Task Two Literature Search for Federal Highway Administration (ITS-JPO)

Assessment of State of the Practice and State of the Art in Evacuation Transportation Management

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16. Abstract

Much of what is known about evacuations is based on preparations for incidents, such as hurricanes, for which there is advance warning. With advance warning, evacuations can be planned and managed using procedures and systems that have been developed as a result of extensive and methodical pre-planning. This approach, however, does not adequately support management of incidents when there is no advance warning or when conditions are changing rapidly. Evacuations in response to these types of incidents tend to be monitored, but not well managed. The Federal Highway Administration (FHWA) recognized the importance of and need for new tools and processes to help agencies plan for and manage evacuations where there is little or no advanced warning. Consequently, the FHWA initiated a project to assess the state of the practice and state of the art in evacuation transportation management.

This report was prepared to document a literature search to assess what is currently known about the management of evacuations and transportation management during evacuation situations, including the necessary support from public safety and other public organizations with a role in managing evacuations.

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1 Executive Summary

Much of what is known about evacuations is based on preparations for incidents, such as hurricanes, for which there is advance warning. With advance warning, evacuations can be planned and managed using procedures and systems that have been developed as a result of extensive and methodical pre-planning. This approach, however, does not adequately support management of incidents when there is no advance warning or when conditions are changing rapidly. Evacuations in response to these types of incidents tend to be monitored, but not well managed.

Communities can plan for an incident and the associated evacuation; however, during no-notice evacuations, they generally have little time to assess the situation before starting the evacuation process. In a no-notice situation, the need to react is immediate—with little advance warning. The *American City and Country* article "Community Evacuation: Ensuring Safe Passage," reported: "Some disasters come with notice, while others hit without warning. As a result, planners have to factor in lead times for communicating and implementing evacuations. For some planners, time is on their side. For example, in Grand Forks, emergency managers monitored the development of a major spring flood in 1997 by tracking winter snowfall and melting rates. 'We geared up slowly and reported regularly to the public through the media,' Bryon Sieber, Commander for Planning and Research at Grand Forks North Dakota Police Department, says. 'The long lead time enabled us to plan a two-stage evacuation. The first stage was voluntary; second came an ordered evacuation.'"

No-notice evacuations result in the need to respond immediately. During the derailment of a train carrying chlorine gas in Graniteville, South Carolina, emergency officials had to respond quickly. As reported in the ContraCostaTimes.com article "Chlorine Spill Forces Evacuations," "a rapid response by local emergency officials in the hours after two trains collided on Thursday morning helped evacuate hundreds of residents from a 'hot zone' of contamination around the still-volatile wreck. Officials continued to cordon off a mile radius around the now-deserted site, unable to staunch the flow of chlorine from one crushed rail car and worried about the possibility of leaks from two other cars loaded with toxic chemicals."

The phrase "no-notice" evacuations at times may be misleading because some incidents can be anticipated although they may occur with no notice. For example, communities that are located in fire- and flood-prone areas should expect to see wildfires during any fire or flood season. Communities located next to main line railroad tracks that are used to transport hazardous materials might expect to see a hazardous waste or chemical spill. On the other hand, these communities would not expect to see acts of terrorism such as the 9/11 terrorist attacks on New York City and Washington, DC.

The Federal Highway Administration (FHWA) recognized the importance of and need for new tools and processes to help agencies plan for and manage evacuations where there is little or no advance warning. Consequently, the FHWA initiated a project to assess the state of the practice and state of the art in evacuation transportation management.

There are eight tasks for the FHWA Assessment of State of the Practice and State of the Art in Evacuation Transportation Management. Task 2 is a literature search, and this report is the second deliverable for the project.

This report is organized into the following sections:

1. Executive Summary
2. Introduction

3. Methodology for Literature Selection
4. Findings
5. Lessons Learned
6. Best Practices
7. Potential Tools.

The Booz Allen Hamilton (Booz Allen) team employed a three-step process to complete the literature review and research: (1) collection of relevant domestic and international evacuation reference materials, plans, policies, procedures, newspaper and magazine articles, journals, industry publications, and other documents; (2) review and analysis of the documents; and (3) compilation of the results of the analysis for presentation to the FHWA in a final report.

The first task of the literature search was to identify anecdotal information and documented assessments of evacuation experiences; lessons learned; and any guidance for transportation, public safety, and emergency management agencies that may have been developed for evacuation events. As a result, the team identified several documents that relate to no-notice evacuations regarding incidents such as the 9/11 terrorist attacks in New York City and Washington, DC; the blackouts of New York City and Detroit, Michigan; the firestorms of British Columbia, Canada; the southern California wildfires; the Northridge earthquake; the I-95 tanker explosion; and the Howard Street rail tunnel fire in Baltimore, Maryland. Although the focus of these documents was not necessarily on evacuations, they were included because information can be gleaned from them that is applicable to evacuation events. The team also identified and included relevant information from any type of evacuation experience.

From these reports and numerous other articles and publications, this literature search assessed what is currently known about the management of evacuations and transportation management during evacuation situations, including the necessary support from public safety and other public organizations with a role in managing evacuations.

1.1 Key Issues and Findings

The Booz Allen team identified the following key issues for developing and implementing transportation evacuation plans:

- Nature of the hazard
- Transportation objectives
- Infrastructure
- Coordination
- Communication
- Special needs
- Changing conditions
- Impacts to transportation systems.

Table 1-1 summarizes the finding for each key issue.

Table 1-1. Key Findings

Key Issue	Findings
Nature of the Hazard	• No-notice evacuations are chaotic and difficult to manage. • Enforcement of evacuation orders is problematic, and it can be difficult to get people to evacuate. • Evacuation decisions are generally a local affair. • There are impacts from and to the transportation system. • Communities are aware of hazards that can lead to evacuations, but some events are too extraordinary to plan for. • Evacuations can occur in all conditions, including at night. • The responses to an advanced evacuation and a no-notice evacuation are similar.
Transportation Objectives	• Critical facilities are needed after an incident to bring in supplies. • Evacuation routes and detours have been identified and/or predetermined for emergency situations. However, at times, citizens may not be aware of the routes and their final destination and which areas to avoid. • The distance of an evacuation depends on the reason for the evacuation. • Evacuations lead to activation of emergency plans. However, transportation is not always integrated into the plans. • Emergency planners need to account for traffic from adjacent surrounding communities. • Traffic and people need to be managed during an evacuation. • The number of vehicles that are involved in evacuations can be problematic. Hurricane evacuations may have 21 to 25 percent of the evacuees taking more than one vehicle. • Agencies can create redundant systems for incidents, but at times, events overcome this level of preparedness with agency staff filling in the breach. • Public transit can be used to provide mobility during an evacuation, but there could be limitations to the use of public transit.
Infrastructure	• The loss of infrastructure, including power, and equipment can impact evacuations. • Critical evacuation routes are monitored by government entities during an evacuation. • Contra-flow operations have been found with advance-notice evacuations and used during no-notice evacuations, but do present issues such as inadequate time to set up the operation. • Resources can be staged to assist during an evacuation incident. • Intelligent transportation system (ITS) equipment has been used to assist in evacuations. However, the equipment does need power and, after a blackout event, to be reset. • Highway construction zones can impact evacuations.
Coordination	• One can plan for contingencies but not for all events. • Evacuation coordination and cooperation is important since evacuations may cross state lines or into other jurisdictions. Coordination also includes external entities, multiple groups, non-traditional emergency management personnel, and public transit. Coordination also includes having a unified voice providing information. • An incident command system is identified in the literature as an item that should be in place and used during an evacuation incident. • Mutual-aid and other agreements (such as formal procedures for coordination of multi-county evacuations) have been cited in the literature as being important. • The need for training and training exercises is emphasized in the literature, along with the need to include public transit in the training exercises. • An incident command system can be operated within an area command when an incident is very complex or multiple incidents are located in close proximity. • Specialty teams (tiger teams) have been deployed that can assist in an evacuation situation.
Communication	• There are multiple ways to communicate from the traditional methods of loud speakers and the canvassing of streets to high-technology cell phones with television screens that receive evacuation orders and information. • After the 9/11 terrorist attack, the use of transit call centers and Web sites increased by passengers seeking out transit information. • During evacuations, communication between all parties (evacuees, the general public, entity staff, etc.) can be difficult and problematic. People and entities have been creative in overcoming these

Key Issue	Findings
	communication problems, such as the use of personal cell phones to neighbors alerting them of the need to evacuate. • Some companies have emergency communication plans. • Information communicated during an evacuation needs to be accurate and consistent. One way to handle this is the use of a joint information center that manages the information in order to deliver a consistent message. In addition, the media will eventually become involved in the evacuation situation and can be a valuable ally. • Information should be shared among various entities. • Some evacuations have advance warning, while others do not, thus impacting the type of communication issued.
Special Needs	• There was very little information in the literature regarding the evacuation of bicyclists or truckers. • Special needs evacuees such as the elderly, medical patients, disabled, and people without transport require special assistance during evacuations and at shelters and at times these evacuees may be overlooked. • Jail facilities and nursing homes are special needs facilities that have been evacuated. • People who are evacuated that have pets or animals that need to be left behind in the rush of an evacuation worry about their pets/animals. • The events of 9/11 in both New York City and Washington, DC, involved the evacuation of pedestrians. To move the evacuees out of the cities, public transit played a significant role. People also walked home.
Changing Conditions	• Priorities change during evacuations from safety and protection of evacuees to providing mobility for evacuees. • During the 2003 blackouts, responsibilities for items such as traffic management shifted spontaneously from the police to citizens.
Impacts to Transportation Systems	• During the blackouts in the Great Lakes Region, manufacturing plants ceased operations and thus impacted the transportation network. • Reentry of evacuees requires coordination to ensure their return is successful and manageable. • During the New York City blackout, transit managers' decisions impacted the evacuation of evacuees. • Transportation systems can become overwhelmed with evacuees.

However, the purpose of this literature search was not to assess transportation evacuation plans but to find information on these issues, key findings, and lessons learned from the responses to evacuation incidents.

1.2 Lessons Learned

Lessons can be learned from the 9/11 terrorist attacks, the 2003 blackouts, the I-95 tanker explosion, hurricanes, and other incidents. The literature search found that there are common themes in the lessons learned by the various entities. **Table 1-2** summarizes these common themes.

Table 1-2. Common Lessons Learned Among Various Entities

Common Themes	Lessons Learned
Advanced Preparations and Planning	• Do not ignore low-technology solutions • Review and learn from past events • Establish mutual-aid agreements • Plan for all types of emergencies • Review emergency plans after an event

Common Themes	Lessons Learned
	• Develop procedures to guide actions to be taken early in an emergency
Advanced Technology	• Realize advanced technologies play an important role in communications and decision making • Use ITS technology but also a mix of older technology • Be prepared for limited use of ITS technology • Consider ITS functionality that could be particularly useful during an emergency • Use ITS technologies to provide information and assist in decision making • Utilize portable ITS equipment in responding to incidents • Realize communication systems can complement ITS technology • Keep traffic management centers open during the incident; use alternative power if necessary • Establish reliable backup power to maintain normal ITS functions
Command and Control	• Delegate decision making down • Maintain close ties with law enforcement entities • Make use of an incident command system • Use incident management teams • Have incident management teams work with infrastructure and utility personnel • Establish pre-selected incident command post locations
Communication	• Be prepared to communicate using various methods, such as fax, handouts, maps, cell phones, satellite phones, cable television, face-to-face, email, Internet/Web, and ham radio operators • Communicate with a unified voice • Understand communication may be difficult during an incident • Develop a joint information center • Be prepared to activate the emergency alert system early • Have compatible radio systems • Expect loss of power and communications • Have both internal and external communication mechanisms • Inform all participants • Realize a multimedia approach may be necessary • Ensure information is accurate and consistent
Cooperation	• Practice cooperation during normal times • Practice interagency cooperation
Coordination	• Coordinate the response with others • Maintain relationships (pre-existing relationships among agencies and personnel are key to emergency management success) • Utilize the resources of all participants • Involve law enforcement and non-traditional agencies • Conduct a collaborative post-incident review • Establish internal coordination as well as external
Emergency Plans	• Develop emergency plans • Test the emergency plan
Evacuations	• Develop evacuation routes and remember evacuations can cross state lines • Modify evacuation routes as needed • Allow for individual initiative • Identify evacuation routes • Maintain emergency services access to the disaster area and evacuation routes • Include evacuation of dispatch centers

Common Themes	Lessons Learned
	• Use available tools to aid in the decision to evacuate • Communicate with people who do not evacuate • Ensure reentry of evacuees • Realize priorities may conflict • Realize priorities will change over time
Operations	• Be ready to throw out the procedures if they do not work in an evacuation • Delegate responsibility down to the appropriate level in the organization • Empower employees • Expect chaos • Know where you are going and how to get there • Use volunteers in a support role • Overcome the need to take action without planning • Prepare for emergencies in advance to make day-of-event decisions earlier • Set priorities as quickly as possible • Reduce impacts of work zones • Develop clear procedures for evacuations
Redundancy and Resiliency of Systems	• Build redundancy into institutions and physical systems including personnel, communications, utilities, and control centers • Pre-position supplies and equipment (if the supplies and equipment can be identified) • Adopt a mindset of resiliency • Have redundant system of trained agency personnel • Remember the transit system can provide redundancy • Conduct inventory of backup resources • Establish backup power • Have alternative emergency operations centers • Use multiple communications technologies
Training	• Conduct training exercises • Practice with other entities • Adapt response plans to the incident • Train first, second, and third string staff for emergencies • Review and update crisis plans with training

1.3 Best Practices

Best practices were identified from the southern California wildfires of 2003, the 9/11 terrorist attacks, the 2003 blackouts, hurricanes, and other incidents.

Some common principles were identified during the literature search including:

- Distributing maps and route-evacuation information
- Informing the community of the dangers before an incident
- Practicing cooperation between entities
- Practicing coordination between entities
- Practicing training and drills

- Preparing evacuation plans
- Using an incident command system
- Using incident planning
- Using intelligent transportation system (ITS) to monitor the situation
- Using various means to communicate.

1.4 Tools

The literature search identified available tools for use in evacuations and/or areas where further research and development may be useful to develop tools to respond to evacuation issues. The focus was on potential technology applications for evacuations. Tools were identified for evacuation planning, evacuation routing, identifying hazardous materials and manifest, identifying infrastructure, identifying evacuation routes, informing people of the need to evacuate, locating public bus and public bus/rail systems to be used during an evacuation, and traffic monitoring in rural areas and/or blackout areas.

During this literature search, there was no definitive article or publication that addressed evacuations from no-notice evacuation incidents. However, there are many articles and publications prepared after incidents that proved invaluable for this literature search. These documents included the *Effects of Catastrophic Events on Transportation System Management and Operations Studies*, the *San Bernardino County Fire Chiefs' Association: Lessons Learned Report: Fire Storm 2003: "Old Fire,"* and the *Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center*. Although the two wildfire reports were not written from a transportation perspective, information from the two was applicable because they required no-notice evacuations.

2 Introduction

Much of what is known about evacuations is based on preparations for incidents, such as hurricanes, when advance warning occurs. With advance warning, evacuations can be planned and managed using procedures and systems that have been developed as a result of extensive and methodical pre-planning. This approach, however, does not adequately support management of incidents when there is no advance warning or when conditions are changing rapidly. Evacuations in response to these types of incidents tend to be monitored, but not well managed.

The FHWA recognized the importance of and need for new tools and processes to help agencies plan for and manage evacuations where there is little or no advance warning. Consequently, the FHWA initiated a project to assess the state of the practice and state of the art in evacuation transportation management.

Objectives identified for this project are to:

- Assess what is known about transportation management during evacuations in no-notice situations
- Provide initial guidance that agencies can use in planning for evacuations
- Provide input to the development of tools for real-time management of evacuations, especially from a transportation perspective.

A decision to evacuate residents, visitors, and businesses in the event of an emergency is normally not a decision for transportation agencies. Emergency management and senior elected officials make that decision. However, transportation and law enforcement personnel are key to a safe and successful evacuation.

In an advance-notice evacuation, there is adequate time to alert the public on the routes to take, to install and place messages on variable message signs, to provide the media with critical transportation information to broadcast, and to post information on agency Web sites, as well as to take necessary precautions such as locking down drawbridges when winds reach a certain threshold.

In a no-notice evacuation, transportation personnel have no time to accomplish those activities. They must rely on whatever evacuation procedures and processes are in place, and then make adjustments as events progress. Transportation staff must rely on information from agencies and individuals providing emergency management, law enforcement, fire, and other critical services, and coordinate with them while maintaining their primary mission of moving people quickly and safely on the transportation system during an evacuation.

There are eight tasks for the FHWA Assessment of State of the Practice and State of the Art in Evacuation Transportation Management. Task 2 is a literature search, and this is the second deliverable for the project.

This report is organized into the following sections:

1. Executive Summary
2. Introduction
3. Methodology for Literature Selection
4. Findings
5. Lessons Learned
6. Best Practices

7. Potential Tools.

From these reports and numerous other articles and publications, this literature search assessed what is known about transportation management during evacuations of no-notice situations, which is one of the objectives of the project.

The literature search found that there was no definitive article or publication that addressed evacuations during no-notice incidents. However, a review of the literature found several documents that relate to evacuations regarding the 9/11 terrorist attacks in New York City and Washington, DC; the blackouts of New York City and Detroit, Michigan; the firestorms of British Columbia, Canada; the southern California wildfires; the Northridge earthquake; the I-95 tanker explosion; and the Howard Street rail tunnel fire in Baltimore, Maryland. The focus of these reports was not necessarily on evacuations, but information was included on these incidents and others incidents because it is applicable to no-notice events.

Several articles and publications prepared after incidents proved invaluable for this literature search including the *Effects of Catastrophic Events on Transportation System Management and Operations Studies*, the *San Bernardino County Fire Chiefs' Association: Lessons Learned Report: Fire Storm 2003: "Old Fire,"* and the *Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center*. Although the two wildfire reports were not written from a transportation perspective, information from them was applicable since the incidents involved no-notice evacuations.

From these reports and numerous other articles and publications, this literature search attempted to assess what is known about transportation management during evacuations in no-notice situations. The search addressed issues regarding evacuations, lessons learned, best practices, and tools.

The next step in this project is the identification of no-notice evacuation case studies that are to be researched from a transportation point of view. Three possible candidates are the South Carolina chlorine gas incident in Graniteville; the El Dorado, Arkansas, hazardous-material fire; and the southern California wildfires. The Graniteville and El Dorado incidents both involved no-notice evacuations and are recent events with lessons learned still fresh in the mind of participants. In addition, the El Dorado incident involved the evacuation of a jail and two nursing homes. The southern California wildfires have been studied but not from a transportation aspect.

3 Methodology for Literature Search

The Booz Allen team employed the following three-step process to complete the literature review and research process:

1. Collection of relevant domestic and international evacuation reference materials, plans, policies, procedures, newspaper and magazine articles, journals, industry publications, and other documents
2. Review and analysis of the documents
3. Compilation of the results of the analysis for presentation to the FHWA in a final report.

3.1 Collection of Relevant Documents

To properly research the data needed for the literature search, an extensive Internet search was performed. Information was gathered and documented from a variety of sources including:

- 511 Deployment Coalition Web site
- Association of Bay Area Governments Library
- DisasterRelief.org Web site
- Federal Department of Transportation Library
- Federal Emergency Management Agency Web site
- FHWA Web site
- Federal Transit Administration Web site
- Fire Protection District Web sites
- General Accounting Office Web site
- Institute of Transportation Engineers Web site
- Intelligent Transportation Society of America – News of the Week
- James E. Clyburn University Transportation Center – South Carolina State University
- Journals
- Louisiana State University – LSU Hurricane Center Web site
- MIPT – Oklahoma City National Memorial – Institute for the Prevention of Terrorism Web site
- National Fire Protection Association Web site
- National Hurricane Center Web site
- National Oceanic and Atmospheric Administration Web site
- Natural Hazards Center (University of Colorado) Web site
- Newspaper and News Organizations Web sites
- Norman Y. Mineta International Institute for Surface Transportation Policy Studies – San Jose, California
- North Carolina A&T State University Transportation Institute
- Oak Ridge National Laboratory Web site
- Province of British Columbia, Canada, Web site
- Special events, ITS, hurricane workshops and/or conferences

- State of Florida multiple Web sites
- State of Georgia Department of Transportation Web site
- State of South Carolina Web site
- Texas Transportation Institute Web site
- Transportation Libraries Catalog
- Transportation Research Board Web site
- US Army Corps of Engineers Web site
- US Nuclear Regulatory Commission Web site
- University of California Transportation Library
- University of South Carolina – Hazards Research Lab, Department of Geography Web site
- Wildfire Lessons Learned Center – National Advanced Fire Resource Institute, Tucson, Arizona, Web site.

The literature search included domestic and international documents describing evacuations with an emphasis on no-notice evacuations. **Appendix A** provides a comprehensive listing of the literature reviewed categorized by source, title, author, date, and type of evacuation.

The focus of the literature search was on evacuations during no-notice incidents; however, there was little applicable literature found. As a result, the literature search also included lessons learned, anecdotal information, and any tools or best practices from advance-notice evacuations that can be adapted for no-notice evacuations.

3.2 Review and Analysis of Information

The literature search sought to identify anecdotal information and documented assessments of evacuation experiences, lessons learned, and any guidance for transportation, public safety, and emergency management agencies that may have been developed following evacuation events. The Booz Allen team identified the following evacuation transportation issues and considerations: nature of the hazard, transportation objectives, infrastructure, coordination, communication, special needs, changing conditions, and impacts to transportation.

A review of the literature found that very little has been written and documented on no-notice evacuations. Part of this may be due to the nature of the incident (perceived as once in a lifetime) and the willingness of participants to conduct an examination of the event. Information has been written regarding the 9/11 terrorist attacks in New York City and Washington, DC; the blackouts of New York City and Detroit, Michigan; the firestorms of British Columbia, Canada; the southern California wildfires; the Northridge earthquake; the I-95 tanker explosion; and the Howard Street rail tunnel fire in Baltimore, Maryland. However, the focus was not necessarily on evacuations. Information was included on these incidents and others since it is applicable to no-notice events and those with some notice such as hurricanes.

4 Findings

Evacuations sometimes occur without advance warning or preparation. The phrase "no-notice" evacuations at times may be misleading. Communities that are located in fire- and flood-prone areas should expect to see wildfires during any fire or flood season. Communities located next to main line railroad tracks that are used to transport hazardous materials might expect to see a hazardous waste or chemical spill. On the other hand, communities should not expect to see acts of terrorism frequently such as the 9/11 terrorist attacks on New York City and Washington, DC.

What makes no-notice evacuations different is that communities can plan for the incident but generally have little time to assess the situation and start the evacuation process. During a no-notice situation, the need to react is immediate, with little advance warning. No-notice evacuations tend to be monitored rather than managed due to their chaotic nature.

4.1 Common Themes from the Analysis of the Available Literature

The following are some common themes regarding evacuations that have been identified through the literature search. This list, not meant to be exhaustive, is organized alphabetically and not in order of importance.

- Events can be difficult to manage.
- One can be trained but not fully prepared.
- People can be left behind.
- There are increased difficulties in coordinating and directing the evacuation.
- There can be a lack of or little information on the event.
- There is "on the fly" decision making.
- There is a need for tabletop exercises conducted on possible scenarios.
- There is an increased probability of road accidents or unforeseen circumstances.
- There is conflicting information on the event.
- There is limited ability to issue "prior to event" evacuation orders.
- There is the inability to predict the time available for the population to seek shelter.
- There may be a lack of or little choice in the situation.
- There may be a lack of or little opportunity to shelter in place due to the rapid nature of the incident.
- There may be a reliance on evacuation procedures (emergency management practices) in place and adjustments as the event progresses.
- There may be difficulty in implementing special traffic regulation measures and plans.
- There may be panic-type evacuations, in which there are changes in ordinary behavior due to panic situations.
- There may be rumors due to lack of information on the event.

4.2 Issues Regarding Evacuations

As part of the literature search, key issues such as the nature of the hazard, transportation objectives, infrastructure, coordination, communication, special needs, changing conditions, and impacts to transportation systems were identified for developing and implementing transportation evacuation plans. The purpose of this literature search was not to assess transportation evacuation plans, but to identify these issues, key findings, and lessons learned from the responses to evacuation incidents.

4.2.1 Nature of the Hazard

This section of the report provides information on the nature of the hazard, divided into information on the chaotic nature of evacuations, enforcement of evacuation orders, evacuation decisions, evacuation management, getting people to evacuate, impacts of and to transportation systems, knowledge of the hazard, nighttime evacuations, and response to hazards.

Some of the findings of this issue include:

- Evacuations are chaotic.
- Enforcement of evacuation orders is problematic.
- Evacuation decisions are generally a local prerogative.
- No-notice evacuations are difficult to manage.
- It is difficult to get people to evacuate.
- There are impacts from and to the transportation system.
- Communities are aware of hazards that can lead to evacuations, but some events are so extraordinary to plan for.
- Evacuations can occur in all conditions, including at night.
- The responses to an advanced evacuation and a no-notice evacuation are similar.

4.2.1.1 Chaotic Nature of Evacuations

Evacuations by their very nature tend to be chaotic and disruptive. For example, the Transit Cooperative Research Program (TCRP) report *Synthesis of Transit Practice 27: Emergency Preparedness for Transit Terrorism* details the chaotic nature of the explosions that occurred at a fertilizer chemical plant in Toulouse, France, on September 21, 2001: “These explosions caused total panic throughout the city as everyone assumed it was a terrorist attack. There were vapors in the air that people feared might be toxic. Everyone tried to leave town at once. Regular telephone service did not work; only mobile phones were effective. Fire and police personnel had a very difficult time reaching the scene of the explosions, taking an hour to get there and organize the response.” Certainly, there was risk to the citizens of Toulouse and emergency officials due to the panic situation associated with this evacuation.

4.2.1.2 Enforcement of Evacuation Orders

Enforcement of evacuation orders can prove to be problematic. For example, during the 1997 flood in Grand Forks, South Dakota, the *American City and County* article “Community Evacuation: Ensuring Safe Passage” reports that some residents would not leave even when evacuation was ordered: “While cities and counties have multiple tools to communicate with residents, getting the residents to listen is another matter. In any disaster, there are die-hards who refuse to leave their homes, and, as a result, cities and counties have to be ready to enforce their evacuation plans.” Bryon Sieber, Commander for Planning

and Research at the Grand Forks North Dakota Police Department, notes in the article that the police had to physically remove residents from their homes—some because they were unable to move themselves, while others because they were simply stubborn and did not want to leave their homes. Ultimately, approximately 50,000 people from Grand Forks and surrounding communities fled the flood.

The *Valley Times* article "Train Carrying Chlorine Gas Derails: 8 Killed" details the chlorine gas derailment in Graniteville, South Carolina, on January 6, 2005: "Authorities ordered all 5,400 people within a mile of the crash to evacuate in the afternoon because chlorine was continuing to leak and the gas was settling near the ground as temperatures dropped. Authorities convinced all but about a dozen people in the area to evacuate, and set up shelters for evacuees."

4.2.1.3 Evacuation Decisions

Evacuation decisions (evacuation or shelter in place) generally lie with state and/or local government officials.

Who Determines Evacuation – Decisions on when to evacuate vary, but generally are the responsibility of state and/or local emergency officials. The article "Community Evacuation: Ensuring Safe Passage" reports that, in North Dakota, "only the governor can order a forced evacuation. A city ordinance enables our mayor to order an evacuation, but such an order won't have full authority unless the governor backs it up. This is true in many states."

During the South Carolina chlorine gas derailment, the New York Times.com article "8 Are Killed in Train Crash and Gas Leak" reported that Governor Mark Sanford declared a state of emergency for Aiken County, South Carolina, and officials told residents within a mile of the crash site to leave.

The Indystar.com article "Plant Fire Brings Call to Evacuate" details the chemical fire in Anderson, Indiana, on January 14, 2005: "Mayor Kevin Smith declared an emergency and ordered evacuations in a one-square-mile area around the Advanced Magnesium Alloys Corp. plant at 1820 East 32nd Street. Police spokesman Terry Sollars said 8,000 to 10,000 people may be affected."

Shelter-in-Place – Shelter-in-place has been debated among the emergency management profession. During the literature search, the emphasis was not to seek out literature on this debate. However, in some areas prone to wildfires, shelter-in-place communities have been developed. Shelter-in-place means that occupants of a building deemed safe will remain in that building rather than be evacuated from it due to the hazard. The length of time of the shelter-in-place is determined by local authorities based upon the nature of the hazard. Often extra precautions are required for shelter-in-place such as turning off ventilation systems that could draw in air contaminated from the hazard.

In answer to the question "Why not evacuate?" a Rancho Santa Fe Fire Protection District brochure entitled *Sheltering In Place During Wildfires* states "Most wildfire-related deaths occur during evacuation efforts. Factors contributing to the high number of evacuation injuries and deaths include: heavy smoke, flying embers, panicked drivers and the sheer volume of cars and horse trailers on the road. During past wildfires, dark smoke and last minute evacuations have caused panicked evacuees to drive off roads and crash, trapping them in the fire's path. Traffic collisions are also common during evacuation efforts. These incidents compromise the evacuation of other residents, as well as delay firefighters from protecting homes threatened by flames. For these reasons, it is safer for residents in shelter-in-place communities to stay inside their fire-resistive homes than risk evacuating on dangerous roadways."

Use of Non-Traditional Shelters – Research has been conducted into the use of non traditional facilities such as nursing homes as public shelters. As reported on the NBC 17 Web site article "Study: Nursing Homes Could Be Safe Havens in Disasters":

> A nursing home may not seem like the safest harbor in a storm, but a researcher at RTI International says it might actually be an excellent place to provide shelter, storage and emergency medical treatment in a disaster. Lucy A. Savitz is a health services researcher at Research Triangle Institute, the nonprofit scientific research and technology development corporation. In a study she recently completed for the federal Agency for Healthcare Research and Quality, Savitz found that nursing homes have the potential to contribute to their larger communities in times of public-health emergency. They can serve as alternative treatment centers, provide shelter to the displaced, and store hazardous material gear and other supplies, she said. Savitz said she decided to look at nursing homes' possible role in emergency response plans because no one else had.

The NBC 17 Web site article also reported:

> Susan Feeney of the American Health Care Association said nursing homes and elderly care centers in Florida took in senior citizens left homeless from the rash of hurricanes that ravaged the state last year, while New York first responders converted nursing homes into triage centers after the terrorist attacks of Sept. 11, 2001. Feeney said the homes are a perfect refuge because of the combination of trained nurses, medical supplies, and possibly empty beds. The key is to include nursing home administrators in emergency response planning. "I think utilizing nursing homes in disaster planning would make sense for all parties involved," she said. Involving the homes in planning would be good for their own sake, Savitz found. Her research also examined the homes' own emergency response plans and what special needs they might have if threatening situations arise. She found that most nursing homes have plans for natural disasters, but not for such man-made catastrophes as bioterrorism responses.

4.2.1.4 Evacuation Management

Until September 11, 2001, US citizens had limited experience with terrorist attacks on American soil. However, after the 9/11 attacks, the *Homeland Response* article "Evacuation: What We Can Learn—and Cannot Learn—from Hurricanes" reports that "this is a new reality and it is recognized that these events have the potential to be difficult to manage. Evacuations from a weapon of mass destruction would be incredibly difficult to manage. While emergency planners and responders can train and practice together, any local evacuations will hinge on two largely unknown factors: the ability of officials to discern the nature of the threat and communicate an action plan within minutes, and the ability of ordinary citizens to follow that plan."

4.2.1.5 Getting People to Evacuate

There are numerous studies on the behavior of people in a hurricane evacuation, and these studies have not been included in this literature search. However, the psychology of evacuation needs to be considered during evacuations and particularly during no-notice evacuations due to the short time available to execute the evacuation. As reported in the *Northwest Florida Hurricane Evacuation Study Technical Data Report*, "empirical evidence in evacuation after evacuation demonstrates emphatically that the very same people will leave promptly or slowly depending upon the circumstances of the particular threat. When people believe they have the luxury of taking their time to depart, most tend to do so. However, when the urgency of immediate response is communicated to people, they respond very swiftly, even

leaving between midnight and daybreak. One other factor is also clear: very few evacuees (less than 20%) leave before officials issue an evacuation notice." Notifying people as soon as possible that they need to evacuate is critical.

4.2.1.6 Impacts of and to Transportation Systems

Evacuations due to disaster may be impacted by the transportation system. As reported in *Disaster Response and Evacuation User Service: An Addendum to the ITS Program Plan*, "a major disaster may severely damage the transportation system in the impacted area. Local transportation activities will be hampered by damaged facilities, equipment, and infrastructure, as well as disrupted communications and electrical services. At the same time, the disaster will create significant demands on the transportation system in and around the disaster area as it is used to transport: outbound evacuees, inbound mutual aid operational resources, inbound state and federal operational resources, outbound returning mutual aid operational resources, inbound support shipments, inbound returning evacuees and outbound state and federal resources." Therefore, additional hazards may occur in responding to the initial event due to the movement in and out of an evacuated area.

4.2.1.7 Awareness of the Hazard

Communities located next to rail lines or natural hazards are generally aware of the hazards and the potential for an evacuation. However, some events are so extraordinary and occur so infrequently that communities and people are taken by surprise.

Graniteville, South Carolina – Evacuation incidents occur infrequently, but emergency officials plan for their likely occurrence. For example, on January 6, 2005, a freight train had a derailment that released clouds of chlorine gas, killed nine people, and forced the evacuation of 5,400 citizens of Graniteville. The initial decision was to shelter in place, but due to the nature of the incident (toxicity of chlorine gas), emergency management officials decided to evacuate.

The *Contra Costa Times* article "Chlorine Spill Forces Evacuations" reported: "A lethal plume of chlorine leaking from a shattered rail tanker car kept 5,000 residents of this mill town away from their homes and forced officials to bring in repair crews a day after a pre-dawn train wreck and chemical spill killed eight people and sent scores to hospitals for treatment. A rapid response by local emergency officials in the hours after two trains collided on Thursday morning helped evacuate hundreds of residents from a 'hot zone' of contamination around the still-volatile wreck. Officials continued to cordon off a mile radius around the now-deserted site, unable to staunch the flow of chlorine from one crushed rail car and worried about the possibility of leaks from two other cars loaded with toxic chemicals."

