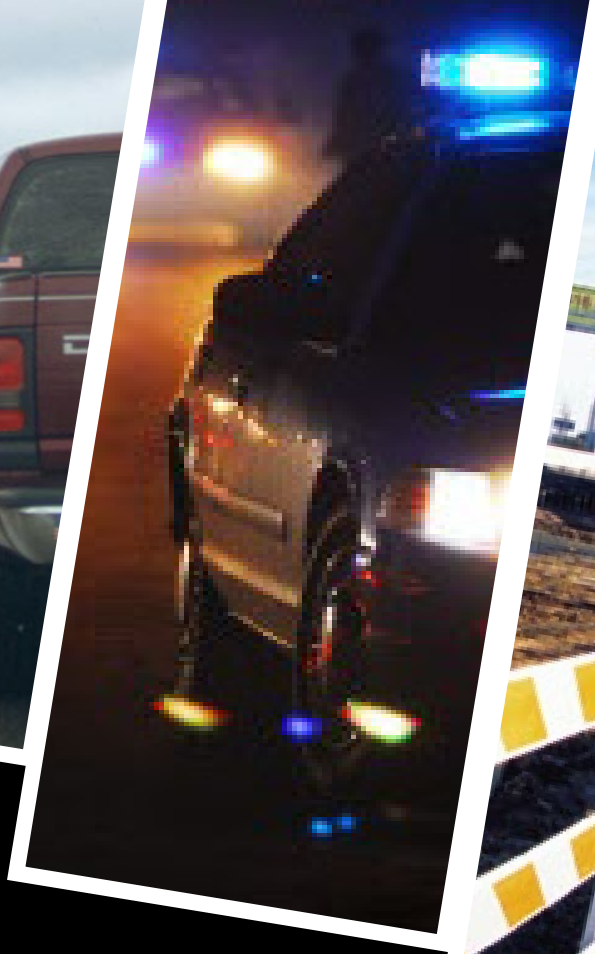
TRAFFIC INCIDENT MANAGEMENT IN CONSTRUCTION AND MAINTENANCE WORK ZONES

U.S. Department of Transportation
Federal Highway Administration



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TECHNICAL REPORT DOCUMENTATION

1. Report No. FHWA-HOP-08-056	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Traffic Incident Management in Construction and Maintenance Work Zones		5. Report Date January 2009
		6. Performing Organization Code
7. Author(s) Kevin Balke, Ph.D., P.E.		8. Performing Organization Report No.
9. Performing Organization Name and Address Texas Transportation Institute The Texas A&M University System College Station, Texas 77843-3135		10. Work Unit No. (TRAIS)
		11. Contract or Grant No. DTFH61-06-D-0007
12. Sponsoring Agency Name and Address Federal Highway Administration Office of Transportation Operations 1200 New Jersey Avenue, SE Washington, DC 20590		13. Type of Report and Period Covered Technical Report
		14. Sponsoring Agency Code HOTO-1, FHWA

15. Supplementary Notes
Project performed under contract to Battelle for the Federal Highway Administration Office of Operations

16. Abstract
In 2004, the Federal Highway Administration published updated rules governing work zone safety and mobility; all highway construction and maintenance projects using federal-aid highway funds are required to develop transportation management plans (TMP) focusing on safety and the reduction of traffic mobility impacts through coordination. The project TMP should consist of a collection of administrative, procedural, and operational strategies for managing and mitigating the impacts of work zones. It is important for planners, operations personnel, and incident responders to understand why the transportation operation elements are vital in the process of developing the TMP. This document addresses the special needs and concerns when managing traffic incidents within a work zone and focuses on incident management as a strategy to be considered in the transportation operations component of the TMP. A description of techniques and strategies that can be used to handle incidents in work zones is presented Some trend-setting approaches used on high-profile construction projects are also showcased as examples of good incident response planning incorporated at the design level. The contractor's role in dealing with incidents within the work zone is addressed as well as the description of processes, procedures, and practices related to the detection, response, and clearance of incidents. The importance of including incident management procedures as an element of the transportation operations component of these plans is emphasized. The goals, objectives, and reasons for incident management as well as the issues and concerns that work zone planners, incident responders, and traffic operators need to consider in the planning phases of a work zone project are presented. Common work zone incident management strategies are described.

17. Key Words Transportation Management Plans, Work Zones, Traffic Incident Management	18. Distribution Statement No restrictions. This document is available to the .		
19. Security Classif.(of this report) Unclassified	20. Security Classif.(of this page) Unclassified	21. No. of Pages 68	22. Price

Form DOT F 1700.7 Reproduction of completed page authorized

U.S. Department of Transportation
Federal Highway Administration

1200 New Jersey Avenue, SE.
Washington, DC 20590

Dear Transportation Professionals & Traffic Incident Management (TIM) Partners:

As part of the mission of the Federal Highway Administration (FHWA) to "***Keep America Moving,***" we need to safeguard the motoring public and those responding to traffic incidents. Safe, quick clearance of highway incidents—a foundation of both mature and developing TIM programs—depends on strong, coordinated multi-agency operations that are supported by integrated communications.

With more vehicles on the Nation's highways, traffic incidents become increasingly life threatening for those involved, including responders dispatched to help. According to the National Traffic Incident Management Coalition (NTIMC), "struck-by" secondary incidents are on the rise. In conjunction with the NTIMC partner organizations in the public safety and transportation arenas, FHWA promotes policies that enhance responder safety (such as driver removal and move-over laws); encourages the use of new technologies and gear to protect responders during roadside operations; and promotes improved safety procedures and safety training of traffic incident responders. In the coming year, FHWA will be launching a new campaign, similar to the highly successful "***Click It or Ticket*"** campaign, to increase driver awareness of their roles and duties in safely addressing traffic incidents or public safety responses on the roads.

As a part of this campaign and in support of TIM practitioners, FHWA is pleased to introduce a new set of primers, collectively known as the "***Safe, Quick Clearance Primer Series.***" This series includes five primers that address various issues associated with roadside clearance operations and provide basic building blocks on:

- ***Information Sharing for Traffic Incident Management***
- ***Traffic Incident Management in Construction and Maintenance Work Zones***
- ***Traffic Incident Management in Hazardous Materials Spills in Incident Clearance***
- ***Traffic Incident Management Resource Management***, and
- ***Traffic Control Concepts for Incident Clearance***

We encourage comments and contributions to these primers and other FHWA Traffic Incident Management documents. Please feel free to contact our Emergency Transportation Operations Team at ETO@dot.gov with suggestions for future revisions.

Sincerely,

Jeffrey A. Lindley
Associate Administrator for Operations

MOVING THE AMERICAN ECONOMY

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1.0 INTRODUCTION

Work zones provide unique challenges to incident responders, including reduced access, narrowed lanes, minimal refuge locations, physical barriers, and reduced sight distances. At times, work zone elements can violate driver expectancy. In addition to reducing the normal capacity of roadways, the potential also exists to confuse drivers with conflicts between construction and maintenance traffic control and incident management traffic control. All of these factors combine to not only increase the likelihood of incidents occurring within a work zone, but also increase the impact that even a minor incident has on traffic operations in the work zone.

Traffic incident management (TIM) and work zone management are two of the tools in the transportation professional's "operations toolbox" that focus on reducing congestion. Incident management focuses on developing procedures, implementing policies, and deploying technologies to identify incidents more quickly, improve response times, and manage the incident scene more effectively and efficiently. With work zone management, agencies attempt not only to reduce the amount of time work zones are needed, but also deploy strategies for moving traffic more effectively in and around the work zone, particularly during peak travel times.

Many locations already have, either formally or informally, established TIM programs. In these locations, the goal of work zone planners should be not to establish new incident management programs or functions, but to augment or expand these existing programs, ensuring that the specific needs of their construction/ maintenance activities are met. In other locations, where incident management programs are not as well-defined, a construction or maintenance project can be the catalyst for bringing these agencies together to strengthen the incident management process. Oftentimes, formal incident management programs, and the relationships that develop, continue well after the construction project ends and form the foundation for future incident management efforts.

Purpose of This Document

The purpose of this document is to address the special needs and concerns when managing traffic incidents within a work zone. In this document, the user will find a discussion on the importance of transportation management plans in work zones and how incident management is one strategy that should be considered in the transportation operations component of a work zone transportation management plans (TMP). Techniques and strategies that can be used to handle incidents in work zones are contained in this document. The document also contains information showcasing some trend-setting approaches that have been used on high-profile construction projects as examples of how incident response planning can be incorporated into the design of construction projects. This document also discusses the contractor's role in dealing with incidents in work zones.

Target Audience

This document is targeted toward three distinct audiences that might be required to deal with incident management as part of a construction or maintenance activity. These include the following:

- *Work Zone Planners and Construction/Maintenance Personnel* – These would include construction personnel from both public and private entities that are responsible for working with operations personnel to develop, implement, and execute TIM responses in construction and maintenance work zones.
- *Traffic Operations Personnel and Incident Responders* – These would be operations personnel that have the responsibility for implementing TIM strategies and systems identified in TMPs. These include not only transportation agencies, but also law enforcement and other emergency services that typically respond to traffic incidents and collisions.
- *Project Planners/Design Personnel* – These would be individuals responsible for developing the plan, specifications, and estimates (PS&Es) associated with construction/maintenance projects. These would include individuals that would also be responsible for designing TMPs (see below) for specific construction projects as well as those responsible for developing traffic control standards on an agency-wide basis so that baseline TIM plans can be included as part of project requirements.

Structure of This Guidebook

This guidebook is one in an Information Series on Traffic Incident Management Safe, Quick Clearance. This guidebook focuses on Traffic Incident Management in Construction and Maintenance Work Zones. Other guidebooks available in this information series deal with the following topics:

- Traffic Control Concepts for Incident Clearance,
- Hazardous Materials Spills in Incident Clearance,
- Information Sharing for Traffic Incident Management, and
- A Multi-disciplinary, Holistic Approach to Traffic Incident Management Resource Management.

This document discusses the special needs and concerns of managing traffic incidents within work zones and describes processes, procedures, and practices related to the detection, response, and clearance of incidents in work zones. Chapter 2 provides background information on the importance and process of developing TMPs for work zones and how incident management procedures and practices are an element of the transportation operations component of these plans. Chapter 3 provides additional background information of the goals, objectives, and reasons for incident management. Chapter 4 discusses some of the issues and concerns that

work zone planners, incident responders, and traffic operators need to consider in the planning phases of a work zone project. Chapter 5 provides a brief description of common incident management strategies and lists some of the advantages and disadvantages associated with deploying these strategies in a work zone. Chapter 6 focuses on actions that work zone planners, traffic operators, and incident responders can do during the execution of a particular work zone project to provide insight into enhancement or improvements to incident management activities. Chapter 7 contains references and other suggested readings that were used to develop this guidebook.

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2.0 TRANSPORTATION MANAGEMENT PLANS FOR WORK ZONES

In September 2004, the Federal Highway Administration (FHWA) published updates to rules that govern work zone safety and mobility.[1] Under the new rule, all highway construction and maintenance projects that use federal-aid highway funds are required to develop transportation management plans (TMP) that not only ensure the safety of the motoring public, but also reduce the traffic mobility impacts and promote coordination within and around work zones. A TMP is a collection of administrative, procedural, and operational strategies for managing and mitigating the impacts of work zones. Traffic incident management (TIM) is one of the tools available for transportation professionals to relieve the impacts of work zones on traffic operations.

Before beginning the process of developing a TIM program for work zones, it is important for work zone planners, operations personnel, and incident responders to understand what a TMP is and why it is important in the process of developing TIM programs.

What is a Transportation Management Plan?

A TMP lays out a set of coordinated transportation management strategies and describes how they will be used to manage the work zone impacts of a road project.[2] Developing a TMP is an iterative process that involves the identification and evaluation of applicable transportation management strategies to manage the impacts of the construction project on traffic operations. These strategies include not only the deployment of temporary traffic control measures and devices, but also public information and outreach, and operational strategies, such as travel demand management, signal retiming, and traffic incident management.

What are the Components of a Transportation Management Plan?

As shown in Figure 1, a TMP consists of three functional components:[2] a **Temporary Traffic Control (TTC)** plan, a **Transportation Operations (TO)** plan, and a **Public Information (PI)** plan; depending upon the expected impacts of the work zone on transportation operations.

The TTC plan describes the measures that will be used to facilitate road users through the work zone and is required for all construction and maintenance projects. The TTC plan must be consistent with Part 6 of the *Manual on Uniform Traffic Control Devices (MUTCD)*[3] and with the hardware requirements of Chapter 9, “Traffic Barriers, Traffic Control Devices and Other Safety Features for Work Zones,” of the American Association of State and Highway Officials’ (AASHTO) *Roadside Design Guide.*[4] The TO plan component identifies the strategies that will be used to mitigate the impacts of the work on the operation and management of the transportation system within the work zone impact area. The PI plan component describes the strategies that will be used to communicate and inform affected road users, the

general public, area residences and businesses, and others about the potential impacts of the work zone and changing project conditions. TO and PI elements are required for all projects deemed to have a significant impact on traffic and encouraged for all construction and maintenance projects.

The nature, scope, and level of detail contained in these components depends upon the nature, scope, duration, extent of the work zone activities and levels of safety and mobility impacts of the work zone.

A TMP consists of strategies to manage impacts of work zones. A TMP may contain the following three components.

- ***Temporary Traffic Control (TTC)*** – A plan for handling traffic through a specific highway or street work zone or project. The TTC includes:
  - *Control Strategies*
  - *Traffic Control Devices*
  - *Project Coordination, Contracting, and Innovative Construction Strategies*
- ***Public Information (PI)*** – A plan for disseminating information concerning construction activities and projects to road users and the community. The PI includes:
  - *Public Awareness Strategies*
  - *Motorist Information Strategies*
- ***Transportation Operations (TO)*** – A plan for using operational and management strategies for mitigating the impacts of work zones on traffic operations. The TO includes:
  - *Demand Management Strategies*
  - *Corridor/Network Management Strategies*
  - *Work Zone Safety Management Strategies*
  - *Traffic/Incident Management and Enforcement Strategies*

Figure 1. Components of a Transportation Management Plan

Why is a Transportation Management Plan Needed?

