden braking and slowing down unnecessarily to avoid receiving a citation. Due to the reduced speeds, these conflicts may not necessarily be escalated into crashes, as they may provide more time to react. Furthermore, in the crash study, crashes were observed over years, whereas conflicts were observed during a shorter period. Therefore, these short-term conflict observations may not accurately reflect the long-term safety improvements in school zones, as captured in crash data.

CHAPTER 5. SUMMARY AND RECOMMENDATIONS

The primary objective of this research study was to investigate the effectiveness of ASE on safety and vehicle speeds in school zones and to explore public opinions on this camera program. This involved comprehensive crash analysis, speed analysis, and a road user survey. In the crash study, CMFs were estimated using (1) a before-and-after study with EB approach only considering treated schools and (2) a before-and-after study using the comparison-group method, following the HSM methodologies. Speed analysis was performed primarily to examine key speed parameters, including the percentages of drivers who exceeded school zone speed limits, and to statistically compare variance distributions and speed distributions at schools with and without ASE cameras. A road user survey was conducted among drivers aged 18 or over across GA to explore public opinions on ASE. The road user survey received a total of 502 responses, which were analyzed through descriptive statistics and cross-classification analysis.

According to the estimated CMFs, ASE is effective in reducing total crashes, speeding-related crashes, and all severity categories considered in this study. From the before-and-after study using the comparison-group method, it was found that the CMF for total crashes was 0.90 for on-system schools and 0.91 for off-system schools, within the school zone, showing a 10 percent and a 9 percent reduction, respectively. Fatal and injury crashes were reduced by 3 percent (CMF=0.97) and 1 percent (CMF=0.99), respectively, within the school zones at on-system and off-system treated schools, after implementing ASE. Also, speeding-related crashes were reduced by 35 percent (CMF=0.65) and 54 percent (CMF=0.46) at on-system and off-system schools, respectively. Similarly, all the other categories showed a reduction in total and speeding-related crashes after implementing ASE. The before-and-after study using the comparison-group method is capable of incorporating several temporal variations and external factors, resulting in more reliable CMF estimates.

The speed analysis was conducted using free-flow speeds during the camera-operating time at treated schools, along with free-flow speed data from similar time windows at control schools. The results of the speed analysis indicated that the estimated 50th percentile, 85th percentile, and mean speeds for the treated schools were lower than those of the control group. Additionally, the percentages of drivers who exceeded the school zone speed limit by more than 5 mph and 10 mph were lower at the treated schools. At treated schools, 28.1 percent of drivers exceeded the school zone speed limit by more than 5 mph, and 8.9 percent exceeded the school zone speed limit by more than 10 mph. These percentages were 67.4 percent and 44.9 percent, respectively, for control school locations. Levene's test showed that the speed variance distribution at treated schools was statistically significantly lower than that at control schools. Mann–Whitney *U* test and K-S test results showed that the speed distribution curve at treated schools was also statistically significantly lower, compared to the control schools. All three statistical tests yielded similar results for elementary, middle, and high school locations.

The responses to the road user survey showed that 76 percent of respondents were aware of the ASE cameras in school zones, and 74 percent among those drivers had driven past schools with cameras. Of those who had driven past schools with ASE cameras, 81 percent agreed that ASE caused them to slow down in school zones. Additionally, 71 percent of respondents expressed support for these ASE programs in school zones. Cross-classification analysis indicated that support for ASE was significantly affected by respondents' direct connections to schools, age, driving experience, and whether they had received a fine. Specifically, respondents with direct school connections were more likely to support ASE. However, there are concerns about the validity of these findings due to low participation from individuals who opposed ASE.

Overall, ASE is effective in reducing total crashes and speeding-related crashes in school zones across all scenarios examined in this study. Also, ASE helps to reduce speed and enhance driver compliance with school zone speed limits. Further, ASE promotes consistency in driver behavior across school zones. Therefore, the agencies may consider ASE as an effective countermeasure or enforcement practice for improving traffic safety in school zones, making it a worthwhile investment. Furthermore, this study provides data-driven insights that would be useful for the continuous use of ASE, enabling agencies to make informed decisions to enhance safety in school zones in GA and beyond.

Further, this study has a few limitations that should be acknowledged to contextualize the findings and guide future work. The unavailability of exact implementation dates for ASE programs at some schools was one of the limitations of this study. Although efforts were made to obtain this information, including contacting camera vendors, some companies were unresponsive or unwilling to share the information. Therefore, this study only focused on locations with sufficiently reliable information. In the crash study, the HSM recommends examining at least 3 years before and after the implementation to ensure a reliable estimation of safety changes. However, depending on the implementation dates of ASE programs, some school zones had less than 3 years of before-and-after periods, which is not ideal. Also, SPFs from the HSM require a calibration factor to adjust the predictive models to local conditions. At present, GA lacks established calibration factors for the relevant facility types. Additionally, the results of the road user perception survey may be biased because many individuals who opposed ASE declined to participate. Although this limitation is common in voluntary surveys, it remains important to acknowledge because it may influence the interpretation of the survey findings. Overall, while these limitations do not invalidate the study, they provide essential context for interpreting the results and highlight areas where future research can be enhanced.

APPENDICES

APPENDIX A. BEFORE-AND-AFTER PERIODS OF SELECTED SCHOOLS

On-System Schools

School ID	Treated School	Control School	Before Period	After Period	Before-and-After Duration (Years)
1	Bethlehem Elementary School	Auburn Elementary School	2/28/2017–2/29/2020	8/3/2021-8/3/2024	3.0
2	Coleman Middle School	Berkmar Middle School	9/30/2017-2/29/2020	8/1/2021-1/14/2024	2.5
3	Summerour Middle School	Osborne Middle School	12/17/2017-2/29/2020	8/1/2021-10/26/2023	2.2
4	Beaver Ridge Elementary School	Roberts Elementary School	12/17/2017-2/29/2020	8/1/2021-10/26/2023	2.2
5	South Gwinnett High School	Mill Creek High School	10/4/2017-2/29/2020	8/1/2021-1/6/2024	2.4
6	Duncan Creek Elementary School	Browns Mill Elementary School	6/7/2018–2/29/2020 & 8/1/2021–11/7/2021	11/8/2021-11/8/2023	2.0
7	Anderson-Livsey Elementary School	Centerville Elementary School	8/30/2018–2/29/2020 & 8/1/2021–1/30/2022	1/31/2022-1/31/2024	2.0
8	Starling Elementary School	Fort Daniel Elementary School	8/25/2022-8/25/2023	8/26/2023-8/26/2024	1.0
9	Baldwin High School	North Springs High School	5/31/2018–2/29/2020 & 8/1/2021–10/31/2021	11/1/2021-11/1/2023	2.0
10	Oakland Elementary School	Timber Ridge Elementary School	2/28/2017–2/29/2020	8/4/2021-8/4/2024	3.0
11	Stockbridge Elementary School	Browns Mill Elementary School	3/13/2022-3/13/2023	3/14/2023-3/14/2024	1.0
12	Houston County High School	Coosa High School	2/28/2019-2/29/2020 & 8/1/2021–8/1/2022	8/2/2022-8/2/2024	2.0
13	Eagle Springs Elementary School	Battlefield Primary/Elementary School	2/28/2019-2/29/2020 & 8/1/2021–8/1/2022	8/2/2022-8/2/2024	2.0
14	Perry Middle School	Atkinson County Middle School	1/5/2022-1/5/2023	1/6/2023-1/6/2024	1.0
15	Crescent Road Elementary	Milford Elementary School	9/24/2018–2/29/2020 & 8/1/2021–2/24/2022	2/25/2022-2/25/2024	2.0

16	Griffin High School	Marietta High School	4/26/2019-2/29/2020 & 8/1/2021-10/3/2022	10/4/2022-10/4/2024	2.0
17	Jackson Road Elementary	Pine Ridge Elementary School	4/26/2019-2/29/2020 & 8/1/2021-10/3/2022	10/4/2022-10/4/2024	2.0
18	Southland Academy	Fourth District Elementary School	11/30/2021-11/30/2022	12/1/2022-12/1/2023	1.0
19	Upson-Lee Middle School	North Clayton Middle School	11/1/2017-2/29/2020	8/1/2021-11/2/2023	2.3
20	Dougherty High School	Mundy's Mill High School	3/13/2019-2/29/2020 & 8/1/2021–8/14/2022	8/15/2022-8/15/2024	2.0
21	Crooked River Elementary School	Ruskin Elementary School	3/15/2017–2/29/2020 & 8/1/2021–8/15/2021	8/16/2021-8/16/2024	3.0
22	Taylor Creek Elementary School	Button Gwinnett Elementary School	8/14/2018–2/29/2020 & 8/1/2021–1/14/2022	1/15/2022-1/15/2024	2.0
23	Vidalia Comprehensive High School	Appling County High School	6/6/2017–1/5/2020	1/6/2020-2/29/2020 & 8/1/2021-1/6/2024	2.6
24	JR Trippe Middle School	Mary McLeod Bethune Middle School	6/6/2017–1/5/2020	1/6/2020-2/29/2020 & 8/1/2021-1/6/2024	2.6
25	Knox Elementary School	Live Oak Elementary School	5/25/2018–2/29/2020 & 8/1/2021–10/25/2021	10/26/2021-10/26/2023	2.0
26	Cherokee High School	Pickens County High School	5/3/2017–2/29/2020 & 8/1/2021–10/3/2021	10/4/2021-10/4/2024	3.0
27	Armuchee Elementary School	Abbotts Hill Elementary School	10/23/2021-10/23/2022	10/24/2022-10/24/2023	1.0
28	Main Elementary School	Sonoraville Elementary School	11/27/2021-11/27/2022	11/28/2022-11/28/2023	1.0
29	Cedartown Middle School	Howard Middle School	2/28/2019-2/29/2020 & 8/1/2021–8/1/2022	8/2/2022-8/2/2024	2.0
30	E.J. Swint Elementary School	Roberta T. Smith Elementary School	3/8/2017–2/29/2020 & 8/1/2021–8/8/2021	8/9/2021-8/9/2024	3.0
31	Drew Charter School	Chapel Hill Elementary School	5/30/2022-5/30/2023	5/31/2023-5/31/2024	1.0
32	Burgees-Peterson Academy (HO Burgess)	Avondale Elementary School	6/6/2022-6/6/2023	6/7/2023-6/7/2024	1.0
33	Vickery Mill Elementary School	Grayson Elementary School	7/4/2017–2/2/2020	2/3/2020-2/29/2020 & 8/1/2021-2/3/2024	2.6
34	Central Gwinnett High School	Shiloh High School	2/28/2019-2/29/2020 & 8/1/2021–8/2/2022	8/3/2022-8/3/2024	2.0
35	Matt Arthur Elementary School	Mulberry Creek Elementary School	7/29/2019-2/29/2020 & 8/1/2021–1/5/2023	1/6/2023-1/6/2025	2.0
36	Ringgold Middle School	Northwestern Middle School	7/2/2019-2/29/2020 & 8/1/2021–11/30/2022	12/1/2022-12/1/2024	2.0

37	David Emanuel Academy	Emanuel County Institute	2/1/2017-2/29/2020	8/1/2021-9/1/2024	3.1
38	Greene County High School	Groves High School	5/30/2022-5/30/2023	5/31/2023-5/31/2024	1.0
39	Wrens Elementary School	Louisville Academy School	7/29/2018-2/29/2020 & 8/1/2021-12/31/2021	1/1/2022-1/1/2024	2.0
40	Park Elementary School	New Mountain Hill Elementary School	10/29/2017 & 2/29/2020	8/1/2021-11/30/2023	2.3
41	Harris County High School	Rockmart High School	10/29/2017 & 2/29/2020	8/1/2021-11/30/2023	2.3
42	Clinch County High School	Berrien High School	3/14/2017-2/29/2020 & 8/1/2021-8/14/2021	8/15/2021-8/15/2024	3.0
43	Marlow Elementary School	Birmingham Falls Elementary School	4/29/2017-2/29/2020 & 8/1/2021-9/30/2021	10/1/2021-10/1/2024	3.0
44	Guyton Elementary School	Briarlake Elementary School	3/2/2019-2/29/2020 & 8/1/2021-8/3/2022	8/4/2022-8/4/2024	2.0
45	Sharp Creek Elementary School	Northside Elementary School	11/19/2017-2/29/2020	8/1/2021-11/11/2023	2.3
46	Tate Elementary School	Van Wert Elementary School	10/9/2022-10/9/2023	10/10/2023-10/10/2024	1.0
47	Hill City Elementary School	Tiger Creek Elementary School	10/9/2022-10/9/2023	10/10/2023-10/10/2024	1.0
48	Banks County High School	Browns Mill Elementary School	9/5/2016-2/29/2020	8/1/2021-1/25/2025	3.5
49	Stewart County High School	Armuchee High School	7/30/2022-7/30/2023	7/31/2023-7/31/2024	1.0
50	Comer Elementary School	Berrien Middle School	10/8/2022-10/8/2023	10/9/2023-10/9/2024	1.0
51	Free Home Elementary School	West Clayton Elementary School	5/23/2017-2/29/2020 & 8/1/2021-10/25/2021	10/26/2021-10/26/2024	3.0
52	R M Moore Elementary School	Lyons Upper Elementary	5/23/2017-2/29/2020 & 8/1/2021-10/25/2021	10/26/2021-10/26/2024	3.0
53	Tallulah Falls Middle School	Twin Rivers Middle School	4/3/2019-2/29/2020 & 8/1/2021-9/6/2022	9/7/2022-9/7/2024	2.0
54	Midway Hills Academy	Kingsland Elementary School	8/1/2022-8/1/2023	8/2/2023-8/2/2024	1.0
55	Oglethorpe County High School	Arabia Mountain High School	10/8/2022-10/8/2023	10/9/2023-10/9/2024	1.0