The *San Francisco Chronicle* article "Rail Spill Creates Ghost Town: Survivors Tell How Chlorine Gas Killed Their Coworkers at South Carolina Plant" reported "The disaster has turned Graniteville into a ghost town; its inhabitants replaced by investigators in hazardous materials suits."

The *New York Times* article "8 Are Killed in Train Crash and Gas Leak" reported "Governor Mark Sanford declared a state of emergency for Aiken County, South Carolina, and officials told residents within a mile of the crash site to leave. Area residents went to two local schools, where paramedics evaluated them and sent many to hospitals, where more than 50 were admitted."

The *Contra Costa Times* article "Chlorine Spill Forces Evacuations" also reported "Local emergency officials said Friday that they were able to move quickly to the collision scene, aided by practice drills and heightened planning since the Sept. 11, 2001, terrorist attacks." Therefore, plans and practice can lead to successful evacuations.

After the evacuation, an agreement was reached with the rail carrier, Norfolk Southern, "to reimburse more than 1,000 victims who suffered minor injuries, property damage, expenses and lost wages from a deadly chemical spill in January 2005," as reported in the *Virginian-Pilot* article "Norfolk-based Railroad to Pay Damages for Chemical Spill."

Great Lakes Region – On the other hand, there are events that are so extraordinary and occur so infrequently that people are taken by surprise when they occur. The blackout in the Great Lakes region is an example of that type of event. Massive blackouts have occurred on the East Coast before, but the blackout of August 2003 impacted the Great Lakes region in addition to the East Coast. As reported in *Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout Great Lakes Region*, "blackouts should be considered as part of standard emergency preparations and planning for all types of public infrastructure, including transportation." Lessons learned from the blackout event will be addressed later in this report.

La Conchita, California – Evacuations can occur at any time and any place with little to no warning. However, there are histories of certain events occurring in the same area. For example, the southern California city of La Conchita recently endured (January 10, 2005) a mudslide, brought on by 5 days of heavy rain. The mudslide killed 10 people and forced the evacuation of approximately one-half of the community or 150 people.

The *San Francisco Chronicle* article "3 Killed, 15 Homes Crushed by Tons of Rain-Soaked Mud: Death Toll in Southern California Storm Rises to 11 After Landslide" reported "Worried emergency workers had already started evacuating about 150 residents of La Conchita to shelters in Ventura when the steep hillside that looms over the town on Highway 101 broke loose about 2 p.m., turning into a 20-foot wall of mud."

The *San Francisco Chronicle* article "Slide Area Notoriously Unstable Same Hillside Failed in '95: Locals Debated Danger" reported mudslides in the same area in 1995, and as a result, "the county had promised to terrace the hillside as a way to stabilize it, but never followed through. County officials and residents knew about the danger but debated how serious it was. Signs warning of a potential landslide have been posted in the community for years. County officials had begun installing motion detectors on the slope and built a $400,000 retaining wall at the base of the hill between the slide zone and the community. But the detectors did not warn of the hillside's collapse and the retaining wall—designed to control minor slides or catch loose debris—only redirected some of the mud's flow into an adjacent part of town."

So one can conclude that the residents of La Conchita had an idea that the community was subject to mudslides, but they were still surprised when the event occurred in January 2005.

In addition, the geology of the ground at La Conchita impacted the rescue efforts. The "3 Killed, 15 Homes Crushed by Tons of Rain-Soaked Mud: Death Toll in Southern California Storm Rises to 11 After Landslide" article explained that search efforts "were suspended late in the evening when geologists determined that the remaining hillside was extremely unstable." Thus, the nature of the hazard can impact evacuation and rescue efforts.

4.2.1.8 Nighttime Evacuations

Evacuations occur in all types of weather conditions and sometimes at night. *Fire Lessons Learned in California* describes the Cedar Fire blazes in southern California: "The evacuation was frightening for residents because it took place at night. The fire started on Oct. 25 at dusk. It burned 273,000 acres,

demolished 2,820 structures, and killed 14 people. At its peak speed, the Cedar Fire burned 12,000 acres per hour, [Thomas] Cova [a researcher from the University of Utah] said, or two to three acres per second. 'That's breakneck speed for a fire in the middle of the night.'"

The report also noted, "Evacuations are typically made when a wildfire draws between two and eight miles from homes, said Cova. But some evacuations during the 2003 wildfires were as far as 10 miles out when they were playing it cautious."

Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center stated: "Experienced firefighters reported the importance of having confidence that their tactical decisions—based on training, planning, doctrine, and experience—were the right ones. In the aftermath, after revisiting affected areas, these same firefighters reported that they could see their decisions were the best they could make under the circumstances."

4.2.1.9 Response to Hazard

Hazards that force evacuations vary from a no-notice situation, such as a tsunami, to an advanced-notice situation, such as a hurricane, providing some level of warning to people. However, as reported in *Protecting Surface Transportation Systems and Patrons From Terrorist Activities: Case Studies of Best Security Practices and a Chronology of Attacks*, "to an overwhelming degree the type of emergency response to the scene of a terrorist attack will be the same as that required for emergencies and disasters from natural or accidental causes. Derailments and explosions occur accidentally as well as intentionally, as do hazardous material incidents, and every agency should have in place emergency response procedures that can be adapted to such incidents."

The I-95 Corridor Coalition's Mary Grace Parker states in *Learning from the 2003 Blackout*, "at the end of the day, whether it's a hurricane, a blackout, or a terrorist event, the way you manage traffic incidents is essentially the same. There's no incident that occurs on any scale that doesn't have traffic impacts. And most important is having the institutional and personal relations in place, nurturing and sustaining them."

So while hazards exist that require evacuations, tools, relationships, and communication protocols can be developed and in place to respond to evacuation events regardless of the nature of the hazard.

4.2.2 Transportation Objectives

Evacuations can be disruptive to existing transportation systems. As reported in *Disaster Response and Evacuation User Service: An Addendum to the ITS Program Plan*, "over 3 million people were evacuated as a result of Hurricane Floyd, which skirted the east coast of Florida and made landfall in South Carolina. This evacuation resulted in overloading of evacuation routes, causing extreme delays and exposing evacuees to personal risk."

This section will address literature found on transportation objectives. This includes areas to avoid, critical facilities, destinations (potential routes), distance for evacuation, emergency plans, evacuee locations, managing of traffic and people, number of vehicles involved in an evacuation, planning for evacuee return, redundant systems, staging of resources, and use of transit to evacuate.

Some of the findings on this issue include:

- During an evacuation, people may not know which areas to avoid.
- Critical facilities are needed after an incident to bring in supplies.

- Evacuation routes and detours have been identified and/or predetermined for emergency situations. However, at times, citizens may not be aware of the routes and their final destination.
- The distance of an evacuation depends on the reason for the evacuation.
- Evacuations lead to activation of emergency plans. However, transportation is not always integrated into the plans.
- Emergency planners need to account for traffic from adjacent surrounding communities.
- Traffic and people need to be managed during an evacuation.
- The number of vehicles that are involved in evacuations can prove to be problematic. Hurricane evacuations may have 21 to 25 percent of the evacuees taking more than one vehicle.
- There was little information found in planning for evacuee returns.
- Agencies can create redundant systems for incidents, but at times, events overcome this level of preparedness with agency staff filling in the breach.
- Public transit can be used to provide mobility during an evacuation, but there could be limitations to the use of public transit.

4.2.2.1 Areas to Avoid

During any evacuation, but especially during a no-notice evacuation, people fleeing the area may not be cognizant of areas that need to be avoided. People with cell phones, subscription service, or access to the 511 service (discussed later in the tools section) may be able to identify areas to avoid, but others would have limited information on these areas.

However, variable or dynamic message signs, highway advisory radio, and the media can provide information and guidance to drivers to avoid upcoming areas on roadways. As reported in *Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study*, during the 9/11 terrorist attack on Washington, DC, "traffic into the city was detoured, as Washington declared a state of emergency. Ramps were closed from interstates, and variable message signs alerted motorists to avoid the area. Retiming traffic signals for very heavy peak-period outbound traffic facilitated traffic flow out of Washington. High occupancy vehicle restrictions were removed, and overhead sign changes, travelers' advisory radio, and the media alerted motorists to changes in traffic patterns."

4.2.2.2 Critical Facilities

After a natural disaster such as an earthquake, supplies are needed for the area impacted by the earthquake and routes into the area can become critical. As reported in *Riding out Future Quakes: Pre-Earthquake Planning for Post-Earthquake Transportation System Recovery in the San Francisco Bay Region*, "since the Northridge earthquake, the California Department of Transportation has been working on adopting a system of lifeline routes that would facilitate movement between major staging areas and impacted areas following major earthquakes. The Stockton and Tracy areas (Central Valley) may serve as such a staging area for getting emergency supplies into an impacted San Francisco Bay region. In that case, I-580 becomes a critical lifeline route."

4.2.2.3 Destinations – Potential Routes

Evacuation routes and detours have been identified and/or predetermined for emergency situations. However, at times, citizens may not be aware of the routes and their final destination.

Detours Associated with Routes – Many states have predetermined detours for emergency situations. As reported in *I-95 Shutdown: Coordinating Transportation and Emergency Response*, "Maryland State Highway Administration and local police lost no time setting up the predetermined detours for affected travelers (tanker explosion—Baltimore, Maryland). At 2:57 p.m., staff in the Maryland State Highway Administration traffic operations centers followed established procedures to alert local police and redirected motorists traveling northbound on I-95 to Maryland 100, and moved southbound traffic to I-195."

Evacuation Routes for the Chemical Stockpile Program – Transportation evacuation routes and host counties have been identified for the Chemical Stockpile Emergency Preparedness Program (CSEPP) at Jacksonville State University. According to their Web site, "certain emergencies may require mandatory action such as evacuation. Calhoun County has been divided into zones in order to coordinate evacuations. Primary and alternate evacuation routes and reception/mass care hosts counties have been established, by zone, for major emergencies. It is recommended that citizens know their evacuation routes (primary and alternate) and reception/mass care host counties."

Evacuation Routes for the Nuclear Industry – Evacuation routes are identified for the nuclear industry. To assist in identification of the routes, the US Nuclear Regulatory Commission Web site reports: "evacuation time estimates are developed for each nuclear power plant site. These estimates assist government authorities to determine the best exit routes and traffic control points. The time estimates are used to identify potential traffic congestion and to develop plans for traffic management and use of traffic control personnel during an evacuation."

For example, the Emergency Management Agency for the Borough of Monaca, Pennsylvania, has developed evacuation routes by ward in the event of an incident at the Beaver Valley Power Station (nuclear facility). The Borough informs the public on its Web site: "in no way should you begin to evacuate your home or business unless you are specifically directed to do so by an official source as described above. If an evacuation is ordered, you should take local Monaca routes as described below. Using any other route may slow your egress from Monaca and may disrupt the important flow of emergency vehicles." Pre-identified evacuation routes have been communicated to the public in case of the need to evacuate.

Maps of Evacuation Routes – Evacuation routes may be identified for the public, but, at times, citizens may not know where the evacuation routes are located. *South Carolina's Response to Hurricane Floyd* reported, "About 63% of respondents carried road maps, yet only 51% used them to determine their route."

Wildfires Evacuation Routes – Fire districts, such as the Rancho Santa Fe Fire Protection District of California, inform citizens of the need for evacuation routes. The *Wildfire Preparedness and Evacuation* brochure stated: "During a wildfire, roads become congested with vehicles, making evacuation a slow process. Long before evacuation seems likely, gather your family, your pets and your belongings and leave the area. When evacuating, use a route that takes you in the opposite direction of the fire. Try to avoid roads encased in dense vegetation and lined with trees; if the fire sweeps through this area while you are in your car, you may become trapped."

4.2.2.4 Distance for Evacuation

How far one evacuates depends on the reason for the evacuation. For the State of South Carolina, prior to Hurricane Floyd, officials evacuated up to 50 miles during hurricanes. But after Hurricane Floyd, the state now evacuates the entire coast line and up to 100 miles inland, as reported in *South Carolina Hurricane Evacuation Program 2003.*

However, citizens will determine how far they need to evacuate. *South Carolina's Response to Hurricane Floyd* reported, "the majority of South Carolinians traveled out of state to destinations farther than necessary for safe sheltering."

During situations, evacuations may be up to a few miles out of the danger zone. During the derailment in Graniteville, South Carolina, that involved the release of chlorine gas, the evacuation occurred within a distance of 1 mile from the scene of the event, as reported in the *New York Times* article "Fateful Decisions as Deadly Gas from Train Wafted Toward Mill."

4.2.2.5 Emergency Plans

When a hazard occurs and an evacuation is required, government agencies and citizens activate their emergency plans. However, transportation is not always integrated into the plans.

Activation of Emergency Plans – Evacuations lead to activation of emergency plans. During the terrorist attack in New York City on September 11, 2001, *Saving City Lifelines: Lessons Learned In the 9/11 Terrorist Attacks* reports: "New York City Transit dispatchers, hearing of the plane crash, activated their emergency plans. One train was approaching Cortland Street when the driver received word of the crash from the operations center. He moved rapidly through the station and pulled the train and its passengers to safety. Other trains were rerouted or held back from the damaged area. According to New York City Transit's longstanding plan for emergencies, all trains were to go to the closest station and evacuate passengers and crew, pending fire department response and New York City Transit evaluation."

Emergency plans and experience pay off for officials during incidents. For example, *I-95 Shutdown: Coordinating Transportation and Emergency Response* describes the I-95 tanker explosion in Baltimore, Maryland: "Within 20 minutes of the incident, Maryland State Highway Administration personnel and police units implemented traffic detours and disseminated information to motorists about alternate routes." In addition, "according to Major [Bill] McMahon [of the Howard County Police], the attacks on September 11, 2001, and local weather events like snowstorms and hurricanes have helped law enforcement and emergency response professionals work together in many cross-jurisdictional situations. 'In fact,' says McMahon, 'Howard County has plans for what we call an 'in-vacuation' that recognizes the traffic effects of what would happen if there was an emergency in Washington, DC, to our immediate south.' He attributes part of Howard County's success on January 13, 2004 [tanker explosion] to these preparations for possible terrorist activities."

Learning from the 2003 Blackout reports that, during the New York City blackout of 2003, "because of lessons learned from past emergencies, the agencies responsible for the city's transportation system had response plans in place. Previous major blackouts, preparations for the year 2000 (Y2K), and the events of September 11, 2001, had prepared the region to deal with significant disruptions to its transportation network. But the plans did not anticipate the scope and duration of the August 2003 blackout."

Earthquakes and Transportation – Transportation can be part of an emergency plan, and has been incorporated into earthquake preparedness in the San Francisco Bay area. The *ITE Journal* article "Improving Transportation Response and Security Following a Disaster" reports the San Francisco Bay Area developed a Trans Response Plan in the late 1990s. The Trans Response Plan has assigned the Metropolitan Transportation Commission (MTC) several roles. (1) Regional Clearinghouse—"collects and analyzes each individual transit agency's damage and operating status to develop an ongoing regional transportation status report for all nine counties throughout the course of the emergency. The regional transportation status report is to be distributed to inform transit agencies, the state Office of Emergency Services (OES), the media and the public of new events and as situations change." (2) Interagency

Coordinator—"by compiling a centralized, comprehensive damage picture, the OES and the Federal Emergency Management Agency can be coordinated with the region's priorities." The MTC also is notified of where coordination is needed and gets the involved agencies to address the need." (3) Developer of Long-Term Alternatives—focus on developing long-term transportation alternatives "including the creation of new transit service and roadway options to substitute for inoperable highways and transit services and the coordination of new and surviving services to facilitate movement of emergency resources throughout the Bay area."

Transportation Identified – Emergency plans exist for various entities, but, as reported in *Transportation for Emergency Response and Recovery*, "few have transportation fully integrated into the plan. In addition, (a) under 50% mention media coordination, traveler information and asset protection, (b) 15% mention coordination with Emergency Operations Center and transit, (c) less than 50% have no evacuation routes specified, (d) transportation contacts are included in 2/3 state plans, 1/3 municipal plans, and (e) ITS applications are not discussed."

In addition, *Vision 2010: Enhanced National Capabilities for Emergency Transportation Operations* reports:

> "Historically, emergency planning in the United States has been the responsibility of local and state emergency management and law enforcement agencies. Prior to September 11, 2001, with the exception of hurricane evacuations in the southeast, relatively little attention had been paid to full-scale emergency situations that required the maximized and coordinated use of the entire transportation infrastructure available in a given community or region. In response to recent events, however, this situation is changing."
>
> "State and local departments of transportation and public transportation systems are being recognized as more significant players in emergency operations and evacuation planning, warning, response, and recovery. Emergency managers, at all levels of government and within the private sector, are also developing a growing appreciation for the importance of transportation in their plans, procedures, operations and exercises."
>
> "Although there are established protocols in the emergency management and public safety communities for emergency planning and operations, the degree of integration of transportation systems is uneven. The FHWA recently completed a survey that compiled emergency transportation plans at the state and local levels. Between 20 and 30 emergency transportation plans were gathered and assessed for their content. Fewer than half of the plans surveyed had any media coordination, traveler information, or asset protection pertaining to transportation. Only one in ten identified coordination between transportation, the Emergency Operations Center, and the transit system. Fewer than half of the transportation plans specifically identified evacuation routes. Two-thirds of the plans contained a contact for a transportation person in a state and only one-third of the municipal plans contained the name of a transportation contact. Not one of the plans discussed the use of ITS applications for emergency response."
>
> "These results indicate a dramatic need to look at emergency plans and to fully incorporate transportation, including ITS applications. These results also reflect the experience of TMC managers around the nation, who are calling for improved technical and policy tools to support their efforts to coordinate more closely with emergency planning and public safety communities."

4.2.2.6 Evacuee Locations

Emergency planners need to account for traffic from adjacent surrounding communities. During hurricane evacuations, adjacent states sometimes receive traffic while trying to evacuate their own citizens. The Times-Picayune Online article "Communication Called Storm Evacuation Key," reported: "Hurricane Ivan was the first test of the plan, developed in 1999, and it produced a rash of complaints from people stuck in traffic for 10 hours or more as severe bottlenecks developed in Hammond, at the intersection of Interstates 55 and 12, and in Baton Rouge, where I-12 merges into I-10. The jams were exacerbated when cars streaming out of the New Orleans area were joined by motorists from Mississippi, Alabama and Florida who also were fleeing west."

According to the FHWA Transportation Evacuation Planning and Operations Workshops 2004 presentation "Hurricane Evacuation Routes," to account for out-of-state traffic, the Mississippi Department of Transportation and the City of Hattiesburg, Mississippi, recognized that "all Gulf Coast evacuation routes converge at the City of Hattiesburg. Fiber optic cable [was] installed to allow the City to see camera sites on the coast and prepare for what is coming. The City and the Mississippi Department of Transportation stay connected with information."

During evacuations, evacuees are fleeing from the incident and may come from multiple directions depending on the incident. Thus, it is important that plans for evacuations extend beyond traditional jurisdictional boundaries and consider an evacuation that may impact multiple communities.

4.2.2.7 Managing Traffic and People

Traffic and people need to be managed during an evacuation.

Blackout 2003 – During the 2003 blackout in New York City and Detroit, Michigan, measures were implemented to manage traffic and people out of the cities. According to *Learning from the 2003 Blackout*, the following events occurred:

New York City:

- The New York Police Department – Reassigned approximately 2,000 traffic agents to begin directing traffic.
- The Metropolitan Transportation Authority Bridges and Tunnels – Switched to backup generator power and continued to operate. Reversed lanes in crossings to accommodate buses returning to Manhattan, and suspended outbound tolls.
- New Jersey Department of Transportation Traffic Operations-North – Initially lost power, but within an hour was displaying highway advisories on its variable message signs.
- New Jersey Transit – Implemented its pre-established plan for communications outages, established a bus "bridge" to replace the Hoboken light rail system, and started a "load and go" operation from the Port Authority Bus Terminal in Manhattan to the Meadowlands Stadium.
- New York City Transit (Bus) – Started a shuttle service from Penn Station to the Long Island Rail Road station at Jamaica, sent buses to major subway stations, and suspended fares.
- New York City Transit (Paratransit) – Continued operations and prioritized patrons needing life-sustaining services.
- New York City Transit (Subway) – Began the evacuation of 400,000 subway passengers.
- Port Authority of New York and New Jersey – Activated the Emergency Operations Center; closed or restricted access to facilities that lost power.

- Port Authority Trans-Hudson Corporation – Identified the location of its 19 en-route trains and then shut down the system and evacuated passengers.
- Transportation Operations Coordinating Committee – Issued facility status bulletins by fax, e-mail, and phone, including a toll-free number.

Detroit:

- Ambassador Bridge – Used existing backup power to maintain operations throughout the duration of the blackout.
- Detroit-Windsor Truck Ferry – Continued operations with reduced communications capabilities, processing documentation by hand rather than electronically and suspending online reservation and advanced notification systems.
- Detroit-Windsor Tunnel – Used preplanned emergency protocol to close and evacuate the tunnel within 15 minutes of the blackout.
- Michigan Department of Transportation – Powered down all computer network operations to prevent the system from crashing and communicated with the Governor's office by landline telephone.
- Michigan ITS Center – Ceased regular operations in order to reserve staff members for activities associated with the restoration of power.
- Oakland County Emergency Response and Preparedness County Service Center – Opened and remained operational throughout the outage, supporting an area consortium of police, fire, and other responders. Distributed generators, managed water supplies, and relocated 120 critical patients to hospitals that had backup power.
- Road Commission for Oakland County – Prioritized intersections for use of portable generators.
- Suburban Mobility Authority for Regional Transportation (SMART) – Maintained operations throughout the first day of the blackout, suspended general service during the second day due to loss of communications equipment, but continued service to priority paratransit customers, and loaned vehicles to area fire departments for use as public cooling stations.

Gates in Chicago, Illinois – During an evacuation, the need for traffic management can become critical to help direct people and cars fleeing from the evacuated area and to ensure additional people and cars do not enter the evacuated area. The Illinois Department of Transportation is "testing an emergency plan to shut off access to downtown Chicago from local expressways during a terrorist attack or other catastrophe in the Loop, officials said Tuesday (May 17, 2005). The measure is aimed at speeding up the evacuation of the downtown during a disaster by more effectively controlling traffic and panicky drivers. It involves installing up to 80 gates to block access to inbound expressway ramps along five interstate highways that lead into the city, according to the Illinois Department of Transportation (IDOT). The remotely operated gates, a heavy-duty version of the barriers already in place on the Kennedy Expressway's reversible express lanes, would swing closed to prevent vehicles from entering highways to travel to or through the central business district," as reported in the *Chicago Tribune* article "Gates Would Cut Access to Loop in Terror Attack."

In addition, according to the article, "the automatic gates would free up officers for other duties in an emergency. The Chicago region's evacuation plan counts on posting police at highway ramps to stop non-emergency vehicles from entering. 'With the gates, you wouldn't need a police cruiser blocking or guarding every ramp,' said IDOT spokesman Mike Claffey. If the experiment is successful, the barrier system would be expanded to include up to 80 inbound ramps on the Kennedy, Dan Ryan, Eisenhower, Stevenson and Edens Expressways, Claffey said."

General Traffic Management – Traffic management is needed to handle the flow of traffic and people out of an evacuation zone. According to "Urban Evacuation in Seismic Emergency Conditions," published in the *ITE Journal*: "If the evacuation is carried out, even partially, using private cars (if this is found to be possible and compatible with rescue operations) and, particularly if the evacuation is coordinated, it would be worthwhile to implement traffic control measures that make it possible to optimize the working of the system and take on unforeseen situations. In particular: (1) place two officers at each critical intersection so that one can give assistance and information to drivers in need; (2) set signal patterns to provide the most green time for the approach leading away from the area; (3) leave a lane open for use by emergency vehicles and vehicles traveling against the flow of evacuation traffic; (4) suspend the payment of any tolls to maximize the access capacity of the roads concerned; (5) select the evacuation routes that minimize left-turn conflicts; (6) supplement the directions to be imposed with physical barriers; and (7) prevent the movement of long vehicles (trucks and mobile homes)".

Hurricane Lessons – Hurricanes have been studied for many years and lessons from them can be applied to no-notice evacuations. As reported in the *South Carolina Hurricane Evacuation Program 2003*:

- Traffic (needs to be accounted for) from adjacent states
- Avoid conflict points on evacuation routes and all conflict points manned by law enforcement
- Efforts for (hurricane) re-entry should match evacuation efforts
- Interstate reversal for return traffic is an option.

Maryland 9/11 – To manage traffic in and out of the Maryland area during the terrorist attack of September 11, 2001, the *Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study* reports: "Maryland transportation authorities implemented a number of specific actions statewide in response to the situation. Stranded or abandoned vehicles, especially under bridges, were moved. All video surveillance cameras at high-profile locations, including major bridges and tunnels, were activated and monitored."

4.2.2.8 Number of Vehicles Involved in Evacuations

The number of vehicles that are involved in evacuations can prove to be problematic. According to *South Carolina's Response to Hurricane Floyd*, "at least 21 percent of households took two cars." However, this information was in regard to a hurricane evacuation when people may have more time to reason and plan during an evacuation, as opposed to a no-notice evacuation in which the need is to flee quickly.

The *Coastal Heritage* article "Floyd Follies: What We've Learned" reports: "The number of vehicles on the road during evacuations has grown even faster than the coastal population. During Hurricane Floyd, about 25 percent of households from the Charleston area evacuated in more than one vehicle. 'One of the reasons that the roads were so clogged was because people were taking more than one car,' says Susan L. Cutter, a geographer at the University of South Carolina who studies evacuation behavior. Many families also hauled boats or recreational vehicles, adding to congestion. People were evacuating as a household unit, but they were traveling in separate cars and communicating by cell phone, doing it in a caravan."

According to the *Hazard Laboratory Hurricane Floyd Evacuation Study: Preliminary Report*, "People were surveyed on the number of cars took during the evacuation. Vast majority took one car; however, 25 percent took two or more cars with them during the evacuation."

4.2.2.9 Planning for Evacuee and Personnel Return

During the literature search, there was very little information on planning found for evacuee returns. However, the publication *Riding out Future Quakes: Pre-Earthquake Planning for Post-Earthquake*

Transportation System Recovery in the San Francisco Bay Region addressed workers returning to their place of employment.

After an evacuation, with transportation facilities coming back on line, problems may arise during workers return to work. *Riding out Future Quakes* describes the Loma Prieta earthquake in 1989: "The San Francisco airport was shut down not due to road failures or freeway closures but for the ability of air traffic controllers to travel to work safely and quickly."

4.2.2.10 Redundant Systems

Agencies can create redundant systems for incidents, but at times, events overcome this level of preparedness with agency staff filling in the breach. According to *Saving City Lifelines: Lessons Learned in the 9/11 Terrorist Attacks*: "The new Emergency Operations Center at the World Trade Center had been built with redundant systems and independent power supplies. Emergency planners had relied on internal redundancy to store emergency plans and vital records, but those records and plans were now inaccessible. With the evacuation of Building 7, copies of the city's emergency operations plans had to be retrieved from other agencies and from personal storage, which required some time. Fortunately, the well-trained Office of Emergency Management staff members were able to implement their emergency action plans from memory and combined knowledge."

During the Great Lakes region blackout of 2003, the *Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout Great Lakes Region* reports: "'Immediate backup generating capability enabled the Ambassador Bridge to remain fully operational throughout the blackout, as did US Customs at one end of the bridge. A bridge representative estimated that there was about a three- to four-hour backup to get into Canada during the blackout. There were also US-bound backups, but they were much less severe."

4.2.2.11 Use of Transit

Public transit can be used to support evacuations and has been in the past; however, there are some limitations to the use of public transit.

Limitation of Use of Transit – Transit can be used to provide mobility during an evacuation; however, there could be limitations in its use. According to *Emergency Evacuation: Ensuring Safe and Efficient Transportation Out of Endangered Areas*, "Most emergency management officials agree that roadway capacity and mass transit assets are not sufficient to evacuate major metropolitan centers like New Orleans, Louisiana, or Miami, Florida, in two or three days. A contributing problem is evacuation over response, or 'shadow evacuation,' which occurs when people receive incorrect information or overreact to a threat. For example, during Hurricane Floyd, the Florida Division of Emergency Management estimated that about 35 percent of the approximately 2 million evacuees on state roads did not need to leave their homes." Public transit does have a role to play, but it depends on the size and nature of the evacuation.

New York City 9/11 – Public transportation played a critical role in the evacuation of citizens from New York during the terrorist attacks of September 11, 2001. According to *Saving City Lifelines: Lessons Learned in the 9/11 Terrorist Attacks*: "When the city's transit stations and tunnels were damaged by the collapse of the World Trade Center towers, and its vehicular tunnels and bridges were shut down for security reasons, the huge, complex public transportation system became its lifeline… Emergency operators at the Metropolitan Transportation Authority ordered all available equipment into Grand Central and Penn Stations. Three lines on Metro-North and three lines on the Long Island Rail Road were used for evacuation. Trains operated on a load-and-go basis, departing as soon as they were filled. This procedure had been used before, and interviewed sources said that commuters were familiar with it. …

Buses loaded passengers and headed north. No one paid attention to fares or routes. New York Police Department's Harbor Unit ferried 5,000 people to New Jersey and Staten Island, and the commercial ferry transports and tugboats moved victims and fleeing people to New Jersey.…As the areas of damage were identified, alternate methods of providing transportation were being evaluated. Bus service could be substituted on a limited basis for some train service in Lower Manhattan, and alternate lines still in service could take passengers to nearby stations."

Public transit moved evacuees out of New York City; it also moved rescue personnel into the city and equipment to the rescue efforts. *Saving City Lifelines* also reports: "The transportation system did not collapse. Civilians were moved out of harm's way, and emergency personnel were moved in. In addition to its normal duties, New York's Metropolitan Transportation Authority mobilized its redundant transportation capacity. When the subway service to Lower Manhattan was suspended in the aftermath of the attack, Metropolitan Transportation Authority could enlist New York City Bus and Paratransit to move civilians from Lower Manhattan and security duties. Metropolitan Transportation Authority also had its own armada of specialized heavy equipment and personnel to assist in the rescue effort."

In addition, *Saving City Lifelines* reports that within minutes of the 9/11 terrorist attacks, "New York City Transit went to emergency operations one minute after the first plane hit; Port Authority Trans-Hudson did so within six minutes. Hundreds of buses were dispatched as a 'rescue brigade' to move people uptown from the World Trade Center area."

The *Metro Magazine* article "Transit Steps Up Security" reports: "Travel between New Jersey and Manhattan surged 3 percent overnight and travel between Newark and Penn Station grew 45 percent in the days following the attack. Travel on the Hudson-Bergen light rail system shot up between 60 percent and 80 percent, with 6,000 new riders using the system. Several cars from the line had seats removed and were used to transport materials and rescue workers."

According to the article, ferry service also transported passengers after the 9/11 terrorist attacks: "Within five days after September 11, New Jersey Transit, in cooperation with the New Jersey Department of Transportation, designed, permitted, constructed and began service from a new ferry facility at Liberty State Park. [Jeffrey] Warsh says five times as many people are now using the ferry service across the Hudson River."

Evacuees used buses and ferries to evacuate New York City. *Effects of Catastrophic Events on Transportation System Management and Operations: New York City: September 11* reports: "People who were trying to cross into Brooklyn were able to use the series of bridges across the East River. Buses were rerouted to pick up passengers on the Brooklyn side of the bridges and take them to destinations in Staten Island, Queens, Brooklyn and Long Island. Those trying to cross into New Jersey from Manhattan had fewer options because the only river crossings in the area across the Hudson River are tunnels. Therefore people had to rely on the numerous ferries pressed into service that day."

The publication also notes: "According to the Port Authority, 160,000 people evacuated New York City on New York Waterway ferries, and 250,000 to 300,000 left by other water transportation, which included Coast Guard vessels and other privately operated dining boats and even tug boats. A retired fire boat evacuated 150 people on September 11, and came back to pump water to the World Trade Center site. This ad hoc flotilla operation was overseen by the US Coast Guard, with the assistance of the Port Authority and New York City Department of Transportation."

Saving City Lifelines reports: "As the areas of damage were identified, alternate methods of providing transportation were being evaluated. Bus service could be substituted on a limited basis for some train service in Lower Manhattan, and alternate lines still in service could take passengers to nearby stations."

According to the article "Transit Steps Up Security," "Realizing an evacuation of federal agencies in DC was imminent; the Virginia Railway Express halted a northbound train in Manassas and ordered everyone off. The train was then run express to Alexandria, where it was set up to provide shuttle service to Manassas for the rest of the day. Most Virginia Railway Express equipment was trapped north of the 1st Street tunnel under the Capitol. The tunnel was shut down until federal agents could conduct an inspection, says Dave Snyder, Virginia Railway Express's superintendent of railroad services. Fredericksburg line service was supplemented with buses until the tunnel was reopened."

Possibilities of Use – Public transit can assist in evacuation situations. According to the *Role of Public Transportation Operations in Emergency Management: Research Report*: "Possibilities for transit agency involvement in Texas include the following: evacuation of local residents during flooding, fires, hazardous-material spills, bomb threats, or other emergency conditions; transport of emergency workers and volunteers to and from an emergency staging site; supplemental transportation for people and supplies within a city or county during recovery from flooding or other area-wide disasters; use of air-conditioned/heated buses as shelter/respite facilities for emergency workers and victims; especially valuable during a fire or hazardous-material response effort; communications support, if buses are radio-equipped; monitoring of road and weather conditions; determining safe travel routes; and supplemental vehicles for police or other local agency."

San Francisco Earthquake – Public transportation can provide mobility to an area after a natural disaster by providing transportation into and out of the incident area. The *Role of Public Transportation Operations in Emergency Management: Research Report* also describes the 1989 San Francisco earthquake: "The 1989 San Francisco earthquake destroyed some of the area's primary traffic arterials and damaged others to the point of impassability. The San Francisco-Oakland Bay Bridge and the I-880 freeway, which together comprised the main connection between the cities of San Francisco and Oakland, were closed after sections of these roadways collapsed. Several other freeways and on-ramps within San Francisco also closed, making travel in the city difficult. Within nine hours of the earthquake, the undamaged Bay Area Rapid Transit District subway system was running, providing the only reliable transportation in the city. In the aftermath of the quake, other transit systems in the area joined in the effort to keep residents and repair crews mobile. Buses, subway, commuter rail, and ferries maintained transportation in and around the cities until the roadways were rebuilt and kept a significant portion of the increased ridership even after automobiles were able to return to the freeways."

