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Final Report 542

Improving Freight Crash Incident Management

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16. Abstract

The objective of this study was to determine the most effective way to mitigate the effect of freight crash incidents on Louisiana freeways. Candidate incident management strategies were reviewed from practice in other states and from those published in the literature. Current legislation in the state was also reviewed. A procedure to estimate the cost of delay caused by an incident was developed and used to provide a rough estimate of the cost efficiency of an Instant Tow Dispatch Program and an Expedited Towing Program. Both were estimated to be highly cost-efficient with the estimated cost of delay far exceeding the estimated cost of the programs. Implementation of an Instant Tow Dispatch program and an Authority Removal Law was recommended.

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ABSTRACT

The objective of this study was to determine the most effective way to mitigate the effect of freight crash incidents on Louisiana freeways. Candidate incident management strategies were reviewed from practice in other states and from those published in the literature. Current legislation in the state was also reviewed. A procedure to estimate the cost of delay caused by an incident was developed and used to provide a rough estimate of the cost efficiency of an Instant Tow Dispatch Program and an Expedited Towing Program. Both were estimated to be highly cost-efficient with the estimated cost of delay far exceeding the estimated cost of the programs. Implementation of an Instant Tow Dispatch program and an Authority Removal Law was recommended.

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IMPLEMENTATION STATEMENT

The two programs recommended for implementation (i.e., the Instant Tow Dispatch Program and the Authority Removal Law) should be implemented taking the following factors into account:

1. The training of police in the handling of incidents must include instruction on how to implement these two programs.
2. To the extent possible, implementation of the two programs, as well as implementation of other ad hoc strategies (e.g. streaming of video to police prior to them arriving at the scene of the incident) must be conducted separately for a period in which the cost of the program and its impact on incident detection and duration can be measured and analyzed.
3. The cost-effectiveness of different incident management strategies must be assessed from the information gained in (2) above.
4. New incident management strategies must be developed and tested in trial applications.
5. The DOTD should investigate developing a more accurate cost-of-delay estimation procedure.

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INTRODUCTION

Traffic congestion is a national problem. According to the Texas Transportation Institute, the cost of congestion in 2011 was $121 billion. This figure translates into 5.5 billion hours of wasted time, 2.9 billion gallons of wasted fuel, and 56 billion pounds of carbon dioxide greenhouse gas released. The resulting delay on the trucking community was $27 billion or 22 percent of the total and $818 on the average commuter.

Traffic incidents are a major source of congestion, both in urban and rural areas. Nationally, about 25 percent of total congestion can be attributed to traffic incidents. Further, traffic incidents create unexpected congestion – congestion that occurs in times and places where travelers do not expect to be delayed – and are therefore a major source of frustration for our customers.

Traffic-Incident Management (TIM) is a program typically coordinated through State Departments of Transportation (DOTs) and is focused on detecting, responding, and clearing traffic incidents as quickly and as safely as possible. An effective TIM program utilizes available tools such as Intelligent Transportation Systems (ITS) and established lines of interagency communication from a strategic standpoint to reduce impacts of traffic crashes. It also incorporates tactical policies and procedures such as an incident command structure, removal laws, and quick clearance incentives.

Incidents that occur on the Interstate system not only involve and impact commuters but commerce as well. On many Interstate segments, commercial vehicles are likely to be involved in an incident. Several recent crashes that have occurred in the Baton Rouge area have brought attention to the significant cost to the public, not only in terms of delay and safety, but in management, control, and mitigation by public agencies. Given a crash that blocks critical travel lanes or an entire direction for multiple hours, the cost could be enormous. Additionally, the vehicles involved in these crashes were not transporting hazardous materials or no significant injuries resulted. If hazardous material is involved, or if a serious injury or fatality occurs, the clearance procedure is complicated considerably. Since each case can vary depending on the circumstances, the clearance procedure and the delay caused can vary considerably.

OBJECTIVE

The purpose of this research was to determine the most effective way for the Louisiana Department of Transportation and Development (DOTD) to mitigate the impact of major incidents on Interstate freeways in the state. Applying a lane rental fee to the owner of the affected freight, similar to the way lane rental charges are levied against a road contractor, has been suggested. Properly equipping the DOTD and/or the Louisiana State Police (LSP) with appropriate resources and hold harmless legislation, referred to as authority removal law, necessary to execute quick clearance, is another possible remedial measure. Developing a solution, in terms of benefit/cost to the state, was the focus of this research.

SCOPE

The scope of this study is limited to non-hazardous freight crash incidents on Interstate highways in Louisiana. It is also limited to incidents where no fatalities occurred. The cost of freight crash incidents is assumed to include the value of time of motorists and commercial vehicle operators as well as the cost of delay of the freight being transported. In estimating the cost of delay caused by a freight crash incident it is assumed that vehicles typically using the blocked lanes of the facility at the time at which the incident occurs are delayed for the duration of the incident as well as for the time taken for the accumulated traffic to dissipate after the incident is cleared. Thus, the fact that some vehicles may deviate to other routes or that others may not travel at that time due to knowledge of the incident is ignored. While this may inflate the cost of delay from reality it must be realized that as traffic deviates off the freeway onto alternative routes it will impose delay on vehicles already on those routes, thereby expanding the number of vehicles experiencing delay even while those leaving the freeway experience less. It is also assumed that traffic on unblocked lanes, whether they are in the same or opposite direction to the one on which the incident occurs, are not affected by the incident even though experience shows that an incident always has an effect on adjoining lanes even though they do not experience any physical obstruction. Making more accurate estimates of delay than those estimated in this study will require research beyond the scope of this study.

METHODOLOGY

The overall method of investigation conducted in this study was to review national practice and laws as documented in the literature, review practice in Louisiana, develop a procedure to estimate the cost of freight crash incidents dependent on their time of occurrence and duration, and then use this procedure to evaluate candidate tactics aimed at reducing the cost of freight crash incidents on freeways in the state. The individual aspects of the methodology are addressed in the following sections.

Literature Review of Best Practices for Incident Clearance

Incident Command

Oftentimes, multiple agencies are represented at the scene of an incident. These responding organizations typically include law enforcement, fire and rescue, emergency medical services, towing and recovery, and DOTs. Depending on the severity or complexity of an incident, other agencies such as coroners and environmental quality could be called upon. How these responders perform their duties at a scene and the protocols that are used are defined in the National Incident Command System or NIMS, a nationwide template describing how agencies are to work together during an emergency. NIMS has as its goal public safety, stability of the incident, and protection of property. It is the command structure to apply to all incidents including those that occur on the Interstate system.

Quick Clearance

Traffic Incident Quick Clearance is the practice of rapidly and safely removing temporary obstructions—such as disabled, wrecked, or abandoned vehicles, and spilled cargo—from the roadway. Quick clearance practices are aimed at reducing incident clearance time and restoration of traffic flow. The effectiveness of each operational procedure depends on the type of equipment, trained operators and supervisors, infrastructure, and technology. Equipment, such as heavy-duty tow trucks, dump trucks, front-end loaders, sweepers, and air cushion recovery systems, help to speed the clearance of major truck-involved incidents. New technologies such as total station surveying equipment and photogrammetry will reduce investigation time for law enforcement officers *[1]*. Examples of quick clearance programs are found in the states of Florida, Washington, and Georgia as described below.

Rapid Incident Scene Clearance (RISC) in Florida. The Florida Department of Transportation and Florida Highway Patrol (FHP) adopted and implemented an "Open Roads Policy" for incident clearance termed Rapid Incident Scene Clearance (RISC). The RISC program establishes a 90-minute goal for clearance of a crash or incident to support Florida's Open Roads Policy. The RISC program was developed and implemented in 2004. Now it covers 1,464 centerline miles of limited-access highways with 21 contracted vendors in those areas *[2]*.

The vendor has 60 minutes from the activation request by the Traffic Management Center (TMC) or FHP to arrive on the scene, or they are ineligible to receive a $600 flat rate incentive. After being given the go-ahead, the vendor has 90 minutes to clear the incident. An incentive of $2,500 is awarded if they can meet the 90-minute goal. If the vendor exceeds 180-minute clearance time, they are assessed damages in the amount of $10 per minute or $600 per hour. Additional training is required for vendors participating in RISC. A vendor can be awarded $1,000 if additional extra equipment is officially requested, utilized, and brought to the scene. A maximum of $3,500 of incentive bonuses can be received by the RISC vendors for each RISC incident. FDOT paid $221,200 one year in incentive bonus funds.

Major Incident Tow (MIT) Program in Washington. In July 2007, the Washington State Department of Transportation (WSDOT) and Washington State Patrol (WSP) implemented the Major Incident Tow (MIT) Program and established a 90-minute clearance goal for heavy trucks involved in accidents in King, Pierce, and Snohomish Counties. In 2009, the program was expanded to include the rest of the I-5 Corridor from Oregon to British Columbia, Canada. The program provides monetary incentives to authorized heavy towing companies who complete the clearance and recovery process within 90 minutes *[3]*.

From July 2007 to December 2011, 90 MIT requests were activated of which 73 met the 90-minute clearance goal. Twelve activations were unsuccessful and five activations had to be cancelled. The average clearance time was 69.8 minutes and the total cost was $189,994 *[3]*.

Towing and Recovery Incentive Program (TRIP) in Georgia. The Georgia Department of Transportation (GDOT) introduced and implemented the Towing and Recovery Incentive Program (TRIP) in early 2008. TRIP provides incentive bonuses to heavy-duty towing and recovery companies for the quick clearance of large commercial vehicle incidents in the metro area of Atlanta *[4]*. If a company equipped with well-trained operators and appropriate heavy-duty equipment met all the guidelines from TRIP, it was added to the program.

When a commercial vehicle incident occurs, GDOT notifies a TRIP-registered company and it must respond to the incident scene within 30 minutes between 5:30 a.m. and 7:00 a.m., Monday to Friday and within 45 minutes at any other time outside of these hours. Two heavy duty recovery trucks must be dispatched. At least one TRIP-certified, well-trained supervisor and two certified operators must be on the scene at all times. The supervisor is in command of the towing and recovery process.

TRIP incentive bonuses include $600 if the TRIP company responds within the specified time, $2,500 if the TRIP company responds within the specified time and has cleared the obstruction and opened the traffic within 90 minutes, and an extra $1,000 if additional equipment was provided and all other requirements were met. Considering the development of the program, training the operators and emergency response personnel, documentation of the TRIP incident, coordination of After Incident Reviews (AIR), and the bonus payment, the total cost of the program from 2007 through the end of 2010 was $551,000 *[5]*.

In 2013, the average activation time for TRIP was 30 minutes. The average arrival time for TRIP company responses was 33 minutes, the average NTP (Notice to Proceed) time was 19 minutes and the average clearance time was 30 minutes. Adding these times together gives a total of 112 minutes, which is a dramatic decrease from the 269 minutes it was in 2007 *[6]*.

Service Patrols

Safety service patrols, sometimes referred to as motorist assistance patrols (MAP), are equipped with the necessary tools to assist with incidents that impede traffic flow along the interstate and expressway systems. Their objective is to help move disabled vehicles from the main lanes and ultimately get them operating or off the facility completely. Most of the patrols use vehicles such as pickup trucks, so their towing capacity limits the assistance they can provide in freight incidents.

In freight vehicle incidents, the two most important issues that should receive attention are providing a heavy duty tow truck in a timely manner and clearing the road way immediately of vehicles and spilled loads *[7]*. A study found that full-time support staff from Service Patrols reduce incident duration by 15-30 percent compared to a program with part-time staff. An analysis with five years data from 1995 to 2000 in Oregon concluded that Service Patrol operations reduced incident delay on average by 39 minutes on Highway18 and 9 minutes on Interstate 5 *[8]*.

According to the I-95 Corridor Coalition, the main issue with Service Patrol is money to support the programs *[9]* State DOTs often provide funding for the programs but others may share financing by public-public and public-private partnerships. For most toll roads, the cost of service patrols are covered by tolls from road users. On the East Coast, CVS Drug Stores sponsor FSPs (Freeway Service Patrols) in several states.

Chicago's Emergency Traffic Patrol. District 1 of the Illinois DOT pioneered the modern incident clearance practice and established Chicago's Emergency Traffic Patrol (ETP) in 1960 *[10]*. The objective of ETP is to respond and remove the traffic incidents to maintain open roads. The ETP operates 24 hours a day, 365 days a year and patrols Chicago's seven major expressways. For a major incident involving a truck, the ETP fleet is supplemented with four more recovery tow trucks, making up a recovery truck fleet that comprises one 50- and one 60-ton-capacity static boom recovery tows, one 50-ton-capacity rotating boom recovery tow, and one severe-service 60-ton-capacity rotating boom crash crane. An air-cushion recovery system in the ETP can lift more than 90,000lb. ETP operators receive extensive training on the removal of traffic incidents, including heavy equipment use, emergency recovery procedures and air-cushion recovery work.