Off-System Schools

School ID	Treated School	Control School	Before Period	After Period	Before-and-After Duration (Years)
1	Bethlehem Elementary School	Auburn Elementary School	2/28/2017-2/29/2020	8/3/2021-8/3/2024	3.0
2	Bear Creek Middle School	Jones Middle School	2/28/2017-2/29/2020	8/3/2021-8/3/2024	3.0
3	Bramlett Elementary School	Bethesda Elementary School	2/28/2017-2/29/2020	8/3/2021-8/3/2024	3.0
4	County Line Elementary School	Burnette Elementary School	2/28/2017-2/29/2020	8/3/2021-8/3/2024	3.0
5	County Line Elementary School	Northside Elementary School	2/28/2017-2/29/2020	8/3/2021-8/3/2024	3.0
6	Holsenbeck Elementary School	Baggett Elementary School	2/28/2017-2/29/2020	8/3/2021-8/3/2024	3.0
7	Winder Elementary School	Brookwood Elementary School	4/3/2018-2/29/2020 & 8/1/2021-9/5/2021	9/6/2022-9/6/2024	2.0
8	Barrow Arts and Science Academy	Peachtree Ridge High School	9/24/2019-2/29/2020 & 8/1/2021-2/27/2023	2/28/2023-2/28/2025	2.0
9	Mason Elementary School	Roswell North Elementary School	2/29/2016-2/29/2020	8/1/2021-8/1/2025	4.0
10	Chattahoochee Elementary School	Findley Oaks Elementary School	2/29/2016-2/29/2020	8/1/2021-8/1/2025	4.0
11	Arcado Elementary School	College Park Elementary	1/22/2016-1/22/2020	1/23/2020-2/29/2020 & 8/1/2021-6/24/2025	4.0
12	Trickum Middle School	Mill Creek Middle School	2/29/2016-2/29/2020	8/1/2021-8/1/2025	4.0
13	Duluth Middle School	Freedom Middle School	2/29/2016-2/29/2020	8/1/2021-8/1/2025	4.0
14	Norcross Elementary School	Asa Hilliard Elementary School	2/29/2016-2/29/2020	8/1/2021-8/1/2025	4.0
15	Baldwin Elementary School	Hamilton E. Holmes Elementary	2/29/2016-2/29/2020	8/1/2021-8/1/2025	4.0
16	Snellville Middle School	Dacula Middle School	2/29/2016-2/29/2020	8/1/2021-8/1/2025	4.0
17	Lawrenceville Elementary School	Camp Creek Elementary School	2/28/2019-2/29/2020 & 8/2/2021-8/2/2022	8/3/2022-8/3/2024	2.0

18	Central Gwinnett High School	North Gwinnett High School	2/28/2019-2/29/2020 & 8/2/2021-8/2/2022	8/3/2022-8/3/2024	2.0
19	South Gwinnett High School	Shiloh High School	2/29/2016-2/29/2020	8/1/2021-8/1/2025	4.0
20	Corley Elementary School	Cooper Elementary School	2/28/2019-2/29/2020 & 8/2/2021-8/2/2022	8/3/2022-8/3/2024	2.0
21	Lanier Middle School	Elkins Pointe Middle School	2/28/2019-2/29/2020 & 8/2/2021-8/2/2022	8/3/2022-8/3/2024	2.0
22	Richards Middle School	Radloff Middle School	8/24/2022-8/24/2023	8/25/2023-8/25/2024	1.0
23	Meadowcreek High School	Berkmar High School	8/26/2022-8/26/2023	8/27/2023-8/27/2024	1.0
24	North Gwinnett Middle School	Northbrook Middle School	8/27/2022-8/27/2023	8/28/2023-8/28/2024	1.0
25	Baldwin Primary School	Cornelia Elementary School	2/29/2016-2/29/2020	8/1/2021-8/1/2025	4.0
26	John Millegde Academy	Mountain View High School	8/12/2017-2/29/2020 & 8/1/2021-1/14/2022	1/15/2022-1/15/2025	3.0
27	Ola High School	Locust Grove High	2/16/2016-2/16/2020	2/17/2020-2/29/2020 & 8/1/2021-7/19/2025	4.0
28	Luella Elementary School	Locust Grove Elementary School	11/17/2015-11/17/2019	11/18/2019-2/29/2020 & 8/1/2021-5/20/2025	4.0
29	Union Grove High School	Cedar Grove High School	11/17/2015-11/17/2019	11/18/2019-2/29/2020 & 8/1/2021-5/20/2025	4.0
30	Hampton High School	Redan High School	2/28/2017-2/29/2020	8/4/2021-8/4/2024	3.0
31	Stockbridge High School	Lithonia High School	2/16/2016-2/16/2020	2/17/2020-2/29/2020 & 8/1/2021-7/19/2025	4.0
32	Austin Road Elementary School	Tussahaw Elementary	2/28/2017-2/29/2020	8/4/2021-8/4/2024	3.0
33	Unity Grove Elementary School	Woodland Elementary School	2/28/2017-2/29/2020	8/4/2021-8/4/2024	3.0
34	Hickory Flat Elementary School	Bob Mathis Elementary School	2/28/2017-2/29/2020	8/4/2021-8/4/2024	3.0
35	Luella Middle School	Stockbridge Middle School	2/28/2017-2/29/2020	8/4/2021-8/4/2024	3.0
36	Mt. Carmel Elementary School	Brockett Elementary School	2/28/2017-2/29/2020	8/4/2021-8/4/2024	3.0
37	New Hope Elementary School	Indian Knoll Elementary	2/28/2017-2/29/2020	8/4/2021-8/4/2024	3.0

38	Pates Creek Elementary School	Hillside Elementary School	2/28/2017-2/29/2020	8/4/2021-8/4/2024	3.0
39	Fairview Elementary School	Dolvin Elementary School	2/28/2017-2/29/2020	8/4/2021-8/4/2024	3.0
40	Rock Spring Elementary School	Jackson Elementary School	2/28/2017-2/29/2020	8/4/2021-8/4/2024	3.0
41	Eagles Landing Middle and High School	Roswell High School	2/28/2017-2/29/2020	8/4/2021-8/4/2024	3.0
42	Flippen Elementary School	Westside Elementary School	2/28/2017-2/29/2020	8/4/2021-8/4/2024	3.0
43	Wesley Lakes Elementary	Allgood Elementary School	8/1/2022-8/1/2023	8/2/2023-8/2/2024	1.0
44	Red Oak Elementary	Level Grove Elementary School	3/13/2021-3/13/2023	3/14/2023-3/14/2025	2.0
45	McDonough Middle and High School	Dutchtown Middle and High School	8/1/2022-8/1/2023	8/2/2023-8/2/2024	1.0
46	Excel Academy	Morrow Middle School	8/1/2022-8/1/2023	8/2/2023-8/2/2024	1.0
47	Mossy Creek Middle School	Feagin Mill Middle School	2/28/2019-2/29/2020 & 8/1/2021-7/31/2022	8/1/2022-8/1/2024	2.0
48	Perry High School	Northside High School	2/28/2019-2/29/2020 & 8/1/2021-7/31/2022	8/1/2022-8/1/2024	2.0
49	Jordan Hill Elementary	Palmetto Elementary School	10/22/2017-2/29/2020 & 8/1/2021-3/23/2022	3/24/2022-3/24/2025	3.0
50	Griffin High School	Northview High School	9/22/2017-2/29/2020 & 8/1/2021-2/24/2022	2/25/2022-2/25/2025	3.0
51	Beaverbrook Elementary School	Wilson Creek Elementary School	10/22/2017-2/29/2020 & 8/1/2021-3/23/2022	3/24/2022-3/24/2025	3.0
52	Kennedy Road Middle School	Crabapple Middle School	10/22/2017-2/29/2020 & 8/1/2021-3/23/2022	3/24/2022-3/24/2025	3.0
53	Spalding High School	Southwest DeKalb High School	10/22/2017-2/29/2020 & 8/1/2021-3/23/2022	3/24/2022-3/24/2025	3.0

54	Rehoboth Middle School	Camp Creek Middle School	10/22/2017-2/29/2020 & 8/1/2021-3/23/2022	3/24/2022-3/24/2025	3.0
55	Cowan Road Elementary	Ashford Park Elementary School	10/22/2017-2/29/2020 & 8/1/2021-3/23/2022	3/24/2022-3/24/2025	3.0
56	Sumter High School	Norcross High School	1/3/2023-1/3/2024	1/4/2024-1/4/2025	1.0
57	Alice Coachman Elementary School	Martin Luther King, Jr. Elementary School	3/14/2017-2/29/2020 & 8/1/2021-8/15/2021	8/16/2021-8/16/2024	3.0
58	Dougherty High School	Jenkins High School	3/13/2019-2/29/2020 & 8/1/2021-8/14/2022	8/15/2022-8/15/2024	2.0
59	Sherwood Elementary School	International Studies Elementary Charter School	3/14/2017-2/29/2020 & 8/1/2021-8/15/2021	8/16/2021-8/16/2024	3.0
60	Westover High School	New Hampstead High School	3/14/2017-2/29/2020 & 8/1/2021-8/15/2021	8/16/2021-8/16/2024	3.0
61	Robert Harvey Elementary School	James L Dewar Elementary	3/14/2017-2/29/2020 & 8/1/2021-8/15/2021	8/16/2021-8/16/2024	3.0
62	Pinvale Elementary School	Pine Grove Elementary School	4/24/2023-4/24/2024	4/25/2024-4/25/2025	1.0
63	Thomasville High School (E. Clay Street)	Dacula High School	2/29/2016-2/29/2020	8/1/2021-8/1/2025	4.0
64	Jerger Elementary School	Cross Creek Elementary School	2/29/2016-2/29/2020	8/1/2021-8/1/2025	4.0
65	Richmond Hill High School	Columbia High School	2/28/2017-2/29/2020	8/2/2021-8/2/2024	3.0
66	Sugarmill Elementary School	Mary Lee Clark Elementary School	3/14/2017-2/29/2020 & 8/1/2021-8/15/2021	8/16/2021-8/16/2024	3.0
67	Georgetown K-8 School	Butler Elementary School	3/14/2017-2/29/2020 & 8/1/2021-8/15/2021	8/16/2021-8/16/2024	3.0
68	Isle of Hope K-8 School	Charles Ellis Montessori Academy	2/29/2016-2/29/2020	8/1/2021-8/1/2025	4.0
69	St. Andrews School	Islands High School	3/14/2017-2/29/2020 &	8/16/2021-8/16/2024	3.0

			8/1/2021-8/15/2021		
70	Myers Middle School	Oglethorpe Charter School	6/1/2019-2/29/2020 & 8/1/2021-11/3/2022	11/4/2022-11/4/2024	2.0
71	Godley Station	West Chatham Elementary School	1/2/2023-1/2/2024	1/3/2024-1/3/2025	1.0
72	South Effingham Elementary School	Kings Chapel Elementary School	4/29/2017-2/29/2020 & 8/1/2021-9/30/2021	10/1/2021-10/1/2024	3.0
73	Blandford Elementary School	David A. Perdue Elementary School	4/29/2017-2/29/2020 & 8/1/2021-9/30/2021	10/1/2021-10/1/2024	3.0
74	Rincon Elementary School	Oak Grove Elementary School	10/1/2022-10/1/2023	10/2/2023-10/2/2024	1.0
75	Harmony Elementary School	Clark Creek Elementary School	10/9/2022-10/9/2023	10/10/2023-10/10/2024	1.0
76	Pickens Junior High School	Dawson County Junior High School	10/9/2022-10/9/2023	10/10/2023-10/10/2024	1.0
77	Cedartown High School	Clarkston High School	2/28/2019-2/29/2020 & 8/1/2021-8/1/2022	8/2/2022-8/2/2024	2.0
78	Joseph H. Huie Elementary School	Kilpatrick Elementary School	8/1/2022-8/1/2023	8/2/2023-8/2/2024	1.0
79	Ash Street Center School	North Clayton High School	8/1/2022-8/1/2023	8/2/2023-8/2/2024	1.0
80	G.P. Babb Middle School	Kendrick Middle School	8/1/2022-8/1/2023	8/2/2023-8/2/2024	1.0
81	Riverdale Middle School	Rex Mill Middle School	2/28/2019-2/29/2020 & 8/1/2021-8/2/2022	8/3/2022-8/3/2024	2.0
82	Riverdale High School	North Clayton High School	2/28/2019-2/29/2020 & 8/1/2021-8/2/2022	8/3/2022-8/3/2024	2.0
83	Church Street Elementary School	Martin Luther King, Jr. Elementary School	2/28/2019-2/29/2020 & 8/1/2021-8/2/2022	8/3/2022-8/3/2024	2.0
84	St. Martin's Episcopal School	Sweetwater Middle School	9/4/2022-9/4/2023	9/5/2023-9/5/2024	1.0
85	Seaborn Lee Elementary School	Barnwell Elementary School	12/3/2015-12/3/2019	12/4/2019-2/29/2020 & 8/1/2021-5/5/2025	4.0
86	Arlington Christian School	Creekland Middle School	2/29/2016-2/29/2020	8/1/2021-8/1/2025	4.0