4.2.3 Infrastructure Issues

This section addresses literature found on infrastructure issues such as loss of infrastructure, monitoring of evacuation (critical routes, reverse flow), contra-flow lanes, transit assistance, use of specialty teams, use of ITS, and work zones.

Some findings regarding infrastructure issues include:

- The loss of infrastructure, including power, and equipment can impact evacuations.
- Critical evacuation routes are often monitored by governmental entities during an evacuation.
- Contra-flow operations have been have been used for evacuations, but do present issues such as having enough time to set up the operation, which may impact their utility for a no-notice evacuation.
- Resources can be staged to assist during an evacuation incident.
- Transit systems can assist following evacuations since transit agencies have infrastructure, personnel, and equipment that could prove to be useful.

- ITS equipment has been used to assist in evacuations. However, the equipment does need power, and after a blackout event, ITS equipment needs to be reset.
- Highway construction zones can impact evacuations.

4.2.3.1 Loss of Infrastructure

The loss of infrastructure, including power, and equipment can impact evacuations.

Loss of Computer Equipment – Loss of computer equipment can impact evacuations, particularly during blackouts. According to *Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout Great Lakes Region*: "The Road Commission for Oakland County staff maintained some computers and other essential or sensitive equipment at their Traffic Operations Center but lost all FAST-TRAC (Faster And Safer Travel Through Routing and Advanced Controls) technology of which the heart is a signal system known as the Sydney Coordinated Adaptive Traffic System which uses adaptive control technologies to regulate traffic signal timing and coordination to meet changes in vehicle demand capability in the field. Furthermore, a Road Commission for Oakland County representative explained that any ITS functionality would have been useless without signals to moderate traffic."

Loss of Power – Loss of power also can impact evacuations. The *Effects of Catastrophic Events on Transportation System Management and Operations* also reports: "In general, highways can function well without electricity. However, toll collection, tunnel ventilation, lighting, pumps to control flooding, and ITS equipment such as cameras, loop detectors, and variable message systems, depend on electricity. In the Detroit area, only the Ambassador Bridge was able to maintain these types of functions."

In addition, the publication reports: "The Michigan Intelligent Transportation System Center and its field equipment lost all power, leaving Michigan Department of Transportation staff unable to collect data, receive video feeds, or control variable message systems. They also had no telephones and had only spotty two-way communications with field staff. Like other agencies, they reported the loss of communications to be most frustrating."

According to *Learning from the 2003 Blackout*, "In Cleveland, public officials were unable to use the emergency response center immediately after the start of the blackout due to a lack of backup power."

Portable Equipment – Lack of portable equipment can also impact evacuations. *Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout Great Lakes Region* reports: "In Oakland County, the Road Commission for Oakland County staff faced 1,300 darkened signals, with just 20 portable generators to service them. On the fly, they tried to identify the most important intersections and deployed crews to install and supervise generators at the intersections."

Traffic Management – Standard operating procedures are used for traffic management; however, an evacuation situation can overwhelm the procedures. During standard operations, the *Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout Great Lakes Region* reports: "Police normally respond to darkened signals first, by directing traffic if necessary until a managing agency can relieve the officer by supplying backup generation, repairing the signal, or by erecting portable stop signs. But in this case, because the [blackout of 2003] outage was so widespread, police were able to cover only a few intersections."

Traffic Signals – Traffic signals can be impacted during an evacuation situation. According to *Effects of Catastrophic Events on Transportation System Management and Operations – August 2003 Northeast*

Blackout Great Lakes Region, during the Great Lakes region blackout, "'one of the most immediate effects that impacted surface transportation was the loss of traffic signals. Reports indicate that drivers exhibited remarkable courtesy in treating darkened intersections as four-way stops. This treatment, however, gave no priority to major corridors, which slowed traffic everywhere to a crawl. People were taking two to three hours for trips that would normally take 15 minutes,' according to one report. To try to relieve the congestion at key intersections, many citizens attempted to direct traffic themselves." Redundant systems that relied upon electricity for power were inadequate.

According to *Learning from the 2003 Blackout*, in Cleveland, "off-duty and auxiliary police officers assisted in directing traffic, and emergency generators were later used to power some of the traffic signals."

4.2.3.2 Monitoring of Critical Routes

The literature search also found documents that address the monitoring of critical evacuation routes. For example, the publication *Evacuating Florida in 2004* reports: "Florida Department of Transportation selected 50 traffic sensor locations specifically to support evacuation needs. Traffic counters provide hourly vehicle counts, average speed, historical numbers for that specific day and time; each counter senses vehicles in both directions to support the five designated contra-flow plans. Fifteen can be activated at one time and some will have live video camera view capability."

Riding Out Future Quakes: Pre-Earthquake Planning for Post-Earthquake Transportation System Recovery in the San Francisco Bay Region details the San Francisco Bay area's monitoring of critical routes: "California Department of Transportation, the Metropolitan Transportation Commission and the county congestion management agencies continue to work cooperatively to identify routes that are critical for life safety and emergency response, to examine routes that serve major roles in the economic recovery of the Bay Area, and to evaluate performance level needs for these routes and their structures."

Due to its location below sea level, New Orleans is subject to flooding during severe weather such as hurricanes. The State of Louisiana monitors water levels along the major evacuation routes out of New Orleans. *How the Big Easy Became the Worst Possible Hurricane Disaster* details this effort: "Seven major routes are identified out of New Orleans, six subject to flooding. Louisiana uses United States Geologic Survey hydrowatch stations to monitor water levels. The stations provide real-time information, are solar-powered and transmit data to a satellite during a storm."

4.2.3.3 Reverse Flow – Contra-Flow Lanes

Although contra-flow operations have been used with both advance-notice and no-notice evacuations, they present issues such as insufficient time to set up the operation.

Concerns with Contra-Flow Operations – Contra-flow lanes are used to add additional roadway capacity; however, there are concerns with their use. According to the *ITE Journal* article "Planning for the Evacuation of New Orleans": "The benefits of contra-flow evacuation on freeways come with an increased level of risk. Freeways are designed for travel in one direction. Guidance features like signs and pavement markings may not be visible to drivers traveling in the opposite direction. Likewise, roadway safety features such as crash attenuators, guardrail transitions and breakaway support posts are not designed to provide protection from the reverse direction. There is also the risk of vehicles entering the reverse flow lanes from the 'wrong' direction. When these factors are combined with the stress of evacuation and the confusion that exists for drivers unfamiliar with contra flow, such operation can move from a level of inconvenience to one of danger."

Decisions of States for Contra-Flow Operations – Contra-flow operations are not always popular with government officials. As reported in "Floyd Follies: What We've Learned," "South Carolina officials were unprepared to reverse lanes of I-26, that is, to turn coast-bound lanes into inland-bound lanes, allowing traffic to flow faster from the storm. 'Our decision-making was a little bit behind,' says Jon Boettcher, hurricane coordinator with the South Carolina Emergency Management Division. After receiving blistering criticism for the stalled traffic, Governor Jim Hodges ordered lane reversals on I-26, which took several hours to complete."

Equipment/Supplies for Contra-Flow Operations – Equipment is needed to set up contra-flow operations. According to *Reverse-Laning I-65 for Hurricane Evacuations*: "equipment includes dedicated traffic control equipment; fold-down signs and variable message signs. Four Alabama wreckers are stationed along the reverse-flow interstate."

South Carolina Hurricane Evacuation Program 2003 includes "bottle water, maps, and additional port-a-lets at rest areas" among the equipment and supplies needed for the public.

In addition, a contra-flow operation needs to be communicated. The State of South Carolina Web site states, "hurricane evacuation route maps, directions and brief instructions for evacuation routes, reverse flow maps and graphics for certain intersections showing the lane reversal/changes" are provided to the general public. Additional information on communication will be presented in a later section of this report.

Guidance for Use of Contra-Flow Lanes – The use of contra-flow or one-way traffic operations is not considered lightly by public officials. According to *Reverse Lane Standards and ITS Strategies Southeast United States Hurricane Study: Technical Memorandum Number 1: Final Report*, "Florida uses a checklist to guide senior managers in the decision process. All three states (Florida, Georgia and South Carolina) agreed that a one-way operation (contra-flow) should be used for category 3 and up hurricanes." In addition, contra-flow lanes need to be long enough to move people out of the critical path; this could range from 80 to 100 miles away from the event site. During an evacuation, people may not need to move that great of a distance, or they may need only move far enough to clear the event site, which could be just a few miles away.

Setting Up Contra-Flow Operations – Setting up contra-flow operations varies from state to state and locale to locale. For the State of Alabama, *Reverse-Laning I-65 for Hurricane Evacuations* reports: "Time to implement—approximately four hours for Alabama Department of Transportation employees to report to assigned location once Stage One is called into effect (notification time and travel time). Approximately one hour for Alabama Department of Transportation employees to complete implementation of the plan and have reversed-flow traffic moving. Evacuation should be complete and plan removed prior to storm landfall and/or nightfall."

According to *South Carolina Hurricane Evacuation Program 2003*, the State of South Carolina "requires two hours to place barricades, [and] requires two hours to flush traffic."

According to *Reverse Lane Standards and ITS Strategies Southeast United States Hurricane Study: Technical Memorandum Number 1: Final Report*, the time for setting up contra-flow operations for the State of North Carolina takes 3 to 4 hours, depending on the corridor, to set up and upwards to 12 hours to mobilize the National Guard [to assist in the evacuation].

Contra-flow operations are geared towards massive evacuations of people with time available to set up the operation. In a no-notice situation, time may be unavailable to set up a contra-flow operation.

Tunnel Contra-Flow Operations – Decisions made prior to an evacuation may impact evacuation efforts. As reported in *Learning from the 2003 Blackout*, "In New York, tunnel managers made several key decisions throughout the blackout. One was to close some traffic lanes within some tunnels. Because the facilities' ventilation systems require an excessive amount of power, managers previously had decided not to connect them to the backup system. Therefore, the tunnel operators had to reduce the number of cars allowed through at any one time to decrease the pollutants. Some bridge and tunnel operators reversed one lane so that there would be three lanes for traffic leaving Manhattan and one for vehicles entering the area."

Types of Contra-Flow Operations – Traffic strategies have been developed for hurricane evacuations that involve moving massive numbers of people. According to *Reverse Lane Standards and ITS Strategies Southeast United States Hurricane Study: Technical Memorandum Number 1: Final Report*, these strategies include:

- "Normal lane operation
- All lanes reversed
- No lanes reversed, and the right side paved shoulder is used as a driving lane
- One coast-bound lane is reversed, with the remaining coast-bound lanes not reversed—the remaining coast-bound lane is used for public access to the coast
- One coast-bound lane is reversed, with the remaining coast-bound lanes not reversed—the remaining coast-bound lane is restricted to emergency vehicle access only."

Use of Contra-Flow Operations – Transportation measures have been identified for hurricane evacuations that assist in accelerating evacuations. *TR News: Emergency Evacuation: Ensuring Safe and Efficient Transportation out of Endangered Areas* reports: "Recent evacuations have failed to take full advantage of the obvious counterpart to limiting demand—maximizing the use of the available transportation infrastructure. One technique to increase evacuation capacity is the use of contra-flow freeway segments—reversing one or more lanes or shoulders in the inbound direction for use by outbound traffic. Preliminary studies have shown that contra-flow strategies can increase the outbound volume by about 70 percent. Other methods of infrastructure maximization include the coordination of traffic controls on parallel, non-freeway routes; the use of mass transit systems; and limiting the interruptions to evacuation flow at railroad crossings and drawbridges." However, setting up contra-flow lanes takes time, which may not be available for no-notice evacuations.

In New Orleans, contra-flow lanes have been developed. The article "Planning for the Evacuation of New Orleans" describes their development: "To accelerate the flow of evacuees out of the city, local and state emergency planning and transportation officials in Louisiana have developed an evacuation plan that includes the reversal of freeway routes into the city. Under this plan, traffic flow on some or all of the inbound lanes of the freeways into the city will be reversed to flow in the outbound direction. These 'contra flow evacuations' were used during Floyd in both Georgia and South Carolina with mixed success."

Recently, the State of Louisiana used contra-flow operations during Hurricane Ivan (2004). The *Natural Hazards Observer* article "What If Hurricane Ivan Had Not Missed New Orleans?" reported: "To aid in the evacuation, transportation officials instituted contra flow evacuation for the first time in the area's history whereby both lanes of a 12-mile stretch of Interstate 10 were used to facilitate the significantly increased outbound flow of traffic toward the northwest and Baton Rouge. The distance of the contra flow was limited due to state police concerns about the need for staff to close the exits.''although [Louisiana] officials were initially pleased with the results, evacuees felt the short distance merely shifted the location of the major jams…it took residents up to 11 hours to go the distance usually traveled in less than 1.5".

Evacuation to Texas frequently exceeded 20 hours. Since the storm, the consensus of the Louisiana experience was that "to alleviate this congestion (a) much more secondary highway coordination was necessary throughout the state, (b) contra flow needs to be considered for much greater distances, (c) residents who are able and willing to evacuate early must be doubly encouraged to do so, (d) families with multiple cars need to be discouraged from taking more than one unless they are needed to accommodate evacuees, and all (e) modes of transportation must be fully considered for the contributions they can make to a safe and effective evacuation."

4.2.3.4 Staging of Resources

Resources can be staged to assist during an evacuation incident. During the blackout of 2003 in the Great Lakes region, "half of the 400-truck emergency fleet of the Cleveland-area American Automobile Association was rendered inoperable by the blackout, their in-cab computers unable to receive the data necessary to route the trucks to stranded motorists. The availability of fuel was also an issue in Cleveland in the hours immediately following the blackout, both for private motorists and for public vehicles," as reported in *Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout Great Lakes Region*. Fuel needs may be an overlooked supply during an evacuation.

The State of Maryland has pre-outfitted trailers with equipment for rerouting traffic during emergencies that were useful during the I-95 tanker explosion. According to *I-95 Shutdown: Coordinating Transportation and Emergency Response*, "The traffic operations centers contacted nearby highway maintenance facilities and mobilized pre-outfitted trailers—each loaded with signage, cones, flares, generators, and other specialized equipment needed to reroute traffic at the scene—to the north and south sides of the incident."

The State of Florida has witnessed numerous hurricanes over the years and has identified equipment and supplies that needed to be staged for evacuations. According to the *State of Florida Regional Evacuation Procedure*, "Implementation of a regional evacuation will require substantial personnel, equipment and supplies at various locations along the evacuation routes and at facilities designated as risk and host shelters: (1) programmable electronic public information signs/displays; (2) local/small area radio broadcast stations; (3) wreckers, tow trucks, and other heavy equipment for clearing roadways; (4) gasoline tankers for replenishing fuel supplies at gas stations on regional routes; (5) ambulances, medical personnel; (6) shelter management personnel and supplies; (7) buses for transport of evacuees without other means and (8) sampling/testing equipment and personnel."

Governor Jeb Bush of Florida recognized the importance of having a secure fuel source as reported in the *Orlando Sentinel* article "Bush Offers Ways to Increase Gas Supply When Hurricanes Hit". "The petroleum industry needs to keep more gasoline stored in Florida, and some gas stations should have generators so they can get running again as quickly as possible after a hurricane" Governor Jeb Bush said Tuesday. "Some [people] unnecessarily hoard gas for generators and sometimes evacuate when they don't need to, contributing to difficulties for everyone else." Bush also said the state is exploring whether gasoline can be strategically placed before the storm just out of the danger area so it can be quickly delivered, much as ice and water are now.

Hurricane evacuations involve large numbers of people leaving their homes. Evacuees require services to assist them in their evacuation efforts. As reported in *Reverse Lane Standards and ITS Strategies Southeast United States Hurricane Study: Technical Memorandum Number 1: Final Report*, "During the Floyd evacuation, the availability of motorists' services and access to restrooms were a problem in all three states, due to the extended travel times. The state needs to arrange with private operators to ensure fuel is available and restaurants are open during the critical evacuation period. The state needs to be

responsible for keeping the rest areas open. In addition, the state needs to pre-arrange for the fueling of state vehicles during an evacuation. Low fuel was an issue, and Florida Department of Transportation had to rent a fuel tanker to refuel state vehicles and private vehicles that were stranded."

In addition, the *Coastal Heritage* article "Floyd Follies: What We've Learned" reported: "At least 3.5 million people from four states—Florida, Georgia, South Carolina, and North Carolina—evacuated during Hurricane Floyd. It was the largest evacuation in US history. Lines of cars backed up for hundreds of miles on several interstates. Trips that would have taken two hours on a normal day took 16 or 18. Many evacuees could not find bathrooms, motel rooms, or shelters. Cars ran out of gas or broke down, littering highways and small roads."

4.2.3.5 Transit Infrastructure

Transit systems can assist following evacuations since transit agencies have infrastructure, personnel, and equipment that could prove to be useful. According to *Saving City Lifelines: Lessons Learned in the 9/11 Terrorist Attacks*, "Crisis management planning normally views public transportation systems as targets or venues for terrorist attack. There is a tendency to overlook their critical role in the evacuation of urban areas threatened by or following terrorist attacks. Another overlooked role is that of assisting in rescue efforts. In increasingly service-oriented economies, however, transit systems may be the only entities with the specialized equipment and skills required for large-scale rescues."

In addition, following the 9/11 terrorist attacks on New York City, *Saving City Lifelines* reported: "It is notable that [the] Metropolitan Transportation Authority has many assets that can help with rescue and recovery work, including truck cranes, hydraulic equipment, portable lights, emergency generators, dump trucks, and snow plows. [In addition,] New York's transportation operators moved thousands of police officers and emergency personnel into the city by train and then ferried them by bus to Ground Zero, while the New York City Transit emergency operations center immediately began to assemble equipment and workers to assist in the rescue effort. Within two hours of the attack, only minutes after the collapse of the North Tower, the Metropolitan Transportation Authority had mobilized a two-mile-long convoy of specialized heavy construction equipment and 3,500 employees to assist in rescue and debris removal. Also, New York City Transit ironworkers assisted the fire department by cutting steel to rescue victims, and workers from every New York City Transit division staffed bucket brigades to remove debris from the search and rescue areas. At one point, Metropolitan Transportation Authority employees comprised 60 percent of the rescue force, according to one official interviewed."

4.2.3.6 Use of ITS

ITS equipment has been used to assist in evacuations. However, the equipment does need power and, after a blackout event, needs to be reset.

Loss of ITS Equipment and Communication – Evacuation situations may involve the loss of power to equipment and communication systems. *Learning from the 2003 Blackout* reported: "Under emergency operating procedures developed after September 11, many of the tunnels and bridges into Manhattan were immediately closed or access to them was restricted. Each of the region's 13 traffic management centers is linked through an interagency remote video network of more than 400 cameras. Although the network maintained connections with two-thirds of the centers, the system was compromised because most of the cameras in the field failed due to the lack of backup electricity. A portable generator arrived about 8 hours later."

Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout New York City reported: "The region also has over 300 miles of roadway that is

covered by Transmit readers. These readers report back speed and congestion data to the transportation management centers. This information is used by transportation officials to quickly identify problems on the system. Within 15 minutes of the blackout, over 90 percent of the readers failed. Therefore, even if the transportation management centers were operating on backup power, they were mostly without video and data readings to understand how the system was operating."

According to *Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout Great Lakes Region*: "Staff reported that the data-collection devices that would have been most helpful during the blackout were the cameras. When the freeways flooded on Saturday, they could not see the incident on their cameras and could not use their variable message systems to warn motorists. In addition, the Michigan Intelligent Transportation System Center staff also lamented the lost opportunity to record traffic volume data during what was essentially a full evacuation of Detroit on Thursday."

Need to Reset Equipment – After an evacuation situation, such as a blackout, power needs to be reset. *Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout Great Lakes Region* reported: "Power began to return to the area on the afternoon of Saturday, August 16, 2003. In the aftermath of the event, it took several days for all the ITS equipment to come back on line. Some had to be reset manually, some suffered damage from the blackout, and some had communications problems that required in-field maintenance visits, once power was restored late on Saturday. In addition, although approximately 90 percent of Oakland County's signals returned without trouble, approximately 200 signals required restorative maintenance."

In addition to the need to reset traffic signals, the *Effects of Catastrophic Events on Transportation System Management and Operations* explained: "One problem the Michigan Intelligent Transportation System Center staff encountered was that their variable message signs had already been programmed for the whole weekend to announce lane closures for anticipated construction areas. So when power returned, there was not a good match between what the signs were saying and the actual situation on the road."

In the New York City blackout experience, *Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout New York City* reported: "In the aftermath of the event, most of the ITS field equipment returned to service with the resumption of power, but it took several days for all the ITS equipment to come back on line. Some had to be reset manually, some suffered damage from the blackout, and some had communications problems that required in-field maintenance visits."

Redundant Power – The power requirements for ITS equipment generally involve the use of electricity. However, during the blackout in New York City, *Effects of Catastrophic Events on Transportation System Management and Operations* reported: "Long Island had portable variable message signs that were able to operate with backup power. Metropolitan Transportation Authority Bridges and Tunnels had backup power for their installed variable message signs."

In addition, *Effects of Catastrophic Events on Transportation System Management and Operations* reported: "Subsequent to the event, many agencies have already begun the process of purchasing new backup power. New York City Department of Transportation staff has already installed uninterrupted power supplies for each of the traffic control servers at the Joint Transportation Operation Center. Over the past two years, New York City Department of Transportation has upgraded many of its signals from incandescent lamps to LED, which require much less power to operate. As a result of the blackout, agency managers are looking at the possibility of adding battery backup to critical intersections. This would allow signals to work for a period of several hours during a similar blackout."

Software Programs – The State of Florida uses a program called HEADS UP to assist in evacuation planning. According to *A Study of the Impact of Nine Transportation Management Projects on Hurricane Evacuation Preparedness*, "Florida used the Federal grant to help develop a geographic information system GIS-based hurricane evacuation software system known as HEADS UP (Hurricane Evacuation Analysis and Decision Support Utility Program). This program extends the capabilities of ETIS (Emergency Transportation Information System) by including additional data. In the future, ETIS will include a model that will compute dynamic clearance times."

In addition, the study reported that the State of Virginia "used the Federal Highway Administration grant to update estimated hurricane evacuation clearance times for the at-risk population in the Hampton Roads area by developing an interim abbreviated transportation model (ATM)."

Traffic Management Centers – Traffic management centers can assist in managing traffic in evacuation and normal operations such as during the Northridge earthquake. According to *Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study*, "At the time of the [1994 Northridge] earthquake, the Traffic Management Center was being staffed 24 hours a day, 365 days a year with California Department of Transportation and California Highway Patrol personnel. Extensive traffic management capabilities were already in place on most of the major freeways well before the earthquake, including speed monitoring loop detectors, closed circuit television, on-ramp meters, and permanently mounted variable message signs."

During the I-95 tanker explosion incident in Baltimore, Maryland, the Maryland Operations Center (traffic management center) coordinated and responded to the incident. According to *I-95 Shutdown: Coordinating Transportation and Emergency Response*, "Simultaneously, the Operations Center at the Maryland Transportation Authority, which maintains Maryland's seven toll facilities, began to redirect traffic on I-895. Staff at the Maryland State Highway Administration Statewide operations centers north and south of the incident and at multiple centers in nearby states launched systems to redirect traffic around and away from I-95. Four minutes after the crash, as emergency response vehicles and personnel left their respective stations, Maryland's Coordinated Highways Action Response Team changed variable message signs along the I-95 corridor and other feeder interstates in Maryland to inform motorists that I-95 near Baltimore was closed and offer alternate routes."

Types of Equipment – There are multiple ITS types of equipment. According to the presentation *SCDOT (South Carolina Department of Transportation) Evacuation Route*, in South Carolina, "closed circuit televisions, changeable message signs, highway advisory radio and vehicle speed detector counters [are] used to monitor traffic during an evacuation."

According to *A Study of the Impact of Nine Transportation Management Projects on Hurricane Evacuation Preparedness*, the State of Georgia is "expanding traveler information during evacuations through portable highway advisory radio, variable message signs, and cooperative agreements with Georgia Public Radio stations" to provide information to the traveling public. The state is also "expanding traveler assistance by the Highway Emergency Response Operator (HERO) incident response vehicles."

Use in Washington, DC, During 9/11 Terrorist Attack – ITS technology was used during the 9/11 terrorist attacks. During the DC attacks, *Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study* reported: "Signal coordination, suspension of construction lane closures statewide, and reversing and opening of high occupancy vehicle lanes in the outbound direction were immediately implemented. In addition, retiming traffic signals for very heavy peak-period outbound traffic facilitated traffic flow through suburban Montgomery County."

4.2.3.7 Work Zones

Highway construction zones can impact evacuations. According to *National Review of Hurricane Evacuation Plans and Policies*: "A historically overlooked issue in evacuation planning and preparedness has been highway work zones. In 1998, during the evacuation for Hurricane Georges, the States of Alabama, Mississippi, and Louisiana all had construction zones on evacuation routes. In Louisiana, evacuation traffic on westbound I-10 out of New Orleans was limited to a single lane. Early recognition of this problem by the Department of Transportation allowed them to request the contractor to clear construction equipment and open both of the partially constructed lanes to outbound traffic. Fortunately, the contractor acted quickly and delay was minimized."

The review reports that a year later similar problems of construction on evacuation routes were also experienced in North Carolina during Hurricane Floyd: "Since the need for maintenance and construction during the hurricane season is unavoidable, some Departments of Transportation have made attempts to avoid conflicts by adding special provisions in construction contracts to accommodate evacuation traffic through work zones. The most common way to do this has been to add clauses that require a contractor to cease all construction activities once an evacuation is declared, clear all equipment, and open all lanes of traffic including those under construction."

According to *Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study*, during the terrorist attacks on New York City, "all construction work zones involving lane closures were terminated."

4.2.4 Coordination Issues

This section addresses information found on coordination. It is further subdivided into contingency planning, cooperation, evacuation coordination, incident command system, mutual-aid and other agreements, training, and unified command.

Findings from the literature search include:

- One can plan for contingencies but not for all events.
- Cooperation has been cited as important during evacuations in terms of both personal and interagency cooperation.
- Evacuation coordination is important since evacuations may cross state lines or into other jurisdictions. Coordination is needed with external entities, multiple groups, non-traditional emergency management personnel, and public transit. Coordination also includes having a unified voice providing information.
- An incident command system is identified in the literature as an item that should be in place and used during an evacuation incident.
- Mutual-aid and other agreements (such as formal procedures for coordination of multi-county evacuations) have been cited in the literature as important.
- The need for training and training exercises is emphasized in the literature, along with the need to include public transit in the training exercises.
- A unified command structure can be operated alongside an incident command system.
- Specialty teams (tiger teams) have been deployed that can assist in an evacuation situation.

4.2.4.1 Contingency Planning

One can plan for contingencies but not for all events. According to *Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center*, during the southern California wildfires, "This center had conducted contingency planning for power requirements, phones, and computer networks so that when expanded dispatch was required, everything could be set up and ready to go in modular units. This planning was particularly valuable when the center was faced with the unexpected requirement that they themselves might have to evacuate because of fire. Terrorism and bomb threats had been considered, but not an entire center re-location. This center created a plan to select a new location and set up laptops over a virtual private network set up to run Multi-Agency Incident Resource Processing System (MIRPS). Portable radios were in short supply, and the center decided to rely on vehicle-mounted radios. Again, interagency cooperation was crucial to the plan's success. A center manager declared, 'We shared everything [between us], vehicles, radios, everything, no boundaries, and no agency lines.' Ultimately, the dispatch center did not need to be relocated, but respondents said the experience taught them some valuable lessons for future contingency planning."

4.2.4.2 Cooperation

Cooperation has been cited as important during evacuations in terms of both personal and interagency cooperation.

Cooperation During the Olympics – For the Sydney Olympics, *Evaluation of Intelligent Transportation Systems for the Planning and Operations of Olympic Events* reported: "The Roads and Traffic Authority's Transport Management Centre, was developed with an extensive institutional integration effort. The Roads and Traffic Authority is a statewide organization of New South Wales that was assigned responsibility for the development and management of the Transport Management Centre. The Roads and Traffic Authority developed a new regional facility as a replacement of a prior traffic control center for mainly the City of Sydney. The Roads and Traffic Authority conducted an extensive outreach effort to better define its functional services and integrate those within the other modes of transportation and the police and emergency services. These institutional integration efforts have resulted in a formalized, well-established, transportation management process that was readily available for the Sydney Olympics."

Cooperation Needed for Identification of Critical Routes – In the San Francisco Bay Area, critical routes for evacuation and entry of personnel and supplies have been identified for earthquake planning. Cooperation is needed to identify these routes. According to *Riding Out Future Quakes: Ideas for Action: Improving Planning of Transportation Providers, Government, Utilities and Businesses for Post-Earthquake Transportation Disruptions in the San Francisco Bay Region*: "The need for emergency vehicle routes is clear and when selecting routes it is critical to coordinate with local law enforcement, the California Highway Patrol and Public Works. The routes must be survivable, bridges that have not been seismically retrofitted pose the greatest threat. A regional approach to designating such routes and standardizing the marking systems would be effective in speeding aid to the most impacted communities."

Importance of Cooperation – During the blackout of the Great Lakes region, city departments cooperated during the incident. *Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout Great Lakes Region* reported: "Cuyahoga County, of which Cleveland is a large part, maintains an emergency response center for use in times of crisis. A portable generator arrived about eight hours after the blackout started, which enabled facility staff to begin official operation. As a result, the major public agencies of the city of Cleveland—including the transportation agencies—worked together, in a collaborative and sometimes improvised way, to see the city through the hours of the blackout."

In addition, during the Great Lakes region blackout, transit agency staff cooperated with other local agencies. According to *Effects of Catastrophic Events on Transportation System Management and Operations*, "In preparing for the Year 2000 (Y2K) and based on their experiences from September 11, transit managers had developed a plan for the rapid establishment of an integrated operations center in case of emergency. In addition to assisting at the agency's emergency operations center, their Chief of Security participated in the municipal-level emergency response to the blackout, working with other local agency heads to coordinate and streamline all response activities."

According to *I-95 Shutdown: Coordinating Transportation and Emergency Response*, coordination between state agencies proved successful for the management of Howard Street rail tunnel fire: "Sergeant Rick Vecera of the Maryland State Police attributes the successful management of the crash to the preparedness and cooperation of those who addressed the emergency and managed the related transportation issues. 'Three factors contributed significantly to the operation's success,' he says. 'The Maryland State Highway Administration's high-tech operation centers are fully equipped for efficient information management not just locally, but up and down the I-95 corridor. Post-9/11 training has accelerated and enhanced multi-jurisdictional cooperation and planning. In addition, emergency response staff and transportation managers in the area know one another personally through established professional networks and near-daily interactions during the profusion of planned and unplanned events in Maryland, Virginia, and Washington, DC.'"

In addition, *I-95 Shutdown* reported during the I-95 tanker explosion: "During the mid-1980s, the Maryland State Highway Administration mapped the Maryland interstate system, interchange by interchange, and identified alternative routes in case vehicles would have to be directed off the interstate. The Maryland State Highway vetted its draft plans with local police, fire, and maintenance crews—the people most familiar with the State's secondary road systems. In 1986, the Maryland State Highway and its partners approved the first Freeway Incident Traffic Management plan and distributed it throughout the State to the appropriate agencies. The Maryland State Highway updates the plan regularly to keep pace with changes in the State's transportation network."

Interagency cooperation was cited during fighting of the southern California wildfires. According to *Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center*: "The value of interagency cooperation paid off. 'Everyone spoke the same language,' [says the Battalion Chief]. Despite the normal difficulties associated with interagency cooperation, those interviewed overwhelmingly stated that cooperation between agencies was extremely strong and was a key factor in being able to deal with a series of crises of this magnitude."

Interagency Cooperation – Interagency cooperation is helpful during an evacuation incident. The *San Bernardino County Fire Chiefs' Association: Lessons Learned Report: Fire Storm 2003: "Old Fire"* stresses its importance: "For fourteen months prior to the 'Old Fire,' the San Bernardino County Fire Chiefs Association had conducted joint training and interagency cooperation with all Mountain Fire agencies—Crest Forest Fire District, the California Department of Forestry and Fire Protection, the US Forest Service, the San Bernardino County Fire Department, and the San Bernardino City Fire Department. This interagency cooperation proved to be a significant factor in managing the fire."

Personal Relationships – Personal relationships are cited as providing the relationships needed when entity cooperation is difficult to achieve. According to *Saving City Lifelines: Lessons Learned In the 9/11 Terrorist Attacks*: "The destruction of the [New York City] Office of Emergency Managements Emergency Operations Center and the scramble to set up alternative command posts delayed the centralized coordination that had been practiced, but the network built on personal relationships established in the drills survived."

During the southern California wildfires of 2003, personal relationships were cited as useful. *Southern California Firestorm 2003—Report for the Wildland Fire Lessons Learned Center* reported: "Nearly universally, respondents reported the importance of trust, developed through established personal and professional relationships with peers and cooperators. During the initial chaos of these incidents and at the times when dispatch and incident command systems were overwhelmed, these relationships became the primary means by which things got done, until the system could be brought on-line. These networks, enabled by these relationships, were frequently the primary force behind successful operations. Respondents also reported that networks of personal relationships minimized unproductive conflict. In situations where conflict did occur—sometimes under incredibly stressful conditions—it was often resolved by leaders who sought out their counterparts for face-to-face meetings."

Sharing of Equipment – Agencies cooperated during the New York City blackout of 2003. However, an issue that was raised was "the sharing of equipment. Interviewees stressed that more planning is needed in this area," as reported in *Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout New York City*.

4.2.4.3 Evacuation Coordination

Because evacuations may cross state lines or into other jurisdictions, coordination is important. Evacuation coordination is needed with external entities, multiple groups, non-traditional emergency management personnel, and public transit. Coordination also includes having a unified voice providing information.

