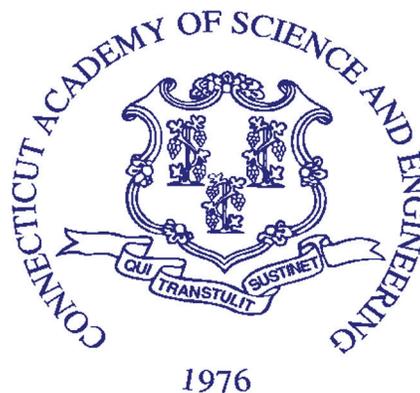


**INNOVATIVE TECHNOLOGY  
DEPLOYMENT: DEVELOPMENT OF A  
VIRTUAL SCREENING FACILITY  
PILOT PROJECT FOR CONNECTICUT'S  
COMMERCIAL VEHICLE  
ENFORCEMENT PROGRAM**

**NOVEMBER 2017**

**A REPORT BY**

**THE CONNECTICUT  
ACADEMY OF SCIENCE  
AND ENGINEERING**



**FOR**

**THE CONNECTICUT DEPARTMENT OF  
TRANSPORTATION  
THE CONNECTICUT DEPARTMENT OF  
MOTOR VEHICLES**



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ORIGIN OF INQUIRY:	THE CONNECTICUT DEPARTMENT OF TRANSPORTATION THE CONNECTICUT DEPARTMENT OF MOTOR VEHICLES
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This study was initiated at the request of the Connecticut Department of Transportation and the Connecticut Department of Motor Vehicles on October 18, 2016. The project was conducted by an Academy Study Committee with the support of BGM Consulting, with Barry Mason serving as Study Manager and David Pines, PhD, serving as a Study Advisor. The content of this report lies within the province of the Academy's Transportation Systems Technical Board. The report has been reviewed on behalf of the Academy's Council by Academy Members John DeWolf, PhD, and John N. Ivan, PhD. Martha Sherman, the Academy's Managing Editor, edited the report. The report is hereby released with the approval of the Academy Council.

Richard H. Strauss  
Executive Director

#### Disclaimer

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## GLOSSARY

ADT	Average Daily Traffic
ASTM	American Society for Testing and Materials
AVI	Automatic Vehicle Identification (i.e., license plate readers, USDOT number readers, commercial vehicle transponder readers, cellular applications)
CCTV	Closed-circuit Television
CSP	Division of State Police, Connecticut Department of Emergency Services and Public Protection
CTDMV	Connecticut Department of Motor Vehicles
CTDOT	Connecticut Department of Transportation
CV	Commercial Vehicle
CVE	Commercial Vehicle Enforcement
CVEO	Commercial Vehicle Enforcement Officer. A CTDMV or CSP officer with duties and authority that includes commercial vehicle enforcement
CVEF	Commercial Vehicle Enforcement Facility. An operations site where commercial vehicle enforcement is performed. A staffed facility is typically called a weigh station. Enforcement activity may include any or all of the following: weight, size, credentials, driver safety, and commercial vehicle safety. CVEFs may operate part-time or 24/7.
CVISN	Commercial Vehicle Information Systems and Networks Program of the Federal Motor Carrier Administration. As of October 2016 this program was re-designated the Innovative Technology Deployment (ITD) Program. Both CVISN and ITD are used in this report.
CVSA	Commercial Vehicle Safety Alliance, a North American organization focused on CV safety enforcement
Direct Enforcement Site	Location for Commercial Vehicle Enforcement personnel to conduct inspections of trucks, trailers and drivers for weight, size and safety violations
DMS	Dynamic Message Signs
FHWA	Federal Highway Administration, USDOT
Fixed Site	In Connecticut, a fixed site is a direct enforcement site (also known as a Connecticut Weigh Station) that includes static scale and scale house, as well as potentially other enforcement equipment/facilities (low speed ramp WIM [Greenwich, Union] and safety inspection building [Union])
FMCSA	Federal Motor Carrier Safety Administration
GIS	Geographic Information System