Freeway Service Patrol in Tennessee. The state of Tennessee has an excellent Freeway Service Patrol (FSP) in four major Metropolitan cities: Knoxville, Chattanooga, Memphis and Nashville, covering 365 highway miles. The program began in June 1999. In the four-city area, they have deployed 46 Freeway Service Patrol vehicles and 89 full-time, authorized DOT operators and supervisors *[11]*. Operators and supervisors receive initial training involving “quick clearance” training which lasts nine weeks. Each operator has two-way radio communication with a dispatcher and the other operators. Each shift supervisor has a police radio to facilitate response and clearance to incidents. All of these personnel have to be certified as emergency medical First Responders. Patrols can provide services on traffic control, tag abandoned vehicles, change tires and provide fuel and mechanical assistance. During 2002, the operators from the Tennessee FSP moved damaged or disabled vehicles from travel lanes more than 6,300 times, removed 3,700 vehicles from unsafe locations to an appropriate place, provided first aid 667 times and extinguished fires 153 times *[12]*.

Freeway Courtesy Patrol in Michigan. In Michigan, the Freeway Courtesy Patrol was established in 1994. The Michigan Department of Transportation (MDOT) has expanded the use of the Freeway Courtesy Patrol (FCP) beyond Southeast Michigan to include select freeways on US-23, I-96, I-94 and M-14. In 2008, the Courtesy Patrol saved an estimated 11.5 million hours of delay on freeways in the coverage area. According to a report issued by SEMCOG (Southeast Michigan Council of Governments), a benefit of $15.20 is realized for each dollar spent on this program *[13]*.

Literature Review of Laws Governing Traffic Incident Management

In response to traffic incident losses, many states and local governments have adopted general legislation constituting Quick Clearance Laws. Laws and policies on incident clearance have far-reaching effects on maintaining open roads. These laws relieve congestion and reduce the time to restore normal operations. Carson indicates that three laws – the “Move Over Law,” the “Driver Removal Law,” and the “Authority Removal Law” - constitute and support quick clearance operation and enhance safety *[1]*. NCHRP 318 classifies the legislation into 4 categories: “Driver Stop law,” “Driver Removal law,” “Authority Removal law,” and “Authority Tow law” *[10]*. Legislation can guarantee the operational procedures achieve their full potential for response and clearance of incidents.

Move Over Law

Move Over laws require drivers approaching a scene where emergency responders are present to either change lanes when possible and/or reduce vehicle speed. An investigation from Ohio State Highway Patrol indicates that 55 percent of responders struck-by incidents results in serious injuries and fatalities and 60 percent occurred on interstate highways under high speed and high volume *[14]*. The primary intent of Move Over laws is to ensure responder safety.

In 2002, Scott's Law in Illinois was passed in honor of Scott Gillen of the Chicago Fire Department, who was struck and killed by a drunk driver while assisting at a crash on a busy Chicago Expressway. Scott's Law requires motorists to move over a lane and reduce speed if there is a stationary emergency vehicle stopped with visual signals. People found guilty of violating this law can be fined up to $10,000 and their driving privileges suspended up to 2 years *[15]*.

Florida's Move Over laws requires that on a two-lane roadway, drivers must slow to a speed that is 20 miles per hour less than the posted speed limit *[16]*. If the speed limit is 20 miles per hour or less, drivers must slow down to five miles per hour. If driving on an interstate or roadway with multiple lanes of travel in the same direction and approaching an emergency or law enforcement vehicle parked along the roadway, drivers must vacate the lane closest to that vehicle as soon as it is safe to do so. If drivers are not able to safely move over, they must slow down to a speed of 20 MPH below the posted speed limit unless directed otherwise by a law enforcement officer.

Carson indicated that Move Over laws contain challenges or shortcomings *[1]*. Some states may not include all types of incident responders in Move Over laws, thereby not offering these responders the necessary safety enhancement. The laws in Georgia, Tennessee and Kansas are considered as model legislation that include transportation, towing/recovery, or service patrol personnel and/or vehicles, as well as emergency responders and/or vehicles. At the same time, when drivers are changing lanes, they may take additional risks. California revised their early version of the law and re-introduced it with the following language for changing lanes: "with due regard for safety and traffic conditions, if practicable and not prohibited by law" *[17]*. In addition, Move Over laws may be difficult to enforce because of lack of public awareness and limited law enforcement activity.

Driver Stop Law

Driver Stop law is the oldest quick clearance legislation. It requires the drivers involved in a crash to stop their vehicles without blocking traffic.

The Uniform Vehicle Code has enacted a model driver stop law since 1956 *[18]*. State driver stop laws typically mirror the Uniform Vehicle Code law. Kansas and Maryland both cite their States' Driver Stop law directly. However, the Uniform Vehicle Code focuses on Property Damaged Only (PDO) crashes. Some states have also included injury and fatal crashes as well.

The Code of Virginia, Section 46.2-894 requires a driver to stop in the event of an accident "involving injury or death or damage to attended property" *[11]*. The driver should report his name, address, driver’s license number, and vehicle registration number to the State Police or local law-enforcement agency, and to the person injured in the accident.

Florida Driver Stop Law 361.027 and 316.061 requires the driver of any vehicle involved in a crash resulting in “injury of any person; death of any person or only in damage to vehicle or other property which is driven or attended by any person” to stop the vehicle at the scene *[11]*.

Minnesota Statutes Section169.09.1 entitled “Driver to stop for accident with person” states that a driver of any vehicle involve in an accident resulting in “bodily injury or death of any person” should immediately stop the vehicle *[10]*.

According to the survey from NCHRP, it shows that 34 states possess driver stop laws *[10]*. There are 29 states that apply driver stop laws to all crashes, including PDO crashes, personal injury crashes and crashes involving a fatality. The other 5 states apply to PDO crashes only.

Driver Removal Law

Driver Removal laws require motorists in traffic incidents involving disabled vehicles, PDO crashes, and injury crashes with no apparent physical injury to move their vehicle out of the travel lanes as soon as they can do so safely. This law differs from the Driver Stop Law in that it puts the responsibility on drivers involved in an accident whose vehicle are blocking travel lanes. The Driver Removal Laws may accomplish the clearance of affected lanes before the incident is detected and responded to by transportation or law enforcement agencies. However, many drivers are reluctant to move their vehicles due to the old impression that the vehicle should not be moved until police or law enforcement arrives.

A strong Driver Removal law should address the following provisions according to NCHRP 318:

- Incident type
- Incident severity
- Type of roadway facility where the incident occurs
- Lateral location of the incident
- Specification of who may move a disabled or wrecked vehicle
- Specification of where to move a vehicle blocking traffic
- Specification of immobilized vehicle handling
- Specification of a hold harmless clause.

A typical Driver Removal law from Connecticut Statutes, section 14-224(d) specifies *[19]:*

> Each person operating a motor vehicle who is knowingly involved in an accident on a limited access highway which causes damage to property only shall immediately move or cause his motor vehicle to be moved from the traveled portion of the highway to an untraveled area which is adjacent to the accident site if it is possible to

move the motor vehicle without risk of further damage to property or injury to any person.

When an immobilized vehicle is disabled on a street or highway, Driver Removal laws from some states mandate that drivers seek assistance and move the vehicles so as not to obstruct the regular flow of traffic, for example, the entitled “Disabled vehicles obstructing traffic” from Florida Statue 316.071 *[20]*.

NCHRP 318 indicates that 14 states in the U.S. maintain Driver Removal laws, 6 States apply laws to driver-attended disablements, 12 states apply to PDO crashes and 7 states apply to minor injury *[10]*.

Many documents, including the National Traffic Incident Management Coalition and US Fire Marshal’s documents, indicate that the main weakness of the Driver Removal laws currently enacted is the lack of a hold harmless clause *[21]*. Other shortcomings and challenges include that the Driver Removal law may be limited to metropolitan areas, drivers may be reluctant to move vehicles, and law enforcement personnel will not have drivers move vehicles before finishing the crash investigations *[1]*.

Authority Removal Law

Authority Removal laws clarify the authority and responsibility of agencies to remove disabled or wrecked vehicles and spilled cargo or other personal property from the roadway to prevent the occurrence of secondary incidents and to allow normal traffic flow to resume. Authority Removal laws typically provide incentive to agencies when they can finish clearance within specific time. Generally, state DOTs, state, county and local law enforcements are responsible for the vehicle or cargo removal.

Rhode Island expanded the Authority Removed law to all types of traffic incidents *[22]*:

a. Whenever any public safety agency through the legitimate exercise of its police powers determines that an emergency is caused by the immobilization of any vehicle(s) on the interstate system or limited access highway, as defined in § 31-1-23(e), resulting in lane blockage and posing a threat to public safety, public safety agencies and those acting at their direction or request shall have emergency authority to move the immobilized vehicle(s).

b. There shall be no liability incurred by any state or local public safety department or agents directed by them whether those agents are public safety personnel or not for damages incurred to the immobilized vehicle(s), its contents or surrounding area caused by the emergency measures employed through the legitimate exercise of the police powers vested in that agency to move the vehicle(s) for the purpose of clearing the lane(s) to remove any threat to public safety.

Hold Harmless Legislation
According to NCHRP 318, there are three types of hold harmless laws *[10]*. The first type of law is associated with the Driver Stop law and the Driver Removal law. The general hold harmless law states that a driver or other person who moves the vehicle involved in a crash out of the travel lane is not liable or at fault with regard to the cause of the crash.

The second type of hold harmless law is associated with the Authority Remove law and protects incident responders who are fulfilling requirements. This type of hold harmless law states that respondents removing disabled or wrecked vehicles and cargo that obstruct the normal flow of traffic are prohibited from incurring liability. Agencies, such as DOTs, law enforcement, and any person working under the direction of a designated authority, are protected under the law.

The third type of hold harmless law protects incident responders from potential liability incurred by the failure to execute the requirement of a quick clearance law. Virginia Statute Section 46.2-1212.1, part B of the law contains a hold harmless provision: "The Department of Transportation, Department of State Police, local law-enforcement agency and other local public safety agencies and their officers, employees and agents, shall not be held responsible for any damages or claims that may result from the failure to exercise any authority granted under this section provided they are acting in good faith." *[23]*.

Louisiana Programs of Incident Clearance

Legal support of quick clearance of incidents has been addressed by state legislatures across the country. As noted in the previous section, there are three basic laws that govern most public agencies' handling of crashes, commonly referred to as: "Move Over," "Driver Removal," and "Authority Removal" laws. Louisiana has implemented a version of the "Move Over" and "Driver Removal" law.

In Louisiana Act 429 was passed and signed by the Governor in 2008 *[24]*. Act 429 addresses several issues related to highway incident management in Louisiana. The primary objective of the legislation is to improve the management of incidents by emergency responders by improving safety, site management, clearance and traffic control.

There were several items addressed in the legislation. A brief summary of each is provided below:

Move Over Law
This provision requires motorists driving on an interstate highway or other highway with two or more lanes in one direction to move to a lane not adjacent to a response vehicle at an incident. This is a safety measure to create a buffer between responders at an incident and passing vehicles.

Abandoned Vehicle Time Change
This provision reduces the time a vehicle can be left on a highway unattended before it is towed from 72 hours to 24 hours. Abandoned vehicles create a safety hazard and this reduces the exposure time on a highway for an abandoned vehicle.

Open Roads Agreement
This requires the DOTD and LSP to set performance standards for the response and clearance of traffic incidents and include a post-action review process to evaluate long delays and recommend improvements. The Open Roads Agreement is to be provided to parish and municipal authorities for their consideration of adopting the agreement. The intention of the agreement is to establish a policy of clearing incidents as quickly as possible.

Police Officer Standards and Training (POST)
Act 429 requires that every law enforcement officer in the state shall be trained in a traffic incident management POST-certified course to be taught at a POST-certified academy. Traffic incident management training for police officers has not been required in the past. This requires that POST training for officers include a highway traffic incident element.

Towing and Recovery Pilot Programs
Act 429 legislation established two towing and recovery pilot programs with the objective of reducing extended delays caused by accidents on multi-lane highways. The programs are titled in the legislation as the Instant Tow Dispatch Pilot Program and the Expedited Towing Pilot Program.

Instant Tow Dispatch Program
The Instant Tow Dispatch Pilot Program is directed at reducing the time required to get a towing vehicle to an incident on the highway. A common delay experienced by tow vehicles trying to access an incident site is the long queues that quickly form behind an incident particularly on high traffic volume interstate highways. The intent of the Instant Tow Dispatch Program is to encourage police departments to dispatch a tow vehicle to the incident as soon as they are aware that a tow might be needed. The current dispatch procedure for most police departments is that an officer who has arrived at the incident scene requests a tow after he determines that the driver of the vehicle needing to be towed does not have a tow company that he wants to use. If the driver does not have a preferred tow company the police department dispatches a tow company from its tow rotation list.