Crossing State Lines – Evacuations sometimes involve the crossing of state lines, and coordination is needed between the states to ensure the safe evacuation of citizens. According to *Emergency Evacuation: Ensuring Safe and Efficient Transportation out of Endangered Areas*: "Crossing jurisdictional and state boundaries can complicate the planning of contra flow operations. Until recently, hurricane evacuation planning was seldom region wide, primarily because evacuation orders follow a more localized, county-by-county, procedure. Florida Department of Transportation found that a lack of coordination between counties produced congestion when evacuations intersected and traffic from one county entered the already-crowded evacuation routes of another. With increased coastal populations, region wide evacuations must be prepared to move substantially larger numbers of people. States like Florida are addressing these problems with statewide evacuation plans."

In addition, *Emergency Evacuation* reported: "Interstate evacuation coordination is also critical, as shown in the state-to-state overlap of evacuation traffic during Hurricane Floyd. During the Hurricane Floyd evacuation, traffic from Florida and Georgia contributed to congestion on evacuation routes in South Carolina. South Carolina, Georgia, and Florida Departments of Transportation are working together to correct the deficiencies. Interstate regional plans now incorporate interstate contra flow and the use of secondary highways to keep local traffic from interstate routes whenever possible."

According to *A Study of the Impact of Nine Transportation Management Projects on Hurricane Evacuation Preparedness*, agreements between states are needed when contra-flow operations impact and flow into other states: "By June 2003, Mississippi and Louisiana had reached a revised agreement for Mississippi to use contra flow on I-59 in Mississippi to support Louisiana's evacuation when contra flow was implemented on I-59 in Louisiana."

The *Planning Magazine* article "Danger! Coastal States Get Ready for a Really Rainy Day: By Cranking Up Their Evacuation Plan" reported: "Delaware, Maryland, and Virginia have formed the Delmarva Emergency Task Force to improve evacuation traffic flow between the states. The Georgia Emergency

Management Agency has created an interstate coordinator position to facilitate communications with neighboring states."

Cross Training – Cross training can prove to be beneficial during an incident. As reported in *Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center*, "At one center (southern California wildfires), interagency cooperation was a decisive factor in the success of operations. Dispatchers had cross-trained in other agency dispatchers' duties on previous fires. They had become knowledgeable on agency similarities and differences to minimize agency specific problems. One respondent said, 'Our goal is to be seamless. They hear one voice no matter who answers the phone.'"

Southern California Firestorm 2003 also reported: "Respondents indicated that this level of interagency cooperation took many years to develop (for the southern California wildfires) before they could begin to work on the functional design of the center and possible plans and contingencies for mega fires and other disasters. The center found ways to organize more efficiently. Now an Initial Attack dispatcher just looks up, and there's the person she needs to talk to right in front of her, instead of across the room looking in the wrong direction."

Decisions of States – Evacuation of people during hurricanes can impact other states. Decisions made in one state can impact another. As reported in "Floyd Follies: What We've Learned," "As many as two million Floridians left home during Floyd, an exodus that overwhelmed highways and transportation networks. As they poured into Georgia and South Carolina, they bumped into people traveling west from Savannah and Charleston to escape the hurricane. The result was massive traffic gridlock. To compound the problem, each state planned and carried out its evacuation in isolation as if it were an independent republic with restricted borders. 'Everyone did his own thing,' says William Massey, hurricane program manager for the Federal Emergency Management Agency. 'The evacuation was not a concerted, coordinated effort.'"

External Coordination – External coordination is important during an evacuation situation. Cooperating agencies provide information that can assist another entity in its evacuation efforts. According to *Learning from the 2003 Blackout*: "Within 5 minutes of the blackout, Con Edison, Inc., personnel had notified New York City Transit managers that the power outage was extensive and potentially long in duration. Evacuation of subway passengers began in the next 10 minutes."

External coordination is needed to institute an agreement to use contra-flow operations during an evacuation event. According to *Reversing the Flow: Corpus Christi Unveils New Hurricane Evacuation Plan*, the Texas Transportation Institute "presented the results of its findings to, and facilitated consensus-building among a 50-member hurricane evacuation committee. The full support of the hurricane advisory committee was essential to the adoption of the new plan. The consensus of the committee was, with the adoption of the new plan, to reverse flow for approximately 90 miles of I-37. Estimates from the model showed that reverse flow would increase evacuation significantly by allowing over 40,000 more citizens to evacuate during a 12-hour period."

As a result of the Texas Transportation Institute efforts, *Reversing the Flow* reported: "Texas Department of Transportation presented the plan to county commissioners, with the meeting being broadcast over public access television. The plan met with endorsement from Department of Public Safety, the agency in charge of evacuation procedures, and has been approved and adopted for use in any hurricane rated at Category 3 or above."

In the San Diego area, a mountain area safety taskforce was created to support coordination efforts during the southern California wildfires. *Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center* reported: "Mountain Area Safety is a county organization composed of local,

state, and federal government agencies, private companies, and volunteer organizations. Among other things, these organizations are tasked with assuring public safety through the development of evacuation plans, hazard tree and fuel removal, and planning and public information. There is no question in the respondents' minds that the Mountain Area Safety effort, including training and planning, saved a large number of lives and homes. Respondents indicated that Mountain Area Safety planning cut two to three days off of the time required to establish an effective multi-agency, unified command."

According to the *Southern California Firestorm 2003* report, the Mountain Area Safety Taskforce also "conducted tabletop rehearsals of evacuations in the event of catastrophic wildfires. As a result, nearly 100,000 people were evacuated quickly and without incident (during the southern California wildfires). The Mountain Area Safety Taskforce prepared a training video for law enforcement officers (basic fire behavior, incident command systems), and all law enforcement agency leaders had trained all their personnel prior to these fires. These efforts proved instrumental, allowing law enforcement agencies to seamlessly pull together into the unified command vs. the traditional approach of a separate law enforcement command structure and incident command post."

Importance of Coordination – Coordination is cited as important during an evacuation incident. According to *Disaster Response and Evacuation User Service: An Addendum to the ITS Program Plan*: "Hurricanes are anticipated and occur slowly, providing time for adequate warning and an orderly, well-planned evacuation. Other types of disasters may occur rapidly, without warning, and allow little or no time for evacuation preparation or public warning. Whether an evacuation is pre-planned and directed by local government, or is a spontaneous evacuation by a portion of the population, many agencies will be involved and must coordinate."

Emergency management officials emphasize the importance of coordination. The *American City and County* article "Community Evacuation: Ensuring Safe Passage" reported: "More than ever, city and county officials are building relationships with state, federal and local partners to create comprehensive emergency response plans. Those partnerships are invaluable in evacuation planning. 'It is important to involve elected officials from state, city and county governments,' Lieutenant Byron Sieber, commander for planning and research for the Grand Forks, North Dakota Police Department says. 'They all have to be on board with a decision to tell thousands of people to leave their homes.' Grand Forks' evacuation plan focuses primarily on the threat of flooding. Situated along the Red River, which forms North Dakota's eastern border, the city has a flat terrain that offers no protection when the river rises; water swelling just one foot above the riverbank will cover a floodplain of one square mile."

Coordination is citied as necessary between entities involved in evacuations. According to *I-95 Shutdown: Coordinating Transportation and Emergency Response*: "'In Maryland,' says Sergeant [Rick] Vecera [of the Maryland State Police], 'when an incident involves fire, hazardous materials, or rescue, it is the fire companies who decide when the situation will allow roads to reopen. However, it is seldom a black-and-white decision, so cooperation among all concerned parties at the scene, like we saw on this crash [I-95 tanker explosion in Baltimore, Maryland], is what really comes into play.'"

Improvements in Coordination – Improvements, at times, can be made to coordination efforts. *From the Ashes of the 2003 California Wildfires: Perspectives on the Future—S04-13* reported: "Local issues are some of the biggest challenges now and in the future, especially in San Diego where fire management is very fragmented and citizens will not support more organized fire services. In Cedar Glen [part of the Old Fire—southern California wildfires), an area with very old infrastructure, a lot of people want to rebuild in the same manner as what was there before. An after action report on emergency management highlighted the need for better integration across all phases of emergency management; improved access to information before, during, and after an event; and better post-fire hazard identification and inter-agency collaboration."

Inclusion of Multiple Groups – Coordination requires the inclusion of multiple groups impacted by an evacuation incident. The *American City and County* article "Community Evacuation: Ensuring Safe Passage" reported: "Flooding occurs frequently in Grand Forks, and, as a result, the city's evacuation planners meet regularly with representatives of the Police, Fire, Emergency Medical Services, Public Health, Public Works, and Public Relations departments to evaluate existing protocols and consider all contingencies. Communication with local and national weather services is instrumental in giving decision-makers the information they need to call for and manage evacuations (during the flood). Planners also are in contact with relief organizations—such as the Red Cross, Salvation Army, and United Way—that can provide shelter and food for residents who have nowhere to go during an evacuation. In addition to working with local and private partners, Grand Forks' planners communicate regularly with state officials. 'They provide the authority you need to evacuate,' Sieber explains."

Inclusion of Non-Traditional Emergency Management Personnel – Personnel from various entities departments are included in interagency coordination efforts during evacuations or during the cleanup efforts. "Community Evacuation: Ensuring Safe Passage" reported: "Terry Tullier, Deputy Chief of the New Orleans Fire Department and Interim Director for the City's Office of Emergency Preparedness, notes that, in addition to public safety and emergency services personnel, New Orleans' parks personnel are on call during natural disasters. 'Winds from a hurricane will knock down trees, and our Parks Department and local utility company must be prepared to clear them out of the way,' he explains."

Inclusion of Transit – Transit entities are being included in external relationships. According to *Saving City Lifelines: Lessons Learned in the 9/11 Terrorist Attacks*: "The New York Office of Emergency Management staff members are working with transit agencies to continue to strengthen their relationships. As a consequence of 9/11 (terrorist attacks), plans are now in place to add cars to trains or to alter bus service in response to disaster needs. The Office of Emergency Management has developed stronger links to all transit agencies. Each Metropolitan Transit Authority agency had its own evacuation plan in place before 9/11, but these plans were not all coordinated with each other or with the Office of Emergency Management. In addition, the Metropolitan Transit Authority has since assigned two of its employees to act as liaison officers to ensure coordination of emergency plans with the Office of Emergency Management. In future events, these officers will become the lead staff to coordinate the emergency response between the Office of Emergency Management and Metropolitan Transit Authority, which represents the transit community."

Internal Coordination – Internal coordination of an entity should be in place before an evacuation is needed. *Synthesis of Transit Practice 27: Emergency Preparedness for Transit Terrorism* detailed the following guidelines for internal coordination: "Develop internal coordination to allow for communication and information to flow to those departments responsible for notification and response. Understand the jurisdictional relationships—control over a situation should not be determined on the spot. [It is] important to clarify jurisdictional authorities and responsibilities in advance of a response."

Unified Voice – Having a unified voice has been cited as essential. According to *Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center*, "Respondents reported that it was essential for the protection and suppression effort to work collaboratively with line officers, their natural and cultural resource specialists, and city and county government (during the southern California wildfires). Fire suppression and resource management goals are often in natural conflict with one another, and it is important that the land management agency line officer, resource specialists, and the incident organizations all have the same goals and that those common goals translate into planning and are communicated to the community with a unified voice."

Working Groups – Cities have created working groups and agreed-upon responses to emergency, thus leading to a coordinated response to an emergency. For example, *Homeland Security: Effective Regional Coordination Can Enhance Emergency Preparedness* reported: "The Dallas-Fort Worth's Regional Emergency Managers Group has served as a forum for the region's emergency preparedness officials to analyze, plan for, and make decisions about various regional initiatives, such as improving inter jurisdictional communications interoperability. Within this group, an associated subgroup explored technical issues related to communications interoperability. The Regional Emergency Managers Group evaluated technology options and is creating a regional purchasing plan to facilitate the purchase of interoperable communications equipment. Without interoperable radios and other communications equipment, police and fire departments in different jurisdictions cannot easily communicate when responding to an emergency."

4.2.4.4 Incident Command System

An incident command system is identified in the literature as an item that should be in place and used during an evacuation incident. According to *National Fire Protection Association 1600: Standard on Disaster/Emergency Management and Business Continuity Programs*: "In disasters/emergencies, an incident management system would be used to systematically identify management functions assigned to various personnel. The system used varies among entities and among jurisdictions within entities. In minor disasters/emergencies, incident management functions might be handled by one person, the incident commander."

Establishing Priority – As reported in the literature, the first on the scene sometimes establishes the command of the situation and the priorities. *I-95 Shutdown: Coordinating Transportation and Emergency Response* reported: "On January 13, with more than 20 agencies at the crash scene and controlling traffic in the surrounding areas, the unified command enabled responders to address the situation quickly and efficiently (at the I-95 tanker explosion site). Chief Herr's first moves were to meet with leaders from all the attending agencies, establish his command, and assess the situation from the multiple viewpoints represented. Since no rescues were possible, Chief Herr and the other incident commanders established five priorities to ensure continued safe and efficient operations for the duration of the event."

Incident Command and Planning Efforts – The use of an incident command system was cited favorably in *San Bernardino County Fire Chiefs' Association: Lessons Learned Report: Fire Storm 2003: "Old Fire"*: "As expected, the Incident Command System (during the southern California wildfires) worked as it was designed to function. It provided a common operational area which enabled participants to function effectively, even in the initial absence of an effective, unified command. From the onset of the fire, unified incident commanders successfully used the Mountain Area Safety Taskforce planning effort for critical, strategic, and tactical decisions. The Mountain Area Safety Taskforce effort proved critical to a successful evacuation effort when winds shifted and blew the fire into the mountain communities. 70,000 citizens were evacuated. The Mountain Area Safety Taskforce project that had cleared dead trees from the evacuation routes proved successful as firefighters used these corridors for a major backfire in an attempt to keep fire out of the mountain communities."

Jurisdictions – Incident command center jurisdictions vary from location to location. For example, during the I-95 tanker explosion, *I-95 Shutdown: Coordinating Transportation and Emergency Response* reports that in the State of Maryland, "today the Maryland's Coordinated Highways Action Response Team no longer focuses on a single need but assists with highway management systems statewide. The response team is now a multi-agency organization with a governing board featuring representatives from the Maryland State Highway Administration, the Maryland State Police, Maryland Transportation Authority, Federal Highway Administration, and local governments."

Lead Agencies – Incident command centers establish "a unified command—[by] taking into account the missions of all responding agencies when making decisions at the scene of an incident—[which] is the job of the incident commander. Characteristic of the unified command structure, fire and rescue emergency response agencies sometimes are the first on the scene of an incident and normally are the first lead agencies to establish incident command. In the Maryland crash [I-95 tanker explosion]; therefore, the first incident command was established under Chief Herr, who managed the crash within a familiar and practiced organizational structure that is standard for most emergency response situations," as reported in *I-95 Shutdown: Coordinating Transportation and Emergency Response*.

New York City – Incident command centers have been established by various cities. According to *Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout New York City*: "Established in 1996, the New York City Office of Emergency Management oversees emergency preparedness for the city, including the transportation agencies' response efforts. On August 14, the Office of Emergency Management activated the City's Emergency Operations Center at 4:20 p.m. to begin the process of providing coordination and direction to agencies (during the blackout), including the region's 13 traffic management centers. During an emergency, the Emergency Operations Center is staffed by senior officials from City agencies, as well as representatives from state and federal agencies."

Use of Incident Command Southern California Wildfires – The use of an incident command was cited during the southern California wildfires of 2003 in *Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center*: "Respondents said that the Incident Command System proved its worth as common doctrine. The Incident Command System provided common ground around which diverse cooperators could rally and begin to function effectively, even in the initial absence of effective, centralized command."

4.2.4.5 Mutual-Aid and Other Agreements

Mutual-aid and other agreements (such as formal procedures for coordination of multi-county evacuations) have been cited in the literature as important.

Mutual-Aid Agreements – Mutual-aid agreements are identified in the literature as an item that should be in place before an emergency. According to *National Fire Protection Association 1600: Standard on Disaster/Emergency Management and Business Continuity Programs*: "Mutual aid agreements between entities are an effective means to obtain resources and should be developed whenever possible. Mutual aid agreements should be in writing, be reviewed by legal counsel, be signed by a responsible official, define liability, and detail funding and cost arrangements."

Mutual-aid agreements need to be factored into the entities internal operations. For example, *Increasing FDNY's (Fire Department of the City of New York) Preparedness* reported: "the Fire Department New York requested and received mutual aid from Nassau and Westchester counties on (the) September 11 (terrorist attacks). However, the Department had no process for evaluating the need for mutual aid, nor any formal methods of requesting that aid or managing it. Therefore, the Department had limited ability to evaluate how the mutual aid could be integrated into its operations."

Other Agreements – Other types of agreements or procedures have been instituted for evacuation incidents. According to the *Planning Magazine* article "Danger! Coastal States Get Ready for a Really Rainy Day—By Cranking Up Their Evacuation Plan": "Florida has developed formal procedures to coordinate multi-county evacuations. These procedures include the designation of inland 'host counties' that will open shelters for evacuees from coastal counties."

4.2.4.6 Training

The need for training and training exercises is emphasized in the literature. For example, *Modeling Transit Issues Unique to Hurricane Evacuations: North Carolina's Small Urban and Rural Areas* reported: "The need to evaluate multiple scenarios (for hurricanes) through simulated evacuation crises management environment cannot be over emphasized as it will provide initial training and knowledge base for the events that will unfold."

Importance of Training Exercises – Emergency response training has been credited with saving lives. As reported in *California Transportation Security Summits: March 28 and 29, 2002*, "Many lives were saved on 9/11 (terrorist attacks) because the transit workers knew what to do. They knew to get the trains and the passengers away from harm. There were people in the [World Trade Center] who had participated in evacuation drills. And they knew when to leave when there was a problem. And so we can probably credit thousands of saved lives to previous training and planning."

Inclusion of Public Transit in Training Exercises – The inclusion of public transit in training exercises has been citied in the literature. For example, the *National Transportation Security Summit: Washington DC* reported: "Annual training exercises/drills occur around natural hazards, such as earthquakes, hurricanes, floods, or ice storms. Transit elements should be included in the exercise/drill. For example, with a flood exercise, a bus bridge around a flooded area can be included. Also, can include the need to reroute some of the public routes due to emergency conditions."

The *Metro Magazine* article "Transit Steps Up Security" reported: "For several years, New York City Transit has participated in multi-agency disaster training with such organizations as the New York Police and Fire Departments."

Testing of Mutual-Aid Agreements – The testing of mutual-aid agreements has been cited in the literature. For example, *Synthesis of Transit Practice 27: Emergency Preparedness for Transit Terrorism* reported: "Roles and responsibilities can be instituted in a memorandum of understanding or similar document. To test the agreements, have a variety of training scenarios to ensure all local responders recognize their respective roles and responsibilities."

Training Exercises – Evacuation training exercises have been conducted before an actual need. The State of South Carolina staged an evacuation exercise with the use of contra-flow lanes in 1999. The Greenville.com article "South Carolina Ready for Hurricane Evacuation" reported: "The South Carolina Department of Transportation and State Highway Patrol staged a short rehearsal for the emergency evacuation procedures that they plan to follow in the event of a hurricane. The biggest part of their plan is to reverse the eastbound lanes of I-26 and block all eastbound entrance ramps between Charleston and Columbia, South Carolina. The two state agencies used 125 State Highway patrolmen and 200 Department of Transportation workers to stage the drill. The Department of Transportation distributed fluorescent orange barrels at each of the entrance ramps for I-26 east, but did not block the entrances in the drill. The State Highway Patrol had patrol cars at each of the entrance ramps as a means to enforce the closure of the entrance ramps. The two departments found that the evacuation plans take approximately three hours to implement. The only problem that the agencies discovered was that their communications systems were overloaded due to the heavy communication traffic during the exercise. They think that they can correct this problem before South Carolina experiences a hurricane this season."

According to *Reversing the Flow*, the State of Texas conducts training exercises prior to the start of the hurricane season: "The operating agencies involved also perform an annual exercise nicknamed Hurricane Polly every April, just prior to hurricane season, where they walk through the processes involved with a major hurricane evacuation. Reversing the interstate ramps is a part of this exercise."

According to *Protecting Surface Transportation Systems and Patrons from Terrorist Activities: Case Studies of Best Security Practices and a Chronology of Attacks*, New York City Transit also conducts training exercises for terrorist attacks: "In anticipation of major emergencies, New York City Transit conducts regular emergency response and rescue exercises. These vary from desktop simulations to organized, planned drills to 'no-notice' simulations. The primary objective of these exercises is to identify deficiencies in the emergency plans and coordination and communication problems."

Training was credited during the southern California wildfires as a benefit. As reported in *Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center*, "Respondents believed that interagency training had an impact on how effectively responding agencies coordinated their response to these incidents. They felt that agencies that had trained together were able to establish a unified command faster and had a more effective response. Agencies that provided incident command systems training down to the tactical level were decidedly more effective prior to the establishment of unified command, as well as after it had been established. Respondents reported that joint training with ancillary agencies, such as the Red Cross, exposed firefighters to the planning and operational considerations of cooperators and gave cooperators training needed to function in the wildland fire environment."

In addition, *Southern California Firestorm 2003* reported: "Respondents indicated that tabletop planning and exercises proved especially important in those areas with strong pre-incident planning (during the southern California wildfires). Joint sessions brought cooperators together and enabled them to identify and plan for areas likely to be impacted by wildfire-urban interface fires. This planning involved reviewing fire history records, conducting fire hazard analyses, and having leaders talk through the planning and response issues. This process provided the opportunity to become familiar with local areas and cooperators and allowed cooperators to 'work-out the bugs,' identifying opportunities and potential problems. Respondents said they would like to see the same kind of training done at the tactical level with firefighters. Agencies with responsibilities in the wildfire-urban interface conducted training sessions to plan strategy and tactics and walk through an anticipated incident. Fire managers simulated the fire suppression planning and execution with engine and hand crews walking through their expected activities such as engine crews driving into wildfire-urban interface neighborhoods, implementing triage procedures, and practicing tactics."

Also according to *Southern California Firestorm 2003*, because of efforts "in the training and standards, those who participated in the California Office of Emergency Services wildland fire curriculum believed they were better prepared to function as part of a strike team (during the southern California wildfires). Other departments had taken advantage of training provided by cooperator agencies or their own wildland divisions for training. Respondents felt that those who did not have that training were exposed to greater risks by being less familiar with wildland tactics and not fully understanding their role in a strike team."

4.2.4.7 Unified Command

A unified command structure can operate alongside an incident command system. According to the *Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center*, "Unified command proved far more effective when agency representatives had the authority to make decisions on behalf of their agency concerning resources and strategy (during the southern California wildfires). Incident command and staff said that law enforcement agencies, transportation departments, utilities, and others needed to be co-located in unified command. Respondents said they would like to see plans targeting incident command posts and planned trigger points to establish unified command and dispatch its staffing. For example, when a trigger point for evacuations is reached, the sheriff's office, highway

patrol, and department of transportation would move toward a planned incident command posts and deputies would move to traffic chokepoints. If evacuation is needed, deputies are already on site."

4.2.4.8 Use of Specialty Teams

Specialty teams have been deployed that can assist in an evacuation situation. According to *Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study*, during the Washington, DC, terrorist attack, "tiger teams were deployed to assist the Northern Virginia District." Tiger teams are Virginia Department of Transportation crewmembers who are deployed to regions in the state that need additional assistance in preparing for and responding to severe weather events or any other emergencies involving the roads and highways.

4.2.5 Communication Issues

This section of the literature search addresses information found on communication. It is subdivided into communication devices, demand for travel information, difficult communication incidents, information sources, need for communication, redundancies in the system, information sharing, and communication staging.

Some of the communication issue findings include:

- Communication is key during an evacuation incident.
- There are multiple ways to communicate from the traditional methods of loud speakers and the canvassing of streets to high-technology cell phones with television screens that receive evacuation orders and information.
- After the 9/11 terrorist attacks, the use of transit call centers and Web sites increased from passengers seeking transit information.
- During evacuations, communication between all parties (e.g., evacuees, the general public, and entity staff) can be difficult and problematic. People and entities have been creative in overcoming these communication problems (e.g., the use of personal cell phone calls to neighbors alerting them of the need to evacuate).
- Some companies have emergency communication plans.
- Information communicated during an evacuation needs to be accurate and consistent. One way to handle this is the use of a joint information center that manages the information in order to deliver a consistent message. In addition, the media will eventually become involved in the evacuation situation and can be a valuable ally.
- Entities have redundant communication systems that can be used during an incident.
- Information should be shared among various entities.
- The type of evacuations (i.e., advance-warning or no-notice) impacts the type of communication issued.

4.2.5.1 Communication Devices

There are multiple ways to communicate including the traditional methods of loud speakers and canvassing of streets and high-technology cell phones with television screens that receive evacuation orders and information.

Governmental units such as the federal government understand the need to communicate and are "in the first stages of planning ways to communicate with endangered downwind communities (based on a nuclear incident), via radio, television or cell phones," as reported in the *Washington Post* article "US Called Unprepared for Nuclear Terrorism."

The term "communication device" includes software used to communicate traffic information and hydrowatch information that is communicated to the state. Communication devices also include the traditional devices such as bullhorns and highway advisory radio.

511 Travel Information – As of early 2005, there are 20 states with statewide coverage and 7 regions that have 511 travel information services, which covers about 48 percent of the US population. Another 18 states and regions are planning to begin 511 service in 2005 and 2006. In an emergency situation, 511 services can provide information to the traveling public. As reported in *America's Traveler Information Number: Deployment Assistance Report #3: 511 and Homeland Security*, "511 system operators must consider the broader impacts of the emergency on travel options. This may require wider coordination with other agencies to determine 'safe' escape routes to locations where travel options are less disrupted, and a thorough interpretation of available options including alternative means, e.g., ferry, walking. This, in turn, may require 511 system operators to have a regional and multi-modal knowledge of transportation systems in their area."

Weather information is also available on 511. This service can be used by evacuees to provide information on changing weather conditions. *America's Traveler Information Number* also reported: "Weather information on a 511 system can range from a regional alert (hurricane, winter storm, etc.) to a route specific observation or alert (low visibility, icy pavement, high winds, etc.). Deployers should include any available weather-related information that could impact a person's travel and attempt to package and deliver the information in a consistent manner. The two keys to weather are relaying impacts and providing navigational references to aid the traveler."

511 travel information can also provide information that may be of use to evacuees during an evacuation incident. The report adds: "In times of emergencies, uninterruptible broadcast messages can deliver a brief, important message at or after the greeting of a 511 service and terminate the call, thus creating a 511 system that has short call durations and is able to disseminate the most critical information to all callers and nothing else. This will alleviate some of the peak capacity issues that deployers are experiencing."

In addition, *America's Traveler Information Number* reported that the Virginia Department of Transportation has "found that 511 is a welcome asset during incident and traffic management situations. The 511 service is being used in conjunction with permanent and portable changeable message signs to relay critical information to travelers during major incidents, typically hazardous material spills that can close an Interstate. Because changeable message signs are limited to three lines of text on three panels, multiple detour listings and describing complex situations is generally not possible. The changeable message signs convey the necessary information as they normally would in these situations, but they also prompt travelers to dial 511 for additional information."

According to the report, "In one situation, Virginia Department of Transportation used changeable message signs up to 100 miles from an incident to alert drivers to dial 511 where they received information on up to three detours depending on their desired destination. Virginia Department of Transportation has documented that by using the changeable message signs and 511 together, call volumes to the service doubled almost immediately."

511 travel information can also be used for major events. As reported in the *America's Traveler Information Number* report, "511 is a capable tool in assisting in the management of major events. While most major events around the country tend to be weather-related, or incident related, some are planned events, like the Winter Olympics held in Salt Lake City, Utah in 2002. Utah Department of Transportation developed the 511 service with special content features designed specifically for the Olympics. These features included driving directions to venues, event schedules and tips for commuters. The service also offered a link to transit services and provided roadway conditions for the area. In all, the Olympics were a significant and immediate successful test for the system. Major events, such as bridge collapses that completely shut down roadways, also offer an opportunity to use 511 in conjunction with traffic and incident management tools familiar to department of transportation's."

According to the *Intelligent Transportation Society of America: News of the Week* article "WSDOT (Washington Department of Transportation) Answers the Call for a Push-Button 511 Option," the State of Washington provided improvements to the 511 system: "Motorists calling the travel information line, 511, are now offered an alternative to the voice-activated system, the Washington State Department of Transportation announced last Friday (December 2, 2004). Callers can now press the 'pound' sign (#) to get information in a push-button manner. Washington State Department of Transportation implemented the new option to ease caller frustration when the system couldn't understand callers' voices."

Automated Calling System to Emergency Planners – The State of California has an automated calling system that alerts local emergency planners. In July of 2005, state officials learned of the issues with the system. As reported in the *Contra Costa Times* article "Tiny Wave Reveals Gaps in Tsunami Readiness," The tiny wave generated by a major undersea earthquake off the far Northern California coast last month revealed large gaps in how ready communities hugging the Pacific shoreline are for a true tsunami threat. Although the alert was canceled about an hour after blaring sirens warned some towns of a possible killer wave that never arrived, the effects of the 7.2-magnitude quake are still rattling emergency planners. Some residents received no warning on the evening of June 14; in other cases, word was not spread wide enough or fast enough. The event also exposed how some heavily populated areas lack an evacuation plan even if they did receive quick warning.

"The underwater earthquake about 90 miles west of Crescent City produced a 1-centimeter wave, roughly the width of an adult's finger, detected by an ocean pressure-measuring buoy. That triggered the tsunami warning. Sirens sounded, and thousands of people fled for higher ground in far northern California and parts of Oregon. Many residents heard warnings through TV and radio, but some remote communities received no notice. Last month, Henry Renteria, the director of the California Office of Emergency Services, acknowledged gaps in the alert system but told state lawmakers that he was pleased with the overall response. The state has since retrained its staff and plans to spend $300,000 to expand a warning system that would automatically contact cell phones and pagers of as many as 2,000 local emergency planners," as reported in the *Contra Costa Times* article.

Bullhorn, Loud Speakers, Street-by-Street Canvas, Face-to-Face, and Hand Outs – Occasionally, a traditional communication device such as the bullhorn, may be necessary. As reported in the *American City and County* article "Community Evacuation: Ensuring Safe Passage," "Television and radio have their shortcomings as well, making it necessary for emergency departments to retain their oldest technology—the bullhorn. [Terry] Tullier [Deputy Chief of the New Orleans Fire Department and Interim Director for the City's Office of Emergency Preparedness] notes that street-by-street canvassing is part of any evacuation and is especially important in communities with non-English-speaking residents."

Transportation in Emergencies: An Often Neglected Story cites the use of loud hailers and door-to-door communication: "The 1979 Mississauga evacuation began late on a Saturday night with a train carrying styrene, toluene, caustic soda, propane and chlorine derailed and caught fire. When the Propane cars

started to BLEVE (explode) and police smelled the leaking Chlorine, they decided an evacuation was essential. They started by moving out those in the immediate vicinity but eventually cleared out 217,000 persons, the largest evacuation in Canadian peacetime history. Police announced each evacuation in advance—even showing maps on cable television—then sent police officers door to door with police cars using loud hailers following them."

The Indystar.com article "Plant Fire Brings Call to Evacuate" reports the use of loud speakers to evacuate residents during the chemical fire and evacuation at Anderson, Indiana, on January 14, 2005: "Officers went through Anderson neighborhoods with loudspeakers, urging residents to leave." During the southern California wildfires of 2003, *Fire Lessons Learned in California* reported: "'In some smaller communities, evacuation orders were issued via a helicopter equipped with a loudspeaker system,' recalled Thomas Cova, a researcher from the University of Utah."

In flood-prone areas in New South Wales, door knocking is targeted due to the number of potential evacuees. According to *Flood Warnings: Recent Lessons Learned and Developments Under Way*, "In the latest Grafton Local Flood Plan, a map showing numbers of households in census collector districts is included to help the flood response managers plan their door knocking strategies."

During the hazardous materials fire in El Dorado, Arkansas, on January 2005, "police were knocking on doors and calling out over loud speakers, alerting people living around the warehouse to leave fast," as reported in the NWAnews.com article "Air Near Plant Safe; Residents Sent Home."

In some evacuation situations, entity staffers are sent to distribute information verbally and in handouts. According to *Saving City Lifelines: Lessons Learned in the 9/11 Terrorist Attacks,* during the 9/11 terrorist attacks in New York City, "New York's Metropolitan Transportation Authority and New York City Transit and New Jersey Transit also sent administrative staff into the streets and subways armed with bullhorns and newly printed maps and instruction sheets, to provide up-to-date information, hand out flyers, and directly assist passengers."

During the southern California wildfires, the radio systems were incompatible leading to difficult communications. According to *Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center*, various methods were used to communicate including face-to-face contact between structure protection group leaders: "As the structure protection group leaders recognized the communications disconnect, they took the initiative to find each other, meet face to face, and resolve the situation. Once this error chain was broken, resources began to flow to critical areas and the incident management teams started receiving more accurate situation awareness from resources in the city."

In addition, according to the *Southern California Firestorm 2003* report, "Leaders repeatedly reported that the most effective way to overcome communications incompatibility and conflicts was to meet face-to-face to coordinate. However, while leaders were engaged in face-to-face discussions, they could not always give updates and new information to resources under them. In many areas, especially those protected by resources that were not local to the area, leaders reported this information gap caused a hesitancy to engage because they felt they faced increased risk resulting from the lack of communication. Other units, recognizing the lack of communication, were forced to exercise their initiative and take independent action in areas where they felt the situation and the values at risk required it."

According to the report, "Respondents reported that stopping and communicating with residents, as much as the situation allowed, was very important in preventing homeowners from becoming dangerous distractions (during the southern California wildfires). In some cases, firefighters provided fire shirts and hard hats to residents who would not evacuate, and got them busy preparing homes and assisting firefighters as field observers or sources of local information. Respondents said that communicating their

risk criteria, trigger points and contingency actions seemed to reduce the stress in the residents and subsequently the stress the residents placed on firefighters when the situation worsened."

Bus and Train Communications System – Some evacuations, such as the 9/11 experience in New York City, involve the evacuation of people through the use of public transit. Evacuees used a mix of transit options. However, information regarding the next available vehicle was provided by transit agency personnel. Another option is a bus and train communication system that provides communication between the two services to provide location and time information to the public.