Some of the key benefits that agencies can expect to be derived from developing TMPs for work zones include the following:[2]

- Increased awareness of the broader safety and mobility impacts that work zones have at the corridor and network levels;
- More efficient and effective utilization of construction phasing and staging, which in turn can reduce contract duration and control costs;
- Improved work zone safety for both construction personnel and the traveling public;
- Reduction in the impacts of work zones on traffic operations and mobility;
- Reduction in the number of complaints from the travelling public, local businesses, and communities on the effects of work zone congestion;

- Reduction in circulation, access, and mobility impacts to local communities and businesses;
- Improved intra- and inter-agency cooperation and coordination; and
- Clearer understanding of the roles, responsibilities, and actions to be performed to reduce the impacts of work zone traffic operations.

When is a Transportation Management Plan Needed?

As outlined in *Rule 630*, every project that utilizes federal-aid highway funds is required to have a TMP. At a minimum, every TMP must contain at least a TTC plan. Whether a TMP needs to have a TO or PI component depends on whether or not a project is expected to be "significant." *Rule 630* defines a "significant" project as "one that, alone or in combination with other concurrent projects nearby is anticipated to cause sustained work zone impacts…that are greater than what is considered tolerable based on State policy and/or engineering judgment." While every project may not require TO and PI components, states are encouraged to consider TO and PI components for all projects.

Factors that should be considered in developing the contents of a TMP include the following:[2]

- Type of construction project (e.g., new construction, major reconstruction, major rehabilitation, or bridge/pavement replacement)
- Degree of roadway congestion at and/or near the project location
- Type, number, and duration of capacity restrictions (e.g., lane, ramp, or facility closures)
- Impact on mobility through and within the project area
- Impact of safety through and within the project/work zone impact area
- Impact on local businesses and communities
- Impact from or on special events and/or seasonal variations (e.g., weather, tourist traffic, etc.)
- Presence of major traffic generators or special traffic generators (such as freight warehouses or distribution centers) in the vicinity of the project
- Availability of suitable detour or alternative routes or other transportation options (such as transit) in the corridor
- Traffic characteristics, such as local versus through traffic, percent trucks, etc.

Who Needs to be Involved in the Development of a Transportation Management Plan?

Rule 630 states that the TMP shall be included as part of the construction documentation – the Plans, Specifications, and Estimates (PS&Es) – prepared for a project. *Rule 630* also permits state agencies to allow the contractor to develop a TMP; and states that if a contractor is used to develop a TMP, it is subject to approval by the state and shall not be implemented in the field before it is approved by the state. PS&Es shall include appropriate pay item provisions for implementing the TMP, either through method- or performance-based specifications.

TMPs should not be developed in isolation, but should be developed in "sustained consultation" with other stakeholders that are likely to be impacted by the construction activities. The stakeholders for any particular project depend on the extent, duration, and impact of the construction activities on traffic operations in the surrounding transportation network. Potential stakeholders that should be consulted in the development of a TMP might include one or more of the following entities:[2]

- Other state and local transportation agencies, including regional mobility authorities and toll road operators,
- Railroad agencies/operators,
- Transit providers,
- Freight movers,
- Public and private utility suppliers,
- State and local police agencies,
- Fire and emergency medical service providers,
- Schools,
- Business communities,
- Neighborhood associations, and
- Regional transportation management centers.

What is the Process for Developing a Transportation Management Plan?

FHWA's *Developing and Implementing Transportation Management Plans for Work Zones*[2] outlines an 11-step process that agencies can follow to develop a TMP. The steps in the process include the following:

- *Step 1. Compile project material for each stage of the project.*
- *Step 2. Determine the type of TMP needed for specific projects.*
- *Step 3. Identify appropriate stakeholders.*
- *Step 4. Develop initial TMP.*

- *Step 5. Update and revise initial TMP.*
- *Step 6. Finalize construction phasing/staging and TMP.*
- *Step 7. Re-evaluate and revise TMP.*
- *Step 8. Implement TMP.*
- *Step 9. Monitor the performance of the TMP.*
- *Step 10. Update/Revise TMP based on performance metrics.*
- *Step 11. Conduct post-project TMP evaluation.*

For more details on the process for developing transportation management plans, see FHWA's Work Zone Mobility and Safety Program Web site.

What do Transportation Management Plans Have to do With Traffic Incident Management?

One strategy for reducing work zone impacts involves monitoring traffic conditions and making real-time adjustments to traffic operations based on these observed changes. Traffic incidents are events that disrupt the normal flow of traffic, usually by physical impedance in the travel lanes. These events can be vehicular crashes, breakdowns, or debris in travel lanes. Incident management involves deploying technology, establishing procedures and policies, and implementing systems for improving the detection, verification, response, and clearance of these events when they occur in the work zone and on associated detour routes. Therefore, one element of the TO component of the TMP is to establish a TIM program that provides specialized techniques for detecting, verifying, responding to, and clearing incidents in work zones.

Factors Impacting the Need for Work Zone Incident Management

Not every work zone requires that special incident management procedures and practices be put into place prior to construction beginning. A work zone that is associated with a short-term maintenance activity located on a low-volume, rural roadway may only require that maintenance personnel meet with incident responders to discuss detection and clearance procedures. Long-term construction projects, which require extensive lane closures for extended periods, are likely to have a more severe impact on traffic operation and, thus, require a more comprehensive set of incident management policies and procedures to minimize the impact of incidents within the work zone. The effects of incidents on traffic operations in a work zone are influenced by two key factors: the intensity of the work zone and the intensity of the incident.

Intensity of the Work Zone

Work zone intensity is defined by three parameters: the duration of the work zone project, the length of the work zone, and the number of travel lanes that are affected by the work zone[5]. A work zone project that reduces the number of travel lanes for an extended period throughout the day over an extended length of roadway has a greater impact on traffic operations than one that uses fewer lanes over a shorter

distance for less time. Other factors that influence the impacts of work zones on traffic operations include the:

- Functional classification of the roadway on which the work zone is located,
- Type of work activity being performed in the work zone area,
- Type of area where the work zone is located (i.e., rural, suburban, or urban area),
- Type and amount of traffic using the facility,
- Proximity of the work zone to special trip generators, such a large commercial or office complexes, schools, special event facilities, etc. and
- The availability of alternate modes and routes in the corridor.

Work zone planners should work with traffic operations personnel and incident responders to assess the impact a proposed construction or maintenance activity may have on traffic operations and incident management activities. Some agencies have developed relatively simple criteria for determining the impact of a work zone on traffic operations. Other agencies, however, may require more extensive data collection and analysis procedures. Procedures for assessing the impact of work zones on traffic operations can be found in *Work Zone Impact Assessment: An Approach to Assess and Manage Work Zone Safety and Mobility Impacts of Road Projects.*[6]

Intensity of the Incident

In addition to intensity of the work zone, the intensity of the incident also affects the degree to which an incident will impact traffic operations on a roadway. Three factors can generally be used to characterize the intensity of an incident: the amount of capacity reduction (i.e., the number of lanes) impacted by the incident, the amount of time that the capacity reduction is in effect, and the amount of traffic demand entering the incident area at the time of the incident. Each of these factors is discussed below.

Amount of Capacity Reduction

The amount of capacity reduction caused by an incident depends on the proportion of the travel lane that is blocked by the stopped vehicle and the total number of available lanes on the roadway before the incident occurred. The *Highway Capacity Manual*[8] shows that when an incident occurs on a freeway the amount of capacity loss is greater than the proportion of original capacity that is physically blocked. For example, when an incident blocks only one lane of a three-lane facility, the freeway retains only 49 percent of its original traffic moving capacity even though the physical capacity of the roadway is reduced by 33 percent.

Because of factors such as narrowed lanes, lack of shoulders, limited access, decreased or shifted travel lanes, speed reduction, and the presence of obstructions, barriers, and equipment being located closer than expected, work zones already have reduced capacity levels. That is why incidents that occur in work zones tend to

have a greater impact on traffic operations than if the same incident occurred when the work zone was not present. Therefore, one method of reducing the impact of incidents in work zones is to employ strategies that temporarily restore the roadway capacity. Examples of strategies that temporarily enhance capacity in work zones include:

- Temporary use of the shoulder as a travel lane,
- Reopen lanes originally closed or blocked for work zone purposes, and
- Shift traffic to alternate routes where excess capacity exists.

Incident Duration

The amount of time that a lane is blocked or affected by an incident is another major factor that contributes to the amount of congestion caused by an incident. The longer the incident reduces the roadway capacity, the greater the amount of time it will take for the congestion to dissipate. Therefore, many incident management procedures and strategies are directed toward reducing the duration that an incident blocks the roadway. As work zones already have reduced capacities, reducing the duration of an incident can significantly reduce the impact of an incident on traffic operations in the work zone. Strategies commonly used to reduce the duration of incidents in work zones include:

- Installing technology and processes to shorten the time required to detect and verify incidents
- Using procedures and practices for shortening the amount of time required to respond to incidents, and
- Implementing policies and procedures that shorten the amount of time required to remove (or clear) the incident from the travel lanes.

Traffic Demands

A final way in which incidents affect traffic operation is in the time of day and the amount of traffic using the roadway (i.e., traffic demand) when the incident occurs. Incidents that occur during peak condition generally have a greater impact on traffic operations than if the same incident occurred on the roadway late at night when demand for the roadway was not as great. This is the same reason why work zone planners frequently prohibit lane closures during peak periods and, instead, require the work activity to occur when traffic demands are lighter (for example during off-peak periods or at night).

One method of reducing the effects of incidents in work zones is to reduce the amount of traffic using the roadway at the time of the incident. Because incidents are random events and cannot be predicted, the only way to reduce demand is to warn motorists that an incident has occurred and encourage them to use alternate modes, routes, or times of travel to avoid the incident area. That is why it is important to consider information dissemination strategies when developing incident management plans for work zones.

3.0 TRAFFIC INCIDENT MANAGEMENT CONCEPTS IN HIGHWAY WORK ZONES

A highway incident is any non-recurring event (such as a vehicle crash, a vehicle breakdown, or a special event) that causes a reduction in roadway capacity or an abnormal increase in traffic demand that disrupts the normal operation of the transportation system. Most highway incidents are random events that occur with little or no advance warning. They can vary widely in terms of severity, ranging from a minor crash involving a single response agency (such as law enforcement) to a natural disaster or other catastrophe requiring a multi-agency response from multiple jurisdictions and disciplines. Incidents are a major source of congestion on the roadway system and can contribute to problems away from the actual incident scene (for example, secondary crashes caused due to unexpected congestion).

Traffic incident management (TIM) is defined as the coordinated, preplanned use of technology, processes, and procedures to reduce the duration and impact of incidents, and to improve the safety of motorists, crash victims, and incident responders. Specifically, TIM involves the use of technology, procedures, and processes to accomplish the following:

- Reduce the amount to time to detect and verify that an incident has occurred,
- Shorten the time required for appropriate response personnel and equipment to respond to the scene,
- Facilitate the management of response apparatus and personnel on site so as to minimize the amount of capacity lost due to the incident and the response equipment,
- Reduce the amount of time required to clear the incident from the travel lanes
- Provide for the rapid notification of travelers upstream of the incident so as to encourage a reduction in traffic demand entering the incident area and to reduce driver frustration.

Planning and Coordinating With Incident Response Agencies

Incident management programs are successful when they are built on a foundation of cooperation and collaboration. When planning or organizing a construction project, it is essential that work zone planners and construction personnel coordinate with the incident responders in the area. This includes identifying and meeting with agencies to discuss current response policies, procedures, and practices.

Table 1 shows an example of typical incident responder who may perform key response functions at an incident scene. On minor construction and maintenance projects, work zone planners and contractors may only need to coordinate with a few of these stakeholders (such

as fire and police agencies); however, on more complex projects, it may be necessary to coordinate with all of these stakeholders to develop an implementable incident management plan.

Table 1. Example Roles and Responsibilities of Key Incident Responders

Typical Traffic Incident Management Functions	Traffic Incident Management Responders												
	Emergency Dispatch (911 Center)	Fire/Rescue	Emergency Medical Services (EMS)	HAZMAT	Law Enforcement	Medical Examiner/ Coroner	Towing & Recovery	Transportation/ Public Works	Media	Transit Operator	Metropolitan Planning Organization	Transportation Management Center	Construction Contractor
Quick Clearance Policies					●		●	●			●	●	
Detection / Notification of Incident	●							●	●	●		●	●
Dispatch of Incident Management Assets / Emergency Responders		●			●		●	●					
Public Safety at Incident Scene		●			●			●					
Fire Suppression		●											
Rescue/Extraction of Victims		●	●										
Triage, Treatment, and Transport of Crash Victims			●										
Hazardous Material Cleanup and Disposal		●		●									
Secure / Stabilize Incident Scene					●			●					
Traffic Control / Road and Lane Closures /Openings					●			●				●	●
Crash/Fatality Investigation					●	●							
Removal of Wrecked or Disabled Vehicles							●	●					●
Debris Removal / Spilled Fluid Removal		●											
Activation / Traffic Management of Diversion Routes					●			●		●		●	
Stabilization and Repair of Roadway Infrastructure								●					●
Public Notification								●	●		●	●	

● represents those agencies that may be involved in a discussion of agency responsibilities in local incident response

The Incident Command System and Unified Command

To improve the nation's preparedness to response to incidents of all magnitudes, the Department of Homeland Security has developed the National Incident Management System (NIMS). NIMS was developed so responders from different jurisdictions and disciplines can work together better to respond to natural disasters and emergencies. Part of the NIMS structure involves the use of the **Incident Command System** (ICS). ICS is a systematic tool used for the command, control, and coordination of an emergency response.[9] It is designed to facilitate agencies working closely together through the use of common terminology and operating procedures to control personnel, facilities, equipment, and communications at a single incident scene. The guiding concepts and principles of ICS are as follows:

- Most incidents are managed locally by local agencies to provide a coordinated, cooperative response.
- The field command and management functions should be performed in accordance with a standard set of ICS organizations, doctrine, and procedures.
- ICS is modular and scalable so that responses can be adapted as situation, technology, size, and complexity of the incident changes.
- All component of the response are managed interactively in a coordinated manner.
- ICS establishes common terminology, standards, and procedures that enable diverse organizations to work together effectively.
- Incidents are managed by objectives, which are measureable and begin at the top and are communicated throughout the entire response.
- Implementation of ICS should have the least amount of disruption of existing systems and processes as possible.
- ICS should be user friendly and be applicable across a wide spectrum of emergency response and incident management disciplines.