The existing process for dispatch of a tow company usually results in the tow company being dispatched after the police officer has assessed the scene, requested EMS if necessary, and is beginning to investigate the accident. By this time a traffic queue has formed and makes it difficult for the tow vehicle to access the incident. This difficulty is further complicated if the incident is in a section of the interstate that does not have shoulders. The traffic queue causes delays in removing the vehicle(s) and reopening the highway travel lane(s). The Instant Tow Dispatch Program addresses this by encouraging police agencies to dispatch the tow company as soon as there is information that a tow may be needed. The need for a tow may come from observing the incident on a Traffic Management Center camera or from a report called in from the incident scene.

A primary reason that police departments do not quickly dispatch tow companies is that if a tow dispatched by them reaches the incident and is not used to tow a vehicle the tow company receives no compensation. This is referred to as a "dry run." A dry run may occur because a driver involved in the incident has requested a specific tow company or the vehicle(s) involved in the incident was able to be driven away under its own power.

The Instant Tow Dispatch Program provides funding for the police agency to reimburse a tow company that has incurred a dry run. Providing this reimbursement encourages the police agencies to "instantly" dispatch a tow company to an incident as soon as there is an indication that a tow may be needed to clear the roadway. Instant dispatch allows the tow company to be in route and access the scene before the queue from the accident reaches its maximum.

Expedited Towing Program

The Expedited Towing Pilot Program addresses the recovery phase of incident management. The program provides monetary incentives to tow companies that can recover vehicles or cargo that are blocking travel lanes within a prescribed time frame. The tow company is paid an incentive fee in addition to normal towing and recovery charges. The program only applies to heavy duty tows required by trucks, buses, large recreational vehicles, etc. that are involved in an incident blocking travel lanes.

The Expedited Towing Program is based on the concept that if tow companies have an incentive to expedite recovery the roadway will be cleared faster. The regular fee structure for a heavy duty tow is based on hourly charges. This does not encourage quick recovery. This regular fee structure is not changed by the pilot program. The incentive fee is in addition to the company's regular fee with the incentive fee being paid by the government.

Driver Removal

Louisiana state law sets the policy for moving vehicles from travel lanes in the event of a vehicle crash. The law stipulates, "In the event of a motor vehicle accident, if the driver is not prevented by injury and the vehicle is not disabled by the accident, or the accident has not resulted in serious injury or death of any person, the driver shall remove the vehicle from the travel lane of the highway to the nearest safe shoulder. Compliance with the provisions of this Subsection shall in no way be interpreted as a violation of requirements to remain at the scene of an accident as provided for in the Highway Regulatory Act or R.S. 32:414." *[25]*.

Also enacted by the 2010 legislative session was a revision to the authority given to public safety agencies for the removal of deceased persons involved in a fatal crash *[26]*. The law permits a law enforcement agency to move the body from the travel lane necessary to "maintain the flow of traffic on a highway or railroad."

Literature Review of Cost of Delay

Value of Time Studies

Traffic incidents, and the congestion they incur, result in travel delay that is onerous to travelers, increases the operating costs of the vehicles involved, and delays delivery of the freight transported. Freight receiving stations that rely on just-in-time delivery to minimize warehouse space are thwarted in that objective, truck driver itineraries are disrupted, and travelers are unable to keep appointments resulting sometimes in serious costs to business and society. Ascribing a value to the travel time of travelers, freight, and vehicles is a way to quantify the cost of an incident. The value of time (VOT) is a topic that has been studied in the context of transportation planning for many decades and its quantification in various studies within the context of traffic incidents is discussed below *[27]*.

Khattak, Fan and Teague tried to quantify the business-related costs of incident-induced traffic congestion on North Carolina's Interstate facilities *[27]*. A case study approach was used to explore both the quantitative and qualitative aspects of incident-induced traffic congestion. Telephone interviews and face-to face interviews were conducted with transportation managers of major private employers in North Carolina. A total of 29 businesses were surveyed and showed average hourly cost of unexpected delay of $145 to the businesses surveyed. The information obtained from each business was used to calculate an average hourly cost of unexpected delay using the equations below:

$$C_{hourly} = C_{annual} / d_{annual} \tag{1}$$

$$S_{annual} = S_{day} * n * p \tag{2}$$

$$d_{annual} = S_{annual} * \bar{d} \tag{3}$$

where, C_{hourly} is hourly cost of unexpected delay. C_{annual} is the annual cost of unexpected delay, which could be estimated by equation (4) below, d_{annual} is annual unexpected delay in hours. S_{annual} is annual delayed shipments. S_{day} is shipments per day. n is the number of shipment days per year. p is percentage of shipments delayed. $\bar{d}$ is average unexpected delay per shipment in hours.

Wheeler and Figliozzi developed multi-criteria tools for measuring the impact of recurring and nonrecurring congestion on freight *[28]*. They used three kinds of major data sources to analyze the effects of congestion on I-5 in the Portland, Oregon, metropolitan area: Global Positioning System data from commercial trucks, Oregon Department of Transportation corridor travel time loop data, and incident data. They found that traditional traffic sensor data underestimates the impact of congestion on travel times and variability of commercial vehicles compared to the GPS truck data. In addition, this study developed monetary performance measures of the effect of congestion on freight. They used the Texas Transportation Institute formula to determine the annual cost of congestion for freight vehicles *[29]*:

$$C_{annual} = d_{delay} * p * VOT * 250\ working\ days/yr \quad (4)$$

where,

C_{annual} = the annual commercial vehicle cost of unexpected delay,

d_{delay} = the daily vehicle hours of delay,

p = the percentage of commercial vehicles, and,

VOT = the commercial vehicle time value ($/h).

Travel time reliability is another parameter which could be considered in travel cost calculations. Reliability of travel time is particularly important to time-sensitive shippers and time-definite delivery carriers *[28]*. The equation below is used to estimate cost:

$$c = \alpha_1 * T + \alpha_2 * V(T) + \alpha_3 * M \quad (5)$$

where,

c = travel cost of travel time variability,

T = trip travel time,

V(T) = trip time variability,

M = cost of travel, and,

$\alpha_1, \alpha_2, \alpha_3$ = parameters representing the dislike of travel time, variability, and travel cost, respectively.

A study from Brand et al. estimates the total value of time saving for a truck is $80 per hour *[30]*. Of this amount, truck operation and maintenance cost including depreciation is $70 at an average speed of 50 mph based on operating and financial data compiled by the American Trucking Associations, and the time value of goods shipped by truck is estimated at $10 per hour. Tyworth and Zeng estimated that for just-in-time service delivery, the value of reducing transit time by 24 hours (i.e., from 3 to 2 days) for the average shipper was $310, which implies an average truckload time-saving value of $12.90 per hour *[31]*. Considering

$70 for operation and maintenance mentioned above, it would seem that total truck VOT is reasonably estimated at $80 per hour.

In 2003, Smalkoski and Levinson studied truck VOT in order to quantify the impact of the spring load restriction policy in Minnesota *(32)*. The average commercial vehicle VOT was estimated as $49.42. Considering the increased fuel prices and monetary inflation, the VOT would be higher now.

Small et al estimated the effects of congestion on the value of travel time and on travel time predictability *[33]*. They indicate that during heavy congestion, freight carriers place a premium on travel-time savings of $144.22 to $192.83 per hour. For late schedule delay, the premium is $371.33 per hour.

Trego and Murray suggest that freight carrier hourly costs are more accurately estimated using actual truck operation costs rather than the more abstract and qualitative measure of the "value of travel time" *[34]*. According to Fender and Pierce, fuel and driver wages continued to be the largest cost for carriers, taking up 62 percent of the average operating cost *[35]*. Lease or purchase payments, repair and maintenance cost, driver benefits, and insurance are taking up 11 percent, 9 percent, 9 percent, and 3 percent, respectively. Also, they indicate that the average marginal cost per mile for 2011 was $1.71 and the total average industry cost per hour was $68.20 in 2011.

Variables such as employment, trip purpose, mode, and distance are considered to influence the value of travel time. The USDOT recommends that VOT be 100 percent of wage rate for local business travel and 50 percent of wage rate for local personal travel *[36]*. Brownstone and Small conducted stated preference and revealed preference surveys and they found that VOT on the morning commute is $20-$40 per hour, or 50 percent to 90 percent of the average wage rate in the sample *[37]*. Litman suggested that under urban-peak conditions, VOT for drivers is $7.50 (50 percent of median wage rate at that time) and $3.75 for passengers (25 percent of median wage rage) *[38]*. Under urban off-peak and rural conditions, drivers' and passengers' time is valued at 25 percent of median wage rage. Concas and Kolpakov also set the rules for estimating drivers' VOT. They suggested that if the trip purpose is work-based commercial, VOT is equal to 100 percent of the driver's hourly wage *[39]*. If trip purpose is work-based private, VOT is equal to 50 percent of the drivers' hourly wage. According to TTI's Urban Mobility report, value of travel delay is estimated at $16.79 per hour of personal travel *[40]*. Truck congestion cost is estimated at $86.81 per hour.

Value of Time Assumed in Louisiana

According to the Bureau of Labor Statistics, the mean hourly rate for Louisiana was $18.99 in 2013 *[41]*. In this study, VOT is assumed to be $17 (90 percent of mean hourly rate) for personal trips on peak hours from Monday to Friday and $8.5 (45 percent of mean hourly rate) on off-peak hours during the week. The VOT assigned to trucks is $80 per truck in the cost estimation procedure described below.

Procedure to Estimate Cost of Delay

The method of estimating the cost of delay outlined below depends on estimating the time that vehicles are delayed as a result of an incident and then applying the value of time to those affected. It assumes that those affected take no remedial action such as choosing an alternative route, delaying their departure, or canceling their trip entirely. Thus, the estimate is likely to be exaggerated for incidents that take a long time to clear. Estimating how people are likely to respond to an incident, and the impact their actions will have on traffic flow on the facilities to which they migrate, is a detailed study of human behavior and beyond the scope of this project.

Symbols

V = traffic volume in vehicles per hour
P_k = percent of daily traffic at the k^{th} hour of the day
Q_k = proportion of truck traffic at the k^{th} hour of the day
T = Time when incident occurs
R = duration of incident in hours
n = number of lanes blocked
VOT_x = Value of time for mode x (in $/vehicle-hour)
r = hours since incident occurred (r = 0,1,2,3, ….. ,R)
k = hour of the day
S = saturation flow rate (vehs/lane/hour)

Input Information

1. Time, date, and location of incident
2. Duration of incident in hours (i.e., R)
3. Number of lanes blocked (i.e., n)
4. AADT (annual average daily traffic) on road section where incident occurred
5. Weekly, daily, and hourly variation of traffic (on section or in general)
6. Traffic composition by day of week and hour of day (truck vs other vehicles)
7. Value of time for trucks and cars (separately) (i.e., VOT_x)
8. Saturation flow rate (i.e., S)

Note that items 5-8 above typically remain the same from incident to incident and can, therefore, be built into any automation of the cost estimation procedure thereby requiring input information only on the incident itself (items 1-4 above). The opportunity can be provided to allow their values to be manually changed should that be warranted.

Calculations

Estimating Volume of Traffic Affected. From the date and location of the incident, establish the AADT on the lanes affected and adjust by the season and day of week to get an estimate of the average daily traffic at the location on the day of the incident. Apply the percentage of daily traffic by the hour of the day, P_k, and the proportion of truck traffic by hour of the day, Q_k, to estimate truck and auto traffic at the location by hour of the day:

$$V_{truck,k} = AADT(adjusted) * P_k * Q_k \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (6)$$

$$V_{auto,k} = AADT(adjusted) * P_k * (1 - Q_k) \dots\dots\dots\dots\dots\dots\dots\dots (7)$$

$$V_{truck,k} + V_{auto,k} = V_k \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (8)$$

With estimates of V_k for each hour of the day as shown in Figure 1, interpolate to obtain estimates of the hourly volume on the road section at the time of the incident and for each hour afterwards for the duration of the incident. Write these volume estimates as V_r with r = 0, 1, 2, ….. R. The traffic affected by the incident will be as shown in Figure 2 with the assumption that no traffic deviates from the facility when they learn of the incident. This is a great simplification but traffic deviating from the affected facility will cause congestion on surrounding routes resulting in delay being transferred rather than eliminated. This simplification is adopted until a more realistic characterization of traffic behavior can be developed.