According to the *ITS International News* article "World First Claimed for Bus/Train Communications System," in Copenhagen, Denmark, the Greater Copenhagen Authority "is working with ITS consultant Hyder Consulting to introduce global positioning software technology which will minimize passenger waiting times when interchanging between the two services. Buses and trains will be able to communicate with each other in real time using a city wide digital communication architecture, and thus report to drivers the location and time of arrival of corresponding services. Passengers on board trains and buses will be informed by way of on-vehicle screens of the status of their next corresponding service."

Cable Television – Local cable services can also provide information during an evacuation incident. For example, the *American City and County* article "Community Evacuation: Ensuring Safe Passage" reported its usage in Grand Forks, North Dakota: "A cable interrupt system allows the city to communicate with residents directly via television. 'The system is activated by picking up a phone in our dispatch center, and we can deliver a message to everyone watching cable television,' [Lieutenant Byron] Sieber [Commander for Planning and Research for the Grand Forks, North Dakota, Police Department] says."

According to the *Compendium: Graduate Student Papers on Advanced Surface Transportation Systems: Application of ITS Technology to Hurricane Evacuation Routes*, in Galveston, Texas, "the Emergency Management Coordinator has access to the only cable provider on the island. He has the power to override all programming to alert the public of a recommended evacuation."

Cell Phones – In an evacuation situation, traditional methods of seeking information about the evacuation event, such as the use of the Internet, television, and/or radio, may be difficult. Phone service has been used to seek out and provide information regarding the evacuation incident. As reported in *America's Traveler Information Number: Deployment Assistance Report #3: 511 and Homeland Security*, "Under 'normal' conditions there are multiple media for dissemination information to travelers. However, on September 11, the need for a(n) exodus on foot from the affected areas precluded the options to use the Internet, television, or even radio. For many, cell phones became the primary means of communication in the hours following the attacks. Perhaps, one of the most immediate lessons that can be learned from September 11 is how the demand for travel information changed during the attacks and in the following days and weeks."

Driving while talking on a cell phone can be unsafe, especially during an evacuation. According to the *Intelligent Transportation Society of America: News of the Week* article "Ford Selects Sprint as Preferred Provider for Hands-Free Bluetooth Communication System," on September 1, 2004, Sprint PCS and the Ford Motor Company announced that the "Ford Motor Company has selected Sprint to be the preferred wireless provider of Bluetooth phones and service for the company's new Mobile-Ease Hands-Free Communication System. Mobile-Ease is a dealer-installed option for select Ford, Lincoln and Mercury vehicles that utilizes Bluetooth technology to wirelessly integrate mobile phones with the vehicle's audio system, providing drivers and passengers the safety and convenience of hands-free calling." As a result, evacuees are able to communicate hands free.

Services are now available for cell phone users to alert them to real-time traffic information. As reported in the *San Jose Mercury News* article "Stuck on the Freeway? Your Cell Phone Will Guide You," in February 2, 2005, Rand McNally launched a traffic information service (www.randmcnally.com/traffic) for $3.99 a month for customers of AT&T, Sprint PCS, and Verizon Wireless. "Rand McNally Traffic puts highway maps on your phone's screen with color coding to speed. If a stretch of Highway 101 is red, traffic is crawling along at 33 miles per hour, yellow section along Interstate 880 means cars are moving at a moderate 33 to 59 mph. If there's green along Interstate 280, you're free to move at or near the speed limit—California Highway Patrol isn't looking, even faster. The maps also display icons to indicate the location of accidents, construction, and other killers. You can click the icons, using the keypad on your phone, to get details of why in traffic." According to the article, there are at least three other companies offering similar services: MapQuest Traffic (http://www.mapquest.com/explore/traffic), Pharos Science & Applications (www.pharosgps.com), and Vindigo Traffic (www.vindigo.com/traffic).

In addition, there is another tool, the Palm Traffic for Treo Smartphones. It costs $4.99 a month for traffic updates for one city. As reported in the *Contra Costa Times* article "New Software Helps Commuters Dodge Traffic," "you can zoom into the part of the map that affects you most and bookmark spots of greatest interest. Tap on one of the flashing circles for detailed written information. One recent example: 'Garden State Parkway at Exit 145. There is an accident involving an overturned vehicle causing heavy delays on the northbound Garden State Parkway north of Exit 145 I-280-Central Avenue-East Orange-Newark.' The dots may also tell you if highway traffic is moving slow ('Miles per Hour: 35—Southern State Parkway Exit 32') or if there are delays at major 'chokepoints' ('Lincoln Tunnel to Manhattan has 10 min. delays'). Palm Inc. gets the traffic data from a company called MetroCommute, which takes sensor and accident data from local transportation officials. It also adds information obtained through its own cameras and speed detectors at bridges, tolls and other high-traffic areas. The traffic updates for some cities are also available for free on MetroCommute.com and as text messages. The data refresh every 15 minutes by default, though you can set it to refresh as quickly as every 5 minutes or simply tap a button on the screen for an instant update."

Cell phones have been used by the traveling public to alert officials to accidents that lead to an evacuation effort. According to *I-95 Shutdown: Coordinating Transportation and Emergency Response*, "Within minutes of the [tanker] explosion [on I-95], the Maryland State Police began receiving calls about the incident from motorists dialing #77 on their cellular phones, and fire and police departments from multiple jurisdictions reported to the scene and its vicinity."

According to *Flood Warnings: Recent Lessons Learned and Developments Under Way*, New South Wales uses a short messaging service to alert citizens of the possibility of flooding: "The State Emergency Service's short messaging service system is currently being trialed in Lismore. The mobile phone based short messaging service is being used to broadcast text messages to targeted, geographically defined groups of mobile phone users who have registered for the free service. The system has only recently been rolled out, and so far, only test broadcasts have been sent. In the near future however, the system will be used during flood and storm events. For example, as a flood approaches, the State Emergency Service will send text messages to subscribers in the areas affected. The messages will warn of the impending flood, provide predictions of the flood's likely severity, recommend courses of action and refer the user to sources of further information."

Cell phones with video capabilities also have the potential to assist the authorities during times of emergencies. As reported in the *Tri-Valley Herald* article "Cell Phone Cameras Aid TV News Coverage": "The video was grainy, shaky but undeniably compelling: passengers standing in the aisle of a subway car, its windows shattered following one of the coordinated explosions in London. Several US television executives said that as far as they knew, it was the first time video taken from a cellular phone was used during coverage of a major story. It was no doubt a harbinger of things to come. 'It was a clip that we

used no more than two, three thousand times,' joked John Moody, Fox News Channel senior vice president. The video taken by a commuter first aired on Britain's Sky News, a Fox sister station. Still photographs taken by cell phone also were used in many newspapers. One cell phone picture by commuter Alexander Chadwick, distributed by *The Associated Press*, appeared on the front pages of both *The New York Times* and *The Washington Post*. News stations have increasingly relied on amateur video to help tell major stories such as last December's tsunami. But as more people get cellular phones with video capability, it's much more likely that a bystander at an unexpected news event will be carrying a phone instead of a video camera. 'I think you're looking at a portent of things to come,' said NBC News President Neal Shapiro. When he heard about Thursday's explosions, London-based Sandy MacIntyre, director of news for Associated Press Television News, said the first thing he told his staff was that someone must have cellular phone or video footage."

Cell phones occasionally have shortcomings. For example, these shortcomings were cited in *San Bernardino County Fire Chiefs' Association: Lessons Learned Report: Fire Storm 2003: "Old Fire"*: "Although cell phones were used to attempt to overcome communications problems, the cell systems became overloaded by the inordinate cell phone use. In addition, some areas lost cell towers or experienced power outages because of the fire."

During times of crisis, people with cell phones tend to use them to contact others. Government entities have the potential to tap into this occurrence with the ability to map cell phone use in a community. While unable to detect what type of incident, this mapping should alert authorities to potential incidents or events that generate cell phone usage. As reported in the Massachusetts Institute of Technology Web site article "MIT Researchers Map City by Cell Phone": "Using anonymous cell phone data provided by the leading cell phone operator in Austria, A1/Mobilkom, the researchers developed the Mobile Landscapes project, creating electronic maps of cell phone use in the metropolitan area of Graz, Austria, the country's second-largest city. The researchers used three types of data—density of cell phone calls, origins and destinations of the calls, and position of users tracked at regular intervals—to create computer-generated images that can be overlayed with one another and with geographic and street maps of a city to show the peaks and valleys of the landscape as well as peaks in cell phone use. In recent years, techniques to locate and track mobile devices have become increasingly available; such techniques were crucial to law enforcement officials in their investigation of the Madrid and London terrorist bombings. MIT's Mobile Landscapes project takes advantage of these techniques at an unprecedented scale by mapping an entire urban region continually at regular intervals. The research could also have implications for use in large-scale emergencies and for transportation engineers seeking ways to better manage freeway traffic."

Cell Phone Television Screen – New and improved cell phones may be available in the future that could receive evacuation orders and information. The Japan Times Online article "Disaster Broadcasts Via Cell Phone Eyed" reported: "KDDI Corp. and Hitachi Ltd. have gotten together to develop a phone where the phone's liquid crystal screen automatically changes to a TV screen, and information appears on the lower part. The terminal is equipped with a global positioning system. The developers want terrestrial digital broadcasting and mobile phone technology combined to send evacuation orders and disaster information during large-scale disasters."

According to the Japan Times Online article "Cell phones to Be Used as Data Source in Disasters," "More than one year has passed since terrestrial digital broadcasting services began a new TV era in Japan, with the services spreading from major cities to some rural areas where prefectural government offices are located. 'This is a news bulletin. There was a strong earthquake in the Kanto region,' the voice of an announcer sounded from a mobile phone in a shirt pocket. When the user looked at the liquid crystal screen, it automatically changed to a TV screen, and text containing information began to appear in the lower part of the screen. This is the scene of a demonstration using a mobile phone produced on a trial basis that can receive terrestrial digital broadcasting services. KDDI Corp and Hitachi Ltd are jointly

developing the mobile phone. The terminal is equipped with a global positioning system (GPS). 'Linked with the GPS, broadcasters can also automatically send information about the nearest shelter,' said Tatsuo Shibata, deputy director of the media technology development department at KDDI. The combination of terrestrial digital broadcasting and cell phone technology is what the developers want to be used for sending evacuation orders and alarm information to people during large-scale disasters. The services to cell phone are scheduled to begin during fiscal 2005."

Catastrophic Level Event and Emergency Response (CLEER) – A new software may be soon available for local authorities with a visual display of disaster events as they unfold. As reported in the *London Free Press* article "Software Firm Can Model Disasters," the CLEER program can provide "police and fire officials a real-time graphic display of an unfolding disaster... It's really giving you a view from the clouds, top down. You now have a visual display that allows you to make decisions." The program can be used to plan evacuations and emergency response to such emergencies as tornadoes, train derailments, floods, and terrorist attacks. The program will be accessed through a controlled-access Internet Web site. [Paul] Paolatto [Keigan Systems chief executive] said the CLEER system should be ready for launch by next spring and will be marketed, in collaboration with 3M Canada, to municipalities and private corporations such as chemical companies. The CLEER program will be marketed on a subscription basis for between $25,000 and $50,000 annually."

Community Awareness Programs: Emergency Planning – The Department of Homeland Security provided an ad campaign beginning in September 2004 in an effort to prepare the nation for another terrorist attack.

As reported in the *USA TODAY* article "Ad Campaign Urges Employers, Families to Plan for Emergency," "For the past year, the Homeland Security Department and groups, such as the American Red Cross, have encouraged families to make plans and put together emergency kits. The kits should include food and water, flashlights, battery-powered radios, and anything else needed to get by for up to three days if the power is out, communications are down and it's impossible to leave home. Officials have promoted these preparations as crucial not just for a terrorist attack but also for hurricanes, earthquakes, and other disasters. Polls show 4 in 10 Americans have followed the advice."

The article also reported: "Employers will be encouraged to develop continuity plans so they can keep operating through a crisis. They also will be encouraged to give their workers wallet cards with company information and to clearly mark exit routes. Steven Brill of the non-profit America Prepared Campaign says businesses must do more to prepare for emergencies. 'Some are doing a good job, but some aren't.'"

Community Awareness Programs: Storm Ready Communities – The National Oceanic and Atmospheric Administration recognizes communities around the country as storm ready. The goal of the program is to reduce the impact of severe weather and flooding threats on communities.

According to the National Oceanic and Atmospheric Administration Web site, "The nationwide community preparedness program uses a grassroots approach to help communities develop plans to handle local severe weather and flooding threats. The program is voluntary, and provides communities with clear-cut advice from a partnership between the local National Weather Service Weather Forecast Office and state and local emergency managers. Storm Ready started in 1999 with seven communities in the Tulsa, Oklahoma, area. There are now more than 820 Storm Ready communities in 47 states, five of which are now located in Virginia. The Storm Ready recognition will be in effect for three years, at which time the community will go through a recertification process. To be recognized as Storm Ready, a community must: establish a 24-hour warning point and emergency operations center; have more than one way to receive severe weather warnings and forecasts and to alert the public; create a system that monitors weather conditions locally; promote the importance of public readiness through community

seminars; and develop a formal hazardous weather plan, which includes training severe weather spotters and holding emergency exercises."

Community Awareness Programs: Tsunami Certified Communities – The National Oceanic and Atmospheric Administration certifies communities as Tsunami Ready. According to its Web site, in order to be certified, "the community must have an Emergency Operations Center, the ability to disseminate a tsunami warning (sirens, local media), have a Tsunami Hazard Plan, have a community awareness program and have multiple ways to receive National Weather Service tsunami warnings."

One of these certified communities is Cannon Beach, Oregon. The ABC News.com article "US on Guard for Tsunami Risks: West Coast Prepares with Warning Systems and Drills" reported: "The town is one of 11 communities, stretching from California to Alaska, that have now been certified by the federal government as 'tsunami-ready.' [As a result,] evacuation routes have been established. Residents have signed up to call each other in emergencies. Loudspeakers have been put up around town—and are tested, twice a month, with a recording of a cow's mooing. A siren sound would send people running. 'It tells them that high-speed waves are expected and that they should head to high ground,' said Alfred Aya, the emergency management chief for Cannon Beach. 'Tsunamis are very rare, but you never know when they're going to hit, so we can't afford to take chances.'"

eCall – A potential new technology that is planned for Europe in 2009 is eCall—an automatic emergency call system using global positioning software that is to be installed in new cars. The Carconnection.com article "EU to Use New Emergency Call System," reported: "As part of a new safety initiative, the European Union (EU) plans to require an automatic emergency call system, using global positioning software technology, in all new cars by 2009. The plan, called eCall and confirmed by a commission meeting in Brussels Thursday, would report your exact coordinates and any other information it can collect about the crash to a Public Service Answering Point (PSAP), which would report the information in a standardized way to the proper local emergency dispatch crews. The exact coordinates and standardized form will help reduce response times, and direct access to other information will help with EMT preparedness. No such system exists yet for the US Automaker-implemented systems like GM's OnStar and Mercedes-Benz's TeleAid allow accidents to be reported, but the call or signal is first routed through an operator who then relays the information to the appropriate emergency operator. According to a release, studies have suggested that, once fully implemented, eCall could save up to 2000 lives per year in Europe. Implementation specifics are to be decided by the end of this year with field tests beginning next year."

E-Mail Notification and Phone Alert Rings – E-mail notification and phone alert rings have been used to communicate information. According to the Federal Highway Administration Transportation Evacuation Planning and Operations Workshops 2004 presentation "How the Big Easy Became the Worst Possible Hurricane Disaster," the State of Louisiana has "identified 180 key decision makers who need weather information, [with] automatic emails alerting them of the weather and alert rings selected by them [for phone calls that need to be made]."

Emergency Alert System – The City of Denver uses an emergency alert system to communicate to the public. As reported in the *American City and County* article "Community Evacuation: Ensuring Safe Passage," the Office of Emergency Management uses the Emergency Alert System, which replaced the conventional Emergency Broadcast System. Using digital technology, the Emergency Alert System can transmit live or recorded messages to broadcast media and to specially equipped consumer televisions, radios, pagers, and other digital devices. The Emergency Alert System also allows unattended media to receive and transmit emergency messages automatically.

Evacuation Traffic Information System – Software systems are utilized by states to assist in hurricane evacuations and provide communication to affected states. The *TR News* article "Emergency Evacuation: Ensuring Safe and Efficient Transportation Out of Endangered Areas" reported: "The Federal Highway Administration, along with the Federal Emergency Management Agency, the US Army Corps of Engineers, and state agencies, supports the Evacuation Traffic Information System, a web-based, geographic information system tool for sharing information among states and agencies. Developed in response to the evacuation for Hurricane Floyd, the ETIS (Evacuation Traffic Information System) graphically displays the evacuation status of coastal counties, counties, contra flow segments in use, and the number of vehicles expected to cross state lines. The ETIS (Evacuation Traffic Information System) is the first step in using technology to improve coordination among the various state and federal agencies involved in hurricane evacuations."

Flood Bulletins – Flood bulletins are issued by local governments for potential flood situations. According to *Flood Warnings: Recent Lessons Learned and Developments Under Way*, in New South Wales, Australia, flood bulletins are issued by the state and provided to the media. These bulletins can include "advice on what actions people should take to protect themselves and their property (indicating appropriate time frames for these actions); areas of danger to be avoided; road conditions (roads that are currently closed, may become closed and/or will not be closed); contact details for State Emergency Service Units in the event of assistance being required; and contact details for obtaining road information."

Flood Warnings also reports that flood bulletins tend to be "'media unfriendly.' They can be overly long, and contain lists of information, such as road closures, which are poorly suited to radio broadcasts. This is understandable, given the large volume of information that flood response managers try to get across to the public during floods." However, emergency officials are trying to improve the style and content of their flood bulletins.

According to *Flood Warnings*, "The best flood bulletins are short (one page maximum) and cover a small number of themes. To get the necessary information to the public via the media will mean that the State Emergency Service will have to release more bulletins more frequently than in the past. In other words there could be three different kinds of flood bulletins—warning bulletins, road closure bulletins and news bulletins (media releases)."

In addition, *Flood Warnings* reports: "Flood response managers should not fear that they would create 'panic' in disseminating these bulletins; the real challenge is to make sure that people hear and understand the message and are therefore given a chance to do something which is in their own interests."

Ham Operators – Ham operators have assisted in communicating information during an evacuation. For example, the *American Radio Relay League Inc.* article "Hams Staffing Shelters, Nets as Floyd Nears" reported: In the State of Georgia, ham operators "assisted evacuees needing assistance with directions or locating shelter."

Ham operators provided information and assistance during the evacuation from Mississauga, Canada. According to the *Hot Bananas* (Oakville, Canada's amateur radio club monthly newsletter) article "Canada's Largest Evacuation," a rail vehicle crashed and burned in 1979, and resulted in the largest peacetime evacuation of Canada with 12 evacuation centers and two command centers at that time: "As each centre became active, a station was put on the air with two operators at each. Health and welfare inquires began pouring in soon after the evacuation centres were opened, and it was decided to us a second repeater to handle the overflow traffic." The ham operators were on the air for 80 hours assisting the evacuation efforts.

Highway Advisory Radio – Highway advisory radio is used to communicate information to evacuees and the general public that could be too much information for a message sign. For example, according to the *Business Journal of Kansas City, Missouri* article "KC Scout Officially Hits the Highway," a new information system was recently unveiled in the Kansas City area: "The $43 million Scout system, which is operated from the Lee's Summit site, uses closed-circuit video cameras and traffic sensors to monitor traffic along area highways. It uses electronic message boards and highway advisory radio broadcasts to alert motorists to accidents and other delays."

HydroWatch – A communication issue cited in the literature is the collection and transfer of traffic information during an evacuation. The *TR News* article "Emergency Evacuation: Ensuring Safe and Efficient Transportation Out of Endangered Areas," reported: "Traffic information is critical to the strategic management of evacuation routes and to the effective allocation of transportation resources. States are turning to ITS technologies to gain this input—however, the concentration of ITS deployment is in urban areas, and evacuation travel mostly occurs in rural areas. One system now in testing addresses the lack of rural ITS resources—the Louisiana Department of Transportation and Development's traffic, weather, and flooded-road alert system. The system combines low-tech traffic data recorders with the US Geological Survey's Louisiana HydroWatch stream monitoring stations, to collect traffic, weather, flood, and bridge scour data at critical locations along key evacuation routes in the southern third of the state. The data then are relayed via satellite to the state emergency operations center."

Interoperable Communications – Communication systems at times may be unable to communicate with one another due to separate channels or technology. Recently, ARINC was awarded a contract to incorporate a countywide interoperable communication solution for Clallam County in Washington state. As reported in the *ARINC News* article "ARINC Wins Nation's First Communications Contract Based on SAFECOM Guidelines from DHS," "It is the first project of its kind in the US, and the first ever to follow the guidelines for interoperability established by the US Department of Homeland Security's SAFECOM program. ARINC will deploy its AWINSSM interoperability technology to enable more than 40 separate police, fire, emergency medical, and government agencies to communicate with one another while retaining their existing radio systems. The award is significant because AWINS is currently the only technology able to connect all types of radio, phone, data, and video communications as recommended by SAFECOM. The Clallam County deployment will point the way for five neighboring counties, as well as for thousands of other jurisdictions in the US who are grappling with similar interoperability issues."

The *ARINC News* article also reports "ARINC has already started field work for the project's first stage, a turnkey Voice-over-IP (VoIP) solution, at the county seat of Port Angeles. By August 2005, OPSCAN participating agencies will have the ability to communicate with each other easily, using their existing radio equipment and communications infrastructures."

As stated in the press release titled *IAFC Releases Interoperability Handbook (Top Priority: A Fire Service Guide to Interoperable Communications)*, the International Association of Fire Chiefs also has recognized the problem of radio interoperability and "developed a handbook to help fire and emergency services chiefs and officers understand communications interoperability and to provide steps to improving communications in their region. This handbook provides a common operational definition of interoperability, discusses the foundation for interoperable communications and provides direction to establish interoperability between and among public safety services, including fire, emergency medical services and law enforcement organizations."

According to *Top Priority: A Fire Service Guide to Interoperable Communications*, "many reports have been published supporting interoperability; unfortunately, most of them have been largely ignored. Interoperability is viewed by many as desirable but not essential. This view can no longer be supported. Although interoperability is a critical issue affecting the ability to deliver emergency services, it continues

to be an elusive goal for most fire and emergency medical services organizations. Communications problems and the inability to coordinate with other disciplines and jurisdictions have been recognized as major operational limitations in every major incident, from the shootings at Columbine High School to the terrorist attack on the World Trade Center."

Available commercial communication systems identified in *Top Priority: A Fire Service Guide to Interoperable Communications* to provide communication interoperability include:

- Cellular service with push-to-talk capability
- Nextel Direct Connect radio communication network, which is a nationwide wireless voice and data system
- One- and two-way paging services using cellular phones and/or Internet-ready phones
- Console integration providing an integrated communications system by connecting several disparate communication systems into one interoperable system
- Global position systems enabled cellular phones
- Commercial global position systems location and tracking systems
- Interoperability directory of emergency response services
- Database look-up applications to provide emergency services with remote access to key information databases
- Patient tracking systems such as Emergency Patient Tracking System using handsets or personal digital assistants
- Nextel emergency response team (ERT), which responds to state and federally declared disasters.

ITS Technology – ITS technology can provide information to state emergency officials. The FCW.com article "Intelligent Transportation Gets Rolling" reported: "The Federal Highway Administration has tapped Florida to embark on an ambitious intelligent transportation systems. Elements of the project include: equipping Orlando's transit fleet with automatic vehicle location technology, monitoring the two major highways that support hurricane evacuations from the Cape Canaveral coastal area, using road weather sensors to provide information on conditions, creating a statewide reporting system to house data on events, incidents, construction and other capacity restrictions."

According to *Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout New York City*, "One of the primary benefits of certain ITS equipment, including variable message signs, highway advisory radio, and traveler information sites on the Internet, is the ability to communicate transportation conditions as early as possible so that people can make choices in how they travel."

Effects of Catastrophic Events on Transportation System Management and Operations described the use of ITS equipment to communicate information to states outside of the blackout areas during the New York City blackout: "On August 14, the I-95 Corridor Coalition worked to coordinate the posting of messages among its member agencies that were outside of the affected areas. The ability to divert traffic away from an incident can help relieve congestion and speed up the recovery of the system. Numerous agencies that were located outside of the blackout area, including New Jersey Department of Transportation, New Jersey Turnpike, Pennsylvania Department of Transportation, and Maryland Department of Transportation, took advantage of their agency's ITS technology and displayed messages on their variable message signs for traffic heading to the New York area. Those agencies with highway advisory placed messages on the system and several put traffic alerts on their web pages."

According to the 2001 ITS America 11th Annual Meeting and Exposition presentation "Utilization of Florida's Existing and Future Intelligent Transportation Systems for Enhancing Statewide Transportation System Management During and After Hurricane Evacuations," ITS technology also includes "ITS roadside device-based systems such as video cameras, dynamic message signs (permanent), dynamic message signs (portable), traffic signal systems, highway advisory radio and (am/fm override), satellite imaging, and data collection systems."

According to the Federal Highway Administration Transportation Evacuation Planning and Operations Workshops 2004 presentation "Reverse-Laning I-65 for Hurricane Evacuations," the State of Alabama uses a combination of technologies, including reversed direction signing, variable message boards, Alabama Emergency Radio, and the Alabama Department of Transportation web page (www.dot.state.al.us) for emergency road closures links and general posting of information. Future plans include public service announcements, printed materials (rest areas, etc.), and low-band AM radio for hurricane evacuations.

Maps and Brochures – Maps and brochures have been created and distributed to the general public for areas prone to natural disasters. The Ribble Valley Borough Council of England provides a brochure and maps of areas prone to flooding. On its Web site, the Council recommends "to find out if you are at risk from flooding, use the Environment Agency Floodplain maps on their Web site: www.environment-agency.gov.uk."

The Council publishes a brochure (one-page handout) entitled "No-Notice for Evacuation Homeowners Checklist." Examples from the brochure include: "follow official advice, ignore rumors; get together your family and pets; get together a supply of warm clothing; get together special foods for babies, invalids, and pets; get together any medicines in use; get together purse, wallet, personal documents, and special sentimental valuables; pack suitcases and load the car (if you have one); make sure that fires are out and that cookers, domestic fans, TVs, etc are turned off; in winter, drain the water system to avoid problems with frozen pipes; switch off/turn off all mains supplies to your property; lock your property and take this leaflet with you when you leave; and domestic rubbish to be taken outside in readiness for collection—if time permits."

The National Hurricane Center of Miami, Florida, provides information on hurricane evacuations such as a list of necessary items for family disaster planning and information regarding evacuation locations.

Florida, Georgia, Mississippi, and South Carolina provide maps showing hurricane evacuation routes on their Web sites. Georgia and South Carolina include contra-flow operations. Miami-Dade County, Florida, provides hurricane evacuation zone maps and hurricane evacuation bus pick-up points on its Web site.

During a hurricane evacuation, citizens need information. The TBO.com article "Evacuation Right Call, Say Local Leaders" reported: "In Sarasota County, sheriff's deputies found themselves answering the same questions as thousands of evacuees driving over bridges from barrier islands slowed to ask where they could find a shelter. To speed the exodus from future storms, Sarasota plans to give deputies pamphlets to distribute with directions."

According to the *Compendium: Graduate Student Papers on Advanced Surface Transportation Systems: Application of ITS Technology to Hurricane Evacuation Routes*, "Hurricane information is also presented at [Galveston] hotels to help keep tourists informed."

The Borough of Monaca, Pennsylvania, is located near the Beaver Valley Power Station Nuclear Facility. The Borough of Monaca Emergency Management Agency produces a brochure on evacuation routes. The

agency recommends that citizens place the brochure in the glove compartment of their vehicles for reference in case they are required to evacuate at short notice.

Message Centers – Message centers have been established after an evacuation incident to assist in communicating information. In July 1995, the Paris Metro was bombed due to a terrorist attack, and the subway was eventually evacuated. According to *Protecting Surface Transportation Systems and Patrons from Terrorist Activities: Case Studies of Best Security Practices and a Chronology of Attacks*, during the evacuation, "a local contact center was set up at a café near the entrance to the station. This provided a site that was easy for people to find, near the scene of the disaster, yet far enough away from the station to prevent its activities from interfering with rescue efforts. The center, which became operational within 15 minutes of the explosion, was manned by six regular Reseau Express Regional (RER) employees plus two persons from the RER's legal department and two government social workers. The contact center offered information and assistance to family members of victims. People at the scene could also use the center to call their homes to provide worried families with information. In addition to this practical assistance, the RER's Public Relations Department also managed media inquiries and provided continuous information to RER and Metro passengers and employees."

Message Signs – Variable and/or dynamic message signs communicate upcoming traffic situations and conditions to evacuees and/or the driving public and/or provide information of what is ahead. For example, according to the *Intelligent Transportation Society of America: News of the Week* article "Key Roads to Get Message Boards," in the State of North Carolina, "taking a city innovation to the country, the North Carolina Department of Transportation plans to install overhead message boards at four key roadway junctions in Southeastern North Carolina. Although normally seen on urban highways, like the Beltline in Raleigh or I-77 around Charlotte, the new signs are intended to provide motorists with traffic information at the earliest possible occasion, allowing them to make better decisions. But the area signs—among 12 the Department of Transportation plans to add in the next few months to the existing 77 electronic message boards scattered across the state—aren't there just to detail detours around accidents, highway construction or congestion 60 miles up the road. With memories of the traffic gridlock tied to Hurricane Floyd evacuations still fresh in their minds, officials plan to use the signs to advertise alternate evacuation routes to Interstate 40."

Information regarding travel times can be presented on message signs, thus helping evacuees select evacuation routes. According to the *RFID Journal* article "RFID Drives Highway Traffic Reports," "the "Orlando/Orange County Expressway Authority is deploying radio frequency identification based traffic—monitoring system in central Florida. The system will use roadside radio frequency identification readers to collect signals from transponders already installed in about 1 million E-Pass and SunPass customer vehicles. The goal is to implement a system that would trace the travel time of individual cars as they pass the roadside readers, create an average trip time and then disseminate that information to the public. Information about commute times will be sent to the public on dynamic message signs, installed at motorists' decision points around the roadway system to provide up-to-date traffic information. Motorists will also be able to access traffic information by calling 511 (the national travel information telephone number currently in use by 21 states) or by accessing a Web site that has not yet activated."

According to *I-95 Shutdown: Coordinating Transportation and Emergency Response*, message signs can also communicate to others outside of the evacuation zone to not enter: "Four minutes after the crash (I-95 tanker explosion), as emergency response vehicles and personnel left their respective stations, Maryland's Coordinated Highways Action Response Team changed variable message signs along the I-95 corridor and other feeder interstates in Maryland to inform motorists that I-95 near Baltimore was closed and offer alternate routes."

Emergency Transportation Operations: Stakeholders, Functions and Automated Tools reported that during the 9/11 terrorist attack on New York City, "using its virtual communications system, the Transportation Operations Coordinating Committee, which serves as the incident information coordinator for the entire northeast corridor of the I-95 Corridor Coalition, was able to alert I-95 Corridor member agencies of problems in the New York City region. These agencies, in turn, used highway advisory radio, and variable message signs on I-95 as far south as Delaware and as far north as New Haven to instruct traffic to avoid the New York City region."

OREIS – Chemical spills and derailments occur frequently. In Graniteville, South Carolina, a train recently derailed spilling chlorine gas that required the evacuation of part of the town. The *Columbus Dispatch* article "Rails Bring Danger to Town, But Threat Hard to Quantify," reported: "The Columbus Division of Fire is equipped with an Operation Respond Emergency Information System, a computer system that allows local responders in an emergency to see a railroad company's cargo list and identify hazardous materials by container number, trailer number and carrier name."

According to the Operation Respond® Institute Web site, the system mentioned in the *Columbus Dispatch* is the OREIS™ software, "which provides real-time HazMat contents of railcars and trucks that have been in an incident. OREIS is a software program that provides first responders with time and lifesaving real-time information about hazardous materials and passenger railroad incidents. OREIS transmits real-time information about the hazardous materials contents of freight railcars and motor carriers and schematics for passenger railcars and locomotives."

According to the Web site, in September 2004, Operation Respond Institute, Inc. teamed with Qualcomm to "integrate its OREIS emergency response software with Qualcomm's OmniTRACS satellite-based mobile communications and position location system to demonstrate the ability to track the movement and contents of vehicles as they travel the highways, and provide this information to first responders in the case of an incident or security breach. Operation Respond has partnered with Emergency Services Information Network (ESINC) to allow emergency responders to quickly and accurately receive information about the presence of hazardous materials, and respond accordingly. ESINC is an electronic network of OREIS users who receive emergency messages and alerts via fax, cell phone, pager and email."

Plain Old Telephone Service (POTS) – Cell phone technology, at times, may prove problematic. According to *Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout Great Lakes Region*, during the Great Lakes Region blackout in 2003, "in some instances, older technology worked while new technology did not. The most dramatic example of this is the plain old telephone system (POTS) that for the most part functioned throughout the blackout. In comparison, cell phones, networked phone systems, and portable phones experienced varying degrees of failures due to the loss of electricity or ceased working when limited backup power was exhausted."

According to *Learning from the 2003 Blackout*, the manager of electronics and communications at SMART in Detroit says, "The local phone carrier did fine in keeping analog services up and running, just as they have been doing since my grand-father's day. The digital service didn't die immediately, but did 12 to 14 hours into the event, as the in-circuit devices between the central phone office and customers' offices lost power."

Pre-Notice Evacuation Notices – Wildfires typically are a no-notice evacuation situation; however, residents may have a small amount of time before evacuating. To assist in the eventual evacuation, the emergency management organization may issue a pre-evacuation order informing residents of the possible need to evacuate. According to the *Seattle Post Intelligence* article "Evacuation Notice Lifted for

Some Tiny Oregon Towns," during the Biscuit wildfire in Oregon during 2002, a pre-notice evacuation notice was issued "warning people to pack and be ready to leave if the fire got closer to their homes."

