

# **Determining Ideal Locations for Radar Speed Signs for Maximum Effectiveness: A Review of the Literature**

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**May, 2017**

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*for the*  
**Delaware Department of Transportation**

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## EXECUTIVE SUMMARY

Motorist and worker safety improvement is one of the most important tasks for transportation agencies. Many studies have concluded that the speed has significant effect on the risk and severity of a crash. Radar speed signs installed below the black-and-white posted speed limit signs are used to regulate speeds typically deployed in city streets, school zones, neighborhoods, work zone, high-accident areas and neighborhoods. As the digital speed values appear and change as the vehicle's speed changes, they tend to draw the attention of the driver to the sign by making drivers more aware of how fast they are traveling relative to the posted speed limit.



Previous studies have examined the impacts of radar speed sign effectiveness for various conditions. However, the review of national research on this topic has shown mixed results in the effectiveness of radar speed signs as a traffic calming solution for regulating speeders on city streets. Consequently, it was necessary to establish criteria regarding in what roadway locations/traffic conditions are radar speed signs most effective over time.

This study attempts to fill this gap by providing transportation planners and engineers with guidance for the deployment of radar speed signs which could be employed in a systematic manner to restore and maintain a balance between mobility and neighborhood quality of life. In order to maximize the cost-effectiveness of the resources available to this investigation, we have explored the state of art and best practice about assessing the safety impact of radar speed signs.

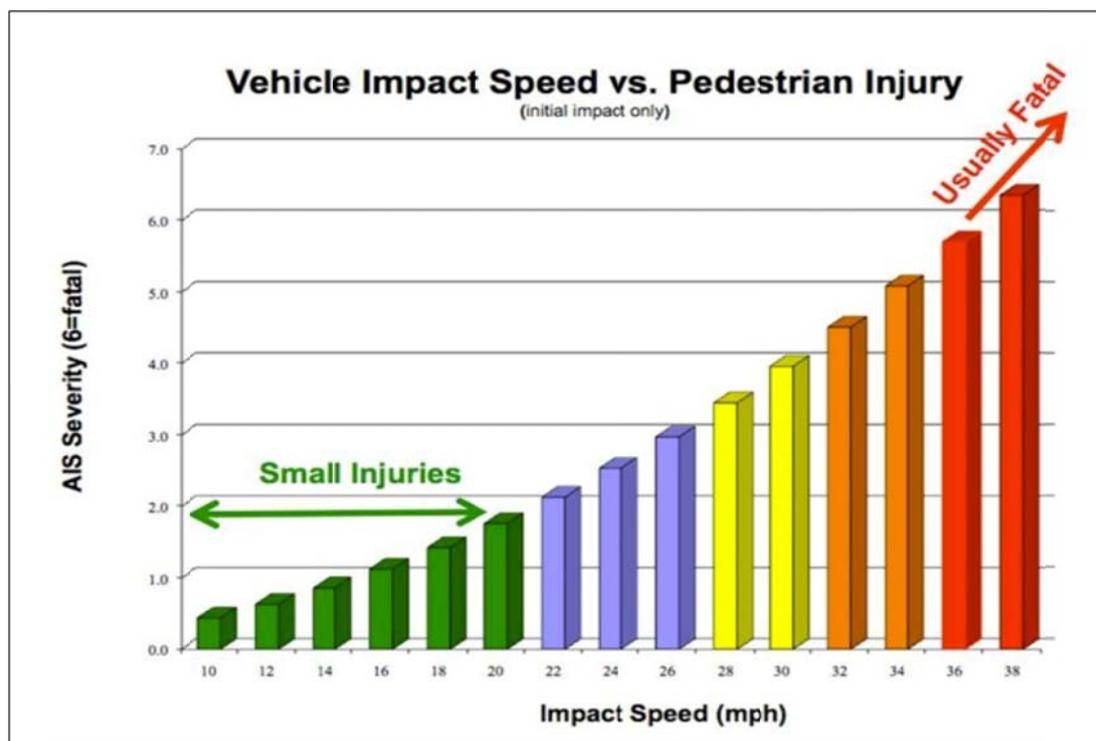
While radar speed signs, particularly trailer-based and portable sign-mounted versions, can be deployed anywhere, the primary applications have been documented in the literature: private communities, school zones, work zones and police enforcement.

The method developed in this project is intended to be used for planning and initial design ideas for traffic engineering and city or regional planners who are plagued by a road in urban or rural area with recurring safety problems.

## 1 INTRODUCTION

### 1.1 Problem Statement

Motorist and worker safety improvement is one of the most important tasks for transportation agencies. In 2015, speed-related crashes claimed the lives of 35,092 people in the United States, resulting in more than \$52 billion in economic costs and \$203 billion in comprehensive costs<sup>1</sup>. Many studies have examined the relation between speed and crash rate and concluded that the speed has significant effect on the risk and severity of a crash (Martin, 2002; Aarts & Van Schagen, 2006) as shown in *Figure 1*. Motivating drivers to comply with speed limit is a critical yet challenging task.



*Figure 1: Vehicle impact speed vs. pedestrian injury*

Source: Peter Swift, Streets and public safety

It is commonly recognized that the most effective method of reducing speeding and other inappropriate behavior is through the use of law enforcement (Fontaine, Schrock, & Ullman, 2002; Brewer M. , Pesti, Schneider, & William, 2005; Hajbabaie, Benekohal, Chitturi, Wang, & Medina, 2009; Debnath, Blackman, & Haworth, 2012). Unfortunately, police presence is not always feasible due to availability of police officers and patrol cars and the high labor cost (Bowie, 2003). Another deterrent to using police enforcement is the lack of space for maneuvering and for apprehending violators without adversely affecting the rest of the traffic stream (Fontaine, Schrock, & Ullman, 2002; Bowie, 2003; Saito & Bowie, 2003). Furthermore,

<sup>1</sup> <https://crashstats.nhtsa.dot.gov/Api/Public/Publication/812412>

some drivers use passive radar detectors to detect police radar with the purpose of evading prosecution by slowing down within an enforcement zone.

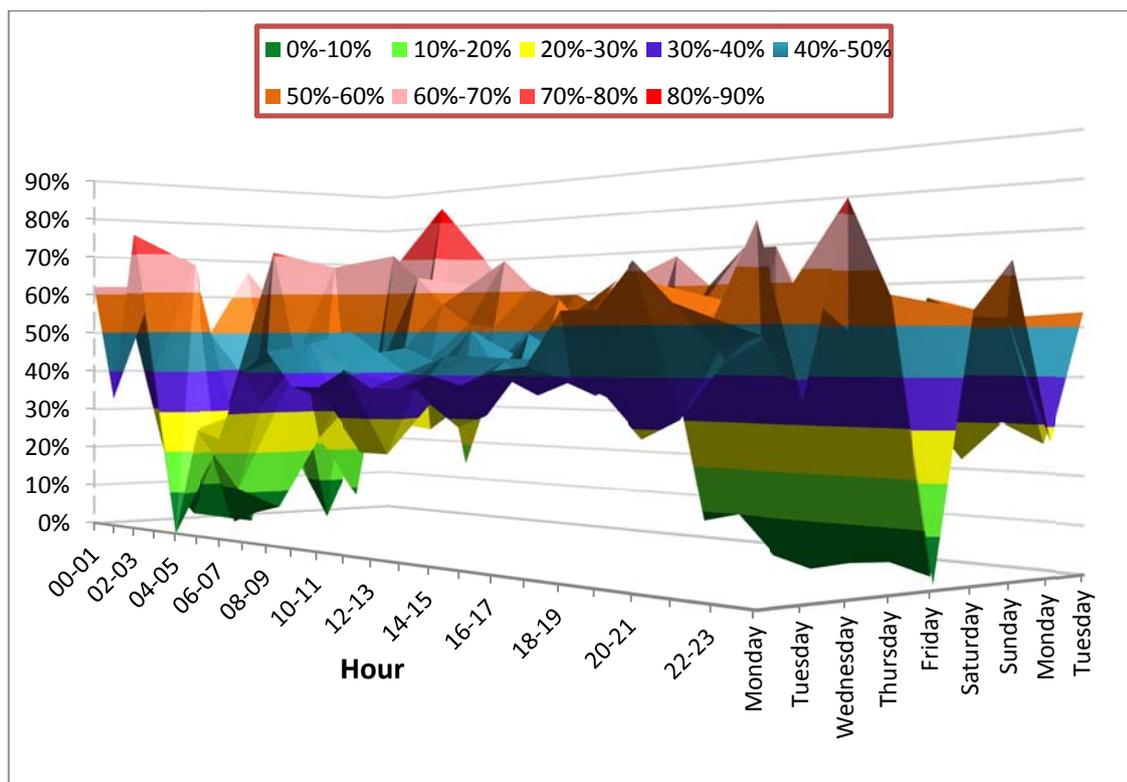
To overcome this problem, many early research efforts have been devoted to investigating how to reduce vehicles' speeds using traffic calming devices to attract drivers' attention (Pau & Angius, 2001). Raised pavement markers, flashing lights, lane striping, speed bumps, speed humps, channelizing devices, traffic islands, and median barriers, were used to slow traffic down and improve overall safety and mobility (Corbett & Simon, 1999; Jamson, Tate, & Jamson, 2005; Hallmark, Peterson, Fitzsimmons, Hawkins, Resler, & Welch, 2007; Kattan, Tay, & Acharjee, 2011; Gregory, Irwin, Faulks, & Chekaluk, 2014).



**Figure 2: Radar speed sign on Skyline Drive, Wilmington, Delaware**  
(Photo taken on March 25, 2017)

Radar speed signs (*Figure 2*) installed below the black-and-white posted speed limit signs are used to regulate speeds typically deployed in city streets, school zones, neighborhoods, work zone, high-accident areas and neighborhoods. A radar speed sign dynamically displays the actual speed of vehicles, and is often supplemented with a regulatory speed limit sign. *Figure 3* indicates the percentage of speed violations data measured by a radar speed sign in Spring Valley, NY. As the digital speed values appear and change as the vehicle's speed changes, they tend to draw the attention of the driver to the sign by making drivers more aware of how fast they are traveling relative to the posted speed limit. These have also been referred to as "Your

Speed" signs and driver feedback signs<sup>2</sup>. The installation of the radar speed signs was considered as a practical solution to balance neighborhood needs with mobility<sup>3</sup>. To a significant extent, previous research studies have examined the impacts of radar speed sign effectiveness for various conditions (Wertjes, 1996; Maze, 2000; Thompson & Gayne, 2002; Chang, Nolan, & Nihan, 2005; Ullman & Rose, 2005; Brewer, Pesti, & Schneider IV, 2006; Chitturi & Benekohal, 2006; Davis, Bennink, Pepper, Parks, Lemaster, & Townsend, 2006; Ash & Saito, 2007; Cunningham, Hummer, & Moon, 2008).



**Figure 3: Percentage of speed violations**

**Data source:** Traffic Logix Corp (Address: 3 Harriett Lane, Spring Valley, NY, 10977; Report Period: 4/11/2011 to 4/17/2011)

## 1.2 Motivation and objectives

While the radar speed sign were found effective in reducing speeds, some researchers argued that their effect is temporary or localized (Debnath, Blackman, & Haworth, 2012; Debnath, Blackman, & Haworth, 2014). Veneziano et al. (2010) pointed out that the deployment of radar

<sup>2</sup> <http://www.radarsign.com/radar-speed-sign-products>

<sup>3</sup> [http://www.chulavistaca.gov/City\\_Services/Development\\_Services/Engineering/Traffic/TrafficSafety/documents/100709min.pdf](http://www.chulavistaca.gov/City_Services/Development_Services/Engineering/Traffic/TrafficSafety/documents/100709min.pdf)

speed signs has been conducted in an unscientific manner. Consequently, it was necessary to establish criteria regarding in what roadway locations/traffic conditions are radar speed signs most effective over time. The California Department of Transportation (Caltrans) paper provided general guidance in addressing general concerns and locations-specific guidance in addressing site concerns. But this paper focused on warranting conditions rather than actual effectiveness. The paper includes anecdotal information from many other agencies related to effectiveness. A 2009 report<sup>4</sup> by the City of Bellevue, WA, may be the most comprehensive report on the topic, and showed long-term speed reductions between 2 and 6 mph. Some of the lessons that staff have learned over the last eight years are provided in this report. However, the report does not indicate in what situations the radar speed signs might be most effective. Study variables should include location installed (residential subdivision, local road, collector road), speed limit (25 to 45 MPH), and effectiveness over time. The central question is: What is the effectiveness of radar speed signs in reducing vehicular speeds? In what roadway locations/traffic conditions are radar speed signs most effective?

In the previous works, only the guidance in addressing general concerns and some of the lessons that have been learned are provided, it does not indicate in what situations the radar speed signs might be most effective. To this end, it is necessary to establish criteria regarding in what roadway locations/traffic conditions are radar speed signs most effective over time. More specifically, study variables should include location installed (residential subdivision, local road, collector road), speed limit, and effectiveness over time. Since the radar speed sign is not an enforcement tool to slow down speeders, the human factor aspects of its applications also needs careful examination.

This study attempts to fill this gap by providing transportation planners and engineers with guidance for the deployment of radar speed signs which could be employed in a systematic manner to restore and maintain a balance between mobility and neighborhood quality of life. In order to maximize the cost-effectiveness of the resources available to this investigation, we have explored the state of art and best practice about assessing the safety impact of radar speed sign.

### 1.3 Report Outline

This report consists of four chapters, which are structured as follows: Chapter 1 gives a brief introduction to our research activities – the problem statement and motivation of our research, the research goal, and our approach.

Chapter 2 provides a comprehensive review of a large amount of previously published evidence about impact study for the effective application of radar speed sign.

Chapter 3 describes existing federal and state guidance.

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<sup>4</sup> <http://www.ci.bellevue.wa.us/ntss-publications.htm>

Chapter 4 summarizes the findings. Concluding remarks, recommendations for implementation and future research extensions are given in this chapter.