87	Cliftondale Elementary School	Summit Hill Elementary	2/29/2016-2/29/2020	8/1/2021-8/1/2025	4.0
88	Haynes Bridge Middle School	Autrey Mill Middle School	1/18/2016-1/18/2020	1/19/2020-2/29/2020 & 8/1/2021-6/20/2025	4.0
89	Creek View Elementary School	Hembree Springs Elementary School	2/29/2016-2/29/2020	8/1/2021-8/1/2025	4.0
90	Hapeville Charter Career Academy	Langston Hughes High School	2/29/2016-2/29/2020	8/1/2021-8/1/2025	4.0
91	West Lake High School	Centennial High School	2/29/2016-2/29/2020	8/1/2021-8/1/2025	4.0
92	Stonewall Tell Elementary School	River Eves Elementary School	2/29/2016-2/29/2020	8/1/2021-8/1/2025	4.0
93	Love T. Nolan Elementary School	Heards Ferry Elementary School	2/29/2016-2/29/2020	8/1/2021-8/1/2025	4.0
94	Feldwood Elementary School	Bethune Elementary School	2/29/2016-2/29/2020	8/1/2021-8/1/2025	4.0
95	Alpharetta High School	Chamblee High School	3/8/2017-2/29/2020 & 8/1/2021-8/9/2021	8/9/2021-8/9/2024	3.0
96	Evoline C. West Elementary School	Shakerag Elementary School	2/29/2016-2/29/2020	8/1/2021-8/1/2025	4.0
97	Lake City Elementary and Forest Park High School	Chattahoochee High School	8/2/2022-8/2/2023	8/3/2023-8/3/2024	1.0
98	Liberty Point Elementary School	Mimosa Elementary School	6/7/2017-2/29/2020 & 8/1/2021-11/7/2021	11/8/2021-11/8/2024	3.0
99	CH Gullatt Elementary School	Mountain Park Elementary School	06/7/2017-2/29/2020 & 8/1/2021-11/7/2021	11/8/2021-11/8/2024	3.0

APPENDIX B. EXAMPLE CALCULATION

Before-and-After Study with EB Approach Only Considering Treated Sites

School: South Gwinnett High School

School category: On-system schools

Boundary: 4,000 ft distance measured from the camera

Before period: 2.4 years

After period: 2.4 years

Segment length: 1.67 miles

Road category: Urban and suburban arterials

HSM chapter: Chapter 12

Applicable SPF: Five-lane arterial including a center TWLTS (5T)

Average traffic volume before period: 39,975

Average traffic volume after period: 37,650

Observed total crash count during the before-period: 689

Observed crash count during the after-period: 337

Predictive models for urban and suburban arterial roadway segments:

$$N_{predicted} = C_r \times (N_{br} + N_{pedr} + N_{biker})$$

$$N_{br} = N_{spf} \times (CMF_{1r} \times CMF_{2r} \times \dots \dots . \times CMF_{nr})$$

$$N_{spf} = N_{brmv} + N_{brsv} + N_{brdwy}$$

Where:

$N_{predicted}$ = Predicted average crash frequency of an individual roadway segment for the selected year;

N_{br} = Predicted average crash frequency of an individual roadway segment (excluding vehicle-pedestrian and vehicle-bicycle collisions);

N_{pedr} = Predicted average crash frequency of vehicle-pedestrian collisions for an individual roadway segment;

N_{biker} = Predicted average crash frequency of vehicle-bicycle collisions for an individual roadway segment;

C_r = Calibration factor for roadway segments of a specific type developed for use for a particular geographical area (this was taken as 1.0);

N_{spf} = Predicted total average crash frequency of an individual roadway segment for base conditions (excluding vehicle-pedestrian and vehicle-bicycle collisions);

CMF_{1r}.....CMF_{nr} = Crash modification factors for roadway segments;

N_{brmv} = Predicted average crash frequency of multiple-vehicle no driveway collisions for base conditions;

N_{brsv} = Predicted average crash frequency of single-vehicle crashes for base conditions; and

N_{brdwy} = Predicted average crash frequency of multiple-vehicle driveway-related collisions.

Thus, the SPFs and adjustment factors were applied separately to the before and after periods to determine five components: N_{brmv}, N_{brsv}, N_{brdwy}, N_{pedr}, and N_{biker}, which together provided a prediction of the total average crash frequency for the roadway segment.

Before period

Predicted crash frequency for,

Multiple-vehicle non-driveway collisions:

$$N_{brmv} = \exp(a + b \times ln(AADT) + ln(L))$$

Where:

a and *b* = Regression coefficients;

AADT = Average annual daily traffic volume (vehicles/day) on roadway segment; and

L = Length of the roadway segment (miles)

Here, *a* = -9.7, *b* = 1.17 (From the HSM-coefficients for total crashes)

$$N_{brmv} = \exp((-9.7) + 1.17 \times ln(39{,}975) + ln(1.67))$$

$$N_{brmv} = 24.78$$

Single-vehicle crashes:

$$N_{brsv} = \exp(a + b \times ln(AADT) + ln(L))$$

Here, *a* = -4.82, *b* = 0.54 (From the HSM-coefficients for total crashes)

$$N_{brmv} = \exp((-4.82) + 0.54 \times ln(39{,}975) + ln(1.67))$$

$$N_{brsv} = 4.12$$

Multiple-vehicle driveway-related crashes:

$$N_{brdwy} = \sum_{\substack{all \\ driveway \\ types}} n_j \times N_j \times \left(\frac{AADT}{15{,}000}\right)^{(t)}$$

Where:

n_j = Number of driveways within roadway segment of driveway type j including all driveways on both sides of the road;

N_j = Number of driveway-related collisions per driveway per year for driveway type j (Table 12-7 in Chapter 12 of the HSM Volume 02); and

t = coefficient for traffic volume adjustment (Table 12-7 in Chapter 12 of the HSM Volume 02).

Seven specific driveways were considered in estimating predicted crash frequency.

Multiple-vehicle major commercial driveway-related crashes:

$$N_{brdwy} = n_j \times N_j \times \left(\frac{AADT}{15{,}000}\right)^{(t)}$$

Here, n_j = 9, N_j = 0.165, t =1.172

$$N_{brdwy} = 9 \times 0.165 \times \left(\frac{39{,}975}{15{,}000}\right)^{(1.172)}$$

$$N_{brdwy} = 4.68$$

Multiple-vehicle minor commercial driveway-related crashes:

Here, n_j = 16, N_j = 0.053, t =1.172

$$N_{brdwy} = 16 \times 0.053 \times \left(\frac{39{,}975}{15{,}000}\right)^{(1.172)}$$

$$N_{brdwy} = 2.67$$

Multiple-vehicle major industrial/institutional driveway-related crashes:

Here, n_j = 4, N_j = 0.181, t =1.172

$$N_{brdwy} = 4 \times 0.181 \times \left(\frac{39{,}975}{15{,}000}\right)^{(1.172)}$$

$$N_{brdwy} = 2.28$$

Multiple-vehicle minor industrial/institutional driveway-related crashes:

Here, $n_j = 7$, $N_j = 0.024$, $t = 1.172$

$$N_{brdwy} = 7 \times 0.024 \times \left(\frac{39{,}975}{15{,}000}\right)^{(1.172)}$$

$$N_{brdwy} = 0.53$$

Multiple-vehicle major residential driveway-related crashes:

Here, $n_j = 0$, $N_j = 0.087$, $t = 1.172$

$$N_{brdwy} = 0 \times 0.087 \times \left(\frac{39{,}975}{15{,}000}\right)^{(1.172)}$$

$$N_{brdwy} = 0$$

Multiple-vehicle minor residential driveway-related crashes:

Here, $n_j = 3$, $N_j = 0.016$, $t = 1.172$

$$N_{brdwy} = 3 \times 0.016 \times \left(\frac{39{,}975}{15{,}000}\right)^{(1.172)}$$

$$N_{brdwy} = 0.15$$

Multiple-vehicle other driveway-related crashes:

Here, $n_j = 1$, $N_j = 0.027$, $t = 1.172$

$$N_{brdwy} = 1 \times 0.027 \times \left(\frac{39{,}975}{15{,}000}\right)^{(1.172)}$$

$$N_{brdwy} = 0.09$$

Total multiple-vehicle driveway-related crashes:

$$N_{brdwy} = 4.68 + 2.67 + 2.28 + 0.53 + 0 + 0.15 + 0.09 = 10.4$$

Therefore,

$$N_{spf} = N_{brmv} + N_{brsv} + N_{brdwy}$$

$$N_{spf} = 24.78 + 4.12 + 10.4$$

$$N_{spf\ rs} = 39.3$$

Crash modification factors for roadway segments:

CMF_{1r} – On-Street Parking:

The base condition is the absence of on-street parking on a roadway segment. At this school location, on-street parking is not available. Therefore,

$$CMF_{1r} = 1.0$$

CMF_{2r} – Roadside Fixed Objects:

The base condition is the absence of roadside fixed objects on a roadway segment. The CMF for roadside fixed objects, where present, is determined using the following equation:

$$CMF_{2r} = f_{offset} \times D_{fo} \times p_{fo} + (1.0 - p_{fo})$$

Where:

f_{offset} = Fixed-object offset factor (Table 12-20 in Chapter 12 of the HSM Volume 02);

D_{fo} = Fixed-object density (fixed objects/mile) for both sides of the road combined; and

$p\ fo$ = Fixed-object collisions as a proportion of total crashes (Table 12-20 in Chapter 12 of the HSM Volume 02).

Here, f_{offset} = 0.068, D_{fo} = 70.52, and p_{fo} = 0.016

$$CMF_{2r} = 0.068 \times 70.52 \times 0.016 + (1.0 - 0.016)$$

$$CMF_{2r} = 1.06$$

CMF_{3r} – Median Width:

The value of this CMF is 1.00 for undivided facilities. The road at this selected school is undivided, hence,

$$CMF_{3r} = 1.0$$

CMF_{4r} – Lighting:

The base condition is the absence of lighting on a roadway segment. At this school location, lighting is available. Therefore, CMF was calculated using the following equation:

$$CMF_{4r} = 1.0 - (p_{nr} \times (1.0 - 0.72 \times p_{inr} - 0.83 \times p_{pnr}))$$

Where:

P_{nr} = Proportion of total crashes for unlighted roadway segments that occur at night (Table 12-23 in Chapter 12 of the HSM Volume 02);

P_{inr} = Proportion of total nighttime crashes for unlighted roadway segments that involve a fatality or injury (Table 12-23 in Chapter 12 of the HSM Volume 02); and

P_{pnr} = Proportion of total nighttime crashes for unlighted roadway segments that involve property damage only (Table 12-23 in Chapter 12 of the HSM Volume 02).

Here, P_{nr} = 0.274, P_{inr} = 0.432, and P_{pnr} = 0.568

$$CMF_{4r} = 1.0 - (0.274 \times (1.0 - 0.72 \times 0.432 - 0.83 \times 0.568))$$

$$CMF_{4r} = 0.94$$

CMF_{5r} – Automated Speed Enforcement:

The base condition for this is the absence of automated speed enforcement cameras. However, throughout the analysis, this was not accounted for because the objective of the study is to fully capture the isolated effect of ASE cameras on crash frequency. Hence,

$$CMF_{5r} = 1.0$$

Then, N_{br} was calculated for the before period.

$$N_{br} = N_{spf} \times (CMF_{1r} \times CMF_{2r} \times \dots \dots . \times CMF_{nr})$$

$$N_{br} = 39.3 \times (1.0 \times 1.06 \times 1.0 \times 0.94 \times 1.0)$$

$$N_{br} = 39.16$$

Vehicle-pedestrian collisions:

$$N_{pedr} = N_{br} \times f_{pedr}$$

Where:

f_{pedr} = Pedestrian crash adjustment factor (Table 12-8 in Chapter 12 of the HSM Volume 02).