The overwhelming majority of highway incidents do not require the formal implementation of the ICS.[9] Instead, most highway incidents involve just law enforcement or highway personnel and a tow truck. In these situations, there is usually no need for the organization and command structure of the ICS. Only when traffic incidents are large and more complex does the ICS become necessary because of the need for multiple responders from multiple agencies. In these situations, it is critical for work zone planners and construction personnel to understand what the ICS is and how emergency responders use the ICS to manage all types of incidents, not just highway traffic incidents.

The term **Unified Command (UC)** is used to define the application of ICS when there is more than one agency with incident jurisdiction or when an incident crosses political jurisdictions. In situations where an incident crosses multiple jurisdictions, or in the case where multiple agencies have jurisdiction over the same incident (for example, a wreck with injuries or

fatalities), unified command allows all agencies that have statutory authority for an incident to jointly participate in the development of the overall response strategy.

For more information on the ICS, and its application to highway incidents, the reader is encouraged to review *Simplified Guide to the Incident Command System for Transportation Professionals.* [9]

Assessing the Need for Traffic Incident Management in Work Zones

The process to be used to develop a TIM program for a particular construction or maintenance project is not unlike the process used to develop a traditional incident management program. What is different about the TIM program for a construction or maintenance program is who commonly initiates the development process – the construction project manager or the contractor. This process needs to begin at the very early planning stages of the project, oftentimes well before traditional incident responders are aware that the project is going to be let.

Work zone and construction planners need to first assess if there is a need to implement special incident management procedures with a particular work zone. Questions that transportation agencies and work zone planners should ask in determining whether or not a particular work zone project needs improved TIM responses include:[10]

- Will this project impact emergency response in this segment of highway?
- Are there access issues for responding to incidents within the work zone?
- If an incident closes the highway in one or more directions, how will traffic be re-routed?
- Are there strategies to minimize project impacts on response agencies?
- Are there strategies to minimize incident impacts on the public?
- Are there procedures that would enhance traffic incident clearance and safety?
- What equipment would improve emergency response and management during construction? Is it available? Where is it located?
- How will project personnel coordinate and assist emergency responders?

The Planning Process

Figure 2 shows steps involved in developing a TIM program for an individual construction or maintenance project deemed to be in need of special procedures and practices to mitigate the impact of traffic incidents in the work zone. Each step is discussed in detail below.

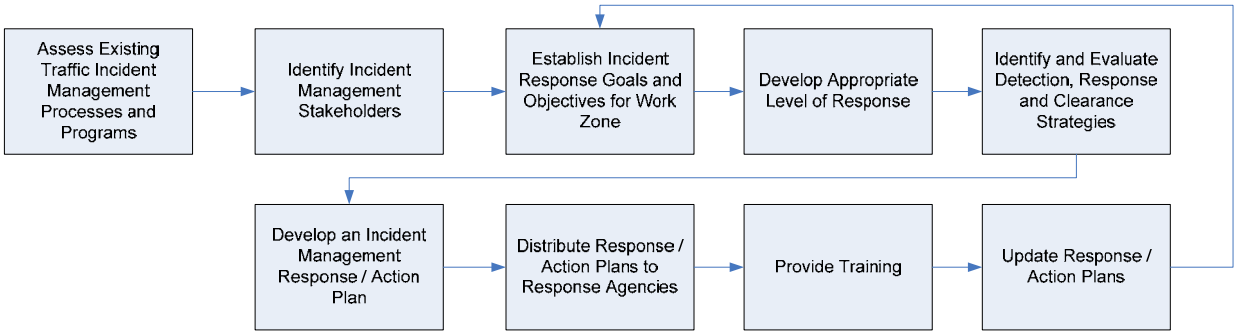

Figure 2. Process for Planning Traffic Incident Management for Highway Work Zones (Adapted from *10*)

Assessing Existing Traffic Incident Management Processes and Procedures

In many locations throughout the United States, comprehensive incident management programs and processes already exist; therefore, the first step in developing a TIM program for a specific construction or maintenance project is to determine and assess what incident management processes and procedures already exist in the area where the work zone will be in effect. In many cases, it may be wasteful and counterproductive to develop new and different response procedures. Work zone planners need to first check to see if the project lies within the boundaries and jurisdiction of any existing incident management program. If it does, work zone planners and contractors need to coordinate with appropriate response and traffic operations personnel to determine if the existing processes and procedures are adequate for the project. Together, these agencies can identify those changes, additions, and modifications to the existing procedures and responses that may be needed to accommodate the project. In the situation where existing TIM practices and procedures are already in place, at a minimum, work zone planners should contact appropriate response agencies in the corridor to discuss issues and concerns about managing incidents in the proposed work zone and agree upon the procedures and strategies that will be implemented to support TIM in the work zone. On more complex projects, it is necessary for the work zone planner, project administrators, and construction personnel to become active partners in the existing incident management program for the duration of the project. On projects with multiple phases, it may be necessary to develop a plan for each phase of the project.

Identifying Incident Management Stakeholders

If the proposed project lies outside the jurisdiction of any existing TIM program, it may be necessary for work zone planners and contractors to identify, develop, and deploy TIM strategies that are appropriate for the type and level of work zone. In most regions, multiple agencies are involved in the TIM process. At a minimum, work zone planners and contractors should meet with key incident response agencies to discuss how the project will impact TIM responses. The following is a list of potential agencies and organizations that are traditionally involved in the development of TIM programs in a region:

- Federal, state, and local transportation agencies
- State and local law enforcement personnel
- Public and volunteer fire and rescue agencies
- Regional, county, or local 911 dispatch
- Towing and recovery providers

- Emergency medical service providers
- State and local hazardous material recovery personnel
- Media, and
- Other response personnel (as defined by the project area), including state and local offices of emergency management, coroner's office, etc.

Work zone planners and contractors must be aware that multiple agencies may have jurisdiction over incident responses within the limit of a construction project. It is not uncommon for multiple police, fire and rescue, and emergency service providers to have incident management responsibilities on a given highway. Work zone planners need to make sure that all appropriate incident responders are identified for any given project.

Establishing Incident Response Goals and Objectives for the Work Zone Project

After becoming familiar with the capabilities and structure of current incident management programs that may be impacted by a work zone project, the next step in the process is to establish goals and objectives (or response targets) for the incident responders in a work zone. Goals define the desired effects of agencies in responding to incidents in the work zone while objectives define discernible (or measurable) outcomes that show how a particular goal is being met by one or more strategy.[5] Table 2 shows common goals and objectives used in determining incident management response procedures and strategies in the work zone.

Table 2. Common Goals and Objectives Used in the Planning of Work Zone Incident Management Programs

Goal	Objective
Improve work zone mobility	• Minimize detection and verification times • Minimize notification times among response agencies • Minimize the time needed to transport equipment to an incident location • Minimize incident investigation time • Minimize number of closed lanes • Minimize the length of exposure • Minimize road and lane closure times • Minimize motorist delay • Minimize traffic demand at and approaching the scene without causing severe impacts on surrounding streets • Provide data for automated incident detection • Provide temporary surveillance system for high incident locations • Improve coordination with the diversion route's traffic control system to carry increased traffic volume
Improve work zone safety	• Minimize the response time of emergency medical services • Minimize the time necessary to identify the characteristics of hazardous material cargo • Minimize traffic hazards near the incident location • Maximize the safety of responders and travelers • Exercise proper and safe on-site management of personnel and equipment • Improve personnel training for site response • Improve personnel training for response to hazardous material incidents

Goal	Objective
Efficiently and effectively use resources	• Minimize the personnel cost associated with incident management • Minimize the cost to motorists of incident related delay • Maximize the use of existing communication resources • Protect the roadway and private property from unnecessary damage during the removal process • Develop resource sharing agreements
Improve inter-agency cooperation	• Maximize understanding of agency perspectives and responsibilities • Maximize information sharing among agencies • Maximize coordination between response and transportation agencies • Establish inter-agency field communications • Employ advanced communication technologies among agencies • Develop administrative coordination among agencies • Form consensus among agencies
Improve public perception	• Educate drivers to improve their reactions to traffic incidents • Provide timely, accurate information to the public that enables them to make informed decisions • Provide motorists with information about the cause of their delay to minimize their level of frustration with the road system • Adequately inform motorists of the location and scope of incidents • Improve the public image of the response agencies • Foster wide dissemination of real-time traffic information

Source: Guidebook on Incident Management Planning in Work Zones[5]

It should be noted that different stakeholders involved in the project may have different goals and objectives. For example, the prime contractor may want to limit costs so as to maximize profits. The agency project manager may desire to complete the project on-time and within budget while avoiding major cost overruns or change orders. Incident responders may want to minimize their response times while ensuring responder safety. Traffic operators may want to minimize the amount of disruption to normal traffic flow. Oftentimes, the goals and objectives of individual agencies conflict with one another. It is imperative that all agencies responsible for responding to incidents within the limits of the area impacted by the construction project be involved in setting the goals and objectives and in determining which strategies are best for responding to an incident in the work zone. Keep in mind that effects of the construction project on traffic operations may extend well beyond the actual limits of the construction project.

Determining Appropriate Levels of Response

Agencies have at their disposal a large number of strategies, technologies, techniques, and procedures for providing incident management in work zones; however, not all are appropriate for every work zone situation or incident scenario. Each strategy, technology, and procedure needs to be evaluated within the context of project needs and duration, the infrastructure requirements, the level of cooperation and coordination between incident responders, and the costs and perceived effectiveness of the strategy. Some strategies are needed to provide a solid foundation for other strategies, while other strategies are more appropriate when the work zone project is expected to impact traffic operation for extended periods (years, for example). Agencies need to carefully evaluate each strategy and incident scenario and determine the appropriate level of response for each type of incident. Agencies also need a realistic assessment of the likelihood that an incident of major severity may occur when the work zone is in effect.

Agencies need to keep in mind that all incident situations are not the same and that not all incidents require or mandate the same level of response. Recognizing this fact, the *Manual on Uniform Traffic Control Devices* [11] divides incidents into three general classes based on duration, each of which has unique traffic control characteristics and needs. These classes are as follows:

- Major – typically traffic incidents involving hazardous materials, fatal traffic crashes involving numerous vehicles, and other natural or man-made disasters. These traffic incidents typically involve closing all or part of a roadway facility for a period exceeding 2 hours.
- Intermediate – typically affect travel lanes for a time period of 30 minutes to 2 hours, and usually require traffic control on the scene to divert road users past the blockage. Full roadway closures might be needed for short periods during traffic incident clearance to allow traffic incident responders to accomplish their tasks.
- Minor – typically disabled vehicles and minor crashes that result in lane closures of less than 30 minutes. On-scene responders are typically law enforcement and towing companies, and occasionally highway agency service patrol vehicles. Diversion of traffic into other lanes is often not needed or is needed only briefly. It is not generally possible or practical to set up a lane closure with traffic control devices for a minor traffic incident. Traffic control is the responsibility of on-scene responders.

Agencies can use these general criteria for classifying incident levels as a beginning point for determining appropriate levels of responses. However, these criteria should be refined to be consistent with agency goals and objectives.

One underlying principle of the ICS is that it allows responses to be scaled to the level that is appropriate for the situation and existing conditions. An initial small response can be transitioned to a large, multi-agency operation with only minimal adjustment for the agencies involved.[9] ICS provides a structure that allows responses to expand and adapt the real-time conditions that exist in the field.

Identifying and Evaluating Detection, Response, and Clearance Strategies

Once the appropriate level of response has been determined for the work zone, the next step in the process is to identify and evaluate candidate strategies for detecting, responding to, and clearing incidents from the roadway. Chapter 5 lists a number of strategies commonly used by agencies to improve incident detection, enhance responses, and promote rapid clearance of incidents in work zones. Advantages and disadvantages of each strategy have been provided along with reference information to determine more details about strategies.

In determining which incident management strategy is appropriate for a particular work zone, agencies may want to consider the following:[2]

- Facility type (freeway, highway)
- Area type (urban, rural)
- Project length

- Project duration
- Multiple construction stages/phases
- Traffic volume
- Capacity reductions
- Expected delays
- Crash rates
- Percentage of trucks
- Available detour route(s)
- Available alternative travel modes
- Community factors (public exposure, business impacts, and residential impacts)

It is also critical that agencies examine how incidents will be managed during all phases of the construction project. Agencies need to assess how changes in access restrictions, capacity reductions, and lane management techniques (such as shoulder usage) impact each strategy.

Developing an Incident Management Response/Action Plans

After determining which strategies are appropriate for a particular work zone, agencies then need to develop criteria and conditions for when and how these responses should be executed. This is typically called a response or action plan. The response or action plan lays out the conditions and criteria for what types of responses are needed for different levels of incidents that might occur in the work zone.