## 2 LITERATURE REVIEW

### 2.1 Introduction

This section involves having a thorough understanding of the work which is identified in a problem statement, conducting a critical examination of the state of art and best practice about assessing the safety impact of radar speed sign, and identifying the appropriate level of detail and tools. Evaluations of existing research conducted nationally and internationally have been synthesized for key lessons learned, and serve as a basis for defining user and functional requirements to provide a proven and effective traffic calming solution for reducing speeders in neighborhoods. This section also offers an overview of road safety theories that explain how and why these factors affect road traffic accidents

#### Key National Safety Analysis Resources

- National Highway Traffic Safety Administration (NHTSA)<sup>5</sup>
- FHWA Safety Program<sup>6</sup>
- AAA Foundation for Traffic Safety<sup>7</sup>
- AASHTO Highway Safety Manual (HSM)<sup>8</sup>
- American Traffic Safety Services Association (ATSSA)<sup>9</sup>
- Fatality Analysis Reporting System (FARS)<sup>10</sup>
- NHTSA, National Center for Statistics and Analysis<sup>11</sup>
- FHWA Data and Safety Analysis Tools<sup>12,13</sup>
- National Safety Council's Information Gateway<sup>14</sup>
- FHWA/NHTSA National Crash Analysis Center<sup>15</sup>
- Bureau of Transportation Statistics (BTS) Databases<sup>16</sup>
- Association of Traffic Safety Information Professionals (ATSIP)<sup>17</sup>
- Proven Safety Countermeasures<sup>18</sup>

#### Key DelDOT Safety Analysis Resources

- Delaware Office of Highway Safety (OHS)<sup>19</sup>
- Delaware State Police (DSP)<sup>20</sup>
- Delaware's Strategic Highway Safety Plan<sup>21</sup>

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<sup>5</sup> <https://www.nhtsa.gov>

<sup>6</sup> <https://safety.fhwa.dot.gov>

<sup>7</sup> <https://www.aaafoundation.org/research>

<sup>8</sup> <http://www.highwaysafetymanual.org/Pages/default.aspx>

<sup>9</sup> <https://www.atssa.com>

<sup>10</sup> <https://www.nhtsa.gov/research-data/fatality-analysis-reporting-system-fars>

<sup>11</sup> <https://www.nhtsa.gov/research-data/national-center-statistics-and-analysis-ncsa>

<sup>12</sup> [https://safety.fhwa.dot.gov/rsdp/Tool\\_1\\_Final\\_2015\\_05\\_04.pdf](https://safety.fhwa.dot.gov/rsdp/Tool_1_Final_2015_05_04.pdf)

<sup>13</sup> <https://safety.fhwa.dot.gov/rsdp>

<sup>14</sup> <http://www.nsc.org/pages/home.aspx>

<sup>15</sup> <https://www.fhwa.dot.gov/publications/research/safety/06110>

<sup>16</sup> [https://www.rita.dot.gov/bts/data\\_and\\_statistics/databases](https://www.rita.dot.gov/bts/data_and_statistics/databases)

<sup>17</sup> <http://www.atsip.org>

<sup>18</sup> <https://safety.fhwa.dot.gov/provencountermeasures>

<sup>19</sup> <http://ohs.delaware.gov>

<sup>20</sup> <http://dsp.delaware.gov>

- DelDOT Road Design Manual
- Delaware Manual on Uniform Traffic Control Devices (DE-MUTCD)
- Crash Analysis and Reporting
- State Traffic Safety Information System (NHTSA)

#### Key National Safety Analysis Resources

- FHWA Work Zone Mobility & Safety Program<sup>22</sup>
- National Highway Work Zone Safety Program<sup>23</sup>
- National Highway Traffic Safety Administration<sup>24</sup>
- FHWA Safety Program<sup>25</sup>
- AASHTO Highway Safety Manual<sup>26</sup>
- Proven Safety Countermeasures<sup>27</sup>
- FHWA Data and Safety Analysis Tools<sup>28</sup>

#### Key DelDOT Safety Analysis Resources

- Delaware Office of Highway Safety<sup>29</sup>
- Delaware's Strategic Highway Safety Plan<sup>30</sup>
- DelDOT Road Design Manual<sup>31</sup>
- Delaware Manual on Uniform Traffic Control Devices (DE-MUTCD)<sup>32</sup>

## 2.2 Traffic calming

Previous studies have examined the impacts of radar speed sign effectiveness for various conditions. However, the review of national research on this topic has shown mixed results in the effectiveness of radar speed signs as a traffic calming solution for regulating speeders on city streets. *Figure 4* indicates sample traffic-calming treatments in urban communities. The cost, Advantages and Disadvantages of each traffic-calming treatments are provided in *Table 1* and *Table 2*.

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<sup>21</sup> [http://www.deldot.gov/information/community\\_programs\\_and\\_services/DSHSP](http://www.deldot.gov/information/community_programs_and_services/DSHSP)

<sup>22</sup> <https://ops.fhwa.dot.gov/wz/index.asp>

<sup>23</sup> [https://safety.fhwa.dot.gov/wz/wz\\_natl\\_pro.cfm](https://safety.fhwa.dot.gov/wz/wz_natl_pro.cfm)

<sup>24</sup> <https://www.nhtsa.gov>

<sup>25</sup> <https://safety.fhwa.dot.gov>

<sup>26</sup> <http://www.highwaysafetymanual.org/Pages/default.aspx>

<sup>27</sup> <https://safety.fhwa.dot.gov/provencountermeasures>

<sup>28</sup> <https://safety.fhwa.dot.gov/rsdp>

<sup>29</sup> <http://ohs.delaware.gov>

<sup>30</sup> [http://www.deldot.gov/information/community\\_programs\\_and\\_services/DSHSP](http://www.deldot.gov/information/community_programs_and_services/DSHSP)

<sup>31</sup> [http://deldot.gov/information/pubs\\_forms/manuals/road\\_design/index.shtml](http://deldot.gov/information/pubs_forms/manuals/road_design/index.shtml)

<sup>32</sup> [http://deldot.gov/information/pubs\\_forms/manuals/de\\_mutcd](http://deldot.gov/information/pubs_forms/manuals/de_mutcd)



	Traffic Circle		Radar Speed Sign		Speed Bump	<b>Legend</b>	
	Speed Hump		Raised Crosswalk		Diverter		

Figure 4: Sample traffic-calming treatments in urban communities

Table 1: Passive control

Passive Controls	Cost (\$)	Advantages	Disadvantages
Signage	250	Inexpensive	Ineffective without speed enforcement
Speed enforcement	Varies	Inexpensive if used temporarily	Expensive to maintain for a long period
Speed legends	100	Inexpensive	Has not been shown to significantly reduce travel speeds

Radar speed signs	8,000	Does not slow trucks and emergency vehicles; Does not require much time for design; Can mount to existing poles	long-term maintenance
Lane striping	0.30 /ft	Does not require much time for design	Increases regular maintenance
Raised pavement markers	15	Inexpensive	Noise, Snow plows often remove

**Table 2: Active control**

Active Controls	Cost (\$)	Advantages	Disadvantages
Raised crosswalks	10,000	Improve safety for pedestrians	Slows and may damage emergency vehicles; Poor aesthetics; Increased noise; May change or restrict drainage
Roundabouts	250,000	Enhanced safety compared to traffic signal	Landscaping must be maintained; require major reconstruction and extensive right-of-way; Potential loss of on-street parking
Speed bumps	4,000	Relatively inexpensive	Slows and may damage emergency vehicles; Poor aesthetics
Speed humps	200	Relatively inexpensive	Slows and may damage emergency vehicles; Poor aesthetics
Speed tables	10,000	Effective at slowing travel speed	Slows and may damage emergency vehicles; Poor aesthetics; Increased noise
Full closure	150,000	Effective in reducing traffic volumes	Expensive; May limit access to businesses
Half closure	10,000	Effective in reducing traffic volumes	Expensive; Drivers can circumnavigation barrier
Diagonal diverters	45,000	Effective in reducing traffic volumes	Cause indirect routes for local residents
Median barriers	400/ft	Can improve safety at intersection	May require right-of-way acquisition; May limit access for emergency vehicles
Forced turn islands	5,000	Can improve safety at intersection	May simply divert traffic problem to different street
Raised intersections	70,000	Can improve safety at intersection	Expensive; Increased noise; May change or restrict drainage

### 2.3 Impact study for the effective application of radar speed sign

Speeding in transition zones, work zone and school zone areas continues to be one of the major safety concerns when speed adaptation phenomenon changes from high-to-low speed (McCoy, Bonneson, & Kollbaum, 1995; Lee, Lee, Choi, & Oh, 2006; Woo, Ho, & Chen, 2007; Forbes, 2011). Drivers' lack of compliance with speed restrictions is among the major contributing factors most often reported for work zone accidents (Ha & Nemeth, 1995). During the 2003 to 2010 period, there were 7,009 fatalities in work zones<sup>33</sup>, 962 workers were killed while working at a road construction site. Nearly half of these deaths resulted from a vehicle or mobile equipment striking the worker<sup>34</sup>. There is a disproportionately higher frequency of crashes in work zones than they are on stretches of highway under normal traffic volumes. Therefore, there is an urgent need to reduce speeding vehicles and improve safety in work zones and other speed zones.

To address the existing speed related safety concerns, various speed control strategies ranging from enforcement by patrol vehicles (Retting, Farmer, & McCartt, 2008; Retting, Kyrychenko, & McCartt, 2008) to Speed photo-radar enforcement (Bloch, 1998; Benekohal, Chitturi, Hajbabaie, Wang, & Medina, 2008; Benekohal, Wang, Chitturi, Hajbabaie, & Medina, 2009; Wang & Kou, 2014) and other radar speed signs (City of Garden Grove, 2003; Dalton, 2005; Veneziano, Hayden, & Ye, 2010; Williamson & Fries, 2015; Williamson, Fries, & Zhou, 2016; Jafarnejad, Gambatese, & Hernandez, 2017) as well as more sophisticated changeable message signs (with and without radar) (Garber & Patel, 1995; Garber & Srinivasan, 1998; Sorrell, Sarasua, Davis, Ogle, & Dunning, 2007; Zech, Mohan, & Dmochowski, 2008; Bai, Huang, Schrock, & Li, 2011; Li, 2011; O'Brien & Simpson, 2012; Huang, Strawderman, & Garrison, 2013) have been studied, developed and evaluated by experts.

McCoy et al. examined the effectiveness of speed monitoring displays at a work zone on an interstate highway in South Dakota. Data were collected before deployment at three locations in advance of the work zone. The after study was conducted about one week after the deployment. The mean speeds of the two-axle vehicles and the vehicles with more than two axles were reduced by about 4mph and 5 mph respectively. (McCoy, Bonneson, & Kollbaum, 1995)

Garber and Patel (1995) examined the effectiveness of the CMS integrated with radar a radar unit at seven temporary work zones on interstate highways in Virginia. The results based on statistical tests indicate that the CMS with radar significantly reduced the speeds of speeding drivers. The results also indicated that the CMS with radar reduces the probability of speeding at work zones and that this long-term effectiveness appeared to last for at least 7 weeks. Garber and Srinivasan further examined the effectiveness of fixed overhead Changeable Message Sign

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<sup>33</sup> FARS (Fatality Analysis Reporting System), [www-fars.nhtsa.dot.gov](http://www-fars.nhtsa.dot.gov)

<sup>34</sup> <http://www.bls.gov/opub/mlr/2013/article/pdf/an-analysis-of-fatal-occupational-injuries-at-road-construction-sites-2003-2010.pdf>

(CMS) systems programmed to display “You Are Speeding Slow Down” to warn drivers when their speed exceeded the maximum safe speed. (Garber & Srinivasan, 1998)

Bloch (1998) examined the effectiveness of two forms of automated motor-vehicle speed control, speed display boards and photo-radar. The study was conducted on school zones as well as residential and commercial areas. The results of a statistical analysis of the volume and speed data, collected over 4 weeks at each location, indicated that both devices significantly reduce vehicle speeds about 5 mph. Significant reductions in the percentages of speeders traveling 10 mph or more over the posted limit were observed.

Casey and Lund has pointed out, engineering treatments most effectively influence speed compliance when combined with local law enforcement by patrol vehicles (Casey & Lund, 1993; Streff, 1995). Chang et al. (2005) investigated the effectiveness of radar speed signs by conducting speed studies before, during, and after installation on traffic speeds along collector and arterial roadways in King County of Washington State.

Pesti and McCoy (2001) evaluated the long-term effectiveness of Speed Monitoring Displays (SMDs) in a rural interstate work zone in Nebraska. The improvements for passenger were 3 to 4 mph for mean speed, 2 to 7 mph reduction for 85th percentile speed, and 20% to 40 % of vehicles complying rate with the 55-mph speed limit and the 60-mph speed threshold. A 2-mph reduction in both mean and 85th percentile speed was observed for other vehicles (McCoy P. , 2000).

The City of Garden Grove, California, examined the impacts on 85th percentile speeds that radar speed feedback signs had in five school zones. Significant reduction in the 85th percentile speeds from 5.6 to 22.3 percent was reported in this study. The mean speeds were observed to decrease by 1 to 7 mph.(City of Garden Grove, 2003). Dalton (2005) analyzed crash data, public complaints about speeding and speed survey data, which is done once every seven years for each segment of roadway, in city of Fremont, California to identify locations where speeding is a chronic safety concern for users on roadways. The radar speed trailer was deployed in different streets adjacent to schools throughout the City of Fremont an average of 15 days per month.

The effectiveness of the Driver Feedback Signs (DFS) at five school zones were evaluated using a combination of factors including vehicle speeds, proximity of school to capture pedestrian traffic, pedestrian traffic, average daily traffic (ADT), proportion of pedestrian conflicts, Braking driver, and citizen complaints. It was reported that there were significantly higher proportion of braking drivers at the five school locations after the DFS were installed. The research team recommended that the DFS should not be deployed at all school locations. The DFS may be deployed only in school zones where a speed study indicates that the average vehicle speed is 35 mph or greater (KLS Engineering, 2006).

Hallmark et al. (2007) examined various traffic-calming treatments for major routes in small communities in Iowa. Results indicated that significant reduction in the 85th percentile speeds from 1 to 4 mph was reported in this study. The mean speeds were observed to decrease by 1 to

5.2 mph depending on the site. Teng et al. (2009) evaluated speed monitoring display trailers for interstate and principal arterial work zones in Las Vegas, Nevada. More than one speed trailer was recommended for additional speed reduction.

The detailed review results are provided [Table 3](#) in Appendix.

## 3 EXISTING FEDERAL AND STATE GUIDANCE

### 3.1 Federal guidance

Guidance specific to radar speed signs is provided in sections 2B.13 and chapter 2L of the 2009 version of the MUTCD.