Public Education Campaigns – The public can be informed through public education campaigns of evacuations incidents and the need to evacuate. For example, *Flood Warnings: Recent Lessons Learned and Developments Under Way* reported that in New South Wales, "working within the constraints of a limited budget, the State Emergency Service has been building on past experience to mount community education campaigns in conjunction with local government councils and other stakeholder organizations. This year (2002) the State Emergency Service has been involved in flood awareness weeks to capitalize on the first anniversary of last year's floods on the north coast of New South Wales (Lismore, Kempsey, Bellingen, Grafton, Maclean and the villages and rural areas between them)."

Flood Warnings also reported: "The flood awareness week messages went out via newspaper articles and advertisements (usually in the form of special 'flood supplements' in the local press), in pre-recorded radio spots, interviews and talk-back sessions, through public displays and information stands, and through information brochures that the State Emergency Service call FloodSafe guides. These guides are tailored to small areas. For example, the State Emergency Service produced six separate brochures for specific communities in the Macleay valley, seven for communities along the Clarence, three for the Bellinger River valley and five for Lismore."

Public Information Campaigns – The public can also be informed of evacuation information via a public information campaign. According to *What Can I Do to Prepare for a Radiological Emergency?* persons living within the vicinity (10 miles) of a nuclear power plant "receive emergency information materials annually. This information is commonly distributed via phone books, calendars, brochures, utility bills, and so forth. These materials contain educational information on radiation, instructions for evacuation and sheltering, special arrangements for the handicapped, and contacts for additional information. The Nuclear Regulatory Commission advises citizens to become familiar with this information and store it where it can be easily retrieved if needed."

Public Meetings – Public education campaigns also include public meetings with various citizen groups or homeowners. For example, the TBO.com article "Evacuation Right Call, Say Local Leaders" reported: "Pinellas County Administrator Steve Spratt said too many mobile home residents refused to go [during hurricane evacuations], some saying they wouldn't leave their possessions and others saying they had ridden out storms before. To try to overcome residents' reluctance to leave, Spratt plans to hold meetings at Pinellas mobile home parks to illustrate how Charley flattened similar neighborhoods in its path."

According to the *Compendium: Graduate Student Papers on Advanced Surface Transportation Systems: Application of ITS Technology to Hurricane Evacuation Routes*, in Galveston, Texas, "lectures are conducted at schools, the University of Texas Medical Branch (the island's largest employer), other large employers, and at other functions."

Public Radio Stations – Public radio stations also have been used to provide information to evacuees. The *TR News* article "Emergency Evacuation: Ensuring Safe and Efficient Transportation Out of Endangered Areas" reported: "Emergency officials in Florida now also have agreements with the state's network of public radio stations to broadcast traffic and shelter information during evacuations."

Radio-Satellite Communication – Radio communication has traditionally been used to communicate among emergency management officials. While cell phones have proven useful in communicating among personnel, at times, radios and satellite communication is a fallback technology. According to *Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study*, "During a previous disaster, the 1989 Loma Prieta earthquake in San Francisco, transportation officials

found that cell phones proved to be invaluable as radio communications were damaged. As a result, California officials came to rely more on cell phone technology over radio. But because of the location of the Northridge earthquake, cell phone communications in the canyon areas was intermittent due to terrain and limited coverage and the California Department of Transportation has now also incorporated satellite and radio communications to its system."

However, radio systems can be incompatible among emergency management officials. The *San Bernardino County Fire Chiefs' Association: Lessons Learned Report: Fire Storm 2003: "Old Fire"* reported: "One of the largest problems encountered on the Old Fire (southern California wildfires) was the incompatible communications systems. Most California municipal and county fire departments use an 800 MHz radio communication system, which is incompatible with the state and federal forest service UHF or VHF communications system."

The *Lessons Learned Report* also reported: "Radio communication problems caused major coordination problems between cooperating agencies, command and tactical units, air and ground units, as well as engine companies on the same strike team. Firefighter safety was placed in unnecessary risk when engine companies became temporarily unaccounted for and were unable to communicate their status." In addition, the *Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center* reported: "In one case, respondents reported the lack of communication system interoperability (during the southern California wildfires) contributed to two structure protection groups being created and tasked with staging and deploying resources as the fire entered a city, even though neither group was aware of the other's existence."

The *Southern California Firestorm 2003* also reported: "Many units have created workarounds that prove adequate for one incident. For example, some Battalion Chiefs carry one to six handheld radios compatible with cooperating agency frequencies. However, this workaround had limitations. During a series of disasters, as was the case in Southern California, the result was that both systems became so overwhelmed with radio traffic that it was impossible to monitor all traffic back and forth. As a result, respondents said that people tended to default back to their own frequencies, degrading common tactical and command communications."

Reverse 911® – Reverse 911® is a communication system that can be used during an evacuation incident. For example, the *American City and County* article "Community Evacuation: Ensuring Safe Passage" reported: "Both Denver and New Orleans have Reverse 9-1-1 capabilities, allowing them to call thousands of residents at once with recorded messages. However, [Terry] Tullier [Deputy Chief of the New Orleans Fire Department and Interim Director for the City's Office of Emergency Preparedness] notes that Reverse 9-1-1 does have drawbacks; its success depends on the availability of phone lines and the residents' willingness to answer their phones."

Reverse 911® has the capability to communicate warnings to a large number of people. The 2004 Annual Hazards Research and Applications Workshop: Natural Hazards Center, University of Colorado, Boulder, presentation "Transportation and Evacuation Issues in Emergencies: S04-3" reported: "Reverse 911® is tailored to communicate a warning message to as many as 11,000 telephones in 30 seconds" and can be targeted "to citizens directly impacted by the hazard and allows an alert to be communicated at hours when individuals may have turned off traditional mass media."

According to the *Northwest Florida Hurricane Evacuation Study Technical Data Report*, in "Escambia and Santa Rosa Counties an automated telephone notification system was used to phone thousands of households in the surge-prone areas. A few people in other counties (mainly special needs populations) might have received evacuation notices by phone from emergency management officials."

However, Reverse 911® systems are not foolproof and can lead to confusion. As reported in the *Orlando Sentinel* article "14,000 Warned to Stay in During Volusia 911 Goof," "A high-tech 'Reverse 911®' telephone system warned more than 14,000 residents Thursday morning to stay indoors because of a 'small chlorine leak' at a city water plant. The warning prompted a flurry of 911 calls and briefly sparked fears of a terrorist attack. The problem was, only about 100 homes in a three-block radius around the Ormond Beach plant should have gotten the warning about the accidental chlorine leak, which was quickly contained. Dave Byron, a Volusia County spokesman, said the Code Red emergency notification system worked the way it was supposed to. Thousands of extra phone calls—20,621 phone numbers were dialed, and 14,600 calls were likely the result of human error, he said. 'We're still trying to figure out exactly what happened, but at this time it does not appear to be a system problem,' Byron said." Technology can assist in notifying people of the need to evacuate, but human error can impact the use of the technology.

Satellite Traffic Communication – A new communication system is the receipt of traffic information by satellite radio informing drivers of evacuation routes. The *ITS International News* article "Real-Time XM Satellite Traffic Powered by Navteq" reported: "Starting this month, Cadillac will begin offering XM NavTraffic, claimed to be the first real-time satellite traffic information service for vehicle navigation systems in the US First available on the Cadillac CTS, the XM NavTraffic system will provide continuously-updated traffic information in a selected city. The system will come standard in cars equipped with the DVD navigation feature. This new technology, offered exclusively by XM Satellite Radio, is fully integrated with the vehicle's on-board global positioning software navigation system to display current information about traffic incidents and average traffic speed along specific roadways. A driver can enter a destination into the navigation system, and then, aided by a colourcoded display, obtain instant traffic data on the preferred route. XM NavTraffic is powered by Navteq Traffic, which checks and aggregates planned and unplanned incident data from multiple sources across the US, including the leading commercial traffic data providers, government departments of transportation, police and emergency services, road sensors, cameras, and airborne reports. Once received, the information is then merged with Navteq maps and continuously broadcast via XM's network of satellites and ground-based repeaters, ensuring that the latest information is available to the driver."

Beginning November 2005, "Navteq and Sirius Satellite Radio will broadcast traffic data for 22 major US metropolitan areas. Navteq Traffic is a data gathering, aggregation, and quality-tested solution that links up-to-the minute traffic information to map data and enables wireless transmission directly to a navigation system. It combines data from multiple sources, including the leading commercial traffic data providers, government departments of transportation, police and emergency services, road sensors, cameras and airborne reports."

Short Message Service – "Short message service (SMS) is a globally accepted wireless service that enables the transmission of alphanumeric messages between mobile subscribers and external systems such as electronic mail, paging and voice mail systems," as reported on the Flextronics Software Systems Web site.

The Dutch government is testing a mobile phone danger alert system that sends text messages to people who could be affected by natural disasters or terrorist attacks. The system, called Cell Broadcast, uses GSM technology to identify cell phone users in a particular area. If a disaster occurs, a message is sent to all phones in the area, warning of the danger. Interior ministry spokesman Frank van Beers told CNN that if successful, the 2-year pilot would become common policy throughout the country. He said the Cell Broadcast system will be used in addition to the other warning systems that are currently used if disaster strikes, such as sirens and special emergency broadcasts on radio and television.

"This is a more instantaneous way of informing people about what is going on right now. It's an extra medium to communicate directly with people during a disaster," he said. "If something happens in the center of The Hague, for example, we can select communication points from telecom companies and everyone who is within a few 100 meters can get the information."

Other scenarios could include terrorist attacks, fires, explosions, and leaks of toxic substances. "If there was a toxic leak, we could tell people to stay inside." Van Beers said only those in the area would receive the warning. "When you are out of the Hague, if that is where the disaster is, you don't get that information. The government is also investigating sending out the messages in different languages, so that tourists can also be informed, Van Beers said," as reported in the *CNN.com* article "Dutch trial SMS Disaster Alert System".

Sirens – Sirens can be used to inform people of the need to evacuate. According to the US Nuclear Regulatory Commission in *Nuclear Facility Response Plans*, people living near nuclear power plants "will be notified by means of sirens, tone-alert radios, and similar alert mechanisms" in the event of a nuclear incident.

Software Tools for Providing Information to the General Public – According to the *ICDN Newsletter* article "Interactive Web Site to Aid Travelers During Marquette Interchange Project," the State of Wisconsin was reconstructing a major intersection and used software tools that could assist drivers in navigating the construction site: "The Wisconsin Department of Transportation launched mchange.org as a key component of the department's efforts to inform the public and assist drivers during the four-year reconstruction of the Marquette Interchange. Interactive features available on the site include: Map-It Routing an interactive mapping tool allows drivers to map their route into and out of downtown Milwaukee by choosing either a downtown destination or entering a downtown address and TrafficBug™ which sends traffic alerts directly to a person's computer."

The State of Georgia utilizes a program called NaviGAtor. A part of this tool is Navigator Traffic Alerts. The *Intelligent Transportation Society of America: News of the Week* article "My NaviGAtor Traffic Alerts Literally at Your Fingertips" reported: "'Navigator Traffic Alerts are designed to get real-time traffic information into the hands of as many motorists as possible,' [Mary] Peters [of the Federal Highway Administration] said. 'Now motorists can have traffic information delivered directly to them at the times of their choosing, via cell phone, PDA, pager, or computer. All you need is an e-mail address.' The Navigator Traffic Alerts service provides user-customized e-mail notification of traffic incidents. This unique system offers a comprehensive approach to getting the information to the customer wherever they may be—at home, at the office or on the road. A wireless version of the Navigator Web site reaches Georgia motorists while they're on the go. Plasma display screens have been placed in Welcome Centers to reach out-of-state motorists as they pass through the state."

According to the *Intelligent Transportation Society of America: News of the Week* article "Yahoo! Maps Provides Real-Time Traffic Solution," Yahoo announced "the launch of a service that lets consumers view live local traffic information on their online maps and driving directions. Yahoo! is the first online site to provide speed conditions and dynamic traffic information nationwide. The new mapping feature will initially be integrated in Yahoo! Search, Yahoo! Local, and Yahoo! Maps—and is available to consumers at http://maps.yahoo.com. With this new mapping service, consumers can now—customize their Yahoo! Maps display and layer traffic information on top of driving directions or maps, scroll over the traffic icons—an extension of Yahoo's SmartView technology—to find out the road conditions on their journey ahead including the time the incident occurred and the estimated time that it will be resolved, find traffic accident reports and road construction information in over 70 metropolitan areas, find real-time driving speed data in over 20 top metropolitan areas, pan and zoom to find the traffic information most relevant to them, provide the best way to reach their destinations by incorporating

reliable information from embedded road sensors, traffic cameras, police scanners/reports, and traffic helicopters."

Text Messaging – Cellular subscribers can receive comprehensive traffic management information using text messaging from Orion Information Services. Orion is offering this service in conjunction with TrafficCast (www.trafficcast.com). As reported in the Orion Information Services press release, "it is the only true national network that provides personalized, route-specific, real-time and predictive speed and travel time information. Unlike its competitors, it is offering monitors traffic flows on all routes in major US cities, predicts traveling times, and factors in the effects that local weather patterns and special events will have on transit times."

Traffic Counters – Traffic counters are used in the State of Florida to gather data on hurricane evacuees in order to better manage the evacuation. The Federal Highway Administration Transportation Evacuation Planning and Operations Workshops 2004 presentation "Evacuating Florida in 2004" reported: "The traffic counters alerts host counties and communities upstream of evacuating areas to the arrival time and numbers of potential evacuees on roadways and shelters and provides public information to inform evacuees and others of areas experiencing traffic congestion, monitor(s) the actual status of evacuations relative to predicted clearance times. [The traffic counters] supports evacuation shutdown planning; determining when to divert traffic or shut down interstate interchanges based on: average vehicle speed at the sensor and the time needed to clear predicted vehicle queues before the arrival time of tropical storm force winds."

Video Feed – Video information provides traffic information in a very graphic way, with little need to explain. According to *Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study*, "The Interregion Video Network operated by the Transportation Operations Coordinating Committee allows 13 traffic management centers in the New York region to share video feeds of its network. This allows other agencies to better understand what is happening outside of its purview, but that might have a significant impact on its operations. This system is available on a more limited basis to the general public through the MetroCommute Web site, giving motorists real-time information through the web."

Web Sites – Some cities place emergency information on public Web sites. The *American City and County* article "Community Evacuation: Ensuring Safe Passage" reported: "For example, Denver, Grand Forks and New Orleans all place emergency advisories on their Web sites, but they do not rely heavily on online transmissions, reasoning that many people do not own computers."

The Rancho Santa Fe Fire Protection District in California posts wildfire preparedness and evacuation information on its Web site. It also has a brochure entitled *Getting Out Alive: Preparing for and Protecting Yourself During a Wildfire Evacuation*, which offers tips to help residents prepare for evacuation to ensure their family and pets make a safe escape from wildfire.

Wireless Traffic Sensor Network – The Maryland State Highway Administration signed an agreement with Traffic.com (traffic data collection and reporting firm) to construct a network of wireless roadside traffic sensors. According to the *ITS America* article "Maryland Signs Traffic.com to Construct Wireless Traffic Sensor Network in Maryland," "The completion of this project will provide Traffic.com with sensor coverage from north of Baltimore in Maryland to south of Washington, D.C. in Virginia, including the stretch of Interstate 95 that connects the two Beltways. The new sensors will provide vehicle speed, congestion levels, and travel times to Baltimore and Washington, D.C. based operations centers staffed and managed by Traffic.com, which distribute reports and incident/event information to Traffic.com's broadcast media affiliates, commercial customers, and to the public through its Web site at www.traffic.com. Traffic.com currently provides vital traffic information to Baltimore Beltway-area

drivers through several media affiliates including TV stations … and to radio listeners," and also through AM radio stations.

4.2.5.2 Demand for Travel Information

After the 9/11 terrorist attack, the use of transit call centers and Web sites increased from passengers seeking transit information. According to *America's Traveler Information Number: Deployment Assistance Report #3: 511 and Homeland Security*, "New Jersey Transit's transit information center, which normally receives approximately 8,400 calls per day, received over 16,000 calls on September 12. The Metropolitan Transportation Authority's Web site, which normally gets 200,000 hits per day, received 10 million hits per day in the week following the attacks. The SmarTraveler (Washington, DC) service Web site hits were up by approximately 100,000 to slightly in excess of 500,000. As a general observation, SmarTraveler operated with high levels of demand on its system, requiring staff to work longer hours and additional staff to be added on September 11."

According to the report, during an evacuation, "travel conditions during the early stages of a homeland security emergency may be very dynamic, and it may be necessary to provide travel information with content that is more regional or multi-modal in nature than is normally the case. During the emergency, normal travel options may be unavailable, meaning people may need very basic and specific information on alternative travel options."

4.2.5.3 Difficult Communication Incidents

During evacuations, communication between all parties (evacuees, the general public, entity staff, etc.) can be difficult and problematic. People and entities have been creative in overcoming these communication problems, for example, the use of personal cell phone calls to neighbors alerting them of the need to evacuate.

Blackouts: 2003 – Communication during a blackout can be problematic. For example, as reported in the *Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout Great Lakes Region*, the Suburban Mobility Authority for Regional Transportation (SMART) had a generator providing power. However, "according to SMART executives, one of the biggest challenges during the blackout was communicating with drivers, paratransit customers, and the public. Even though SMART's operations center was fully functional, many people had lost phone service, computer access, and had no TV or radio. Messages relayed from SMART managers to the media were a low priority and aired infrequently. Managers were not certain of how many drivers would come in. Furthermore, it was particularly difficult to find out what medical facilities were open. In some cases, drivers physically went to customers' houses and to clinics to exchange information and call it in to the operations center. In one instance, SMART's staff was able to coordinate with an area fire department that borrowed vehicles and drivers in order to provide cooling stations for senior centers. In addition, had the blackout persisted longer, other area agencies probably would have relied on SMART for refueling"

Effects of Catastrophic Events on Transportation System Management and Operations also reported that during the Great Lakes region blackout, "Greater Cleveland Regional Transportation Authority experienced failures within its communication system until a backup diesel generator was connected. In particular, the repeaters used to strengthen and extend the signals produced by the agency's internal radio system failed during the blackout, and not all were connected to backup sources of power. Furthermore, the loss of a key radio tower in the far eastern section of Cleveland left the Greater Cleveland Regional Transportation Authority without its global positioning system (GPS) network. Throughout the blackout, transit employees were able to use their mobile telephones and mobile radios. Traditional telephone service also worked, without break, during the blackout."

Derailment: Graniteville, South Carolina – On January 6, 2005, a derailment of a train carrying chlorine gas spilled its contents in Graniteville, South Carolina. People working in the plant (scene of the incident) and residents living nearby were evacuated. The *San Francisco Chronicle* article "Deadly Chlorine Gas Gone—But Fear Hangs Over Hard-Hit Town: Some Residents Warily Return Home After Train Wreck" reported one survivor: "Lamar Ledford, a night-shift worker at Avondale Mills, described watching white patches spread across the clothes on his body while he waited for a 911 operator to tell him it was safe to leave the building. His cell phone began to corrode in his hand, he told television crews, and he called his mother to tell her he wanted to be cremated." According to the article, "chlorine corrodes copper elements in telecommunications equipment and computer chips, and it can disable a 911 service under some circumstances."

Hurricane Floyd: 1999 – During Hurricane Floyd, communication proved to be problematic. The *Coastal Heritage* article "Floyd Follies: What We've Learned" reported: "South Carolina's leaders were not able to receive basic information about traffic flow. Various South Carolina agencies used incompatible radio systems and frequencies, and cell phones were unreliable at peak usage times. So when vehicles got stacked up for miles, top public-safety officials couldn't communicate with personnel on the ground and didn't know the extent of the problem. 'We had a failed, fractured communications system,' says state 'traffic czar' Captain Harry Stubblefield of the South Carolina Highway Patrol. 'We didn't have a good feel for monitoring [the evacuation], and we couldn't give our commanders the big picture to let them know what was going on.'"

Loma Prieta Earthquake: 1989 – During the Loma Prieta, California, earthquakes, normal communication and transportation systems were disrupted. According to *Riding Out Future Quakes: Ideas For Action: Improving Planning of transportation Providers, Government, Utilities and Businesses for Post-Earthquake Transportation Disruptions in the San Francisco Bay Region*, communication was difficult to provide: "During the first hours following Loma Prieta, the Red Cross units in the Bay Area were unable to effectively communicate with each other. Movement of critical supplies and personnel were delayed by a combination of lack of knowledge of priorities (created by lack of effective communication systems), disrupted transportation routes and in the next few days, and traffic jams created by the loss of vital commute routes."

Southern California Wildfires: 2003 – Some evacuees were not informed of the need to evacuate by officials, they were informed by neighbors during the southern California wildfires. According to *Fire Lessons Learned in California*, "One family warned their neighbors to leave. The blaze was moving so fast the community hadn't received official word, and had to rely on its own judgment."

Terrorist Attacks: September 11, 2001 – During the 9/11 terrorist attack in New York City communication networks were overwhelmed. As reported in *America's Traveler Information Number: Deployment Assistance Report #3: 511 and Homeland Security*, "Immediately following the September 11 attacks, landline and cellular telephone services became unreliable, apparently as a result of overload. In Lower Manhattan, the situation on September 11 with regard to using telephone service was compounded by damage to a Verizon central hub, resulting in the loss of 200,000 phone lines, cellular sites knocked out, local telephone switching office damaged, fiber optic transport equipment crushed, and high-speed internet service down for many companies because of power failures. Not only did this make it difficult for callers to get access to travel information, it also impacted the ability of agencies to communicate between office and field staff, and to share information with other agencies."

According to *Saving City Lifelines: Lessons Learned in the 9/11 Terrorist Attacks*, communication was chaotic during the terrorist attacks: "Communications were impossible in the chaos at the scene, so people did what they had been taught to do in drills. Training was critical. A report later commissioned by the

New York Police Department to review its performance on 9/11 was critical of police response but gave high marks to the transit police who had received specialized training in disaster response."

Saving City Lifelines also reported: "personal cell phones and makeshift equipment enabled [the] Metropolitan Transportation Authority to maintain communications with [the] Office of Emergency Management and other critical partners in the rescue and response effort's earliest hours."

During the 9/11 terrorist attack in Washington, DC, the local transit agencies had to operate with limited information regarding the incident. According to *Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study*, "The transportation agencies had to respond to the attack and subsequent partial evacuation by closing certain key transportation facilities near the Pentagon and other strategic locations in the nation's capital, redirecting transit assets, and coordinating these closing and changes with other agencies. This was all happening during a time when the voice communications networks were overwhelmed with demand and accurate information on closings and redeployments was scarce."

4.2.5.4 Information Sources

Information communicated during an evacuation needs to be accurate and consistent. One way to handle this is the use of a joint information center that manages the information in order to deliver a consistent message. In addition, the media will eventually become involved in the evacuation situation and can be a valuable ally.

Consistent Information – Information needs to be accurate and consistent to evacuees. As reported in *Disaster Response and Evacuation User Service: An Addendum to the ITS Program Plan*, "A comprehensive public information strategy is necessary. Coordinate evacuation public information between emergency management, transportation, and other allied agencies so that consistent, accurate information is provided to evacuees."

In response to the need for consistent information, the National Disaster Education Coalition released "Talking about Disaster: A Guide for Standard Messages." The 2004 Annual Hazards Research and Applications Workshop: Natural Hazards Center, University of Colorado presentation "Transportation and Evacuation Issues in Emergencies: S04-3," reported: "the updated guide was produced with collaboration from 20 disaster preparedness organizations in the US and attempts to provide consistent, accurate information on various types of disasters to the public. It includes standardized safety messages on 20 natural, technological, and human-induced hazards as well as general disaster preparedness and safety topics."

Joint Information Center and Information Management – Information found in the literature search suggests one entity provide information for multiple agencies involved in the evacuation incident. This allows for the development of a consistent message to the media and the public. The *San Bernardino County Fire Chiefs' Association: Lessons Learned Report: Fire Storm 2003: "Old Fire"* reported: "The San Bernardino County Fire Chiefs' Association (during the southern California wildfires) recognizes the need to establish a centralized multi-agency Joint Information Center. A centralized Joint Information Center will permit the public agencies to provide a proactive, unified message to the media and the community, which is critical in communicating the latest fire and evacuation information. The San Bernardino County Fire Chiefs' Association also recognizes that large, multi-agency incidents receive national and international attention and that an individual agency's public information officer will become inundated with requests for information very quickly. Therefore, the public information officers needed to think well beyond the customary everyday information officer's activities."

According to the report, "the Joint Information Center staff also included some who had worked in the Joint Information Center at San Bernardino during the Southern California firestorm in 2003, and they applied lessons learned from that experience. In particular, they suggested that the Joint Information Center maintain a philosophy of 'the buck stops here,' making every effort to be the last, best point of contact for concerned residents. This meant making the extra effort to track down legitimate answers to questions, even if that required calling residents back with the answer."

According to *Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center*, the Joint Information Center staff "combined the public affairs resources of numerous full-time and professional public affairs staff of city and county cooperating agencies, combining them with the technical expertise of the wildland agencies." The report also noted, "a proactive, well-staffed Joint Information Center not only provided current information but also helped form public opinion. Senior leaders said it was important to tell the success stories of fuels hazard reduction programs in order to gain political and public support for future efforts."

However, there was some criticism of the communication efforts by fire personnel, according to the *Southern California Firestorm 2003* report: "Many respondents reflected that information efforts did not consider some unique factors in a major media market like Los Angeles or San Diego. They felt the information campaign must consider the impact of commercial mass media, including talk radio, in shaping public opinion. In one case, talk radio hosts significantly drove public opinion, with very negative influence. Consequently, respondents felt that at a time when the community needed to pull together, it was being divided over information provided by a popular radio host with national exposure. Instead of focusing on its mission of getting information out to the public, the information function had to focus on the distraction of defending itself against attack."

Southern California Firestorm 2003 reported that in areas were there was no Joint Information Center: "Many respondents reported the public and media received fragmented and often conflicting and confusing information—and different agencies had different information at different times. Rumors circulated, and the public and media filled the information voids with whatever voices were available (during the southern California wildfires). This usually did not reflect well on the responding agencies and created firefighter morale problems as they and their efforts were portrayed inaccurately."

Sharing of Information – Sharing information between entities is critical and could prevent an evacuation. As reported in the CSX Train Derailment and Subsequent Fire in the Howard Street Tunnel, Baltimore, Maryland, July 18, 2001 (*National Transportation Safety Board Accident Report: Railroad Accident Brief – Accident Number: DCA-01-MR-004)*, "During the course of the investigation (Howard Street rail tunnel fire), it became apparent that information about modifications and construction in or near the tunnel had not been reliably documented or exchanged among interested parties. For example, there was an opening in the tunnel's arch immediately below the 40-inch water main where a repair had at least been started. Safety Board investigators attempted to obtain information about this void and repair, but neither CSX nor the city of Baltimore knew of or had documentation about when the void was first discovered or who had initiated the repair. In another instance, information used by the city of Baltimore indicated that a storm sewer was 19 feet below the surface near a test drilling. However, during the drilling project, the drill struck the storm sewer, which was actually only about 8 feet below the surface."

According to the *National Transportation Safety Board Accident Report*, the Board made the following safety recommendations as a result of its investigation of the Howard Street Tunnel railroad accident, "To CSX Transportation, Inc.: Maintain historical documentation of maintenance and inspection activities affecting the Howard Street Tunnel. (R-04-13) Take action necessary to enhance the exchange of information with the city of Baltimore on maintenance and construction activities within and in the vicinity of the Howard Street Tunnel. (R-04-14) To the city of Baltimore, Maryland: Take action

necessary to enhance the exchange of information with CSX Transportation on maintenance and construction activities within and in the vicinity of the Howard Street Tunnel. (R-04-15)."

Communication between entities regarding infrastructure could prevent the need for an evacuation.

Sharing of information is critical during evacuations. On March 6, 2005, a railcar leaked toxic chemicals (hazardous materials) in Salt Lake City, Utah, forcing the evacuation of over 6,000 people. Authorities evacuated a half-square mile area around the accident site. As reported in the CNN.com article "Toxic Chemical Spill Forces Thousands to Evacuate," "fifteen hours after the leak was discovered Sunday morning, officials still were not certain of the contents of the leaking tanker, but they were pumping it into portable tanks and were letting people return to their homes. Officials were angered that they could not pin down what was in the tank and the information they were given conflicted with their own observations. The manifest said it was sulfuric and hydrofluoric acids; the company told them it was hydrochloric, hydrofluoric, nitric and sulfuric acids. Late Sunday, the company corrected itself, saying the contents were phosphoric, acetic, sulfuric and hydrofluoric acids, and ammonia—all at a concentration of only 10 percent." Officials took some time to respond to the crisis due to the lack of information on the contents of the railcar. Having the correct manifest information might have reduced the response time.

Relationships with the Media – During evacuations, the media will eventually become involved and either assist evacuation efforts or not (not necessarily by design). As cited in the literature, the media can be a valuable ally.

During the I-95 tanker explosion incident in Baltimore, the media was used to assist in providing information to the general public. As reported in *I-95 Shutdown: Coordinating Transportation and Emergency Response*: "Using Maryland's battery of ITS tools, including variable message signs, highway advisory radio, and the Web, traffic managers and police units launched the quick response that moved travelers away from the incident. Later, after the traffic situation was under control, the story of what caused the crash and speculation on the road closure took on new importance. The media became a valuable ally in sharing current information as people turned to news programs at home or switched to radio programs with regular traffic and news updates. 'The public depends on accurate and timely information from news reports,' says Major Shipley. 'We wanted to be sure to keep reporters in the loop as much as possible while remaining sensitive to the investigative aspects of the situation.' That cooperation extended to broadcasting the message that two lanes were reopened and mitigating the effects of the inevitable rubbernecking that would take place as motorists passed by the scene."

The media can also influence evacuation behavior. For example, during Hurricane Floyd, "'the Weather Channel got blamed for [much of the evacuation problems] because they really hyped it, but people were really taking their cues from what they believed public officials were saying,' said Jay Baker, the Florida State University professor who completed the study," as reported in the DisasterRelief.org article "Floyd-Hit States Ready for Hurricane Season."

The media could also receive incorrect evacuation messages from the government. The wnbc.com article "Emergency Broadcast Test Mistakenly Calls for Evacuation," reported: "Despite what residents may have seen on television, the state of Connecticut was not ordered to evacuate on Tuesday [February 1, 2005]. State emergency management officials said a worker entered the wrong code during the weekly test of the emergency alert system, leading television viewers and radio listeners to believe that the state was being evacuated. 'Civil authorities have issued an immediate evacuation order for all of Connecticut, beginning at 2:10 p.m. and ending at 3:10 p.m.,' a message that scrolled across television screens read. 'There is absolutely no evacuation or state emergency,' said Kerry Flaherty of the Office of Emergency Management. 'It was an erroneous message.' State officials sent faxes to every police department in the state, notifying them that it was a false alarm. Workers who enter the codes read off a monitor and punch

them in on a keypad, triggering the test or alert, Flaherty said. He said the code for the weekly test is one line below the code for evacuation, and the worker entered the wrong code."

Single Communication Facility – The need for a single facility to communicate has been identified in the literature. The *TR News* article "Emergency Evacuation: Ensuring Safe and Efficient Transportation Out of Endangered Areas" reported: "Transportation officials involved in evacuations have cited the need for better communication among the various emergency management, transportation, and law enforcement agencies involved. Communication difficulties with the public also were significant. Many states are combining emergency management personnel and resources in single facilities."

4.2.5.5 Need for Communication

Communication is necessary during an evacuation incident. For example, on September 21, 2001, an explosion occurred at a fertilizer chemical plant (hazardous materials) in Toulouse, France. The plant was next to the SA d'Economie Mixte des Transports Publics de Voyageurs de l'Agglomeration Toulousaine (SEMVAT) bus depot. SEMVTA needed to communicate to the public and its employees. According to *Safety and Security Issues at All-Bus Systems in Small- to Medium-Sized Cities in Western Europe*, "It was decided that one SEMVAT person would communicate the transit situation to the general public. The SEMVAT representative, the communication manager, went to the media, television, radio, and press, to get the message out to the public. SEMVAT asked the media to publicize one telephone number for employees and another telephone number for passengers. SEMVAT staff recalled that media interest was extremely high, but suggests that one should organize the information to be conveyed, anticipate questions, be informative, use precise briefing points, and do not get overwhelmed by the pressure."

4.2.5.6 Redundancies in the System

Entities have redundant communication systems that can be used during an evacuation.

For example, the New York Metropolitan Transportation Authority has redundant communication systems that proved useful during the 9/11 New York City terrorist attack. According to *Saving City Lifelines: Lessons Learned in the 9/11 Terrorist Attacks*: "The fact that the Metropolitan Transportation Authority could still communicate demonstrates the necessity of redundant communications capabilities. New York City Transit had multiple communications systems for both bus and subway systems, its own radio network, a six-wire system, an emergency booth communications system, a train dispatch system, and computer networks, all of which continued to function. New York City Transit also had the only telephone structure independent of Verizon. This capacity enabled New York City Transit to provide landline service to the New York Police Department command post and to emergency services in the field, while transit technicians assisted in the repair of the damaged communications systems."

During the 2003 Great Lakes region blackout, several agencies had redundant power systems. The Detroit–Windsor Tunnel has quadruple redundancy, as it is serviced by four separate power feeds. According to *Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout Great Lakes Region*, during the blackout, "the tunnel operator followed a pre-planned protocol in declaring a tunnel emergency and shutting down the facility. The tunnel cleared in less than 15 minutes. For the tunnel authority, the loss of communications was a challenge because the phones were dead. A backup battery and then a portable generator supported a radio system. They were able to notify the media and other agencies of their plans to close and, later, to re-open."

According to the *Effects of Catastrophic Events on Transportation System Management and Operations* report, SMART had a generator providing power: "SMART's operations center was fully functioning throughout the blackout, with dispatchers, phone lines, fax machines, e-mail, computers, and a Web site,

which was updated with current information. Staff also maintained their radio system, used to communicate with drivers, for 10 or 12 hours. However, when they lost their radio communications system overnight, they decided not to run service on Friday except for critical paratransit customers, some of whom depend on SMART for life-saving dialysis treatment."