Gore	An unpaved area created between the highway mainline and a ramp that merges into or diverges from the mainline
ITD	Innovative Technology Deployment Program (formerly known as CVISN) of FMCSA. The mission of this program is to improve commercial motor vehicle safety ( <a href="https://www.fmcsa.dot.gov/information-systems/itd/innovative-technology-deployment-itd">https://www.fmcsa.dot.gov/information-systems/itd/innovative-technology-deployment-itd</a> )
	CTDOT Environmental Permit Coordination Unit
Intelligent Transportation Systems	Advanced information and communications applications to improve road operations and safety through the use of state of the art telecommunications, computers, and other technologies. Examples include WIM, CCTV cameras, and DMS as well as the communications backbone, control, data processing, and data storage equipment.
Level of Inspection (I, II, III, IV, V)	The type of CVE safety inspection conducted. Level I is the most comprehensive; Level V is the least comprehensive. CVSA defines these types of inspections. For full details see: <a href="http://cvsa.org/inspections/inspections/all-inspection-levels/">http://cvsa.org/inspections/inspections/all-inspection-levels/</a>
	Federal Emergency Management Agency
MCSAP	Motor Carrier Safety Assistance Program
PreClearance Systems	A method to allow commercial vehicles to bypass a CVEF or VSF as a result of safety and size and weight compliance.
USDOT	US Department of Transportation
VSF	Virtual Screening Facility. An unstaffed facility that provides a CVEO with real-time commercial vehicle information electronically using in-pavement sensors and communications. The intent is to provide data and information for CV screening based on site functionality using a combination of WIM, AVI, over height detection and other equipment at each site.
Weigh Station	A location used to conduct safety inspections and/or weigh commercial vehicles. If a facility has static scale, some level of safety inspection is also typically conducted. These are a subset of CVEFs.
WIM	Weigh-in-Motion System. A WIM is used to weigh commercial vehicles at highway or low speeds using in pavement sensors. WIMs are typically located either on the mainline just upstream of a CVEF, on the entrance ramp to a CVEF (ramp or low speed WIM), and at a VSF.

## EXECUTIVE SUMMARY

This study was conducted for the Connecticut Department of Transportation (CTDOT) and the Connecticut Department of Motor Vehicles (CTDMV) by the Connecticut Academy of Science and Engineering (CASE) for the purpose of creating an implementation document for development of a virtual electronic screening (e-screening) and weigh-in-motion (WIM) pilot project.

Additionally, a goal of the analysis is to select virtual screening functionalities that are matched with enforcement strategies and provide flexibility taking into consideration factors such as new technologies, and changing enforcement strategies and traffic volumes over time. The performance of the functions needs to be the focus, using the technology to support those functions. Desired outcomes include

- positively changing the behavior of motor carriers/commercial vehicles and drivers that violate state and federal regulatory requirements;
- protecting the state's highway infrastructure;
- enabling motor carriers/commercial vehicles and drivers operating in a safe and legal manner to bypass inspection stations thus improving mobility by saving time, fuel and operational costs; and
- providing enhanced motor vehicle safety for the public.

## OVERVIEW

Study research methods included:

- Review and analysis of current and relevant literature and best practices of selected states
- Project meetings for Research Team discussion on various study issues with CTDOT/CTDMV staff.
- Site visits including a tour of Connecticut weigh stations and potential Virtual Screening Facility (VSF) sites and a tour of weigh stations utilizing e-screening technologies and functionalities in Florida.
- Mobile enforcement observation ride-along at the I-91 VSF site
- Guest Speaker Presentations from experts who provided presentations on study issues to the CASE Study Committee and agency study contacts. The data and information presented has been incorporated into the study report as appropriate. Guest speaker presentation information is available electronically, as noted in Appendix C.

The study report includes the following sections: Background, Introduction, Feasibility Analysis, Proven Functionalities and Technologies, Appropriate Technologies for the VSF Pilot Project, Smart Roadside Initiative Technologies Deployed by States, List of Technological

Components and Data Modules, Implementation Time frame and Cost Estimate, and Recommendations and Concluding Remarks.

## **BRIEF STATEMENT OF PRIMARY CONCLUSION**

Investment in the deployment of innovative technologies to screen commercial vehicles and drivers for weight and safety inspection has the potential to improve the effectiveness of Connecticut's commercial vehicle enforcement program and achieve outcomes including improved safety, highway preservation, and increased mobility of commercial vehicles traveling in Connecticut.

Virtual Screening Facilities (VSFs) and weigh stations with enhanced screening functionalities will enable enforcement officers to focus enforcement operations on those commercial vehicles most likely to be in violation of state and federal weight, size, and safety laws, while providing those in compliance with increased mobility by allowing them to bypass enforcement activities. Importantly, analysis of the 24/7 data collected from these sites provides the opportunity to strategically design enforcement strategies to maximize enforcement effectiveness.

