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Highway Construction Work Zone Safety Performance and Improvement in Louisiana

by

Helmut Schneider
Cory Hutchinson
Emily Pfetzer

Highway Safety Research Group
E. J. Ourso College of Business
LSU

4101 Gourrier Avenue | Baton Rouge, Louisiana 70808
(225) 767-9131 | (225) 767-9108 fax | www.ltrc.lsu.edu

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16. Abstract

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Helmut Schneider
Cory Hutchinson
Emily Pfetzer

Highway Safety Research Group
E. J. Ourso College of Business
Louisiana State University, Baton Rouge

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ABSTRACT

This project provides a review of current work zone crash reporting practices in the US in general and specifically in Louisiana. While national guidelines such as the MMUCC standardize definitions and data elements, the degree to which states have adopted the MMUCC guidelines/data elements regarding work zone crashes varies considerably across states. About 50% of states include 4 or more of the MMUCC's work zone data elements (C18), while the remaining include 3 or less. Because these elements reflect the "minimum model standard," it is reasonable to conclude that most states do not collect enough data about work zones on their crash report forms to fully analyze work zone-involvement in crashes. This is clearly the case in Louisiana, in which the primary data indicator of a "work zone crash" is a check box called "Work Zone." One of the most important findings from this research is that work zone crash reporting practices in Louisiana are inconsistent in several ways. First, according to the crash data analysis, 1910 crashes were identified as having taken place within the actual work zone boundaries, i.e., after the first orange warning sign was posted, while work zone signs were officially in-place; however, officer reporting only captured 104, accounting for only 5.5% of crashes occurring within the physical boundaries of work zones. Second, some crashes that were reported as work zone crashes were actually located outside of the project boundaries. This observation is inconsistent with the instructions stated in the Louisiana crash report guide. Third, a content analysis of the accessible population of crash report narratives (N=2723) indicated that only 3% contained an explicit mention of the work zone in their description, but slow/stop conditions were explicitly contained in 49% of narratives and congestion/backups were explicitly contained in 23%. In addition to assessing the overall data quality of work zone crash reporting in LA, this report provides several recommendations to improve reporting of work zone crashes and work zone related crashes.

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IMPLEMENTATION STATEMENT

Implementation of some of the recommendations in 2019 will likely lead to a better reporting of work zone crashes. There are several strategies to be implemented:

1. Clearly define what needs to be reported, i.e., work zone crashes versus work zone related crashes.
2. Change the crash report to follow the suggested factors in MMUCC.
3. Improve the diaries from contractors to assure that location and work hours are reported consistently.
4. Revise the crash handbook to clearly define work zone crashes.
5. Improve training of police officers to report work zone crashes.
6. Build model for assessing average work zone effect using DOTD location and timing of sign postings and diaries.

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INTRODUCTION

The primary goal of Louisiana's *Destination Zero Deaths* initiative is to reduce the number of motor vehicle-fatalities and serious injuries. One area of emphasis is improving roadway infrastructure and operations. Like many other states in the US, Louisiana's transportation system suffers from an ageing and inadequate infrastructure in dire need of improvement. As of January 2017, Louisiana has a $13 billion backlog of road and bridge construction projects. Data from the Federal Highway Administration indicates that in 2015, about 29% of Louisiana's bridges are structurally deficient or functionally obsolete [*1*]. The American Society of Civil Engineers (ASCE) estimates that 62% of Louisiana's roads are in mediocre or poor condition [*2*].

Work zones associated with roadway repair and construction are unavoidable necessities. The immense need for infrastructure improvements throughout the state has important implications for the efforts to reduce number of fatalities on Louisiana roads and highways. Work zones are of specific importance because of the apparent risk of crashes and injuries associated with changes in traffic lanes or pavement drop-offs. They also pose a number of safety and operational challenges due to interrupted traffic patterns, travel delays and, congestion. However, the ability to gain insight into work zone involvement in crashes is limited by the level of detail captured in crash reporting data.

The overall goal of the project is to provide a review of current practices for reporting work zone crashes, to review literature to obtain the state of knowledge on work zone crashes and reporting practices, to identify factors associated with work zone crashes in Louisiana to gain insight into work zone crash characteristics, and to develop recommendations for improved reporting of work zone related crashes.

OBJECTIVE

The overall goal of the project was to provide a review of current practices for reporting work zone crashes on the Louisiana crash reports by police officers, to review literature to obtain the state of knowledge on work zone crashes and reporting practices, and to develop recommendations for improved reporting of work zone related crashes.

SCOPE

The scope of this project was to assess current practices of reporting work zone crashes in Louisiana and compare them to national guidelines and practices in other states in the US. This project includes basic tabulation analysis of crash data but does not include detailed analysis of work-zone crashes or answer questions regarding whether or not work zones have an effect on crash frequencies. Instead, the report evaluates what is necessary to obtain consistent data to make these assessments.

METHODOLOGY

This section reviews the current state of knowledge about work zone crashes and work zone crash reporting practices in Louisiana as well other states before detailing the methodologies and data collection procedures used in this study.

Literature Review

State Crash Reporting Practices

In general, each state has a standard crash report form (also referred to as police accident reports, or PARS) that police use to generate and submit to a centralized state agency that coordinates the reports [*3*]. For the most part, states collect similar information about crashes (e.g., location, vehicles and persons involved, contributing circumstances, environment, etc.); however, the forms vary considerably in terms of design, procedures, and level of detail captured [*4*]. The differences in crash report form design and data elements/attributes, as well as how the data are coded in state databases make combining and comparing state crash data difficult.

The Model Minimum Uniform Crash Criteria (MMUCC) provides states with a minimum standardized dataset for describing motor vehicles crashes and the people, vehicles, and conditions involved in them [*5*]. The MMUCC was first published in 1998 and has been revised several times, most recently in 2017. Now in its 5th edition, the MMUCC contains 115 data elements [*6*]. Each data element has a standardized definition, rationale, a set of attribute values, and potentially applicable "edit checks" to improve data quality and consistency across states. While compliance with the MMUCC guidelines is not federally-mandated, all states are encouraged to implement the MMUCC recommendations or to, at least, adopt as many of the recommended data elements as possible. NHTSA and the Governors Highway Safety Association (GHSA) have developed a data-mapping methodology to assist states in determining how consistent they are with MMUCC by standardizing how states compare their crash report forms and databases to MMUCC *[7*]. Data elements that contain work zone-related attributes will be discussed later in this literature review.

Work Zone Crash Data. Each state has their own data collection processes and procedures regarding work zone crash data. The Federal Highway Administration (FHWA) updated a rule in 2004 requiring state highway agencies receiving federal funds to collect and analyze work zone data to better address work zone safety and mobility issues [*8*].

Specifically, the rule requires agencies to "use available work zone information and data" which includes "mobility/operational data in addition to safety/crash data" to manage work zone impacts and to "pursue ongoing improvement of their work zone processes and procedures" [*9*]. There are three primary sources and/or systems of work zone crash data: state crash reports, the MMUCC guideline-based enhancements to state crash reports and State Department of Transportation (DOT) Agency-based work zone crash reporting [*3*].

The use of state crash reports to track and assess work zone safety is not surprisingly, limited by the data elements applicable to work zones. The MMUCC has several work zone-related data elements that, when adopted, allows states to capture more information about work zone crashes than what is collected on most state crash report forms [*3*]. States that implement the MMUCC guideline-based enhancements to their crash reports are generally able to collect more detailed information about work zone-related crashes than they would otherwise. A more efficient (though also more expensive) option would be for the state to come up with an internal data collection system where information about work zone crashes is collected by agency personnel or contractors at project sites [*3*]. The benefit to collecting internal data is the ability to link crashes to project sites, which would allow states to better monitor and manage work zone safety. Some states already do this; in general, though, the majority of work zone crash data come from state crash reports.

Definitions and Data Quality. Overall, data collection practices and crash reporting procedures have a fundamental impact on work zone-crash data quality. In many respects, this begins with how a state defines what exactly constitutes a work zone crash. While some states adopt the MMUCC definitions as their own for the purposes of identifying work zone or work zone-related crashes, many other states use some variation or another definition entirely. According to Clark and Fontaine, "many states…define a work zone crash based on its physical location, not the role that the work zone played in the crash" [*10*]. The MMUCC defines a Work Zone as:

> an area of a trafficway where construction, maintenance, or utility work activities are identified by warning signs/signals/indicators, including those on transport devices (e.g., signs, flashing lights, channelizing devices, barriers, pavement markings, flagmen, warning signs and arrow boards mounted on the vehicles in a mobile maintenance activity) that mark the beginning and end of a construction, maintenance or utility work activity. It extends from the first warning sign, signal or flashing lights to the END ROAD WORK sign or the last traffic control device pertinent for that work activity. Work zones also include roadway sections where there is ongoing, moving (mobile) work activity such as lane line painting or roadside mowing only if

the beginning of the ongoing, moving (mobile) work activity is designated by warning signs or signals [*6*].

The MMUCC also provides a comprehensive definition of what constitutes a “Work Zone Crash” which appears verbatim in Appendix A. Within the definition, multiple different scenarios are provided as examples illustrating the range and variability of factors in such crashes. What all of the examples share in common is a clear indication that the crash occurred because of work zone activity/behavior or the traffic control related to the movement of traffic through the designated area. When states define a work zone by its physical location, it is not possible to tell what if any role the work zone actually played in the crash from the data unless either additional data elements are collected or the events leading to the crash are explained in the narrative.

State Differences in Work Zone Crash Reporting. A manual review of primary sources provides further insight into how states define work zones. Primary sources, in this case, refers to current (i.e., the most recent revision in use) crash report forms, as well as any accompanying instruction/ training manuals or data-collection support guides (e.g., data dictionary, coding manuals, and the like) for each state. All sources were located online, beginning with the documents available on NHTSA's website [*11*]. NHTSA provides crash report forms, manuals, data dictionaries, etc. for most states, however, most states were last updated prior to 2014. Some states do not have instruction manuals or data dictionaries available on NHTSA's site. When documents were not available (or appeared as if they might be significantly out-of-date) they were searched for online (via Google) and in most cases, successfully located. If documents were available but missing sufficient information (e.g., no definitions), a Google keyword search was conducted. If the crash report on file was last revised in e.g., 2002, then an online search for either a more recent revision of the form or a valid confirmation that the form was indeed still current. Appendix B contains a list of sources for each state.

There were five states in which sources defining “work zone” or “work zone crash” could not be found online: West Virginia, Wisconsin, Tennessee, Massachusetts, and Delaware. For all other states, it was possible to confirm these definitions from available sources. Using the MMUCC definitions as a point of comparison, states’ definitions were content-coded “1” if the state uses the MMUCC definition verbatim, “2” if the state uses a variation of the MMUCC definition (i.e., to the same effect) and “0” if the state’s definition was significantly different in scope, detail, and/or clarity. Table 1 displays four columns. The first two columns show how the state defines “work zone” relative to the MMUCC (verbatim or variation) and the second two columns show how they define "work zone crash" relative to the MMUCC (verbatim or variation). With the exception of the five states in which definitions were not available, all other states had definitions that differed substantially from the definition advanced in the MMUCC.

Table 1
State definitions of work zone and work zone crash, relative comparison to MMUCC

State uses MMUCC definition of **Work Zone** *verbatim*	State uses *variation* of MMUCC definition of **Work Zone**	State uses MMUCC definition of **Work Zone Crash** *verbatim*	State uses *variation* of MMUCC definition of **Work Zone Crash**
Alaska	Alabama	Arizona	Alabama
Connecticut	Arizona	Maine	Alaska
Illinois	Arkansas	Ohio	Connecticut
Kansas	Florida	Utah	Florida
Maine	Hawaii	Wyoming	Hawaii
Missouri	Louisiana		Idaho
	Minnesota		Illinois
	Nebraska		Iowa
	North Carolina		Kansas
	Oklahoma		Louisiana
	Utah		Nebraska
	Virginia		South Dakota
	Wyoming		Washington

Work zones are further defined by the 2009 Manual on Uniform Traffic Control Devices (MUTCD), revised in 2012, which sets the nation's standards for all aspects surrounding the use of traffic control devices (such as placement of signage, cones/barrels barricades, etc.). States are required to comply with the MUTCD by either adopting the national MUTCD, by adopting the national MUTCD with a state supplement, or by using the MUTCD as the foundation for developing State manuals, which must "substantially" conform to the national MUTCD [*12*]. Part 6 of the MUTCD outlines the national standard for traffic control devices used during work zone activities and provides a diagram illustrating the component parts of a temporary traffic control zone, shown in Figure 1.

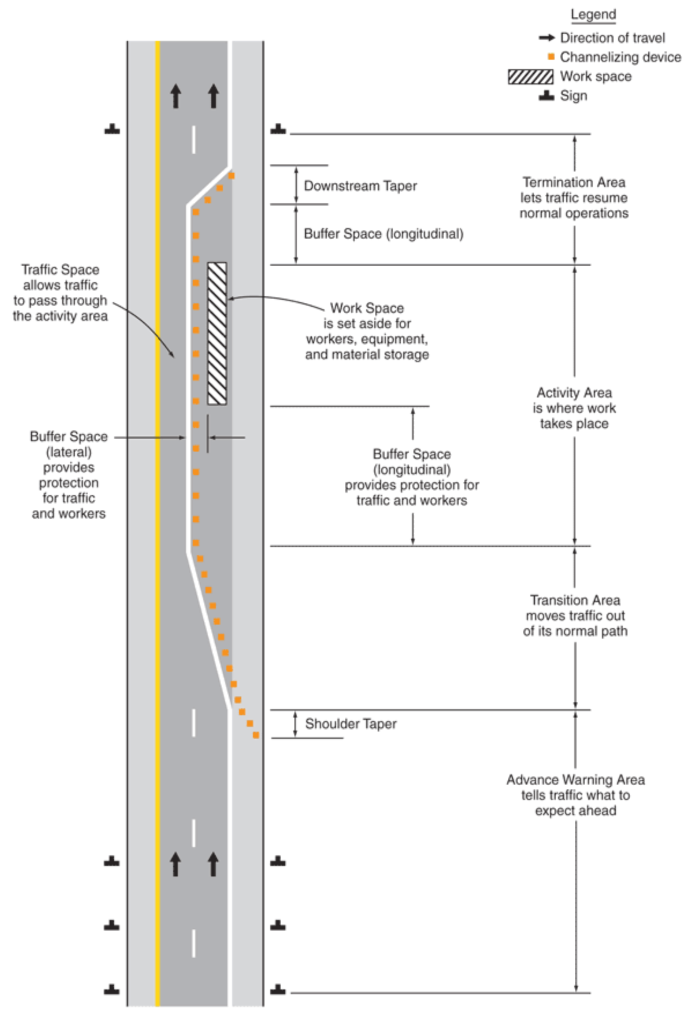


Figure 1
Components of a temporary traffic control zone

The MMUCC 5th edition includes slightly simplified version of this diagram to illustrate a typical work area. As illustrated in the diagram, the MUTCD defines and describes the component parts in the order drivers encounter them, which consists of four basic areas:

- the advance warning area, which tells traffic what to expect ahead
- the transition area, which moves traffic out of its normal path
- the activity area, which is where work takes place, and
- the termination area, which lets traffic resume normal operations [*13*].

Work Zone-Related Crashes. The definitions of work zone and work zone crash provide guidance for determining whether a crash took place in a work zone. In addition to these terms, the MMUCC has one primary data element that captures work zone crash attributes, crash data element C18, which specifically defines a work zone related-crash as one that:

> occurs in or related to a construction, maintenance, or utility work zone, whether or not workers were actually present at the time of the crash. ”Work zone-related” crashes may also include those involving motor vehicles slowed or stopped because of the work zone, even if the first harmful event occurred before the first warning sign [*5*].

The MMUCC C18 data element has five subfields, each containing a set of attributes that describe work zone relation in more detail, such as the type of work or location of the crash within the work zone. C18 data elements and attributes are displayed in Table 2. In addition to C18, the MMUCC contains two other crash data elements in which at least one of the available attributes refers to work zone-related factors. These elements include data element *C7. First Harmful Event*; Collision with Person, Motor Vehicle, or Non-Fixed Object in which “Construction Equipment (backhoe, bulldozer, etc.)” is an available attribute value, and *C14. Contributing Circumstances—Roadway Environment* contains two attribute values, “Non-Highway Work” and “Work Zone (construction, maintenance, utility).” Additionally, the MMUCC includes several vehicle data elements that describe characteristics of the crash-involved vehicles: *V2. Motor Vehicle Unit Type*: “Working vehicle/Equipment;” *V8. Motor Vehicle Body Type Category*: “Construction Equipment (backhoe, bulldozer, etc.);” *V10. Special Function of Motor Vehicle in Transport*: “Highway/Maintenance;” Finally, *V20. Sequence of Events* and *V21. Most Harmful Event*, both contain the attribute, “Work Zone/ Maintenance Equipment” [*5*].

Because states are not required to implement the MMUCC guidelines, the inclusion of all or some of the data elements is at the discretion of individual states. States are also free to include additional data elements regarding work zone factors, such as the posted speed limit or the duration of the work being conducted (i.e., short term/maintenance or long term/construction). In general, the more detailed the data collected on the crash report, the more information available to understand work zone-involvement in crashes. Unfortunately, most states do not collect sufficient information about work zone-crash involvement to examine the relationship thoroughly [*3*].

Table 2
MMUCC recommended attributes for work zone-related crashes

C18 Subfield		
1	Was the crash in a construction, maintenance, or utility work zone or was it related to activity within a work zone?	No Yes Unknown
2	Location of the Crash	Before the First Work Zone Warning Sign Advance warning area Transition area Activity Area Termination Area *x Not Applicable/Not Within or Related to a Work Zone*
3	Type of Work Zone	Lane closure Lane Shift/Crossover Work on Shoulder or Median Intermittent or Moving Work Other type of Work Zone *x Not Applicable…*
4	Workers Present	No Yes *x Not Applicable…* Unknown
5	Law Enforcement Present	No Yes *x Not Applicable…*

In order to determine states' inclusion of one or more of C18's five subfields, as well as the work zone-related attribute values under elements C7 and C14, each state's crash report form was reviewed. Some states used MMUCC language verbatim while others collected the same information but with wording variation. For each item, binary scores were assigned to indicate if the item was included on the state's form ("1" if item was included; "0" if not). From there, it is possible to compare states by the sum of these scores (Range=0-5) to represent the "degree of inclusion," shown in Table 3. The table reads from left to right, beginning with Column 2 which shows the states (n=12) including all 5 C18 subfields. On the far right of the table, Column 7 displays the states (n=7) that exclude all 5 of the C18 subfields. As illustrated, Louisiana's crash report form includes only one of the C18 subfields (i.e., C18 Subfield 1) which is included on the front page of the crash report form as a check box.