Table 3 shows an example of a response plan developed by the Colorado Department of Transportation for the T-REX construction project in Denver.[12] The T-Rex construction project was a multiple year effort to reconstruct Denver's I-25/I-225 Southeast Corridor and to extend the region's light rail system. As shown in Table 3, different response actions have been defined for each level of incident. The incident levels are defined based on the extent and duration of the anticipated impacts on traffic operations on the roadway. The levels are not intended to be hard and fast “thresholds” for defining incident responses, but are intended to provide responders with an initial assessment of the type and magnitude of response that might be needed to manage the incident.

Table 3. Example of Recommended Incident Response Plan Used in the T-REX Construction Project by the Colorado Department of Transportation

Level	Impact to Roadway	Action to be Taken
1	Impact to traveled roadway estimated to be less than 30 minutes with no lane blockage. Or – Impact to traveled roadway is estimated to be less than 30 minutes with lane blockages	• Follow agency protocols • Contact the CDOT Traffic Operation Center (TOC) **TOC Action:** • Contact CDOT Region 6 Maintenance Supervisor • Consider activating selected variable message signs (VMS)
2	Impact to traveled roadway estimated to be greater than 30 minutes, but less than 2 hours with lane blockages, but not a full closure of the roadway	• Establish Incident Command • Consider designating staging areas • Contact the CDOT TOC **TOC Action:** • Consider implementing alternate routes • Update CDOT and T-REX Web sites • Activate highway advisory radio (HAR)and signs • Place messages on dynamic message signs (DMS) • Consider activating the following VMS: *[List of VMS devices to be activated]* • Fax out advisories to Level 2 contacts • Contact the following: *[List of responders to be activated]*
3	Congestive impact to traveled roadway is estimated to be greater than 2 hours or roadway is fully closed in any direction.	• Establish Command Center or Post • Coordinate with CDOT to implement alternative routes • Consider designating staging areas • Contact CDOT TOC **TOC Action:** • Update CDOT and T-REX Web sites • Activate HAR and signs • Place messages on DMSs • Consider activating VMS: *[List of VMS devices to be activated]* • Fax out advisories to Level 2 and Level 3 contacts • Request METS broadcast notification – update to emsystem.com • Contact the following: *[List of responders to be activated]* • Contact signal jurisdictions on alternate routes.

As part of developing a response or action plan, agencies may also want to develop procedural guidelines for how and when a certain response or incident management function should be performed in a work zone. The following lists topics where procedural guidelines may be needed for incidents that occur in work zones:

- Notifying other incident responders
- Managing the scene
- Moving damaged or disabled vehicles
- Closing and openings lanes

- Implementing alternative routes
- Using emergency flashing lights
- Parking and staging of response apparatus
- Disseminating information to travelers and the media

Distributing the Response/Action Plans to Response Agencies

Once the response plans have been developed, the next step in the process is to distribute the response plans to the appropriate response agencies. Because the response plans are usually developed in cooperation and collaboration with emergency responders, dissemination of the plan to the incident responders often occurs naturally, but it is important for traffic operators to ensure that the response/action plan is disseminated to the appropriate response and field personnel. As part of the plan development process, stakeholders should also discuss methods and procedures for distributing and disseminating the response plan to appropriate personnel within their organization—both at the administrative and field personnel levels.

Providing Training

Training is often an overlooked, but important aspect of developing and implementing a TIM plan for work zones. Most incident responders are well versed on how to respond to incidents during normal operations; however, very few responders have experience responding to an incident and establishing lane closures inside the constraints of a work zone. Transportation agencies should work with local incident responders to develop field exercises that allow responders to become familiar with the issues and constraints associated with working in a work zone environment.

In addition to field exercises, transportation agencies and incident responders should also get together prior to the beginning of the actual work activities to ensure that response procedures are practical and appropriate. Agencies should not assume that just because a response or action plan is in place, it works flawlessly the first time it is needed. It is essential that procedural guidelines, such as notification procedures, be exercised prior to the beginning of the construction project so that rough spots or limitations in the processes are identified and corrected prior to the construct project actually beginning.

Public education is also another critical training function that needs to occur prior to the actual groundbreaking of a construction project. Agencies need to develop a comprehensive public education program that informs the public of what is being done to address traffic issues associated with the project. If “Move-it” laws or quick clearance policies are being implemented for the first time in association with a construction project, the public needs to be educated about what these laws mean and why they are important. If these laws already exist, agencies may want to consider implementing a public education program that reminds the traveling public that these laws exist and are critical to the success of the construction program.

Updating the Incident Management Response/Action Plans

A critical aspect of planning for TIM in work zones is ensuring that emergency response procedures and practices remain valid through all phases of construction. Agencies should also plan to meet routinely to ensure that the important elements of the plan remain valid and up-to-date. On large construction projects, incident responders, transportation agencies, and

construction personnel should meet routinely through the life the project to review actual responses to incidents that have occurred during the project and update response and communication plans as needed. Response plans often need to be updated and/or revised as conditions, lane closures, and access to the work zone changes. It is essential that incident responders be notified when new conditions might impact response times or access to the site.

Furthermore, response plans may need to be revised based on feedback from the public, agency decision-makers, and field personnel. If any part of the response plan or program is revised, it is critical that all responding agencies receive notification of how the established response procedure or access needs have changed. Likewise, incidents that damage the pavement or other infrastructure within the work zone need to be communicated to work zone traffic planners as these may impact or change the construction sequences in the work zone. Good two-way communication between incident responders and construction personnel is critical.

4.0 PRE-CONSTRUCTION STRATEGIES AND ACTIVITIES

Incorporating incident management strategies and techniques needs to occur in the very initial preparation and design stages of the work zone project. This section highlights some of the strategies and activities that work zone planners and incident managers can perform during the initial planning stages of a construction or maintenance project.

Role of the Contractor/Construction Personnel in Work Zone Incident Management

One of the first issues that must be dealt with in determining which type of incident management to include in a work zone transportation management plan (TMP) is the issue of the particular role the contractor or construction personnel should play in managing incidents in work zones. In some cases, the contractor may be responsible for providing clearance functions of minor incidents. In other cases, the contractor may be required to purchase and install equipment and systems to support detection and clearance functions. Changes in the construction phasing may be required to better facilitate incident responders. Whatever role the contractor is to play, it must be clearly spelled out in the development of the plans, specifications and estimates (PS&Es) for the project.

Contractors and construction personnel should never be asked to perform investigatory functions associated with clearing incidents. At a minimum, contractors and construction personnel should be briefed on the procedures for the types of information to include when reporting incidents that occur in the work zone. These procedures should be clearly defined and construction personnel should receive adequate training on the information that is needed by incident managers to respond to different types of incidents.

In some situations, on-scene construction personnel may be asked or directed to provide assistance with establishing traffic control, or providing on-site scene management. Furthermore, contractors and construction personnel may also be asked to post incident-related messages on portable dynamic message signs (DMS) intended to provide work-zone related messages. At a minimum, construction personnel and incident responders should discuss potential uses of construction-related traffic control devices and traveler information systems for incident management purposes; and all agencies need to understand when and where it is appropriate to modify an established TMP in response to an incident. Private contractors should be made fully aware of the liability issues associated with using their equipment or personnel to assist in managing incidents in the work zone.

For larger construction projects, contractors may be required to provide specified incident management functions (such as providing courtesy patrol, implementing wrecker contracts, installing incident detection and surveillance equipment, etc.) as part of the transportation operation element of the TMP for the work zone. The work zone regulations require agencies to provide appropriate pay item provisions for implementing the TMPs (which may include contractor provided traffic incident management [TIM] functions), either through method or performance-based specifications.[2]

Institutional Arrangement and Agreements

Incident management is a cooperative and collaborative effort between multiple agencies and entities. Successful incident management programs have a solid foundation of trust between incident responders. Participants in the process know and understand their roles and responsibilities.

One of the first things that must occur after work zone planners and incident responders have agreed upon the types of strategies to be deployed in a work zone is to examine what, if any, new or existing agreements, policies, or laws need to be enacted or modified to ensure that they are applicable to a particular work zone situation. In most cases, modifying existing policies and laws can require extensive lead time and effort to accomplish. For example, many agencies rely upon “move-it” laws or quick clearance policies to ensure the rapid removal of minor crashes and debris from overturned vehicles. In some cases, agencies may need to work with state and local legislators to establish “move-it” laws or quick clearance policies. In other cases, existing legislation may need to be amended so it can be extended to work zone application. Work zone planners need to check with local incident management providers to determine which type of agreement already exists in an area, and what needs to be done to strengthen or adapt these policies to a specific work zone situation.

Another potential agreement, which might be helpful to incident managers and responders in managing incidents in work zones, is a mutual aid agreement. Mutual aid agreements are common between fire and emergency medical responders. These agreements permit these responders to provide emergency assistance to each other in the event of disasters or emergencies (*Mutual Aid Agreements for Public Assistance and Fire Management Assistance (*Available at http://www.fema.gov/government/grant/pa/9523_6.shtm*)*.[13] Similar types of agreements can be used to allow other governmental agencies to provide incident management functions outside their own jurisdictions.

Coordination with Existing Incident Management Programs

As discussed previously, many agencies and locations have already established protocols and procedures for responding to incidents. These may be formally adopted procedures that are documented in a TIM plan or may be informal, common practices that have developed over time. Work zone planners should not try to re-invent TIM, but instead work with incident managers to identify, incorporate, or supplement the special needs of a particular work zone project in the existing TIM program. For example, as part of the Big I Interchange Reconstruction, the New Mexico State Highway and Transportation Department (NMSHTD) purchased two additional courtesy patrol vehicles (or HELP vehicles) using construction funds and then allowed the contractor (with a no-cost lease) to use this vehicle to move a disabled vehicle from the work zone during weekday, daytime periods. At the end of the construction period, the vehicles were turned back over to NMSHTD for continued use in their existing incident management program.[14]

Another important existing incident management asset that work zone planners should consider when planning a work zone is keeping existing incident detection and surveillance technologies operating as long as possible. For incident managers and traffic operators, it is important to keep this technology operating as it is often their “eyes” for assessing the operation of the roadway. Incident managers and traffic operators frequently use traffic detection and video surveillance technologies to detect when and where incidents occur and

to assist them in dispatching resources and managing traffic during incidents. This technology can be a valuable asset when managing incidents in work zones as well. Work zone planners and operators need to work together to develop strategies to keep this equipment operating and maintained throughout the construction project (through the use of temporary devices or communications systems).

Existing incident management capabilities can be expanded as part of a construction project. Common methods used to promote expansion of exiting traffic management capabilities are including communication conduits and constructing device or cabinet foundations. In other cases, actual surveillance and control technologies can be designed and installed as part of a construction project. Again, the Big I Reconstruction project serves as an example of how a construction project was used to expand the incident management capabilities of an agency. In this project, NMSHTD used a design contractor with construction oversight to design and implement an intelligent transportation system (ITS) network as part of the work zone. The contract called for the purchase and installation of all components of the ITS network as a lump sum purchase. Through a subcontractor, the system hardware and software components were implemented as part of the construction project. To utilize the system while construction was still ongoing, temporary wireless communications were established to the devices in the work zone. NMSHTD employees then used the system to detect and manage incidents in the Big I work zone.[14]

Alternate Route Planning

Another important pre-construction activity that work zone planners and incident responders need to do is decide how to detour traffic to an alternate route when a major incident occurs in the work zone. Diverting traffic to a parallel roadway specified in a carefully planned alternate route plan is an effective, temporary response that can be used to mitigate the effects of incidents on roadways. Since it is common practice to provide alternate route information as part of the normal work zone TMP, work zone planners and incident managers must work together to determine appropriate alternate routes which can be used to manage work zone traffic during an incident condition. To compound the problem of establishing incident-related alternate routes in a work zone, planners need to consider not only what to do when an incident occurs on the roadway that is under construction, they also need to consider what to do when an incident occurs on a detour route that has been established as part of the work zone TMP.

The *Alternate Route Handbook*[15] suggests that the following factors be considered when selecting alternate routes:

- Proximity of alternate route to closed roadway,
- Ease of access to/from alternate route,
- Safety of motorists on alternate route,
- Height, weight, width, and turning restrictions on alternate route,
- Number of travel lanes/capacity of alternate route,
- Congestion induced on alternate route,
- Traffic conditions on alternate route,

- Number of signalized intersections, stops signs, and unprotected left turns on alternate routes,
- Travel time on alternate route,
- Pavement conditions on alternate route,
- Type and intensity of residential development on alternate route,
- Existence of schools and hospitals on alternate route,
- Percentage of heavy vehicles (e.g., trucks, buses, RVs, etc.) on route form which traffic is to be diverted,
- Grades on alternate route,
- Type and intensity of commercial development on alternate route,
- Availability of fuel, rest stops, and food facilities along alternate route,
- Noise pollution,
- Transit bus accommodation,
- Air quality,
- Ability to control timing of traffic signals on alternate route,
- Ownership of road,
- Availability of ITS surveillance equipment on alternate route, and
- Availability of ITS information dissemination equipment (such as DMSs, and HAR) on alternate route.

In planning alternate routes, work zone planners and incident responders should realize that the suitability of selected alternate routes may change over time. Work zone planners and incident responders should meet prior to each stage of construction to review and revise the alternate routes plans.

In addition to identifying and selecting candidate alternate routes that can be used to manage work zone traffic during an incident, agencies also need to develop guidelines and criteria that define when traffic should be diverted to an alternate route in response to a work zone incident. The *Alternate Route Handbook*[15] recommends that the following factors be considered when developing guidelines for when to establish alternative routes:

- Anticipated duration of the incident,
- Number of lanes blocked by the incident,
- Observed traffic conditions, both on the roadway where the incident exist and on the alternate route,
- Time-of-day and day-of-week when the incident occurred,
- Capacity of the proposed alternate route,

- Resources (in terms of personnel, equipment, and traffic control) needed to establish the alternate route, and
- Time required to deploy those resources.