#### **Section 2B.13 Speed Limit Sign Guidance:**

*“If a changeable message sign displaying approach speeds is installed, the legend YOUR SPEED XX MPH or such similar legend should be displayed. The color of the changeable message legend should be a yellow legend on a black background or the reverse of these colors.”*

#### **Section 2L.01 Description of Changeable Message Signs Guidance:**

*“Blank-out signs that display only single-phase, predetermined electronic-display legends that are limited by their composition and arrangement of pixels or other illuminated forms in a fixed arrangement...”*

#### **Section 2L.02 Applications of Changeable Message Signs Guidance:**

*“State and local highway agencies should develop and establish a policy regarding the display of the types of messages provided in Paragraph 2. When changeable message signs are used at multiple locations to address a specific situation, the message displays should be consistent along the roadway corridor and adjacent corridors, which might necessitate coordination among different operating agencies.”*

#### **Section 2L.03 Legibility and Visibility of Changeable Message Signs Guidance:**

*“Changeable message signs used on roadways with speed limits of 55 mph or higher should be visible from 1/2 mile under both day and night conditions. The message should be designed to be legible from a minimum distance of 600 feet for nighttime conditions and 800 feet for normal daylight conditions. When environmental conditions that reduce visibility and legibility are present, or when the legibility distances stated in the previous sentences in this paragraph cannot be practically achieved, messages composed of fewer units of information should be used and consideration should be given to limiting the message to a single phase (see Section 2L.05 for information regarding the lengths of messages displayed on changeable message signs).”*

#### **Section 2L.04 Design Characteristics of Changeable Message Signs Guidance:**

*“Except in the case of a limited-legend CMS (such as a blank-out or electronic-display changeable message regulatory sign) that is used in place of a static regulatory sign or an activated blank-out warning sign that supplements a static warning sign at a separate location, changeable message signs should be used as a supplement to and not as a substitute for conventional signs and markings...”*

**Section 2L.05 Message Length and Units of Information Guidance:**

*“The maximum length of a message should be dictated by the number of units of information contained in the message, in addition to the size of the CMS. A unit of information, which is a single answer to a single question that a driver can use to make a decision, should not be more than four words.”*

**Section 2L.06 Installation of Permanent Changeable Message Signs Guidance:**

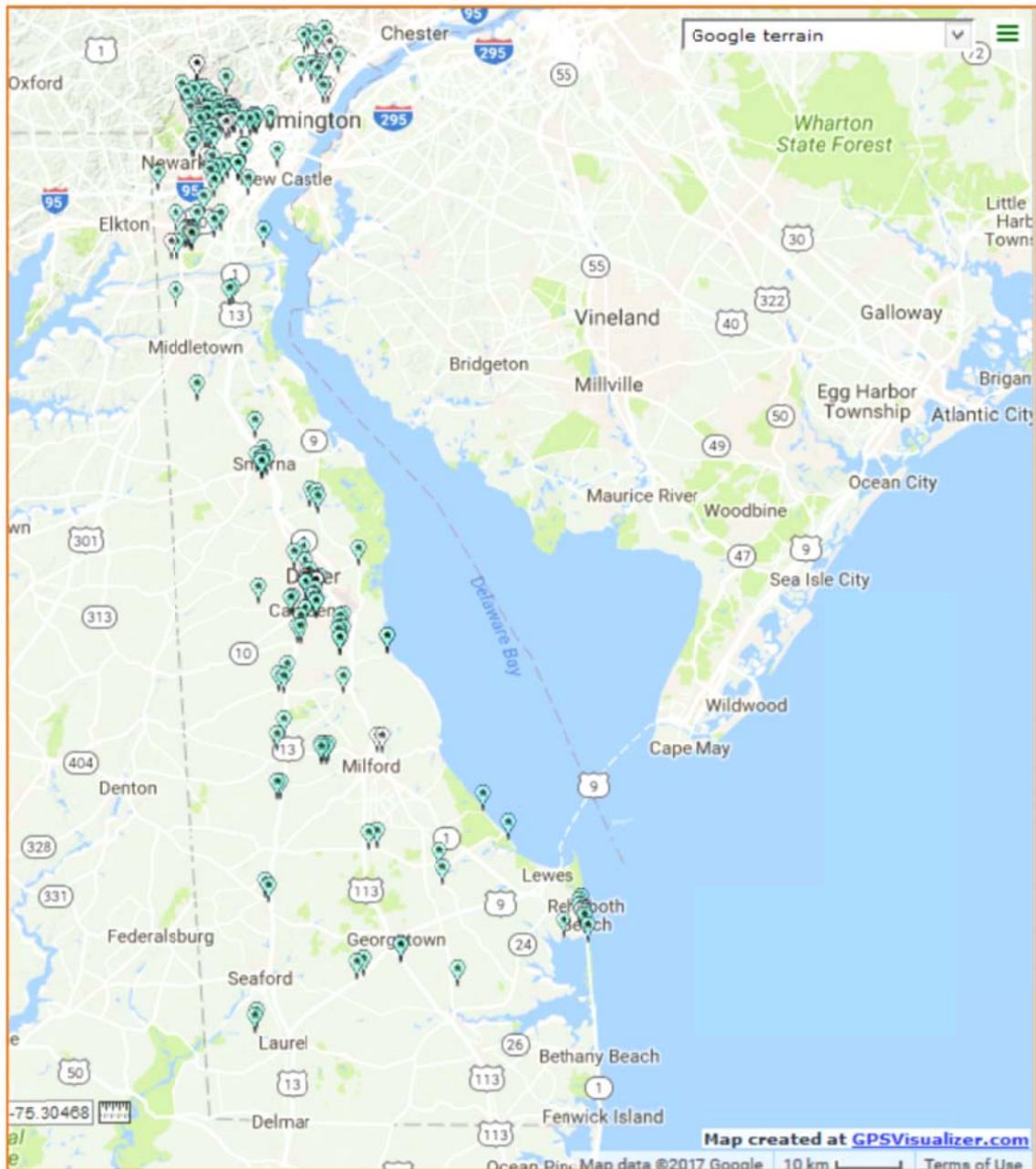
*“A CMS that is used in place of a static sign (such as a blank-out or variable legend regulatory sign) should be located in accordance with the provisions of Chapter 2A. The following factors should be considered when installing other permanent changeable message signs...”*

**3.2 Delaware guidance**

The primary and most beneficial locations for Radar Speed Signs remain on suburban development streets, and other residential streets, where the speed limit does not exceed 25 mph. On state owned roads outside of municipalities, through the CTF process, DeIDOT will install Radar Speed Signs on these types of roads. The locations of radar speed signs in Delaware are shown in [Figure 5](#).

The installation of Radar Signs on non-residential roads, with speeds posted above 25 miles per hour, is discouraged. However, if funded through the CTF process, DeIDOT will purchase and install these signs upon legislative request.

Freeways and major arterials are not appropriate for the long term placement of Radar Speed Signs. Short term use might be feasible in cases such as during a construction project.



*Figure 5: Radar speed sign in Delaware*

### 3.3 Summary of guidance in other states

Veneziano et al. (2010) summarized the guidance in other states as follows:

- ⚠ Does the 85th percentile speed exceed the posted speed limit by at least 5 mph, or by at least 3 mph in a school zone?

- ◆ Is the area within 500 yards of a major pedestrian generator (e.g. school, park, library, senior center, office building)?
- ◆ Is the area primarily a residential area or a heavily traveled pedestrian area?
- ◆ Is the posted speed limit 35 mph or less?
- ◆ Is the work zone currently in operation and observations suggested that the 85% speed at a location within the work zone exceed the posted speed limit by at least 5 mph?
- ◆ Will workers be located adjacent to the open traffic lane.
- ◆ Are there hazardous roadway conditions, such as a temporary unusually tight curve, or a rough road surface, requiring extra driving precaution?
- ◆ Are there other Dynamic Speed Display Signs along the route encountering the speed transition, within 5 miles in either direction?

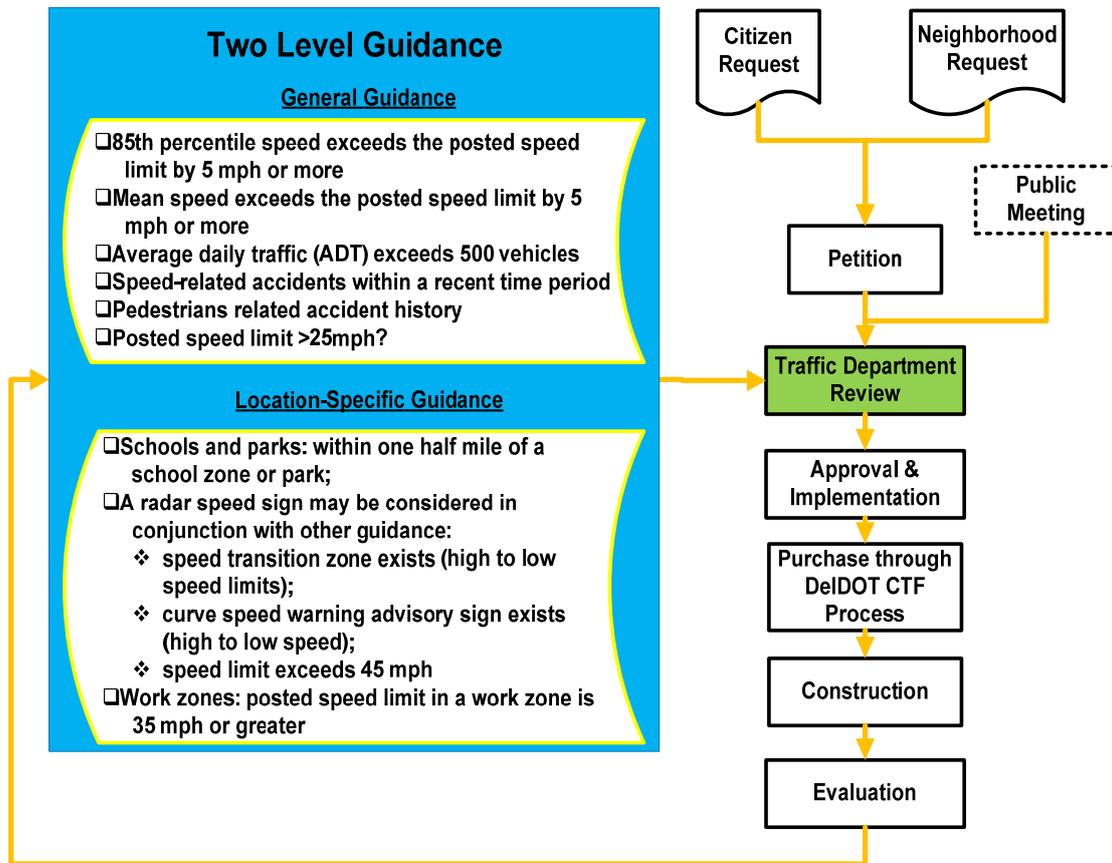
## 4 CONCLUSIONS AND RECOMMENDATIONS

### 4.1 Conclusions

The following conclusions are made based on the literature search described in [Table 3](#):

The goal of our research was to provide comprehensive literature and current best practices to establish criteria regarding in what roadway locations/traffic conditions are radar speed signs most effective. Directed by this goal, the research team has summarized the results of tasks above, and incorporate the resultant insights and findings into the final report, which describes how to evaluate and quantify the effectiveness of radar speed sign. In other words, whether or not these signs have been successful in calming neighborhood traffic? So that the recommended solution will best meet the safety and user needs of a particular area. While radar speed signs, particularly trailer-based and portable sign-mounted versions, can be deployed anywhere, the primary applications have been documented in the literature: private communities, school zones, work zones and police enforcement.

The method developed in this project is intended to be used for planning and initial design ideas for traffic engineering and city or regional planners who are plagued by a road in urban or rural area with recurring safety problems. A two level guidance framework is shown in [Figure 6](#).



*Figure 6: Two level guidance on determine the location of the radar speed signs*

## 4.2 Recommendation and directions for future work

The following recommendations are made for future studies:

The purpose of this research is to provide transportation planners and engineers with guidance for the deployment of radar speed signs which could be employed in a systematic manner to restore and maintain a balance between mobility and neighborhood quality of life. In order to maximize the cost-effectiveness of the resources available to this investigation, the project team has suggested future research: (a) a further research is needed to explore the state of art and best practice about assessing the safety impact of radar speed sign for the State of Delaware; (b) safety gains versus improvement costs can be expressed as benefit/cost ratios for each alternative to determine a preferred solution; (c) A field study of the effectiveness of radar speed signs in reducing traffic speeds under various locations and conditions as determined by Phase I of this study (literature search). Study variables should include location installed (residential subdivision, local road, collector road), speed limit (25 to 45 MPH), and effectiveness over time. The expected end result will be actionable recommendations that will outline the

options available to DelDOT. To evaluate the effectiveness of these signs, speed studies will be conducted before, during, and after installation.

Several case studies will be provided to explain how these radar speed signs benefit our neighborhoods. The analysis in these case studies is based on data obtained from the selected sites (see [Figure 7](#) and Appendix C).

It was necessary to establish criteria regarding in what roadway locations/traffic conditions are radar speed signs most effective. Also, it is important that the proposed development of radar speed sign be evaluated before they become available for use to ensure their quality. The evaluation will make sure that the tool that has been created is useful to the transportation community and achieves its intended objectives.