Table 3
Degree of inclusion/exclusion of MMUCC C18 subfields on state crash report forms

C18 R=0-5	**C18** Includes All 5	**C18** Excludes 1	**C18** Excludes 2	**C18** Excludes 3	**C18** Excludes 4	**C18** Excludes All 5
	Alabama Alaska Arkansas Connecticut Florida Idaho Maine New Hampshire Ohio Pennsylvania Tennessee Virginia	Delaware Iowa Kansas Massachusetts Michigan Nebraska North Carolina Oklahoma South Carolina South Dakota Utah West Virginia Wyoming	Illinois Minnesota Mississippi	Arizona Indiana Kentucky Missouri Rhode Island Texas	Colorado Hawaii Louisiana Maryland Montana New Jersey Oregon Washington Wisconsin	California Georgia Nevada New Mexico New York North Dakota Vermont
Total States	**12**	**13**	**3**	**6**	**9**	**7**

A majority of states include the MMUCC data elements C7 (First harmful event: Collision with Non-Fixed Equipment) and C14 (Contributing Circumstances, Roadway Environment) with work zone-relevant attributes on their crash report forms. Table 4 shows each of these data elements along with the states in which the item/attribute was observed on their crash report forms and a list of states where it was not observed.

Finally, it is worth noting that states use a variety of terms to refer to work zones. In some states, the usage of the alternative term(s) may vary between the crash report and the supporting documents (e.g., data dictionary/ training manual, etc.). Some states use multiple terms, often interchangeably, like “construction”/ “construction zone” and “work zone,” or “Construction/Maintenance Zones.” Four states use the term “workzone” in addition to “work zone.” Some states use other unique terms. For example, Oregon uses the term “Special Zone” as a data element in which available attributes include four “kinds” of work zones (i.e., construction, maintenance, utility, and “unknown work”) alongside other attributes like snow and school. Table 5 displays these terms as well as the states in which they were observed.

Table 4
State inclusion MMUCC work zone related data elements C7 & C14

C7: MMUCC First Harmful Event Collision with Fixed/ Non-Fixed Object: Construction Equipment		C14: MMUCC Contributing Circumstances, Road Work Zone (Construct./ Maint./ Utility)	
✓	X	✓	X
Alaska	Alabama	Alaska	Alabama
Arizona	Georgia	Arizona	Arkansas
Arkansas	Idaho	California	Colorado
California	Illinois	Connecticut	Georgia
Colorado	Indiana	Delaware	Hawaii
Connecticut	Iowa	Florida	Idaho
Delaware	Kansas	Indiana	Illinois
Florida	Maryland	Iowa	Maryland
Hawaii	Missouri	Kansas	Michigan
Louisiana	Montana	Kentucky	Mississippi
Maine	New York	Louisiana	Missouri
Massachusetts	North Carolina	Maine	New York
Michigan	North Dakota	Massachusetts	Ohio
Minnesota	Oregon	Montana	Oklahoma
Mississippi	Pennsylvania	Nebraska	Oregon
Nebraska	Tennessee	Nevada	Washington
Nevada	Washington	New Hampshire	Wisconsin
New Hampshire	Wisconsin	New Jersey	
New Jersey	Kentucky	New Mexico	
New Mexico		North Carolina	
Ohio		North Dakota	
Oklahoma		Pennsylvania	
Rhode Island		Rhode Island	
South Carolina		South Carolina	
South Dakota		South Dakota	
Texas		Tennessee	
Utah		Texas	
Vermont		Utah	
Virginia		Vermont	
West Virginia		Virginia	
Wyoming		West Virginia	
		Wyoming	
		*Missing: Minnesota**	
Note MMUCC element C14 "roadway condition-environment" attributes include a variety of environmental factors making the element wide in scope. Missing indicates there were no clearly comparable similar elements on the state crash report form.*			

Table 5
Other terms states use to refer to "work zone"

"Workzone"	Construction; Construction Zone	Construction/ Maintenance Zone	Other Terms Unique to Individual States	
Alabama	Colorado	Georgia	Construction-Repair Zone	California
Iowa	Indiana	Maryland	Temporary Traffic Control Zone	New Jersey
Minnesota	Louisiana	Michigan	Traffic Control: Cons., Maint., Util. Work Areas	New York
Mississippi	New Mexico	Montana		
	Rhode Island	North Dakota	"Special Zone"	Oregon
	Tennessee			
	Texas			
	Wisconsin			
	Wyoming			

Summary. This observational comparison provides a general overview of the degree to which states have adopted the MMUCC guidelines/data elements regarding work zone crashes. States use a variety of terms to refer to work zones, which may or may not be equivalent. Some states refer to MMUCC definitions verbatim but most either have a modified version of the definition or they have their own version of the definition, which is typically shorter and simpler. Most include work zone attributes in elements C7 and C14 but still a sizable percentage does not. About 50% of states include at least 4 of the 5 MMUCC work zone-related C18 subfields, while the other 50% include 3 or less. Since the MMUCC recommended guidelines represent the minimum model standard, this general observation is consistent with prior research in that that most states generally do not collect enough data about work zones on their crash report forms to fully analyze work zone-involvement in crashes [*3*]. This has important implications for data quality. Because many studies looking at work zone crashes analyze state crash reporting data, there are clearly research implications as well.

The lack of consistency with respect to work zone-related data elements included on state crash report forms has long been an issue. In 1996, a study was conducted by Wang, Hughes, Council and Paniati to determine what is known about the magnitude of highway work zone crashes and to investigate crash characteristics and how work zone crashes are reported, and to identify "critical voids" in work zone safety knowledge [*14*]. At the time of the study, past studies examining work zone crashes were based on "very limited data" with little ability to compare findings because of the variation in methods, databases, and crash reporting formats (p60). The lack of complete, accurate data about work zone crashes makes it difficult to answer questions about the nature of work zone crashes, which the researchers discuss in their conclusions. The researchers also noted that the inconsistencies between states in how crash report data are collected and coded must be addressed in order to improve understanding of the magnitude of work zone crashes.

Overview of Work Zone Crash Research

Over the past several decades, there have been many studies examining characteristics and contributing circumstances in work zone crashes. The known data limitations of police-reported crash data as well as the state-determined crash reporting form/protocol presents many challenges for interpreting findings in a general sense. Researchers examined the state-of-knowledge about work zone safety in a 2014 paper where they reviewed literature from the past five decades to identify issues in work zone safety analysis and modeling [*15*]. The researchers examined 81 past studies, which were predominantly descriptive analyses of crash data to explore findings and conclusions on crash severity, crash location, crash rate, and crash types. For the most part, the researchers found a lack of consensus among studies concerning crash severity. They found a great deal of inconsistency in research examining crash rate. Though the general implication of the literature was that work zones do increase crash rates, there was a lot of variability in crash rates from study to study. The researchers determined that data quality (i.e., accuracy/correctness and completeness) presents the greatest challenge to work zone safety research.

Ullman and Scriba examined the impact of differences in *how* work zone crashes are reported by police on states' standard crash report forms on the data contained in the Fatality Analysis Reporting System (FARS) from 1998-2000. They determined that the manner in which states record information about work zone crashes (i.e., using an explicit variable on the form, using explicit attributes identifying work zone relation on the form, and using only the narrative on the form) has a statistically significant impact on the percentage of fatalities coded in FARS as being in a work zone. In other words, states with forms explicitly noting whether or not the crash occurred in a work zone also had a higher percentage of fatalities occurring in work zones than states where this information is captured in the narrative. The study concludes that the way work zone data is collected on a state's crash report form can affect data quality. They estimate that the states not explicitly coding a crash as work zone related may "be responsible for as much as a 10% underreporting of work zone fatalities nationwide between 1998 and 2000" [*16*].

Carrick, Heaslip, Srinivasan, and Zhu conducted a case study of 388 work zone crashes in Florida to assess the spatial accuracy of crashes coded as occurring in work zones [*17*]. The researchers focused on one project in particular, the I-95 Trout River Bridge in Duvall County, Florida, and filtered crash data to ensure only crashes occurring between July 1, 2006 and June 30, 2007 were included for analysis. The researchers obtained "maintenance of traffic" indexes from the construction project coordinator to account for the precise placement of temporary traffic control devices and the various areas of the MUTCD-defined work zone. The reported crash locations were manually plotted on a map. They compared the location of the crashes with the location of the work zone and found approximately 1/3 of crashes were misclassified. The most common misclassification was a crash being coded as not occurring in the work zone when it actually did (15.9% of the sample). The researchers also found that 13.4% of the crashes were misclassified as occurring in the work area when they were clearly not. Including crashes that were coded "nearby" the work zone further increased misclassification of the crashes. In total, the researchers determined that 139 out of 388 crashes were misclassified. Suggested improvements include addressing the report format, officer training, and precision spatial data collection [*17*].

A study by Swansen, McKinnon, and Knodler assessed the quality of crash reporting data as it pertains to the "work zone involvement" field by examining crash report narratives in the state of Massachusetts [*18*]. The Massachusetts motor vehicle crash report form has a field indicating whether or not a work zone was involved in the crash. Officers can report the details of work zone involvement in the narrative section of the form, which is electronically searchable. The University of Massachusetts Traffic Safety Data Warehouse contains more than 390,000 crash reports from January 1, 2007, to December 31, 2009, but only 23% of them had narratives. Only 2,811 narratives were reported as "work zone related" while the vast majority (90,279) of narratives were from crashes not marked "work zone related." Analysis took place in multiple steps. First, the researchers conducted a double-blind narrative search on a random sample of 100 crashes marked "work zone related" and 100 that were not marked work zone related. They found that, of those crashes marked "work zone related," only 28% of narratives included details of work zone involvement, while 72% gave no indication. Of the sample of crashes not marked as "work zone related," none indicated work zone involvement [*18*].

Next, they conducted a keyword search analysis of the 90,279 non-marked narratives [*18*]. Keywords included terms such as construction zone, work zone, road work, construction, barrels, closure, etc. For each keyword returning more than 30 narratives, they selected a random sample of 30 for review. For keywords returning less than 30 narratives, they reviewed all of them. This yielded over 528 narratives from crashes not marked "work zone related." Upon review, the researchers determined that 18.6% of these narratives actually indicated work zone involvement, even though they were not marked as such. The two most commonly occurring causes in the narratives involved rear-end crashes in a queue formed because of a backup and crashes from unsafe or quick lane changes/merging due to lane closure prior to entering the work zone [*18*].

Similarly, Clark and Fontaine explored the causes of work zone crashes and the implications for safety performance measures in Virginia and found a disparity between the crashes coded as occurring within the bounds of a work zone and those that were determined directly related to the work zone [*10*]. The Virginia crash report defines a work zone crash as "any crash occurring within the work zone area defined by the MUTCD" (p. 61). The specific goal of the study was to evaluate the impact of work zone activities on the likelihood or severity of crashes occurring within a work zone. Virginia DOT's Roadway Network System crash database contained 6,774 crashes coded as work zone crashes occurring in 2011 and 2012. These crashes were analyzed by crash type in order to determine most common crash types in work zone crashes (the type had to constitute at least 10% of all work zone coded crashes to be deemed common). Four crash types (rear-end, angle, sideswipe-same direction, and fixed object-off road crashes) account for 94.8% of all coded work zone crashes in 2011-2012. The researchers assessed the likelihood that a work zone contributed to the crash by examining the narratives and relevant data fields of these crashes and determined that 1,480 (23%) of coded crashes were directly related to work zone activities. Many coded crashes lacked sufficient information to determine the role of the work zone activities and they often had several contributing factors, with many being caused by driver error (e.g., following too closely, reckless driving, etc.). Among the crashes determined as directly related to the work zone, significant causes included stopping or slowing because of congestion and lane changes. Given the disparities in the coded crashes, is inappropriate to assume that crashes coded as occurring within the bounds of a work zone directly involve work zone activities [*10*].

Schrock, Ullman, Cothron, Kraus, and Voigt conducted an in-depth study of fatal work zone crashes in Texas over a period of 15 months (Feb. 1, 2003-April 30, 2004) [*19*]. By visiting the crash sites specifically to investigate the crash in depth, they collected data not typically available through state databases or police reports. Over the course of the study, the researchers responded to 77 fatal work zone crash sites in 21 of 25 TxDOT districts as they were notified by TxDOT. Analysis of historical trends (e.g., roadway type, work activity type, weather and lighting conditions, etc.) from 1995-2001 and prior research indicated the data are consistent and the 77 crashes were a representative sample of crashes throughout the state. A particular area of interest for the study concerned the extent to which the presence of a work zone played a role in a particular crash. Upon examining each crash, the researchers concluded that only 8% of investigated crashes had a direct influence from work zone, 39%

involved indirect influence, and 45% appeared to have no influence. The remaining 8% of crashes were either non-traffic fatalities (4%) or during the work zone set-up/removal (4%). For the most part, human factors and driver errors were responsible for fatal work zone crashes uninfluenced by the work zone itself. Indirect influences tended to encompass an array of factors typically involved in work zone crashes such as slowing vehicles, rear-end crashes where queues had formed, vehicles or pedestrians entering work area, or lane shift/pavement issues. The researchers propose potential countermeasures that could lead to improved work zone safety, some that TxDOT could control, and some in which they have less control but could nevertheless lead to improved safety [*19*].

Characteristics of Work Zone Crashes

According to McAvoy et al. 2011, "for many work zone crashes, both infrastructure and driver-related causes exist" [*20*]. State DOTs tend to evaluate work zone safety and mobility impacts using a variety of quantitative measures such as traffic, crash, injury, and fatality counts occurring in all work zones, or in some states, only some types (i.e., construction and/or maintenance) of work zones [*21*]. In general, performance measures are classified in terms of exposure, safety, and mobility/ traffic operations [*22*]. Exposure measures can be outcome or output-based. Output-based measures refer to the amount of effort or resources being expended (e.g., number of hours for a lane closure), while outcome-based exposure measures include such metrics as vehicle miles of travel (VMT) or the count of vehicles going through a particular area for a specified amount of time [*22*]. Safety measures are those concerned with safety or crash risk of motorists traveling through the work zone. Metrics are typically outcome-based and focus on crash counts. Mobility measures include queue formation, length, and duration or average speed. These measures are useful for a variety of reasons but tend to provide very little insight into crashes themselves. There have been many studies analyzing work zone crashes for the purposes of identifying factors and/or describing crash characteristics, frequency and/or severity, location, time of day, and crash type.

Crash Characteristics. Zhao and Garber analyzed the characteristics of crashes in Virginia work zones from 1996-1999 using police crash-report data [*23*]. They determined that most crashes tended to occur in the activity area, with rear-end being the most typical type of crash. Same direction side-swipe crashes tended to occur in the transition area. The study also found a greater number of multi-vehicle crashes occurring in work zones compared to non-work zones [*23*]. Similarly, Akepati and Dissanayake examined work zone crash characteristics in multiple states (Iowa, Kansas, Missouri, Nebraska, and Wisconsin) from 2002-2006 [*24*]. The researchers analyzed percentage-wise distributions of a number of crash characteristics and contributive factors under several different conditions (e.g., weather, lighting, roadway). In all five states, work zone crashes tended to occur under clear environmental conditions in daylight. They found multi-vehicle crashes occurred more frequently than single vehicle crashes and rear-end crashes being the most common crash type [*24*].

Crash Frequency/Severity. Examining the characteristics of work zone crashes is important for understanding the differences between work zone crashes and non-work zone crashes; however, descriptive analysis of existing crash data provides only limited insight. Yang, Ozturk, Ozbay, and Xie noted a lack of consensus among studies concerning crash severity and considerable variability in calculated crash rates, though research generally tends to find work zones are associated with some degree of higher crash rates [*15*]. Overall, the relationship of work zones to crash frequency and severity is not clear. To the extent that the work zone presence influences crash likelihood, some research suggests the work zone presence increases crash risk, while other research finds little to no elevated crash risk [*25*].

With regard to severity, some studies suggest work zone crashes are more severe than non-work zone crashes, while other studies do not find a difference [*26*]. Zhao and Garber found that work zones had higher proportion of multi-vehicle crashes as well as a higher proportion of fatal crashes than non-work zones [*23*]. A 2014 study of work zone safety culture in Missouri compared work zone crash data to overall crashes over the same period (2009-2011) to determine to what extent crash risk in work zones differs from non-work zones. In comparing fatal, injury and property damage-only (PDO) crashes occurring in work zones to non-work zones, results indicate almost no difference in the percentage of fatal crashes and less than 1% difference in the percentage of injury and PDO crashes. In other words, the study found no elevated crash risk in work zones compared to non-work zones [*25*].

Ultimately, crash severity is affected by the same risk factors common in other crashes, such as driver errors. Li and Bai (2009) examined the impact of work zone risk factors on crash severity [*27*]. Risk factors were identified using statistical methods and empirical findings and included: at-fault driver (age, gender); environmental condition (lighting); crash information (vehicle type); road condition (road class, number of lanes, speed limit, surface type) and driver error (disregarded traffic control, followed too closely) among others. Looking only at fatal and injury work zone crashes occurring in Kansas (1998-2004), the researchers examined the impact of work zone risk factors by comparing the conditional probabilities of there being a fatality when a severe crash occurred. Statistically significant risk factors included driver characteristics (i.e., being male and over the age of 64) and road condition with regard to class (i.e., “other principal or minor arterials”), lanes (i.e., rural two-lane highways), speed (i.e., urban highways with speed limits over 60 mph) and roads with “unfavorable geometric alignment” (p. 701). Poor lighting, heavy truck involvement and driver errors also tended to impact crash severity. The researchers note that when the driver error “disregarded traffic control” was a factor in the crash, the odds of the crash being fatal tripled than in severe crashes that did not involve this error; however, when the error “followed too closely” was involved, the odds of the severe crash involving a fatality decreased [*27*].

Time of Day. A 2013 study of work zone crashes in New Jersey occurring 2004-2010 found over 71% of work zone crashes happened during daylight conditions [*28*]. A National Cooperative Highway Research Program (NCHRP) study analyzed similarities of crashes occurring in nighttime and daytime work zones in several states and found no significant difference in the crash risk, implying that work requiring temporary lane closures conducted at nighttime could reduce the number of crashes due to a lower traffic volume [*29*].