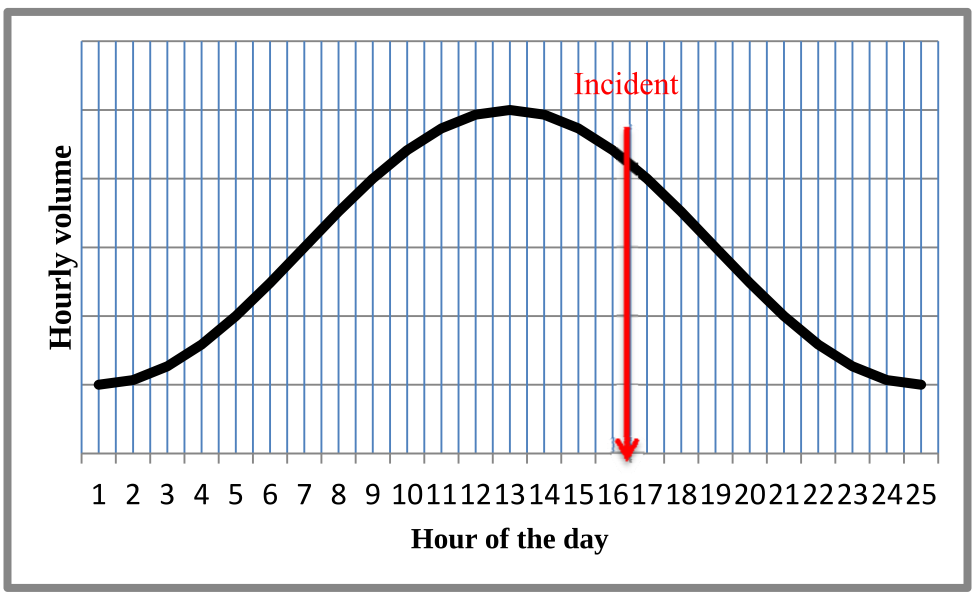

Figure 1
Hourly volume of affected traffic at incident site

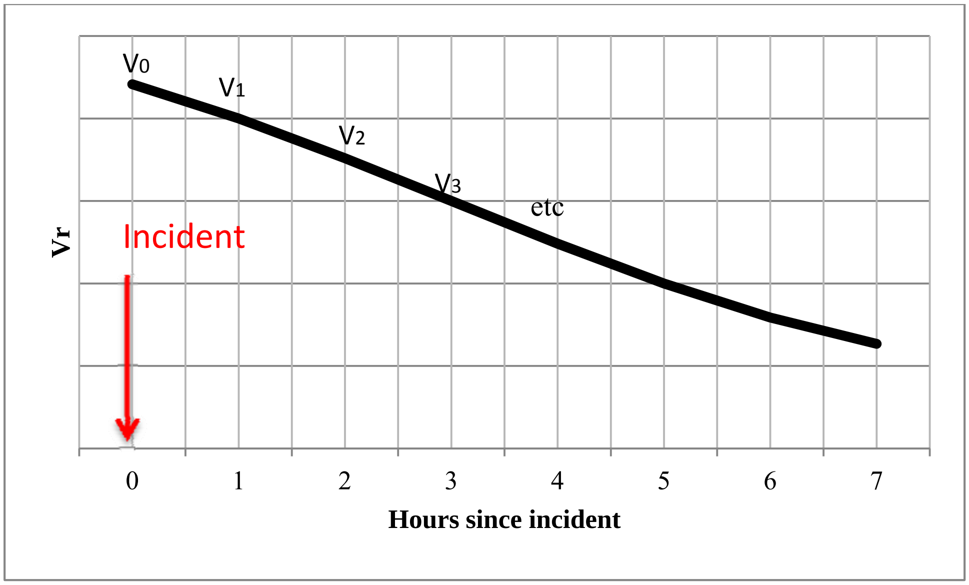

Figure 2
Hourly volume of traffic affected by incident

Estimating Delay during an Incident. If queue formation is ignored, delay in vehicle-hours experienced during the first hour following the incident is the average delay experienced by accumulated traffic multiplied by the duration of the period (1 hr). Assuming uniform arrival, an estimate of the total delay during the first hour is:

$$Delay\ in\ 1st\ hour = \frac{V_0 + V_1}{2} . \frac{1}{2} . 1 = \frac{V_0}{4} + \frac{V_1}{4}$$

In the second hour, the traffic accumulated in the first hour is delayed for the full hour and the traffic arriving at the location during the second hour is delayed, on average, for half of the second hour.

$$Delay\ in\ 2nd\ hour = \frac{V_0 + V_1}{2} . 1 + \frac{V_1 + V_2}{2} . \frac{1}{2} . 1 = \frac{V_0}{2} + \frac{V_1}{2} + \frac{V_1}{4} + \frac{V_2}{4}$$

In the third hour, the traffic accumulated in the first and second hours are delayed for a full hour and the traffic arriving at the location during the third hour is delayed, on average, for half of the third hour.

$$Delay\ in\ 3rd\ hour = \frac{V_0 + V_1}{2} . 1 + \frac{V_1 + V_2}{2} . 1 + \frac{V_2 + V_3}{2} . \frac{1}{2} . 1$$
$$= \frac{V_0}{2} + \frac{V_1}{2} + \frac{V_1}{2} + \frac{V_2}{2} + \frac{V_2}{4} + \frac{V_3}{4}$$

The delay in each hour after the incident can be described by the product of the coefficients in each row and the volume of traffic at the head of the column in Table 1 below for R=7. Total delay is the sum of the products for all rows. Thus, total delay during an incident of duration R can be expressed as:

$$Delay\ during\ incident = \sum_{r=0}^{R} \frac{V_r}{4} + \sum_{r=1}^{R-1} \frac{3V_r}{4} + \frac{V_0(R-1)}{2} + \sum_{r=1}^{R-2} V_r(R-r-1) \ldots\ldots\ldots\ldots (9)$$

Table 1
Coefficients of delay

		Vehicle volume							
		V_0	V_1	V_2	V_3	V_4	V_5	V_6	V_7
Hours since incident occurred	1	1/4	1/4						
	2	1/2	1/2+1/4	1/4					
	3	1/2	1/2+1/2	1/2+1/4	1/4				
	4	1/2	1/2+1/2	1/2+1/2	1/2+1/4	1/4			
	5	1/2	1/2+1/2	1/2+1/2	1/2+1/2	1/2+1/4	1/4		
	6	1/2	1/2+1/2	1/2+1/2	1/2+1/2	1/2+1/2	1/2+1/4	1/4	
	7	1/2	1/2+1/2	1/2+1/2	1/2+1/2	1/2+1/2	1/2+1/2	1/2+1/4	1/4

Estimating Delay after Obstruction Is Removed. To estimate the delay after obstruction is removed note that the traffic that has accumulated is:

$$Accumulated\ traffic = \sum_{r=0}^{R-1} \frac{V_r + V_{r+1}}{2} \quad (vehicles)$$

Time taken for accumulated traffic to dissipate is the accumulated traffic divided by the saturation flow of the facility (S):

$$Time\ to\ clear\ accumulated\ traffic = \sum_{r=0}^{R-1} \frac{V_r + V_{r+1}}{2nS} \quad (hours)$$

$$Total\ vehicle\ delay = \sum_{r=0}^{R-1} \frac{V_r - V_{r+1}}{2} . \frac{1}{2} . \sum_{r=0}^{R-1} \frac{V_r - V_{r+1}}{2nS}$$

$$= \sum_{r=0}^{R-1} \frac{(V_r - V_{r+1})^2}{8nS} \quad (veh - hrs) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots .. (10)$$

Estimating Cost of Delay

Using equations (6) and (7), the delays estimated in equations (9) and (10) can be broken into the cost of delay experienced by trucks and private vehicles separately by applying the appropriate value of time to trucks and private vehicles:

$$Cost\ of\ delay\ to\ trucks = \left[\sum_{r=0}^{R}\frac{V_r}{4}Q_r + \sum_{r=1}^{R-1}\frac{3V_r}{4}.Q_r + \frac{V_0(R-1)}{2}.Q_r + \sum_{r=1}^{R-2}V_r(R-r-1).Q_r + \sum_{r=0}^{R-1}\frac{(V_r+V_{r+1})^2}{8nS}.Q_r\right].VOT_{truck} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.(11)$$

$$Cost\ of\ delay\ to\ private\ vehicles = \left[\sum_{r=0}^{R}\frac{V_r}{4}(1-Q_r) + \sum_{r=1}^{R-1}\frac{3V_r}{4}.(1-Q_r) + \frac{V_0(R-1)}{2}.(1-Q_r) + \sum_{r=1}^{R-2}V_r(R-r-1).(1-Q_r) + \sum_{r=0}^{R-1}\frac{(V_r+V_{r+1})^2}{8nS}.(1-Q_r)\right].VOT_{priv.\ veh.} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (12)$$

where,

VOT_x = value of time for vehicle type *x* (in $ per vehicle hour).

The total cost of delay due to an incident is the sum of equations (11) and (12). The entire cost estimation process has been programmed in Excel for ease of application. AADT values by road section have been entered into the program for all freeways in Louisiana and are retrieved automatically once the date, time, and location of an incident is input to the system. In addition, default values of the value of time, saturation flow, and variation in traffic flow by time of day, day of week, and week of the year are stored in the system.

Computer Model to Estimate Cost of Delay

Input Describing Incident

Figure 3 shows the input information required for each incident. In the first input item, users input time, date, and location of the incident. The highway and milepost information is required to identify AADT on the road section where the incident occurred. If the milepost value the user inserts is beyond the length of the highway recorded in the computer file, the return value of AADT (item 4 in Figure 4) will display “Wrong Milepost” and the user will need to insert the correct milepost. For items 2-3 in Figure 3, users need to input the duration of incident in hours and minutes, and the number of lanes affected by the incident.

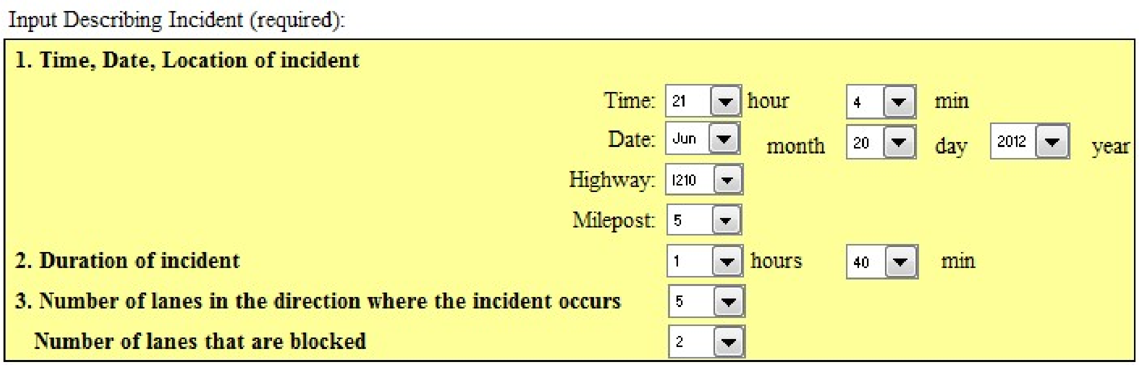

Figure 3
Input information on "homepage" worksheet

Default Input

Figure 4 shows default input values. For item 4, the value of AADT is automatically derived in the program once the location of the incident is entered. The derived AADT values for a specified milepost are based on interpolation of recorded AADT values at specific sites from Louisiana DOTD’s traffic counting program. Users can only change AADT values by changing values in the worksheet “AADT” shown in Figure 5. AADT values in the worksheet include traffic in both directions while incidents typically only affect only one direction of traffic (if the effect of “rubbernecking” of traffic in the opposing direction is ignored). As a consequence, only 50 percent of the AADT flow is considered delayed due to an incident in the program. In addition, if only some of the lanes in one direction are blocked, then that proportion of the traffic (i.e., blocked lanes/all lanes) in that direction is considered affected.

Default Input Derived from Historical Records (alter manually if necessary):

4. AADT on road section where incident occurred	17218
5. Weekly, daily, and hourly variation of traffic	
Monthly variation:	0.97076
Daily variation:	0.9958
Hourly variation:	0.05
6. Traffic composition (truck vs other vehicles)	
Truck:	0.15
Other vehicle:	0.85
7. Value of Time ($/hr)	
Truck:	80
Car:	7.5
8. Saturation Flow Rate (veh/lane/hr)	2000

Figure 4
Default input information on "homepage" worksheet

	A	B	C	D	E	F	G	H
1	Interpolated ADT				ADT value from LA DOTD:			
2	Pri Hwy Num	milepost	adt		ROUTE	milepost	YEAR1	ADT1
3	10	1	38559		I-0010	1.74	2010	38800
4	10	2	38532		I-0010	5.47	2010	34959
5	10	3	37503		I-0010	9.11	2010	35478
6	10	4	36473		I-0010	20.703	2010	37434
7	10	5	35443		I-0010	21.68	2010	58073
8	10	6	35035		I-0010	24.78	2010	77721
9	10	7	35177		I-0010	26.41	2010	60107
10	10	8	35320		I-0010	28.09	2010	66795
11	10	9	35462		I-0010	30.724	2010	54444
12	10	10	35628		I-0010	31.245	2010	52966
13	10	11	35797		I-0010	32.12	2010	58619
14	10	12	35966		I-0010	33.03	2010	54362
15	10	13	36134		I-0010	33.217	2010	50198
16	10	14	36303		I-0010	34.07	2010	57506
17	10	15	36472		I-0010	36.26	2010	45421
18	10	16	36640		I-0010	44.76	2012	53892
19	10	17	36809		I-0010	45.77	2012	49280
20	10	18	36978		I-0010	54.11	2012	35110
21	10	19	37147		I-0010	59.169	2012	40906
22	10	20	37315		I-0010	63.13	2012	48216
23	10	21	43708		I-0010	65.46	2012	43313

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Figure 5
AADT worksheet

The factors describing the default monthly, weekly, and daily variation in traffic in item 5 of Figure 4 are derived from the traffic variation factor tables shown in the “factor” worksheet in Figure 6 given the date and time the incident occurred. Users can only change the traffic variation factors in the “factor” worksheet.