Here, school zone speed limit>30 mph, hence, f_{pedr} = 0.023

$$N_{pedr} = 39.16 \times 0.023$$

$$N_{pedr} = 0.90$$

Vehicle-bicycle collisions:

$$N_{biker} = N_{br} \times f_{biker}$$

Where:

F_{biker} = Bicycle crash adjustment factor (Table 12-9 in Chapter 12 of the HSM Volume 02).

Here, school zone speed limit>30 mph, hence, f_{pedr} = 0.012

$$N_{biker} = 39.16 \times 0.012$$

$$N_{biker} = 0.47$$

Therefore, predicted crash frequency for the before period is,

$$N_{predicted,B} = C_r \times (N_{br} + N_{pedr} + N_{biker})$$

$$N_{predicted,B} = 1.0 \times (39.16 + 0.9 + 0.47)$$

$$N_{predicted,B} = 40.5$$

<u>After period</u>

Predicted crash frequency for,

Multiple-vehicle non-driveway collisions:

$$N_{brmv} = \exp(a + b \times ln(AADT) + ln(L))$$

$$N_{brmv} = \exp((-9.7) + 1.17 \times ln(37{,}650) + ln(1.67))$$

$$N_{brmv} = 23.1$$

Single-vehicle crashes:

$$N_{brsv} = \exp(a + b \times ln(AADT) + ln(L))$$

$$N_{brmv} = \exp((-4.82) + 0.54 \times ln(37{,}650) + ln(1.67))$$

$$N_{brsv} = 3.98$$

Multiple-vehicle driveway-related crashes:

Multiple-vehicle major commercial driveway-related crashes:

$$N_{brdwy} = n_j \times N_j \times \left(\frac{AADT}{15,000}\right)^{(t)}$$

$$N_{brdwy} = 9 \times 0.165 \times \left(\frac{37,650}{15,000}\right)^{(1.172)}$$

$$N_{brdwy} = 4.37$$

Multiple-vehicle minor commercial driveway-related crashes:

$$N_{brdwy} = 16 \times 0.053 \times \left(\frac{37,650}{15,000}\right)^{(1.172)}$$

$$N_{brdwy} = 2.49$$

Multiple-vehicle major industrial/institutional driveway-related crashes:

$$N_{brdwy} = 4 \times 0.181 \times \left(\frac{37,650}{15,000}\right)^{(1.172)}$$

$$N_{brdwy} = 2.13$$

Multiple-vehicle minor industrial/institutional driveway-related crashes:

$$N_{brdwy} = 7 \times 0.024 \times \left(\frac{37,650}{15,000}\right)^{(1.172)}$$

$$N_{brdwy} = 0.49$$

Multiple-vehicle major residential driveway-related crashes:

$$N_{brdwy} = 0 \times 0.087 \times \left(\frac{37,650}{15,000}\right)^{(1.172)}$$

$$N_{brdwy} = 0$$

Multiple-vehicle minor residential driveway-related crashes:

$$N_{brdwy} = 3 \times 0.016 \times \left(\frac{37,650}{15,000}\right)^{(1.172)}$$

$$N_{brdwy} = 0.14$$

Multiple-vehicle other driveway-related crashes:

$$N_{brdwy} = 1 \times 0.027 \times (\frac{37,650}{15,000})^{(1.172)}$$

$$N_{brdwy} = 0.08$$

Total multiple-vehicle driveway-related crashes:

$$N_{brdwy} = 4.37 + 2.49 + 2.13 + 0.49 + 0 + 0.14 + 0.08 = 9.7$$

Therefore,

$$N_{spf} = 23.15 + 3.99 + 9.7$$

$$N_{spf} = 36.8$$

Crash modification factors for roadway segments:

CMF_{1r} – On-Street Parking:

$$CMF_{1r} = 1.0$$

CMF_{2r} – Roadside Fixed Objects:

$$CMF_{2r} = 1.06$$

CMF_{3r} – Median Width:

$$CMF_{3r} = 1.0$$

CMF_{4r} – Lighting:

$$CMF_{4r} = 0.94$$

CMF_{5r} – Automated Speed Enforcement:

$$CMF_{5r} = 1.0$$

Then, N_{br} was calculated for the after period.

$$N_{br} = 36.8 \times (1.0 \times 1.06 \times 1.0 \times 0.94 \times 1.0)$$

$$N_{br} = 36.7$$

Vehicle-pedestrian collisions:

$$N_{pedr} = N_{br} \times f_{pedr}$$

$$N_{pedr} = 36.7 \times 0.023$$

$$N_{pedr} = 0.84$$

Vehicle-bicycle collisions:

$$N_{biker} = N_{br} \times f_{biker}$$

$$N_{biker} = 36.7 \times 0.012$$

$$N_{biker} = 0.44$$

Therefore, predicted crash frequency for the after period is,

$$N_{predicted,A} = C_r \times (N_{br} + N_{pedr} + N_{biker})$$

$$N_{predicted,A} = 1.0 \times (36.7 + 0.84 + 0.44)$$

$$N_{predicted,A} = 38.0$$

Over-dispersion parameter:

The overdispersion parameter k is available for multiple vehicle non-driveway collisions (k_{rmj}), single-vehicle crashes (k_{rsj}), and multiple-vehicle driveway-related crashes (k_{rdj}).

k_{rmj}: 0.81

k_{rsj}: 0.52

k_{rdj}: 0.1

The average value of those three over-dispersion parameters was estimated.

$$k = \frac{0.81 + 0.52 + 0.1}{3} = 0.48$$

Weighted adjustment factor:

$$w_{i,B} = \frac{1}{1 + k \sum_{\substack{Before \\ years}} N_{predicted}}$$

$$w_{i,B} = \frac{1}{1 + (0.48 \times 40.5)}$$

$$w_{i,B} = 0.05$$

Expected crash frequency during before-period:

$$N_{expected,\mathrm{B}} = w_{i,B} \times N_{predicted} + (1 - w_{i,B}) \times N_{observed,B}$$

$$N_{expected,B} = (0.05 \times 40.5) + (1 - 0.05) \times 689$$

$$N_{expected,B} = 657.0$$

Adjustment factor:

$$r_i = \frac{\sum_{\substack{After \\ years}} N_{predicted,A}}{\sum_{\substack{Before \\ years}} N_{predicted,B}}$$

$$r_i = \frac{38.0}{40.5}$$

$$r_i = 0.94$$

Expected crash frequency during after-period:

$$N_{expected,A} = N_{expected,B} \times r_i$$

$$N_{expected,A} = 657.0 \times 0.94$$

$$N_{expected,A} = 617.6$$

Odds ratio:

$$OR_i = \frac{N_{observed,A}}{N_{expected,A}}$$

$$OR_i = \frac{337}{617.6} = 0.546 \sim 0.55$$

Safety effectiveness:

$$Safety\ Effectiveness = 100 \times (1 - OR_i)$$

$$Safety\ Effectiveness = 100 \times (1 - 0.546)$$

$$Safety\ Effectiveness = 45.4\%$$

Variance term:

$$Var(N_{expected,A}) = r_i^2 \times N_{expected,B} \times (1 - w_{i,B})$$

$$Var(N_{expected,A}) = 0.94^2 \times 657.0 \times (1 - 0.05)$$

$$Var(N_{expected,A}) = 547.51$$

Likewise, all steps were repeated for the remaining 54 schools in the on-system school group. Considering all schools,

Observed crash frequency at all sites during the after period = 4,380

Expected crash frequency at all sites during the after period = 4,576.47

Summation of the variance term for all sites = 3,885.10

Therefore,

$$OR' = \frac{\sum_{ALl\ sites} N_{observed,A}}{\sum_{All\ sites} N_{expected,A}}$$

$$OR' = \frac{4,380}{4,576.47}$$

$$OR' = 0.957$$

Adjusted odds ratio:

$$Var\left(\sum_{All\ sites} N_{expected,A}\right) = \sum_{All\ sites} \left(r^2 \times N_{expected,B} \times (1 - w_{i,B})\right)$$

$$Var\left(\sum_{All\ sites} N_{expected,A}\right) = 3,885.10$$

$$OR = \frac{OR'}{1 + \frac{Var(\sum_{All\ sites} N_{expected,A})}{[\sum_{All\ sites} N_{expected,A}]^2}}$$

$$OR = \frac{0.957}{1 + \frac{3,885.10}{4,576.47^2}}$$

$$OR\ = 0.9569 \sim 0.96$$

This OR is equivalent to the CMF. Therefore, CMF = 0.96

Safety effectiveness:

$$Safety\ Effectiveness = 100 \times (1 - 0.9569)$$

$$Safety\ Effectiveness\ = 4.31\%$$

Variance:

$$Var(OR) = \frac{OR'^2\ \times [\frac{1}{N_{observed,\,\mathrm{A}}} + \frac{Var\{\sum_{All\ sites} N_{expected,A}\}}{[\sum_{All\ sites} N_{expected,A}]^2}]}{1 + \frac{\mathrm{Var}\{\sum_{All\ sites} N_{expected,A}\}}{[\sum_{All\ sites} N_{expected,A}]^2}}$$

$$Var(OR) = \frac{0.957 \times [\frac{1}{4,380} + \frac{3,885.10}{4,576.47^2}]}{1 + \frac{3,885.10}{4,576.47^2}}$$

$$Var(OR) =\ 0.0004$$

Standard error:

$$\mathrm{SE(OR)}\ =\ \sqrt{\mathrm{Var(OR)}}$$

$$\mathrm{SE(OR)}\ =\ 0.0195$$

SE (Safety effectiveness):

$$\mathrm{SE(Safety\ Effectiveness)} = 100 \times \mathrm{SE(OR)}$$

$$\mathrm{SE(Safety\ Effectiveness)} = 1.9467$$

Statistical significance:

$$\mathrm{Abs}|\frac{\mathrm{Safety\ Effectiveness}}{\mathrm{SE(Safety\ Effectiveness)}}|$$

$$\text{Abs}|\frac{4.31}{1.9467)}| = 2.21 > 2.0$$

Therefore, the treatment effect is significant at the 95 percent confidence level.

Before-and-After Study with Comparison Group Method

Treated School: South Gwinnett High School

$$N_{predicted,B} = 40.5$$

$$N_{predicted,A} = 38.0$$

Control School: Mill Creek High School

$$N_{predicted,B} = 44.1$$

$$N_{predicted,A} = 48.8$$

These predicted crash frequencies were obtained from the steps described in the previous example.

Adjustment factor for the before period:

$$Adj_{i,j,B} = \frac{N_{predicted,T,B}}{N_{predicted,C,B}} \times \frac{Y_{BT}}{Y_{BC}}$$

$$Adj_{i,j,B} = \frac{40.5}{44.1} \times \frac{2.4}{2.4}$$

$$Adj_{i,j,B} = 0.92$$

Adjustment factor for the after period:

$$Adj_{i,j,A} = \frac{N_{predicted,T,A}}{N_{predicted,C,A}} \times \frac{Y_{AT}}{Y_{AC}}$$

$$Adj_{i,j,A} = \frac{38.0}{48.8} \times \frac{2.4}{2.4}$$

$$Adj_{i,j,A} = 0.78$$

Expected average crash frequency at control school for the before period:

$$N_{expected,C,B} = \sum N_{observed,C,B} \times Adj_{i,j,B}$$

$$N_{expected,C,B} = 114 \times 0.92$$

$$N_{expected,C,B} = 104.9$$

Expected average crash frequency at control school for the after period:

$$N_{expected,C,A} = \sum N_{observed,C,A} \times Adj_{i,j,A}$$

$$N_{expected,C,A} = 116 \times 0.78$$

$$N_{expected,C,A} = 90.4$$

Likewise, expected crash frequencies for the before and after periods should be estimated relative to all control schools in the group. Then, the sum of all those expected crash frequencies was obtained.