Crash Type. Some crash types are overrepresented in work-zone crash analysis. A number of studies have identified rear-end collisions as the most frequently occurring type of crash in work zones [*23*, *24*, *28*, *30*, *31*]. Ozturk, Ozbay and Yang found that rear-end crash frequency was 8.6% higher in work zones in non-work zones, which were also found to have greater severity than crashes in work zones [*26*]. Sideswipe collisions are also quite common in work zones [*23*, *28*].

Human Factors and Work Zone Traffic Control

The degree to which the mere presence of a work zone has a direct or indirect influence on crashes is not clear, as many findings suggest that driver errors, inattention, and/or risky driving behavior are primarily responsible for crashes occurring in work zones [*25*]. This makes sense given the fact that human factors are usually the cause of most traffic crashes. Work zones place extra demands on drivers due to the changing traffic patterns associated with lane closures, speed limit reductions, increased congestion, etc. There are many safety measures (speed bumps, physical barriers such as barrels, etc.) and traffic control devices (signage, signals, dynamic message signs, etc.) in work zones as a form of traffic control. These methods are implemented to improve safety for workers and the traveling public, but, as with any regulatory attempt at controlling driver behavior, there are limits to their effectiveness [*32*].

States have placed a great deal of emphasis on controlling driving speed through work zones through reducing speeds and enforcing compliance [*20*]. According to NHTSA, “speeding is one of the most prevalent factors contributing to traffic crashes,” making up 30% of all traffic fatalities in 2012 [*33*]. The premise that lowering the speed limit through a work zone will reduce the number of crashes is generally accepted. Almost all states have increased penalties for motorists caught speeding in a work zone; however, there have been no studies showing that enforcement of reduced speeds through work zones reduces the number of crashes [*20*, *34*].

A 1996 NCHRP digest summarizes findings from a comprehensive research project titled, *Procedure for Determining Work Zone Speed Limits*. The study finds that motorists tend to reduce speed when traveling through a work zone regardless of speed limit reduction [*35*]. Compliance with posted speed limits tended to be higher in work zones where the speed limit was not lowered, whereas compliance tended to decrease with speed limits lowered by 10mph or more. In general, the research concludes that lowering the speed limit through work zones should be avoided if possible and when reducing speed is appropriate, it is best not to reduce it by more than 10mph. There appears to be a fine line for several reasons. First, drivers will not typically reduce speeds more than 10mph, regardless of enforcement [*36*]. Second, lowered speed limits through work zones can also backfire by increasing speed differentials [*20*, *34*].

Regardless of posted speed limits, research has shown that drivers typically will decide their own safe travel speed based on road conditions, which may exceed posted limits [*34*]. Research has also shown that drivers will voluntarily reduce travel speed upon entering a work zone, further reduce travel speed when passing through the active work area, and then increase their speed after exiting [*36*]. Enforcement may be effective to a certain extent, but once drivers have passed the police, they tend to resume prior speeds. According to Sommers and McAvoy, “The most influential factor in achieving speed compliance in the work zone is the driver’s perception of heightened risk” [*34*]. Finley conducted field studies on motorists’ reactions to reduced work zone speed limits and other conditions and concluded that motorists reduced speed when they perceived a need to do so [*34*]. The amount they reduced depended on such factors as the normal speed limit, enforcement activities and the nature of the situation. Also, reduced speed limits with no apparent work conditions to justify it led to increased noncompliance.

Methods

This section describes the data sources, collection, processes, and methodologies used in analysis for this project. First, a description of the Louisiana Crash Report Form provides an overview of how work zone crashes may be reported, which provides necessary background for the methods used in this study.

Louisiana Crash Report

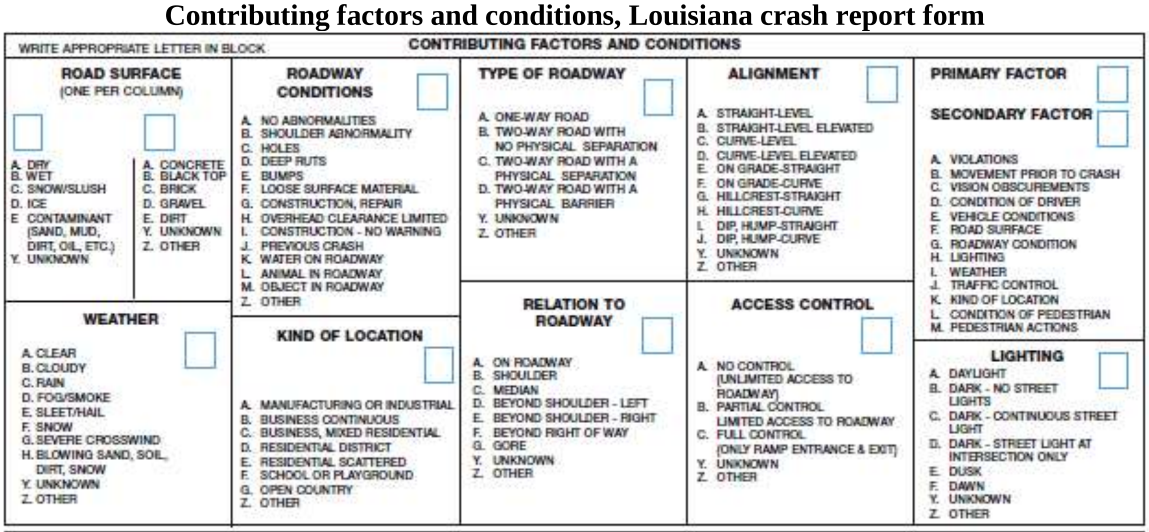
The manner in which work zone crashes are recorded/reported in Louisiana differs from other states and warrants some description. Specifically, the Louisiana crash report form has a field called "Work Zone" which is displayed next to a check box. The Louisiana Uniform Crash Report manual instructs officers to: "Only mark an 'X' in the block if the crash occurred in a construction or maintenance work zone. A work zone crash is a crash where the first harmful event occurs within the boundaries of a work zone…" [*37*]. The manual goes on to define "work zone" as "an officially designated portion of a public thoroughfare on which the Department of Transportation and Development (DOTD), a subcontractor representing DOTD, or the local city or parish road department is doing construction or maintenance" [*37*]. The definition continues, clarifying that the work zone definition is applicable to the main roadway or the shoulder and reiterating that only government-authorized work (e.g., construction, maintenance, utility) meets the definition criteria. The manual also indicates that the definition is location/area based in that work does not need to be actually occurring at the time of the crash and that the box should be checked "for ALL crashes occurring in a designated construction or maintenance work zone…" [*37*].

Officers are instructed to look for the typical markings of a work zone to determine whether or not the crash is in a work zone. These typical markings include signs, channelizing devices, barriers, pavement markings, and/or work vehicles. The work zone begins at the "first warning sign or flashing lights on a vehicle and ends at the sign indicating the end of construction or road work or at the last traffic control device" [*37*]. The first warning sign is the color orange, placed precisely 1 mile from the work area, and is considered the beginning of the work zone for crash reporting purposes. When no signs are present, officers are instructed to use the first and last points of construction/maintenance work to determine whether or not the crash took place in a work zone. Finally, despite being technically work zone-related, "crashes involving vehicles slowed or stopped because of the work zone should not be included unless the vehicles had actually entered the work zone when the first harmful event occurred" [*37*]. In other words, if a crash took place in an approach to a work zone, but before the first warning sign, then according to these instructions, officers should not report the crash as a work zone crash. This instruction appears to have no exceptions, even if traffic conditions are directly related to work zone activities, such as when traffic backups extends miles beyond the first warning sign.

Additionally, there is one other data field on the Louisiana crash report form concerning work zones: "Roadway Condition" which appears under the general section of Crash-specific data, "Contributing Factors and Conditions." There are two coded roadway condition options involving work zones: “Construction, Repair (G)” and “Construction-No warning (I).” Officers can only enter one code in this field and are instructed to “choose the element that best describes the factor present which most contributed to the crash” [*37*]. If additional factors are present, officers are instructed to list them in the narrative section, accompanied by a description stating what if any effect the other factors had on the crash. If, in the officer’s opinion, these other factors did not contribute to the crash, the instructions indicate the officer should report “No Abnormalities (A)” [*37*]. This section of the Louisiana crash report form appears in Figure 2.

It is worth noting that under Primary/Secondary Factor, “Roadway condition” is one of the available options. If, for instance, an officer determines that the primary contributing factor in the crash was driver violations—and multiple roadway conditions including “construction” are present—the officer may report “No abnormalities” (A) in the Roadway condition field. Thus, it is possible to see how work zone as a road condition could be overlooked and subsequently not reported (unless the officer details these factors in the narrative). Thus, the roadway condition field may not be a reliable indicator of work zone involvement.

Figure 2
Contributing factors and conditions, Louisiana crash report form


WRITE APPROPRIATE LETTER IN BLOCK — CONTRIBUTING FACTORS AND CONDITIONS

ROAD SURFACE (ONE PER COLUMN)
A. DRY
B. WET
C. SNOW/SLUSH
D. ICE
E. CONTAMINANT (SAND, MUD, DIRT, OIL, ETC.)
Y. UNKNOWN

A. CONCRETE
B. BLACK TOP
C. BRICK
D. GRAVEL
E. DIRT
Y. UNKNOWN
Z. OTHER

ROADWAY CONDITIONS
A. NO ABNORMALITIES
B. SHOULDER ABNORMALITY
C. HOLES
D. DEEP RUTS
E. BUMPS
F. LOOSE SURFACE MATERIAL
G. CONSTRUCTION, REPAIR
H. OVERHEAD CLEARANCE LIMITED
I. CONSTRUCTION - NO WARNING
J. PREVIOUS CRASH
K. WATER ON ROADWAY
L. ANIMAL IN ROADWAY
M. OBJECT IN ROADWAY
Z. OTHER

TYPE OF ROADWAY
A. ONE-WAY ROAD
B. TWO-WAY ROAD WITH NO PHYSICAL SEPARATION
C. TWO-WAY ROAD WITH A PHYSICAL SEPARATION
D. TWO-WAY ROAD WITH A PHYSICAL BARRIER
Y. UNKNOWN
Z. OTHER

ALIGNMENT
A. STRAIGHT-LEVEL
B. STRAIGHT-LEVEL ELEVATED
C. CURVE-LEVEL
D. CURVE-LEVEL ELEVATED
E. ON GRADE-STRAIGHT
F. ON GRADE-CURVE
G. HILLCREST-STRAIGHT
H. HILLCREST-CURVE
I. DIP, HUMP-STRAIGHT
J. DIP, HUMP-CURVE
Y. UNKNOWN
Z. OTHER

PRIMARY FACTOR
SECONDARY FACTOR
A. VIOLATIONS
B. MOVEMENT PRIOR TO CRASH
C. VISION OBSCUREMENTS
D. CONDITION OF DRIVER
E. VEHICLE CONDITIONS
F. ROAD SURFACE
G. ROADWAY CONDITION
H. LIGHTING
I. WEATHER
J. TRAFFIC CONTROL
K. KIND OF LOCATION
L. CONDITION OF PEDESTRIAN
M. PEDESTRIAN ACTIONS

WEATHER
A. CLEAR
B. CLOUDY
C. RAIN
D. FOG/SMOKE
E. SLEET/HAIL
F. SNOW
G. SEVERE CROSSWIND
H. BLOWING SAND, SOIL, DIRT, SNOW
Y. UNKNOWN
Z. OTHER

KIND OF LOCATION
A. MANUFACTURING OR INDUSTRIAL
B. BUSINESS CONTINUOUS
C. BUSINESS, MIXED RESIDENTIAL
D. RESIDENTIAL DISTRICT
E. RESIDENTIAL SCATTERED
F. SCHOOL OR PLAYGROUND
G. OPEN COUNTRY
Z. OTHER

RELATION TO ROADWAY
A. ON ROADWAY
B. SHOULDER
C. MEDIAN
D. BEYOND SHOULDER - LEFT
E. BEYOND SHOULDER - RIGHT
F. BEYOND RIGHT OF WAY
G. GORE
Y. UNKNOWN
Z. OTHER

ACCESS CONTROL
A. NO CONTROL (UNLIMITED ACCESS TO ROADWAY)
B. PARTIAL CONTROL LIMITED ACCESS TO ROADWAY
C. FULL CONTROL (ONLY RAMP ENTRANCE & EXIT)
Y. UNKNOWN
Z. OTHER

LIGHTING
A. DAYLIGHT
B. DARK - NO STREET LIGHTS
C. DARK - CONTINUOUS STREET LIGHT
D. DARK - STREET LIGHT AT INTERSECTION ONLY
E. DUSK
F. DAWN
Y. UNKNOWN
Z. OTHER

Officers are instructed to use the narrative section to describe how the crash occurred, including vehicle directions and any other descriptive information that explain the events immediately preceding the crash. The Louisiana Crash Report Manual emphasizes the importance of the officer including descriptions of their personal observations of the area, physical evidence, driver conditions and their opinions. If the crash took place in a work zone but was clearly caused by violations, it would be appropriate for the officer to report this detail in the narrative. Therefore, part of the analysis in this study involves a content analysis of the officer narratives, detailed in a later section.

Work Zone Project Selection

DOTD maintains a file of work zone projects in Louisiana. The file contains information on several key characteristics including: Project Number, Road/Highway Code/ Number Hwy, Parish, Begin Date, End Date, Begin Milepost, End Milepost, Number of Crashes, Number of Fatal Crashes, Number of Work Zone Crashes, Average Daily Traffic (ADT), Number of Days Under Construction, Vehicle Miles, Crashes Per Million Vehicle Miles (MVMT), Work Type, Project Name, and Year. Projects selected for this project had to meet the following criteria: (1) The sample should include a variety of work types, (2) each project selected should have some work-zone related crashes, and (3) the sample should include recent projects (as opposed to projects completed years ago). Recent projects are more indicative of current safety issues relating to work zone management. Therefore, the sampling frame was narrowed so that only work zone projects on interstates in Louisiana between 2012-2015 were included. An overview of the sampling frame is provided in Appendix C, which contains a tabulation of the number of projects by work type and includes the number of crashes reported as well as the number of reported work zone crashes. The research team worked with the Project Review Committee (PRC) to select projects statewide for further analysis. The projects selected for this project appear in Table 6, which includes brief project descriptions including work type, Route/highway, Parish, active dates (as determined by the dates signs were put up and the dates that the signs were taken down), and the project durations (in months and days).

Table 6
Selected work zone projects overview, characteristics

				Work Zone Sign Dates		Duration	
Project No.	Project Description	Work Type	Parish	Up	Down	Mos.	Days
H.009600.6	I-12 Tangipahoa Parish Line	Asph ovly asph pvmt	St. Tammany	7/16/2014	7/21/2015	12	370
H.009836.6	I-12 Walker to 0.5 mi West of Satsuma	Asph wdn and ovly	Livingston	1/24/2014	11/12/2015	19	658
H.009480.6	I-20 Ouachita River Bridge	Bridges rcnd	Ouachita	Apr-14	May-16	25	760
H.010350.6	I-10 Ramp improvements at JCT LA 3184	Traffic flow improve	Lafayette	1/9/2015	9/29/2015	9	264
H.009319.6	I-10 Overpass bridges: cleaning, painting and repairs	Bridges rcnd	Calcasieu, Jefferson Davis & Acadia	Mar-16	Sep-16	6	185
H.011272.6-210	I-210 pavement marking and replacement, phase II	Striping/pv mt markers	Calcasieu	May-15	Oct-15	5	154
H.011272.6-10	I-10 pavement marking and replacement, phase II	”	”	”	”	”	”

H.011270.6	I-10 pavement marking and replacement, phase III	Striping/pvmt markers	Lafayette & Acadia	4/29/2015	5/9/2015	0	11
H.010440.6-210	I-210 Interstate lighting	Roadway lighting	Calcasieu	1/26/2016	N/A	20+	610+
H.010440.6-10	I-10 Interstate lighting	”	”	”	”	”	”

In total, 10 work zones reflecting a variety of work types were selected from eight distinct projects. Two projects involved work on two separate Interstates, which individually represent a work zone. These work zones share the same main project number, individually differentiated by a hyphen with the corresponding route (H.010440.6-210; H.010440.6-10). Next, in order to identify crashes that took place in the vicinity of each work zone, LTRC provided the research team with the following details for each work zone: Sign dates (up and down), Route, Control Section, Mileposts indicating “Beginning of Project” (BOP) and “End of Project” (EOP), as well as the mileposts where work zone signs were placed. These signs include “Road Work Ahead” (i.e., the first warning sign, 1 mile before work area begins; RWA), “Road Work Next XX Miles” (RWNM) and “End Road Work” (ERW) for both travel directions. These details are displayed in Table 7.

Table 7
Work zone projects, mileposts and sign placement

				Milepost					
				Direction 1 (EB/NB)			Direction 2 (WB/SB		
Project	Control Section	BOP (milepost)	EOP (milepost)	RWA	RWNM	ERW	RWA	RWNM	ERW
H.009600.6	454-04	52.910	63.716	51.900	52.910	63.804	64.646	63.716	52.814
H.009836.6	454-02	16.000	17.550	15.296	16.000	17.815	20.058	17.550	15.933
H.009480.6	451-06	115.666	117.483	114.666	115.666	117.578	118.483	117.483	115.571
H.010350.6	450-05	99.873	100.346	98.873	99.873	100.441	101.346	100.346	99.774
H.009319.6	450-91/ 450-04	14.088	86.870	12.654	14.088	86.984	87.644	86.870	13.952
H.011272.6-210	450-30	4.188	5.300	3.214	4.188	5.395	6.300	5.300	4.101
H.011272.6-10	450-91	25.300	34.200	24.300	25.300	34.295	35.200	34.200	25.205
H.011270.6	450-04/ 450-05	66.380	103.534	65.393	66.380	103.627	104.610	103.534	66.288
H.010440.6-210	450-30	0.209	3.663	N/A*	0.209	3.757	4.620	3.663	0.114
H.010440.6-10	450-91	24.634	25.584	23.634	24.634	25.679	26.584	25.584	24.539
* sign on I-10									

Crash Report Data Collection & Analysis

The primary objective of this study is to provide information about work zone crashes and how they are reported in Louisiana and other states. The systematic review of state crash report forms and definitions presented in the literature review provided a general overview of work zone crash data collection in the US. It is not clear if all work zone crashes are reported and without additional details captured in the coded data fields, it is impossible to examine to what extent the work zone played a role in the events leading up to the crash from the coded fields alone.