4.2.5.7 Information Sharing

Information should be shared among various entities. *Disaster Response and Evacuation User Service: An Addendum to the ITS Program Plan* emphasizes this necessity: "Share current and forecast evacuation information between transportation, emergency management, law enforcement, and other allied agencies at the county, multi-county, and multi-state levels. This coordination must include the evacuated counties (evacuation origins), host and response counties (evacuation destinations and counties that provide assistance in the evacuation process) and counties on evacuation routes. Counties must work as a team during evacuation. Multi-state response is also important to ensure that evacuees from one state do not compound evacuation problems in another state."

4.2.5.8 Communication Staging

The type of evacuation (i.e., advance-warning or no-notice) impacts the type of communication issued. The *American City and Country* article "Community Evacuation: Ensuring Safe Passage" reported: "Some disasters come with notice, while others hit without warning. As a result, planners have to factor in lead times for communicating and implementing evacuations. For some planners, time is on their side. For example, in Grand Forks, emergency managers monitored the development of a major spring flood in 1997 by tracking winter snowfall and melting rates. 'We geared up slowly and reported regularly to the public through the media,' Sieber says. 'The long lead time enabled us to plan a two-stage evacuation. The first stage was voluntary; second came an ordered evacuation.'"

Real-Time Information – To be of use to evacuees, evacuation information needs to be in real time. The following information is cited in *Disaster Response and Evacuation User Service: An Addendum to the ITS Program Plan*:

"(a) Provide real-time information to evacuees regarding: the services available at the evacuation destinations and along the evacuation routes. In recent evacuation operations, motorists were frustrated with the lack of information regarding hotel rooms, gas, bathrooms, restaurants, and shelters. In addition, evacuees were not informed about accommodations for people with special needs (e.g., disabled, elderly and pets/livestock).

(b) [Provide] the evacuation route conditions such as the expected travel time to their destinations, incidents, road closures, lane closures, weather, the route to a certain destination, and the availability of alternative routes. In recent evacuation operations, motorists were left without information regarding what to expect on their trips while waiting for hours in traffic.

(c) [Provide] information regarding conditions in their home counties. This has been a problem because the media at evacuation destinations is not normally interested in broadcasting information about counties that are not in their coverage areas.

(d) [Provide] information regarding available transit services supporting evacuation. Provide alternative evacuation destinations to evacuees that request this information. In recent evacuations, many motorists left their homes without knowing where they are going."

According to the report, during Hurricane Floyd, officials and evacuees expressed dissatisfaction with the "lack of information regarding travel conditions and services along the routes and at evacuation destinations."

4.2.6 Special Needs

This section of the literature search addresses information found on special needs evacuees. It is subdivided into evacuation of special needs evacuees; accommodations for special needs evacuees; location of special needs shelters; evacuation of special needs facilities; and incidents involving special needs evacuees, evacuees with pets or animals, pedestrians, bicyclists, and truckers.

Findings from the literature search on special needs include:

- Special needs evacuees with disabilities may require assistance during evacuations.
- Special needs evacuees, such as the elderly, medical patients, and people without transport, require special assistance during evacuations.
- Jail facilities and nursing homes are special needs facilities that have been evacuated.
- At times, special needs evacuees are overlooked during the evacuation.
- Special needs evacuees need shelters during evacuations.
- People who are evacuated that have pets or animals that need to be left behind in the rush of an evacuation worry about their pets or animals.
- The events of 9/11 in both New York City and Washington, DC, involved the evacuation of pedestrians. To move the evacuees out of the cities, public transit played a significant role; in addition, people also walked home.

There was very little information in the literature regarding the evacuation of bicyclists and truckers.

4.2.6.1 Evacuation of Special Needs Evacuees

Special needs evacuees, such as the elderly, medical patients, and people without transport, require special assistance during evacuations.

Elderly – The elderly have special needs.

> As reported in the *Final Report: An Assessment of Emergency Transportation Management for the Rural Elderly*, "The elderly were very limited in their understanding of emergency preparedness and maybe vulnerable during disasters. They depended very heavily on others within their family and community to alert and get them to safety when disasters occurred. This dependence on family and the community does not suggest a lack of interest about emergency evacuation and safety in times of disaster. On the contrary, most of the respondents indicate a need for more information about emergency preparedness programs and how to get to safety in term[s] of [the] disaster."
>
> The assessment also suggests "the need for more technologies geared to increase communication, education and links between emergency management centers and the local communities. The study also suggests the need for emergency management centers to review their current strategies to assure that they can identify, locate and assist all special needs populations in times of disasters."
>
> The elderly may be reluctant to leave their homes, and experienced entities may encounter difficulties in evacuations: "The Red Cross is one of the largest organizations responsible for the evacuation of the special needs populations. In an article in which they discuss the problems in evacuating the elderly they noted the following: the elderly are usually reluctant to leave their homes, the elderly are reluctant to leave what is familiar to them and go to an unfamiliar place,

> often they have pets or animals that they do not wish to leave, in some cases they have objects or family keepsakes that they consider valuable and they do not wish to leave them behind, the elderly may not comprehend the danger and the need of immediate evacuation and the elderly may be reluctant to go with strangers."
>
> "Even though the Emergency Management Service workers are professionals, they still must deal with the suspicions of older people who would prefer to rely on a familiar face."
>
> "Another problem in transporting older citizens is that [there] may be physical or sensory impairments making it difficult for them to comprehend instructions or follow simple commands. Many may have medications or they may not remember where certain things are such as eyeglasses, canes, hearing aids, and dentures. They may also have hospital equipment that must be moved with them. Finally, there is the question of time. Professional Emergency Management Service workers may have to find the location of the person and then spend valuable time preparing them or convincing them to evacuate."
>
> "Professional Emergency Management Service workers may not be familiar with the person's location and, getting to them may impose time and problems if they are off a secondary road. In the Milwaukee International Conference one of the 'best practices' models presented was the use of Geographic Information System (GIS) to locate areas in the delivery of certain services. The GIS can be used in other situations as well. Using the GIS during terrorist attacks was one of the 'best practices' presented at the conference."

The 42nd Annual Conference of the Floodplain Management Authorities of New South Wales, Kempsey, Australia, presentation "Flood Warnings: Recent Lessons Learned and Developments Under Way" reported that elderly people may require assistance during flood evacuations: "Some people in a community are, of course, more vulnerable then others to the adverse effects of flooding. This is because certain social characteristics may impair a person's ability to protect themselves from, or respond to, critical situations. Elderly people are often frail and unable to respond quickly without assistance. Some of them may also be socially isolated, resulting in them being unaware of evacuation warnings or unable to decide on a course of action."

According to the *Compendium: Graduate Student Papers on Advanced Surface Transportation Systems: Application of ITS Technology to Hurricane Evacuation Routes*, during the hurricane evacuation in Galveston, Texas, "police cruise through assigned districts with public announcement systems to alert residents of an impending hurricane. Police are very familiar with their districts and even go door-to-door to alert the elderly and hard-of-hearing."

Modeling Transit Issues Unique to Hurricane Evacuations: North Carolina's Small Urban and Rural Areas recognized the special needs for the evacuation of the elderly: "The results of the completed work consist of modeling transit issues unique to hurricane evacuations in small urban and rural areas located in the state of North Carolina. Particular emphasis is placed on identifying transit options needed to assist underrepresented populations such as the elderly and disabled, who maybe, in some ways, captive without transportation means or limited in terms of evacuation means."

The elderly may require communication regarding evacuations that is different from the general public due to age-related declines in perception. The 2004 Annual Hazards Research and Applications Workshop: Natural Hazards Center, University of Colorado, Boulder, presentation "Transportation and Evacuation Issues in Emergencies: S04-3," reported: "Christopher Mayhorn of North Carolina State University spoke about the importance of designing risk communications that can be understood by the growing segment of elderly citizens. Age-related declines in perception and cognition raise issues that

must be considered in the design and dissemination of warning messages. Vision and auditory difficulties suggest a need to avoid specific fonts, color shades, and frequencies, while cognitive declines require an emphasis on reducing distraction and not overtaxing working memory."

Medical Patients – During an evacuation, medical patients may fear that they cannot reach a medical facility in time and may decide against evacuation. The DisasterRelief.org article "Hurricane Floyd: Filled with Sound and Fury, Signifying—Traffic?" reported: "Shoulders of roadways became clogged with abandoned automobiles, some because they ran out of gas, others because of engine problems, and still others perhaps of sheer frustration. Hotels and shelters were forced to turn away hundred of evacuees. Rest stops became makeshift shelters where motorists spent the night. Reports surfaced of many simply giving up after several hours and returning to their homes. Medical patients, such as those needing kidney dialysis treatments, also turned back out of fear they would not reach a treatment facility in time. Complicating matters, service stations, restaurants and convenience stores boarded up and closed, leaving many without options for refueling or eating."

After the 9/11 terrorist attack in New York City, medical patients were evacuated out of the city. As reported in *Saving City Lifelines: Lessons Learned in the 9/11 Terrorist Attacks*, "the New York City Health Department had to move and allocate patients to medical care facilities immediately after the 9/11 attack. Historically, New York City Transit has cooperated with the Health Department by providing buses to move patients, taking the moderately injured ("greens" or "walking wounded") to medical facilities further from the event site so that nearby resources could be reserved for the more seriously injured."

In addition, *Saving City Lifelines* reported: "Effective emergency medical response depends on participating agencies working together as closely as possible. This principle was important when self-dispatched patients, the walking wounded, showed up at the hospitals nearest the World Trade Center. Others went to New Jersey on the ferry, following an instinct to flee the danger and then seek medical attention. Walking wounded patients from the World Trade Center were reported to be as far away as Long Island, Connecticut, upstate New York, and Montreal, Canada. Many people used public transportation to get to medical facilities (after the terrorist attacks)."

Saving City Lifelines also reported: "Water assets augmented traditional transit for moving patients. More than 8,000 patients were decontaminated and treated by New Jersey Emergency Medical Services personnel and fire personnel at the Hoboken Ferry Terminal in New Jersey (after the terrorist attacks). Patients and evacuees arrived by small boats, yachts, tugboats, sightseeing boats, Coast Guard boats, and New York Police Department boats."

Evacuations may be necessary at any facility, including nursing homes, hospitals, and jails. As reported in *Transportation in Emergencies: An Often Neglected Story*, "It's not just public transit and school bus systems that have contingency plans. In the Toronto area, the ambulance authority has a plan for a hospital evacuation. As it is sending vehicles to assist the evacuating hospital, it is canvassing other hospitals to see how much bed space they have and how much room they have for specific types of patients. That allows it not only to move patients quickly but to get them to a facility that will look after their special needs."

Nursing Homes/Rehabilitation Units of Hospitals – Evacuations of the elderly from either nursing homes and/or rehabilitative units of hospitals can be stressful and disruptive to residents. Evacuations of nursing homes and rehabilitation units of hospitals can differ in terms of an evacuation. Nursing homes, as reported in *Elderly Populations in Disaster: Recounting Evacuation Processes from Two Skilled-Care Facilities in Central Florida, August 2004*, took approximately 6 to 7 hours to complete with the residents being evacuated and relocated in groups along with the staff. On the other hand, the rehabilitation unit of

a hospital took approximately 1 ½ days to complete due to the patients "special needs that prohibited the evacuation of all patients to the same place. Instead patients were evacuated to surrounding hospitals as beds with adequate levels of care were found for them."

Nursing homes may not be included in community-wide disaster plans. As reported in *Elderly Populations in Disaster: Recounting Evacuation Processes from Two Skilled-Care Facilities in Central Florida, August 2004,* "nursing homes were able to support one another in an informal manner during disasters. In order to formalize these relationships, the authors encouraged the inclusion of nursing homes in community-wide disaster plans. The logistics of how to best protect the nursing home population during disasters must be understood in order to incorporate these facilities effectively into a community-wide plan."

Offenders – The State of Florida has a new policy that bans sex offenders from being allowed into public hurricane shelters. As reported in the *Orlando Sentinel* article "Offenders Banned from Shelters," "Hundreds of sex offenders being tracked by the state won't be allowed into public hurricane shelters in Florida under a new policy that will allow them to ride out the storm in prisons instead. The policy was created to keep sex offenders and predators away from children in public shelters, Robby Cunningham, spokesman for the Department of Corrections, said Saturday. Sex offenders who choose to seek safety in a prison would be kept in areas such as visitor or meeting rooms, not with inmates, Cunningham said. 'They are not incarcerated' Cunningham said. 'We don't want them on the streets. We don't want them violating their probation either.'"

People without Transport – People without transport have special needs. According to *Transportation in Emergencies: An Often Neglected Story*: "While most persons in Mississauga had their own vehicles and used them, some did not. To take care of them, police arranged for Mississauga Transit buses to follow its officers. The buses took those without their own transportation to Square One, a well-known shopping centre, where Red Cross had established a reception facility."

The *TR News* article "Emergency Evacuation: Ensuring Safe and Efficient Transportation out of Endangered Areas" reported: "In New Orleans, for example, 25 to 30 percent of the population—more than one-quarter million people—are without access to personal transportation. In addition to people without vehicles, the indigent, the elderly, prisoners, the infirm, and tourists must be evacuated. Although most state emergency operation plans include these groups, many departments of transportation have not addressed the evacuation of low-mobility and special-needs populations."

In addition as reported in the *ITE Journal* article "Planning for the Evacuation of New Orleans," "In response to the need for a full evacuation, emergency-preparedness officials, in conjunction with local and state transportation and law-enforcement agencies, have developed a regional plan to evacuate the New Orleans metropolitan area in the event of a major hurricane. The New Orleans evacuation plan recognizes that while a total evacuation of the city may be required, an evacuation of only part of the population is practically possible. Of the 1.4 million inhabitants in the high-threat areas, it is assumed only approximately 60 percent of the population or about 850,000 people will want, or be able, to leave the city. The reasons for this are numerous. Although the primary reasons are a lack of access to transportation (it is estimated that about 200,000 to 300,000 people do not have access to reliable personal transportation), an unwillingness to leave homes and property (estimated to be at least 100,000 people) and a lack of outbound roadway capacity."

As reported in the Victoria Transport Policy Institute paper "Lessons from Katrina: What a Major Disaster Can Teach Transportation Planners," "This indicates that public officials were aware of and willing to accept significant risk to hundreds of thousands of residents unable to evacuate (during Hurricane Katrina) because they lacked transportation. The little effort that was made to assist non-drivers

was careless and incompetent. According to accounts, public officials provided little guidance to people without personal vehicles, and when asked, they simply directed them to the Superdome (Renne, 2005), although it had insufficient water, food, medical care, and security. This led to a medical and humanitarian crisis."

For low-mobility groups, busing is an option to transport evacuees. As reported in the *National Review of Hurricane Evacuation Plans and Policies*, "Busing is the most common mode of transportation for low-mobility groups. To transport people in busses, emergency management agencies have in the past contracted with local transit authorities, school districts, and tour operators, with varying levels of success."

According to the Victoria Transport Policy Institute paper "Lessons from Katrina: What a Major Disaster Can Teach Transportation Planners," "The New Orleans Regional Transit Authority had a policy for hurricane evacuations: drivers should evacuate buses and other agency vehicles with their families and transit-dependent residents, thereby protecting people and vehicles. There are unconfirmed stories that Amtrak offered use of a train for evacuation that was not accepted by local officials. But neither public buses nor trains were deployed to evacuate people out of the city. Residents who wanted to leave the area by public transport were expected to pay for commercial services, a major barrier to many low-income residents."

According to *National Review of Hurricane Evacuation Plans and Policies*, people with low mobility are generally overlooked in state evacuation plans: "Evacuation of these low-mobility and special needs groups is an area that while included in most state emergency operation plans, has been largely unaddressed by departments of transportation. In practice, the responsibility for the evacuation of low mobility groups in facilities like prisons, hospitals, and schools is given to facility administrators."

The *San Francisco Chronicle* article "Deadly Chlorine Gas Gone—But Fear Hangs Over Hard-Hit Town: Some Residents Warily Return Home After Train Wreck" reported: "Rhonda Smith described gazing out at emergency workers whizzing back and forth in safety suits (after the derailment), and waking her children to tell them she loved them. She had no car at her house and was waiting for somebody to stop by to ask if she was safe; no one came until more than 18 hours after the crash. 'I don't even know how to explain the feeling,' she said."

In New Orleans, the use of public transit was not implemented to transport evacuees without transport during 2004's Hurricane Ivan. The *Natural Hazards Observer* article "What if Hurricane Ivan Had Not Missed New Orleans?" reported: "Residents who did not have personal transportation were unable to evacuate even if they wanted to. Approximately 120,000 residents do not have cars. A proposal made after the evacuation for Hurricane Georges to use public transit buses to assist in their evacuation out of the city was not implemented for Ivan."

In addition, the article reported: "Emergency managers and representatives of nongovernmental disaster organizations, local universities, and faith-based organizations formed a working group to engage additional faith-based organizations in developing ride-sharing programs between congregation members with cars and those without."

During Hurricane Katrina, buses also did not appear to be used to transport special needs evacuees. According to the Victoria Transport Policy Institute paper "Lessons from Katrina: What a Major Disaster Can Teach Transportation Planners," "buses to transport residents to the Superdome reflected the emergency plans' intent, and there were insufficient buses to evacuate everybody who needed assistance. The city had approximately 500 transit and school buses, a quarter of the estimated 2,000 buses needed to evacuate all residents needing transport. However, if given priority in traffic buses could have made

multiple trips out of the city during the 48-hour evacuation period, and even evacuating 10,000 to 30,000 people would have reduced emergency shelter overcrowding. Many public buses were subsequently ruined by the flooding. Federal emergency officials also failed to deploy buses for evacuation as planned. A top Federal Emergency Management Agency staff described his surprise and frustration at the agency's inadequate preparation before Katrina struck, despite his urgent warnings to agency executives. He says that at the time he wondered, 'Where are the buses to get people out of there?' The importance of buses for evacuation of the city became clear soon after the hurricane hit. On September 1 Mayor Nagin said on a local radio station, 'I need 500 buses…This is a national disaster. Get every doggone Greyhound bus line in the country and get their asses moving to New Orleans.'"

The paper also reports: "This indicates that bus deployment was ad hoc, implemented by officials during the emergency without a detailed action plan. Such a plan would include the designation of certain staff as *essential*, meaning that they are expected to work during emergency situations. [New Orleans Regional Transit Authority] Transit agency staff would have an incentive to volunteer for such a role because they would be allowed to evacuate their own families."

The City of New Orleans expects people without transportation to develop a support system for evacuation as seen during Hurricane Katrina. As reported in the Victoria Transport Policy Institute paper "Lessons from Katrina: What a Major Disaster Can Teach Transportation Planners," "The City of New Orleans does provide a section on 'Emergency Guide for Citizens with Disabilities' in its *Comprehensive Emergency Management Plan* posted on the City's Web site (New Orleans, 2005), but it contains little practical support, placing most of the responsibility for safety and evacuation on individuals. The Guide recommends that people with disabilities develop a 'support system' to provide help during disasters. The 'General Evacuation Guidelines' advises, 'If you need a ride, try to go with a neighbor, friend, or relative,' but provides no directions for people who lack neighbors, friends or relatives who have extra capacity in their evacuation vehicles, which is likely to be common in areas were poverty is concentrated."

According to the paper, "From a transport planning perspective, the greatest mistake in New Orleans was the lack of a detailed action plan to dispatch buses for evacuating transit-dependent residents. Such a plan would include an inventory of all available buses and essential staff, and pre-established procedures to deploy buses when an evacuation order is announced. The plan should include designated collection locations, guidelines as to what each evacuee should bring with them, reliable communication networks, and roadway management to give buses and other service vehicles priority in traffic. Extra effort should be made to provide comfort to evacuees, for example, by having public officials and community volunteers accompany evacuation buses to provide physical and emotional support. Had such a plan been implemented more residents would have evacuated, lives would have been saved, unnecessary suffering avoided, and total costs reduced."

Single Parents – Single parents also have special needs when evacuating their children. As reported in *Transportation in Emergencies: An Often Neglected Story*, "Single-parent families are often characterized by low adult-child ratios, which make evacuation more difficult. Census data have been used to identify areas within Grafton (evacuation of Mississauga, Canada) that have a high proportion of residents with these characteristics that translate into vulnerability. Maps of these areas can be used to help target particular areas for door knocking and for the provision of transport."

4.2.6.2 Accommodations for Special Needs Evacuees

Evacuees with disabilities may require special accommodations during evacuations. As reported in the Web site article "Precedent-Setting Decision on Emergency Evacuations for People with Disabilities Issued in Maryland," on www.washlaw.org, the Circuit Court for Montgomery County, Maryland, issued

a decision on December 28, 2004, that "shopping malls, stores, restaurants, movie theaters, museums, and other private entities subject to the Americans with Disabilities Act throughout the country, whether landlords or tenants, must now seek to accommodate people with disabilities in the development and modification of emergency evacuation procedures.

"The court's significant decision arises out of a lawsuit that was filed in Spring 2003 by Katie Savage, a Washington, D.C. resident who became trapped during an emergency evacuation in a local shopping mall that had no accessible exits for persons with disabilities. Ms. Savage, who uses a wheelchair, was shopping at a Marshall's store in Silver Spring, Maryland's City Place Mall on September 3, 2002, when the store and the Mall were evacuated. After Marshall's required her to exit into an area of the Mall that is below ground level, Ms. Savage found that she was trapped there and unable to evacuate, because the elevators were shut down and all the exits had stairs. Abandoned by store employees and trapped, Ms. Savage resolved to use her terrifying ordeal as a vehicle for ensuring that fellow citizens with disabilities would not be similarly victimized in emergency evacuation situations. Ms. Savage joined the Disability Rights Council of Greater Washington (the DRC) in filing a lawsuit against Marshall's and City Place Mall that alleged violations of the ADA in both the Mall's emergency evacuation plan and Marshall's corporate-wide evacuation policies."

Special needs evacuees may require longer-term evacuation accommodations due to the nature of the evacuation, thus surprising local authorities and impacting resources. According to the *Orlando Sentinel* article "Florida Not Ready," "one of the biggest shortcomings last year was the state's lack of preparation for the needs of sick and elderly evacuees, he [Governor Jeb Bush] said. No one had planned to keep the 'special needs' shelters open for weeks at a time. So keeping those shelters running was a strain on staff and resources. Bush said the state has improved the way it will communicate with hospitals and nursing homes as a storm approaches."

4.2.6.3 Location of Special Needs Shelters

Special needs evacuees need shelters during evacuations. The *Natural Hazards Observer* article "What if Hurricane Ivan Had Not Missed New Orleans?" reported: "For those without means, the medically challenged, residents without personal transportation, and the homeless, evacuation required significant assistance. The medically challenged can only be moved short distances to medically equipped shelters. A large storm-resistant structure with appropriate equipment has yet to be constructed or retrofitted; the Superdome was used to shelter non-evacuees during Ivan."

The City of New Orleans also used the Superdome as a special needs shelter during Hurricane Georges. The *Homeland Response* article "Evacuation: What We Can Learn—and Cannot Learn—from Hurricanes" reported: "New Orleans tried using the Superdome as a last-resort shelter during Hurricane Georges, but people showed up that were not special needs. When the threat subsided, they broke into concessions and carried off furniture. Planners have since identified future special needs shelters, but they do not plan to announce to the general public."

4.2.6.4 Evacuation of Special Needs Facilities

Jail facilities and nursing homes are special needs facilities that have been evacuated in the past. For example, during the evacuation from a hazardous material fire in El Dorado, Arkansas, in January 2005, the KSLA-TV article "Arkansas Inmates Spend Night in Louisiana Because of Fire" reported 139 "inmates from the Union County Jail in Arkansas were transferred to the Union Parish Detention Center in Louisiana after a fire broke out at an El Dorado area chemical plant."

The *Texarkana Gazette News* article "Fire Occurs at El Dorado Waste Plant" reported the evacuation of two nursing homes during this incident: "Two nursing homes—Hillsboro Manor and Oakridge Nursing Home—were evacuated and will have to remain away. [David] Smith said those who needed constant care were at area hospitals and that the others were at church and community center shelters along with other evacuated residents."

The NWAnews.com article "Air Near Plant Safe; Residents Sent Home" reported: "Nancy Cook, Hillsboro's director of nursing, said the evacuation went well. And while some of the residents were grumpy and anxious, no one was hurt. 'We're keeping them dry and comfortable. The question every few minutes is, 'When can I go home?' she said Monday morning."

Patients at Hospitals – Special needs evacuees may require assistance when evacuating from hospitals. During the evacuation of Mississauga, Canada, *Transportation in Emergencies: An Often Neglected Story* reported: "Police assist by keeping clear traffic lanes open among the involved hospitals. That plan was put in place in November 1979, when a train derailment forced a massive evacuation in Mississauga, Ontario, next to Toronto, an evacuation that included the Mississauga General Hospital."

4.2.6.5 Evacuees with Pets or Animals

According to *Quick Response Research Report 171: Providing for Pets During Disasters: An Exploratory Study*, "Studies have found that as many as 20 percent of residents will refuse to evacuate because they will not leave their pets."

Evacuees with pets or animals that have to be left behind in the rush of an evacuation worry about their pets and/or animals. *The Herald Bulletin* article "Those Evacuated Return Slowly" described the chemical fire in Anderson, Indiana: "[Scott] Stanley and [Henry] White …weren't worried about their safety throughout the ordeal, but were concerned about their pets. Stanley has three dogs and two cats; White has three cats. 'I left them here. I had no choice,' he said. 'I love my pets like family, but people come first. There was so much smoke here I was afraid my animals weren't going to be alive. …I kinda snuck back in early this morning to feed the animals,' he said, chuckling. 'I'm definitely ready to come home.'"

The NewYorkTimes.com article "Ninth Victim of Chlorine Leak Is Found" described the chlorine gas derailment in Graniteville, South Carolina: "At the corner of Bettis Academy and Ascauga Lake Roads, at a police roadblock, Antwon Miller spent part of Saturday trying to persuade a police officer to allow him and his mother-in-law, Jeanette Hartley, to return to his home in the hot zone to check on the family pets—two dogs and a cat—that were left behind. The police officers at the roadblock told him to call the sheriff's office, where he was directed to the animal control office. 'It's just me and my mother-in-law, it won't take but a minute,' he pleaded into his cell phone. But the official on the other end said it would be at least two hours. So the two tried again with Travis Blackwelder, an Aiken County Deputy Sheriff at the roadblock. The deputy said he could escort into the area only people who had left behind medicines. 'I forgot my mother's blood pressure medication and my glucose monitor,' said Ms. Hartley. So the deputy put her in the passenger seat of his police car and took her inside the zone. She returned later with Hershey on her lap; Rex, for now at least, was still at home."

As reported in *Quick Response Research Report 171: Providing for Pets During Disasters: An Exploratory Study*, "Failure to evacuate animals places subsequent risk on people, especially rescue workers. For instance, following a mandatory evacuation because of a hazardous chemical spill in Weyauwega, Wisconsin, in 1996, 40 percent of dogs and 75 percent of cats were not evacuated. Most people who did not evacuate their animals reported thinking that they would not be out of their homes for long. However, the 1,700 residents of Weyauwega were kept away from their homes for several days,

rather than hours. Shortly after the evacuation, several residents illegally reentered their homes to rescue their pets, at considerable risk to their own safety."

In addition, according to the *Quick Response Research Report 171*: "Four days after the evacuation, the emergency operations center organized an official pet rescue, supervised by the National Guard and using the Guard's armored vehicles. This response challenged resources that could have been put to other uses and it jeopardized the safety of rescue workers as well. The Weyauwega study concludes that residents who do not evacuate with their pets could adversely affect the health and safety of many other people and animals during disasters."

According to *Reverse Lane Standards and ITS Strategies Southeast United States Hurricane Study: Technical Memorandum Number 1: Final Report*, during the evacuation of hurricanes, people traveling with pets increase their time to commute: "The evacuation of pets and animals needs to be considered. There were some problems due to prolonged travel time drivers had to stop to give animals a rest break alongside the Interstate."

The Reno/Tahoe Blog article "Pleasant Valley Fire" reported: "If people have livestock or pets at their homes that they cannot get to, they are advised to notify Nevada Highway Patrol officers who are enforcing road closures of this. If they are allowed through, they should meet at the intersection of US 395 and Rhodes Road to make arrangements for their animal's care."

4.2.6.6 Pedestrians

The terrorist attack events of 9/11 in both New York City and Washington, DC, involved the evacuation of pedestrians. To move the evacuees out of the cities, public transit played a significant role; in addition, people also walked home. According to *Saving City Lifelines: Lessons Learned in the 9/11 Terrorist Attacks*, "thousands walked uptown or across the bridges that had been closed to vehicle traffic."

The *Metro Magazine* article "Transit Steps Up Security" reported: "When the Pentagon was hit, transit authorities in Washington, DC, moved into high gear. The Washington Metropolitan Area Transit Authority promptly shuttled back out of the city the 200,000 people that just came in. Train service was stopped over the river and to the Pentagon and nearby airports. Bus drivers worked overtime and picked up people walking along the street who had no other means of transportation. 'Employees felt compelled to stay in service without any direction,' says Chief Safety Officer Fred Goodine. 'And not one passenger acted out.'"

According to *Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout New York City*, transit operations were impacted with the loss of power during the blackout: "Between 4:20 p.m. and 4:30 p.m., both New York City Transit and Port Authority Trans-Hudson Corporation crews began the process of shutting down their systems and evacuating their passengers. This included making sure that power was disconnected to all third rails to ensure the safety of passengers walking along the tracks in the event that power was restored during the evacuation. The decision to shut down a transit system, evacuate the passengers, and then restore service can be extremely complicated and time consuming."

4.2.6.7 Bicyclists

There was very little information in the literature regarding the evacuation of bicyclists.

However, *Riding Out Future Quakes: Ideas For Action: Improving Planning of Transportation Providers, Government, Utilities and Businesses for Post-Earthquake Transportation Disruptions in the*

San Francisco Bay Region reported: "The Director of Office of Emergency Services, San Jose, California advises citizens of San Jose to have pre-mapped routes from home to key facilities, such as hospitals, pharmacies, food stores, and their work location. They also suggest that people consider using bicycles, roller blades, or other small vehicles for essential trips in the first days following an earthquake."

4.2.6.8 Truckers

Very little information was found on evacuation efforts associated with truckers. The *Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout New York City* reported: "While several agencies did use their operating variable message sign system(s) and highway advisory radio system(s) to post messages to alert drivers of closings and traffic conditions, there were no messages posted specifically to inform truckers."

In addition, according to the *Reverse Lane Standards and ITS Strategies Southeast United States Hurricane Study: Technical Memorandum Number 1: Final Report*, "Florida Highway Patrol is working with the trucking associations to curtail commercial vehicles during a hurricane evacuation. This would improve the roadway capacity and safety. Any truck traffic would be confined to the normal lanes and not the reversed lanes. The trucking associations are agreeable and volunteered to curtail trips during Hurricane Floyd."

4.2.7 Changing Conditions

This section of the literature search addresses information found on changing conditions. It is subdivided into changing priorities and responsibility for the changing requirements.

Findings regarding changing conditions include:

- Priorities change during evacuations from safety and protection of evacuees to providing mobility for evacuees.
- During the 2003 blackouts, responsibilities for items such as traffic management shifted spontaneously from the police to citizens.

4.2.7.1 Changing Priorities

Priorities change during evacuations from safety and protection of evacuees to providing mobility for evacuees.

9/11 Terrorist Acts: New York City and Washington, DC – During the initial terrorist attacks, the priority for transportation entities was for the safety and protection of passengers and employees. As events unfolded and time passed, the priority changed to mobility of the communities. As reported in *Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study*, "The initial guiding priority in every emergency is the protection of life. Transportation officials must begin almost immediately to implement evacuation plans and institute recovery procedures. In each of these cases, officials were charged with making decisions without full knowledge of the rapidly changing existing conditions and uncertainty of what future events might occur to change the situation. Because of this, safety and security took priority over mobility. As time passed and more information was available, officials began to restore mobility. This restoration of mobility varied with each of the events. Within days, mobility was restored to the Washington and Baltimore areas. Because of the physical damage in Los Angeles and New York, it was months before key pieces of the transportation infrastructure could be reopened to the general traveling public at normal levels."

Adjustments During Evacuations – The literature search found information on the need for adjustments during evacuations. As reported in the *State of Florida Regional Evacuation Procedure(s)*, "During a regional evacuation, for a wide variety of unanticipated reasons, it may become necessary to adjust or modify procedures stipulated in the hazard-specific annexes. The most readily apparent reasons for such modifications could include, but not necessarily be limited to, the following: changes in the direction or intensity of the hazard; blockage or excessive vehicle congestion on a regional evacuation route; filling of available capacity at public shelters and hotels/motels in host counties; and anticipated failure to complete the evacuation prior to hazardous conditions impacting evacuees."

Blackouts of 2003 – During the 2003 blackouts, the initial reaction to the incident was to perceive it as an act of terrorism; however, as more information became available, the reaction to the incident changed. As reported in *Learning from the 2003 Blackout*, "The first question on many peoples' minds, including speculations transmitted by the press: Was this emergency related to national security? The guiding priority in every emergency is the protection of life, but many transportation staff in the affected areas initially feared a terrorist attack. Reaction and response to a terrorist attack would be different from a non-security-related emergency, making it vital to communicate the causes of failure as quickly as possible. Once the causes of the blackout became clear, agency managers shifted their focus from security to safety and then to mobility."

The collection of tolls is important to respective transportation entities. However, priorities shifted for the New York Metropolitan Transportation Authority during the blackout in New York City. As reported in *Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout New York City*, "Tolls were suspended on toll facilities, with the exception of the New York State Thruway. Because this agency maintains emergency generator power at all of its toll facilities as a standard business practice, they were able to operate under normal conditions. While Metropolitan Transportation Authority bridges and tunnels were able to operate on backup generator power and their toll collection facilities were operational, agency management suspended the collection of tolls outbound from Manhattan."

Southern California Wildfires: 2003 – According to the *Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center*, during the southern California wildfires, the initial response of officials was to act in a reactionary mode—depend on pre-existing relationships until the situation became manageable. The following four paragraphs are excerpts from the report.