Comparison group adjusted crash frequency for the before period:

$$N_{expected,C,B,Total} = \sum_{ALl\ control\ sites} N_{\text{expected},C,B}$$

$$N_{expected,C,B,Total} = 97{,}666.76$$

Comparison group adjusted crash frequency for the after period:

$$N_{expected,C,A,Total} = \sum_{ALl\ control\ sites} N_{\text{expected},C,A}$$

$$N_{expected,C,A,Total} = 86{,}160.77$$

Comparison ratio:

$$r_{ic} = \frac{N_{expected,C,A,total}}{N_{expected,C,B,total}}$$

$$r_{ic} = \frac{86,160.77}{97,666.76}$$

$$r_{ic} = 0.88$$

Expected crash frequency at the treated school for the after period:

$$N_{expected,T,A} = \sum N_{observed,T,B} \times r_{ic}$$

$$N_{expected,T,A} = 689 \times 0.88$$

$$N_{expected,T,A} = 607.83$$

Odds ratio:

$$OR_i = \frac{N_{observed,T,A}}{N_{expected,T,A}}$$

$$OR_i = \frac{337}{607.83}$$

$$OR_i = 0.55$$

Log odds ratio:

$$R_i = \ln(OR_i)$$

$$R_i = \ln(0.55)$$

$$R_i = -0.59$$

Squared standard error of log odds ratio:

$$R^2_{i(SE)} = \frac{1}{N_{observed,T,B,total}} + \frac{1}{N_{observed,T,A,total}} + \frac{1}{N_{expected,C,B,total}} + \frac{1}{N_{expected,C,A,total}}$$

$$R^2_{i(SE)} = \frac{1}{689} + \frac{1}{337} + \frac{1}{97,666.76} + \frac{1}{86,160.77}$$

$$R^2_{i(SE)} = 0.0044$$

Weighted adjustment:

$$w_i = \frac{1}{R_{iSE}^2}$$

$$w_i = 225.2$$

Weighted product:

$$Weighted\,product = w_i \times R_i$$

$$Weighted\,product = 225.2 \times -0.59$$

$$Weighted\,product = -132.8$$

Likewise, all steps were repeated for the remaining 54 treated schools in the on-system group.

Weighted average log odds ratio for all schools:

Summation of the weighted products for all schools = -284.41

Summation of the weighted adjustments for all schools = 2,317.37

$$R = \frac{\sum_n w_i R_i}{\sum_n w_i}$$

$$R = \frac{-284.41}{2{,}317.37}$$

$$R = -0.122$$

The overall effectiveness or the odds ratio:

$$OR = e^R$$

$$OR = e^{-0.122}$$

$$OR = 0.8845$$

This OR is equivalent to the CMF. Therefore, CMF = 0.88

Safety effectiveness:

$$\text{Safety Effectiveness} = 100 \times (1 - \text{OR})$$

$$\text{Safety Effectiveness} = 100 \times (1 - 0.8845)$$

$$\text{Safety Effectiveness} = 11.5\%$$

SE (Safety Effectiveness):

$$\text{SE (Safety Effectiveness)} = 100 \times \frac{\text{OR}}{\sqrt{\sum_{n} w_i}}$$

$$\text{SE (Safety Effectiveness)} = 100 \times \frac{0.8845}{\sqrt{2{,}317.37}}$$

$$\text{SE (Safety Effectiveness)} = 1.837$$

Statistical significance:

$$\text{Abs}\left|\frac{\text{Safety Effectiveness}}{\text{SE(Safety Effectiveness)}}\right|$$

$$\text{Abs}\left|\frac{11.5}{1.837}\right| = 6.2 > 2.0$$

Therefore, the treatment effect is significant at the 95 percent confidence level.

APPENDIX C. BEFORE-AND-AFTER CRASH COUNTS AT TREATED AND CONTROL SCHOOLS

On-System Treated Schools: All Crashes

Parameter	Total Crashes	PDO Crashes	Fatal & Injury Crashes
Boundary 1 (250 ft measured from each camera)			
Crashes (B/A)	537/306	382/179	155/127
Average crash reduction per site	4.2	3.7	0.5
Boundary 2 (500 ft measured from each camera)			
Crashes (B/A)	881/520	617/320	264/200
Average crash reduction per site	6.6	5.4	1.2
Boundary 3 (1,000 ft measured from each camera)			
Crashes (B/A)	1,696/1,159	1,242/766	454/393
Average crash reduction per site	9.8	8.9	1.1
Boundary 4 (School zone)			
Crashes (B/A)	945/624	638/371	307/253
Average crash reduction per site	5.8	4.9	1.0
Boundary 5 (2,000 ft measured from each camera)			
Crashes (B/A)	2,122/1,593	1,638/1,054	484/539
Average crash reduction per site	9.6	10.6	-1.0
Boundary 6 (4,000 ft measured from each camera)			
Crashes (B/A)	5,457/4,380	4,909/3,379	548/1,001
Average crash reduction per site	19.6	27.8	-8.2

B and A refer to the crash counts for the before and after periods, respectively.

On-System Treated Schools: Speeding-Related Crashes

Parameter	Total Crashes	PDO Crashes	Fatal & Injury Crashes
Boundary 1 (250 ft measured from each camera)			
Crashes (B/A)	10/3	10/3	0/0
Average crash reduction per site	0.1	0.1	0.0
Boundary 2 (500 ft measured from each camera)			
Crashes (B/A)	17/14	11/8	6/6
Average crash reduction per site	0.05	0.05	0.0
Boundary 3 (1,000 ft measured from each camera)			
Crashes (B/A)	33/24	23/15	10/9

Average crash reduction per site	0.2	0.1	0.02
Boundary 4 (School zone)			
Crashes (B/A)	26/19	16/10	10/9
Average crash reduction per site	0.1	0.1	0.02
Boundary 5 (2,000 ft measured from each camera)			
Crashes (B/A)	41/28	31/16	10/12
Average crash reduction per site	0.2	0.3	-0.04
Boundary 6 (4,000 ft measured from each camera)			
Crashes (B/A)	54/42	38/28	16/14
Average crash reduction per site	0.2	0.2	0.04

B and A refer to the crash counts for the before and after periods, respectively.

On-System Control Schools: All Crashes

Parameter	Total Crashes	PDO Crashes	Fatal & Injury Crashes
Boundary 1 (577 ft measured from the school entrance in each direction)			
Crashes (B/A)	694/639	489/468	205/171
Average crash reduction per site	1.0	0.4	0.6
Boundary 2 (813.5 ft measured from the school entrance in each direction)			
Crashes (B/A)	1,341/1,128	972/814	369/314
Average crash reduction per site	3.9	2.9	1.0
Boundary 3 (1,286 ft measured from the school entrance in each direction)			
Crashes (B/A)	1,936/1,696	1,406/1,229	530/467
Average crash reduction per site	4.4	3.2	1.1
Boundary 4 (School zone)			
Crashes (B/A)	1,323/1,232	951/896	372/336
Average crash reduction per site	1.7	1.0	0.7
Boundary 5 (2,231.5 ft measured from the school entrance in each direction)			
Crashes (B/A)	3,430/3,097	2,438/2,207	992/890
Average crash reduction per site	6.1	4.2	1.9
Boundary 6 (4,122.5 ft measured from the school entrance in each direction)			
Crashes (B/A)	7,603/6,999	5,417/4,989	2,186/2,009
Average crash reduction per site	11.0	7.8	3.2

B and A refer to the crash counts for the before and after periods, respectively.

On-System Control Schools: Speeding-Related Crashes

Parameter	Total Crashes	PDO Crashes	Fatal & Injury Crashes
Boundary 1 (577 ft measured from the school entrance in each direction)			
Crashes (B/A)	10/13	8/7	2/6
Average crash reduction per site	-0.05	0.02	-0.07
Boundary 2 (813.5 ft measured from the school entrance in each direction)			
Crashes (B/A)	16/19	11/10	5/9
Average crash reduction per site	-0.05	0.02	-0.07
Boundary 3 (1,286 ft measured from the school entrance in each direction)			
Crashes (B/A)	32/24	25/10	7/14
Average crash reduction per site	0.1	0.3	-0.1
Boundary 4 (School zone)			
Crashes (B/A)	20/21	12/10	8/11
Average crash reduction per site	-0.02	0.04	-0.05
Boundary 5 (2,231.5 ft measured from the school entrance in each direction)			
Crashes (B/A)	48/37	29/17	19/20
Average crash reduction per site	0.2	0.2	-0.02
Boundary 6 (4,122.5 ft measured from the school entrance in each direction)			
Crashes (B/A)	112/83	64/37	48/42
Average crash reduction per site	0.5	0.5	0.1

B and A refer to the crash counts for the before and after periods, respectively.

Off-System Treated Schools: All Crashes

Parameter	Total Crashes	PDO Crashes	Fatal & Injury Crashes
Boundary 1 (500 ft measured from each camera)			
Crashes (B/A)	984/531	733/354	251/177
Average crash reduction per site	4.6	3.8	0.7
Boundary 2 (School zone)			
Crashes (B/A)	1,037/577	772/387	265/190
Average crash reduction per site	4.6	3.8	0.8

B and A refer to crash counts for the before and after periods, respectively.

Off-System Treated Schools: Speeding-Related Crashes

Parameter	Total Crashes	PDO Crashes	Fatal & Injury Crashes
Boundary 1 (500 ft measured from each camera)			
Crashes (B/A)	30/19	18/10	12/9
Average crash reduction per site	0.1	0.08	0.03
Boundary 2 (School zone)			
Crashes (B/A)	38/19	26/12	12/7
Average crash reduction per site	0.2	0.14	0.05

B and A refer to crash counts for the before and after periods, respectively.

Off-System Control Schools: All Crashes

Parameter	Total Crashes	PDO Crashes	Fatal & Injury Crashes
Boundary 1 (928.1 ft measured from the school entrance in each direction)			
Crashes (B/A)	1,265/838	912/535	353/303
Average crash reduction per site	4.3	3.8	0.5
Boundary 2 (School zone)			
Crashes (B/A)	1,303/859	965/615	338/244
Average crash reduction per site	4.5	3.5	0.9

B and A refer to crash counts for the before and after periods, respectively.

Off-System Control Schools: Speeding-Related Crashes

Parameter	Total Crashes	PDO Crashes	Fatal & Injury Crashes
Boundary 1 (928.1 ft measured from the school entrance in each direction)			
Crashes (B/A)	30/15	22/9	8/6
Average crash reduction per site	0.2	0.1	0.02
Boundary 2 (School zone)			
Crashes (B/A)	32/17	21/10	11/7
Average crash reduction per site	0.2	0.1	0.04

B and A refer to crash counts for the before and after periods, respectively.

APPENDIX D. INSTITUTIONAL REVIEW BOARD (IRB) APPROVAL EMAIL FOR CONDUCTING THE SURVEY

Date: 17/10/2025

IRB #: IRB-FY25-340
Title: Effectiveness of Automated Speed Enforcement in School Zones and Guidance for Continuous Usage in Georgia
Creation Date: 17/1/2025
End Date:
Status: Approved
Principal Investigator: Sunanda Dissanayake
Review Board: KSU IRB
Sponsor: Georgia Department of Transportation (GDOT)

Study History

Submission Type Initial	Review Type Exempt	Decision Exempt
Submission Type Modification	Review Type Exempt	Decision Approved

Key Study Contacts

Member Sunanda Dissanayake	Role Principal Investigator	Contact sdissan1@kennesaw.edu
Member Sunanda Dissanayake	Role Primary Contact	Contact sdissan1@kennesaw.edu
Member Sarala Lasanthi Gunathilaka Udaha Wadiya Ralle	Role Investigator	Contact sudahawa@students.kennesaw.edu

APPENDIX E. RECRUITMENT FLYER FOR THE SURVEY

APPENDIX F. QUESTIONNAIRE FORM

Road User Survey on Automated Speed Enforcement in School Zones in Georgia

Section 1: User Awareness and Perceptions

Q1: Have you heard about ASE cameras in school zones in Georgia before?
Yes ☐
No ☐

If **YES**, continue. If **No,** go to **Q7**.

Q2: Have you ever driven through a school zone with ASE cameras in Georgia?
Yes ☐
No ☐
I have no idea ☐

If **YES**, continue. If **No/Don't have an idea**, go to **Q6**.

Q3: How frequently do you drive through school zones with ASE cameras in Georgia?
Everyday ☐
All weekdays ☐
3 or 4 times a week ☐
Less than 3 times a week ☐
Occasionally ☐

Q4: Did ASE cameras cause you to slow down in school zones?
Yes ☐
No ☐

Q5: Have you ever received a citation from ASE cameras in school zones in Georgia? Check all applicable.

Yes, I have received a warning without any fine ☐
Yes, I have received a citation with a fine ☐
No, I haven't. ☐

Q6: Do you know anyone else who received a citation from ASE cameras in school zones in Georgia?
Yes ☐
No ☐

Q7: Do you support this ASE camera program in school zones in Georgia?
Yes ☐
No ☐
I have no idea ☐

Q8: Please rate the level of agreement or disagreement for the following statements. Insert a check mark.

No.	Statement	Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree	No opinion
1	The sole purpose of ASE cameras is to reduce vehicle speeds and crashes.						
2	ASE cameras are effective in reducing vehicle speeds and crashes.						
3	ASE is a creative trap that is motivated by revenue generation rather than safety.						
4	School zones are selected for camera installation just to maximize violation rates, and the revenue.						
5	It is not clear how the citation revenue is distributed and utilized.						
6	ASE cameras at school zones only benefit private companies.						
7	The authorities use these cameras to control the public in an indirect way.						
8	ASE fines are too high and it's not fair to pay that much money for exceeding the speed limit by just 10 mph.						
9	This 10-mph speeding threshold is too low, that should be increased.						
10	I don't trust the technology used in these cameras.						
11	ASE citations should be issued to the driver, not to the registered owner.						
12	These cameras are a threat to my privacy.						
13	ASE cameras are not required since school speed limits are always low, and drivers obey.						