In Louisiana, work zones are defined by their physical location and the main data field is a check box on the first page. When filling out the crash report, officers are instructed to indicate whether the crash took place in a work zone, however, with the exception of "Roadway Condition," there are no other coded data fields on the Louisiana crash report form that collect work zone-specific information. Moreover, crashes that occur in an approach to a work zone could be potentially be work zone-related, but given Louisiana's definition of "work zone crash," these crashes would not meet the criteria. In fact, the Louisiana Crash Report Manual clearly states, "crashes involving vehicles slowed or stopped because of the work zone should not be included unless the vehicles had actually entered the work zone when the first harmful event occurred." For all pertinent information not otherwise captured in the coded data fields, officers are instructed to report these factors in the narrative section. Since only crashes occurring between the signs meet the criteria of a work zone crash, it is reasonable to expect that officers likely do not report crashes before the first/after the last warning sign as work zone crashes. If details alluding to potential work zone involvement are reported at all, this information would be captured in the narrative/drawing since there is no other coded data field on the Louisiana crash report form through which these details could be reported. Also, to understand work zone involvement in crashes occurring in close proximity of a work zone, the narrative and drawings may supply important insight.

It is possible to examine crash patterns and identify factors affecting work zone crashes using crash report data, but for the various reasons outlined above (as well as the data quality issues) this would yield only limited insight. To better understand the underlying causes of work zone crashes, the degree to which the details surrounding work zone crashes are reported, the content of the narratives and drawings must be reviewed. The narrative section on the crash report is where officers are instructed to describe how the crash occurred and the details surrounding the events leading up to the crash. The Louisiana Crash Report Manual clarifies that this includes “any and all details of the crash, such as what each driver observed and any evasive actions taken, including details about movements prior to impact and subsequent movement to the point of rest.” Throughout the manual, officers are instructed to report details in the narrative not captured in the coded data fields. Thus, if the crash took place within the bounds or in close proximity to a work zone, it would be appropriate for the narrative to indicate this. Moreover, if the crash was directly attributable to work zone-related factors, it would be appropriate for the officer to explain the work zone involvement in the narrative.

The next several pages describe the methodological processes and data collection procedures used to retrieve and systematically analyze crash report data, as well as the content analysis methodology used to collect data from the crash report narratives and drawings.

Crash Identification and Data Retrieval. The Highway Safety Research Group (HSRG) at LSU is responsible for collecting, maintaining, storing, and analyzing crash data for the state of Louisiana. Researchers retrieved crash data from vwtCRASH in the crash data warehouse by location, using the parameters provided by DOTD and LTRC (i.e., control section and milepost, sign placement dates) for each work zone project in our sample. Researchers retrieved all crashes that took place in the work zone and within 5 miles before and after the work zone in both directions. Researchers identified direction of travel and location on a ramp from the LRS_ID, retrieved from the DOTD table for each year in the DOTD_PlusDB database, and retrieved data for every vehicle and driver in each crash based on crash number. The process of retrieving electronic copies of individual crash reports is described later.

Crash Data Analysis. Crash data analysis was completed using Power Pivot, a Microsoft Excel add-in data modeling and analysis tool that readily handles large volumes of data (millions of rows) from multiple data sources. This analysis provides insight into characteristics of crashes occurring in and within 5 miles before and after the work zone and compares findings across the three locations using basic descriptive statistical analytic methods. VMT analysis involved calculating crash rates for the duration of each work zone project, well as for one year before/after. To select crashes for the before and after comparison, we selected crash, vehicle, and driver data for crashes that occurred in the same work zone area before the project began and after the work was completed. Researchers retrieved data for 1 year prior to the beginning of construction and up to 1 year after, until the date 12/31/2016. Projects completed in 2016 did not have a full year of data from the after-period.

Content Analysis of Crash Report Narratives & Drawings

With the exception of Louisiana State Police who have a separate crash database, official copies of crash reports are stored in HSRG's LACRASH database. All crash reports in which the narratives and drawings were electronically available were manually retrieved by crash report number. The primary objective in reviewing the narrative/drawing sections is to determine if the narrative contains *any explicit* indication that the crash might be work zone-related. A related goal is to record the primary factors/ circumstances the officer reports to examine *how* work zone crashes are reported (i.e., what is considered pertinent from the officers' standpoint to include; do work zone related crashes share similar characteristics as reported by the officer in the narrative and/or drawing?).

Content analysis is a research technique that allows for making valid and reliable inferences from texts (e.g., documents, messages, records, mass media) to the contexts in which they are used [*38*]. In order to make meaningful inferences about work zone crash reporting practices in Louisiana, information contained in the narratives must be systematically "coded" into representative categories for analysis. The systematic procedure for empirically recording/examining texts consists of applying pre-established rules and specific operational definitions to identify/record characteristics of interest as they appear in the text. Empirically observable characteristics are "coded" into relevant categories for the purposes of describing contents and for drawing inferences in context. Categories are determined according to research purposes and the nature of the data [*39*]. The categories and analytical constructs of interest must be consistent with what is known about the texts and their context of use [*38*]. Reliability is contingent on the consistent application of the pre-established objective, observer-independent rules to the texts.

Codebook. The codebook provides the "framework" for data collection by specifying the variables of interest as well as instructions for recording observable manifest content into exhaustive, mutually exclusive categories for analysis. Each crash report constitutes a unit of analysis. In this study, two researchers manually coded the crash report narratives (and drawings) for any explicit mention of work zone features/activities as well as explicit descriptions of traffic conditions common to work zone traffic issues (i.e., congestion, slow or stopped traffic). Table 8 contains all of the variable names, labels (i.e., descriptions), and numeric values representing mutually exclusive categories. To inform codebook development, several narratives selected at random for preliminary review. This yielded insight into overall reporting practices and narrative format. Specifically, it was apparent that many narratives contained descriptions of slow/stop or congested traffic conditions, but explicit mentions of work zone activity, construction crew, or any terms clearly indicative of work zone operations were infrequent. In general, narratives were concise and often lacked descriptive detail but because they were also formulaic to a degree and uncomplicated, developing the codebook was a straightforward process.

As Table 8 displays, narratives were coded for explicit work zone-involvement, whether or not the narrative reports traffic conditions were congested, and stopped/slowed. An explicit reference need not refer to only certain terms verbatim as many officers may use alternative terms that clearly convey the same essential meaning (e.g., construction vs. road work, construction zone vs work zone, etc.). A series of dummy variables were created to code for explicit mentions of work zone involvement and related variables of interest. If the narrative explicitly and unquestionably indicated the crash took place in or in the vicinity of the work zone, it would be coded "1" and "0" if not. Similarly, explicit mentions of traffic congestion/back-ups, conditions of slow and/or stopped traffic, and collision with traffic control device were coded "1" and "0" if the narrative contained no explicit reference.

Table 8
Crash report narrative codebook

Variable	Label	Values	Instructions
CrashID	Unique number, crash report no.	N/A	Official crash report number
ExplicitWZ	Does the narrative **explicitly** mention anything about **road work, construction work/crew, WZ or construction/CZ?**	1=yes, 0=no	Any explicit mention in the narrative that road work or construction is taking place/ongoing, may also refer to utility or maintenance work. If other relevant terms are used make note of them
Congestion	Does the narrative **explicitly** mention **traffic congestion/back ups/ queues?**	1=yes, 0=no	Any explicit description of congested traffic conditions
SlowStop	Does the narrative **explicitly** mention **traffic conditions or vehicle(s) were stopped, slowing, or slowed?**	1=yes, 0=no	Any explicit description of a sudden reduction in speed, references to brakes/braking may be involved (e.g., unit 1 slammed on their brakes)
TCDevice	Does the narrative indicate a **collision with a concrete barrier wall or other TC device?**	1=yes, 0=no	e.g., cone, obstructions, barriers, guard rails that are used to control traffic
Wzrelated	Overall, does the crash appear to be work zone-related?	0=no, 1=yes, 2=maybe	Code 2 if not clearly "yes" or clearly "no"
Drawing	Does the drawing provide any additional information or insight into the nature of the crash that is not contained in the narrative?	1=yes, 0=no	If yes, describe details of drawing in Notes
Notes	Any noteworthy observations from the narrative and/or drawing that are not captured in the coded variables	text	Provide brief description/summary of specific terms, crash factors, or other noteworthy or questionable observations, crash report drawing details

One categorical variable “WZRelated” captures the coders’ overall impression of whether or not the crash appears work zone related by the degree of clarity provided in the narrative concerning work zone relation. If the narrative clearly indicated work zone relation, it was coded “1,” if the narrative clearly attributed the crash to factors unassociated with the work zone (such as violations or weather) it was coded “0,” and if it was not possible to determine work zone relation from the information provided in the narrative, it was coded “2.” The vast majority of report drawings tended to re-state information already contained in the narrative and provided no new information. If the drawings included details or explicit mentions not contained in the narrative, it was coded “1,” and if the drawings added nothing further, it was coded “0.”

Intercoder Reliability. Two researchers independently completed the coding of the crash report narratives in this study. Prior to dividing the accessible population of crash reports (N=2,776) intercoder reliability was established using a random subset of crash reports (N=145). Intercoder reliability refers to the extent to which two (or more) coders agree or reach the same conclusion in their observations. Intercoder reliability was calculated using ReCal2 an "online utility that computes intercoder/interrater reliability coefficients for nominal data coded by two coders" [*40*]. Results showed 88.6% agreement across independent observations. Cohen's Kappa statistic, which provides an adjustment for chance-agreement (κ=.77) falls within the range .61-.80 indicating "substantial" agreement [*41*].

Work Zone-Specific Data Sources

Part of the study objectives include generating insight about work zone traffic control configurations as well as which "parts" of the work zone experience higher crash frequencies. While researchers were able to identify the boundaries of a work zone with regard to precise sign placement of the first warning sign, begin road work sign, and end road work sign, it was not possible to divide the work zone into the five parts as specified by the MUTCD. Also, it was not possible to obtain the precise work zone traffic control configuration for each work zone. Traffic control configurations vary over the course of a project as stages are completed or as work activities require. Researchers were able to obtain contractor daily work diaries; however, details regarding traffic control configuration were not included in these diaries. Two of the contractor diaries provided sufficient detail for further analysis. The extent to which the contractor diaries aided in analysis is detailed below.

Contractor Daily Work Diaries. The contractor work diaries were provided for each of the work zone projects in pdf file format (N=8). At first glance, the diaries appeared to share similar page format but varied considerably in the number of pages per file (Range=29-1,176 pages; Mean=547.88 pages). The total number of pages for all projects is 4,383. A cursory examination of the files' content plainly indicated qualitative differences in terms of the level of detail and clarity of documentation. Also, only a few diaries appeared to maintain a relatively high degree of internal consistency with respect to the level of detail/clarity of documentation throughout the project duration. These aspects have important reliability and validity implications. The reason for evaluating the contractor diaries in the first place is to determine whether they can provide any additional insight into work zone activities/operations and if so, how much?

Given the apparent qualitative differences, each diary was systematically reviewed to assess: 1) the degree to which the diary contains a sufficient level of detail for further analysis, and 2) the degree to which the contents are internally consistent throughout the project. To facilitate comparison, these aspects are operationalized in two Likert-type scales as follows:

1) Level of detail: 1=insufficient/sparse; 2=mostly insufficient/low; 3=relatively insufficient/some; 4=generally sufficient/adequate; and 5=sufficient/high

2) Internal consistency: 1=highly inconsistent; 2=mostly inconsistent; 3=relatively inconsistent/somewhat consistent; 4=mostly consistent; and 5=highly consistent

Upon scoring the diaries' content along these two aspects, the qualitative differences among them became clearer. Table 9 illustrates these differences for comparison. The column "total" contains the sum of both scores across work zone projects as an overall score and provides insight into how the diaries varied relative to each other. Two project diaries stood apart from the rest as being suitable for further analysis. These diaries appeared to contain sufficient detail in describing the work activities, time/location, traffic control detail, etc., shown in the highlighted rows on Table 9.

Table 9
Qualitative comparison of work zone daily diaries

	no. pgs	level of detail	Internal consistency	total
H.009319	308	2	4	6
H.009480	980	2	3	5
H.009600	476	4	4	8
H.009836	759	1	3	4
H.010350	342	3	3	6
H.010440	1176	1	3	4
H.011270	29	5	5	10
H.011272	313	1	3	4

Relative to the other six, these diaries generally used precise language (as opposed to general/vague) consistently throughout daily entries. They also tended to provide specific documentation of work activities, hours/location, traffic control etc. These two projects noted location of work activities on a mostly or highly consistent basis. One of them documents specific mileposts where the other refers to lane station numbers. In contrast most of the project diaries contain sparse or low-levels of detail and provide minimal documentation of activities. Some of diaries indicate static work hours (e.g., 8:00pm-6:00am; 12:00am-12:00pm) day after day, sometimes with questionably little variation even for rain or other documented inclement weather. One other common feature among most of the diaries is a lack of elaboration concerning traffic control specifics. For some projects, traffic control was documented daily with general statement referring to another document (e.g., see traffic control (TC) diary; refer to tcd) or general statements like "all signs and barricades were in place as per tc plans" or "All signs, barricades and message boards up and functioning."

There are other limitations with respect to the contractor diaries. For the most part, contractors seldom include nearby mileposts in their activity documentation. Only one diary did so consistently. The other referred to specific lane station numbers in their general remarks and installed item line entries; however, without any clear correspondence to milepost or other location details, the lane station references are not readily informative or intuitively interpreted. For the purposes of this project, it is not clear how these references correspond to mileposts or location with respect to the work zone configuration. The lane station numbers may be sufficient for DOTD's documentation purposes but difficult to assimilate for crash data analysis or location matching. Another limitation concerns the degree to which the diary content is standardized across projects. While the diaries seem share the same format and some of the fields appear standard on every entry, appearing at the top of the page, these items are mostly limited to the bulleted fields that appear below:

- Work Order Date:
- Time Charge Type:
- Allotted Contract Time:
- Ctrl. Work Item:
- High Temp:
- Low Temp:
- AM Cond.:
- PM Cond.:
- Total Charge Days:
- Percent Time Elapsed:
- Days Since Work Order:
- Percent Complete:
- Diary Charged:

The next section of the diary, "DWR Remarks," contains five form fields: Work Hours; Primary Inspector; Time Charge Comments; Traffic Control; and Staff Detail. Some of the diaries include more information in this section than others do; however, there is no discernible pattern as to when and why. It is possible that these fields are optional in that the decision to include additional information is left to the contractor's discretion.
Other fields include General Remarks, Visitors, Traffic Control Manager, Project Progress, and Accidents. Not all of the diaries include the Accidents field and of those that occasionally do, it is very rare and it is not always clear what the contractor is referring to in this field. For instance, one of the diaries includes a person's name and credentials in the

accident field. This could possibly suggest that an accident occurred on the job among the workers, though any interpretation is purely speculative. On relatively few occasions, Accidents clearly describe a vehicular crash. Sometimes the comments indicate work zone relation but other times, the crash appears to be caused by other factors, such as tire debris in the roadway. It is worth mentioning that of the pdfs were keyword searched for the terms "crash," "wreck," and "accident" and "collision," and were remarkably infrequent. When these terms are reported, they might refer to work activities, e.g., "wrecking forms…" or they might refer to a crash. There is no clear requirement for reporting crashes in the contractor diaries.

Contractor Diary Data Collection. The diaries associated with projects H.011270 and H.009600 contained sufficient detail for further analysis. Crashes that took place in the immediate vicinity of these two work zone projects will be analyzed more in depth than crashes associated with other projects. One of the projects was completed in 11 days, while the other took around a year (i.e., 370 days). Each diary was manually reviewed and the following information recorded for each daily entry:

- Date
- Day of Week
- Work Start Time
- Work End Time
- Beginning Milepost/Lane Station
- Ending Milepost/Lane Station
- Direction
- Signs (i.e., traffic control details)
- Comments (i.e., Contractor remarks/pertinent detail

Crash Matching by Date/Time. Because both project diaries provide documentation for the dates and times in which the work zone was active, it is possible to match crashes by date/time and triangulate observations. All crashes that took place during active work zone dates/times were isolated by crash date/time for three primary locations (before work zone, work zone, after work zone). By matching the crash date/time to data collected from the crash report narrative coding, it is possible to examine those crashes that took place while the work zone was active more in depth. This may provide insight into work zone crashes in general as well as to what extent the work zone may play a direct role, however, any potential findings are not generalizable to work zone crash reporting practices or crash incidence in work zones. For two work zone projects in the sample, the diaries may improve understanding of how work zone-related crashes were reported as well as the factors contributing to the crash. Data recorded from the contractor diaries will be matched to crashes and from there, it is possible to compare findings from the narrative content analysis to the two work zone crash identifying fields (i.e., check box and roadway condition)

DISCUSSION OF RESULTS

Findings will be presented in the following order: First, descriptive statistics regarding the work zone projects and crash frequencies are reported and discussed followed by the results from the narrative content analysis for all of the work zone projects in the sample. For two of the projects in the sample, it was possible to perform more detailed crash analysis and these results are last.

Work Zone Crash Data Analysis

The work zone crash data analysis is based on a census of all crashes (N=3636) that happened within 5 miles of the work zone (before, within, and after) during active project dates (when DOTD signs were in place). Table 10 displays the total number of crashes by project and according to relative location. As shown, about 19% of crashes in proximity to the work zone occurred in the approach area, about 28% occurred after exiting the work zone. Slightly over half of the crashes, about 53%, took place within the DOTD work zone boundaries.