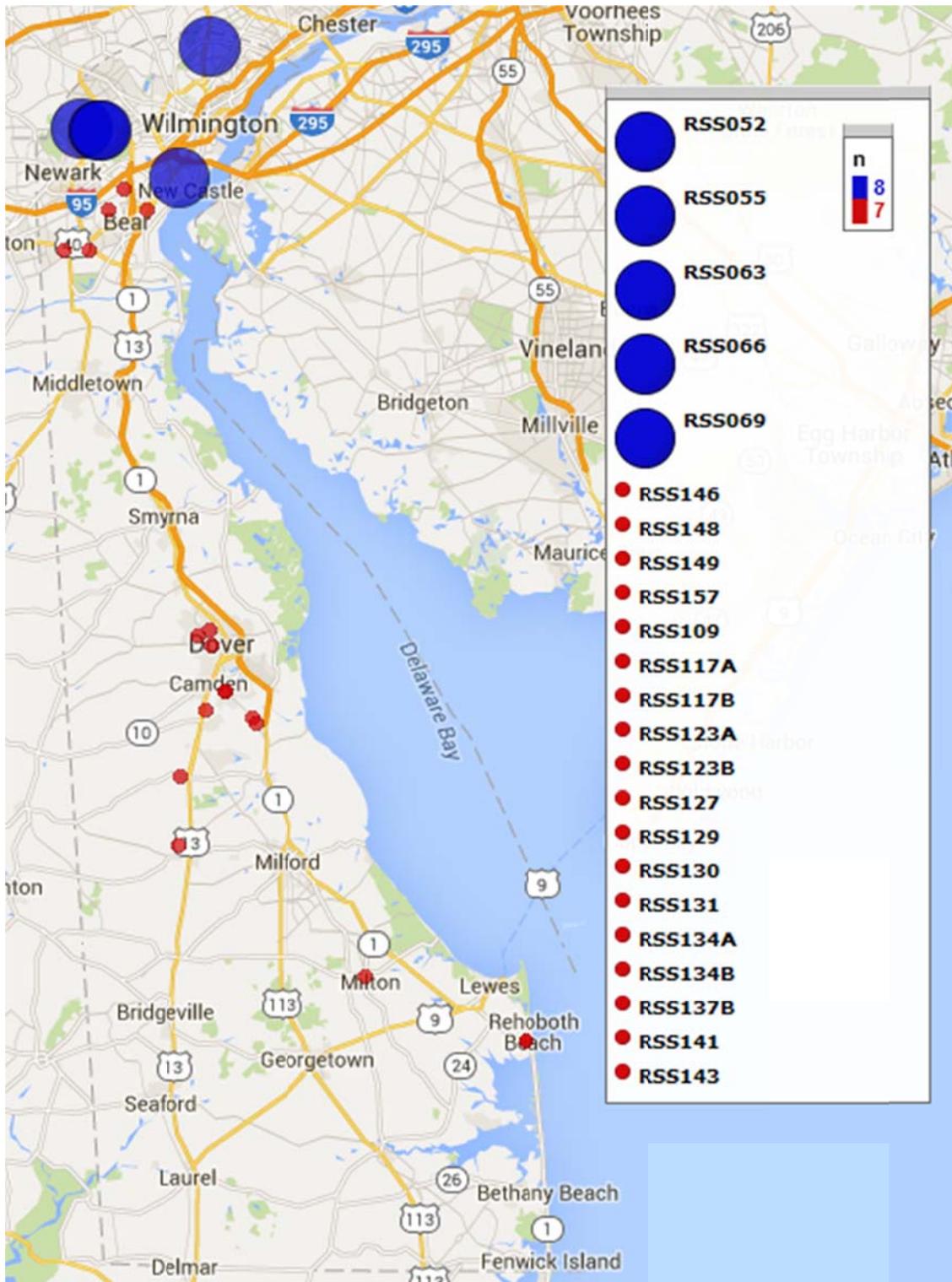


Figure 7: Target sites for case study

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APPENDICES

Appendix A: Summary of past research conducted to radar speed signs

Table 3: Summary of past research conducted to radar speed signs

Basic Info.				Road Info.				Radar Speed Sign Info.						Traffic Info.						Study Periods (Week)			Evaluations /Findings	
Study	Year	State	Locale	Road Type	Location Feature	Street Conditions	Accidents	Manufacturer	Sign Type	Power Sources	Cost (\$)	Year Signs Installed	Modes	ADT	Speed Limit (Mph)	85th Percentile Speed	Speed Thresholds	Average Speed Change	STD	Sample Size	Before Study	Study		After Study
Streff et al.	1995	MI	High speed freeway	Freeway	Construction zone	Police presence	-	-	-	-	-	-	-	-	10	-	-	1.5 mph	-	-	-	-	-	Drone radar with police patrols need be served a speeding countermeasure at locations where high speed trucks are a problem
Carlson et al.	2000	TX	Childress	Four-lane divided highway	Work zone	-	-	Stalker DSR SPEEDGUARD Trailer, Model 3200	-	Trailer	-	-	-	7,000 (20% heavy trucks)	55	-	-	-	-	-	-	0.5	-	Reduced violation rates: Cars - 5.5 - 7.6% Trucks - 9.7 - 25%
Maze et al.	2000	IA, KS, MO, and NE	-	-	Midwest Smart Work Zone	-	-	-	Portable	Solar Power	-	1998	Speed guard radar	-	-	-	-	-	-	-	-	-	-	Wizard CB alert system, speed monitor display, removable orange rumble strips, safety warning system were evaluated
Tribbett et al.	2000	MT	I-5	Highway	Truck speeds and non-truck speeds	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Dynamic curve warning system is most effective	
Pesti and McCoy	2001	NE	Lincoln	Freeway	Work zone	-	-	Speedguard by Applied Concepts, Inc.	Portable, self-contained trailer	Powered by three 12 VDC heavy duty marine batteries	-	1999	YOUR SPEED XX; Flashing arrow	38,000	55	62	60, 65	2 mph reduction	4	2,746	0.7	5	1	3 to 4 mph reduction for mean speed, 2 to 7 mph reduction for 85th percentile speed, and 20% to 40 % of vehicles complying with the 55-mph speed limit threshold

Basic Info.				Road Info.				Radar Speed Sign Info.						Traffic Info.						Study Periods (Week)			Evaluations /Findings					
Study	Year	State	Locale	Road Type	Location Feature	Street Conditions	Accidents	Manufacturer	Sign Type	Power Sources	Cost (\$)	Year Signs Installed	Modes	ADT	Speed Limit (Mph)	85th Percentile Speed	Speed Thresholds	Average Speed Change	STD	Sample Size	Before Study	Study		After Study				
McCoy et al.	2001	IA, KS, MO, and NE	I-80 eastbound near Lincoln, Nebraska	Rural freeway	On-ramp traffic	Signalized	-	-	Portable	Solar Power	-	2000	-	-	55	-	60 and 65-mph	-	-	-	-	2	2	The uniformity of speeds, and increasing speed-limit compliance increased				
Pesti et al.	2001	IA, KS, MO, and NE	I-80 near Lincoln, Nebraska	Rural highway	Two work zones	-	-	-	Speed trailers	-	-	-	-	-	-	-	60 and 65-mph	-	-	-	-	5	1	Greater speed reduced and compliance increased				
City of Garden Grove	2003	CA		Street	Five school zones		Crash data was analyzed	-	-	-	-	2003	YOUR SPEED XX	8,000 to 29,200	35 - 40	25 - 44	-	-	-	-	20	12	4	Significant reduction in the 85th percentile speeds from 5.6 to 22.3 percent				
Ullman & Rose	2003	TX	College station		Multiple zones <sup>35</sup>	Signalized intersection	-	-	-	-	-	-	Your speed xx		-	-	-	-	-	-	-	16	-	Average speed decreased by 5 - 9 mph				
Osmer et al.	2003		New Zealand	Street	200 meters around School zone	-	-	-	Speed trailers	Electronic	-	-	-	-	-	-	-							17 schools	-	-	-	Speed trailers can slow traffic, make drivers more aware of their speeds, and can provide an educational tool for schools and their communities.
Wang et al.	2003			highway	Work zone	Various lighting			Changeable message signs																			Radar significantly reduced the vehicle speeds in the immediate vicinity of the sign
Wong et al.	2004		Hong Kong				Cluster data were																					Evaluation of the overall effects of the road safety strategies

<sup>35</sup> A school speed zone, two transition speed zones in advance of a school speed zone, two sharp horizontal curves, and two approaches to signalized intersections on high-speed roadways

Basic Info.				Road Info.				Radar Speed Sign Info.						Traffic Info.						Study Periods (Week)			Evaluations /Findings			
Study	Year	State	Locale	Road Type	Location Feature	Street Conditions	Accidents	Manufacturer	Sign Type	Power Sources	Cost (\$)	Year Signs Installed	Modes	ADT	Speed Limit (Mph)	85th Percentile Speed	Speed Thresholds	Average Speed Change	STD	Sample Size	Before Study	Study		After Study		
							analyzed.																		can be needed.	
Dalton	2005	CA	Fremont	Street	2 school zone and 4 residential streets	-	-	Fortel Traffic Inc.	Permanent	Solar Power	-	2001	YOUR SPEED XX	-	25	32	25	5-7 mph reduction	-	-	-	8	-	-	85th percentile travel speeds decreased by a range of 5 mph to 7 mph during the AM (6:30-10:00) and PM (2:00-7:00) peak hours Monday thru Fridays	
Saito, M., & Ash, K. et al.	2005	UT	School communities	Street	Reduced-speed school zones	-	-	-	Speed trailers	-	-	-	-	-	10	-	-	-	-	4 schools	-	-	-	-	Effective traffic control devices can improve speed-limit compliance in school zones	
Ullman, G. et al.	2005	-	-	-	School zone	-	-	-	Dynamic speed display signs (DSDS)	-	-	-	-	-	9	-	-	4 mph	-	-	-	-	-	-	DSDSS can be effective at reducing speeds in permanent application	
KLS Engineering	2006	DC	DC	Street	Five school zones	-	260 crashes occurred within the school zone in 5 years	-	-	-	-	2006	Your speed xx	10,000 - 30,000	35	-	-	Reduction is only significant at just over 25 % of the time	-	-	-	-	-	-	-	The DFS should not be deployed at all school locations. The DFS may be deployed only in school zones where a speed study indicates that the average vehicle speed is 35 mph or greater

Basic Info.				Road Info.				Radar Speed Sign Info.						Traffic Info.						Study Periods (Week)			Evaluations /Findings		
Study	Year	State	Locale	Road Type	Location Feature	Street Conditions	Accidents	Manufacturer	Sign Type	Power Sources	Cost (\$)	Year Signs Installed	Modes	ADT	Speed Limit (Mph)	85th Percentile Speed	Speed Thresholds	Average Speed Change	STD	Sample Size	Before Study	Study		After Study	
Hallmark	2007	IA	-	Highway	-	Transition zones	-	-	-	-	-	-	-	200-2300	55	-	-	-	-	-	-	-	-	-	Average speed reduction 1 month - 1 mph 3 months - 0 mph 9 months - 1 to 5.2 mph 1 year - 1 to 3.4 mph  85th percentile speeds reduction: 1 month - 2 mph 3 months - 1 mph 9 months - 1 to 4 mph 1 year - 2 to 3 mph
Mattox, J. et al.	2007	SC		Highway	Work zone crash	Signalized	Mean speed reductions	-	-	-	-	2005	Speed-activated	3.200 to 9.700	-	-	-	-	-	-	-	-	-	-	This average reduction improved to 4.1 mph
Sorrell, M. et al.	2007	SA	-	-	Work zones	-	-	-	Changeable message signs	-	-	-	-	4.800 to 16.100	-	-	-	-	-	-	-	-	-	-	The most effective speed reduction message sequence applied
Woo et al.	2007								speed-monitoring display (SMDs)	electron			board with speed cameras											presence of SMDs could alert drivers of enforcement cameras downstream, making speeders adjust their speed to comply with the limit.	
Walter et al.	2008		London			Free flow traffic			Speed indicator devices				YOUR SPEED XX	25-35 mph				1.4-mph		10 sites	1	3	2	mean vehicle speeds returned to pre-SID levels by the end of the first week	
Zech et al.	2008	NY	I-90	highway	work zones				changeable message					5.300-10.800	45-mph					180,000 vehicles				1.8- 2.7 km/h increased in the driving lane and 0.3-	

Basic Info.				Road Info.				Radar Speed Sign Info.					Traffic Info.						Study Periods (Week)			Evaluations /Findings				
Study	Year	State	Locale	Road Type	Location Feature	Street Conditions	Accidents	Manufacturer	Sign Type	Power Sources	Cost (\$)	Year Signs Installed	Modes	ADT	Speed Limit (Mph)	85th Percentile Speed	Speed Thresholds	Average Speed Change	STD	Sample Size	Before Study		Study	After Study		
									sign (CMS)																3.2 km/h increased in the passing lane.	
Teng et al.	2009	LV NV	-	-	Work zones	Free-flow speed	-	-	Speed trailers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	More than one speed trailer was recommended for additional speed reduction	
Veneziano et al.	2010	CA							speed trailers	solar power		2006	YOUR SPEED XX									4				
Wang et al.	2011	KS			work zones				portable plastic rumble strip									6.8 -mph		2 sites					6.8 mph reduction for car and 6.2 mph mean speed reduction for trucks, 80 percent of truck drivers activated their brakes when they approached sign.	
Wasson et al.	2011	IN	suburban Indianapolis		work zones				13 Bluetooth probe data acquisition stations	Bluetooth					55-mph			5 -mph							compliance techniques upperly bound enforcement activity on work zone speeds	
O'Brien et al.	2012	NC	School Route	sidewalk	school zones	-	-	-	permanent	-	-	-	YOUR SPEED XX	-	-	-	-	1-mph	-	-	-	48	-	-	Speed compliance in school zones improved	
Roberts, C., & Smaglik, E. et al.	2012	AZ	-	highway	-	-	work zone fatality	-	-	-	-	-	Your Speed XX	-	5, 10, 15, 20,25-mph	-	-	-	-	-	-	-	-	-	-	The speed limit decreased by one-fourth
Santiago-Chaparro et al.	2012	-	-	-	-	-	-	-	Speed feedback signs (SFS)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A speed reduction over a segment of road achieved	

Basic Info.				Road Info.				Radar Speed Sign Info.						Traffic Info.						Study Periods (Week)			Evaluations /Findings		
Study	Year	State	Locale	Road Type	Location Feature	Street Conditions	Accidents	Manufacturer	Sign Type	Power Sources	Cost (\$)	Year Signs Installed	Modes	ADT	Speed Limit (Mph)	85th Percentile Speed	Speed Thresholds	Average Speed Change	STD	Sample Size	Before Study	Study		After Study	
Qi, Y.. et al.	2013	NY	-		work zone	-	rear-end crashes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Frequency of rear-end crashes related to work zones for capacity
Saha et al.	2013	-	-	-	-	-	-	-	-	Hybrid Static-Dynamic	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Hybrid static-dynamic signs can applied as A worldwide state range
Ardeshiri	2014	MD	Baltimore	Street	-	-	-	-	-	-	-	-	-	-	25, 35, and 45	-	-	-	-	-	-	1.5	3	-	
Toy et al.	2014		Great Britain	-	-	-	-	-	-	-	-	-	-	-	20-mph	-	-	10 -mph	-	-	-	-	-	-	pragmatists would move en-masse for signs application
Wang, M., et al.	2014		Taiwan	suburban and rural freeway					automatic speed photo enforcement (SPE) devices	photo												3	2	No enough evidence to determine whether the fixed SPE devices would increase the risk of crashes	
Rahman et al.	2015	-	School communities	sidewalk	School zone	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	vehicle speed is significantly lower and compliance is significantly higher in high saturation school zones
Strawderman et al.	2015	-	School communities	-	School zone	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	speeding was more prevalent in the early mornings and during the weekends
Tapp et al.	2015		Great Britain	-	-	-	-	-	-	-	-	-	-	-	20-mph	-	-	-	-	-	-	-	-	-	The incidence of these effects and their implications of speed limits

Basic Info.				Road Info.				Radar Speed Sign Info.						Traffic Info.						Study Periods (Week)			Evaluations /Findings		
Study	Year	State	Locale	Road Type	Location Feature	Street Conditions	Accidents	Manufacturer	Sign Type	Power Sources	Cost (\$)	Year Signs Installed	Modes	ADT	Speed Limit (Mph)	85th Percentile Speed	Speed Thresholds	Average Speed Change	STD	Sample Size	Before Study	Study		After Study	
Zhao, X., et al.	2015	CHINA			School zones				traffic control devices						30-mph										appropriateness of installation of certain devices can be statistically verified by Traffic Control Device Selection Model (TCDSM)
Mekker et al.	2016	IN	I- 65	highway	upstream of a work zone	free-flowing traffic conditions	-	-	variable speed limit (VSL) signs	-	-	-	-	-	70, 60, 55, 55-mph	-	-	-	-	-	-	-	-	-	4% of cars and 10% of trucks complied with the 55-mph speed limit
Williamson, M. et al.	2016	IL	Southern Illinois University campus	Street		AM, PM, peak time and Midday	crash data were analyzed													820 drivers				radar speed display signs in a university environment can help driver accessing a university campus core and effect driver behavior.	