Monthly variation of traffic

1	January	0.99393
2	February	1.01110
3	March	0.98498
4	April	1.01123
5	May	0.98543
6	June	0.97076
7	July	0.97320
8	August	0.97573
9	September	0.99826
10	October	0.97539
11	November	1.00057
12	December	0.97486

Daily variation of traffic

1	Monday	0.9465
2	Tuesday	0.9672
3	Wednesday	0.9958
4	Thursday	1.0392
5	Friday	1.1547
6	Saturday	0.9722
7	Sunday	0.9262

Hourly Variation

1	1a.m.	0.01
2	2a.m.	0.02
3	3a.m.	0.02
4	4a.m.	0.02
5	5a.m.	0.03
6	6a.m.	0.06
7	7a.m.	0.08
8	8a.m.	0.08
9	9a.m.	0.08
10	10a.m.	0.05
11	11a.m.	0.04
12	12a.m.	0.02
13	13a.m.	0.01
14	14a.m.	0.01
15	15a.m.	0.02
16	16a.m.	0.04
17	17a.m.	0.05
18	18a.m.	0.08
19	19a.m.	0.08
20	20a.m.	0.06
21	21a.m.	0.05

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Figure 6
Traffic variation factors

For item 6 in Figure 4, the proportion of truck traffic is differentiated by the functional system used in this study. Functional system 1 means the highway is in a rural area and functional 11 means the highway is in an urban area. Users can only change the default value of proportion of the truck traffic in the "truck" worksheet shown in Figure 7.

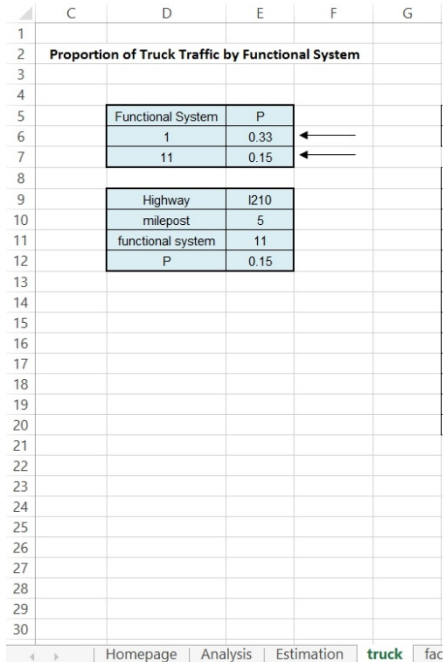

Figure 7
Proportion of truck traffic

For item 7 in Figure 4, the default value of VOT for passenger vehicle is assumed to be $17/hr. for personal travel during the peak hours from 6-9 AM and 4-7 PM Monday to Friday, and $8.50/hr. for personal travel on off-peak hours during the week. During the weekend, all travel time is valued at $8.50/hr. For trucks, the default value of VOT is $80/hr. Users can change the default value in "VOT" worksheet shown in Figure 8.

	A	B	C	D	E	F	G	H	I	J	K
1											
2					Day of Week						
3	weekday:	3		Time:	1	2	3	4	5	6	7
4	hour:	21		1	8.5	8.5	8.5	8.5	8.5	8.5	8.5
5	VOT Car:	**8.5**		2	8.5	8.5	8.5	8.5	8.5	8.5	8.5
6				3	8.5	8.5	8.5	8.5	8.5	8.5	8.5
7	VOT truck:	**80**		4	8.5	8.5	8.5	8.5	8.5	8.5	8.5
8				5	8.5	8.5	8.5	8.5	8.5	8.5	8.5
9				6	17.0	17.0	17.0	17.0	17.0	8.5	8.5
10				7	17.0	17.0	17.0	17.0	17.0	8.5	8.5
11				8	17.0	17.0	17.0	17.0	17.0	8.5	8.5
12				9	17.0	17.0	17.0	17.0	17.0	8.5	8.5
13				10	7.5	7.5	7.5	7.5	7.5	8.5	8.5
14				11	7.5	7.5	7.5	7.5	7.5	8.5	8.5
15				12	7.5	7.5	7.5	7.5	7.5	8.5	8.5
16				13	7.5	7.5	7.5	7.5	7.5	8.5	8.5
17				14	7.5	7.5	7.5	7.5	7.5	8.5	8.5
18				15	7.5	7.5	7.5	7.5	7.5	8.5	8.5
19				16	17.0	17.0	17.0	17.0	17.0	8.5	8.5
20				17	17.0	17.0	17.0	17.0	17.0	8.5	8.5
21				18	17.0	17.0	17.0	17.0	17.0	8.5	8.5
22				19	17.0	17.0	17.0	17.0	17.0	8.5	8.5
23				20	8.5	8.5	8.5	8.5	8.5	8.5	8.5
24				21	8.5	8.5	8.5	8.5	8.5	8.5	8.5
25				22	8.5	8.5	8.5	8.5	8.5	8.5	8.5
26				23	8.5	8.5	8.5	8.5	8.5	8.5	8.5
27				24	8.5	8.5	8.5	8.5	8.5	8.5	8.5
28											
29											
30											

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Figure 8
Value of time worksheet

The saturation flow rate in item 8 is assumed to be 2000 veh/lane/hour. Users can change the default value in the "Homepage" worksheet directly.

Evaluation Procedure

The framework adopted in this study to evaluate alternative tactics aimed at reducing the congestion caused by freight crash incidents is to use the cost estimation procedure above to estimate the differential cost saving that would be incurred by employing the tactic over not employing it, and then dividing this cost saving by the cost of implementing the tactic.

The cost of implementing each tactic will be estimated from the cost to DOTD. In doing so the authors will rely on costs reported in the literature or estimate the costs from a breakdown of the tactic in terms of total labor, material, and equipment. The cost to the shipper, haulier, or insurer due to loss of freight or damage to the vehicle are very commodity related, depend on the characteristics of the crash, and are usually relatively small in comparison to other costs and, therefore, are not considered. In addition, in the long term, these costs are passed on to the consumer in terms of increased transportation costs and insurance premiums. The benefit of each tactic will be estimated from the reduction in delay the tactic is estimated to produce. The value of the reduction in delay will be estimated from the saving in travel time for all road users, the reduction in freight vehicle operating costs, and the time value of freight.

The benefit-cost estimation process described above can only produce approximate benefits and costs. Thus, the values obtained should only be used as rough estimates. At the same time, the estimates will be realistic in broad terms so that the overall findings from an analysis will be meaningful in terms of comparing one tactic with another if the differences are large, or in obtaining a ballpark estimate of the economic efficiency of a specific tactic.

Results will be presented in terms of benefit cost ratios to represent a rough estimate of the economic efficiency of each tactic considered. That is, within a margin of error, the benefit cost ratio will depict the return on investment each tactic is likely to bring in terms of dollars of benefit for each dollar of cost.

DISCUSSION OF RESULTS

Analysis of Past Incidents

Analysis was conducted on data of freight crash incidents on Louisiana freeways during the period 2010-2012. Incidents where fatalities occurred or hazardous material was transported were excluded because of the very different treatment of incidents that results when a fatality occurs or hazardous material is involved. The data also excluded incidents which were cleared in less than one hour after the police were notified. Data included incident location, time of occurrence, and duration.

The analysis was conducted to see what the historical data revealed and whether it could lead to the identification of the main factors influencing the occurrence of freight crash incidents in Louisiana. Three issues were analyzed. First, the general characteristics of freight crash incidents on Louisiana's freeways in the period 2010-2012 are presented. Second, the impact of work zones on freight crash incidents were studied, and, last, the reported primary contributing factors as documented in the crash report are reviewed.

Frequency of Freight Crash Incident Duration

Figure 9 shows the number of incidents (frequency) by duration for commercial vehicles on freeways in Louisiana during the period 2010-2012. Over 60 percent of all freight incidents in that period lasted less than 2 hours. As shown, incidents lasting more than 3 hours are relatively rare but incidents lasting as long as 22 hours did occur during the observation period.

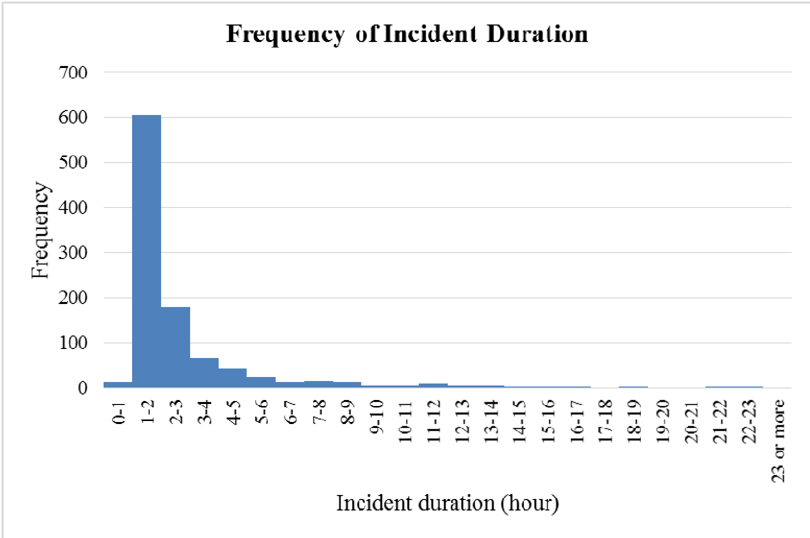

Figure 9
Frequency of incident duration on freeways in Louisiana

Frequency of Incidents Per 10 Mile Length of Freeway

To capture the density of incidents over the freeways in Louisiana, the number of freight crash incidents per 10-mile section of freeway in the analysis period (2010-2012) were derived from the data. The results from some of the busiest freeways in the state are shown in Figure 10, Figure 11, and Figure 12.

In Figure 10 several incident concentration areas on the I-10 are evident. Since mileposts on the I-10 are numbered from zero at the Texas border, the increase in the rate of incidents per unit distance is in the vicinity of Lake Charles at 30-40 miles from the border, the next increase in frequency at approximately 100 miles is Lafayette, Baton Rouge is at a distance of approximately 160 miles, and New Orleans at 230 miles. The frequency of incidents in the vicinity of urban areas is several times that in rural areas and is higher in larger urban areas. The fact that the rate is highest in Baton Rouge is probably due to the fact that the I-12 reduces the amount of truck traffic on the I-10 in the vicinity of New Orleans.

In Figure 11 the frequency of incidents is shown on the I-12. Milepost numbering starts in Baton Rouge and ends where the I-12 and I-10 meet on the eastern side of the state. Incidents occur frequently in the vicinity of Baton Rouge. The I-12 was under construction for much of the period of observation which may have contributed to the high number of incidents recorded.