14	ASE cameras should be installed only in school zones where police officers cannot safely operate.						
15	ASE cameras help to ensure fair and unbiased traffic law enforcement.						
16	ASE cameras are not supported by the public; therefore, I also do not want to support.						
17	I believe these cameras should be implemented in all school zones in Georgia to improve safety.						

Section 2: Additional Comments & Suggestions

Q1: How should the authorities improve the transparency of this camera program? Check all applicable.

They should report and publicize the efficiency of ASE cameras in terms of reducing vehicle speeds and crashes in schools in a regular manner. ☐

They should publicize the total revenue generated from cameras and how the revenue is distributed and utilized in a regular manner. ☐

They should publicize the extent of the safety issue in each school, before implementing cameras. ☐

They should improve the awareness of people regarding the possible ways to contest a violation. ☐

I am satisfied with the current condition. ☐

Q2: How should the authorities gain trustworthiness towards this program? Check all applicable.

They should calibrate cameras in a regular manner and inform the public. ☐

They should ensure that the privacy of people is not invaded through this process and the public should be informed about that. ☐

They should emphasize that the only reason behind implementing cameras is to ensure the safety of school kids, employees, and the public and should show the evidence. ☐

They should clearly publish speed limits and hours being evaluated. ☐

I am satisfied with the current condition. ☐

Q3: How should the authorities make this program fairer for the drivers? Check all applicable.

They should issue citations only to the worst violators, not to all violators. ☐
They should limit the use of these cameras only to schools zones. ☐
I am satisfied with the current condition. ☐

If you have additional comments/suggestions to make this camera program more effective, please mention them below.
…………………………………………………………………………………………………
…………………………………………………………………………………………………
……………………………………………………………………

Section 3: Socio-Demographic and Driving Characteristics

Q1: County of residence?

………………………………………….

Q2: Are you a high school student?

Yes ☐
No ☐

Q3: Are you a parent of school-age kid? or do you have a school-age sibling?

Yes ☐
No ☐

Q4: Your highest level of education completed to date?

Less than high school degree ☐
High school degree or equivalent ☐
Bachelor's degree ☐
Graduate degree ☐

Q5: Your employment status?

Employed ☐
Unemployed ☐

Q6: Your age?

16-34 years ☐
35-64 years ☐
65+ years ☐
Prefer not to say ☐

Q7: How many years have you been driving?

<5 years ☐
5-15 years ☐
15-25 years ☐
>25 years ☐

APPENDIX G. INFORMED CONSENT FORM

KENNESAW STATE UNIVERSITY

CONSENT FORM

Title of Research Study: Effectiveness of Automated Speed Enforcement in School Zones and Guidance for Continuous Usage in Georgia

Researcher's Contact Information: Sunanda Dissanayake, Tel: 470-578-2471,

Email: aseresearch@kennesaw.edu

You are being asked to take part in a research study. The information in this form will help you decide if you want to be in the study. Please ask the researcher(s) if there is anything that is not clear or if you need more information.

Description of Project

The purpose of this study is to evaluate the effectiveness of Automated Speed Enforcement (ASE) cameras in school zones in Georgia (GA) in terms of public perceptions. In GA, ASE cameras have been implemented in approximately 290 schools by 2023. Therefore, public opinions would be useful for relevant agencies to improve the efficiency of these ASE programs and make decisions on long-term use. This project is funded by the Georgia Department of Transportation (GDOT).

Participant Eligibility Criteria

Participation in this study is limited to licensed drivers in Georgia who are 18 years of age or older.

Explanation of Procedures

If you agree to participate in this study:

As a participant in this survey, information on your awareness and understanding of ASE in school zones in GA, additional comments and suggestions from you to improve the transparency and trustworthiness of these camera programs, and your socio-demographic information will be asked. This survey will take approximately 15 mins. Additional activities like audio recording, access to personal information, etc. are not taken placed during the survey.

Participation in this survey is voluntary. You can refuse to take part or stop at any time without penalty. Researchers assure you that your refusal or withdrawal does not affect any rights, benefits, or services to which you are otherwise entitled.

Risks or Discomforts

There are no anticipated risks or discomforts associated with participating in this survey.

Benefits

There will be no direct benefits to you for taking part in this survey, however, the researchers may learn and understand more about public perceptions about ASE cameras in school zones. At the end of the study, recommendations will be provided to relevant agencies, and they will be useful for them to make decisions in improving the effectiveness of these programs. Therefore, your participation is important, and all GA citizens, especially school children will get the benefit from the decisions that the agencies make about these ASE programs.

Compensation

You will not receive any compensation or credit for taking part in this survey.

Confidentiality

All responses to this survey will be kept confidential. Only the research team will have access to the responses. This survey is conducted in 2 modes: in-person and online.

If you are taking part in the in-person survey, your answers will be anonymous, and no personally identifiable information will be collected. Data will be reported in aggregate form to ensure that individual responses cannot be traced back to any participant.

If you are taking part in the online survey, your responses will be kept confidential. While email identifiers are collected, they will only be used for administrative purposes and will not be linked to your responses in the analysis or reporting. Data will be reported in aggregate form to ensure individual responses remain anonymous and cannot be traced back to any participant.

Your responses will not be shared with other researchers and/or for future studies without additional consent after the email identifiers have been removed.

Research at Kennesaw State University that involves human participants is carried out under the oversight of an Institutional Review Board. Questions or problems regarding these activities should be addressed to the Institutional Review Board, Kennesaw State University, irb@kennesaw.edu.

If you agree to participate in this research study, please sign below:

____

Signature of Participant or Authorized Representative, Date

____

Signature of Investigator, Date

PLEASE SIGN BOTH COPIES OF THIS FORM, KEEP ONE AND RETURN THE OTHER TO THE INVESTIGATOR

APPENDIX H. RESPONDENTS' COMMENTS ON ASE PROGRAMS IN GA

Disclaimer: All comments are presented in their original form. The researchers have not modified the wording, spelling, or sentence structure to ensure the integrity and authenticity of participants' input.

A warning could be issued for the first violation (if speed doesn't exceed a specific amount over the limit).
I think 1st violators should receive a warning in the mail rather than a citation. Repeat offenders should receive citations.
They can say whatever they want but follow thru will still be entirely unchecksd.
The cameras often citing those who are driving during non school times. Observation of concern, most drivers seem to forget at lights they are still in a school zone. Many schools are in intersections without flashing reminders or times posted. I will be going 25 but ppl are blaring horns, unaware we are still in the zone. Some enter the road in a turn with no awareness of school zone. When it is school break, they often leave school zone speed limit. Unfortunately many individuals are irresponsible but this should be a physical cop presence verses camera. I know individuals who were given many citations but they were on cruise control. Too many exploits recorded. Trust eroded.
Not all the cameras have flashing yellow lights at them. If they were about safety, put lights and bigger signs to slow down. At their current state without any indication other than a small sign, they are not for safety.
There needs to be better, bigger and way more signage at the beginning and end of each school zone to make sure that drivers cannot miss them and unknowingly enter into a school zone, because there are school zones where you do not actually see the school because it is hidden from view from the road. Also, the signs stating that you are being recorded must also be bigger, more numerous, and easier to read as you're driving by. It is distracting to read all the info about school zone times when the letters are too little to read easily as you are driving by.
These cameras are unconstitutional in Georgia.
i do not support speed cameras in school zones as a general rule.
They should not use them, if you can't violate the driver then you cannot use them. You must violate the person who is committing the crime. Since vehicles can be driven by anyone being insured by that vehicle and really anyone willing to take the risk of driving it without insurance you can only violate that person. Someone else cannot be FULLY responsible for someone's actions and violating the vehicle is just that. These cameras will open up lawsuits of epic proportions. School districts take enough of our tax pay dollars, they can afford 1–2 school cops that can issue speeding tickets if needed. These cameras are a lazy answer to safety. School districts need to get their act together if safety of the children is a priority.
If these cameras would only for when the school zone lights are flashing to issue citations versus monitoring the public continiually, i do not believe people would have had such issues with them. They would have agreed that these were in place for childrens safety rather than revenue generator that the county has NO transparency as to the usage of the income generated.

These cameras should ABSOLUTELY ONLY ONLY ONLY be operating DURING *POSTED* school zone hours (arrival & dismissal times) IF AT ALL!!! It should not be valid or legal to cite and fine drivers for driving 35 mph midday when they are NOT actually exceeding the lower 25 mph limit for school traffic hours. The argument that trying to slow down drivers ALL DAY LONG in school zones helps make them safer for students is not justified with any evidence reported to the public. Also the explanation that fines or citations aren't reported for insurance purposes but failure to remit fees will prohibit citizens from renewing their annual tag registration is absolutely a form of public extortion on top of the tax fee we are required to pay for renewal.
Improve signage to ensure it is very clear cameras are in use, when.
I was forced to answer questions I did not want to answer, not enough information has been presented to make an educated decision one way or another. Until more information is presented, they should have law enforcement present at school zones. Many violations happen passing stopped school buses, however, cameras where taken down. Why? Citations need to go to the driver and not the owner of the vehicle.
Thank you much for the chance to participate in this important issue of public safety and personal liberty!
I believe vehicle speed is primarily determined by the design of the road and not the prevalence of cameras. If roads are designed to be smaller and narrower then speed will also reduce.
Not clear mentioned about these camera being use outside of school hours.
I have heard both that paying the violation does and does not increase points, get reported to insurance, prevent re-registration of vehicles, that there's there’s no penalty for not paying and that it relies on the driver to "fall for it". All together, it's clear no one knows.
I think as long as the process is transparent and the money is not distributed to law enforcement I am okay with it. In school zones our priority should be childrenâ€™s safety so it makes sense to do this kind of thing. I think it could gain popularity if the funds from citations are used to improve schools.
more signage, only fine during dismissal/arrival hours not time before school dismisses or after it starts.
I've heard of people who speed up on purpose to see how high they can get the number, wouldn't it be unfair to ticket them if there was no one in the area and they slowed down immediately after?
I strongly support additional legislation allowing camera speed enforcement of ALL speed zones in the state.
ASE from these devices should not operate outside of school hours. Local Government should be transparent on how much of ticket revenue is going to private company and how much is going to the locals.
Hours of operation should be clear, sign should indicate how to avoid ticket
sometimes you turn from a side road into a school zone and there isnt any signage. So you have no idea that you are supposed to be going slow. Additional signage along a route would be beneficial. For example, you enter a school zone, drive along and get to a stop light. When it turns green, it’s hard to remember you are still in a school zone…there should be additional signage.
School zones should be studied for recorded accidents due to speed violations before installing ASE cameras. There should be a justifiable need or their use will be seen by the public as just a source of revenue.

These cameras are money makers and they serve no good cause.
The calibration needs to be set for school bus transportation hours.
Don't ask me to support installation of more cameras when you have already installed thousands whuch which apparently aren't being used because so many speeders continue to get away with it without consequences.
I do not support the program.
I think the cameras remains impartial when camera takes photos of vehicle tag and the car. Not needed to take pic of the driver. should take photos only when speeding (as dictated by the local law) occurs. If that is in place, tickets will be fairly given out to any driver who breaks those rules. Could make the fines smaller for younger drivers or all but make them have to go before judge to pay it or ask forgiveness the first time to inconvenience them and to learn to not do it again. Or first offenders can submit a request for forgiveness for a one-time first offense, get off with a warning but told the next time would not be subject to forgiveness? I'm all for one second chance, but they have to ask for it.
Abolish speed cameras, and red light cameras!!!
Follow up, publically, with the names of the violators. MDJ would be a good start.
Cameras should be off except for the hours of 7:00 am to 8:00 am as everyone should be in class. Tickets are issued after the hours stated on the sign. The flashing lights are ignored because they do not shut off after posted time frames. I wholeheartedly approve of the use of the cameras but there also needs to be a police presence in the areas where cameras are frequently catching speeders.
Contesting a ticket camera ticket is almost impossible, and traffic courts give too much credence to the cameras and limit the bases on which a citation can be contested. There is no way to ascertain that the car being cited was the car being clocked. Political lobbyists have made a lot of money from ticket camera companies—that needs to be made more transparent.
The cameras should not operate when school is not in session during workdays, weekends, and holidays. Police should not write tickets if school is not in session.
Authorities should disclose the terms of contracts and payments to camera operators in addition to revenue generated by the cameras.
Enforcing violations for speeding is a losing strategy. The speeding has already occured and now you are simply punishing the offender. Instead of deterrence, pursue prevention. Redesign the road to force drivers to slow down in school zones. Put in speed tables, chicanes, narrow lanes, roundabout. Traffic engineers know how to do it, make it impossible for folks to speed in school zones. Yes, do it on highways, and yes it will be in effect all hours and times of year, but IMO that's worth it to save lives.
In addition to speed cameras I would like to see NOISE cameras like Soundvue implemented. This would help reduce distractions of students and also reduce anxiety and other issues caused by loud cars and motorcycles primarily.
These cameras are not on timers. Therefore tickets are being issued during non school zone times such as weekends. Ensure the enforcement is ONLY during the school zine timeframe.
Local authorities should clearly tell the public where the money from the fine is going.
The school zone cameras should be timed for when schools are in session. Weekends, holidays, and school breaks should not be part of the time monitoring.
I got a ticket. I slowed down.