Figure 3 shows the criteria developed by the Colorado Department of Transportation for determining when to establish an alternate route in response to an incident during the T-REX construction project.

When to Establish an Alternate Route

- The use of alternate routes should only be considered when there is full closure of the interstate in either direction or when the Incident Commander deems it necessary for the safety of the traveling public and responders.
- In addition, consideration must be given to the extent the roadway or structural damage, and the extent of bodily injury or fatalities.
- The final determination to use alternate routes will be made by the Incident Commander based on observation of the scene.
- Remember to contact the *CDOT TOC when lanes are reopened* to traffic.

Figure 3. Sample Criteria for Determining When to Use Alternate Routes in Response to an Incident[12]

Work zone planners and incident managers also need to agree to the processes and procedures for implementing alternate route plans during each phase of construction. Incident mangers need to keep in mind that an alternative route or detour route may already be established for the work zone and that the availability of alternate routes may be limited. Furthermore, motorists traveling in a work zone may already be confronted with complex signing associated with the work zone. The potential exists to overload motorists with too much (and potentially conflicting) information when establishing an alternative route for an incident in a work zone. Work zone planners and incident responders should work together to develop step-by-step procedures on how to establish an agreed upon alternate route plan in response to an incident in a work zone, including the following:

- Procedures and contact information for notifying a stakeholder when implementing an alternate route,
- Procedures for transitioning traffic signal timings and other active traffic control devices along the alternate route,
- Procedures for deploying signing, law enforcement personnel, and other traffic control devices along the alternate route, and
- Candidate messages to be deployed on traveler information devices (e.g., DMSs, HARs, Web pages, etc.) during the incident conditions.

Agreements may also be needed that allow agencies for one jurisdiction to deploy resources in another agency's jurisdiction.

Work zone planners and incident managers also need to reach consensus on criteria and procedures for discontinuing an alternate route and removing the deployed traffic control from the detour route. The criteria need to clearly define which stakeholders have the authority to make the decision to discontinue the use of the alternate route and under what circumstances they can make that decision. Guidelines should be developed that provide

step-by-step instructions for removing deployed signing and returning active traffic control devices, such as the traffic signals, to normal operations.

Training

Training of both incident responders and construction personnel is another key element that needs to be addressed early in the construction planning process. This training can be as simple as including a review of developed incident management manuals and guidelines during regularly scheduled training or safety briefings; or as complex as instructor-led training courses which could potentially include field and tabletop exercises. This training should be geared toward incident responders as well as construction and maintenance personnel. It is essential that all personnel, both incident responders and construction personnel, are fully aware of the policies, procedures, and practices that have been implemented for a construction project.

During the project planning stages, it may be helpful to provide work zone planners and project designers with basic training related to incident management concepts and principles so that key incident management amenities (such as accident investigation sites, site access improvements, emergency staging areas, etc.) can be incorporated in the PS&E development process.

On-site construction personnel also need to be provided with training related to proper techniques and procedures to use for securing an incident scene and should be well briefed on the agreements made between incident responder and project planners on how incidents will be managed in the construction zone. If construction personnel are to be used to assist in providing basic incident management functions (such as providing motorist assistance, establishing incident traffic control, etc.), then they need to be provided adequate training on how to perform these functions. Depending upon the type of incident management strategies to be deployed in a work zone, construction personnel should receive specific project-related training on the following incident management practices:[10]

- Notification procedures and incident reporting
- Emergency traffic control
- Moving damaged or disabled vehicles.
- Implementing alternate routes
- Procedures and policies relating to media contacts

Incident response personnel also need to be provided with specialized training for handling projects in work zones. This training should be tailored to the specific strategies that will be deployed as part of the TIM program developed for the project. Furthermore, it is critical that response personnel are aware of any agreements that have been made with construction personnel or other incident responders during the development of the incident management plan. Consideration should be given to providing incident responders with project-specific training on the following:[10]

- Response manual policies and procedures
- Use of emergency flashers

- Apparatus parking and staging
- Implementation of alternate routes
- Communications procedures with other incident management providers
- Vehicle removal policies and procedures
- Procedures for working with the media

Information Sharing

Information sharing is another critical issue that needs to be addressed during the early phases of a construction planning process. Information is vital to providing an effective incident response. With better information, incident response is improved by ensuring that the proper equipment and resources are available to the responders at the time when it is needed on-scene. Better information allows travelers to make better decisions regarding departure time, mode choice, and route to take. As part of the initial planning phase of a project, work zone planners and incident managers should develop strategies to improve information sharing within and between response agencies, with the media, and to the public as a whole.

Within and Between Response Agencies

Interagency communication is critical to achieving effective on-scene management of traffic incidents. Issues with intra- and interagency communications become more critical when the incident response is complex or spread out over a large area. Strategies used to improve interagency communication include the following:

- Conducting incident management preparedness training exercises,
- Adopting common communications and data transmission standards,
- Adopting and using Incident Command System (ICS) practices to manage traffic incidents,
- Establishing electronic paging or an email alert system for notifying incident responders,
- Developing a matrix of radio frequencies used be on-scene incident responders.

Figure 4 shows the radio frequency matrix developed by the Colorado Department of Transportation for the T-REX construction project.

Channel	Agency																			
	Arap. Cty Road & Bridge	Arap. Cty Sheriff	Aurora Fire	Aurora Police	Aurora Public Works	Castle Rock Fire	CDOT TOC	CDOT Region 6	CSP	Cunningham Fire	Denver Fire	Denver Paramedics	Denver Police	Denver Public Works	Doug. Cty Road & Bridge	Doug. Cty. Sheriff	Greenwood Village Police	Parker Fire	Skyline Fire	South Metro Fire
ASCO 1	X	X							X	X						X	X		X	X
ASCO EOC	X	X							X	X							X		X	X
CSP1									X							X				
CSP 2									X							X				
CDOT Traffic 1		X	X	X			X	X	X	X	X		X			X	X			X
CDOT Traffic 2		X	X	X			X	X	X	X	X		X			X	X			X
CLEER		X	X	X						X	X		X				X			
DCSO A										X						X	X			
DCSO B										X						X	X	X		
DCSO C																X	X	X		
DEC		X				X			X	X					X	X	X	X	X	X
DISP 1		X				X				X						X	X	X	X	X
FERN		X	X	X		X			X	X	X	X				X	X	X	X	X
GVPD 1		X								X							X		X	X
ICALL	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
ITAC 1	X	X	X	X		X	X	X	X	X	X	X	X		X	X	X	X	X	X
ITAC 2	X	X	X	X		X	X	X	X	X	X	X	X		X	X	X	X	X	X
ITAC 3	X	X	X	X		X	X	X	X	X	X	X	X		X	X	X	X	X	X
ITAC 4	X	X	X	X		X	X	X	X	X	X	X	X		X	X	X	X	X	X
MAC 1		X				X		X	X	X	X		X	X	X	X	X	X	X	X
MAC 2		X				X		X	X	X	X		X	X	X	X	X	X	X	X
MAC 3		X				X		X	X	X	X		X	X	X	X	X	X	X	X
SNOW			X	X	X															
STAC 5	X	X				X			X	X					X	X	X	X	X	X

Figure 4. Example Radio Frequency Matrix for Incident Responders [12]

Public Education and Outreach

Most large construction projects utilize Web sites, press releases, and/or newsletters to provide the public with information about planned construction and project phasing activities. These outreach efforts can also be utilized to educate the public about the incident management procedures that are also associated with a construction project. Information about motorist assistance or courtesy patrols, “move it,” or quick clearance policies can all be disseminated using outreach efforts. Past experience has shown that the use of public education campaigns, press releases, and signs in the work zone greatly enhance compliance with “move-it” laws and accident alerts.[10]

Procedures for Working with Media

The media can also be considered a partner in disseminating information about incidents and incident management procedures and policies in work zones. Incident responders need to develop procedures and practices for working with the media during incident conditions. The media can be a fast and reliable means of disseminating information about incident conditions and travel alternatives to the traveling public. The media can also serve as an outlet for disseminating information about incident management procedures deployed as part

of the construction activities. Media packets which describe the project and steps that agencies are taking to minimize the impacts of incidents on traffic operations can be a valuable asset to local media providers. Media packets can be used to disseminate information about who the media can contact in the event that an incident occurs in the work zone, maps showing potential staging areas designated for the media, and maps showing how traffic is being detoured in response to major road closures. Other information that can be distributed to the public via the media includes the following:[10]

- How to report an incident to 911,
- Where to go to obtain traffic information during an incident condition, and
- What are “move-it” laws and how do they apply to drivers.

Liability and Legal Issues

In some jurisdictions, incident responders are often hesitant to take actions to quickly clear and remove vehicles and debris from the roadway because of liability concerns over additional damages to vehicles or the losses of cargo and other personal property inside the vehicle. To reduce these concerns, many states have enacted “hold harmless” laws that permit incident responders to quickly clear incidents. These laws give incident responders immunity from civil liability in connection with removing vehicles and cargo involved in a traffic incident and obstructing adjacent traffic flow. According to a recent National Cooperative Highway Research Program Synthesis[16], three types of hold harmless laws pertain to the removal of traffic incidents.

The first type of law applies to drivers or other individuals who remove a vehicle involved in a crash (commonly referred to as “Move-It” laws). This law states that drivers or any other individual who move a vehicle involved in a crash are not liable or at fault with regard to the cause of the crash. The second type of hold harmless law protects incident responders who are fulfilling the requirements set forth in authority removal laws or authority tow laws. This law is designed to protect law enforcement, state departments of transportation (DOTs), and others from incurring liability in connection with damages resulting from the removal of disabled or wrecked vehicles and cargo that creates obstructions or hazards to normal flow of traffic. The final type of hold harmless law provides immunity to incident responders from any potential liability incurred by NOT executing the requirement of a quick clearance law. In these cases, agencies may not be held responsible for any damages or claims that may result from not clearing the incidents from the roadway. This is important for those situations where a detailed investigation may be required or other special extenuating circumstances may exist

Before requiring the contractor to implement any type of incident management, work zone planners and incident responders should examine the types of hold harmless laws that are present in their state or jurisdiction and determine whether or not the contractor, if required to perform these functions, is also covered by these provisions. It may be necessary to amend or expand these protections to work zone personnel who are required or contracted to perform these services.

5.0 INCIDENT MANAGEMENT STRATEGIES AND TECHNIQUES FOR USE IN WORK ZONES

Many strategies and techniques exist for improving incident management in work zones. These strategies are all designed to reduce the severity of the capacity reduction, reduce the duration of the incident, or reduce the amount of traffic wanting to use the facility in and around the incident scene. This section briefly describes various incident management strategies and techniques that can be deployed in work zones. The strategies and techniques are grouped according to the following categories:

- Strategies and Techniques for Improving Incident Detection in Work Zones
- Strategies and Techniques for Improving Incident Response
- Strategies and Techniques for Improving Incident Clearance
- Strategies and Techniques for Improving Incident Site Management
- Strategies and Techniques for Improving Incident Information Dissemination

This section is intended to be a reference for work zone planners, traffic operators, and incident responders in developing or improving incident management in their own specific work zones. Many of the strategies and techniques are the same techniques that are commonly used in incident management programs outside of work zones. Agencies should review the strategies and techniques shown in Table 4 through Table 9 to get an idea of options that can be deployed in their area. The tables provide a brief description of the strategy or technique and list some of the advantages and disadvantages associated with each. Each strategy and technique also provides a listing of online references which can be accessed to obtain more detailed information about when, where, why, and how the strategy can be deployed. With the information, work zone planners, traffic operations, and incident responders can devise an incident management program that fits the specifics of their own individual work zones.

Strategies and Techniques for Improving Incident Detection in Work Zones

Incident detection is the process by which incidents are brought to the attention of the agencies responsible for clearing incidents from travel lanes.[17] Table 4 lists some of the common strategies that incident managers use to improve the time require to detect and clear an incident. All of these strategies are applicable to work zones.