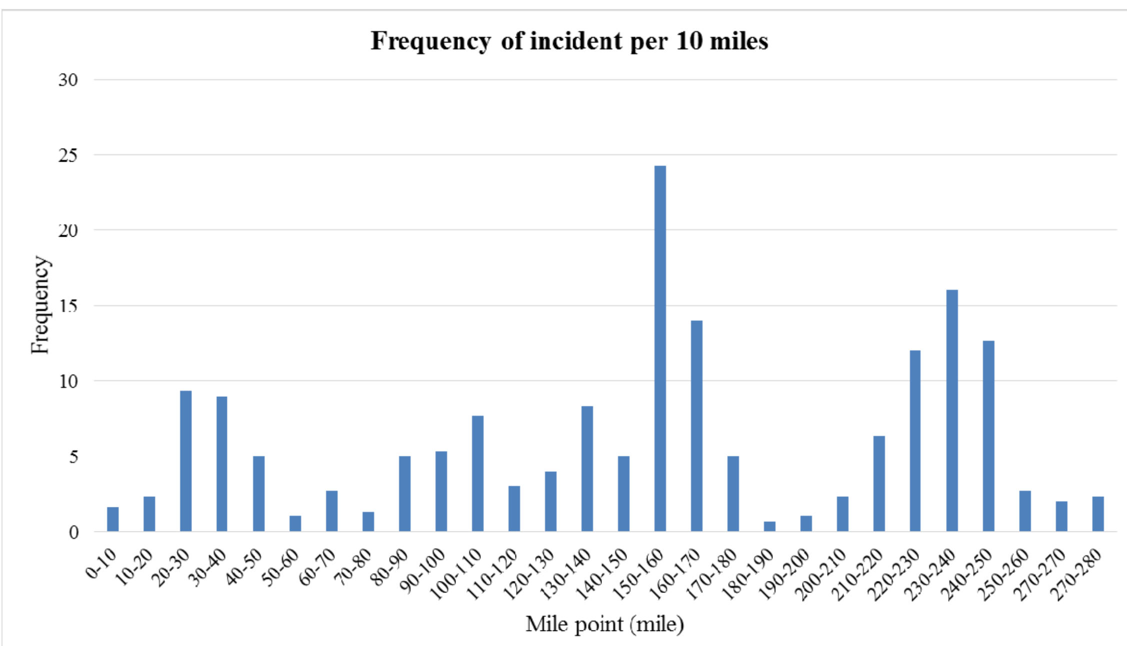

Figure 10
Frequency of incidents per 10 miles on I-10

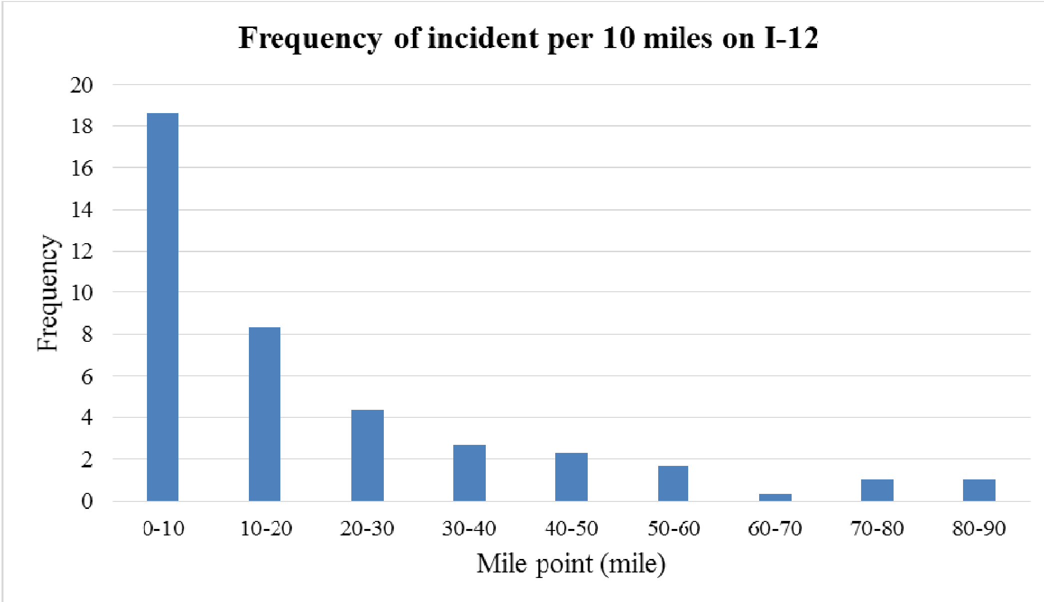

Figure 11
Frequency of incidents per 10 Miles on I-12

The frequency of incidents per 10 mile on I-20 is shown in Figure 12. As with the I-10, milepost numbering starts in the west on the Texas border and ends at the Mississippi border on the east. The impact of the urban areas of Shreveport, Minden, Ruston, Monroe, and Tallulah can be seen in the vicinity of mileposts 20, 50, 80, 120, and 170, respectively.

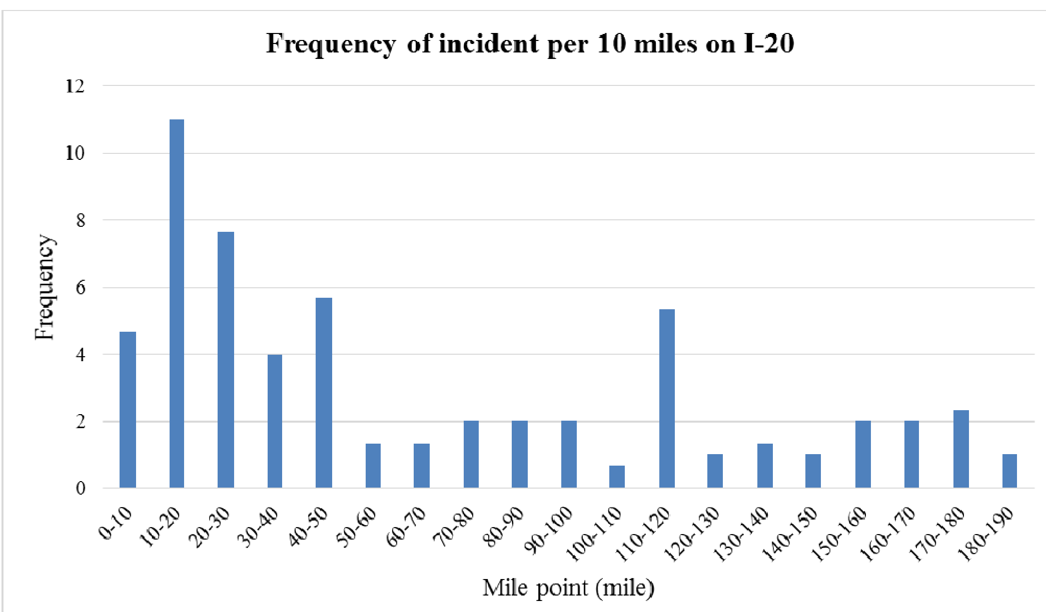

Figure 12
Frequency of incidents per 10-miles on I-20

Frequency of Incidents by Time of Day, Day of Week, and Month of Year

Frequency of traffic incident by time of day in Louisiana from 2010 to 2012 were extracted from the database in one hour intervals as shown in Figure 13. The data show the total frequency of incidents in each hour of the day for the three years. It shows the predominance of incidents in daylight with a spike in incidents at dawn and dusk.

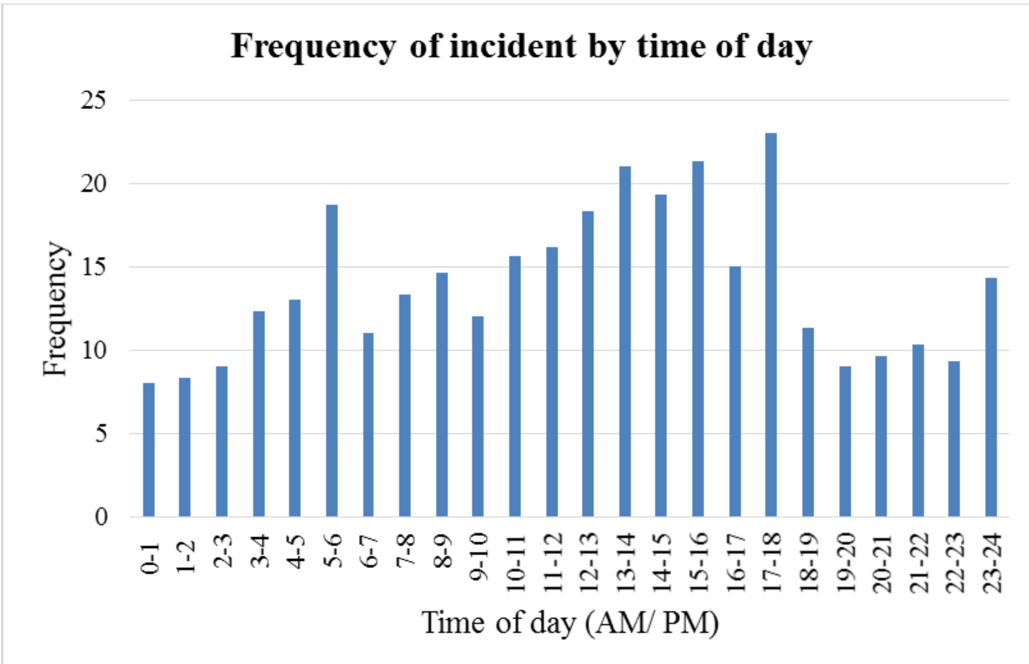

Figure 13
Frequency of incidents by time of day

Figure 14 shows the frequency of incidents by day of week. It shows a slight increase in incidents on a Friday and a reduced number on Saturday and Sunday.

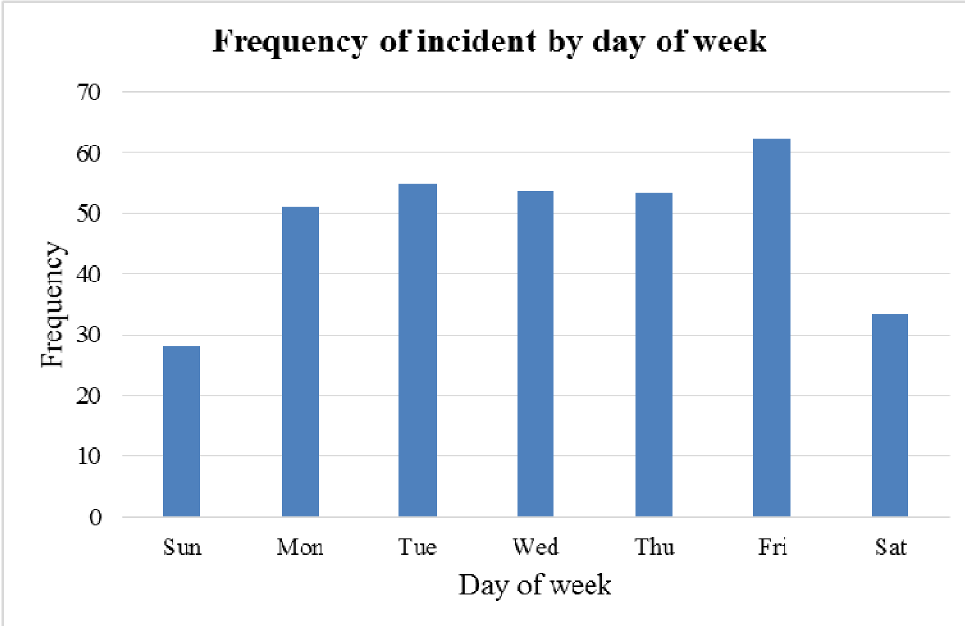

Figure 14
Frequency of incidents by day of week

The variation in frequency of incidents during the months of the year is shown in Figure 15. It appears as though the lowest months are during popular vacation times in June and July, and again in December.

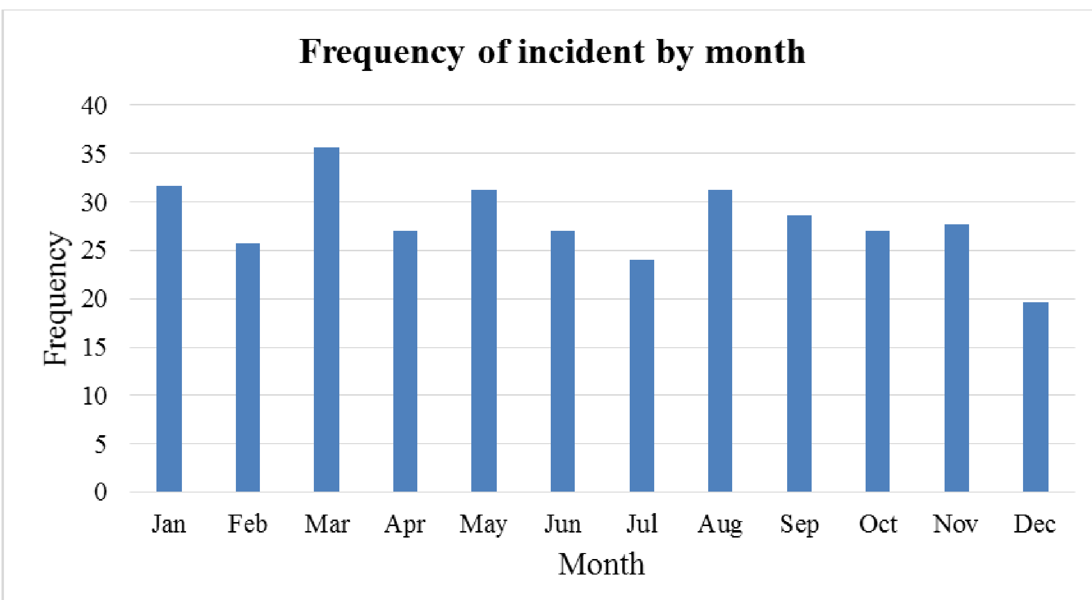

Figure 15
Frequency of incidents by month of the year

Investigating the Impact of Work Zones on Freight Crash Incidents

Work Zone vs. Non-Work Zone. Do incidents occur more frequently in work zones than elsewhere? The actual frequency in Louisiana between 2010 and 2012 is shown in Table 2. Obviously, frequency does not take into account the amount of travel that occurred within work zones versus that which occurred outside work zones. Such so-called "exposure" information was not available in this case so a comparison of the rate of freight incidents within and outside of work zones could not be made. However, observing the proportion of different incident types within work zones and those without provides some insight into the influence of work zones on freight crash incidents as shown in the following subsections.