Table 10
Total crash frequency by project and location relative to work zone

	Approach Total	Work Zone Total	Exit Total	Grand Total
H.009600.6	63	272	69	404 (11.11%)
H.009836.6	97	103	116	316 (8.69%)
H.009480.6	145	319	303	767 (21.09%)
H.010350.6	74	43	61	178 (4.90%)
H.009319.6	39	658	37	734 (20.19%)
H.011272.6-210	46	49	64	159 (4.37%)
H.011272.6-10	15	196	42	253 (6.96%)
H.011270.6	2	17	1	20 (0.55%)
H.010440.6-210	68	172	116	356 (9.79%)
H.010440.6-10	152	81	216	449 (12.35%)
Grand total:	701 (19.28%)	1910 (52.53%)	1025 (28.19%)	3636 (100.00%)

Crashes within the work zone boundaries accounted for the greatest proportion of crashes in four projects (H.009600.6; H.011272.6-10, H.011270.6, and H.009319.6). One project had a higher proportion of crashes in the approach (H.010350.6) while two projects had a higher proportion of crashes in the exit (H.011272.6-210, H.010440.6-10). Two projects had similar proportions of crashes take place in the work zone and the exit (H.09836.6, H.09480.6). In the last column, the percentages refer to the project proportion of the total number of crashes (N=3,636). Projects ranged from 0.55% to 21.09%, with two projects accounting for 41.28% of the total number of crashes in the 10-project sample. A VMT analysis was conducted to calculate the crash rate in work zones (and the transition areas) during construction. For comparison, VMT crash rates were also calculated for the before/after period in the same location, Table 11 displays these results.

Table 11
VMT analysis work zone crash rate during & before/after comparison

	VMT Rates During Work Zone, Work Zone & Transition Areas				
Project	Crashes	WZ Crashes	WZ Rate per MVMT	Transition Crashes	Transition Rate per MVMT
H.009600.6	404	272	0.92	132	0.57
H.009836.6	316	103	0.65	213	0.64
H.009480.6	767	319	1.36	448	0.73
H.010350.6	178	43	0.86	135	0.67
H.009319.6	734	658	0.64	76	0.56
H.011272.6-210	159	49	1.75	110	1.48
H.011272.6-10	253	196	1.44	57	0.46
H.011270.6	20	17	0.88	3	0.61
H.010440.6-210	356	172	2.49	184	2.46
H.010440.6-10	449	81	1.02	368	1.37
Total	3636	1910		1726	
	VMT Rates Before/After Work Zone, Work Zone & Transition Areas				
Project	Crashes	WZ Crashes	WZ Rate per MVMT	Transition Crashes	Transition Rate per MVMT
H.009600.6	817	621	1.07	196	0.43
H.009836.6	482	123	0.70	359	0.97
H.009480.6	273	103	0.95	170	0.60
H.010350.6	421	90	0.90	331	0.82
H.009319.6	605	555	0.54	50	0.37
H.011272.6-210	364	128	2.28	236	1.58
H.011272.6-10	539	388	1.43	151	0.61
H.011270.6	37	30	0.77	7	0.71
H.010440.6-210	296	124	1.80	172	2.31
H.010440.6-10	373	57	0.72	316	1.18
Total	4207	2219		1988	

Manner of Collision

Table 12 shows the most frequent manners of collision by proximate location to the work zone (i.e., approach, work zone, exit). Out of all possible manners of collision, three types accounted for 92.66% of all crashes (N=3,636) within 5 miles of the work zone projects in the sample. These types include: rear end (N=1,775), which reflects 48.82% of the crash count, non-collision with motor vehicle (N=872, 23.98%), and sideswipe-same direction

(N=722, 19.86%). With respect to proximate location, the highest number of crashes for each crash type generally took place within the actual work zone, as opposed to before or after. Because work zones varied in length and duration, these data must be interpreted with caution.

Table 12
Most frequent manners of collision by proximate location to work zone, all projects

	Non-collision w. Motor Vehicle				**Rear End**				**Sideswipe- Same**			
	Approach	Work Zone	Exit	Proj. Total	Approach	Work Zone	Exit	Proj. Total	Approach	Work Zone	Exit	Proj. Total
H.009600.6	23	82	34	139	29	151	28	208	10	39	6	55
H.009836.6	17	36	30	83	52	49	57	158	22	12	23	57
H.009480.6	35	41	41	117	75	156	195	426	28	97	53	178
H.010350.6	6	8	15	29	38	21	28	87	21	13	12	46
H.009319.6	17	218	9	244	12	241	15	268	6	139	8	153
H.011272.6-210	11	3	16	30	19	28	29	76	10	12	11	33
H.011272.6-10	10	42	19	71	2	86	7	95	1	47	10	58
H.011270.6	0	5	0	5	2	10	0	12	0	2	1	3
H.010440.6-210	11	24	20	55	35	110	65	210	10	25	21	56
H.010440.6-10	38	21	40	99	65	37	133	235	34	16	33	83
Loc. Total	168	**480**	224		329	**889**	557		142	**402**	178	
	Grand Total: 872				**Grand Total: 1,775**				**Grand Total: 722**			

Primary Contributing Factor

The LA crash report form has a data element called "Primary Contributing Factor" where the reporting officer indicates the main or most crucial causative factor in the crash, selecting from the following aspects: Violations, Movement Prior to Crash, Vision Obscurements [*sic*], Condition of Driver, Vehicle Conditions, Road Surface, Roadway Condition, Weather, among a handful of others. This data element was examined in relation to the proximate location to the work zone (i.e., approach, work zone, exit) for each of the ten work zone projects. Four factors account for nearly 95% of all crashes: Violations (n=2,806), followed by Movement Prior to Crash (n=398), Condition of Driver (n=137) and Vehicle Conditions (n=109). Table 13 displays frequencies of the four most frequent primary contributing factors by location, for each of the work zone projects. Violations are the primary factors in about 82.6% of crashes taking place within the Approach, 80.9% in the actual Work Zone, and 81.2% in the Exit.

Table 13
Most frequent primary contributing factors, crash count by proximate location to work zone, all projects

N=3,450 (94.88%)	Approach				Work Zone				Exit			
	V	MPC	C/D	VC	V	MPC	C/D	VC	V	MPC	C/D	VC
H.009600.6	53	0	7	1	237	3	18	5	54	0	9	3
H.009836.6	75	10	6	1	69	12	1	4	90	11	10	0
H.009480.6	116	13	6	4	229	59	5	8	243	40	6	6
H.010350.6	58	9	5	1	37	3	0	2	42	13	1	5
H.009319.6	23	7	5	3	488	69	32	31	26	7	0	0
H.011272.6-210	38	5	0	2	42	5	1	0	51	7	5	1
H.011272.6-10	9	0	1	1	132	36	6	9	27	6	0	3
H.011270.6	1	0	1	0	11	3	1	1	1	0	0	0
H.010440.6-210	56	8	0	0	149	9	3	8	93	14	0	2
H.010440.6-10	121	14	2	4	63	6	2	1	172	29	4	3
Total	**550**	**66**	**33**	**17**	**1457**	**205**	**69**	**69**	**799**	**127**	**35**	**23**
Grand Total	666				1,800				984			

Note: **V**iolations; **M**ovement **P**rior to **C**rash; **C**ondition of **D**river; **V**ehicle **C**onditions

Work Zone Crash Severity/Injury

About 72% (n=2608) of crashes occurring within the proximity of the work zone had no injuries reported. Slightly over 21% (n=781) crashes reported complaints. The number of crashes involving moderate injury was just about 5%. Less than 2% of crashes involved severe injuries(n=27) or fatalities (n=28). These data are reported in Table 14, while Table 15 displays the percentages across levels of severity calculated for each project. Percentages in Table 15 are calculated to indicate within-project rates of crash severity/injury. While the rate of non-injury crashes ranged from a low of 60% to a high of about 83%, it is important to take into account these percentages are also a reflection of the total number of crashes and the duration of the project. On average, 72% of crashes resulted in no injury. Fatalities overall occurred in less than 1% of all work zone crashes. Similarly, severe injuries overall occurred in less than 1% of all work zone crashes on average. Approximately 21.5% of crashes involved complaints/possible injuries, though.

Table 14
Injury severity crash frequencies by proximate location to work zone, all projects

	Fatal (N=28)			Severe (N=27)			Moderate (N=192)			Complaint (N=781)			No Injury (N=2,608)		
DOTD Proj. No.	App	WZ	Exit	App	WZ	Exit	App	WZ	Exit	App	WZ	Exit	App	WZ	Exit
H.009600.6	0	1	0	0	0	0	1	5	0	12	41	9	50	225	60
H.009836.6	1	0	1	0	3	2	10	7	8	24	29	29	62	64	76
H.009480.6	1	0	2	1	1	0	7	23	12	26	62	61	110	233	228
H.010350.6	0	2	1	1	0	1	7	1	6	12	9	14	54	31	39
H.009319.6	0	9	0	0	6	0	5	31	2	7	147	10	27	465	25
H.011272.6-210	0	2	0	0	2	1	0	3	6	14	5	19	32	37	38
H.011272.6-10	0	1	0	0	2	0	0	13	3	4	45	10	11	135	29
H.011270.6	0	1	0	0	0	0	0	3	0	0	4	0	2	9	1
H.010440.6-210	1	0	0	1	0	2	7	6	4	18	41	25	41	125	85
H.010440.6-10	2	1	2	1	0	3	5	5	12	31	23	50	113	52	149
Total	**5**	**17**	**6**	**4**	**14**	**9**	**42**	**97**	**53**	**148**	**406**	**227**	**502**	**1376**	**730**

Table 15
Percentage of injury crashes by severity, by work zone project

DOTD Proj. No.	N	% Fatal	% Severe	% Moderate	% Complaint	% Injury	% No Injury
H.009600.6	404	0.25%	0.00%	1.49%	15.35%	17.08%	82.92%
H.009836.6	316	0.63%	1.58%	7.91%	25.95%	36.08%	63.92%
H.009480.6	767	0.39%	0.26%	5.48%	19.43%	25.55%	74.45%
H.010350.6	178	1.69%	1.12%	7.87%	19.66%	30.34%	69.66%
H.009319.6	734	1.23%	0.82%	5.18%	22.34%	29.56%	70.44%
H.011272.6-210	159	1.26%	1.89%	5.66%	23.90%	32.70%	67.30%
H.011272.6-10	253	0.40%	0.79%	6.32%	23.32%	30.83%	69.17%
H.011270.6	20	5.00%	0.00%	15.00%	20.00%	40.00%	60.00%
H.010440.6-210	356	0.28%	0.84%	4.78%	23.60%	29.49%	70.51%
H.010440.6-10	449	1.11%	0.89%	4.90%	23.16%	30.07%	69.93%
Total/ Avg %	3636	0.77%	0.74%	5.28%	21.48%	28.27%	71.73%

Note: percentages are calculated within rows to reflect within-project rates; last row reflects entire sample rate

In total, there were 21 crashes involving pedestrians: 10 occurred within work zone boundaries, 6 in the approach, and 5 after exiting. A closer look at the crash numbers of pedestrian-involved crashes provides insight into the severity. Specifically, about 43% of pedestrian crashes were fatalities (n=9) and, likewise about 32% of fatal crashes involved pedestrians.

Day of Week and Time of Day

Overall, the crash count was highest on Fridays, Mondays, and Thursdays in all three locations. The crash count is lowest on Saturdays and Sundays. Table 16 shows the crash frequencies by day, according to the location where the crash occurred. The last two columns display the days of the week and crash count total, ranked from highest to lowest. Regardless of day, the crash count within the work zone boundaries is always higher than the number of crashes in the approach or exit.

Table 16
Crash frequencies by day of week; proximate location to work zone, all crashes

	Approach	Work Zone	Exit	Grand Total	Rank (Highest to Lowest)	
Monday	111	291	175	577	Friday	678
Tuesday	103	260	144	507	Monday	577
Wednesday	100	272	158	530	Thursday	551
Thursday	93	292	166	551	Wednesday	530
Friday	132	356	190	678	Tuesday	507
Saturday	90	211	107	408	Saturday	408
Sunday	72	228	85	385	Sunday	385
Grand Total	701	1910	1025	3636		

Across all work zone projects in the sample, the time of day with the highest crash count (N=1638) is between the hours of 12:00pm to 6:00pm, followed by the period 6:00am to 12:00pm (N=964), as shown in Table 17. These two time periods account for 45% and 26.5% (respectively) of all crashes associated with the work zones in the sample. It is important to take into consideration that these times include weekday morning and evening commute hours when traffic is typically at its highest.

The total number of crashes between the hours 6:00pm and 12:00am is 708, or about 19.5%, which is significantly lower than the preceding time period, though significantly higher than the number of crashes between 12:00am and 6:00am, when only 9% of crashes took place. Work zones may operate at any time of the day and shift hours vary over time. Relative to the location, the crash counts are highest in the work zone boundaries than they are for the approach or the exit.

Table 17

Crash frequencies by time of day and proximate location to work zone, all projects

	12 A.M. - 6 A.M.			**6 A.M. - 12 P.M.**			**12 P.M. - 6 P.M.**			**6 P.M. - 12 A.M.**		
	App	WZ	Exit	App	WZ	Exit	App	WZ	Exit	App	WZ	Exit
H.009600.6	13	13	11	17	50	8	23	145	31	10	64	19
H.009836.6	13	17	8	16	30	41	46	34	42	22	22	25
H.009480.6	8	10	12	68	84	64	43	166	173	26	59	54
H.010350.6	10	4	5	21	11	14	30	22	27	13	6	15
H.009319.6	6	85	4	7	166	14	16	279	12	10	128	7
H.011272.6-210	4	2	5	10	14	16	27	24	35	5	9	8
H.011272.6-10	4	11	8	3	53	12	6	98	10	2	34	12
H.011270.6	0	1	0	0	6	0	1	3	1	1	7	0
H.010440.6-210	3	12	9	19	54	43	31	72	47	15	34	17
H.010440.6-10	16	12	20	47	10	66	60	37	97	29	22	33
Total	**77**	**167**	**82**	**208**	**478**	**278**	**283**	**880**	**475**	**133**	**385**	**190**
Grand Total	**326**			**964**			**1638**			**708**		

Weather

Nearly two-thirds of crashes within 5 miles of the work zones in the sample happened during clear weather conditions. Table 18 illustrates the most common weather conditions at the time of the crash for the approach, work zone boundaries and exit. As shown, three conditions accounted for 99% of all crashes. The remaining 1% includes crashes that happened during foggy/smoky or other rare weather conditions (e.g., sleet/hail, snow, etc.).

Table 18

Crash frequency by weather condition; proximate location to work zone-all projects

	Clear			Cloudy			Rain		
	App	WZ	Exit	App	WZ	Exit	App	WZ	Exit
H.009600.6	49	199	52	6	35	12	8	37	5
H.009836.6	75	58	81	14	22	11	8	22	21
H.009480.6	90	251	230	19	40	32	33	21	40
H.010350.6	54	31	47	10	7	6	10	5	7
H.009319.6	21	373	23	7	109	6	11	171	8
H.011272.6-210	26	38	36	8	5	11	12	6	17
H.011272.6-10	7	136	23	2	33	4	6	27	15
H.011270.6	2	17	0	0	0	0	0	0	1
H.010440.6-210	40	112	57	10	35	26	16	23	32
H.010440.6-10	93	53	146	30	15	37	28	11	29
Total	**457**	**1268**	**695**	**106**	**301**	**145**	**132**	**323**	**175**
Grand Total	2420			552			630		
	N=3,602								

Vehicle and Human Factors

The next several tables provide insight into some of the vehicle and human factors involved in crashes in the vicinity of work zones. First, Table 19 shows the number of crashes involving a commercial motor vehicle (CMV) for each project, by proximate location.

Table 19
Total CMV crashes by project and location relative to work zone

	Approach	Work Zone	Exit	Grand Total
H.009600.6	4	15	5	24
H.009836.6	11	17	15	43
H.009480.6	13	25	13	51
H.010350.6	13	2	6	21
H.009319.6	6	104	4	114
H.011272.6-210	1	0	1	2
H.011272.6-10*	1	31	7	40
H.011270.6	0	2	0	2
H.010440.6-210	0	5	2	7
H.010440.6-10	15	8	21	44
Grand Total	64	209	74	348

* Note: 1 crash missing from analysis

As shown, 348 crashes involved CMVs. Of these, about one-third were associated with DOTD project H.009319.6, which concerned cleaning, painting, and repairs on I-10 Overpass bridges. CMV involvement was clearly more prevalent in the work zone boundaries than in the approach or exit. Among all crashes within the work zone boundaries for this project (n=658), about 16% involved a CMV.

The human factors examined include driver age (i.e., young, older) and driver conditions (i.e., inattentive, distracted, aggressive) which will be described over the next several pages. Table 20 displays the number of crashes involving older drivers, which are drivers aged 65 or older at the time of the crash, and the number of crashes involving young drivers, which includes drivers between 15-24 years of age at the time of the crash. Crashes are displayed by project and the proximate location to the work zone where they occurred. As shown, about 39% (N=1,406) of crashes involved young drivers, while just about 11% (N=398) involved older drivers.

Table 20
Crashes involving older and young drivers by proximate location, all projects

	Older Drivers				**Young Drivers**			
Proj. No.	Approach	Work Zone	Exit	n	Approach	Work zone	Exit	n
H.009600.6	4	31	5	40	28	113	26	167
H.009836.6	8	2	8	18	42	45	41	128
H.009480.6	22	42	51	115	68	141	114	323
H.010350.6	7	7	8	22	25	15	30	70
H.009319.6	2	67	3	72	14	198	14	226
H.011272.6-210	6	11	3	20	19	26	30	75
H.011272.6-10*	3	20	2	25	1	60	15	78
H.011270.6	0	5	0	5	1	5	0	6
H.010440.6-210	6	15	10	31	45	74	64	183
H.010440.6-10	20	8	22	50	41	24	85	150
Total	**78**	**208**	**112**		**284**	**701**	**419**	
Grand Total	**398**				**1406**			
* *Note: 2 crashes missing from analysis (applies to "young driver" count only)*								

Researchers examined several factors pertaining to the condition of the driver. On the crash report form, the data element “Condition of Driver” contains 13 attribute options (e.g., normal, fatigued, illness, drug/alcohol use, etc.) that officers may report to describe driver condition, one of which includes “inattentive.” Table 21 displays crashes in which the officer reported “Condition of Driver” as “Inattentive.” As shown, this driver condition was reported in 60% of all crashes within the vicinity of the work zone projects in the sample. Among all projects, the percentage of inattentive driver crashes ranged from approximately 45% to 75%.