Table 4. Strategies and Techniques for Improving Incident Clearance in Work Zones

Strategies	Description	Pros	Cons	For More Information
Roving Courtesy / Service Patrols	This strategy involves the use of specially equipped vehicle to provide emergency repairs and rapid clearance of stalled or disabled vehicles from the roadway. Vehicles can be either pre-positioned at strategic locations or rove in traffic stream.	• Permits rapid detection and clearance of minor incidents • Provides assistance and minor repairs for stalled/disabled vehicles • Provides positive public relations image for agency • Can provide traffic control for emergency responders • Service can be contracted to private provider	• When patrol is busy with event, it cannot rapidly respond to secondary incident that may occur • Requires specially equipped vehicles • Operators may require special training and certification • Congestion in work zone may prevent patrol from rapidly reaching incident	• *Intelligent Transportation Systems in Work Zones: A Case Study (1)* • *Freeway Service Patrols: About FSP (2)* • *Benefits Analysis for the Georgia Department of Transportation NaviGAtor Program: Final Report (3)*
Closed-Circuit Television / Video Surveillance Cameras	This strategy involves the use of closed-circuit television or video surveillance cameras to assist in rapid detection and verification of incident location and severity through visual inspections. Cameras are generally installed on poles adjacent to the roadway and images are sent to a TMC. Operators in the TMC can use pan, tilt, and zoom features to observe different aspects of the incident.	• Allows visual detection and confirmation of incident location and severity prior to initiating response • Allows assessment of impacts of incidents on traffic operations • Allows operators in control center to adjust operational strategies as incident conditions change • Support infrastructure (conduit, poles, foundations, etc.) can be installed as part of construction process	• Requires an individual to monitor video surveillance cameras, usually at a traffic management center • Cameras and communications infrastructure may need to be relocated as construction phasing progresses • Requires special technical skills to keep camera and communications system operational • Can be costly to install and maintain during life of construction project.	• *Intelligent Transportation Systems in Work Zones: A Case Study (1)* • Vehicle Detector Clearinghouse *(4)*
Stationary Observers	This involves the use of specially trained spotters or observers who can provide information about incident locations via radio or cell phone to TMC or other emergency dispatch center.	• Volunteers can be used as observers • Observers can be relocated as construction phasing progresses	• Must contact someone else to initiate clearance functions • Volunteer may not always be dependable • May require special agency personnel to manage observers	• *Guidelines for Traffic Incident Management in Work Zones (5)* • *Traffic Incident Management Handbook (6)*
Aerial Surveillance	This strategy involves the use of fixed-winged aircraft or helicopters to detect and verify incident locations. Observer in aircraft generally reports locations to TMC	• Service can be provided by private entity (such as a traffic reporting service)	• Extremely costly to provide continued surveillance • Surveillance may not be possible due to poor weather conditions or at night	• *Guidelines for Traffic Incident Management in Work Zones (5)* • *Traffic Incident Management Handbook (6)*
Traveler Call-in / Reporting Numbers	This strategy involves establishing a special telephone call-in number that motorists can use to report traffic incidents. Generally, requires a toll-free number	• Can be incorporated as part of construction related information dissemination / 511 system • Allows motorists to communicate directly with highway agency • Can be contracted to private entity	• Most motorist are likely to use E911 services to report incidents • Motorists may have difficulty remembering special call-in number • May require specially trained call takers	• *Guidelines for Traffic Incident Management in Work Zones (5)* • *Traffic Incident Management Handbook (6)*

Strategies	Description	Pros	Cons	For More Information
ITS Traffic Sensors	This strategy involves the use of traditional traffic detection and sensing technologies (such a loop detectors, radar detectors, video image detection system, etc.) to monitor traffic flow characteristics. Usually requires the use of automatic detection algorithms to locate incidents	• Transportation operators generally familiar with technology and techniques • Sensors can remain in place after construction has ended	• Detection algorithms prone to high false alarm rates and slow detection times, especially in highly congested locations • Sensors may need to be pre-positioned or retuned when different lane closures required • Requires TMC/Traffic Operations Center (TOC)	• FHWA's *Traffic Detector Handbook (7,8)*
Agency or Transit Probe Vehicles	This strategy involves the use of public and/or private agency personnel that routinely travel through construction area to report incident locations. This could include transit and motor carriers, fleet operators, public work crews, taxicabs, etc.	• Operators generally know importance of rapid reporting of incident location	• Depends on willingness of vehicle operator to report incident • Operators must know who to contact and what information to report about incident	• FHWA's *Freeway Management and Operation Handbook* (*9*)
Improved Milepost Markers / Location Referencing System	This strategy involves improving or augmenting the traditional milepost marking system to allow incident response personnel and citizens more accurate information. This can be accomplished by spacing markers more closely (e.g. tenth of a mile on freeways) or improving visibility of markers (e.g., oversizing).	• Improves communication between citizens and response personnel • Relatively inexpensive • Provides motorists with location information for getting help quickly • Helpful in managing traffic records and subsequent analysis	• May be difficult to keep signs visible /clean during construction activities • Signs subject to damage during construction activity	• *Guidelines for Traffic Incident Management in Work Zones (5)* • *Guidebook on Incident Management Planning in Work Zones* (*10*)

Online Resources:

1. *Intelligent Transportation Systems in Work Zones: A Case Study.* Available at http://www.itsdocs.fhwa.dot.gov//JPODOCS/REPTS_TE//13600.html
2. *Freeway Service Patrols: About FSP* Available at http://www.metro.net/projects_programs/fsp/about_fsp.htm
3. *Benefits Analysis for the Georgia Department of Transportation NaviGAtor Program: Final Report. Available at* http://www.itsbenefits.its.dot.gov/its/benecost.nsf/ID/D8FFBF887F1DF9028525733A006D5A4E?OpenDocument&Query=BApp
4. http://www.nmsu.edu/~traffic/
5. *Guidelines for Developing Traffic Incident Management Plans for Work Zones.* Available at http://www.dot.state.co.us/Traffic_Manuals_Guidelines/incident_management_guidelines/incident_management_guidelines_20030919.pdf
6. *Traffic Incident Management Handbook. November 2000.* Available at http://www.iacptechnology.org/IncidentManagement/TrafficIncidentMgmtHandbook.pdf
7. *Traffic Detector Handbook: Third Edition–Volume I.* Report No. FHWA-HRT-06-108. Federal Highway Administration. October 2006. Available at http://www.tfhrc.gov/its/pubs/06108
8. *Traffic Detector Handbook: Third Edition–Volume II*. Report No. FHWA-HRT-06-139. Federal Highway Administration. October 2006. Available at http://www.tfhrc.gov/its/pubs/06139/
9. *Freeway Management and Operations Handbook*. Report No. FHWA-OP-04-003. Federal Highway Administration. 2004. Available at http://ops.fhwa.dot.gov/freewaymgmt/publications/frwy_mgmt_handbook/
10. *Guidebook on Incident Management Planning in Work Zones.* Available at http://www.ctre.iastate.edu/smartwz/reports/swzdi-2005-horowitz-guidebook-incident-mgmt.pdf

Strategies and Techniques for Improving Incident Response

Table 5 lists some of the strategies and techniques that work zone planners and incident responders can employ to improve incident responses within work zones.

Table 5. Strategies and Techniques for Improving Incident Response in Work Zones

Strategies and Techniques	Description	Pros	Cons	For More Information
Dedicated Response Vehicles / Service Patrol	This strategy can use specially equipped vehicles or courtesy / service patrols to respond to and clear incidents. This can be roving vehicles or prepositioned vehicles. These vehicles should be dedicated to providing assistance in the work zone area only.	• Vehicles can be prepositioned in corridor near high incident locations • Services can be provided by contractor or state/local agency	• Service patrol dedicated to construction project may not be able to respond to incident outside project boundaries • Agency asset may sit idle for extended periods of time	• CDOT's *TREX Incident Response Manual* (*1*)
Incident Response Teams	This strategy involves establishing a multi-agency team for the purposes of responding specifically to incidents. Members of the team should include representatives from the major incident responders in the area, including law enforcement, fire, emergency responders, etc. These individuals should be trained in National Incident Command System/ Unified Command procedures.	• Can build upon ICS principles • Incident responses are developed collaboratively • Multi-disciplinary approach • Streamlines site management and incident responses	• Should not duplicate or replace ICS • Need champion from all response agencies	• *Simplified Guide to Incident Command System for Transportation Professionals (2)* • CDOT's *TREX Incident Response Manual* (*1*)
Communication Protocols (SAFECOM)	This strategy involves establishing a common, predetermined radio frequency that response agencies can use to communicate during incidents. This could also include developing lists of agency channel access, and establishing interagency communications protocols.	• Facilitates interagency communications • Radio frequencies can be placed in incident response/action plan	• Frequency list may become outdated as system gets replaced • May require purchase of new technology to achieve interoperability	• *SAFECOM* Web site (*3*) • NTIMC's *Prompt, Reliable Traffic Incident Communications(4)* • CDOT's *TREX Incident Response Manual* (1)
Incident Response Manuals	This strategy involves developing a manual that outlines the predetermined processes and procedures for how to respond to specific incident situations. Manual might include the roles and responsibilities of responders for different "levels" of incidents.	• Different responses can be established for each phase of the construction project • Provide single source of information for all incident response procedures and policies • Facilitate dissemination of information to other response providers	• Not possible to include response for every type of incident situation • May be difficult to keep up-to-date as work zone phasing progresses • May be difficult to keep contact information current • Requires training to "practice" incident response scenarios prior to construction	• CDOT's *TREX Incident Response Manual* (1)

Strategies and Techniques	Description	Pros	Cons	For More Information
Emergency Personnel Resource List	This strategy involves generating a list of available and trained personnel from all of the response agencies. Information should include geographic or jurisdictional response areas, responsibilities, radio channels, or cell phone numbers.	• Facilitates cooperation and communication among response agencies • May already exist in many urban areas	• Needs to be updated frequently to ensure accuracy • May need to include multiple contacts from agencies to ensure that agency can be reached	• CDOT's *TREX Incident Response Manual* (1)
Equipment and Material Resource Lists	This strategy involves preparing comprehensive lists of equipment and material resources that agencies might need in response to incidents. List should not only include equipment and material but contact information of individual responsible for equipment.	• In many construction areas, heavy equipment may already be on site to assist with clearance activities	• Difficult to keep list accurate over time • Equipment may not always be available if used for other purposes	• CDOT's *TREX Incident Response Manual* (1)
Emergency Flashers / Flashing Light Policy	This strategy involves developing a policy concerning the use of emergency flashers and flashing lights on response vehicles that are already on-scene. Use of emergency flashers, particularly at night, can add to driver confusion at an incident scene.	• Good traffic control and advance warning signs can allow public safety agencies to perform tasks on scene with minimal emergency vehicle lighting • Reduces the potential for secondary collisions / incidents by reducing driver confusion	• Some emergency responders may be hesitant to follow policy	*FHWA's Manual on Uniform Traffic Control Devices (5)*

Online Resources:

1. *TREX Incident Response Manual.* Colorado Department of Transportation. Available at http://www.denvergov.org/Portals/523/documents/1ManualOctober2002.pdf
2. *Simplified Guide to Incident Command System for Transportation Professionals.* Available at http://ops.fhwa.dot.gov/publications/ics_guide/
3. Department of Homeland Security's *SAFECOM* Web site. Available at http://www.safecomprogram.gov/SAFECOM/
4. NTIMC's *Prompt, Reliable Traffic Incident Communications*. Available at *http://www.transportation.org/sites/ntimc/docs/Incident%20Communications11-16-06-v3.pdf*
5. Chapter 6I. Control of Traffic Through Traffic Incident Management Areas. *Manual on Uniform Traffic Control Devices.* Available at http://mutcd.fhwa.dot.gov/HTM/2003r1/part6/part6i.htm

Strategies and Techniques for Improving Incident Clearance

Another method to reduce the impact of incidents in work zones is to implement strategies that provide for the rapid clearance of incidents once they occur. Table 6 lists several common strategies for improving incident clearance in work zones.

Table 6. Strategies and Techniques for Improving Incident Clearance in Work Zones

Strategy	Description	Pros	Cons	For More Information
"Move-It" Laws/ Quick Clearance Policies	This strategy involves enacting legislation requiring vehicles that can safely and physically move from the travel lane to do so	• Encourages quick removal of minor incidents. • Empowers traffic and public safety responders to move any disabled vehicle from travel lane • Indemnifies responders for liability.	• Motor carriers may oppose because of potential losses associated with recovering cargo and/or vehicle • Responders may be hesitant to move vehicles off roadway because of fear of liability issues • Requires public awareness campaign to educate public about laws/policies	• NTIMC's *Safe, Quick Clearance (1)* • NCHRP's *Safe and Quick Clearance of Traffic Incidents (2)*
Wrecker Contracts	This strategy involves the use of special and/or incentive contracts with wrecker services to provide guaranteed response and clearance times	• Response /clearance time "guaranteed" by contract	• May meet opposition from some local wrecker services. • Requires more structured accounting/reporting to collect response/clearance times performance measures	• *Florida's Turnpike Enterprise Takes Proactive 'RISC' in Incident Management (3)* • *City of Houston's SAFEClear Program (4)*
Photogrammetry	This strategy involves using photographs and special software to conduct measurements of a vehicle crash scene	• Reduces time required to complete crash investigation • Photographs provide permanent record of incident scene • Most measurement and calculation performed in office • Scene can be marked then opened for traffic	• Many crash investigators not familiar with technology. • Requires special training to utilize equipment • Equipment costs more than traditional measuring devices, but less than total station	• *Use of Photogrammetry for Investigation of Traffic Incident Scenes (5)*
Total Station Surveying Equipment	This strategy involves using computerized surveying equipment (total stations) to conduct measurements of a vehicle crash scene	• Accident investigation can be completed in less time and with more accuracy than traditional measurement techniques	• Some agencies report longer clearance times because investigators take more measurements than with usual investigation techniques • Specialized training and equipment is required • Limited number of devices and qualified personnel may result in longer response times	• *Incident Management Using Total Stations* (*6*)

Strategy	Description	Pros	Cons	For More Information
Push Bumpers	This strategy involves equipping police, service patrols, and /or specialized vehicles with special bumpers that allow them to push disabled vehicles from the travel lane	• Disabled vehicles can be moved quickly from travel lanes to side of road or refuge area. • Relatively low-cost.	• Some agencies concerned about potential damage to pushed vehicles • Differences in vehicle heights may make pushing some vehicles difficult	• *Guidelines for Traffic Incident Management in Work Zones (7)* • *Traffic Incident Management Handbook (8)*
Dedicated Freeway/ Service Patrols	This strategy involves using specially marked and equipped vehicles to patrol designated sections of roadway to clear disabled vehicles from roadways and provide motorist assistance	• Permits rapid removal and clearance of minor incidents • Results in positive public image for agency • Can be a contracted service with privately owned and operated wrecker	• May meet opposition from local towing and recovery companies • No standardization as to how they should operate	• *Intelligent Transportation Systems in Work Zones: A Case Study (9)* • *Freeway Service Patrols: About FSP (10)* • *Benefits Analysis for the Georgia Department of Transportation NaviGAtor Program: Final Report (11)*
Landing Zone Guidelines	This strategy involves designating pre-determined landing site for medical evacuation/air ambulance helicopters	• Landing locations agreed upon by incident providers prior to need • Locations can be referred in incident management response/action plan	• Special maintenance may be required to keep area free of debris and construction equipment/ supplies • May require transport of victims to landing area	• *Guidelines for Traffic Incident Management in Work Zones (7)*