## Appendix B: Radar speed sign location in Delaware

Latitude	Longitude	Name	Description
38.7055556	75.083336	RSS001A	Location: Robinson Drive at Fisher Street Legislator: Schwartzkopf, Hocker Estimate ID: 11/1/1950 GPS coordinates: 38.705556,-75.083336
38.7067778	75.081631	RSS001B	Location: Robinson Drive at Blackstone Avenue Estimate ID: 11/1/1950 Legislator: Schwartzkopf, Hocker GPS coordinates: 38.706778,-75.081631
39.1312167	75.516006	RSS002A	Location: Beechwood Avenue just west of Upland Avenue Estimate ID:11/1/1951 Legislator: Bennett, A 16TH SEN, 32ND REP GPS coordinates: 39.131217,-75.516006
39.1311472	75.516642	RSS002B	Location: Beechwood Avenue just west of Upland Avenue Estimate ID: 11/1/1951 Legislator: Bennett, A 16TH SEN, 32ND REP GPS coordinates: 39.131147,-75.516642
39.1357451	75.537185	RSS003 - general area	General location based on location from spreadsheet Location: Estimate ID: 11-130 Legislator: Bennett,A 17TH SEN, 32ND REP GPS coordinates:
39.7604778	75.499022	RSS004	Location: Lore Avenue at River Road (approximately 90 feet west of River Road) Estimate ID: 11-155 Legislator: Heffernan 1ST SEN, 6TH REP GPS coordinates: 39.760478,-75.499022
39.1328389	75.517083	RSS005A	Location: Highview Avenue between South State Street and Rodric Drive Estimate ID:11-159 Legislator: Bennett,A 16TH SEN, 32ND REP GPS coordinates: 39.132839,-75.517083
39.1331778	-75.516072	RSS005B	Location: Highview Avenue at Rodric Drive Estimate ID:11-159 Legislator: Bennett,A 16TH SEN, 32ND REP GPS coordinates: 39.133178,-75.516072
39.7872722	75.712989	RSS006A	Location: Southwood Road approximately 70' west of Cricket Lane Estimate ID: 11-257 Legislator: Smyk 12TH REP, 22ND REP GPS coordinates: 39.787272,-75.712989

39.7873083	75.711056	RSS006B	Location: Southwood Road between David Drive and Sassafras Drive Estimate ID:11-257 Legislator: Smyk 12TH REP, 22ND REP GPS coordinates: 39.787308,-75.711056
38.9310361	75.417614	RSS007A (EB)	Location: Woodshaven Estimate ID: 11-565 Legislator: Peterman, Simpson 18TH SEN, 33RD REP GPS coordinates: 38.931036,-75.417614
38.9307833	75.410017	RSS007B (WB)	Location: NE 10th Street between Pecan Avenue and NE Front Street Estimate ID: 11-565 Legislator: Peterman, Simpson 18TH SEN, 33RD REP GPS coordinates: 38.930783,-75.410017
39.7263083	75.708581	RSS008A (EB)	Location: Sheldon Drive Estimate ID: 11-606 Legislator: Ramone 4TH SEN, 22ND REP GPS coordinates: 39.726308,-75.708581
39.7147472	75.664378	RSS009A (EB)	Location: Telegraph Road east of its intersection with Old Capitol Trail Estimate ID: 11-965 Legislator: Williams,K 19TH REP GPS coordinates: 39.714747,-75.664378
39.7153528	75.660228	RSS009B (WB)	Location: Telegraph Road just west of St. James Church Road Estimate ID: 11-965 Legislator:Williams,K 19TH REP GPS coordinates: 39.715353,-75.660228
39.8159583	-75.493928	RSS010 (SB)	Location: Jamaica Drive between Nashua Drive and Riviera Lane Estimate ID: 11-973 Legislator: Short,B 7TH REP GPS coordinates: 39.815958,-75.493928
38.719	75.086931	RSS011A	Location: Columbia Avenue at 4th Street Estimate ID:11-1007 Legislator: Hocker, Schwartzkopf 14TH REP GPS coordinates: 38.719,-75.086931
38.7221667	-75.083575	RSS011B	Location: Columbia Avenue at 2nd Street Estimate ID:11-1007 Legislator: Hocker, Schwartzkopf 14TH REP GPS coordinates: 38.722167,-75.083575
39.7847972	75.511306	RSS012	Location: Baynard Blvd Estimate ID:12-112 Legislator: Heffernan 23RD REP GPS coordinates: 39.784797,-75.511306
39.128567	75.536078	RSS013A	Location: David Hall Road Estimate ID: 12-139 Legislator: Bennett,A 32ND REP GPS coordinates: 39.128567,-75.536078
39.128024	75.533228	RSS013C	Location: Nathaniel Mitchell Road Estimate ID: 12-139 Legislator: Bennett,A 32ND REP GPS coordinates: 39.128024, -75.533228

39.129883	75.532586	RSS013D	Location: Nathaniel Mitchell Road Estimate ID: 12-139 Legislator: Bennett,A 32ND REP GPS coordinates: 39.129883, -75.532586
39.128485	75.535302	RSS013E	Location: Gunning Bedford Drive Estimate ID: 12-139 Legislator: Bennett,A 32ND REP GPS coordinates: 39.128485, -75.535302
39.130632	75.533922	RSS013F	Location: Gunning Bedford Drive Estimate ID: 12-139 Legislator: Bennett,A 32ND REP GPS coordinates: 39.130632, -75.533922
39.127562	75.536961	RSS013G	Location: John Clark Road Estimate ID: 12-139 Legislator: Bennett,A 32ND REP GPS coordinates: 39.127562, -75.536961
39.130272	75.537082	RSS013H	Location: John Clark Road Estimate ID: 12-139 Legislator: Bennett,A 32ND REP GPS coordinates: 39.130272, -75.537082
39.7097371	75.690958	RSS014 - general area	RSS0014 - Burning Bush Drive Radar Speed signs weren't visible on google street view of Bing street view
39.5609222	-75.75625	RSS015A	Location: Brennan Boulevard west of Sarah Circle Date of funding: 2012 Legislator: Hall-Long, Jaques 10TH SEN, 27TH REP Posted speed limit: 35 MPH Travel direction: EB GPS coordinates: 39°33'39.32"N,75°45'22.50"W
39.5611972	75.743883	RSS015B	Location: Brennan Boulevard east of Shawn Lane Date of funding: 2012 Legislator: Hall-Long, Jaques 10TH SEN, 27TH REP Posted speed limit: 35 MPH Travel direction: WB GPS coordinates: 39°33'40.31"N,75°44'37.98"W
39.578115	75.722848	RSS016A	Location: Mansion Farm Road Estimate ID: 12-427 Legislator: Poore 12TH SEN GPS coordinates: 39.578115,-75.722848
39.57835	75.724162	RSS016B	Location: Mansion Farm Road Estimate ID: 12-427 Legislator: Poore 12TH SEN GPS coordinates: 39.578350,-75.724162
39.57791	75.728977	RSS016C	Location: Mansion Farm Road Estimate ID: 12-427 Legislator: Poore 12TH SEN GPS coordinates: 39.577910,-75.728977
39.577588	75.731637	RSS016D	Location: Mansion Farm Road Estimate ID: 12-427 Legislator: Poore 12TH SEN GPS coordinates: 39.577588,-75.731637
39.6842917	75.638442	RSS017	Location: Seneca Drive between Apache Court and Lenni Court Estimated ID:12-442 Legislator: Peterson, Bentz 9TH SEN GPS coordinates: 39.684292,-75.638442

39.6902056	75.719247	RSS018	Location: Hillcroft Road between North Dyllwin Road and South Dyllwin Road Estimated ID:12-444 Legislator: Peterson 9TH SEN GPS coordinates: 39.690206,-75.719247
39.6728333	75.695069	RSS019	Location: Elm Drive between Salem Church Road and Robert Oakes Drive Estimated ID: 12-445 Legislator: Peterson 11TH SEN GPS coordinates: 39.672833,-75.695069
39.7236917	75.662381	RSS020 - Radar Speed Sign has been removed	It appears that the radar speed sign has been removed. It shows up in the 2012 street view but not the 2015 street view in google maps Location: Muggleton Road Estimate ID: 12-446 Legislator: Peterson 9TH SEN GPS coordinates: 39.723692,-75.662381
39.7244222	75.662997	RSS021	Location: Griffin Drive from Limestone road to Kirkwood Highway Estimated ID: 12-447 Legislator: Peterson 9TH SEN, 21ST REP GPS coordinates: 39.724422,-75.662997
39.6977194	75.716997	RSS022	Location: Delaplane Avenue between Waycross Road and North Place Estimated ID:12-448 Legislator: Peterson, Ramone 9TH SEN, 21ST REP GPS coordinates: 39.697719,-75.716997
39.7324278	75.677289	RSS023	Location: Hopkins Drive between Carousel Court and Hopkins Drive Estimated ID: 12-458 Legislator: Peterson, Ramone 9TH SEN, 21ST REP GPS coordinates: 39.732428,-75.677289
39.696725	75.683533	RSS024	Location: Tamara Circle at Hull Avenue Estimated ID: 12-460 Legislator: Bentz, Peterson 9TH SEN, 21ST REP GPS coordinates: 39.696725,-75.683533
39.7570889	75.718719	RSS026	Location: Jupiter Road at Saturn Drive (212 Jupiter Road) Estimated ID: 12-668 Legislator: Sokola 8TH SEN GPS coordinates: 39.757089,-75.718719
39.1704806	75.449869	RSS027	Location: Bayside Drive between South Little Creek and North Little Creek Estimated ID: 12-675 Legislator: Bonini, Carson, Bushweller, Bennett,A 28TH REP GPS coordinates: 39.170481,-75.449869

39.7328556	75.658833	RSS028 - didn't show up in streetview	Location: Hartley Place between Milltown Road and Eric Drive Estimated ID: 12-783 Legislator: Smyk, Sokola 7TH SEN, 19TH REP GPS coordinates: 39.732856,-75.658833 Note: Didn't show up in Bing Maps or Google Earth streetview
39.7222861	75.620994	RSS030A	Location: Kiamensi Road at Cedar Avenue Estimated ID:12-1061 Legislator: Blevins, Williams,K, Peterson 7TH SEN, 9TH SEN, 19TH REP GPS coordinates: 39.722286,-75.620994
39.7222861	75.619736	RSS030B	Location: Kiamensi Avenue at Livingston Avenue Estimated ID:12-1061 Legislator: Blevins, Williams,K, Peterson 7TH SEN, 9TH SEN, 19TH REP GPS coordinates: 39.722286,- 75.619736
39.782125	75.514533	RSS031	Location: Weldin Road between Almond Avenue and Butler Avenue Estimated ID: 12- 1088 Legislator: Heffernan 5TH SEN, 6TH REP GPS coordinates: 39.782125,-75.514533
39.575285	75.723856	RSS033 - general area	Location: Honora Drive Estimate ID: 12-1250 Legislator: Poore 12TH SEN, 27TH REP GPS coordinates:
39.144125	75.532708	RSS034A	Location: Wyoming Avenue at Yearsley Drive Estimated ID:12-1263 Legislator: Lynn 17TH SEN, 31ST REP, 32ND REP GPS coordinates: 39.144125,-75.532708
39.1439917	75.527192	RSS034B	Location: Wyoming Avenue, west of Monroe Terrace Estimated ID: 12-1263 Legislator: Lynn 17TH SEN, 31ST REP, 32ND REP GPS coordinates: 39.143992,-75.527192
39.1343333	75.510969	RSS035A	Location: Kentland Avenue at Beechwood Avenue Estimated ID: 12-1265 Legislator: Bennett,A 16TH SEN, 32ND REP GPS coordinates: 39.134333,-75.510969
39.7599333	75.506906	RSS036A	Location: 123 Brandywine Boulevard Estimated ID: 13-7 Legislator: Heffernan 1ST SEN, 6TH REP GPS coordinates: 339.759933,- 75.506906
39.7307611	75.657722	RSS037	Location: Hartley Place (2431 Hartley Place) Estimated ID: 13-91 Legislator: Smyk, Sokola 7TH SEN, 19TH REP GPS coordinates: 39.730761,-75.657722