Table 21
Total inattentive crashes by project and location relative to work zone

	Approach	**Work Zone**	**Exit**	**Total**	**% Inattentive**
H.009600.6	46	211	46	303	75.00%
H.009836.6	47	35	60	142	44.94%
H.009480.6	94	142	208	444	57.89%
H.010350.6	44	20	29	93	52.25%
H.009319.6	19	386	16	421	57.36%
H.011272.6-210	28	35	41	104	65.41%
H.011272.6-10	8	102	26	136	53.75%
H.011270.6	1	9	0	10	50.00%
H.010440.6-210	47	115	78	240	67.42%
H.010440.6-10	103	51	139	293	65.26%
Grand Total	437	1106	643	2186	60.12%

There are two data elements that pertain to driver distraction on the LA crash report form: "Condition of driver," which also includes "distracted" among its 13 attributes, and "Driver Distraction," which allows officers to indicate the source of distraction such as cell phone, another electronic device, an in-vehicle distraction, or an outside-vehicle distraction. For the purposes of this study, a crash was considered "distracted" if the condition of driver was marked as "Distracted" OR if "Driver Distraction" specified "Cell Phone," "Other Electronic Device," "Other Inside Vehicle," or "Other Outside Vehicle." These crashes appear in Table 22. As shown, the number of crashes in which one or more of the drivers were reported "distracted" is 306, which is 8.42% of all crashes in the vicinity of the work zones in our sample. The percentage of distracted crashes ranged across work zone projects from a low of 5.20% to a high of 10.91%.

Table 22
Distraction-involved crashes by proximate location to work zone, all projects

	Approach	Work Zone	Exit	Grand Total	% Distracted
H.009600.6	4	14	3	21	5.20%
H.009836.6	4	9	11	24	7.59%
H.009480.6	15	30	23	68	8.87%
H.010350.6	5	2	6	13	7.30%
H.009319.6	4	55	1	60	8.17%
H.011272.6-210	2	2	6	10	6.29%
H.011272.6-10	0	24	3	27	10.67%
H.011270.6	0	2	0	2	10.00%
H.010440.6-210	5	13	14	32	8.99%
H.010440.6-10	15	12	22	49	10.91%
Total	54	163	89	306	8.42%

The number of distracted crashes is remarkably lower than the number of crashes in which one or more drivers were reported "inattentive." It is possible that there are specific criteria that officers must observe in order to report a driver as "distracted" as opposed to "inattentive" or vice-versa. While they are similar in that distraction is a form of inattention (a more general construct), distraction implies that the driver's attention is interrupted or diverted from the task at hand and applied elsewhere, such as a crying child in the back seat or a text message alert.

Finally, crashes were analyzed to determine the number of crashes involving aggressive driving. The crash database includes a computed field that is not on the state crash report form called "Aggressive Driving." It is computed based on the violation field on the crash report. Specifically, "Aggressive Driving" is computed as a driver receiving one or more of the following violations:

1) Exceeding stated speed limit
2) Exceeding safe speed limit
3) Failure to Yield
4) Following too closely
5) Cutting in improper passing
6) Disregarded traffic control
7) Careless operation

In this analysis, an aggressive driving crash is any crash in which one or more of the drivers is reported as having committed one or more of the aggressive violation types indicated above. These crashes are shown in Table 23. As shown, just over 75% (N=2,745) of crashes involved one or more drivers reported as committing one or more "aggressive" driving violations. The percentage of aggressive driving crashes by project ranged from about 65% to a high of 88% in project H.009600.

Table 23
Total aggressive driving crashes by proximate location to work zone, all projects

	Approach	Work Zone	Exit	Grand Total	% Aggressive
H.009600.6	55	244	58	357	88.37%
H.009836.6	72	75	95	242	76.58%
H.009480.6	113	212	234	559	72.88%
H.010350.6	56	23	38	117	65.73%
H.009319.6	25	472	23	520	70.84%
H.011272.6-210	39	41	53	133	83.65%
H.011272.6-10	11	130	24	165	65.22%
H.011270.6	2	11	0	13	65.00%
H.010440.6-210	55	136	97	288	80.90%
H.010440.6-10	117	57	177	351	78.17%
Grand Total:	545	1401	799	2745	75.50%

Work Zone Data Fields

As previously mentioned, Louisiana's crash report form has two coded data fields that pertain to work zones: one is a check box called "work zone" and the other, roadway condition, has work zone related attributes. Officers are instructed to mark the work zone check box if the crash occurs between DOTD signs. Based on the crash data analysis, 1910 crashes happened within the boundaries of DOTD work zones while the signs were in place. Overall, officers reported 104 of them as work zone crashes using one of the two available data fields. In total, officers reported 149 crashes as work zone crashes. Table 24 displays the number of reported work zone crashes by location for all projects. The next section provides greater insight into how police officers reported these crashes by presenting results from the content analysis.

Table 24
Work zone crashes reported by officer

	Approach	Work Zone	Exit	Grand Total
H.009600.6	0	13	0	13
H.009836.6	10	55	21	86
H.009480.6	1	12	5	18
H.010350.6	1	1	1	3
H.009319.6	0	12	0	12
H.011272.6-210	2	0	2	4
H.011272.6-10	0	2	0	2
H.011270.6	0	4	0	4
H.010440.6-210	0	2	1	3
H.010440.6-10	1	3	0	4
Grand Total	15	104	30	149

Crash Report Narrative Content Analysis

This section reports the findings from the content analysis portion of the study. Two researchers independently coded crash report narratives for explicit work zone involvement. Given the research design, the population under study includes all crashes 5 miles before/after and within project boundaries (i.e., defined by DOTD signing) for each project in the sample however it was not possible to obtain a full census of the crashes due to agency limitations. Specifically, the narratives and drawings were inaccessible at the time of crash report retrieval. The vast majority of crashes in which narratives were not accessible are located in Calcasieu Parish, which is where five of the 10 work zone projects in the sample took place. The accessible population, i.e., the number of crash reports for which narratives and drawings were available for review (N=2723) includes approximately 75% of the 3636 crashes reported in the crash data analysis. Table 25 displays each project, the total number of crashes associated with that project, the total number of crash narratives coded, as well as the percentage included in the content analysis. Two projects in particular (H.009319 and H.010440) are missing a high number of narratives with respect to the total number of crashes at these sites. Both projects involved work in Calcasieu Parish and are color-coded red in the first column. The percentage of narratives obtained for the remaining projects ranged from 71%-100%. Projects color-coded green indicate at least 85% of crash narratives were included in the content analysis. All other projects in which at least 71% (but less than 75%) of narratives were accessible are color-coded yellow.

Table 25
Accessible population percentage included in content analysis by work zone project

	Project No.	Total N	Coded N	% Coded	Parish
	H.009600.6	404	402	99.50%	St. Tammany
	H.009836.6	316	316	100.00%	Livingston
	H.009480.6	767	657	85.66%	Ouachita
	H.010350.6	178	153	85.96%	Lafayette
	H.009319.6	734	333	45.37%	Calcasieu, Jefferson Davis & Acadia
	H.011272.6-210	159	115	72.33%	Calcasieu
	H.011272.6-10	253	181	71.54%	Calcasieu
	H.011270.6	20	20	100.00%	Lafayette & Acadia
	H.010440.6-210	356	220	61.80%	Calcasieu
	H.010440.6-10	449	326	72.61%	Calcasieu
	Grand Total	3636	2723	74.89%	

As detailed in the Methodology chapter, crash report narratives were coded to determine the extent to which officers explicitly mentioned (1) anything about work zone involvement, (2) traffic congestion, and/or (3) stopped/slowed traffic, as well as (4) collision with some kind of traffic control device (TCD, e.g., cones, barriers, etc.). For the purposes of this study, explicit mentions refer to the presence of any relevant terms clearly communicating the concepts of interest, such as e.g., "construction work," "traffic was backed-up," or "vehicle 1 came to a sudden stop." Narratives containing one or more explicit mention are coded 1 and narratives that do not contain at least one mention were coded 0.

The results are shown in Table 26. Percentages are calculated in row based on the number of narratives coded per project. Because it was not possible to obtain a complete census of narratives for all crashes occurring in the vicinity of work zone projects in the sample, findings should be interpreted cautiously. It is not possible to extrapolate these findings to missing crashes within the project or from one project to other work zone projects. Projects where at least 85% of narratives were coded are noted by the color green. Projects where around 70% of the narratives were coded are noted by yellow and projects missing a significant number of narratives are noted by red.

Table 26
Number of crash report narratives containing explicit mentions, by project

		Coded N	Explicit WZ		Congestion		Slow/Stop		TC Device	
	H.009600.6	402	8	2%	159	40%	206	51%	19	5%
	H.009836.6	316	32	10%	82	26%	139	44%	38	12%
	H.009480.6	657	14	2%	123	19%	353	54%	27	4%
	H.010350.6	153	1	1%	16	10%	69	45%	9	6%
	H.009319.6	333	4	1%	52	16%	147	44%	29	9%
	H.011272.6-210	115	2	2%	22	19%	56	49%	15	13%
	H.011272.6-10	181	1	1%	37	20%	72	40%	10	6%
	H.011270.6	20	4	20%	3	15%	14	70%	3	15%
	H.010440.6-210	220	4	2%	60	27%	121	55%	12	5%
	H.010440.6-10	326	2	1%	67	21%	160	49%	20	6%
	Grand Total	2723	72	3%	621	23%	1337	49%	182	7%

Note: Percentages have been rounded

As shown in the last row of Table 26, 72 narratives explicitly mentioned the work zone somewhere in their description, which is about 3% of the accessible population. Projects with the greatest proportion of explicit mentions include H.009836 (10%) and H.011270 (20%), which also happen to be the two projects in which 100% of crash narratives were available for review. Overall, about 23% of narratives (n=621) explicitly mentioned congestion while slow/stop traffic was explicitly mentioned in just under 50% of narratives. Some narratives mention both. Collision with traffic control devices was observed in approximately 7% of all narratives while the percentage of TC Device collisions within projects ranged 4% to 15% of crashes.

One thing that many crashes in proximity to the work zone projects have in common is the consistent descriptions of traffic conditions at the time of the crash. In about 21% of narratives (N=564) officers described traffic conditions as both congested and slow/stop, while 30% described traffic conditions at the time of the crash as one (or the other). In context, the total number of slow/stop mentions observed is 1337 and the total number of congestion mentions is 621. A closer examination shows that about 90% of narratives that explicitly mentioned congestion also mentioned slow/stop conditions. Taken together, one or both traffic conditions were observed in 51% of crashes. These findings appear in Table 27.

Table 27
Frequency distribution traffic conditions as stated in narrative, by project

		N	Both Traffic Conditions	Congestion or Slow/Stop	N/A
	H.009600.6	402	150	65	187
	H.009836.6	316	72	77	167
	H.009480.6	657	112	252	293
	H.010350.6	153	15	55	83
	H.009319.6	333	49	101	183
	H.011272.6-210	115	21	36	58
	H.011272.6-10	181	31	47	103
	H.011270.6	20	3	11	6
	H.010440.6-210	220	50	81	89
	H.010440.6-10	326	61	105	160
	Grand Total	2723	564 (21%)	830 (30%)	1329 (49%)

As reported earlier, relatively few crash report narratives explicitly mention anything about the work zone. Only 2.46% of narratives clearly indicate the crash was work zone related in some way. While 63.39% of narratives clearly attributed the crash to other factors, over one-third of crashes (n=930) did not contain enough information to determine the potential work zone involvement either way. The number of crash narratives that clearly described work zone relation was slightly less than the number of crashes in which the work zone was explicitly mentioned somewhere in the narrative. In comparing the number of crashes in which officers reported work zone involvement using the data fields on the crash report form to the number of crashes in which work zone relation was clearly described in the narrative, at least 60 crashes did not provide clear indication of work zone involvement. Either the narratives attributed the crash to non-work zone factors or they did not provide enough information.

Table 28 displays the work zone projects along with the number of crashes reported work zone by officers on the crash report form and the extent to which the narratives indicated work zone relation. The coded variable "WZRelated" has three categories: clearly yes, clearly no and unknown/not clear. One thing that stands out is that the vast majority of officer-reported work zone crashes (90%) are associated with just three projects. These three projects also had the greatest number of narratives clearly indicating work zone involvement, however many projects had a substantial number of "possibly" work zone related crashes. It is not clear what drives officers to report the work zone involvement in the data fields but not describe in the narrative.

Table 28
Potential work zone relation in crashes, as described by officer in narrative

	N=2723	Potential Work Zone Relation			Reported
		Yes	Possibly	No	WZ by Officer
	H.009600.6	8	169	225	13
	H.009836.6	30	100	186	86
	H.009480.6	13	207	437	15
	H.010350.6	3	29	121	2
	H.009319.6	1	107	225	2
	H.011272.6-210	2	35	78	1
	H.011272.6-10	2	68	111	2
	H.011270.6	3	4	13	4
	H.010440.6-210	3	94	123	1
	H.010440.6-10	2	117	207	1
	Grand Total	67	930	1726	127
	%N	2.46%	34.15%	63.39%	4.66%

Drawings

Overall, the vast majority drawings provided little additional insight beyond that which officers already described in the narrative. Most of the crash report drawings focused on depicting vehicle positions and points of impact as well final resting spots, on or off the roadway. If the crash report drawing included details about the work zone or conditions that went beyond the narrative, it was coded "1." Out of 2,723 crashes, 88 drawings included content that went beyond the narrative, which reflects approximately 3%. A review of the notes made by the coders indicates that 18 of the 88 drawings included construction-related details, 55 show traffic congestion/backups and 15 displayed other environmental/ circumstantial information such as roadway anomalies or specifically included traffic control details such as concrete barriers.

Summary

The crash data analysis, which is based on a census of crashes occurring within 5 miles before and after the work zone boundaries, provides a general overview of crash characteristics by proximate location to the work zone. Crash counts were highest within the work zone boundaries than they were in the approach or the exit. Of 3636, 1910 (53%) were identified as within the work zone. Four factors account for nearly 95% of all crashes: Violations (n=2,806), followed by Movement Prior to Crash (n=398), Condition of Driver (n=137) and Vehicle Conditions (n=109). Out of all possible manners of collision, three types accounted for 92.66% of all crashes (N=3,636) within 5 miles of the work zone projects in the sample (i.e., rear end, non-collision, and sideswipe-same). With respect to proximate location, the highest number of crashes for each crash type generally took place within the actual work zone. Additionally, there were a lot more crashes on weekdays as opposed to weekends, during the day as opposed to night and in clear weather as opposed to rain/cloudy. CMV crashes are higher in work zone compared to approach and exit.

The content analysis of the accessible population of narratives and drawings provided some additional insight. In total, 72 narratives explicitly mentioned the work zone somewhere in their description, which is about 3% of the accessible population. Most of the narratives contained no clear indication that the crash occurred within or in proximity to a work zone. Though about half of the narratives attributed crashes to other factors such as a driver not paying attention/driver condition or vehicle malfunctions, in about 34% of narratives, it was not clear.

Another noteworthy finding involves frequent and consistent descriptions of traffic conditions at the time of the crash. Overall, about 23% of narratives (n=618) explicitly mentioned congestion while slow/stop traffic was explicitly mentioned in just under 50% of narratives. In total, 51% of crashes involved either or both conditions. While descriptions of congestion and slow/stop traffic conditions were frequent and very common across narratives, officers rarely elaborated on the reasons or sources of the traffic. For instance, sometimes narratives reported the congestion or slow/stop traffic was due to a prior crash but most of the time there was no explanation. The analysis of the census of crashes indicates that for all work zone projects in the sample, the time of day with the highest crash count (N=1638) is 12:00pm to 6:00pm, followed by 6:00am to 12:00pm (N=964). Since these times include typical weekday commute hours, these areas may be prone to recurring backups or congestion. Drawings provided little insight into crashes in general, however when they did, they were more likely to note traffic congestion than work zone-related details. The next section presents results from an in-depth analysis of crashes occurring during active work zone hours in two projects.

Contractor Diary Work Zone Crash In-Depth Analysis

This section reports the findings of the in-depth qualitative crash analysis completed for the two projects in which the contractor diaries provided sufficient detail on a consistent basis throughout the project duration. While findings cannot be generalized beyond the projects themselves, they do provide insight into crash reporting practices and circumstances.

Project H.11270 I-10 pavement marking and replacement, phase III- Lafayette
The daily work diary contained 29 pages total. This project was complete in 11 days, significantly short in duration compared to the other projects in this study. Despite being the shortest project in the sample of work zones, this diary contained the greatest amount of detail that remained highly consistent throughout the project duration. Over the time the work zone signs were in place, there were 20 crashes. According to the active work zone times reported in the contractor diary, four crashes occurred while work was going on.

Table 29 shows the date/day and time of the crash, followed by three columns: Officer-Reported, Narrative WZ, and Active WZ. Officer-reported refers to the crash being recorded as a work zone crash on the official crash report (i.e., either the check box or the roadway condition field). Narrative WZ refers to the coded variable “WZ Related” which has three values: Yes, No, and “?.” Active WZ takes the date/time of the crash and indicates whether or not the work zone was active when the crash happened. The last two columns display comments from the contractor diary and comments summarizing the narrative (i.e., from the coding data) and crash factors as reported by the officer. These appear side-by-side for comparison.

Looking at the columns in Table 29, several observations stand out. First, all of the crashes that took place while the work zone was active were reported by the officer as work zone crashes. Three of these four crashes contained information in the narrative indicating the crash was clearly work zone related, as shown in the narrative summary column. The crash in which the narrative was not clear on potential work zone involvement speculates that the crash was related to a prior crash, but did not mention the work zone. Though the officer did report the work zone conditions in his or her report, this is not obvious from the narrative. Another observation is that all of the crashes that occurred during active work hours were rear-end crashes. Of all crash types, rear-end and sideswipe are the most frequent types of crashes in work zones.