Performance measures used for administrative purposes and required by state statute for assessing the effectiveness the commercial vehicle enforcement program should be based on and aligned with programmatic objectives and outcomes. Metrics used to assess success in achieving desired outcomes should include measures related to improving safety, highway preservation, and mobility.

## **RECOMMENDATIONS**

This study presents an implementation plan for development of a pilot VSF for use by CTDOT/CTDMV. The pilot VSF will be used to test various technologies to determine their value in enhancing commercial vehicle size, weight and safety enforcement in Connecticut. Three sites were analyzed for selection as the pilot project. Based on the analyses, the I-91 SB at Route 510 site was selected as the pilot VSF project by CTDOT/CTDMV.

The study recommendations are shown in two categories: those related to the VSF pilot project, and additional recommendations regarding the commercial vehicle enforcement program based on the research and analyses conducted throughout this study.

### ***VSF Pilot Project***

Based on the analyses conducted, CTDMV/CTDOT should plan, design, construct and operate a pilot VSF at the proposed site for the purpose of testing VSF technologies for potential future use at additional VSF sites and existing weigh stations. The following suggestions are offered for consideration by CTDOT and CTDMV:

- CTDMV/CTDOT: Evaluate the pilot VSF through the collection and analyses of data using the proposed performance measures
  - o Review the proposed performance measures identified in Chapter 7 with the VSF

contractor and revise as necessary to assure that data collected and reported will provide system analyses needed for decisions on deployment of additional VSFs.

- o Report on the impact of the pilot VSF based on the performance measures.
- o Use results of the pilot project for planning additional deployments of VSF technologies and functionalities.
- CTDOT: Utilize traffic data for real time traffic management and future planning needs
- CTDMV/CTDOT/CSP: Establish an interagency Memorandum of Understanding (MOU) to formalize responsibilities of CTDMV/CTDOT and CSP for the planning, design, construction and operation and reporting for the pilot VSF project as part of an interagency MOU for formalizing overall responsibilities for the Commercial Vehicle Enforcement Program (see Additional Recommendations).

### *Additional Recommendations*

The following additional recommendations are included as additional opportunities for consideration by CTDMV/CTDOT to improve and enhance the state's commercial vehicle enforcement program:

- Establish an interagency MOU between CTDMV, CTDOT and CSP to create a multi-agency working group to formalize each agency's responsibilities for the Commercial Vehicle Enforcement Program for the purpose of collaboration, cooperation, and coordination to achieve the program's overall size, weight, and safety goals. Suggested responsibilities of the working group include:
  - o Planning, operation, and management of the Commercial Vehicle Enforcement Program and the facilities that support the program – weigh stations and VSFs. Also, development of a program budget and annual reporting (budget vs. actual) for enforcement operations, maintenance of facilities and systems, and capital projects.
  - o Development of a strategic plan for continuous improvement of the Commercial Vehicle Enforcement Program, including but not limited to
    - ◆ goals/strategies/outcomes;
    - ◆ feasibility evaluation for siting additional VSFs or other facilities;
    - ◆ design and construction guidelines for development of additional VSFs and upgrading of existing weigh stations;
    - ◆ performance measures for operation of the program; include systemic success measures (program outcomes: progress in changing behavior such as accidents, injuries, and fatalities involving commercial vehicles, and pavement preservation); and
    - ◆ reporting on performance measures, and other factors such as VSF system operation.

- Oversight for the development of the pilot VSF, other VSFs, and use of VSF technologies and functionalities to enhance existing weigh stations.
- The following provides guidance for prioritizing the development and installation of additional VSFs, and VSF technologies and functionalities at existing weigh stations:
  - Table ES.1 shows the annual average percentage of overweight citations issued at each of the existing weigh stations for fiscal years 2009 – 2016, calculated by dividing the annual average number of overweight citations issued by the average total number of commercial vehicles weighed. This information provides a foundation for considering the need for additional deployments of VSF technologies. This data shows that the percentage of commercial vehicles issued overweight citations is very low as compared with the number of vehicles weighed for all weigh stations in Connecticut. The results of pilot VSF enforcement operations will be useful in determining the value of screening commercial vehicles for weight and safety inspection in Connecticut. As has been shown in other states, screening has been effective in improving commercial vehicle enforcement effectiveness.