Table 2
Incidents in work and non-work zones

Road Condition	Frequency	Percentage
Work Zone	80	7.5%
Non-work Zone	984	92.5%

Driver Distraction. The impact of driver distraction on incidents in work zones versus elsewhere is shown in Table 3. The percentage of incidents due to distraction in work zones is 3.80 percent, which while being a small percentage of all influences, is significantly higher at the 95 percent level of significance than the 2.89 percent in non-work zones. Given 10 percent of all crashes in the U.S. are distraction-affected, the low level of truck incidents due to distraction in the data suggests that the reported data may not be entirely accurate *[42]*. For this reason, the authors suggest there is insufficient evidence to conclude that driver distraction is higher among truck drivers in a work zone than elsewhere.

Table 3
Impact of distracted driving in work and non-work zones

Driver Distraction	Road Condition	
	Work Zone	Non-work Zone
Distracted	3.8%	2.9%
Not Distracted	73.4%	82.8%
Unknown	22.8%	14.3%

Weather. Analysis of the data on incidents in work zones and elsewhere under different weather conditions produces the results shown in Table 4. The analysis shows a lower proportion of incidents occur in work zones (17.72 percent) under adverse weather conditions than occurring in non-work zone areas (26.78 percent) in adverse weather conditions. Stated differently, bad weather has more influence on incidents occurring outside work zones than in work zones. This may be due to heightened vigilance in work zones versus normal travel.

Table 4
Impact of weather on freight incidents in work and non-work zones

Weather	Road Condition	
	Work Zone	Non-work Zone
Clear	82.3%	73.2%
Adverse Weather	17.7%	26.8%

Alignment. In an effort to determine whether road alignment has been responsible for freight incidents in work zones, an analysis was conducted on the proportion of incidents by alignment type in work zones and non-work zones. The results are shown in Table 5. If it is assumed that work zones and non-work zones have the same distribution of alignment types (i.e., the same proportion of different alignment types occur in work zones as do in non-work zones), then it is clear from the results that freight incidents occur proportionally more often on straight level sections of road (84.81 percent) and less often on curved sections in work zones than elsewhere. That is, the analysis shows that curved alignment in work zones is associated with proportionally less freight incidents than in non-work zones. Given that work zones sometimes have alignments that trucks have difficulty in negotiating, these results are counter-intuitive unless heightened vigilance on the part of the driver more than compensates for the difficulty of safely negotiating these alignments.

Table 5
Impact of road alignment on freight incidents in work and non-work zones

Alignment	Road Condition	
	Work Zone	Non-work Zone
Straight-level	84.8%	62.1%
Straight-level-elevated	8.9%	13.1%
Curve-level	3.8%	6.0%
Curve-level-elevated	0.0%	3.7%
On Grade-straight	0.0%	6.8%
On Grade-curve	0.0%	2.5%
Hillcrest-straight	2.5%	4.3%
hillcrest-curve	0.0%	0.3%
Dip, Hump-straight	0.0%	0.2%
Dip, Hump-curve	0.0%	0.1%
Unknown	0.0%	0.1%
Others	0.0%	0.8%

Location Type. Table 6 shows the proportion of freight incidents by location. Open country is typically associated with higher speeds, which is likely to increase the probability of an incident in a work zone. This seems to be borne out by the results in Table 6 where the percentage of incidents which occurred in work zones in open country is 60.76 percent, while only 49.44 percent occurred outside work zones in open country. For other location types, the difference in the percentage of incidents occurring in work zones and outside work zones is similar.

Table 6
Impact of location on freight incidents in work and non-work zones

Location Type	Road Condition	
	Work Zone	Non-work Zone
Manufacturing or Industrial	2.5%	5.7%
Business Continuous	13.9%	12.2%
Business, Mixed Residential	11.4%	10.0%
Residential District	0.0%	1.9%
Residential Scattered	0.0%	1.9%
School or Playground	0.0%	1.0%
Open Country	60.8%	49.9%
Others	11.4%	17.4%

Lighting. The proportion of freight incidents in daylight and at night in work and non-work zones are shown in Table 7. At night, 43.75 percent of incidents occurred in work zones, which is a little bit higher than those that occurred in non-work zones at night. It would appear as if work zones are a little more likely to result in incidents at night than non-work zones, although the difference is not large.

Table 7
Impact of lighting on freight incidents in work and non-work zones

Lighting	Road Condition	
	Work Zone	Non-work Zone
Daylight	56.3%	60.4%
Nighttime	43.7%	39.6%

Obscured Vision. Obscured vision occurred in work zone and non-work zone freight incidents 10.00 percent and 11.06 percent of the time, respectively. From the results, the authors conclude that obscured vision is not a significant factor differentiating incident rates in work and non-work zones; see Table 8.

Table 8
Impact of obscured vision on freight incidents in work and non-work zones

Vision Obscure	Road Condition	
	Work Zone	Non-work Zone
With Obscurements	10.0%	11.1%
No Obscurements	90.0%	88.9%

Movement Reason. Investigating whether driver behavior is a factor in freight incidents in work zones led to the analysis shown in Table 9. The results show that a clear difference exists between work and non-work zones in terms of the proportion of incidents occurring due to driver violation in work zones (46.84 percent) and non-work zones (27.28 percent). All other reasons are similar except normal movement in work zones which is lower to compensate for the high proportion of incidents due to driver violation in work zones. The reason is not known for these findings but they may indicate that driver violations are easier to commit in work zones since greater inattention in work zones seems implausible.

Table 9
Reported reason for freight incident in work and non-work zones

Movement Reason	Road Condition	
	Work Zone	Non-work Zone
To Avoid Other Vehicle	5.1%	8.3%
To Avoid Pedestrian	0.0%	0.1%
To Avoid Animal	0.0%	0.3%
To Avoid Other Object	0.0%	0.5%
Passing	0.0%	0.5%
Vehicle Out of Control, Not Passing	0.0%	1.0%
Vehicle Out of Control, Passing	0.0%	0.1%
For Traffic Control	1.3%	0.1%
Due to Congestion	3.8%	5.3%
Due to Prior Crash (Collision)	1.3%	2.0%
Due to Driver Condition	2.5%	3.7%
Due to Driver Violation	46.8%	27.3%
Due to Vehicle Condition (Failure)	2.5%	3.3%
Due to Pavement Condition	0.0%	0.5%
High Wind	0.0%	0.3%
Normal Movement	22.8%	39.6%
Unknown	8.9%	4.7%
Others	5.1%	2.5%

Reported Primary Contributing Factor to Freight Incidents

Overall. In the crash reports, the primary contributing factor to the crash is recorded. In the data for 2010-2012, the primary contributing factor for freight incidents on freeways in Louisiana not involving a fatality or hazardous freight, are as shown in Table 10. What is immediately apparent from the results is that the primary factor contributing to non-fatal, non-hazardous material freight crash incidents on freeways in Louisiana is human error, while road- and vehicle-related factors play a minor role (< 8 percent). Thus, the greatest potential to reducing freight crash incidents in Louisiana is apparently through compliance with existing laws. Traditionally, this is achieved by promoting voluntary compliance through education leading to a change in attitude, and/or mandated compliance through enforcement. Both are difficult to implement and the emphasis often falls on specific aspects of human behavior to target, or features of the infrastructure that can be improved because they are within the power of authorities to alter (e.g., improvement of road alignment, removal of hazards). Specific aspects of human behavior and infrastructure improvement are analyzed in the subsections which follow.

Table 10
Primary contributing factors to freight incidents

Primary Contribution Factor	Frequency	Percentage
Violations	1138	77.3%
Movement Prior To Crash	154	10.5%
Vision Obscurements	7	0.5%
Condition Of Driver	63	4.3%
Vehicle Conditions	57	3.9%
Road Surface	7	0.5%
Roadway Condition	31	2.1%
Weather	12	0.8%
Traffic Control	2	0.1%
Kind Of Location	1	0.1%

Driver Condition. When one or more drivers involved in a freight crash incident were classified as driving under the influence of alcohol, the results shown in Table 11 are produced. As expected, the proportion of incidents involving violations increases but the "movement prior to crash" which includes cases where the truck involved in the incident, or other vehicles in the vicinity, make a movement (e.g., lane change, or rapid stop), and "other" contributing factors decrease. Since the "movement prior to crash" may involve other drivers and the "other" causes are primarily outside the control of the truck driver (e.g. road condition, weather), the results show that the proportion of incidents that are primarily the result of the drivers being inebriated, rises significantly.

Table 11
Influence of DUI on freight crash incidents

Driver Condition	Primary Contribution Factor		
	Violations	Movement Prior to Crash	Others
Normal	65.8%	16.0%	18.2%
Drive under Influence	79.2%	8.7%	12.1%

Driver Distraction. When drivers are distracted by cell phone, navigation device or other means, the proportion of freight crash incidents involving a violation increase from 71.11 percent to 93.63 percent (see Table 12).

Table 12
Impact of driver distraction on freight crash incidents

Driver Distract	Primary Contribution Factor	
	Violation	Others
Distracted	93.6%	6.4%
Not Distracted	71.1%	28.9%

Lighting. Table 13 shows that freight crash incidents that occur at dusk or dawn are more likely to involve a violation than incidents that occur at other times of the day. Continuous street lighting appears to reduce the proportion of incidents involving a violation.

Table 13
Impact of lighting on violation rate

Description	Primary Contribution Factor	
	Movement prior to crash	Other
Daylight	62.8%	37.3%
Dark – no street lights	67.2%	32.8%
Dark – continuous street lights	48.0%	52.0%
Dark – street lights at intersections only	55.0%	45.5%
Dusk	66.7%	33.3%
Dawn	73.3%	26.7%

Cost/Benefit Analysis

Freight Incident Management Tactics Evaluated

Three freight incident management tactics are recommended later in this report: an Instant Tow Dispatch Program, an Authority Removal Law, and a Freight Traffic Incident Management Training Program. Estimation of the cost and benefit of each tactic is presented in the following sections.

As discussed in the literature review on Louisiana's Program of Incident Clearance, the Instant Tow Dispatch Program involves reducing the time required to get a tow vehicle to an incident on the Interstate by letting the police initiate a request for a tow vehicle even before the need is confirmed or it is verified that the driver does not have a preferred tow company. Time savings occur because the tow vehicle is dispatched earlier and it is able to access the site more easily because the traffic has had less time to build up.

The Authority Removal Law involves legislation that removes liability for removing vehicles, freight, or personal property from the roadway when it prevents normal traffic flow. It is often combined with incentive programs for quick removal of obstructions. It is not possible to evaluate this tactic since it will depend on the incentive programs introduced and the response that follows.

The Freight Traffic Incident Management Training Program is an ongoing program within the state to train police in handling traffic incidents. The program is currently training trainers who will subsequently train others. It is not known how much benefit this program is expected to produce but it has been deemed sufficiently beneficial to proceed with the program.

There is insufficient data in Louisiana at the moment to evaluate alternative tactics aimed at reducing delay caused by freight traffic incidents. However, some data from observations in other states are used below to provide an initial estimate of the relative benefit of an Instant Tow Dispatch Program that includes incentives to tow companies.

Cost Estimation of Candidate Tactics

The cost of implementing the Instant Tow Dispatch Program in Louisiana is not known even though two pilot programs were launched in the state in 2010. According to police involved in the pilot programs, the Instant Tow Dispatch Program would be helped by the police having access to streaming video from DOTD cameras so that they could more quickly assess the need for a tow to be dispatched. The DOTD is currently investigating that possibility so new costs are associated with that option. The cost of the program is primarily associated with the reimbursement the state would be liable for in case of "dry runs" where tow companies are called to a site but fail to be required to tow a vehicle. If 80 percent of the cases where a tow was ordered turned out to be a "dry run", and payment was as much as $100 per case, then the 1,064 freight vehicle incidents observed in our analysis of Louisiana data between 2010 and 2012 would represent a cost of 0.8(1064/3)$100 or $28,400 per year or 28,400/355 ≈ $80/incident.

An Expedited Towing Program is a program where monetary incentives are provided for tow companies to arrive on the scene and clear an obstruction as quickly as possible. In Georgia, the Towing and Recovery Incentive Program (TRIP) involved incentive bonuses for quick clearance of heavy-duty vehicles in the Atlanta metropolitan area, and the cost over an approximate four-year period was $551,000 or approximately $140,000 per year. The number of incidents involved is unknown. However, since Atlanta and the state of Louisiana have similar lengths of urban freeway (282 miles in Louisiana and 238 miles in Atlanta) and similar freight traffic on them, the incidence of truck incidents are likely to be similar *[43]*. From the authors' analysis between 2010 and 2012 in Louisiana, 1,064 freight vehicle incidents were observed, or approximately 355 freight incidents per year. Thus, the TRIP program cost on average $140,000/355 or $394/incident. This cost estimate seems reasonable given that some incidents would generate no costs whereas others which met all their incentives could earn as much as $4,100 in bonuses (see p. 8).