Table 29
Project H.011270 contractor diary results/analysis

Date/ Day	Time	Work Hours	Officer-Reported*	Narrative WZ	Active WZ	crash no.	Contractor General Remarks/ Daily Summary	Summary of Narrative
4/30/2015 Thursday	7:58 PM	7:30 PM - 10:00 PM	Y	Y	Y	###	contractor onsite at 7:30 PM, did not work due to wreck at 8:00 pm when contractor was getting out of vehicle to set up work area	rear end, slowing due to road construction
	9:29 PM		Y	?	Y	###	Contractor elected not to work tonight due to heavy traffic build up on the WB lane caused by traffic accident.	V2 slow down to a stop due to traffic and was rear ended, seems due to prior crash
5/8/2015 Friday	11:12 PM	7:00 PM- 6:00 AM	Y	Y	Y	###	Wreck in work area near Scott but did not cause traffic/work delays. (11:30 p.m.)	rear end, lane closure, dotd wz about half a mile in front of crash
5/9/2015 Saturday	6:59 PM	7:00 PM- 6:00 AM	Y	Y	Y	###	Wreck occurred @ 7:00 p.m. near mile marker 97, causing delays for start until 9:15 p.m. Wreck happened at the starting point for the day as Contractor was preparing to begin work on the shoulder of the road	rear end, queue formed for construction/ striping detail, officer was present

Note: *= Either by marking the Work Zone box or by reporting Road Condition: Construction
?=Narrative did not contain enough information to determine potential WZ involvement
Y=Officer Reported WZ or Road Condition: Construction; Narrative clearly indicated WZ Relation; Active work zone hours

Finally, the contractor diary comments are consistent with the other crash indicators and provide insight into the impact of crashes on work activities and traffic queuing. To provide some contrast, the narratives in 13 of the 20 crashes attributed the crash to factors that had nothing to do with the work zone. Four crash narratives did not contain insufficient information to determine if the work zone relation. A review of the narrative summary/comments for these 4 crashes indicates that one crash was a sideswipe lane change hit and run during slow/stop traffic and three crashes were rear-ends, also in slowed or stopped traffic. The slow/stop traffic is a common factor in these crashes.

Project H.009600 I-12 Tangipahoa Parish Line-St. Tammany

The second project diary examined concerned work significantly longer in duration, spanning 370 days according to the dates the signs were placed/removed by DOTD. This diary had 476 pages and a generally sufficient/ adequate level of detail, which remained mostly consistent throughout the duration of the project. The total crash count for this project is 404, of which, 402 crash report narratives were accessible for content analysis. Of the total crash count, 13 are officer-reported work zone crashes.

According to the contractor diary's logged active work dates/times, 36 of the 404 crashes took place during active work hours. Nine of the 13 officer-reported crashes took place during active work hours, with the remaining four crashes taking place while the work zone was not active. All of the 36 active work zone crashes were included in the 402 crash reports analyzed for content. Of these, eight clearly indicated work zone relation in the narrative, 19 clearly attributed the crash to other factor(s) and nine crashes in which the potential work zone involvement was not clear in the officer narrative.

The following analysis focuses on the 36 crashes that occurred during active work hours. For comparison purposes, this analysis also includes the four officer-reported crashes that took place when no work was going on. These crashes represent close to 10% of all crashes occurring within 5 miles of the DOTD-designated work zone while the signs were in place. The analysis appears in the next several tables.

Table 30 shows the crashes that took place during active work zone times (i.e., Diary WZ and Diary Work Hours) by the date/day and time of the crash. Table 30 also displays whether or not the crash was reported by the officer as having been in a "work zone" on the crash report (i.e., Officer-Reported); whether or not the narrative clearly attributed the crash to the work zone (i.e., Coded WZ); as well comments summarizing the description in the narrative (i.e., Comments- Narrative Crash Report). As shown, all nine active work zone crashes happened at night. In six of theses crashes, which all involved rear end collisions, the narrative explicitly described traffic as congested and moving at a slow/stop pace. The other crashes included two drivers that ran off the road and a sideswipe merge due to lane closure. Of the two ran-off-road crashes, one narrative explicitly mentioned construction but was not reported as a work zone crash by the officer. The other crash was reported as a work zone crash, however, there was no indication in the narrative that the crash occurred in a work zone. This crash appears in the last row of Table 30.

Table 30
H.009600 crashes during active work zone, explicit narrative, officer reporting

Date/Day	Time	Officer-Reported	Coded WZ	Diary WZ	Crash No.	Diary Work Hours	Comments - Narrative Crash Report
27/Aug/14 Wednesday	9:00 PM	Y	Y	Y	###	8 PM-6 AM	**Rear end**, stop and go, construction
16/Sep/14 Tuesday	10:45 PM	Y	Y	Y	###	8 PM-6 AM	I-12 under construction and closed for repair, work crew - Driver ran off road
18/Sep/14 Thursday	9:13 PM	Y	Y	Y	###	8 PM-6 AM	**Rear end**; active work zone
8/Oct/14 Wednesday	8:50 PM	Y	Y	Y	###	8 PM-6 AM	**Rear end**; drawing shows "temporary" orange diamond-shaped speed signs
9/Apr/15 Thursday	10:15 PM	Y	Y	Y	###	8 PM-6 AM	**Rear end**
14/May/15 Thursday	8:10 PM	Y	Y	Y	###	8 PM-6 AM	**Rear end**, multivehicle crash; drawing shows congestion
5/Jun/15 Friday	10:25 PM	Y	Y	Y	###	8 PM-6 AM	sideswipe merge; lane closure
8/May/15 Friday	8:33 PM	N	Y	Y	###	8 PM-6 AM	**Rear end**; approaching "construction zone," drawing shows other vehicles ahead
19/May/15 Tuesday	8:15 PM	Y	N	Y	###	8 PM-6 AM	Driver ran off road; single vehicle swerved to avoid hitting another vehicle

Note: Y= Officer reported, Narrative explicit about WZ relation, Active work zone
N= Not reported as WZ crash by officer, Narrative attributes crash to other factors
Bold= narrative described traffic conditions as being congested *and* slow/stop;
Non-Bold=narrative described traffic conditions as being either congested *or* slow/stop

There are a total of 13 crashes appearing in Table 31. The first four rows (which are highlighted in gray) in Table 31 display the officer-reported crashes that occurred when the work zone was not active. With the exception of two officer-reported crashes that attributed the crash to the driver running off the road, the rest of the crash narratives (n=11) did not contain enough information to determine possible work zone involvement. Looking at the comments from the narrative for these 11 crashes, 8 are rear end crashes in congested and/or slow/stop traffic and 1 almost-rear end involving slow/stop traffic, 1 is a sideswipe lane change in congested and slow/stop traffic. Finally, one crash that happened while work was not actively taking place involved a driver colliding with traffic construction barrels. The officer reported this crash as a work zone crash, as they are instructed to do in the LA Crash Report Manual.

Table 31
H.009600 possibly WZ related (coded WZ) crashes: officer reporting, active work

Date/Day	Time	Officer-Reported	Coded WZ	Diary WZ	Crash No.	Diary Work Hours	Comments - Narrative Crash Report
20/Jul/14 Sunday	3:50 PM	Y	?	_	###	Not working time of crash	Collision with traffic construction barrels
14/May/15 Thursday	5:15 PM	Y	?	_	###	Not working time of crash	**rear end**; drawing shows congestion
14/Sep/14 Sunday	6:56 PM	Y	N	_	###	Not working time of crash	Ran off road
1/Jun/15 Monday	10:50 AM	Y	N	_	###	Not working time of crash	Ran off road
17/May/15 Sunday	8:30 PM	Y	?	Y	###	8 PM - 6 AM	**Sideswipe** lane change
27/May/15 Wednesday	9:40 PM	N	?	Y	###	8 PM - 6 AM	Rear end; D2 "stated he had his emergency flashers on due to traveling slower *after* exiting the construction zone"
20/Jul/14 Sunday	9:11 PM	N	?	Y	###	8 PM - 6 AM	**Rear end**
5/Aug/14 Tuesday	11:01 PM	N	?	Y	###	8 PM - 6 AM	driver swerved to avoid slowed vehicle; distracted
7/Aug/14 Thursday	9:05 PM	N	?	Y	###	8 PM - 6 AM	**Rear end**
17/Aug/14 Sunday	10:45 PM	N	?	Y	###	8 PM - 3 AM	Rear end
8/May/15 Friday	10:42 PM	N	?	Y	###	8 PM - 6 AM	Rear end; drawing indicates traffic
27/May/15 Wednesday	9:41 PM	N	?	Y	###	8 PM - 6 AM	Rear end; prior crash
5/Jun/15 Friday	8:40 PM	N	?	Y	###	8 PM - 6 AM	**Rear end**, multivehicle crash

Note: Y= Officer reported, Active work zone; Y= Officer reported, Work zone not active at time of crash
N= Not reported as WZ crash by officer; Narrative attributes crash to other factor
?=Narrative not enough information to determine WZ involvement
Bold/**Bold**= narrative described traffic conditions as being congested *and* slow/stop;
Non-Bold=narrative described traffic conditions as being either congested *or* slow/stop

The remaining crashes (n=18) happened during active work zone times and were not reported as work zone crashes by the officer. Unlike 11 of the 13 crashes appearing in Table 31, the report narratives attributed the crash to factors that are clearly not work zone-related (see Comments-Narrative) shown in Table 32.

Table 32
Active work zone crashes, not reported by officer, narrative indicates non-WZ factors

Date/Day	Time	Officer-Reported	Coded WZ	Diary WZ	Crash No.	Comments - Diary	Comments - Narrative Crash Report
29/Jul/14 Tuesday	9:30 PM			Y	###	8 PM - 6 AM	Ran off Road- Lost control
30/Jul/14 Wednesday	8:00 PM			Y	###	8 PM - 6 AM	Debris - Road
11/Aug/14 Monday	8:00 PM			Y	###	8 PM - 6 AM	Debris - Tire
11/Aug/14 Monday	8:15 PM			Y	###	8 PM - 6 AM	Debris - Tire
17/Aug/14 Sunday	9:10 PM			Y	###	8 PM - 3 AM	Sideswipe
5/Sep/14 Friday	2:50 AM			Y	###	8 PM - 6 AM on 9/4	Ran off Road- Impaired
1/Oct/14 Wednesday	11:30 PM			Y	###	8 PM - 6 AM	Ran off Road- Overcorrected
11/Oct/14 Saturday	2:30 AM			Y	###	8 PM - 6 AM - 10/10	Wrong way
20/Oct/14 Monday	4:15 AM			Y	###	8 PM - 6 AM - 10/19	Ran off Road- Lost control
9/Nov/14 Sunday	8:18 PM			Y	###	8 PM - 6 AM	Sideswipe
11/Nov/14 Tuesday	5:26 AM			Y	###	8 PM - 6 AM - 11/10	Ran off Road- Careless operation
21/Nov/14 Friday	8:40 PM			Y	###	8 PM - 6 AM	Debris - Road
8/Apr/15 Wednesday	5:40 AM			Y	###	8 PM - 6 AM - 04/07	Read end- Inattentive
24/Apr/15 Friday	1:55 PM			Y	###	8 AM - 4 PM	Rear end- On Ramp
29/May/15 Friday	3:55 AM			Y	###	8 PM - 6 AM - 5/28	Read end- Sleepy
3/Jun/15 Wednesday	12:35 AM			Y	###	8 PM - 6 AM - 6/02	Collision with traffic barrier- Impaired or Sleepy
9/Jun/15 Tuesday	10:03 PM			Y	###	8 PM - 6 AM	Ran off Road- Overcorrected
9/Jul/15 Thursday	8:10 PM			Y	###	8 PM - 6 AM	Ran off Road- Impaired

Note: Y= Active work zone
Non-Bold= slow/stop traffic condition

In reviewing these crashes, several observations stand out: First, all but one of the crashes took place between the hours of 8:00pm and 6:00am; i.e., the hours of the typical work shift for this project. The only daylight crash took place when the work zone happened to be active between the hours of 8:00am to 4:00pm. This is also the only crash shown on Table 32 in which the narrative mentioned slow/stop traffic and it involved a rear end (on-ramp). Second, for many of these crashes, the narratives tended to attribute the crash to driver errors/ conditions or collision with object/debris on the road. Figure 3 displays the factors as described in the narrative, grouped into similar categories for analysis purposes.

Figure 3
H.009600 active work zone, not reported: narrative indicates non-WZ factors

CONCLUSIONS

This research provides important insight into current reporting practices of work zone crashes in Louisiana, as well as an overview of work zone reporting in the US in general. As covered in the literature review, each state has their own data collection processes and procedures regarding work zone crash reporting practices. This begins with how a state defines a work zone (and a work zone crash) which ultimately informs data collection. While national guidelines exist, such as MMUCC standardized definitions and data elements, states are not required by law to adopt them and so the degree to which states have adopted the MMUCC guidelines/data elements regarding work zone crashes varies. The lack of complete, accurate data about work zone crashes makes it difficult to answer questions about the nature of work zone crashes. Analysis of work zone crashes to identify causes is currently difficult because of the lack of consistent reporting. About 50% of states include 4 or more of the MMUCC's work zone data elements (C18), while the remaining include 3 or less. Because these elements reflect the "minimum model standard," it is reasonable to conclude that most states do not collect enough data about work zones on their crash report forms to fully analyze work zone-involvement in crashes. This is clearly the case in Louisiana, in which the primary data indicator of a "work zone crash" is a check box called "Work Zone."

The LA Crash Report Guide instructs officers to only mark the check box if the crash occurred in a construction or maintenance work zone, "defined as an officially designated portion of a public thoroughfare on which the Department of Transportation and Development (DOTD), a subcontractor representing DOTD, or the local city or parish road department is doing construction or maintenance." (Note: these instructions appear verbatim in Appendix D, but are paraphrased here for illustrative purposes). In order for a crash to be considered a "work zone crash," the first harmful event must occur within the boundaries of a work zone. The guide goes on to state that stopped or slowed vehicles *because* [emphasis added] of the work zone should not be included unless the vehicles in fact entered the work zone when the first harmful event took place. There is no way for officers to indicate the extent to which the work zone played a direct or indirect role in the crash, unless they do so in the narrative section, however, this would not be captured in the crash data.

A related issue with work zone crash reporting in Louisiana comes down to the structure of data collection on the form itself. For example, the "roadway condition" data element under "Contributing Factors and Conditions" contains two attributes relevant to work zone crashes (i.e., Construction, repair and Construction-no warning). The "roadway condition" element also includes attributes like "no abnormalities," "previous crash," "water on the roadway," and “object in the roadway,” among others. The instructions direct officers to report only one attribute that best describes the crash or its causes, even if more than one are appropriate. Hypothetically, if an officer deems a crash to be primarily caused by “violations” and that the secondary factor is best reported as “movement prior to crash,” the instructions state that officers should report “No abnormalities” under roadway condition if in his/her opinion, the roadway conditions did not contribute to the crash. Thus, the decision to report one of the construction attributes in the roadway condition element is highly conditioned on the officers’ assessment of what factors contributed most and in what ways.

One of the most important findings from this research is that work zone crash reporting practices in Louisiana are inconsistent in several ways. First, according to the crash data analysis, 1910 crashes were identified as having took place within the actual work zone boundaries, i.e., after the first orange warning sign was posted, while work zone signs were officially in-place; however, officer reporting only captured 104 of them, accounting for 5.5% of crashes occurring within the physical boundaries of work zones. Second, according to the crash report instructions, crashes outside of the work zone boundaries should not be reported as work zone crashes. The crash data analysis identified 701 crashes in the 5 miles before the first sign and 1025 crashes in the 5 miles after the last sign for the work zone projects in the sample. Despite the fact that these crashes are outside of the boundaries, officers reported 15 crashes in the approach and 30 crashes after the exit as work zone crashes on the crash report form. In total, officers reported 149 out of the 3636 crashes as work zone crashes, approximately 4%. Of the 149 officer-reported crashes, only 69.8% were actually inside the boundaries. Taken together, this amounts to 1806 crashes that *technically* should have been marked “work zone” but clearly, they were not. Officers are instructed to mention any additional factors that could not be reported on the form in the narrative, however, this study finds inconsistencies here as well as in most cases, there is no mention of the work zone.

While this study was based on a sample of 10 work zone projects, it is still possible to draw some general conclusions regarding work zone reporting practices in Louisiana. Despite limitations, the findings support the conclusion that in Louisiana, most crashes occurring “between the signs” of the work zone boundaries are not being captured on the crash report form consistently. Not only is crash frequency within work zone boundaries greatly underestimated, the manner in which officers are instructed to report such crashes fails to capture the true concept of work zone *involvement*. It is clear from the analysis that officers determined the work zone was a factor in at least some crashes occurring outside the boundaries, however, under current instructions, these crashes are supposed to be excluded.

Realistically, the presence of a work zone may very well impact traffic and operations beyond the boundaries. To the extent that this can be captured on a crash report form, the MMUCC recommended data elements provide much guidance. For instance, the first C18 subfield asks, "Was the crash in a construction, maintenance, or utility work zone, or was it related to activity within a work zone?" By including a provision for work zone-relation in addition to the other data elements, a work zone crash does not necessarily need to occur within the set boundaries in order for the work activity to be a contributing factor in crashes. The narratives often indicated traffic congestion and slow/stop conditions were present at the time of the crash, regardless of where in proximity to the work zone the crash occurred. Many involved rear end or sideswipe collisions, which research shows are common crash types in work zones.

Without additional data elements to better capture work zone relation, the current reporting practices are not sufficient to understand how and to what degree work zone activities are related to crashes. There is an overall lack of consistency with respect to officer narratives and the contractor work diaries but also the degree to which their content provided insight into work zone crashes.

RECOMMENDATIONS

The accurate reporting of work zone crashes serves two objectives: (1) it allows an estimation of a work zone "effect," i.e., do work zones have on average a higher crash count than if there had there been no work zone in place; and (2) it provides opportunities for problem identification such as risk factors that could be eliminated or reduced.

Overall, the relationship of work zones to crash frequency and severity is not clear. One issue that makes assessing this relationship difficult is that most states do not collect sufficient information about work zone-crash involvement to thoroughly examine the relationship [*3*]. It is not possible to assess whether work zones in general increase crash risk without accurate and complete data. While research has generally suggested that the presence of a work zone increases crash risk by some degree, other studies have found no elevated risk when comparing to non-work zones [*25*]. Many studies have noted data quality issues in identifying and reporting work zone crashes such as misclassification of crashes (e.g., coded as being in a work zone when it really was not).

For example, in Louisiana, if *all* crashes taking place between the posted signs (and even several miles in advance/after exit) were reported, it would be possible to gain some insight into how work zone presence impacts crash rate by comparing and contrasting observed crash frequency. The validity of such analysis is dependent on accurate and complete data collection. At a minimum, this means officers must correctly identify a crash as having occurred within the boundaries of a work zone, which is contingent on their ability to do so at the time of crash investigation. Officers may not know where signs are posted, but assuming it is possible to train officers to clearly identify where work zones are located in their jurisdictions, this may be overcome. "Between the signs" might be sufficient to identify crashes in the actual work zone, but it would not be a measure of work zone *involvement* in the crash, which is the second objective behind accurate work zone crash data. To determine the degree to which the work zone played a role in a crash, capturing additional details is necessary, however, to ensure data quality, all terminology, definitions, data attributes and reporting instructions must be applied consistently and recorded objectively, i.e., not based exclusively on the judgment of the police officer.