39.7515361	75.729375	RSS038	Location: Beech Hill Drive between Brookridge Lane and Running Brook Lane Estimated ID: 13-92 Legislator: Sokola 8TH SEN GPS coordinates: 39.751536,-75.729375
39.0589833	75.402739	RSS039A	Location: Main Street in front of Bowers Beech Fire Station Estimated ID: 13-197 Legislator: Bonini, Peterman 16TH SEN, 33RD REP GPS coordinates: 39.058983,-75.402739
39.7087278	75.689475	RSS040	Location: Meadowood Drive Estimate ID: 13-196 Legislator: Ramone, Peterson 9TH SEN, 21ST REP GPS coordinates: 39.708728,-75.689475
39.6844111	75.634931	RSS043	Location: Irouois Court Estimate ID: 13-343 Legislator: Bentz, Peterson 9TH SEN, 18TH REP GPS coordinates: 39.684411,-75.634931
39.7195056	75.614925	RSS044	Location: Burnside Blvd Estimate ID:13-342 Legislator: Williams,K, Peterson 7TH SEN, 9TH SEN, 13TH REP, 19TH REP GPS coordinates: 39.719506,-75.614925
39.572759	75.720697	RSS046A	Location: Rc Peoples Boulevard Estimate ID: 13-336 Legislator: Poore 12TH SEN, 27TH REP GPS coordinates: 39.572759, -75.720697
39.576699	75.719912	RSS046B	Location: Rc Peoples Boulevard Estimate ID: 13-336 Legislator: Poore 12TH SEN, 27TH REP GPS coordinates: 39.576699, -75.719912
39.1211417	75.612619	RSS047	Location: Quail Run Estimate ID: 13-356 Legislator: Paradee 15TH SEN, 29TH REP GPS coordinates: 39.121142,-75.612619
39.5023333	75.659475	RSS048A	Location: Bullen Drive Estimate ID: 13-395 Legislator: Hensley, Hall-Long, Simpson 9TH REP GPS coordinates: 39.502333,-75.659475
39.5051389	75.654933	RSS048B	Location: Bullen Drive Estimate ID: 13-395 Legislator: Hensley, Hall-Long, Simpson 9TH REP GPS coordinates: 39.505139, -75.654933
39.723262	75.670318	RSS049	Location: Lindell Boulevard Estimate ID: 13-429 Legislator: Ramone, Peterson 9TH SEN, 21ST REP GPS coordinates: 39.723262, -75.670318
38.854986	75.244354	RSS050A	Location: Prime Hook Road Estimate ID: 13-503 Legislator: Kenton 18TH SEN, 36TH REP GPS coordinates: 38.854986, -75.244354
38.819717	75.203069	RSS050B	Location: South Bayshore Drive Estimate ID: 13-503 Legislator: Kenton 18TH SEN, 36TH REP GPS coordinates: 38.819717, -75.203069

39.761763	75.737578	RSS051	Location: Penn Manor Drive Estimate ID: 13-532 Legislator: Miro 8TH SEN, 22ND REP GPS coordinates: 39.761763, -75.737578
39.6775972	75.582653	RSS052	Location: Silsbee Road Estimate ID: 13-569 Legislator: Poore 12TH SEN, 17TH REP GPS coordinates: 39.677597,-75.582653
39.7861583	75.543483	RSS053	Location: Murphy Road Estimate ID: 13-751 Legislator: Heffernan, Cloutier 5TH SEN, 6TH REP GPS coordinates: 39.786158,-75.543483
39.6531889	75.689175	RSS054A	Location: Timber Wood Blvd Estimate ID: 13-588 Legislator: Viola 26TH REP GPS coordinates: 39.653189,-75.689175
39.8235667	75.537886	RSS055	Location: Rockfield Drive Estimate ID: 13-589 Legislator: Matthews 10TH REP GPS coordinates: 39.823567,-75.537886
39.0691611	75.478275	RSS057A	Location: Irish Hill Road Estimate ID: 13-616 Legislator: Peterman, Bonini 15TH SEN, 30TH REP, 33RD REP GPS coordinates: 39.069161, -75.478275
39.0657944	75.481622	RSS057B	Location: Irish Hill Road Estimate ID: 13-616 Legislator: Peterman, Bonini 15TH SEN, 30TH REP, 33RD REP GPS coordinates: 39.065794, -75.481622
39.2864528	75.600997	RSS058A	Location: Sunnyside Road Estimate ID: 13-645 Legislator: Ennis,B, Carson 14TH SEN GPS coordinates: 39.286453, -75.600997
39.107161	75.560164	RSS059A	Location: Willow Grove Road Estimate ID: 13-757 Legislator: Bushweller, Yearick 16TH SEN, 17TH SEN, 34TH REP GPS coordinates: 39.107161, -75.560164
39.1090806	75.558319	RSS059B	Location: Willow Grove Road Estimate ID: 13-757 Legislator: Bushweller, Yearick 16TH SEN, 17TH SEN, 34TH REP GPS coordinates: 39.109081,-75.558319
39.733725	-75.655367	RSS060A	Location: Owen Drive Estimate ID: 13-770 Legislator: Williams,K 19TH REP GPS coordinates: 39.733725,-75.655367
39.7333722	75.655169	RSS060B	Location: Owne Drive Estimate ID: 13-770 Legislator: Williams,K 19TH REP GPS coordinates: 39.733372,-75.655169
39.7217667	75.653419	RSS061A	Location: Hendry Drive Estimate ID: 13-864 Legislator: Williams,K 7TH SEN, 19TH REP GPS coordinates: 39.721767,-75.653419

39.7223389	75.652706	RSS061B	Location: Hendry Drive Estimate ID: 13-864 Legislator: Williams,K 7TH SEN, 19TH REP GPS coordinates: 39.722339,-75.652706
39.6184833	75.702628	RSS062	Location: Becks Woods Drive Estimate ID: 13-865 Legislator: Poore, Longhurst 12TH SEN, 15TH REP GPS coordinates: 39.618483,-75.702628
39.7310306	75.696006	RSS063	Location: Skyline Drive Estimate ID: 13-900 Legislator: Ramone 4TH SEN, 21ST REP GPS coordinates: 39.731031,-75.696006
38.68567	75.073633	RSS064A	Location: Coastal Highway Estimate ID: 13-860 Legislator: Schwartzkopf 14TH REP GPS coordinates: 38.685670, -75.073633
38.699849	75.078879	RSS064B	Location: Coastal Highway Estimate ID: 13-860 Legislator: Schwartzkopf 14TH REP GPS coordinates: 38.699849, -75.078879
39.67	75.687961	RSS065	Location: Stature Drive Estimate ID: 13-920 Legislator: Osienski, Townsend 11TH SEN, 24TH REP GPS coordinates: 39.670000, -75.687961
39.7313778	75.698117	RSS066	Location: Champions Drive Estimate ID: 13-1020 Legislator: Ramone 4TH SEN, 21ST REP GPS coordinates: 39.731378,-75.698117
39.7335306	75.724233	RSS069	Location: Mourning Dove Drive Estimate ID: 13-1061 Legislator: Miro, Sokola 8TH SEN, 22ND REP GPS coordinates: 39.733531,-75.724233
39.6898111	75.718461	RSS071	Location: Newbrook Road Estimate ID: 14-28 Legislator: Peterson, Osienski 9TH SEN, 24TH REP GPS coordinates:39.689811,-75.718461
39.3821222	75.712156	RSS072	Location: Cole Road Estimate ID: 14-33 Legislator: Ennis,B 14TH SEN, 11TH REP GPS coordinates: 39.382122,-75.712156
39.723075	75.704022	RSS073	Location: White Clay Crescent Estimate ID: 14-32 Legislator: Miro 4TH SEN, 22ND REP GPS coordinates: 39.723075,-75.704022
38.703559	75.076908	RSS075	Location: Silver Lake Drive Estimate ID: 14-62 Legislator: Lopez 14TH REP GPS coordinates: 38.703559, -75.076908
39.83255	75.504694	RSS076	Location: Birch Knoll Road Estimate ID: 14-76 Legislator: Matthews 10TH REP GPS coordinates: 39.83255,-75.504694
38.575858	75.617165	RSS077	Location: Bethel Road Estimate ID: 14-112 Legislator: Dukes 21ST SEN, 40TH REP GPS coordinates: 38.575858, -75.617165

38.569907	75.619245	RSS078	Location: Main Avenue Estimate ID: 14-147 Legislator: Dukes 21ST SEN, 40TH REP GPS coordinates: 38.569907, -75.619245
39.0562694	-75.47915	RSS079 (EB)	Location: Blue Spruce Drive Estimate ID: 14-148 Legislator: Peterman 16TH SEN, 33RD REP GPS coordinates: 39.056269,-75.47915
39.721701	75.675907	RSS080A	Location: 39.721701, -75.675907 Estimate ID: 14-243 Legislator: Ramone, Peterson 9TH SEN, 21ST REP GPS coordinates: 39.721701, -75.675907
38.915602	-75.5018	RSS081A	Location: Front Street Estimate ID: 14-215 Legislator: Peterman, Simpson 18TH SEN, 33RD REP GPS coordinates: 38.915602, -75.501800
38.915142	75.509971	RSS081B	Location: Front Street Estimate ID: 14-215 Legislator: Peterman, Simpson 18TH SEN, 33RD REP GPS coordinates: 38.915142, -75.509971
38.919427	75.510367	RSS081C	Location: School Street Estimate ID: 14-215 Legislator: Peterman, Simpson 18TH SEN, 33RD REP GPS coordinates: 38.919427, -75.510367
38.920262	75.505224	RSS081D	Location: Broad Street Estimate ID: 14-215 Legislator: Peterman, Simpson 18TH SEN, 33RD REP GPS coordinates: 38.920262, -75.505224
38.920029	75.496785	RSS081E	Location: School Street Estimate ID: 14-215 Legislator: Peterman, Simpson 18TH SEN, 33RD REP GPS coordinates: 38.920029, -75.496785
39.05625	-75.478739	RSS082	Location: Blue Spruce Drive Estimate ID: 14-218 Legislator: Bonini 16TH SEN GPS coordinates: 39.05625,-75.478739
39.731142	75.690667	RSS083	Location: New Kent Road Estimate ID: 14-270 Legislator: Ramone 4TH SEN, 21ST REP GPS coordinates: 39.731142, -75.690667
39.299195	75.603877	RSS084A	Location: Etimate ID: Legislator: GPS coordinates: 39.299195, -75.603877
39.285417	75.608458	RSS084B	Location: South Carters Road Estimate ID: 14-352 Legislator: Ennis,B, Carson 14TH SEN, 28TH REP GPS coordinates: 39.285417, -75.608458

39.290058	75.616163	RSS084C	Location: South Carters Road Estimate ID: 14-352 Legislator: Ennis,B, Carson 14TH SEN, 28TH REP GPS coordinates: 39.290058, -75.616163
38.7614833	75.311544	RSS085	Location: Harbeson Road Estimate ID: 14-378 Legislator: Lopez, Simpson, Kenton, Smyk 6TH SEN, 20TH REP GPS coordinates:38.761483,-75.311544
39.7261528	75.656608	RSS086	Location: Nicholby Drive Estimate ID: 14-434 Legislator: Williams,K 7TH SEN, 19TH REP GPS coordinates: 39.726153,-75.656608
39.7306278	75.659822	RSS087	Location: Pickwick Drive Estimate ID: 14-433 Legislator: Blevins 7TH SEN, 19TH REP GPS coordinates: 39.730628,-75.659822
39.577425	75.603903	RSS089	Approximate location based on the description Location: 5th Street Estimate ID: 14-522 Legislator: Longhurst 12TH SEN, 15TH REP GPS coordinates: 39.577425,-75.603903
38.8068444	75.431531	RSS090A	Location: Beach Highway Estimate ID: 14-554 Legislator: Kenton, Wilson, Simpson 18TH SEN, 35TH REP, 36TH REP GPS coordinates: 38.806844,-75.431531
38.8071972	75.418919	RSS090B	Location: Beach Highway Estimate ID: 14-554 Legislator: Kenton, Wilson, Simpson 18TH SEN, 35TH REP, 36TH REP GPS coordinates: 38.807197,-75.418919
39.2423639	75.517325	RSS092A	Location: Denney Street Estimate ID: 14-576 Legislator: Ennis,B 14TH SEN, 28TH REP GPS coordinates: 39.242364,-75.517325
39.2379083	75.514333	RSS092B	Location: Denney Street Estimate ID: 14-576 Legislator: Ennis,B 14TH SEN, 28TH REP GPS coordinates: 39.237908,-75.514333
39.788324	75.524212	RSS093	Location: Dakota Avenue Estimate ID: 14-557 Legislator: Cloutier, Heffernan 5TH SEN, 6TH REP GPS coordinates: 39.788324, -75.524212
39.66031	75.645519	RSS094	Location: Dogwood Drive Estimate ID: 14-635 Legislator: Bentz 13TH SEN, 18TH REP GPS coordinates: 39.660310, -75.645519
38.73734	75.596687	RSS095A	Location: South Main Street Estimate ID: 14-645 Legislator: Wilson, Pettyjohn 19TH SEN, 35TH REP GPS coordinates: 38.737340, -75.596687
38.743085	75.602742	RSS095B	Location: Market Street Estimate ID: 14-645 Legislator: Wilson, Pettyjohn 19TH SEN, 35TH REP GPS coordinates: 38.743085, -75.602742

39.657778	75.670388	RSS096	Location: Jonathan Drive Estimate ID: 14-661 Legislator: Townsend 11TH SEN, 26TH REP GPS coordinates: 39.657778, -75.670388
39.701118	75.693881	RSS097	Location: Creekside Drive Estimate ID: 14-694 Legislator: Ramone 21ST REP GPS coordinates: 39.701118, -75.693881
39.657396	75.681706	RSS098	Location: Norwegian Wood Drive Estimate ID: 14-691 Legislator: Townsend 11TH SEN, 26TH REP GPS coordinates: 39.657396, - 75.681706
39.0075556	75.474331	RSS099	Location: Rt 12 Estimate ID: 14-751 Legislator: Peterman 16TH SEN, 33RD REP GPS coordinates: 39.007556,-75.474331
39.759035	75.710846	RSS101	Location: Polaris Drive Estimate ID: 14-1013 Legislator: Miro 8TH SEN, 22ND REP GPS coordinates: 39.759035, -75.710846
39.738978	75.680434	RSS102	Location: Woodward Drive Esitmate ID: 14- 1012 Legislator: Ramone 4TH SEN, 21ST REP GPS coordinates: 39.738978, -75.680434
39.725609	75.593213	RSS103	Location: Westmoreland Avenue Estimate ID: 14-1018 Legislator: Mitchell 7TH SEN, 13TH REP GPS coordinates: 39.725609, -75.593213
39.717559	75.706106	RSS104	Location: Chadd Road Estimate ID: 14-1030 Legislator: Ramone 4TH SEN, 12TH REP, 21ST REP GPS coordinates: 39.717559, -75.706106
39.827327	75.530391	RSS106	Location: Jade Drive Estimate ID: 14-1062 Legislator: Matthews 5TH SEN, 10TH REP GPS coordinates: 39.827327, -75.530391
39.281209	75.607856	RSS107	Location: Sunnyside Road Estimate ID: 14- 1063 Legislator: Carson 14TH SEN, 15TH SEN, 28TH REP GPS coordinates: 39.281209, - 75.607856
39.093312	75.537165	RSS108A	Location: Windsor Drive Estimate ID: 14-1092 Legislator: Yearick 34TH REP GPS coordinates: 39.093312, -75.537165
39.093491	75.537253	RSS108B	Location: Windsor Drive Estimate ID: 14-1092 Legislator: Yearick 34TH REP GPS coordinates: 39.093491, -75.537253
38.783457	75.316564	RSS109	Location: Mulberry Street Estimate ID: 15- 139 Legislator: Smyk, Kenton, Lopez, Simpson 6TH SEN, 20TH REP, 36TH REP GPS coordinates: 38.783457, -75.316564
39.085759	-75.47232	RSS110A	Location: PlainDealing Road Estimate ID: 15- 45 Legislator: Peterman 16TH SEN, 33RD REP GPS coordinates: 39.085759, -75.472320