TABLE ES.1: ANNUAL AVERAGE PERCENTAGE OF OVERWEIGHT CITATIONS ISSUED AT EXISTING WEIGH STATIONS (FY2009 – FY2016)

Weigh Station (ordered by percentage of citations issued)	Percentage of Overweight Citations Issued	Overweight Citations	Total CVs Weighed
Middletown (I-91 NB)	1.36%	455	33,397 (Static Scale Only)
Greenwich (I-95 NB)	1.0%	1,660	165,609 (WIM & Static Scale)
Waterford (I-95 SB)	0.93%	133	14,337 (Static Scale Only)
Danbury (I-84 EB)	0.84%	505	59,811 (Static Scale Only)
Waterford (I-95 NB)	0.56%	125	22,239 (Static Scale Only)
Union (I-84 WB)	0.12%	316	262,871 (WIM & Static Scale)
<p>Notes:</p> <ol style="list-style-type: none"> <li>1. Data shown are annual averages for the period of FY2009 – FY2016</li> <li>2. Static Scale Only: CVs are weighed only on static scales at the Danbury, Middletown, and Waterford Weigh Stations</li> <li>3. WIM &amp; Static Scale: CVs are weighed on ramp WIM and static scales at Greenwich and Union Weigh Stations</li> </ol>			

- If it is determined that the pilot VSF project was successful in improving commercial vehicle enforcement effectiveness, it is suggested that testing VSF technologies and functionalities at one of the state's existing weigh stations should be the next priority.
  - ◆ It is suggested that the Greenwich Weigh Station (I-95 NB) be considered as the next site to test VSF technologies. This site has the greatest amount of commercial vehicle traffic of all of the state's weigh stations. Typically, when the weigh station is open, commercial vehicles entering the weigh station quickly queue onto the mainline resulting in frequent closing and opening

- of the station. This VSF installation would include a mainline sorting system to improve safety and effectiveness and enable the manually operated ramp WIM to be decommissioned. It is noted that this installation requires coordination with New York State for installation of signage in New York directing commercial vehicles to use the right lane only.
- ◆ If installation of VSF technologies at the Greenwich Weigh Station is not possible, then the Middletown Weigh Station (I-91 NB) should be considered as the next test site. As shown in Table ES.1, the Middletown Weigh Station has the highest annual average percentage of overweight citations issued compared to the total number of commercial vehicles weighed. This section of I-91 NB also has a high level of commercial vehicle traffic, including both intrastate and interstate. This VSF installation would include a mainline sorting system to improve safety and effectiveness. This project could potentially be considered as part of the CTDOT proposed I-91/I-691 project.
  - Considerations for prioritizing development of additional VSF installations based on the results of the pilot VSF project and an initial weigh station VSF enhancement project are as follows.
    - ◆ Two VSF sites were considered for the pilot project and are potential sites for development of additional VSFs.
      - I-95 SB at the Rhode Island border. This site is just past Exit 93 with the Mystic/North Stonington Rest Area identified to serve as the primary direct enforcement area, along with the I-95 Southbound Waterford Weigh Station being available as a secondary direct enforcement site. An advantage of deployment of a VSF at this location is that enforcement presence would be available before commercial vehicles travel over the Gold Star Bridge in Groton.
      - I-395 SB in the vicinity of Plainfield Service Plaza (identified to serve as the primary direct enforcement area) and U.S. Route 6. This site is currently not protected with a weigh station, with commercial vehicle enforcement only provided through periodic mobile enforcement. Installation of a VSF site would provide enforcement coverage for southbound commercial vehicle traffic entering the state from Massachusetts and Rhode Island, and may serve to reduce the number of vehicles that use I-395 southbound in an effort to bypass the Union Weigh Station on I-84 westbound.
    - ◆ Connecticut's weigh stations, in addition to the Greenwich Weigh Station and the Middletown Weigh Station previously discussed.
      - Danbury Weigh Station (I-84 EB). This weigh station is very close to the New York State border. It is co-located in a rest area used by the public. A VSF installed at this location to support enforcement at the weigh station would need to be located in New York State. Agreement with New York State would be needed. An alternative could be the development of a VSF as part of the I-84/Route 7 project, pending identification of an acceptable site to replace the Danbury Weigh Station.