Online Resources:

1. *Safe, Quick Clearance.* National Traffic Incident Management Coalition, 2006. Available at *http://www.transportation.org/sites/ntimc/docs/Quick%20Clearance11-07-06v2.pdf*
2. *Safe and Quick Clearance of Traffic Incidents*. NCHRP Synthesis 318. Transportation Research Board. 2003. Available at http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_syn_318.pdf
3. *Florida's Turnpike Enterprise Takes Proactive 'RISC' in Incident Management.* Available at *http://www.floridaits.com/Newsletters/2005/May/05-2005.htm#RISC*
4. *SAFEClear Program.* City of Houston Web site. *Available at (http://www.houstontx.gov/safeclear/index.html*
5. *Use of Photogrammetry for Investigation of Traffic Incident Scenes. Report No 4907-2. Texas Transportation Institute. Available at* http://tti.tamu.edu/documents/4907-2.pdf
6. *Incident Management Using Total Stations.* Available at http://www.itsbenefits.its.dot.gov/its/benecost.nsf/ID/0D0D8496BCC0EF69852569E700716FB3?OpenDocument&Query=BApp
7. *Guidelines for Developing Traffic Incident Management Plans for Work Zones.* Available at http://www.dot.state.co.us/Traffic_Manuals_Guidelines/incident_management_guidelines/incident_management_guidelines_20030919.pdf
8. *Traffic Incident Management Handbook. November 2000.* Available at *http://www.iacptechnology.org/IncidentManagement/TrafficIncidentMgmtHandbook.pdf*
9. *Intelligent Transportation Systems in Work Zones: A Case Study.* Available at *http://www.itsdocs.fhwa.dot.gov//JPODOCS/REPTS_TE//13600.html*
10. *Freeway Service Patrols: About FSP* Available at *http://www.metro.net/projects_programs/fsp/about_fsp.htm*
11. *Benefits Analysis for the Georgia Department of Transportation NaviGAtor Program: Final Report. Available at http://www.itsbenefits.its.dot.gov/its/benecost.nsf/ID/D8FFBF887F1DF9028525733A006D5A4E?OpenDocument&Query=BApp*

Strategies and Techniques for Improving Incident Site Management

Dealing with incident site management issues within a work zone presents a special challenge to work zone planners and incident responders. In some work zones, pavement and shoulder widths have already been reduced, and barriers have been installed to separate work zone activities from the normal traffic lanes. All these factors make it more difficult for responders to work incidents that occur in and around work zones. Table 7 lists some of the site management strategies and techniques that work zone planners and incident responders can employ to mitigate the impacts of incidents

Table 7. Site Management Strategies and Techniques in Work Zones

Strategies and Techniques	Description	Pros	Cons	For More Information
Alternate Route Plans	This strategy involves pre-determining available routes for detouring traffic during long-term incidents.	• Removal of traffic demand from impacted roadway • Permits easier access to site by emergency response personnel • Develops collectively and cooperatively with other stakeholders • Diverts traffic to routes that can accommodate demands • Detours traffic around sensitive areas (such as schools, hospitals, etc.)	• Alternate routing for incidents may already be utilized around construction project • Requires extensive pre-planning to execute • Requires agencies to have resources available to implement • Secondary alternate routes may be required to provide detouring of primary construction alternate route • Applies to long-term incidents only	• FHWA's *Alternate Route Handbook* (1)
Emergency Turnarounds / Access Gates	This strategy involves including median breaks and shoulder access to allow emergency responders and highway operations personnel to turnaround between interchanges. This might also include installing access gates in median barriers that can be opened by response personnel to permit access to travel lanes through the construction area or from the opposite direction.	• Allows incident responders to access incident scene from opposite direction • Shortens travel time of responders to scene • May permit removal of incident debris to inside construction area for later removal	• Non-emergency traffic may be tempted to use if no physical barrier is provided • May slow initial responders if they have to remove physical barrier or gate to access site	• AASHTO's *Roadside Design Guide(2)* • AASHTO's *A Policy on Geometric Design of Highways and Streets (3)*
Alternative Emergency Response Access Routes	This strategy involves identifying and establishing procedures that emergency response vehicles can use to reach the scene of an incident inside the work zone, get to another emergency once inside the work zone, and to leave the incident scene from within the work zone. This should also include identifying alternate routes to treatment facilities once clear of the work zone.	• Allows emergency vehicles to access to scene quickly	• May require real-time adjustment if alternate route is congested	• *Guidelines for Developing Traffic Incident Management Plans for Work Zones (4)*

Strategies and Techniques	Description	Pros	Cons	For More Information
Predefined Staging Areas	This strategy involves establishing or setting aside a specific area in or around a work zone where response vehicles and personnel can safely wait away from the immediate incident scene. Special staging areas can also be set aside for media.	• Provides a common area or "rally point" for responders • Provides a safe waiting area for storing response vehicles • Can be used to separate media from the emergency response areas and can be used to keep media clear of the incident scene to ensure their safety and the safety of the responders. • Can be located outside of construction area or off roadway facility	• May be difficult to locate staging area in some tight construction zones • Used only with large scale incidents	• *TREX Incident Response Manual (5)* • *Guidelines for Developing Traffic Incident Management Plans for Work Zones (4)* • *Traffic Incident Management Handbook (6)*
Refuge Areas	This strategy involves constructing pullouts or other small refuge areas adjacent to the travel lanes where motorists can travel (or be pushed) to affect minor repairs to their vehicle (e.g., change flat tire, etc.).	• Provides a safe refuge out of travel lane where minor repairs can be performed • Provides refuge area where disabled vehicles can be pushed to • Important when the shoulders are used as travel lanes through the construction area.	• May require construction of all-weather surface • May be difficult to locate in limited work zone area • May be difficult to access at high traffic speeds	• *Traffic Incident Management Handbook (6)*
Accident Investigation Sites	This strategy involves establishing locations near or adjacent to the freeway, where vehicles and emergency responders can go, out of the way of traffic, to complete an accident investigation. These areas need to be identified in advance and adequate space must be provided for movable vehicles and investigation personnel. These can be designed with screening devices to further reduce the impacts of "rubbernecking." These locations are subject to change as construction phasing progresses.	• Provides an established area for relocating damaged or disabled vehicles • Could potentially serve as staging area of other incident responders	• May require construction of improved area • Area must be large enough to accommodate 3 to 4 vehicles • Requires installation of signs directing motorists to site	• *TREX Incident Response Manual (5)* • FDOT's Accident Investigation Sites Criteria (*7*) • *iROX I-75 Road Expansion Project (8)*

Strategies and Techniques	Description	Pros	Cons	For More Information
Shoulder Usage Policies	This strategy involves establishing procedures and criteria for when a paved shoulder can be used by response personnel and when a shoulder can be used as an alternate travel lane during incident conditions. Procedures need to address how shoulder usage may impact ramps and interchanges.	• Maximizes the utilization of paved surfaces to move traffic • Increases roadway capacity	• May not always be possible when work zones utilize shoulders as travel lanes • Operational problems may exist at ramps and interchanges • Shoulders are no longer available as refuge areas for disabled vehicles • Shoulders may not be wide enough to accommodate travel lane • Shoulder pavement may not be designed to accommodate vehicle loads	• FHWA's *Freeway Management and Operations Handbook*(9)
Incremental Lane Opening Guidelines	This strategy involves developing guidelines for quickly opening lanes, as they become available and safe to travel on.	• Keeps duration of lane closures to minimum required to complete response activity • Maintains traffic flow past incident scene	• Some incident responders may be hesitant to open and close lanes multiple times • May increase tendency for secondary incidents	• FHWA's *Freeway Management and Operations Handbook* (9)
Reopening Work Zone Lanes	This strategy involves establishing procedures and guidelines for quickly opening lanes, as they become available and safe to travel on. Depending upon the circumstances, this may mean postponing a work zone related lane closure if an incident condition already exists, or terminating a work zone related lane closure early, if possible, to provide improved capacity	• Restores roadway capacity potential to pre-construction levels	• Only feasible when temporary lane closures have been deployed as part of construction activity • Depends on the type of work activity • Agency may need to perform an additional lane closures at another time to complete work activity	• *TREX Incident Response Manual (5)*
Equipment Storage Sites	This strategy involves establishing a secured area near the work zone where incident response equipment can be stored to facilitate incident removal. This might include temporary incident management signing (as specified in Chapter 6I. of the MUTCD), portable dynamic message signs, vehicles with push bumpers, heavy lifting vehicle, inflatable air bag systems, etc.	• Equipment readily accessible to responders • Results in quicker response times to incident scene within construction area	• May result in longer response times if equipment needed at incident scene is NOT in close proximity to work zone • Requires a secure storage area in close proximity to work zone • Equipment would need to be routinely checked to ensure that it is functioning properly • Requires inventory control procedures	• FHWA's *Traffic Incident Management Program: Responder and Motorist Safety* Web site (*10*)
Traffic Responsive Signal Control Plans	This strategy involves using pre-established traffic signal control plans that can be implemented on alternative routes in response to changing traffic conditions	• Signal timing plans adjust automatically to changing traffic conditions • Reduces the need for law enforcement officers to manually operate traffic signals at intersections	• Requires surveillance technologies on alternate routes • Signal plan may not fully cover total range of potential incident conditions • May require upgrade of existing traffic signal control equipment	

Strategies and Techniques	Description	Pros	Cons	For More Information
Restrictive Ramp Metering Timings	This strategy involves using existing ramp meter signals to control vehicle access to the freeway. This strategy should be used in conjunction with alternate routes.	• Reduces traffic demands on the freeway • Controls access to the freeway • Ramp meters infrastructure may already be in place to address recurring congestion problems	• Construction may alter ramp geometrics, making it undesirable or unsafe to use ramp metering • Ramp queues may block local arterial streets • Traffic may divert to an undesirable alternate route (unless acceptable alternate route clearly defined) • Requires that TOC have communications with ramp controllers	• FHWA's *Ramp Management and Control Handbook(11)*

Online Resources:

1. *Alternative Route Handbook.* Report No. FHWA-HOP-06-092. Federal Highway Administration, May 2006. Available at http://ops.fhwa.dot.gov/publications/ar_handbook/index.htm
2. *Roadside Design Guide.* American Association of State Highway and Transportation Officials. March 2006.
3. *A Policy on Geometric Design of Highways and Street.* American Association of State Highway and Transportation Officials. 2004.
4. *Guidelines for Developing Traffic Incident Management Plans for Work Zones.* Available at http://www.dot.state.co.us/Traffic_Manuals_Guidelines/incident_management_guidelines/incident_management_guidelines_20030919.pdf
5. *T-REX Incident Response Manual.* Available at http://www.denvergov.org/Portals/523/documents/1ManualOctober2002.pdf
6. *Traffic Incident Management Handbook. November 2000.* Available at *http://www.iacptechnology.org/IncidentManagement/TrafficIncidentMgmtHandbook.pdf*
7. *Accident Investigation Sites*. Florida Department of Transportation. District 1. Available at *http://www.i95coalition.org/Incident-toolkit/documents/Guide/Guide_AIS%20_FL_D1.pdf*
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11. *Ramp Management and Control Handbook. Report No. FHWA-HOP-06-001.* Federal Highway Administration. January 2006. Available at http://ops.fhwa.dot.gov/publications/ramp_mgmt_handbook/manual/manual/1_1.htm

Strategies and Techniques for Improving Incident Information Dissemination to Travelers

Information dissemination plays a vital role in incident management. With accurate and timely information, motorists can make timely, informed mode choices as well as routing and departure time decisions. These decisions not only help to reduce traffic demands through the work zone area where the incident occurred, but can also reduce the potential for secondary crashes and driver frustration. Table 8 lists some strategies and techniques that can be used by work zone planners to facilitate information dissemination about incidents in work zones.