39.083375	75.477679	RSS110B	Location: PlainDealing Road Estimate ID: 15-45 Legislator: Peterman 16TH SEN, 33RD REP GPS coordinates: 39.083375, -75.477679
39.28093	75.607995	RSS111	Location: Sunnyside Road Estimate ID: 15-54 Legislator: Carson 14TH SEN, 15TH SEN, 28TH REP, 29TH REP GPS coordinates: 39.280930, -75.607995
39.752435	75.692682	RSS112	Location: Middletown Drive Estimate ID: 15-204 Legislator: Miro 4TH SEN, 22ND REP GPS coordinates: 39.752435, -75.692682
39.747216	75.684865	RSS113	Location: Northpointe Drive Estimate ID: 15-164 Legislator: Ramone 4TH SEN, 21ST REP GPS coordinates: 39.747216, -75.684865
39.820273	75.517955	RSS114	Location: Grubbs Road Estimate ID: 15-211 Legislator: Matthews 5TH SEN, 10TH REP GPS coordinates: 39.820273, -75.517955
39.597524	75.674124	RSS115	Location: Red Lion Road Estimate ID: 15-227 Legislator: Longhurst 12TH SEN, 15TH REP GPS coordinates: 39.597524, -75.674124
39.71829	75.640189	RSS116	Location: Stanton Road Estimate ID: 15-261 Legislator: Williams,K 9TH SEN, 19TH REP GPS coordinates: 39.718290, -75.640189
38.711933	75.085978	RSS117A	Location: Hickman Street Estimate ID: 15-342 Legislator: Lopez 6TH SEN, 14TH REP GPS coordinates: 38.711933, -75.085978
38.711933	75.085978	RSS117B	Location: Hickman Street Estimate ID: 15-342 Legislator: Lopez 6TH SEN, 14TH REP GPS coordinates: 38.711933, -75.085978
39.737109	75.663614	RSS118	Location: McKennans Church Road Estimate ID: 15-343 Legislator: Blevins, Ramone 7TH SEN, 21ST REP GPS coordinates: 39.737109, -75.663614
39.718927	75.627082	RSS119	Location: Admiral Drive Estimate ID: 15-352 Legislator: Peterson, Williams,K 9TH SEN, 19TH REP GPS coordinates: 39.718927, -75.627082
39.721138	75.694766	RSS120	Location: Videre Drive Estimate ID: 15-413 Legislator: Ramone 9TH SEN, 21ST REP GPS coordinates: 39.721138, -75.694766
39.701949	75.699102	RSS121	Location: Richards Lane Estimate ID: 15-359 Legislator: Smith,M 9TH SEN, 21ST REP GPS coordinates: 39.701949, -75.699102
39.758321	75.701113	RSS122	Location: Village Drive Estimate ID: 15-367 Legislator: Miro 4TH SEN, 22ND REP GPS coordinates: 39.758321, -75.701113

39.104004	75.516547	RSS123A	Location: Please Hill Drive Estimate ID: 15-381 Legisltator: Yearick 16TH SEN, 34TH REP GPS coordinates: 39.104004, -75.516547
39.103819	75.517201	RSS123B	Location: Please Hill Drive Estimate ID: 15-381 Legisltator: Yearick 16TH SEN, 34TH REP GPS coordinates: 39.103819, -75.517201
38.629625	75.287863	RSS124	Location: Rd 297 Estimate ID: 15-383 Legislator: Briggs King 20TH SEN, 37TH REP, 41ST REP GPS coordinates: 38.629625, - 75.287863
39.772027	75.664217	RSS125	Location: Loveville Road Estimate ID: 15-417 Legisltator: Hudson, Lavelle 4TH SEN, 7TH SEN, 12TH REP, 21ST REP GPS coordinates: 39.772027, -75.664217
39.648641	75.777431	RSS126	Location: Oklahoma State Drive Estimate ID: 15-426 Legisltator: Hall-Long, Kowalko 10TH SEN, 25TH REP GPS coordinates: 39.648641, - 75.777431
39.640681	75.685604	RSS127	Location: Goodsir Street Estimate ID: 15-441 Legisltator: Viola, Townsend 11TH SEN, 26TH REP GPS coordinates: 39.640681, -75.685604
39.597235	75.711661	RSS129	Location: Mabel Lane Estimate ID: 15-451 Legislator: Jaques 12TH SEN, 27TH REP GPS coordinates: 39.597235, -75.711661
39.663938	75.662077	RSS130	Location: Old Baltimore Pike Estimate ID: 15- 473 Legisltator: Townsend 9TH SEN, 11TH SEN, 18TH REP, 26TH REP GPS coordinates: 39.663938, -75.662077
39.083741	75.545155	RSS131	Location: Peachtree Run Estimate ID: 15-608 Legislator: Bonini, Yearick 16TH SEN, 17TH SEN, 34TH REP GPS coordinates: 39.083741, - 75.545155
39.070436	75.543745	RSS132A	Location: Walnut Shade Road Estimate ID: 15-628 Legisltator: Paradee, Bennett,A, Spiegelman, Kenton, Lynn, Bushweller, Lawson 15TH SEN, 16TH SEN, 34TH REP GPS coordinates: 39.070436, -75.543745
39.070964	75.550798	RSS132B	Location: Walnut Shade Road Estimate ID: 15-628 Legislator: Paradee, Bennett,A, Spiegelman, Kenton, Lynn, Bushweller, Lawson 15TH SEN, 16TH SEN, 34TH REP GPS coordinates: 39.070964, -75.550798

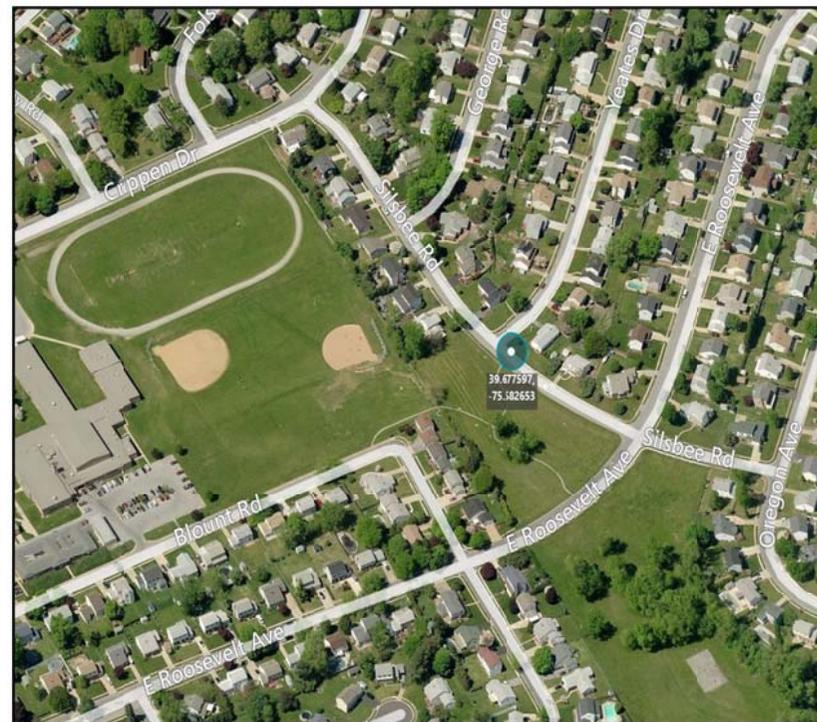
38.661534	75.379621	RSS133A	Location: Shortly Road Estimate ID: 15-640 Legislator: Schwartzkopf, Smyk 21ST SEN, 14TH REP, 41ST REP GPS coordinates: 38.661534, -75.379621
38.660554	75.379832	RSS133B	Location: Shortly Road Estimate ID: 15-640 Legislator: Schwartzkopf, Smyk 21ST SEN, 14TH REP, 41ST REP GPS coordinates: 38.660554, -75.379832
39.07494	75.479071	RSS134A	Location: South State Road Estimate ID: 15- 641 Legislator: Bonini, Peterman 16TH SEN, 33RD REP GPS coordinates: 39.074940, - 75.479071
39.068323	75.474119	RSS134B	Location: South State Road Estimate ID: 15- 641 Legislator: Bonini, Peterman 16TH SEN, 33RD REP GPS coordinates:39.068323, - 75.474119
39.499336	75.748592	RSS135	Location: Colonel Clayton Drive Estimate ID: 15-772 Legislator: Johnson IV, Hall-Long 10TH SEN, 8TH REP GPS coordinates: 39.499336, - 75.748592
39.007475	75.571612	RSS137A	Location: East Main Street Estimate ID: 15- 869 Legislator: Outten, Lawson, Bonini 15TH SEN, 18TH SEN, 30TH REP GPS coordinates: 39.007475, -75.571612
39.009313	75.579987	RSS137B	Location: East Main Street Estimate ID: 15- 869 Legislator: Outten, Lawson, Bonini 15TH SEN, 18TH SEN, 30TH REP GPS coordinates:39.009313, -75.579987
38.869728	75.576964	RSS138A	Location: Andrewville Road Estimate ID: 15- 868 Legislator: Outten, Bonini, Simpson 18TH SEN, 30TH REP GPS coordinates: 38.869728, - 75.576964
38.869189	75.581974	RSS138B	Location: Andrewville Road Estimate ID: 15- 868 Legislator: Outten, Bonini, Simpson 18TH SEN, 30TH REP GPS coordinates: 38.869189, - 75.581974
38.9524	75.571973	RSS140	Location: Hopkins Cemetery Road Estimate ID: 15-992 Legislator: Ennis,B 14TH SEN, 18TH SEN, 30TH REP GPS coordinates: 38.952400, -75.571973
38.931622	75.582815	RSS141	Location: Dorman Street Estimate ID: 15- 1022 Legislator: Outten 18TH SEN, 30TH REP GPS coordinates: 38.931622, -75.582815

38.691911	75.114533	RSS142	Location: West Side Drive Estimate ID: 15-1023 Legislator: Schwartzkopf 6TH SEN, 14TH REP GPS coordinates: 38.691911, -75.114533
39.642446	75.628864	RSS143	Location: Mallard Road Estimate ID: 15-1094 Legislator: McBride, Smith, M 13TH SEN, 5TH REP GPS coordinates: 39.642446, -75.628864
39.589783	75.683612	RSS144	Location: Willow Oak Blvd Estimate ID: 15-1151 Legislator: Longhurst, Poore 15TH REP GPS coordinates: 39.589783, -75.683612
39.660344	75.645416	RSS145	Location: Donwood Drive Estimate ID: 15-1363 Legislator: Bentz 13TH SEN, 18TH REP GPS coordinates: 39.660344, -75.645416
39.166984	75.555464	RSS146	Location: Independence Blvd Estimate ID: 16-26 Legislator: Lynn 17TH SEN, 31ST REP GPS coordinates: 39.166984, -75.555464
39.111115	75.523724	RSS147A	Location: South Old Mill Road Estimate ID: 16-144 Legislator: Yearick 16TH SEN, 34TH REP GPS coordinates: 39.111150, -75.523724
39.12089	75.520064	RSS147B	Location: Old Mill Road Estimate ID: 16-144 Legislator: Yearick 16TH SEN, 34TH REP GPS coordinates: 39.120890, -75.520064
39.172868	75.540096	RSS148	Location: Schoolhouse Lane Estimate ID: 16-112 Legislator: Lynn 17TH SEN, 31ST REP GPS coordinates: 39.172868, -75.540096
39.155817	75.536044	RSS149	Location: Slaughter Street Estimate ID: 16-174 Legislator: Lynn 17TH SEN, 31ST REP GPS coordinates: 39.155817, -75.536044
39.722032	75.708325	RSS150	Location: Rankin Road Estimate ID: 16-195 Legislator: Miro 4TH SEN, 22ND REP GPS coordinates: 39.722032, -75.708325
39.79084	75.509682	RSS151	Location: Bette Road Estimate ID: 16-234 Legislator: Cloutier, Heffernan 5TH SEN, 6TH REP GPS coordinates: 39.790840, -75.509682
39.058977	75.402753	RSS152	Location: Main Street Estimate ID: 16-246 Legislator: Peterman, Bonini 16TH SEN, 33RD REP GPS coordinates: 39.058977, -75.402753
38.644005	75.440393	RSS155A	Location: County Seat Highway Estimate ID: 16-399 Legislator: Dukes, Wilson 21ST SEN, 40TH REP GPS coordinates: 38.644005, -75.440393
38.63911	75.450022	RSS155B	Location: County Seat Highway Estimate ID: 16-399 Legislator: Dukes, Wilson 21ST SEN, 40TH REP GPS coordinates: 38.639110, -75.450022

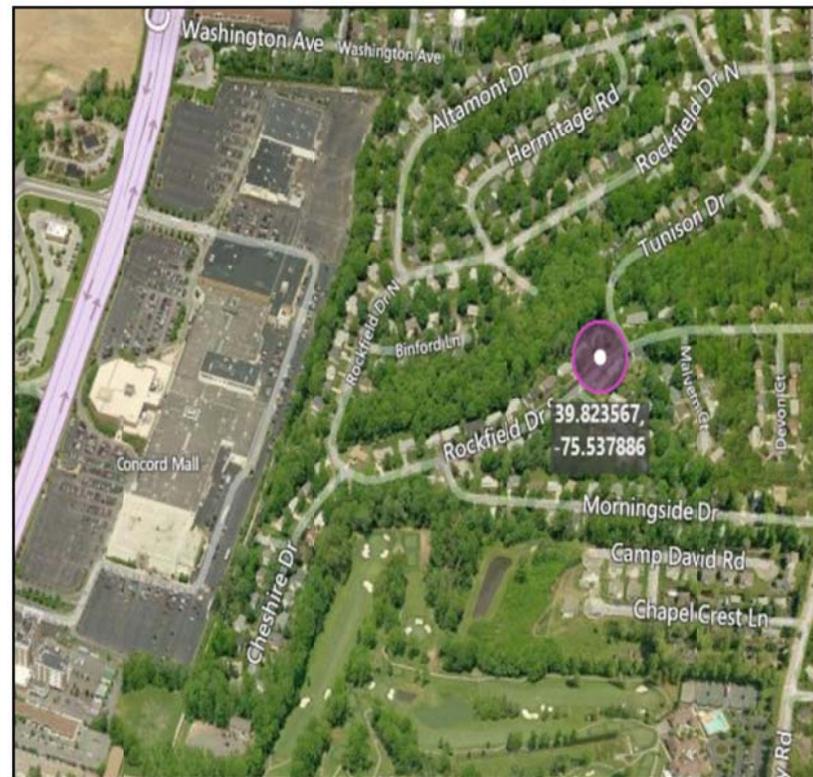
39.597775	75.747182	RSS157	Location: Cann Road Estimate ID: 16-489 Legislator: Hall-Long, Jaques 10TH SEN, 27TH REP GPS coordinates: 39.597775, -75.747182
39.021878	75.567399	RSS159	Location: Peach Basket Road Estimate ID: 16-524 Legislator: Outten, Lawson 15TH SEN, 30TH REP GPS coordinates: 39.021878, -75.567399
39.244861	75.528508	RSS160	Location: Fast Landing Road Estimate ID: 16-543 Legislator: Ennis, B 14TH SEN, 28TH REP GPS coordinates: 39.244861, -75.528508
39.334768	75.619913	RSS161	Location: Smyrna Landing Road Estimate ID: 16-553 Legislator: Ennis, B 14TH SEN, 9TH REP, 28TH REP GPS coordinates: 39.334768, -75.619913
39.798618	-75.48178	RSS162	Location: Parkside Blvd Estimate ID: 16-680 Legislator: McDowell 1ST SEN, 7TH REP GPS coordinates: 39.798618, -75.481780