- Union Weigh Station (I-84 WB). This weigh station is close to the Massachusetts border. Currently, a ramp WIM is used for screening vehicles to be weighed on a static scale. A mainline WIM is installed at this site, but it is not operational at this time. VSF technologies would be installed to enhance enforcement, including replacement of the mainline WIM and decommissioning of the ramp WIM. Additionally, installation of a VSF at this location to enhance enforcement for I-84 EB should be considered, with the weigh station being used as the primary direct enforcement area.
  - Waterford Weigh Station (I-95 NB). This weigh station has limited space for enforcement. A VSF installed at this location with screening functionalities would support enforcement and improve the effectiveness of the weigh station. The proposed I-95 expansion project in southeastern Connecticut may impact the future of this weigh station, and could be a consideration in a decision regarding investment in improvements.
  - Waterford Weigh Station (I-95 SB). A decision on enhancing this weigh station with VSF functionalities should be based on the installation of the proposed VSF on I-95 SB at the Rhode Island border. If this VSF is developed, then this weigh station would serve as a secondary direct enforcement site for the VSF. However, similar to the Waterford Weigh Station NB, the proposed I-95 expansion project may impact a decision to invest in improvements at this weigh station.
- Utilize CTDOT WIM planning data for commercial vehicle enforcement and data analysis.
    - o Provide access to planning WIM site data in real-time for CTDMV/CSP commercial vehicle enforcement
    - o Use WIM planning data and VSF data for trend analysis of a systemic performance measure on the weights of commercial vehicles traveling on Connecticut highways.
  - Consideration of additional functionalities to support commercial vehicle enforcement include:
    - o Development of E-permits and integration into the VSF system.
    - o Integration of hazmat readers into VSF sites that are upstream from a weigh station or a VSF that uses a sorting strategy. Hazmat readers currently are effective if used in the right lane only.
    - o Observation cameras to monitor bypass routes around weigh stations and VSFs. These cameras would provide enforcement staff with the capability to remotely monitor bypass routes with dispatch for enforcement only when necessary.
    - o Use of a self-contained mobile enforcement trailer, similar to that used by

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Massachusetts and Rhode Island, that provides VSF functionalities for mobile enforcement use on interstates and secondary roads throughout the state.

- Add functionality for Amber Alerts at VSF sites. This requires an additional LPR in each lane to read rear license plates.
- Collaborate with other states to enhance the effectiveness of Connecticut's Commercial Vehicle Enforcement Program and regional commercial vehicle enforcement.
  - o Align commercial vehicle codes, where possible, to minimize conflicts.
  - o Data sharing to provide adjacent states with analysis of VSF data and Connecticut's enforcement results, including such information by state registration. Secure this same information from other collaborating states, if available.
  - o Development of facilities at state borders.
- Conduct an analysis of the Judicial Branch's disposition of commercial vehicle and driver citations issued by enforcement officers
  - o Explore opportunities to improve the percentage of guilty verdicts and fine collections through a review of commercial vehicle enforcement procedures and processes, judicial system procedures and processes, and the fine structure.
- Consider legislative initiatives to amend state statutes related to weigh station staffing and reporting requirements.
  - o *CGS Chapter 248, § 270c [1-4]: Official Weighing Areas. Staffing Requirements*

This statute mandates weigh station shift staffing requirements. It is suggested that legislatively mandated staffing requirements should be eliminated and the balance of this statute should be revised to enable staffing flexibility that will provide for more strategic randomized enforcement strategy with a goal of improving the effectiveness of the commercial vehicle enforcement program for weigh station, VSF, and mobile enforcement.

- o *CGS Chapter 248, § 270f: Weigh Station Logs*

Revise legislatively mandated semi-annual weigh station reporting requirements to be consistent with the established performance measures for the commercial vehicle enforcement program.

- o *CGS Chapter 248, § 270e: Program to Implement Regularly Scheduled and Enforced Hours of Operation for Weigh Stations*

Review and revise legislatively mandated annual planned enforcement program reporting requirements to ensure that required reporting information allows for random scheduling of weigh station staffing.

## CONCLUDING REMARKS

The development of a VSF involves design, construction and installation of equipment typical of many highway projects. However, the integration of various VSF functions adds complexity to the development and use of a VSF for real-time commercial vehicle enforcement and highway planning.

The integrator is the project partner with the responsibility to assure that the information collected at the VSF site is analyzed seamlessly in real time to provide enforcement officers with results needed to screen commercial vehicles for weight, size, and safety inspection. The speed, accuracy, and ease of use of the information provided are key elements of a successful VSF. Additionally, a critical element of the integrator's system is the ability to analyze 24/7 VSF data collected to enable strategic development and refinement of enforcement strategies.