I think there should be more visible signs of the cameras while driving. I live by a school zone and I often tend to miss the signs of cameras unless notified by google maps.
They should have a big sign along with the school zone sign letting drivers know there are cameras.
Free for all schools zone both Private and public.
I am satisfied with all condition and hopefully it's working so good
Let's Let's meet Grandmas in front of daycare centers as well. Not all of us have the financial means to afford a car so we have to walk our children to daycare. And I would feel much safer walking my child to daycare in an area with speed cameras.
The cameras do not need to be operational the entire school day (as they are on US 78 at Oglethorpe High School). If we are forced to have them, they should ONLY be operational for the 1 hour period when kids are arriving and the 1 hour period when kids are departing.
The roads are the problem. Our road in front of city schools gets wider indicating to drivers it's OK to go faster. Focus on the road design not on the ticketing.
Complaints about the ASE program: (1) times of enforcement are not always clear; (2) posted limits are sometimes contradictory and confusing; (3) enforcement zones are sometimes not clearly marked. With better signage and utilization of painted roads to mark the enforcement zone, compliance would be improved.
They need to off cameras out of school time, people do not get tickets in normal hours.
I think the main issue is speeding tickets are typically not trusted because they are just a way to fine the public. Most people speed and schools shouldn't need a camera to monitor cars during the busy hours because that should be handled by a person at the school.
Supposedly the fines go to a fund and not the city and is not reported to your insurance.
Automated fines only punish honest people, people with no plates/plate covers avoid fines. Fines by mail don't stop speeders while in the act, only weeks later.
The survey is horribly designed and rigged to generate a bias towards implementing this program. It completely leaves out the fact that these cameras also violate the privacy of the school children walking and crossing the roads.
Iâ€™m not opposed to using some speed cameras, but only for those driving at egregious speeds.
Multiple option questions should not require an answer or have an option with an input. For instance, this last question Q3—I donâ€™t agree with any of the choices but forced to make a selection.
They should only when the schools when they start school and finish not keep it on when the school is not in session. town called Whitesburg Ga keep thereâ€™s on 345 in the evening and itâ€™'s nothing but a speed trap and they have a ðŸ'® park there to so no need for the cameras. itâ€™s a speed trap town all the way and all the time.
Citations should be issued during times when students are arriving and departing school, not during times when students are not involved in transportation.
On the same sign, or very close together, we need the speed limit when the light is flashing. AND we need the speed limit when the light is NOT flashing.

I know of several people that have received citations when school was not in session (i.e. during the summer)....NOT good. The company that installs (maintains?) these is making a fortune on these cameras, how much does our LOCAL government really get? That information is not easily available which makes the public distrust the whole system. The general public does not trust the government because of all of the corruption, this is just one more area for distrust.
I don't understand why the cameras are a problem. If you're speeding (especially in a school zone), you deserve a ticket. If you obey the law, you have nothing to worry about. I got a ticket because the speed limit was lower than I thought but now I am very careful about watching my speed.
Mane they give tickets ONLY during school hours
Thia progrma should not exist. They pretend to be a private company but send letter with the city informatio.isted as if it is a governemnt entiy. But this is not gling through the court system. Pleaae use this data to remove these devices.
Thereâ€™s one of these cameras set up on highway 108 between Waleska and Jasper. There is no school on highway 108 where that camera is at. The elementary school is off a side road. That camera is completely unconstitutional and illegal.
There is NO consideration for mis-calibrated cameras, nor for my ability to travel the roads without being tracked with no search warrant.
Ensure that signs are posted in the camera zones that notify the public of the presence of the camereas and active recording, along with a website of where the time-stamped recordings are posted.
The correct answer to Q3 is, "They should end the ASE program throughout the state of Georgia."
Make them have the flashing speed signs up prior to the camera locations, that way the driver knows what their speed is and if they do not slow down they have no excuse for being ticketed.
The only acceptable solution is a total ban on the cameras.
If a driver is between 2 buses they should not get a ticket
Clear communication of camera enforcement, both with signs near speed zones and public announcements. Nominal fines. If hour restricted needs clear light-based indication that speed zone is being enforced. Lights need to be adjusted for summer, holidays, and weekends. Should not be flashing lights if speed zone is not in active enforcement period.
When i received a citation from a s hook zone canera it was not during the hours in which the school zone speed was impleme ted. The cameras were not set up correctly and my fine was dismissed when i brought this up to the sheriff's department. it felt dishonest and made me wonder how many people hust paid the fine without looking into the details of the citation.
This is TOTALLY unconstitutional. Eventually, these cameras will be ruled unconstitutional by state and federal courts. The ends does NOT justify the means. PERIOD!!
Shutting off outside of typical school hours (which they may or may not already do, not sure) would be a big leap in public trust.
Good luck with your project!
There should be more obvious signage when the cameras are in use.
They should make every school zone exactly the same. They have flashing lights in some school zones to warn you that there is a school zone. However in other school zones which have been in lower income areas, there are no flashing lights and the signs that give school hours are very small.

The first option of Question 2 was weirdly worded and I couldnâ€™’t understand it.
Too Much reliance on technology. Plus 90 percent of kids are driven to school today. pPosition a officer or 2 at the entrance at open and close. much cheaper and fair. Tech companies will be in your bedroom next.

APPENDIX I. CONTINGENCY TABLES FROM THE CROSS-CLASSIFICATION ANALYSIS

Support for ASE in School Zones	Respondent is a Parent, High School Student, or Has a School-age Sibling	Respondent is not a Parent, High School Student, or Doesn't Have a School-Aged Sibling
Yes	108	156
No	63	50

Support for ASE in School Zones	Every Weekday and Everyday Travelers through School Zones with ASE Cameras	Other Travelers
Yes	38	119
No	23	51

Support for ASE in School Zones	Employed Respondents	Unemployed Respondents
Yes	216	48
No	97	16

Support for ASE in School Zones	Bachelor's or Graduate Degree Holders	High School Degree or Equivalent Qualification Holders or Less
Yes	201	63
No	86	27

Support for ASE in School Zones	18–34 Years Aged Respondents	35–64 Years Aged Respondents	Respondents Aged 65+ Years
Yes	120	130	11
No	33	68	10

Support for ASE in School Zones	Respondents with <5 Years of Driving Experience	Respondents with 5–15 Years of Driving Experience	Respondents with 15–25 Years of Driving Experience	Respondents with >25 Years of Driving Experience
Yes	55	77	46	86
No	11	21	20	61

Support for ASE in School Zones	Respondents Who Have Received a Fine	Respondents Who Have Not Received a Fine
Yes	21	136
No	31	43

ASE is a Creative Trap that is Motivated by Revenue Generation Rather than Safety	Respondents Who Have Received a Fine	Respondents Who Have not Received a Fine
Agree	36	79
Disagree	11	64
Neutral / No Idea	5	36

The Sole Purpose of ASE Cameras is to Reduce Vehicle Speeds and Crashes	Bachelor's or Graduate Degree Holders	High School Degree or Equivalent Qualification Holders or Less
Agree	183	63
Disagree	80	17
Neutral / No Idea	24	10

ASE Cameras Should be Implemented in All School Zones in GA to Improve Safety	Every Weekday and Everyday Travelers Through School Zones with ASE Cameras	Other Travelers
Agree	28	93
Disagree	25	58
Neutral / No Idea	8	19

APPENDIX J. NEWSPAPER ARTICLES ON ASE PROGRAMS IN GA

Article Published on February 22, 2024, on FOX 5 Atlanta

Live News Weather More ⁝

Backlash growing against school zone speed cameras in Georgia

By Johnny Edwards | Published February 22, 2024 10:30pm EST | Georgia Politics | FOX 5 Atlanta |

School zone speed cameras backlash

Ongoing complaints about ticket-happy school zone speed cameras have the attention of both state lawmakers and plaintiffs' attorneys. Some want to reform the system, while others want to topple it.

ATLANTA - Georgia's school zone speed cameras, which snap pictures of license plates and cite car owners by mail, face a battle for survival.

While police say the cameras help keep children and school employees safe, drivers have complained for years about ticket-happy cameras that benefit private companies and governments. Both state lawmakers and plaintiffs' attorneys have taken notice.

"I think there have been certain jurisdictions and companies that have run these cameras in excess," state Sen. John Albers, R-Roswell, told the FOX 5 I-Team. "They were not properly marked. They have confused drivers. And it's not been the type of solution that was intended to originally be in some cases."

One bill pending in the state Legislature would banish the automated systems, overturning the 2018 law that allowed them in the first place.

Another bill, passed by the House last year and now carried by Albers in the Senate, would tighten the time window for issuing tickets and bar private companies from taking a financial cut of tickets paid, Albers said.

Meanwhile, an Augusta plaintiffs' attorney has class action lawsuits pending against two camera companies, aiming to outlaw their business model.

"It doesn't throw out the cameras," attorney John Bell said of either of his lawsuits succeeding. "It throws out the private, for-profit company operating on a percentage basis, where their compensation is tied to how much money they can extract."

Last year, the I-Team exposed a glitch in some cameras that caused Jonesboro to ticket hundreds of drivers based on the wrong speed limit, with the city eventually agreeing to refund or dismiss 1,244 citations.

Since then, the I-Team has heard from dozens of drivers complaining about the cameras, some confused about when they operate, some shocked after receiving multiple tickets in a row.

A first ticket ranges from about $75 to $100, depending on the jurisdiction. Bell says the low fine amounts discourage people from fighting the tickets.

"The big thing is, they got the fines low enough, and they tell you, 'It won't go on your record, no points, anything,'" Bell said. "'Just send us your money.'"

Bell, known for successfully taking on Georgia's private probation companies, has filed cases against RedSpeed and Blue Line Solutions, who manage cameras for several police departments throughout the state. The case against RedSpeed is filed in superior court in Jefferson County, near Augusta, and the case against Blue Line is in federal court.

Another class action lawsuit was filed against RedSpeed by an Albany attorney, but a federal judge has already dismissed three of the four counts in that complaint.

"This is a very creative money grab by some very smart plaintiffs' attorneys trying to find a way to make a whole heck of a lot of money," said Christopher Cohilas, an attorney for RedSpeed.

RedSpeed provided statistics to the I-Team showing that in some Georgia locations, speeding has dropped by 84 to 96%, with recidivism rates indicating most drivers only need one ticket to get the message to slow down.

"In reality," Cohilas said, "this is an enforcement scheme that provides tremendous safety to communities and reduces the overall rate of recidivism with respect to speeding."

One of the class action cases started in Tallulah Falls when a couple in their 70s got ticketed for going 56 miles per hour on a four-lane highway past a middle school. The school zone speed limit was 45 at the time.

Bell alleges in the lawsuits that the camera companies aren't police, but they pose as police when they mail citations. The complaints point to Blue Line using its Tennessee address on citations from Tallulah Falls, and RedSpeed using its Atlanta post office box on citations from the city of Wrens, Georgia.

The cases cite the Georgia law against impersonating an officer and accuse the companies of "wrongful impersonation of law enforcement and agencies."

"I think it's offensive," Bell said. "There is a reason we have law enforcement that are elected or serve under elected people, who are responsible for their duties, and who are not paid based on how many people they arrest or how much money they can extract out of people."

The lawsuits also invoke Georgia's racketeering law. One alleges, "RedSpeed has engaged in a pattern of racketeering activity by inflating electronic processing fees, retaining percentages of the civil monetary penalty which it is not authorized to retain, causing notices of violations to be mailed to Plaintiff and Class Members as though RedSpeed is a law enforcement official."

Both companies have denied the allegations in court filings, saying the 2018 law allows what they do.

"The Georgia Legislature literally put in place a mechanism to protect children, and that's all that RedSpeed is doing," Cohilas said. "The allegations in the complaint that this somehow constitutes racketeering are silly, and we've defended lawsuits already in other parts of the state and have been having great success."

In a written statement to the I-Team, Blue Line said, "We strongly disagree with the allegations of the Complaint, and we believe our conduct complied with the requirements set by the Georgia legislature. We have filed a motion to dismiss to that effect, and that is pending a decision by the Court."