Appendix C: Selected sites

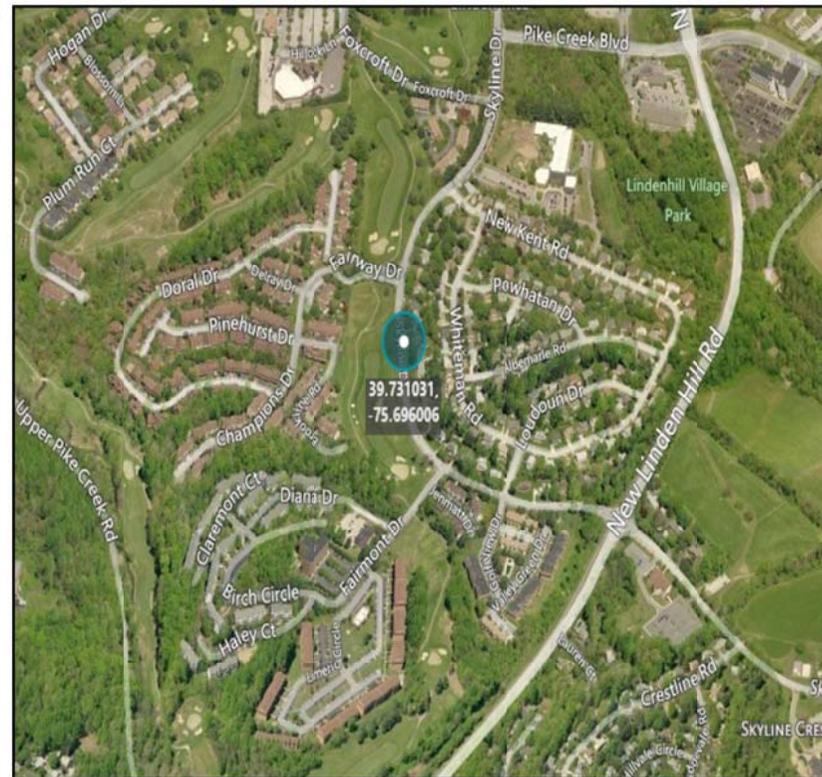
Name	Latitude	Longitude	Score	Greater than posted speed limit by 5 mph	Within 1,500 ft. of a major pedestrian generator	Residential area?	Posted speed limit <35mph?	Hazardous roadway conditions?	Within 5 miles of transition zones?	Installation year
RSS052	39.6775972	-75.582653	8	✓	✓	✓	✓	✓	N	2013



Name	Latitude	Longitude	Score	Greater than posted speed limit by 5 mph	Within 1,500 ft. of a major pedestrian generator	Residential area?	Posted speed limit <35mph?	Hazardous roadway conditions?	Within 5 miles of transition zones?	Installation year
RSS055	39.8235667	-75.537886	8	√	√	√	√	√	N	2013



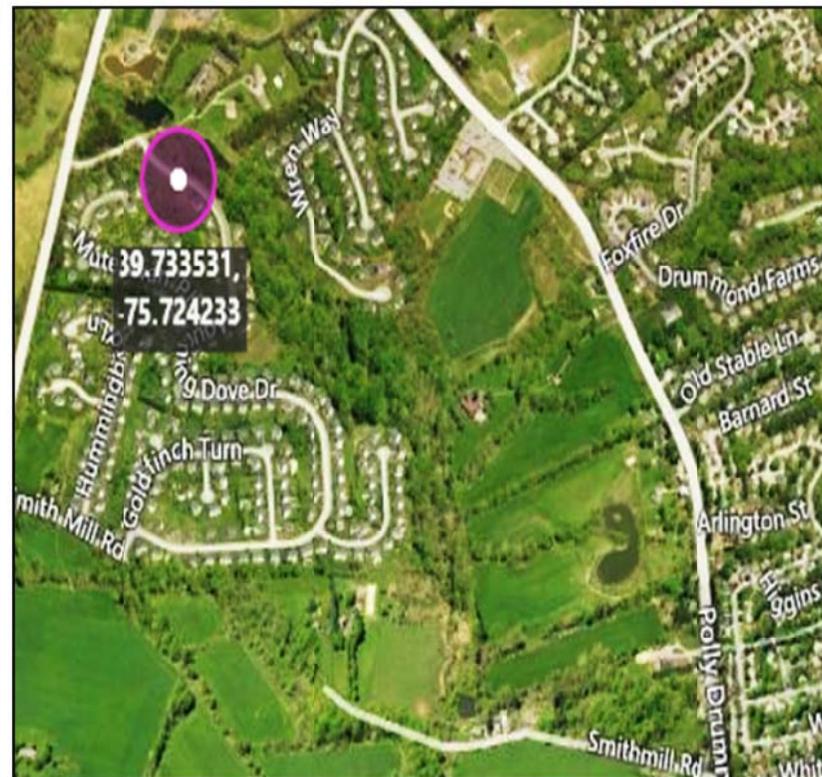
Name	Latitude	Longitude	Score	Greater than posted speed limit by 5 mph	Within 1,500 ft. of a major pedestrian generator	Residential area?	Posted speed limit <35mph?	Hazardous roadway conditions?	Within 5 miles of transition zones?	Installation year
RSS063	39.7310306	-75.696006	8	√	√	√	√	√	N	2013



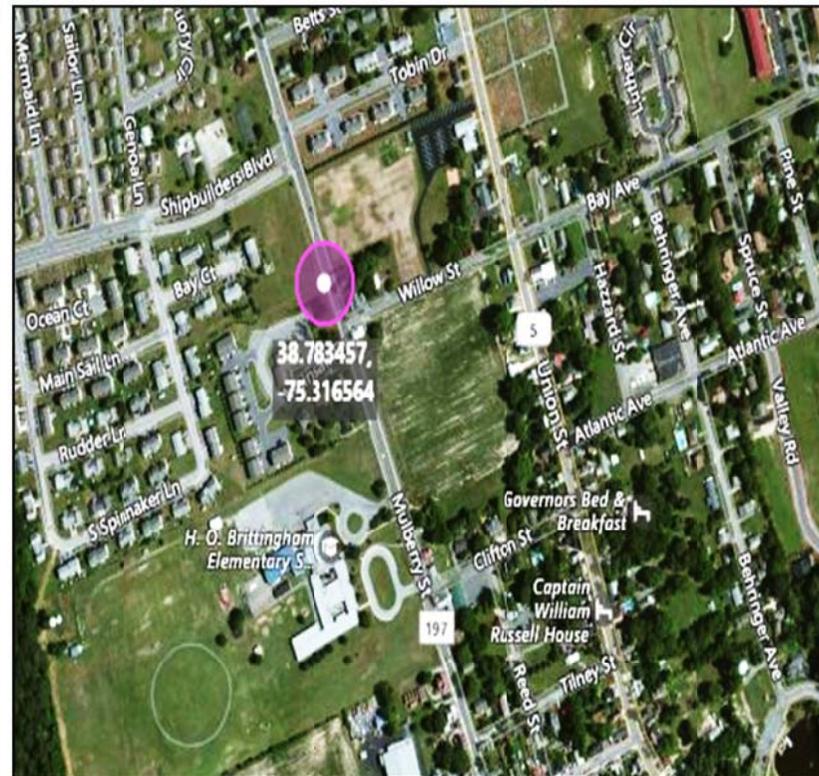
Name	Latitude	Longitude	Score	Greater than posted speed limit by 5 mph	Within 1,500 ft. of a major pedestrian generator	Residential area?	Posted speed limit <35mph?	Hazardous roadway conditions?	Within 5 miles of transition zones?	Installation year
RSS066	39.7313778	-75.698117	8	√	√	√	√	√	N	2013



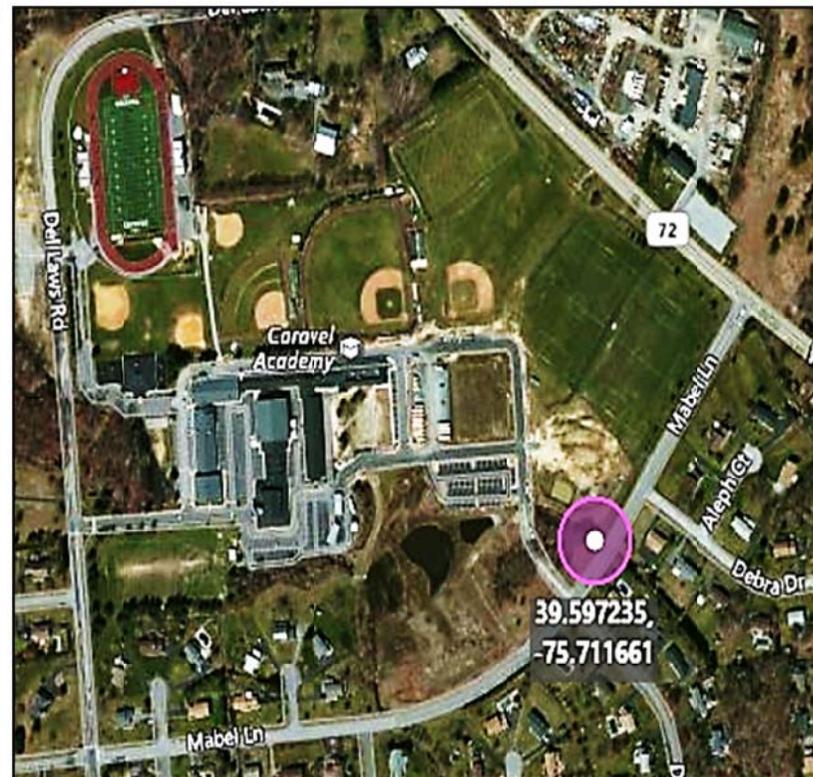
Name	Latitude	Longitude	Score	Greater than posted speed limit by 5 mph	Within 1,500 ft. of a major pedestrian generator	Residential area?	Posted speed limit <35mph?	Hazardous roadway conditions?	Within 5 miles of transition zones?	Installation year
RSS069	39.7335306	-75.724233	8	√	√	√	√	√	N	2013



Name	Latitude	Longitude	Score	Greater than posted speed limit by 5 mph	Within 1,500 ft. of a major pedestrian generator	Residential area?	Posted speed limit <35mph?	Hazardous roadway conditions?	Within 5 miles of transition zones?	Installation year
RSS109	38.783457	-75.316564	7	√	√	√	√	N	N	2015



Name	Latitude	Longitude	Score	Greater than posted speed limit by 5 mph	Within 1,500 ft. of a major pedestrian generator	Residential area?	Posted speed limit <35mph?	Hazardous roadway conditions?	Within 5 miles of transition zones?	Installation year
RSS129	39.597235	-75.711661	7	✓	✓	✓	✓	N	N	2015



Name	Latitude	Longitude	Score	Greater than posted speed limit by 5 mph	Within 1,500 ft. of a major pedestrian generator	Residential area?	Posted speed limit <35mph?	Hazardous roadway conditions?	Within 5 miles of transition zones?	Installation year
RSS134A	39.07494	-75.479071	7	√	√	√	√	N	N	2015



Name	Latitude	Longitude	Score	Greater than posted speed limit by 5 mph	Within 1,500 ft. of a major pedestrian generator	Residential area?	Posted speed limit <35mph?	Hazardous roadway conditions?	Within 5 miles of transition zones?	Installation year
RSS134B	39.068323	-75.474119	7	✓	✓	✓	✓	N	N	2015



Name	Latitude	Longitude	Score	Greater than posted speed limit by 5 mph	Within 1,500 ft. of a major pedestrian generator	Residential area?	Posted speed limit <35mph?	Hazardous roadway conditions?	Within 5 miles of transition zones?	Installation year
RSS137B	39.009313	-75.579987	7	✓	✓	✓	✓	N		2015



Base map source: Bing Maps © 2017 Microsoft Corporation.

## Appendix D: List of Acronyms

AAA	American Automobile Association
AADT	Annual average daily traffic
AASHTO	American Association of State Highway and Transportation Officials
ADT	Average daily traffic
ANOVA	Analysis of variance
ATSIP	Association of Traffic Safety Information Professionals
ATSSA	American Traffic Safety Services Association
BTS	Bureau of Transportation Statistics
Caltrans	California Department of Transportation
CMS	Changeable Message Sign
DE	Delaware
DeIDOT	Delaware Department of Transportation
DE-MUTCD	Delaware Manual on Uniform Traffic Control Devices
DFS	Driver Feedback Sign
DOT	Department of Transportation
DSDS	Dynamic speed display signs
DSHSP	Delaware's Strategic Highway Safety Plan
DSP	Delaware State Police
EB	Eastbound
FARS	Fatality Analysis Reporting System
FHWA	Federal Highway Administration
FT	Feet
HSM	Highway Safety Manual
Info.	Information
LIDAR	Light Detection and Ranging
MPH	Miles per hour
MUTCD	Manual on Uniform Traffic Control Devices
NB	Northbound
NHTSA	National Highway Traffic Safety Administration
OHS	Office of Highway Safety
SB	Southbound
SMD	Speed-monitoring displays
STD	Standard deviation
TMC	Transportation Management Center
WB	Westbound

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