Even with the best of training, police officers might not be in the position to judge whether the work zone was a factor or not, especially when driver error or driver violations are involved. Generally, a crash may involve several factors and thus identifying a single cause is a fruitless effort. To the extent that it is possible to determine that the work zone was involved, however, it is worthwhile to consider how these factors line up using a counterfactual approach. For instance, a driver may have been distracted, driving too fast, followed another vehicle too closely or merged inappropriately and caused the crash. Is it possible the crash might not have occurred if there had not been a work zone? Perhaps the crash might not have occurred if traffic had not backed up, due to the presence of the work zone. Objective measures to assess the potential influence of work zones on crashes is essential. The MMUCC C18 subfield data elements are a good start for obtaining more objective information.

The recommendations for improved reporting of work zone crashes in Louisiana are as follows:

DOTD Oversight of Work Zone Operations, Contractor Reporting

Crash reporting data are not the only data that can provide greater insight into the role of the work zone in crashes. Considering the role of DOTD in overseeing work zone projects and operations, one way to achieve more reliable data collection is through work zone management documents such as the Contractor Daily Work Diaries used in this report. Despite the limitations associated with the diaries in 8/10 work zone projects, the daily work diaries have the potential to provide a more complete and coherent account of work zone activities and crash documentation. Careful measures must be taken to improve the consistency and quality of the daily diaries from the contractors. For example, one project included mileposts of work activities as well as reported crashes and traffic conditions that affected work. Signs for projects within fixed mile posts are static which might make them more reliable. Signs for striping projects may not be static and thus it is important that daily diaries accurately report the location and relative placement of the warning signs.

Assessment of Static Work Zones

Static work zones can be evaluated with respect to an average work zone effect using the method described in this report. Static work zones seem to have reliable information about the location and timing of warning signs. However, because signs may be up for a considerable time after the work has been completed but final inspection has not been formally closed out, the estimated work zone effect on the number of crashes may not be a meaningful assessment of work zone safety. In order to draw causal inferences, the intervention has to be well-defined. The general problem with work zones is that while they may be fixed in a space and have a duration, they are not well-defined with respect to time. The work zone project may be divided in phases where (1) warning signs are set up, (2) preparations for traffic rerouting are taking place, (3) work is being done, (4) traffic rerouting is eliminated, (5) waiting for final inspection, (6) signs are taken off and normal traffic returns. Without an indication of the timing of these project phases, a meaningful assessment of a work zone effect on crashes is not possible. It is therefore not surprising that past research results varied much in their findings of a work zone effect.

In addition, all work zones are not the same: a striping project is different from an overlay project which is different from a bridge project. Hence, there is no general work zone effect on crashes, rather there may be different effects for different work zone projects, i.e., a striping project may have a different effect on the number of crashes than an overlay project. Nevertheless, this research project should be continued to include more static work zone projects and assess whether an average work zone effect can be estimated using “before and after study” methods.

Recommendations for Louisiana Crash Report Form

Identify/Address Shortcomings of Current Crash Report Form

The basic objective behind systematic data collection is to be able to use that data to identify problems, inform decisions, evaluate outcomes, assess relationships and the like. Concepts of interest must be clearly defined, the definitions must be consistently applied so concepts are consistently measured, and measurements must capture what they purport to measure in order to minimize error and for data to provide meaningful insight. This is a reflection of data quality, which includes characteristics of timeliness, accuracy, completeness, consistency, integration and accessibility. Electronic crash reporting has greatly improved many facets of data quality, but areas in need of improvement with regard to work zone crashes include accuracy, completeness, and consistency.

The findings strongly suggest that that at least some of the inconsistencies in crash reporting stems from the fact that the data elements/explanations and instructions are convoluted and difficult to interpret. Consider the existing crash report instructions for reporting work zone crashes, which clearly states that only crashes occurring within the boundaries of the work zone should be considered work zone crashes for crash reporting purposes. On its face, this element does not provide any insight into the involvement the work zone activities played in the crash. Crashes may occur within the physical boundaries of a work zone during times work is not active just as work zone activities can indeed play a factor in crashes as well as the traffic conditions contributing to crashes well outside the first warning sign. It is possible to accurately capture both types of crashes.

Adopt the MMUCC Recommendations as a Minimum Standard

To alleviate the shortcoming of the current Louisiana crash report, the Louisiana crash report form should be revised to include at least four of the five MMUCC work zone related elements under subfield C18, as shown in Table 33. The elements should be objective, easy to interpret and requiring little or no training or expert judgment. This would enable engineers to better evaluate crashes in work zones and assess whether the work zone contributed to the crash.

Table 33
Recommended MMUCC work zone related elements

1	Was the crash within the warning signs of a construction, maintenance, or utility work zone or was it outside the warning signs but related to activity within a work zone?	No Yes Unknown
2	Location of the Crash	Before the First Work Zone Warning Sign Advance warning area Transition area Activity Area Termination Area *x Not Applicable*
3	Type of Work Zone	Lane closure Lane Shift/Crossover Work on Shoulder or Median Intermittent or Moving Work Other type of Work Zone *x Not Applicable…*
4	Workers Present	No Yes *x Not Applicable…* Unknown

Law Enforcement Crash Report Manual

Revise crash manual to clearly instruct officers to look for posted signs of a work zone. For DOTD purposes, when the signs are up, the crash must be coded as in a work zone. One issue that must be addressed concerns the question of whether or not officers have difficulty identify a crash as occurring within the posted signs. Immediate measures that can be taken without waiting for revision of a crash report form would be to advise officers to mark WZ on the Crash report when a crash occurs within the signs, and, if a crash occurred in the approach where traffic was backed up, officers should explicitly mention this in narrative.

Additionally, the crash manual guide must clearly define “approach” including any distance before the first sign indicating a work zone where traffic backed up due to the work zone. Officers working in areas where work zones are in place should be informed on a weekly basis about work zones.

Training of Law Enforcement Regarding Crash Report Manual

Training of officers in the accurate reporting of work zone crashes is important to obtain consistent data. However, the crash report should be designed to include objective questions that do not require the officer to provide a subjective judgment. Officers are well-trained in enforcing the law and thus there is a natural bias toward reporting violations and not engineering features. For that reason, data derived from the crash report that require engineering expertise or medical expertise are often unreliable. It is well-known, for instance, that the injury severity field is unreliable because it requires a judgment about a medical condition officers are not trained in. With respect to work zones it is therefore not surprising that officers mostly concentrate on the driver violations. Therefore, crash report elements should be clear and intuitive requiring little training.

ACRONYMS, ABBREVIATIONS, AND SYMBOLS

ASCE	American Society of Civil Engineers
ADT	Average Daily Traffic
BOP	Beginning of Project
DOT	State Department of Transportation
DOTD	Louisiana Department of Transportation and Development
EOP	End of Project
ERW	End Road Work
FARS	Fatality Analysis Reporting System
FHWA	Federal Highway Administration
GHSA	Governors Highway Safety Association
LTRC	Louisiana Transportation Research Center
MMUCC	Model Minimum Uniform Crash Criteria
MUTCD	Manual on Uniform Traffic Control Devices
MVM	Crashes Per Million Vehicle Miles,
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
PAR	Police accident reports
PRC	Project Review Committee
RWA	Road Work Ahead
RWNM	Road Work Next XX Miles
TCD	Traffic control device
VMT	Vehicle miles of travel
WZ	Work Zone

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APPENDIX A

MMUCC Definition of Work Zone Crash

A work zone crash is a traffic crash in which the first harmful event occurs within the boundaries of a work zone or on an approach to or exit from a work zone, resulting from an activity, behavior or control related to the movement of the traffic units through the work zone. Includes collision and non-collision crashes occurring within the signs or markings indicating a work zone or occurring on approach to, exiting from or adjacent to work zones that are related to the work zone. For example: (1) An automobile on the roadway loses control within a work zone due to a shift or reduction in the travel lanes and crashes into another vehicle in the work zone; (2) A van in an open travel lane strikes a highway worker in the work zone; (3) A highway construction vehicle working on the edge of the roadway is struck by a motor vehicle in transport in a construction zone; (4) a rear-end collision crash occurs before the signs or markings indicating a work zone due to vehicles slowing or stopped on the roadway because of the work zone activity; (5) A pickup in transport loses control in an open travel lane within a work zone due to a shift or reduction in the travel lanes and crashes into another vehicle which exited the work zone;(6) A tractor-trailer approaching an intersection where the other roadway has a work zone strikes a pedestrian outside the work zone because of lack of visibility caused by the work zone equipment. Excludes single-vehicle crashes involving working vehicles not located in trafficway. For example: (1) A highway maintenance truck strikes a highway worker inside the work site; (2) A utility worker repairing the electrical lines over the trafficway falls from the bucket of a cherry picker.

APPENDIX B

Observation data from primary sources was collected in mid-2017. It is possible that some states may have published revisions or updates to their crash report forms and/or accompanying manuals since collecting this data. It is also possible that, despite the conscientious effort to locate the most up-to-date files for each state, that a more recent version could have existed at the time of data collection but for whatever reason, these documents were not retrievable online. The findings in the report are based on a review of the following primary sources:

Alabama	AL eCrash Data Element Manual rev. 2009
Alaska	AK Motor Vehicle Collision Report rev. 2013
Arizona	AZ Crash Forms Instruction Manual 2014
Arkansas	AR Motor Vehicle Crash Report Instructions Guide 2013
California	CA CHP555_manual 2003 (some portions are rev. 2010)
Colorado	CO Accident Reporting Manual 2006 & CDOT Glossary Handbook 2012
Connecticut	CT Investigators Manual for the Connecticut MMUCC v4 Crash Report 2014
Delaware	DE TraCS Support Database Map rev 2007
Florida	FL Instructions for Completing the Florida Uniform Traffic Crash Report Forms, rev. 2015
Georgia	GA DOT Uniform Accident Reporting Guide rev. 2003
Hawaii	HI Investigating Officer's Traffic Accident Reporting Manual rev. 2009
Idaho	ID CIRCA Data Dictionary rev. 2012
Illinois	IL Traffic Crash Report Instruction Manual rev. 2013 & IL Dictionary of Data Elements
Indiana	IN Vehicle Crash Records System Data Dictionary rev. 2011 & IN ARIES Instruction Manual rev. 2009
Iowa	IA Officers Accident Guide rev. 2012

Kansas	KS Motor Vehicle Coding Manual rev. 2014
Kentucky	KY Web Crash Codes, *no date*
Louisiana	LA Crash Manual rev. 2005
Maine	ME Crash Manual rev. 2010
Maryland	MD Motor Vehicle Accident Report Form—*Manual is under revision at time of data collection*
Massachusetts	MA *Data dictionary does not match up to the crash report form avail online*
Michigan	MI UD-10 Electronic Crash Report Manual rev. 2016
Minnesota	MN DPS Accident Report Form (law enf only) rev. 2003; MN Guide to Minnesota Crash Data Files, rev. 2006
Mississippi	MS Crash Report Instruction Manual rev 2006; MS Uniform Crash Report Form rev 2009
Missouri	MO Uniform Crash Report Preparation Manual, rev 2012; MO Crash Report Form rev. 2012
Montana	MT Crash Report Form (hq1599); Montana Crash Data Dictionary Accident Codes (after 7/1/2000)
Nebraska	NE Investigator's Motor Vehicle Accident Report Forms rev. 2009; NE Crash Report Form rev. 2009
Nevada	NV Crash Report Form rev. 2004; NV NCATS Repository Code Table Report v2.3 rev. 2010
New Hampshire	NH Crash Report Form rev. 2007; NH Crash Data Elements Recommendation for Valid Crash Report (*unknown date*)
New Jersey	NJ Crash Report Form, rev. 2005; NJ Police Guide for Preparing Reports of Motor Vehicle Crashes, rev. 2011
New Mexico	NM Crash Report Form, rev. 2011; NM Uniform Crash Report Instruction Manual, rev. 2011
New York	NY Police Accident Report (MV-104COV 11/13); NY Police Accident Report Manual with Bus and Truck Supplement (P-33)

North Carolina	NC PAR Instruction Manual, rev. 2013; NC Crash Report Form, rev. 2009; NC Crash Data Dictionary, rev. 2006
North Dakota	ND Crash Report Database Elements and Attributes, *no date*; ND Motor Vehicle Crash Report Form, rev. 2009
Ohio	OH Crash Report Form, rev. 2012; OH Crash Instruction Manual, 2011; OH Crash Data Dictionary, rev. 2015
Oklahoma	OK Crash Report Form, rev. 2007; OK data dictionary, rev. 2006; OK Traffic Collision Report Instruction Manual, rev. 2007
Oregon	OR Crash Report Form, rev 2015; OR Police Truck/Bus/Hazmat Crash Supplemental Form rev. 2011; OR Crash Report Instruction Manual, rev. 2012; OR Statewide Crash Data System, Motor Vehicle Traffic Crash Analysis and Code Manual, rev. 2007
Pennsylvania	PA Crash Report Form, rev. 2002 (*could not locate later version*); PA Data Dictionary and Field Constraints Tables, *no date*; PA police Officers Crash Report Manual, rev. 7/2016
Rhode Island	RI Crash Report Form (no date, file was submitted to NHTSA in 2013
South Carolina	SC Crash Report Form, rev 2011?; SC Traffic Collision Report Form (tr-310) and Supplement Truck And Bus Report Form Instruction Manual, rev. 2012
South Dakota	SD Crash Report Form, rev. 12/2003, SD Motor Vehicle Traffic Accident Data Dictionary, *no date;* SD Crash Report Instruction Manual, rev. 2006
Tennessee	TN TITAN e-crash report, rev. 2009; TN TITAN Schema Data Dictionary, (u*nknown date*; submitted to NHTSA in 2012) *training manual is not available online*
Texas	TX Crash Report Form, rev 2010; TX Crash Report Instruction Manual, rev 2012 ; TXDOT Glossary, rev 2013
Utah	UT Crash Report Form, rev. 2006 & Overlay, rev. 2015 ; UT Crash Report Instruction Manual, rev. 2011
Vermont	VT Crash Report Form, rev ; VT Investigators Guide For Completing The State of VT Uniform Crash Report, v. 1.5, rev. 2014

Virginia	VA Crash Report Form, rev. 2007; VA Crash Report Manual, rev. 2014
Washington	WA Police Traffic Collision Report Manual, rev. 2014; WA Crash Report Form, rev. 2006
West Virginia	WV Crash Report Form, rev. 2007—*no other information is available online*
Wisconsin	WI Motor Vehicle Accident Report, rev. 2007—*no other information is available online*
Wyoming	WY Investigators Traffic Crash Report Manual, rev. 2008; WY Crash Report Form, rev. 2007

APPENDIX C

Table 34
Project sample selection overview number of projects, crashes, and work zone crashes by work type

	Projects				Crashes				Work Zone Crashes			
Work Type	2012	2013	2014	2015	2012	2013	2014	2015	2012	2013	2014	2015
AC ovly bro/s PCC				1				62				0
AC ovly rubblized pvt	4	5	1		222	210	22		0	13	4	
AC ovly/inplace base			2	2			80	73			5	0
Asph ovly asph pvmt	11	7	7	7	491	520	598	423	18	18	23	3
Asph ovly conc pvmt	3	1	1	1	46	100	135	56	3	8	0	0
Asph surf treat	4			1	179			17	2			0
Asph wdn and ovly	8	5	2	2	1026	732	64	71	88	38	13	32
Asphalt new pvmt				3				16				2
Bridge painting	1	1	2	2	17	44	138	63	0	0	0	0
Bridge removal	1				9				0			
Bridges new	3	1	1	1	43	32	115	35	3	1	18	5
Bridges rcnd	19	18	15	15	651	912	1138	757	23	13	39	10
Clear and grub	1	3	1		51	67	34		0	8	0	
Conc new pvmt	8	11	8	5	1505	1137	486	188	278	100	33	8
Conc pvmt rehab	6		3	4	86		127	131	1		4	2
Crash devices	4				1258				17			
Drainage	3	2	2	1	743	856	874	267	0	6	11	0
Embankment				2				11				0
Embankment repair				1				1				0
Fencing	1	1	1		69	289	112		0	0	0	
Guardrails		2				154				3		
ITS/emergency oper	4	4	10	11	37	67	286	1196	0	0	3	2
PCCP patch	6	6	6	3	441	364	724	200	18	16	6	1
Roadway lighting	3	5	8	8	43	70	191	156	0	0	5	11
Signing	4	6	9	8	541	793	439	206	17	17	1	3
Striping/pvmt markers		11	17	10		87	3450	684		3	53	10
Traffic flow improve	6	6	7	2	71	118	157	52	15	1	4	6
Weigh-in-motion			1	1			6	3			0	0
Grand Total	100	95	104	91	7529	6552	9176	4668	483	245	222	95

APPENDIX D

Louisiana Crash Report Manual Instructions for marking crash report work zone:

Only mark an "X" in the block if the crash occurred in a construction or maintenance work zone. A work zone crash is a crash where the first harmful event occurs within the boundaries of a work zone. A work zone is defined as an officially designated portion of a public thoroughfare on which the Department of Transportation and Development (DOTD), a subcontractor representing DOTD, or the local city or parish road department is doing construction or maintenance. This applies to the main roadway or the shoulder. Included are utility companies, contractors removing or trimming trees, or any other AUTHORIZED endeavor. A private contractor working next to the roadway, or paving a driveway up to the edge of the roadway, does not constitute a work zone.

NOTE: Construction or maintenance work does not need to be actually occurring in this zone at the time of the crash. Check this box for ALL crashes occurring in a designated construction or maintenance work zones. A work zone is typically marked by signs, channelizing devices, barriers, pavement markings, and/or work vehicles. It begins at the first warning sign or flashing lights on a vehicle and ends at the sign indicating the end of construction or road work or at the last traffic control device. If no signs are present the work zone begins at the first point of construction or maintenance work and ends at the last point of construction or maintenance work. An orange warning sign indicating that a work zone begins in 1 mile signifies the beginning of the work zone for the purposes of this report. Crashes involving vehicles slowed or stopped because of the work zone should not be included unless the vehicles had actually entered the work zone when the first harmful event occurred.

LA Crash Report Guide 2005, p 11

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