Table 8. Strategies and Techniques for Disseminating Work Zones Incident Information to Public

Strategies and Techniques	Description	Pros	Cons	For More Information
Dynamic Message Signs	This strategy involves using permanent or movable dynamic message signs to provide motorists with information in advance of, or at, the scene of an incident.	• Information directly provided to motorists affected by incident • Many work zones will have devices as part of TMP • Motorists are familiar/expect to receive information from these devices	• Message content restricted to a relatively few characters • Does not reach travelers outside immediate vicinity of sign • Cannot display complex messages	• FHWA's *Changeable Message Sign Operation and Messaging Handbook*(1) • FHWA's *Intelligent Transportation Systems in Work Zones: A Cross-Cutting Study (2)*
Highway Advisory Radio	This strategy involves using a low-powered AM or FM radio system to provide travelers in the immediate vicinity of work zone with information about incidents.	• Allows operators to provide more detailed messages • Reaches a broader range of travelers in corridor	• Drivers must tune to radio station to receive message • Requires signing to alert motorists that a message is available	• *Deployment of Smart Work Zone Technology in Arkansas* (*3*)
Broadcast Radio and TV Media	This strategy involves developing agreements with broadcast radio and television stations to provide incident information in a pre-established format for a specified period of time.	• Has potential to reach travelers before they enter corridor or begin trip • Can impact mode choice, routing, and departure time decisions	• Accuracy of information being disseminated difficult to control • Media agreement to information format may be difficult to obtain	• *Traffic Incident Management Handbook (8)*
Traffic Reporting Service	This strategy involves utilizing traffic reporting services to disseminate traffic and travel information for incorporation in in-vehicle displays	• Information can be tailored by traffic reporting service for specific users • Information can be integrated with in-vehicle travel information displays	• Agency does not control/influence diversion route of traveler • Agency does not control accuracy of information being disseminated	• *Traffic Incident Management Handbook (8)*
Email /Fax Alerts or Mobile Web Site	This strategy involves deploying a system whereby incident alerts are automatically distributed through electronic means such as emails, faxes, Web pages, etc.	• Has potential to reach a wide distribution of travelers • Technology relatively easy to deploy • Users would need to subscribe to service • Many urban areas have systems already in place	• Requires staff to manage system	• Houston TranStar Traffic Alerts Web site (*5*)

Strategies and Techniques	Description	Pros	Cons	For More Information
Web Sites/ Kiosks	This strategy involves using Web sites and information kiosks in public areas to disseminate information about incidents in work zones	• Has potential to reach travelers prior to initiating trip • Can impact mode choice, routing, and departure time decisions	• Does not reach motorist already in work zone • Requires integration with other systems	• *Traffic Incident Management Handbook (8)*
Dedicated Information Phone Number / 511 System	This strategy involves disseminating work zone incident information through either a dedicated telephone call-in number or an existing 511 service.	• 511 services available in many metropolitan areas • Has potential to reach travelers prior to initiating trip as well as drivers who have already started trip	• Dedicated telephone number requires operator to staff • Requires driver to initiate call to obtain information	• *Resource 511(6)* • *FHWA's 511 Travel Information Telephone Services Web site (7)*

Online Resources:

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2. *Intelligent Transportation Systems in Work Zones: A Cross-Cutting Study on Integrated Work Zone System for Improving Travel Conditions and Safety.* Federal Highway Administration, November 2002. Available at http://www.itsdocs.fhwa.dot.gov/JPODOCS/REPTS_TE/13600.html
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5. Houston TranStar Traffic Alerts Web site. Available at http://traffic.houstontranstar.org/trafficalert/trafficalert_login.aspx
6. 511 Deployment Coalition Web site. Available at http://www.deploy511.org/
7. Federal Highway Administration Web site on *511 Travel Information Telephone Services.* Available at http://ops.fhwa.dot.gov/511/

Strategies and Techniques for Improving Incident Information Dissemination to Responders

Improving the level of coordination and collaboration between incident responders also helps to reduce the impact of incidents on traffic operations in work zones. Better information dissemination can facilitate this coordination and collaboration. Table 9 provides several strategies and techniques that have been used to assist with information dissemination about incident response policies, procedures, and guidelines between incident responders.

Table 9. Strategies and Techniques for Improving Information Dissemination Among Incident Responders

Strategies and Techniques	Description	Pros	Cons	For More Information
Incident Response Manual	This strategy involves developing an incident response manual that collects all the policies, procedures and guidelines for managing incidents.	• All information needed by incident responders in one place • Contains contact information for responders in different response agencies	• May be difficult to keep contact information up-to-date	• *Traffic Incident Management Handbook (1)* • CDOT's *TREX Incident Response Manual(2)* • *Guidebook on Incident Management Planning in Work Zones (3)*
Communication Protocols / Frequency List	This strategy involves developing a listing of predetermined radio frequency assignments that incident responders can use to communicate with each other on scene.	• Provides a quick reference of all radio frequencies for responders	• May be difficult to keep contact information up-to-date	• *Traffic Incident Management Handbook (1)* • CDOT's *TREX Incident Response Manual(2)* • *Guidebook on Incident Management Planning in Work Zones (3)*
Identification Vests	This strategy involves adopting the use of identification vests to be used by incident command and emergency personnel.	• Makes it easier for late arrivals to identify individuals in charge at incident scene • Can be used to limit access by individuals within certain perimetered areas • Vests that follow National Incident Management System Incident Command Structure can be purchased from private vendors	• Multiple vests may be required for same agency to accommodate shifts	• *Guidelines for Developing Traffic Incident Management in Work Zones (4)*
Personnel Resource List	This strategy involves developing a comprehensive contact list of response personnel.	• Provides a quick reference for notifying responders • Usually part of incident response manual	• May be difficult to keep up-to-date	• *Traffic Incident Management Handbook (1)* • CDOT's *TREX Incident Response Manual(2)*
Incident Management Reviews / Debriefings	This strategy involves establishing regular meetings between incident responders to review and discuss coordination and tactical issues associated with responding to incidents.	• Many locations already have a process for doing incident reviews/debriefings • Allows agencies to discuss issues that affected response • Allows agencies to collaborate on modifications to improve responses • Facilitates dialogue between responders	• Some responders may view this as a personal attack on performance • May be difficult to get all field personnel together at same time because of shifts	• *Traffic Incident Management Handbook (1)* • CDOT's *TREX Incident Response Manual(2)*
Media Packets	This strategy involves developing packets that can be distributed to media to disseminate information during incident in work zones.	• May include contact information for agency public information officer • Contains maps showing staging areas, detour routes, etc.	• Information may not be relevant for all incident conditions • Strategy valid for major incidents only	• *Guidebook on Incident Management Planning in Work Zones (3)* • Construction Project Media Kit *(5)*

Online Resources:

1. *Traffic Incident Management Handbook. November 2000.* Available at *http://www.iacptechnology.org/IncidentManagement/TrafficIncidentMgmtHandbook.pdf*
2. *T-REX Incident Response Manual.* Colorado Department of Transportation. Available at http://www.denvergov.org/Portals/523/documents/1ManualOctober2002.pdf
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4. *Guidelines for Developing Traffic Incident Management Plans for Work Zones.* Available at http://www.dot.state.co.us/Traffic_Manuals_Guidelines/incident_management_guidelines/incident_management_guidelines_20030919.pdf
5. *Construction Project Media Kit.* Available at http://inform.enterprise.prog.org/pdf/cpmk.pdf

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6.0 ENHANCING FUTURE WORK ZONE TRAFFIC INCIDENT MANAGEMENT ACTIVITIES

Work zones can be a catalyst for changing existing incident management and policies in an area. In some cases, new strategies and techniques that are implemented as part of the transportation management plan (TMP) for the construction or maintenance project will remain in place after the construction is gone. In other cases, the lessons learned associated with implementing some of these strategies in one work zone can be valuable information to work zone planners and incident responders in the next construction project. This chapter focuses on actions that work zone planners, traffic operators, and incident responders can take during the execution of a particular work zone project that can provide insight into enhancement or improvements to incident management activities in the future.

Performance Monitoring and Evaluation

Monitoring and measuring the effectiveness of the incident management strategies in work zones is an essential step in identifying improvements and enhancements for future traffic incident management activities. Table 10 shows a series of performance measures that have been recommended for measuring the impact of incidents and work zones on freeway operations.[18]

The National Transportation Operations Coalition (NTOC) has proposed using the measures shown in Table 11 as core measures for evaluating the impacts of incidents on traffic operations.[19] Similar performance measures can be used to measure the effectiveness of various work zone related traffic incident management strategies.

Other measures that are used to gauge the effectiveness of incident management programs are: [20, 21]

- Roadway Clearance Time: the time between the first recordable awareness (detection/notification/awareness) of an incident by a responsible agency and the first confirmation that all lanes are available for traffic flow.
- Incident Clearance Time: the time between the first recordable awareness and the time at which the last responder has left the scene.
- The number and overall percentage of responses by type.
- The number of responses and overall average clearance time.
- The number of responses and overall average clearance time for fatality collisions.

- The number of responses and overall average clearance time for non-collision incidents.
- The number of responses and overall average clearance time for service actions taken.
- The number (or percent) of incidents that exceed a specified duration (e.g., 2 hours).
- The average clearance time by month.
- The average clearance time by quarter.
- The number and percentage of blocking incidents by quarter.
- The number and percentage of injury incidents by quarter.
- The number and percentage of non-injury incidents by quarter.
- The number and percentage of fatality incidents by quarter.

Table 10. Recommended Core Measures for Capturing Impacts of Incidents and Work Zones on Freeway Performance

Performance Metric	Definition	Units	Geographic Scale	Time Scale
Incident Characteristics (Activity-Based)				
No. of Incidents by Type and Extent of Blockage	Self-Explanatory	Type: 1) crash, 2) vehicle breakdown, 3) spill, 4) other. Blockage: actual number of lanes blocked; separate code for shoulder blockage	Section and area wide	Morning/Evening peak periods, daily
Incident Duration	The time elapsed from the notification of an incident to when the last responder has left the incident scene	Minutes (median)	Section and area wide	Morning/Evening peak periods, daily
Blockage Duration	The time elapsed from the notification of an incident to when all evidence of the incident (including responders' vehicles) have been removed from the travel lanes	Minutes (Median)	Section and area wide	Morning/Evening peak periods, daily
Lane-Hours Loss Due to Incidents	The number of whole or partial freeway lanes blocked by the incident and its responders, multiplied by the number of hours the lanes are blocked	Lane-hours	Section and area wide	Morning/Evening peak periods, daily

Performance Metric	Definition	Units	Geographic Scale	Time Scale
Work Zones (Activity-Based)				
No. of Work Zones by Type of Activity	The underlying reason why the work zone was initiated: 1) resurfacing only, 2) Resurfacing, Restoration, and Rehabilitation (RRR) projects, 3) lane addition w/o interchanges, 4) lane additions with interchanges, 5) minor cross-section, 6) grade flattening, 7) curve flattening, 8) bridge deck, 9) bridge superstructure, 10) bridge replacement, 11)sign-related	Number	Section and area wide	Daily
Lane-Hours Lost Due to Work Zones	The number of whole or partial freeway lanes blocked by the work zone, multiplied by the number of hours the lanes are blocked	Lane-Hours	Section and area wide	Morning/Evening peak periods, daily
Average Work Zone Duration by Type of Activity	The elapsed time that work zone activities are in effect	Hours	Section and area wide	Daily
Lane-Miles Lost Due to Work Zones	The number of whole or partial freeway lanes blocked by work zone, multiplied by the length of the work zone	Lane-miles	Section and area wide	Morning/Evening peak periods, daily
Adapted from Guide to Effective Freeway Performance Measurement[18]				

Table 11. NTOC Performance Metrics for Measuring Impacts of Incidents [19]

Measure	Definition	Sample Units of Measurements
Incident Duration	The time elapsed from the notification of an incident until all evidence of the incident has been removed from the incident scene.	Median minutes per incident
Non-recurring Delay	Vehicle delay in excess of the recurring delay for the current time-of-day, day-of-week, and day-type.	Vehicle-hours
Travel Time Reliability (Buffer Time)	The additional time that must be added to a trip to ensure that travelers making the trip will arrive at their destination at or before the intended time 95 percent of the time.	Minutes. This measure may also be expressed as a percent to total trip time or as an index.

It should be noted that if a performance-based, incentive/disincentive-based contract is used to provide a guaranteed incident response time, then a system needs to be put into place to measure whether or not a contractor has fulfilled the contract obligations. As part of the contract documents, work zone planners need to develop a performance assessment plan which describes how the contractor's performance will be evaluated and assessed. Several methodologies can be used for assessing a contractor's performance related to the specific incident management function, including the following:

- Random sampling,
- Periodic sampling,

- Trend analysis,
- Customer feedback, and
- Third-party audits.

Good performance monitoring and evaluation often requires developing additional reporting capabilities and resources not commonly available. Work zone planners and incident responders should be careful not to use performance measures that exceed the existing data collection and reporting systems' capabilities to collect the data needed to produce the performance measures.

Post-Incident Debriefings

Many locations routinely conduct post-incident debriefings after major incidents. The purpose of these debriefings is to identify deficiencies, lesson learned, and areas for improvement to apply to future incidents. The debriefings can also serve as a forum for resolving conflicts and inefficiencies between responders. Many agencies have found that these debriefings help to maintain and strengthen the lines of communications between incident responders. Incident debriefings can also assist agencies with their NIMS/ICS preparedness activities.

The process for conducting a post-incident debriefing includes the following steps:

- Recreate the incident chronology for the participants,
- Collect input from each agency on the aspects of the response that worked well as well as critiques of the aspects that worked poorly,
- Collect suggestions from each agency for improving the response for future events,
- Discuss the suggestions for improvement and develop consensus as to the corrective actions to be taken in future events,
- Document the results of the debriefing and update the incident response / action plan

Typically, an incident debriefing includes all the major stakeholders that responded to the incident. Ideally, both field and supervisory personnel should be involved in the debriefing. Construction personnel and work zone planners should also be included as part of the debriefing to offer insight into how the actions could impact phasing or scheduling of work activities and modifications that may be required to the TMP. These debriefings should occur as soon as practical following the incident, while the actions and issues are still fresh on the responders' minds. Consideration should be given to using a facilitator to keep the debriefing frank, but non-confrontational. Action items, if needed, should also be clearly and concisely summarized and incorporated into future responses.

Documentation, Evaluation, and Lessons Learned

At the conclusion of the work zone activities, work zone planners, construction personnel, and incident responders should assess the overall effectiveness of the incident management strategies and techniques employed as part of the project TMP. The feedback will be a valuable asset in planning future work zone activities. Specifically, construction personnel and incident responders should be asked to evaluate the strategies used against the traffic incident management objectives defined during the work zone planning processes. Construction personnel and incident responders should specifically assess the following:

- Did the strategies help reduce the time required to detect the presence of incidents in the work zone?
- How did the strategies help expedite the clearance of incidents in the work zone?
- How did the strategies help facilitate or improve incident responses in the work zone area?
- Did the strategies deployed reduce the frequency and severity of crashes and secondary crashes in the work zone?
- Did the strategies reduce the number of public safety personnel needed to respond to the incidents?
- How did the strategies impact incident responder safety, cooperation, and collaboration within the work zone?
- How might customer satisfaction be improved in future work zone traffic incident management efforts?

Steps should also be taken to document the effectiveness of the strategies, wherever possible, using the performance measures previously discussed.

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FHWA Office of Operations, HOTO
1200 New Jersey Avenue, SE
Washington, DC 20590

http://ops.fhwa.dot.gov

FHWA-HOP-08-056
January 2009