Benefit Estimation of Candidate Tactics

The amount of time saved by an Instant Tow Dispatch Program is not known although police applying the pilot program reported that time savings were realized. To be conservative, assume a 15 minute reduction in clearance time and use the cost model described earlier to estimate the difference in cost with and without the clearance time reduction to estimate the benefit of applying the program.

In the Expedited Towing Program TRIP in Atlanta, average clearance time was reduced from 269 to 112 minutes following introduction of the program. This reduction of over 2.5 hours in 4 hours, or 58 percent reduction in clearance time, may be due to the large incentives offered. Assuming that the same incentives could be offered, we assume a 58 percent reduction in clearance time in the analysis below for an Expedited Towing Program.

Benefit-Cost Estimation

Analysis of a hypothetical incident is presented in Table 14, showing analysis of an incident which occurred at 2.05 pm on June 20, 2012, on the 1-10 at milepost 156 (i.e., in the vicinity of University Lakes in Baton Rouge), blocking 2 of the 3 eastbound lanes for 4 hours and 20 minutes. The cost estimation program estimates the cost of the incident to users at $56,621. If an Instant Tow Dispatch Program had been in operation at the time and the duration of the incident were reduced by 15 minutes, the cost estimation program estimates the cost to users would be $45,738. This represents a saving in cost (i.e., a benefit) of $10,883. Given that the cost of providing the Instant Tow Dispatch Program was estimated at $80 per incident in the previous section, the benefit-cost ratio of the Instant Tow Dispatch Program would be estimated at $10,883/$80 or 136. An Expedited Towing Program could conceivably reduce the clearance time of 4 hours and 20 minutes by 58 percent to 1 hour and 49 minutes. Using the cost estimation program, the estimated cost to users of an incident duration of 1 hour and 49 minutes is $9,420, representing a savings of $47,201 from $56,621. The estimated benefit-cost ratio of this tactic is 120, as shown in Table 14.

Table 14
Evaluation of incident management tactics

Scenario	User Cost per Incident	User Benefit per Incident	Program Cost per Incident	Benefit-Cost Ratio (B/C)
Status quo	$56,621	$0	$0	0
Instant Tow Dispatch Program	$45,738	$10,883	$80	136
Expedited Towing Program	$9,420	$47,201	$394	120

CONCLUSIONS

The objective of this research was to determine the most effective way to mitigate the impact of freight crash incidents on freeways in Louisiana. This was achieved by observing best practices in other states, reviewing literature on the subject of mitigating the effect of incidents on affected traffic, noting laws in place in Louisiana that are aimed at improving management of incidents on Louisiana's freeways, reviewing the history of freight crash incidents in the state, and developing a cost estimation procedure to quantify the impact of incidents on road users. In stating the objectives of this study in an earlier part of the report, the possibility of using a lane rental fee approach, similar to that used in construction, was raised. However, the concept of a lane rental fee in dealing with freight crash incidents was not encountered anywhere in the literature consulted. For that reason it was not considered a potential means of dealing with freight crash incidents in this study. One of the difficulties in the approach is to identify who would be required to pay the fee given that the cause of the incident may rest on various players and true blame may only be established after a long and thorough investigation. Another issue is if the player who is charged with the fee does not have authority in how the cleanup process is handled, they will be required to pay for something they have no control over.

One of the first conclusions drawn from the study is that a number of states are addressing this issue and their main focus has been on early identification of incidents and quick clearance of the site once it is discovered. Early identification has been identified with detection through video cameras monitored at Traffic Management Centers and/or detection in the field by means of Service Patrols. Quick clearance has involved programs which get tow trucks to the site as quickly as possible and then encourage them to clear the obstruction as quickly as possible through cash incentives and/or legal authority to move vehicles or goods from the traveled way without permission from the vehicle owner, shipper, or insurance company. Feedback on the success of these management procedures has been subjectively favorable with little data on what the programs cost or the number of incidents addressed. Thus, while there seems to be virtually unanimous agreement that early detection and quick clearance programs are generally desirable, there is little data to quantify that assessment. Measuring the effect of these programs is necessary to effectively evaluate them and, therefore, should be considered a priority in future applications.

A second conclusion is that laws have been passed in Louisiana that allow the use of quick clearance strategies and early detection. Quick clearance involves an Instant Tow Dispatch Program that has been tested in a pilot program in the state, as well as an Expedited Towing Program in which tow companies are incentivized through a variable fee structure to clear a site as quickly as possible. Current collaboration between the DOTD and police is aimed at streaming video directly to police to allow them early assessment of the scene so that they can make appropriate tow dispatch decisions as early as possible. Data on the application of these programs should be collected.

Another conclusion is that the penalty incurred by incidents on other road users in the form of delay is large and grows rapidly as the duration of the incident is extended. As an example, an incident blocking two of the three eastbound lanes on the I-10 at milepost 156 (i.e., eastbound I-10 in the vicinity of the University Lakes in Baton Rouge) from 2.05 p.m. to 5.25 p.m. on a Wednesday (20 June, 2012) is estimated by the cost procedure described in this report as costing approximately $56,000 in delay to people, vehicles, and freight. If the duration of the incident were extended to 5, 7, or 9 hours, the estimated cost would increase to approximately $178,000, $318,000, and $430,000, respectively. Note that if all eastbound lanes were closed by the incident the cost estimate would be considerably higher; $97,000, $278,000, $551,000, and $780,000 for incident duration times of 3.33, 5,7, and 9 hours, respectively, according to the cost estimation procedure used in this study. Also, if the incident occurred earlier in the day and affected more of the peak traffic, the cost estimate would be inflated even further. Thus, management strategies aimed at reducing the duration of an incident are of prime importance.

A final conclusion is that it is imperative that data on the cost of alternative incident management strategies and their impact on detection and clearance time be collected so that the benefit of each strategy can be calculated. This will allow the cost-effectiveness of alternative strategies to be estimated.

RECOMMENDATIONS

Recommended Laws and Processes

Instant Tow Dispatch Program

The DOTD participated in two pilot programs in 2010 aimed at reducing the impact of traffic incidents on the interstate system. The DOTD implemented the pilot programs at the direction of the Louisiana Legislature. One of the pilot programs, referred to as "Instant Tow Dispatch," showed potential for reducing the duration of blocked travel lanes caused by incidents. Although the data required for an analytical evaluation was not able to be collected, feedback from the police agencies that participated was that the program was useful in reducing the time to clear blocked lanes.

Instant Tow Dispatch is restricted to light duty tows clearing vehicles. Heavy duty tows required to clear commercial vehicles are not used in the program. Although not directly affecting freight carrier incidents, the improved clearance time utilizing Instant Tow Dispatch affects freight carriers by reducing the risk from secondary collisions when incidents block travel lanes. Louisiana has experienced major incidents caused by freight carriers crashing into the back of traffic queues (secondary incidents) caused by lane blockages. On May 2, 2014, a queue caused by a disabled vehicle resulted in three commercial carriers colliding on Interstate 10, closing the I-10 for 22 hours and resulting in two fatalities. A reduction in lane blockage times reduces the risk exposure of traffic queues by reducing the time the queue is present.

Denham Springs Police officers who participated in the program reported that the instant tow dispatch program could be useful in reducing the arrival time for tows based on their experience with the program. They instantly dispatched tows on several occasions and reported that this reduced the time for tow vehicles to arrive at the incident scene and begin lane clearance.

Police departments indicated that the instant tow program would be more useable by the departments if camera views of the incident were available to the department. This would allow the officers to verify the situation and make the determination whether to instantly dispatch a tow. The DOTD is currently making available to police departments a program that allows streaming video of its camera views. The availability of the camera views will allow the police to quickly assess an incident and initiate the proper response. An Instant Tow Dispatch Program would allow the police to immediately dispatch a tow when the situation warranted the tow.

It is recommended that an Instant Tow Program be developed for use by police agencies in Louisiana to support the quick clearance of incidents. This is consistent with the Open Roads Policy jointly supported by the DOTD and the LSP.

Authority Removal Law

Authority Removal Laws allow law enforcement or state DOTs to remove disabled or damaged vehicles or cargo from a highway if the vehicles or cargo are causing a hazard for traffic operations on the highway. Commercial carrier incidents can involve the tractor and/or the trailer blocking the roadway travel lanes. The purpose of authority removal is to allow the police to expedite the removal of vehicles and cargo to allow opening of travel lanes. A key element of Authority Removal Law is to provide the police indemnification if the removal is performed in good faith and without gross negligence. This indemnification also applies to those acting upon the direction of the police such as tow companies. The law typically allows the police to remove the vehicle or cargo over the objections of the owner if the blockage is causing a hazard to traffic.

The Louisiana Legislature passed the Authority Removal Law in 2014 *[44]*. The legislation directs police officers to "immediately remove or have removed any vehicle, cargo, or other moveable property that has been damaged or spilled upon the roadway or shoulder of the roadway which constitutes a hazard or obstructs traffic when such removal will improve public health or safety and reduce crash or incident related traffic congestion or delay." The legislation stipulates that no liability will attach to any police officer or to any person acting under the officer's direction that may result from action to clear the roadway as long as there is no gross negligence.

The legislation does have some restrictions as to when authority removal can be exercised. It only applies to highways in the state and federal highway system. Since the majority of commercial carrier activity occurs on the state and federal system this should not have a significant impact on the effectiveness of an authority removal law.

The legislation restricts the use of authority removal to "peak traffic hours." Peak traffic hours are defined in the legislation as 7:00 a.m. to 9:00 a.m. and 4:00 p.m. to 6:00 p.m. on weekdays. This limits the potential effectiveness of the legislation. Traffic volumes on interstates in urban areas are higher during commute hours but do not significantly decrease during non-commute hours. It should be noted that commute hours generally extend from 6:00 a.m. to 9:00 a.m. and 3:00 p.m. to 6:00 p.m. in all major urban areas of the state. Traffic Management Centers around the state routinely observe traffic queues caused by interstate lane blockages of several miles throughout the day and into the evening. The restriction of the legislation to four hours on weekdays limits its effectiveness significantly by not allowing authority removal to be applied during high traffic volume periods throughout the day and evening.

The implementation of an Authority Removal Law in the state will support safety and congestion reduction on the major highways. It is recommended that an effort be made by the DOTD and the Louisiana State Police to revise the Authority Removal Law to allow its use any time a police officer determines that an incident causes a hazard or obstructs traffic, and expedited clearance of the incident would reduce safety risks and or congestion.

Freight Traffic Incident Management Training

The DOTD and the LSP recently implemented a Traffic Incident Management Training Program statewide. The training is being made available to all highway emergency responders and is designed to increase safety for responders and reduce the duration of an incident through effective incident management. The training addresses all aspects of incident management, but does not go into depth with respect to freight carrier incidents.

Management of freight carrier incidents is usually more complex than incidents involving passenger vehicles: the size of the vehicles requires heavy duty tow equipment; cargo recovery may require equipment such as front end loaders or other specialized equipment, and there is a much higher possibility that a freight incident will involve hazardous materials. The complexity of freight carrier incidents typically results in longer travel lane clearance times than passenger vehicle incidents. Recovery is more complicated when vehicles are overturned or cargo is spilled on the roadway. The size of the vehicles involved and the potential presence of hazardous material cargo increases the possibility of total roadway closures when freight carriers are involved. These factors require a higher incident management skill level for responders to efficiently and effectively manage a freight carrier incident.

Effective management of these types of incidents will improve the safety for responders and reduce the duration of congestion caused by blocked travel lanes. Reducing the duration of congestion also reduces the duration of traffic queues that cause secondary incidents.

It is recommended that an emergency training program be identified or developed that addresses freight carrier incident management. The goal is to train key response personnel in effective freight carrier incident management. Through proper training and experience these personnel can direct response efforts at freight incidents to improve safety and reduce the time these types of incidents block travel lanes or totally close highways.

This effort can be leveraged off the traffic incident management training that the DOTD and LSP are currently implementing. The goal is to have key LSP personnel and personnel in the major urban police departments trained in freight incident management. Effective management will reduce the duration of incidents and blocked travel lanes.

ACRONYMS, ABBREVIATIONS, AND SYMBOLS

AADT	Annual average daily traffic
AIR	After Incident Reviews
DOT	State Department of Transportation
DOTD	Department of Transportation and Development
ETP	Emergency Traffic Patrol
FHP	Florida Highway Patrol
FSP	Freeway Service Patrols
ITS	Intelligent Transportation Systems
LSP	Louisiana State Police
MAP	Motorist Assistance Patrols
MDOT	Michigan Department of Transportation
MIT	Major Incident Tow
NCHRP	National Cooperative Highway Research Program
NTP	Notice to Proceed
PDO	Property Damage Only
POST	Police Officer Standards and Training
RISC	Rapid Incident Scene Clearance
SEMCOG	Southeast Michigan Council of Governments
TIM	Traffic Incident Management
TMC	Traffic Management Center
TRIP	Towing and Recovery Incentive Program
USDOT	United States Department of Transportation
VOT	Value of Time

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