In 2018, the Georgia legislature passed a school speed camera law that opened the doors for dozens of municipalities across the state to contract with private companies to ticket violators. That bill passed after the stroke of midnight on the final day of the legislative session, reportedly with help from then-Speaker of the House David Ralston, whose son Matt Ralston was pushing the bill as a lobbyist for a speed camera company.

Companies that contract with municipalities typically take a cut of about a third of each ticket paid.

Sen. Albers said House Bill 348, which he is sponsoring in the Senate, would put an end to that.

"It's going to make sure that no camera company is benefitting financially from the amount of tickets they write," Albers said. "It's a flat fee that they work with the local municipality."

The bill would also require school zone signs to be uniform throughout the state. Under the proposal, cameras could only write speeding tickets at the beginning and end of school days, when orange lights are flashing on speed limit signs.

"We never want this to be anything more than protecting students," Albers said. "We don't ever want it to be a money grab."

House Bill 1126 would go even further – completely jettisoning the 2018 law.

Its sponsor, Rep. Clay Pirkle, R-Ashburn, called the camera systems a "hot mess" in testimony before the House Motor Vehicles Committee on Tuesday.

"School zone cameras have become a gravy train of revenue, with very little work for the agencies that employ this technology," Pirkle said. "We have been sold a bill of goods. It's actually a Trojan horse. A golden goose, revenue-generator disguised in school safety language."

The committee approved the bill unanimously. It's now with the House Rules Committee.

Georgia Politics **I-Team** **Traffic** **Georgia** **News**

Article Published on June 26, 2024, on FOX 5 Atlanta

Live News Weather More ⁝

After I-Team investigations, ATL and Riverdale to automatically refund drivers wrongly ticketed by speed cams

By Johnny Edwards | Published June 26, 2024 10:50pm EDT | I-Team | FOX 5 Atlanta |

RIVERDALE, Ga. - There's good news for some drivers who received bad tickets from automated school zone cameras.

Just as the cameras slapped them with citations automatically, they'll get their money back automatically.

Over the past school year, the FOX 5 I-Team revealed several spots in metro Atlanta where the devices ticketed thousands of drivers unfairly, citing them for speeding past schools even though they weren't going fast enough to be cited under the law.

I-Team: Refunds for wrongly ticketed speed cams driver

By Johnny Edwards Published June 26, 2024 RIVERDALE, Ga. - There?s good news for some drivers who received bad tickets from automated school zone cameras. Just as the cameras slapped them with citations automatically, they?ll get their money back automatically. FULL STORY: https://www.fox5atlanta.com/news/after-i-team-investigations-atl-riverdale-automatically-refund-drivers-wrongly-ticketed-speed-cams

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The problem: cameras out of sync with flashing school zone lights.

Two cities that saw the problem, Atlanta and Riverdale, will refund motorists who already paid fines for something they didn't do. And drivers don't have to lift a finger – both cities will give out checks and credit card refunds automatically.

"It's just the right thing to do," Riverdale Police Chief Todd Spivey said. "They shouldn't have to go out of their way to get a refund."

Verra Mobility, the camera contractor for Atlanta Public Schools, told the I-Team in a written statement Tuesday that it has already dismissed tickets mailed to motorists cited for speeding on Memorial Drive during times when blinking school zone lights cut off early.

According to an I-Team investigation, the glitch resulted in 4,460 faulty citations, but it's unclear how many of those tickets have already been dismissed or never got paid. A spokesman for APS previously said that roughly 2,000 questionable tickets had been identified.

In Atlanta, first tickets cost $75 and second-time-or-more tickets cost $125.

"For those who submitted payment, the City is issuing automatic refunds via check, regardless of the original payment method," the statement from Verra Mobility said.

Two months after the I-Team identified thousands of drivers wrongly ticketed near Riverdale High and Riverdale Middle schools, the city's police chief said he and camera contractor RedSpeed have confirmed FOX 5's findings and already started the process of making it right.

According to the chief, the total number of bad tickets written in Riverdale: 8,766.

Total tickets already paid, requiring refunds: 5,258.

Total amount going back to drivers: $420,640.

Candace Thompson, who lives near the high school, expects to receive $650 of that. During the past two years, she received six citations from the cameras – five of them erroneous, because the cameras cited her for speeding above 25 mph during times when the school zone flashers weren't blinking.

In Riverdale, first tickets cost $80 and all subsequent tickets cost $130.

"They need to pay what they owe," she said. "It was money that I shouldn't have had to pay out to begin with. I shouldn't have been ticketed in the first place."

Thompson said the tickets caused her a whirlwind of trouble. Some of them, she says, never arrived in the mail, and when she went to renew her auto registration this year, she found a hold on her account because of three unpaid tickets – all of them, it turns out, invalid.

"I had to pay $400 to get my car registration," she said. "And I had no choice, because I was going to have expired tags."

Chief Spivey said credit card refunds and checks in the mail will go out automatically over the next four months, and any holds on vehicle registrations because of erroneous tickets will be lifted.

He also issued a mea culpa, saying the police department and RedSpeed used one set of times for the cameras – the same schedule listed on street signs in the area – while Clayton County Transportation and Development, which programs the school zone flashers, used its own schedule.

"We all thought we all had everything set up the right way," Spivey said. "What we weren't doing is going out into the field, sitting there, watching the yellow signals and making sure that they were going on and off exactly as indicated on those signs."

In Atlanta, near Drew Charter School, two sets of blinking lights with a sign that says "Speed Limit 25 when flashing" cut off too early – at 8:15 a.m. and 4:45 p.m. – while the cameras went on ticketing based on a 25 mph speed limit until 8:30 a.m. and 5 p.m.

The I-Team found that Atlanta Public Schools became aware of the problem in late November, but no one adjusted the cameras before the city finally corrected the flashers on May 2.

The I-Team also learned that under original plans for the school zone required for a state permit to operate the cameras, street signs facing both directions of traffic should have told drivers the schedule of 25 mph times before they passed the cameras. After talking to the camera contractor, the city decided the signs were too confusing and removed them, the I-Team reported, raising questions about whether the cameras should be issuing tickets at that location at all.

The city provided an email address for questions about refunds: oorppd@atlantaga.gov.

David Malkin has been trying to get answers for weeks, he says, leading only to frustration.

"Basically, I feel like I'm stuck in an administrative black hole," he said.

Malkin received a ticket in April, one minute before 5 p.m., for going 37 mph in a 25 mph. Under the law, a vehicle must be going at least 11 miles over the speed limit to be cited by an automated camera, so Malkin wasn't legally speeding above 35 mph at the time.

He says he has sent emails, made several phone calls, and even filled out a city refund request form.

"And then it's been crickets ever since," Malkin said.

According to Tuesday's statement from the camera contractor, he can rest easy.

"No action is required from those who are due a refund," the company said.

Last year, the I-Team also identified hundreds of citations issued in error by Jonesboro. That city, which contracts with RedSpeed, also did automatic refunds, totaling $76,400 for 1,244 citations.

Touted as a school safety measure, automated school zone speed cameras were legalized by the state legislature in 2018, with a bill passed after midnight before that year's Sine Die, reportedly with help from then-Speaker of the House David Ralston, whose son was lobbying for a speed camera company.

Efforts to reform or jettison the controversial systems failed to pass in this year's legislative session. Several lawmakers, including Rep. Chas Cannon, R-Moultire, have said they will revisit the issue next year.

I-Team **Riverdale** **Atlanta** **Crime and Public Safety**

Atlanta Public Schools **Traffic**

Article Published on February 3, 2025, on FOX 5 Atlanta

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Fight to ban school zone speed cameras begins in Georgia House

By Johnny Edwards | Published February 3, 2025 6:52pm EST | I-Team | FOX 5 Atlanta |

Georgia representative wants speed cameras gone

Republican Rep. Dale Washburn has introduced a bill that would force cities and counties across the state to shut their speed cameras down. He says more than half of the House of Representatives are co-signing.

The Brief

- State Rep. Dale Washburn, R-Macon, has introduced a bill that would ban automated school zone speed cameras – effectively forcing police departments across the state to dismantle their automatic ticketing systems.
- The camera systems clock the speeds of passing vehicles, photograph speeders' license plates and send citations by mail.
- The tickets frustrate many drivers – with the FOX 5 I-Team discovering three cities were ticketing drivers unfairly – but supporters say they slow traffic and keep school kids safe.
- The Macon lawmaker filed his bill with the House clerk's office on Monday, telling the FOX 5 I-Team afterward that his proposal had 100 co-signers, plenty of votes to pass the House.
- Washburn, nevertheless, expects a battle, saying camera companies have hired additional lobbyists to fight his bill.

ATLANTA - A state lawmaker just declared war on school zone speed cameras.

New bill against speed cameras in school zones

What we know: State Rep. Dale Washburn (R-Macon) filed a bill Monday with the Clerk of the House of Representatives that would outlaw the cameras in Georgia, overturning a 2018 state law that allowed cities and counties to use automated cameras, instead of police officers, to cite speeders near schools.

Washburn told the FOX 5 I-Team in an interview last year that he'd be dropping the bill, picking up where now-retired state Rep. Clay Pirkle left off last year. Pirkle's bill, which also would have banned the cameras, never moved past the Rules Committee.

Ga. Rep. Dale Washburn told the FOX 5 I-Team he believes automated school zone speed cameras are "designed to entrap." (FOX 5)

Image 1 of 2

Washburn, however, has more than half of the House behind him this time, with 100 co-signers.

You can read the full text of the bill here.

What they're saying: Over the past seven years, camera systems have popped up along roadways outside schools all over the state, generating millions of dollars for local governments.

RELATED: Backlash growing against school zone speed cameras in Georgia

"This is about revenue by citation. It is taxation by citation, and it is wrong," Washburn said. "Local governments are raking in huge amounts of money across the state of Georgia, and our citizens are being victimized by it."

Attempts to reform how these cameras operate also failed at the Capitol last year. Washburn said he's expecting another fight this year.

"The fight is going to be huge," he told the I-Team. "There are a number of lobbyists here that have been hired by these camera companies. They had some lobbyists already. They've hired more."

The other side: Meanwhile, Ashley Rose-Toomer, the executive director of the nonprofit Give School Kids a Brake, said lawmakers who want to ban the cameras are listening to the wrong people: speeders.

"Folks that go eleven miles over the posted speed limit, folks that are breaking the law, quite significantly ... Why are they considered victims? Why is their needs being put above that of parents who are walking their kids to school?" she asked.

Rose-Toomer also argued that it wouldn't be cost-effective to place an officer at every school zone every day.

Camera speeding tickets in Georgia

Dig deeper: Last year, a series of FOX 5 I-Team investigations uncovered thousands of invalid speeding tickets automatically issued across the metro area.

PREVIOUS I-TEAM REPORTS:

- **I-Team finds more school zone cameras ticketed drivers unfairly, this time in east Atlanta**

- **More speed camera trouble: FOX 5 I-Team investigation finds another 6K erroneous tickets**

The FOX 5 I-Team found misalignments between camera ticketing times, and the on/off times of the flashing school zone lights, misled drivers into exceeding the speed limit. Those findings prompted over a half million dollars in reimbursements for drivers ticketed in Jonesboro, Riverdale and Atlanta.

Even when the systems were working as they should, complaints poured in to lawmakers about confusing signage and being ticketed even in the middle of school days when school lights weren't blinking.

What's next: A bill usually has five or six co-signers. Washburn said his legislation has already received 100.

It takes 91 votes to pass a bill in the House.

The Source: The FOX 5 I-Team has been reporting on controversies surrounding school zone speed cameras for more than a year, using data and field research to determine that cameras in Jonesboro, Riverdale and Atlanta were issuing tickets unfairly. For this story, I-Team reporter Johnny Edwards spoke with state Rep. Dale Washburn just as he left the House clerk's office, where he filed a bill to outlaw school zone camera systems in Georgia.

I-Team **Georgia Politics** **Education** **News**

Article Published on May 16, 2025, on WALB NEWS

Bainbridge man arrested, accused of shooting school zone speed equipment on Shotwell Street

He has since posted a $17,100 bond.

Bainbridge man arrested, accused of shooting school zone speed equipment on Shotwell Street

BAINBRIDGE, Ga. (WALB) – WALB has confirmed that Thomas Hubert Parker Jr., of Bainbridge, was arrested on May 15, 2025, for allegedly shooting parts of the school zone speed equipment on Shotwell Street, according to investigators with Bainbridge Public Safety.

According to the Decatur County Sheriff's department, Parker is facing 3 counts of "Possession of Tools for the Commission of a Crime" and "Interference with Government Property." The report also states that Parker's last known employer was "Bainbridge Memorial Hospital," which is officially known as "Memorial Hospital And Manor."

According to the hospital's website, Parker is a Doctor of Anesthesiology, and is currently listed on their team member directory.

Since his arrest, Parker has posted a $17,100 bond.

We have reached out to Memorial Hospital And Manor for a statement, and we are waiting to hear back.

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