"Incident leaders said they had to start out in a purely reactionary mode. Shift changes, team handoffs, and organizational development had to occur during the worst possible incident conditions. Problems between the 800 MHz and VHF communications systems exacerbated these issues because municipal and county firefighters could not talk to state and federal firefighters. Incident commanders responded that during this reactive phase, strong, centralized command and control was impossible to achieve, reporting that, given the available resources, they could not possibly accomplish all the things requiring attention."

"Incident commanders found that it was more successful to set a limited number of critical priorities and work with what was available to accomplish them. They made sure those critical objectives were communicated to the tactical level."

"As incidents escalated and the system became overloaded, respondents reported that pre-existing relationships based on previous interagency cooperation proved essential. There were periods when common sense and collaboration was the only effective way to respond to the escalating nature of what was occurring and cooperators had to jointly determine and execute initial strategies and tactics with other cooperators."

"After the initial influx of resources and as the command systems overcame the initial reactionary postures and gained the initiative, they began to send out 'wranglers' to tie in with divisions, groups, and strike teams to verify units and numbers of people and to ensure that documentation was complete and accurate."

4.2.7.2 Responsibility for the Changing Priorities

According to *Learning from the 2003 Blackout*, during the blackouts, responsibilities for items such as traffic management shifted spontaneously from the police to citizens: "With police, fire, and emergency response personnel focused on freeing people trapped in stiflingly hot elevators and dealing with other life-threatening situations, traffic management took a secondary priority. In many cases, citizens stepped in to direct traffic at major intersections when police were unable to reach their assigned stations."

4.2.8 Impacts to Transportation Systems Due to Evacuation

Earlier sections of this report identified literature found during the search that addressed evacuation impacts to transportation systems (for example, the use of transit to accommodate evacuees during the blackouts and during the 9/11 attacks) and impacts to the road systems during hurricanes. The intent of this section is not to repeat that information, but to identify other literature.

This section is subdivided into transportation impacts due to closure of manufacturing plants, coordination for reentry, impact of transit decisions, and traffic management plans for evacuations.

Findings regarding impacts to transportation systems include:

- During the blackouts in the Great Lakes region, manufacturing plants ceased operations and the release of their employees thus impacted the transportation network.
- Reentry of evacuees requires coordination to ensure their return is successful and manageable.
- During the New York City blackout, transit managers' decisions impacted the evacuation.
- Transportation systems can become overwhelmed with evacuees.

4.2.8.1 Transportation Impacts Due to Closure of Manufacturing Plants

During the blackouts in the Great Lakes region, manufacturing plants ceased operations and, as a result, impacted the transportation network. As reported in *Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout Great Lakes Region*, "Without power to run equipment and without needed materials and other supplies, several automobile-manufacturing plants in Cleveland ceased operations during the period of the blackout. The closure of the plants had a significant effect on commuting and other travel patterns in the Cleveland area in the days after the blackout, allowing many people to remain at home as the city gradually returns to normalcy."

4.2.8.2 Coordination for Reentry

Reentry of evacuees requires coordination to ensure their return is successful and manageable. According to the *State of Florida Regional Evacuation Procedure(s)*, "The process for reentry will be coordinated to ensure the safety of the public and protection of property. The reentry decision and traffic management will be a carefully managed process coordinated by the State Emergency Operations Center. There will be coordinated conference calls with state and local law enforcement, transportation agencies, and all counties affected and will serve to coordinate the timing of reentry. Each county Emergency Operations center will be responsible for making a determination of reentry."

4.2.8.3 Impact of Transit Decisions

During the New York City blackout, transit managers' decisions impacted the evacuation. As reported in *Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout New York City*, "Shortly after the blackout Port Authority managers made the decision to close the Port Authority Bus Terminal in Midtown Manhattan because the facility has emergency power backup designed only to supply the power necessary to evacuate the building but not to keep the building operating. The evacuation was completed in approximately 15 minutes, but this closure complicated the process of getting passengers onto buses and on their way home. As people trying to get to New Jersey descended upon the bus terminal, the Port Authority and New Jersey Transit staffs set up temporary staging areas outside of the building. In order to evacuate as many people as quickly as possible, New Jersey Transit managers set up a shuttle service from the Port Authority Bus Terminal to a temporary staging area it was setting up at the Meadowlands Stadium. From the Meadowlands, New Jersey Transit operated buses that tried to duplicate, as best it could, service throughout its transit district. Several managers commented that installed or portable technology, specifically lights, portable variable message signs, and communication technology, outside of the Port Authority Bus Terminal, would have benefited the evacuation process."

During the blackout in the Great Lakes region, public transit vehicles used to evacuate passengers in turn became delayed due to evacuation efforts. As reported in *Learning from the 2003 Blackout*, "Those passengers who were evacuated from the light rail vehicles were met by Greater Cleveland Regional Transit Authority buses and four-wheel drive vehicles, which had been diverted from their normal routes in order to transport stranded commuters. Although the passenger evacuation was handled smoothly and quickly, many of the diverted vehicles were delayed in the downtown gridlock."

4.2.8.4 Traffic Management Plans for Evacuations

Transportation systems can become overwhelmed with evacuees. To standardize the process of evacuation, the State of Florida has created the *State of Florida Regional Evacuation Procedure(s)*. According to the procedures, "Each county is to have a traffic management plan. The plan is to identify specific actions to maintain a smooth flow from evacuation routes into the region to host shelters including: a) Traffic control points and the responsible agency for providing staffing and operational control; b) Barricade plans including location and staffing; and c) Potential one-way/reverse-lane operations."

5 Lessons Learned

This section of the literature search addresses information found on lessons learned from the 9/11 terrorist attacks, the 2003 blackouts, the I-95 tanker explosion, hurricanes, and other incidents.

Many of the publications issued by and/or for the US Department of Transportation (DOT) and FHWA, as well as other publications, had specific sections addressing lessons learned. These publications include the *Compendium: Graduate Student Papers on Advanced Surface Transportation Systems: Application of ITS Technology to Hurricane Evacuation Routes*; *Saving City Lifelines: Lessons Learned in the 9/11 Terrorist Attacks*, *Firestorm 2003: Provincial Review*; and *Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center*. Other publications had lessons learned identified throughout the publication.

Table 5-1 lists some of the common themes in the lessons learned by the various entities.

Table 5-1. Common Themes in Lessons Learned

Common Themes	Lessons Learned
Advanced Preparations and Planning	• Do not ignore low-tech solutions • Review and learn from past events • Establish mutual-aid agreements • Plan for all types of emergencies • Review emergency plans after an event • Develop procedures to guide actions to be taken early in an emergency
Advanced Technology	• Advanced technologies play an important role in communications and decision making • Use ITS technology but also a mix of older technology • Be prepared for limited use of ITS technology • Consider ITS functionality that could be particularly useful during an emergency • Use ITS technologies to provide information and assist in decision making • Utilize portable ITS equipment in responding to incidents • Realize communication systems can complement ITS technology • Keep traffic management centers open during the incident; use alternative power if necessary • Establish reliable backup power to maintain normal ITS functions
Command and Control	• Delegate decision making down • Maintain close ties with law enforcement entities • Make use of an incident command system • Use incident management teams • Have incident management teams work with infrastructure and utility personnel • Establish pre-selected incident command post locations
Communication	• Be prepared to communicate using various methods, such as fax, handouts, maps, cell phones, satellite phones, cable television, face-to-face, email, Internet/Web, and ham radio operators • Communicate with a unified voice • Understand communication may be difficult during an incident • Develop a joint information center

Common Themes	Lessons Learned
	• Be prepared to activate the emergency alert system early • Have compatible radio systems • Expect loss of power and communications • Have both internal and external communication mechanisms • Inform all participants • Realize a multimedia approach may be necessary • Ensure information is accurate and consistent
Cooperation	• Practice cooperation during normal times • Practice interagency cooperation
Coordination	• Coordinate the response with others • Maintain relationships (pre-existing relationships among agencies and personnel are key to emergency management success) • Utilize the resources of all participants • Involve law enforcement and non-traditional agencies • Conduct a collaborative post-incident review • Establish internal coordination as well as external
Emergency Plans	• Develop emergency plans • Test the emergency plans
Evacuations	• Develop evacuation routes and remember evacuations can cross state lines • Modify evacuation routes as needed • Allow for individual initiative • Identify evacuation routes • Maintain emergency services access to the disaster area and evacuation routes • Include evacuation of dispatch centers • Use available tools to aid in the decision to evacuate • Communicate with people who do not evacuate • Ensure reentry of evacuees • Realize priorities may conflict • Realize priorities will change over time
Operations	• Be ready to throw out the procedures if they do not work in an evacuation • Delegate responsibility down to the appropriate level in the organization • Empower employees • Expect chaos • Know where you are going and how to get there • Use volunteers in a support role • Overcome the need to take action without planning • Prepare for emergencies in advance to make day of event decisions earlier • Set priorities as quickly as possible • Reduce impacts of work zones • Develop clear procedures for evacuations
Redundancy and Resiliency of Systems	• Build redundancy into institutions and physical systems including personnel, communications, utilities, and control centers • Pre-position supplies and equipment (if the supplies and equipment can be identified) • Adopt a mindset of resiliency • Have a redundant system of trained agency personnel • Remember the transit system can provide redundancy

Common Themes	Lessons Learned
	• Conduct inventory of backup resources • Establish backup power • Have alternative emergency operations centers • Use multiple communications technologies
Training	• Conduct training exercises • Practice with other entities • Adapt response plans to the incident • Train first, second, and third string staff for emergencies • Review and update crisis plans with training

Lessons learned are organized into following the areas:

- Advanced Preparations and Planning
- Advanced Technology
- Command and Control
- Communication
- Cooperation
- Coordination
- Emergency Plans
- Evacuations
- Operations
- Redundancy and Resiliency of Systems
- Training

5.1 Advanced Preparations and Planning

1. **Activate Emergency Operation Centers Quickly** – "Minutes after the Northridge earthquake, the City and County of Los Angeles was able to activate its Emergency Operations Center and begin emergency response procedures. This center was built in response to the events associated with the 1992 Los Angeles riots. In addition, the numerous state and local transportation and safety agencies within the region had coordinated on safely moving large numbers of people on the transportation network for numerous large-scale events like the 1984 Olympics, political conventions and special sporting and entertainment events."
   Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

2. **Assess Damage Quickly** – "The earthquake in the Los Angeles region created damage over a 2,100-square-mile area. Transportation officials had to quickly assess damage to the system and prioritize where to immediately place its resources. The California Department of Transportation immediately mobilized technical experts among its staff of 23,000 workers spread across the state to descend upon the Los Angeles region to begin the response and recovery efforts. By the late morning of the first day, engineers were assigned the task of evaluating the structural integrity of the portions of the system and setting up temporary detours. To expedite the clean up process, California Department of Transportation officials in the field were able to quickly enter into 'handshake agreements' with

private contractors to begin demolition and debris removal within 16 hours of the earthquake. This initial day-1 response occurred on a state holiday, Martin Luther King Day."
Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

3. **"Consider the Emergency Needs of Both People and Equipment** – During an emergency, people will need drinking water, food, portable toilets, flashlights, and battery-powered radios."
Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout Great Lakes Region

4. **"Consider the Movement of Pedestrians As Well As Vehicles** – During the September 11th attack and the blackout, severe traffic congestion was caused by numerous employees leaving work within a short period of time and the conflict between both pedestrians and vehicles wanting to use the same river crossings. It was noted that people walking through tunnels and across bridges could prevent emergency vehicles from entering an event's location.

   Therefore, some agency representatives discussed the need to plan for the flow of pedestrians. They stressed the need to identify and publicize transportation hubs—locations where people can assemble and from where they could take public transportation buses out of the city.

   During the blackout, staff at the Metropolitan Transportation Authority Bridges and Tunnels worked with staff from the New York City Transit Buses to transport pedestrians across the bridges and tunnels. Bridges and Tunnels staff marshaled pedestrians into staging areas, mainly near the entrances to a few tunnels and bridges. New York City Transit Buses supervisors sent buses to these locations to transport these people across the facility. They foresaw using a public address system in future emergencies to inform pedestrians of locations to catch transportation out of the city.

   Representatives from other New York City agencies also discussed controlling the conflict between pedestrians and vehicles. They proposed developing a plan that would identify streets to be used only by people on foot and would assign staff or citizens at major intersections along these streets to control traffic. The plan would also identify which bridges would be designated for pedestrians usage and which for vehicle usage."
   Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout

5. **"Coordinate Evacuation Routes across Jurisdictional Boundaries** – Examine and modify evacuation route designs if necessary to accommodate evacuation management strategies. For example, reversible lane operations and the use of shoulders as an additional lane might require modifications to interchange designs."
   Disaster Response and Evacuation User Service: An Addendum to the ITS Program Plan

6. **Coordinate the Reentry of Residents with Hazard Mitigation and Restoration of Services** – "Introducing residents into previously evacuated areas was an issue that most respondents indicated was not adequately addressed even with planning. As a result, there was congestion and confusion as firefighters were maneuvering around residents, utilities, insurance people, and so on. Respondents felt it was important for unified command to coordinate the sequence of hazard mitigation and the restoration of services with the return of residents. They recommended involving utilities and public works departments before allowing residents to return to their homes."
   Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

7. **"Do Not Ignore Low-Tech Solutions** – Agency representatives used a combination of facsimile machines, pagers, 800 numbers and conference call lines, older radio systems, and previously installed dedicated landlines to communicate within and among agencies.

   Staff at INformation FOR Motorists (INFORM) noted that resetting traffic signal controllers with a limited staff was difficult. After assessing their actions during the blackout, they have grouped intersections according to their snow-plowing routes. They will be making laminated sheets of the routes to guide technicians as they check and reset the traffic signal controllers. Police assigned to the Traffic Control Division used scooters to convey messages to officers in the field when their communication was temporarily disrupted."
   Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout

8. **"Do Not Neglect the Small Items** – Several mentioned the need to stock food, such as high-energy food bars, and water for staff that have to operate emergency operations centers over an extended period of time. Others highlighted having additional flashlights and lanterns and charged batteries for cell phones, pagers, portable radios, and portable computers. One interviewee stressed having a portable AM/FM radio and batteries in order to receive information from the media.

   The plan for one agency outlined procedures to follow if its central facility had to be evacuated, one of which called for forwarding phone calls to the agency to another location. Unfortunately, the facility had to be evacuated. Staff then realized that forwarding calls was not an automated process and the telephone carrier had to be contacted. Because of difficulty with the phone service, the provider could not be reached."
   Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout

9. **"Insulate Emergency Response Capacities from Disruption and Compromise** – Emergency telecommunications systems must have redundancy built in, and emergency transportation procedures must provide for sufficient stores of fuel."
   Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout Great Lakes Region

10. **"Learn From Past Events** – Staff at New York City Transit noted that employees were guided by the experience they gained from the blackouts in 1965 and 1977. Many identified their need for backup power sources. Staffs at INFORM and at the Niagara International Transportation Technology Coalition identified several key intersections where generators would be installed to operate the traffic signals. INFORM staff also identified key fueling facilities, and installed generators at those locations.

    The Transportation Operations Coordinating Committee staff noted that while preparing for Y2K they developed strong working relationships with staff from the various emergency operations centers located in New York and New Jersey.

    Furthermore, New Jersey Transit staff noted that they gained experience during the Centennial Celebration and Op Sail 2000. During these events, participants had to be moved from a single location, such as Liberty Park, to various destinations in eastern New Jersey. This movement was similar to what occurred during the blackout—transporting commuters from a single location, such as the New Jersey ferry docks and the Port Authority bus terminal, to surrounding communities.

In response to the events of September 11, staff at INFORM developed emergency management procedures in conjunction with their New York State Department of Transportation headquarters in Albany with some assistance by the FHWA and the Transportation Operations Coordinating Committee staffs. Staff at the Port Authority noted that after September 11, they installed a backup generator at the location of their emergency operations center, and it performed as expected."
Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout

11. **"Periodically Reevaluate the Need for Backup Power and Generators** – Most agencies had some degree of backup power during the blackout. In some cases, the backup power was adequate; in others, it was not. Representatives of some agencies were surprised by what was not covered by their backup systems. Two agencies lost power for the card-key systems that governed access to their offices. Some agencies had backup power for their computers but none for the air conditioning units needed to cool the equipment. Agencies that had newer central telephone systems experienced more problems than agencies with older systems.

    Some agencies had backup power for only a portion of their fueling facilities. Some had backup for the fuel pumps but not for lighting at the facility. One agency recently converted to electronic fuel dispensing stations. After losing and then regaining power, some of the computers that ran the stations had to be manually restarted.

    Some interviewees noted that they had backup power, but it had not been tested under a full load, and did not operate as expected."
    Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout

5.1.1 Agreements, Plans, and Procedures

1. **"Consider Phased Evacuation Plans** using both voluntary and mandatory evacuation orders starting with the most critical areas and moving inland."
   Compendium: Graduate Student Papers on Advanced Surface Transportation Systems: Application of ITS Technology to Hurricane Evacuation Routes

2. **"Conduct Public Awareness Campaigns to encourage the public to pre-plan and to bring** awareness to out-of-town visitors."
   Compendium: Graduate Student Papers on Advanced Surface Transportation Systems: Application of ITS Technology to Hurricane Evacuation Routes

3. **"Develop Coordination Agreements** to establish a chain of command, lists of resources, and mutual-aid agreements."
   Compendium: Graduate Student Papers on Advanced Surface Transportation Systems: Application of ITS Technology to Hurricane Evacuation Routes

4. **"Develop an Emergency Response Plan** – Several representatives of the agencies interviewed cited the importance of formalized emergency response plans—that have been developed and practiced in advance of a real emergency."
   Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout Great Lakes Region

5. **"Develop Evacuation Plans at the County, State, and Multi-State Levels** – Data must be collected and archived for the development of these plans and to ensure the validation of the models used in developing the plans. The data should include items such as traffic flow, speed, occupancy, traveler behavior, and a log of events."
   Disaster Response and Evacuation User Service: An Addendum to the ITS Program Plan

6. **"Develop Procedures to Guide Actions to Be Taken Early in an Emergency** – Most often, these plans and procedures spell out actions that need to be taken early in an event. In some cases, the plan identifies who is responsible for opening the emergency operations center. For example, at New Jersey Transit, the chief of police, the assistant vice president for bus, or the assistant vice president for rail has the authority to open the center.

   During the blackout, however, several line department managers reported to the emergency operations center without being called because they knew the agency's procedures.

   At New York City Transit, once managers establish that an event will last for an extended time, each department or division positions a senior representative at its emergency operations center. Each senior representative has direct communication with the control center of the mode represented."
   Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout

7. **"Develop Service Restoration Plans for the Transportation System** – Where evacuation is not feasible, such plans must allow for immediate transport of critical supplies to support shelter-in-place strategies."
   Disaster Response and Evacuation User Service: An Addendum to the ITS Program Plan

8. **"Ensure Your (Communication) Plan Covers Loss of All Communications** – Agency representatives realized the need to develop plans in the event that communications is lost (NonComm plans), identifying the actions that must be taken in the event of an emergency when no lines of communication are available."
   Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout

9. **"Establish Mutual Aid Agreements—**Establish mutual-aid agreements with partner agencies and neighboring communities."
   Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout Great Lakes Region

10. **Have Agreements Among Entities for Emergencies** – "As a result of September 11, officials from the states of Maryland and Virginia, the District of Columbia and the Federal Government signed an agreement on June 20, 2002, to improve the region's handling of transportation emergencies. The agreement commits the agencies to updating evacuation plans, integrating emergency operations centers, developing a regional data sharing network and performing inventories of resources."
    Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

11. **Incorporate Evacuation Centers in Management Plans** – "Many identified the need for management plans of evacuation centers as a lesson learned. Incident overhead had to deal with a variety of issues concerning support to evacuation centers and evacuees."
    Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

12. **Learn from Previous Events and Incorporate into the Response Plan** – "The need to learn from previous events and incorporate that learning into an agency's response plans is a must."
Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

13. **"Make Plans That Are Specific and Detail-Oriented** – Staff at the Ambassador Bridge of Detroit, for example, credited their advance Y2K preparations for encouraging them to keep both backup generators and bottled water on hand at all times."
Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout Great Lakes Region

14. **"Review Emergency Plans after an Event** – For example, after the blackout, the Ohio Department of Transportation staff reviewed the performance of its emergency plan during the event. To be most effective, emergency response plans and their corresponding preparations should be continually updated."
Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout Great Lakes Region

5.1.2 Planning

1. **Integrate Pre-Incident Planning into the Incident and Unified Command Structure** – "Most of the critical data to support strategic and tactical decision-making existed in pre-incident planning documents, but in general it was not effectively integrated into incident and unified command. When it was, respondents found it extremely valuable they said it should be 'pushed, pulled, or dragged' into the incident command.

   When this information got disseminated down to division and group level, it enabled more effective tactical planning and increased the situation awareness of ground resources.

   Many leaders rated the integration of pre-incident planning information as an area for improvement using existing interagency meetings or developing a GIS-based system."
   Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

2. **Involve Utilities in the Incident Organization and Planning for Service Restoration** – "Pre-incident planning improved coordination between fire agencies and utilities but many did not anticipate the difficulties in sequencing the return of evacuees and services restoration. They said that in the future they would involve utilities in the incident organization and planning early to coordinate restoration of services."
Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

3. **"Plan for All Types of Emergencies** – Emergencies can come in many forms. Some agency staff members indicated that they have developed a single emergency plan—often based upon emergency response to a large storm or other natural disaster—without tailoring it for other types of emergencies. There may be much overlap between types of emergency responses. For example, several organizations mentioned that their snow emergency plans were useful during the blackout. The greater the types of events considered, the more likely an agency will be prepared for whatever happens."
Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout Great Lakes Region

4. **"Plan Evacuation Routes** based on the demand, capacity, and clearance time for a particular region."
   Compendium: Graduate Student Papers on Advanced Surface Transportation Systems: Application of ITS Technology to Hurricane Evacuation Routes

5. **Plan for Evacuations** – "Public transportation played a key role in evacuating Lower Manhattan and Washington, DC. Chemical, biological, or radiological attacks and natural disasters such as hurricanes and earthquakes also may require large-scale evacuations. The evacuation effort in New York was successful because the transit operators had thought about it and planned for it."
   Saving City Lifelines: Lessons Learned in the 9/11 Terrorist Attacks

6. **"Plan for the Evacuation of Those with Special Needs** – This includes the elderly and handicapped as well as hospitals and other institutions with resident populations. Transit plays a critical and unique role in meeting this need."
   Disaster Response and Evacuation User Service: An Addendum to the ITS Program Plan

7. **"Plan for How to Deal with Construction along Evacuation Routes** when construction is scheduled to take place on major evacuation routes during hurricane season. Where feasible, alternate evacuation routes may be developed and provided to the public. Detours around the construction area may also be planned in advance. If the evacuation route is needed despite the delay due to construction, the use of shoulders as temporary travel lanes might be considered with the aid of law enforcement direction."
   Compendium: Graduate Student Papers on Advanced Surface Transportation Systems: Application of ITS Technology to Hurricane Evacuation Routes

8. **"Plan in Concert with Other Agencies** – For example, the Detroit-Windsor Truck Ferry staff is now working more closely with US Customs Service officers to better plan for emergencies that impact the crossing of freight between Canada and the US."
   Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout Great Lakes Region

9. **"Plan for the Use of Shelters** in case evacuation is not possible or is not mandatory."
   Compendium: Graduate Student Papers on Advanced Surface Transportation Systems: Application of ITS Technology to Hurricane Evacuation Routes

10. **Use Pre-Incident Planning** – "Pre-incident planning was essential to effective evacuation compared to those areas that did not conduct extensive pre-incident planning."
    Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

5.1.3 Practice

1. **Continue Ongoing Training and Practice** – "A consistent theme identified in the interview process was that the agencies involved in responding to the Howard Street Tunnel fire had effective plans in place and were prepared to respond to an emergency. Emergency response personnel were on site literally within minutes of the fire being reported and incident command procedures were established promptly. What complicated efforts was that these agencies had not planned for a situation where both a hazardous materials spill and a fire occurred in the same incident, which created some difficulties with establishing response priorities. The agencies interviewed all stressed the importance of on-going training and practice as the key to developing and maintaining incident response capabilities."

Effects of Catastrophic Events on Transportation System Management and Operations: Howard Street Tunnel Fire, Baltimore City

2. **Practice for an Emergency Response** – "Agency officials involved in each of the case studies repeatedly stressed the need and value of practicing for emergency response. In the words of one transit official from New Jersey, the most important thing is 'practice, practice, practice.' The practice of emergency procedures can teach and reinforce lessons first learned in classroom training. A practice exercise is most useful when it involves representatives from multiple transportation and emergency response agencies and results in relationship-building among these agencies in how best to respond to a crisis."
   Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

3. **Practice for the Unexpected** – "There is a need to practice for the expected and unexpected. Knowledge gained and relationships developed through day-to-day contact are extremely useful when catastrophes strike. The I-95 Corridor Coalition was able to help its member agencies disseminate information on roadway conditions all along the Eastern Seaboard. During the 1980s, the City prepared a draft single occupancy vehicle ban on automobiles in case of the subway strike. This single occupancy vehicle ban was not needed at the time but served as the basis for the single occupancy vehicle ban 20 years later, when New York City began to experience debilitating traffic jams as security checks were put in place at key points."
   Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

4. **"Reduce the Time Required for Implementation and Setup of Various Evacuation Strategies** – This must be done due to the short time period available for evacuation in some types of disasters. For example, create a modeling/simulation tool to assist in the development (in near real-time) of evacuation plans. Also, lane reversal might not be a feasible alternative for disasters with little or no forewarning if it takes a long time to setup the operation."
   Disaster Response and Evacuation User Service: An Addendum to the ITS Program Plan

5. **"Rehearse Emergency Response Plans** – Emergency response plans are only as good as the preparations and support that go along with them."
   Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout Great Lakes Region

6. **Rely Upon Field Staff to Take Action** – "Due to prior training and relying on personnel in the field to take action, New York City Transit was able to begin emergency operations of its subway system within one minute of the attack because a subway train operator stopped at Courtland Station felt the vibrations below ground from the plane crashing into the towers and reported that something was wrong. The PATH system began similar procedures six minutes after the first attack as an employee at the train control center in New Jersey ordered the trains to evacuate people at the World Trade Center station and express to safety in New Jersey."
   Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

5.1.4 Preparation for the Future

1. **"Campaign to Install Automatic Vehicle Identification Tags in All Vehicles** so that traffic flow may be monitored during an evacuation and vehicles will be ready once technology has the capability to transmit messages through the automatic vehicle identification equipment."
   Compendium: Graduate Student Papers on Advanced Surface Transportation Systems: Application of ITS Technology to Hurricane Evacuation Routes

2. **"Develop a Database for In-Vehicle Computer Systems** that contains existing road networks and evacuation routes at a minimum. Include directions to shelter areas and alternate routes when construction takes place. Prepare to feed real-time information into the database when technicians develop a reliable communications system for delivering real-time information."
   Compendium: Graduate Student Papers on Advanced Surface Transportation Systems: Application of ITS Technology to Hurricane Evacuation Routes

5.1.5 Public Transit

1. **Plan for the Use of Public Transit to Support Evacuations** – "The Metropolitan Transportation Authority's role in transporting emergency personnel to Lower Manhattan was unanticipated, but could become a necessity in other situations and should be planned for."
   Saving City Lifelines: Lessons Learned in the 9/11 Terrorist Attacks

2. **Use Public Transit Equipment for the Response** – "Because transportation operators had specialized heavy equipment for construction, maintenance, and emergency response, the Metropolitan Transportation Authority played a critical role in the rescue effort at Ground Zero and in helping restore parts of the city's infrastructure, including communications. City officials and transportation operators should look at these assets as essential resources in dealing with all hazards and ensure coordination across department lines within city government."
   Saving City Lifelines: Lessons Learned in the 9/11 Terrorist Attacks

5.2 Advanced Technology

1. **Be Prepared for "Limited Use of ITS Technology** – Realize that with massive outages, the use of ITS to suggest alternative routes may be limited. One value of ITS technology is that it allows agencies to better inform the public of transportation options and to respond to incidents more rapidly. Information relayed during the blackout could have informed the public of certain closures, but because gridlock conditions prevailed on almost all roads for the first three hours following loss of power, there were not many transportation options available."
   Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout New York City

2. **Communicate Updated Traffic Information** – "Since the 1994 Northridge earthquake, the Traffic Management Center has updated the means by which they relay traffic information. Cable TV is now being used; real-time traffic information is available on the Internet; and Teletext, a scrolling sign placed at key points in the freeway system, updates commuters to potential back-ups."
   Effects of Catastrophic Events on Transportation System Management and Operations: Northridge Earthquake

3. **"Consider ITS Functionality That Could Be Particularly Useful During an Emergency** – When Detroit area freeways flooded, operational cameras would have helped the Traffic Management Center personnel monitor the event and advise state police on what resources were necessary to deploy. In addition, functioning variable message signs would have helped the Traffic Management Center operators warn motorists about the incident."
   Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout Great Lakes Region

4. **Share Advanced Technology Information** – "The Interregion Video Network operated by the Transportation Operations Coordinating Committee allows 13 traffic management centers in the New York region to share video feeds of its network. This allows other agencies to better understand what is happening outside of its purview but that might have a significant impact on its operations. This system is available on a more limited basis to the general public through the MetroCommute Web site, giving motorists real-time information through the web."
   Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

5. **Use Dynamic/Variable Message and Highway Advisory Radio to Communicate to the Public** – "The most significant contribution from advanced technology came in the use of dynamic message signs/variable message signs and highway advisory radio to provide information to travelers on the closing of roadways into the City on the day of the event. Maryland's Coordinated Highways Action Response Team system is state-of-the-art, and the State was able to post messages that covered the portions of the Interstate system impacted by the incident."
   Effects of Catastrophic Events on Transportation System Management and Operations: Howard Street Tunnel Fire, Baltimore City

6. **Use ITS Technologies to Provide Information and Assist in Decision Making** – "Once a catastrophic event has occurred, advanced technologies and ITS can aid in providing information and assisting decision-makers in these ways: help make better informed decisions on when and how to open or restrict facilities, aid better communications with other public and private agencies involved in the response, and assist in communicating with the public about the status of the transportation system.

   ITS technologies aided both agencies and travelers on September 11 in several ways. Its ability to alert motorists of problems long before they reached the Manhattan area was critical. Both customers and facility operators benefited in having traffic diverted before it reached the bridges or tunnels. After the Transportation Operations Coordinating Committee alerted I-95 Corridor member agencies of problems in the New York City region, these agencies used highway advisory radio and variable message signs on I-95 as far south as Delaware and as far north as New Haven, Connecticut, to alert travelers to avoid the New York City region."
   Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

7. **Use Traffic Data to Assist In Decisions** – "Traffic along key sections of the roadway system including bridges and tunnels leading to Manhattan was measured, and the information was used to help determine changes in the hours of the lower Manhattan crossings single-occupancy-vehicle ban. Variable message signs were used to communicate real-time information to travelers. Within two minutes of the decision to close the George Washington Bridge, the variable message signs alerted motorists ten miles away. The information provided by its 1-800 telephone lines was simultaneously updated and the information was electronically transmitted for broader dissemination."

Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

8. **"Utilize Portable ITS Equipment in Responding to Incidents** – The Integrated Incident Management System, a joint program by New York City Department of Transportation, New York State Department of Transportation, and New York Police Department includes installed ITS equipment, including mounted and portable cameras, that allow managers to view an accident or situation from remote locations. But, during the blackout, the system was not operational, and agency officials were not sure that the Integrated Incident Management System would have been useful because it is designed primarily to respond to isolated incidents."
Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout New York City

5.2.1 Communication

1. **"Maintain Some Older Technology Which May Be Less Susceptible to Power Outages** – In some instances, older technology worked while new technology did not. The most dramatic example of this is the plain old telephone system that for the most part functioned throughout the blackout. In comparison, cell phones, networked phone systems, and portable phones experienced varying degrees of failures due to the loss of electricity or ceased working when limited backup power was exhausted."
Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout New York City

2. **Realize Communication Systems Can Complements ITS Technology** – "Communication [complemented] the ITS capability of the agencies during the events. ITS technologies employed in Virginia included advanced traffic management center, variable message signs, and closed circuit television. According to the Virginia Department of Transportation, imagery from the closed circuit television network was extremely useful in assessing the progress and effect of traffic management operations. However, Virginia Department of Transportation personnel perceived the telephone as one of the most important items of technology in use on September 11. Maryland made use of many of the same technologies, finding closed circuit television surveillance of particular utility. Dynamic message signs and highway advisory radio were used for traveler information, along with Web sites advising travelers of road closings and transit disruptions.

   In Baltimore and Washington, DC, the most significant contribution from advanced technology came in the use of dynamic message signs/variable message signs and highway advisory radio to provide information to travelers on the closing of roadways into Baltimore on the day of the event. Maryland's Coordinated Highways Action Response Team system is state-of-the-art, and the State was able to post messages that covered the portions of the Interstate system impacted by the incident."
   Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

3. **Use Alternative Phone Technology for Communications** – "Interviewees stated that NEXTEL Direct Connect (digital two-way radio) was the most effective communications system available at the site. Cellular telephones were not as reliable, in particular on the day of the event, and experienced circuit overload. Many of the State personnel involved in the response had been provided with NEXTEL equipment by their agencies."

Effects of Catastrophic Events on Transportation System Management and Operations – Howard Street Tunnel Fire, Baltimore City

4. **Use Other Means to Communicate, Such as Cable Television, the Internet, or Teletext** – "Since the 1994 Northridge earthquake, the traffic management center has updated the means by which they relay traffic information. Cable television is now being used; real-time traffic information is available on the Internet; and Teletext, a scrolling sign placed at key points in the freeway system, updates commuters to potential back-ups."
   Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

5.2.2 Facilities

1. **Establish an Earthquake Planning and Implementation Center as Necessary** – "Although the Traffic Management Center was able to initially deploy the freeway service patrol and serve as an emergency command center for the regional highway network, it quickly became evident that the existing Traffic Management Center could not handle all the unprecedented congestion generated by an earthquake, as it was already operating at capacity. The Traffic Management Plan recognized this, and with federal emergency relief funding of $12.6 million, implemented the Earthquake Planning and Implementation center (EPI-Center). The 2000-square-foot EPI-Center opened on April 17, 1994, and acted as a hub for many advanced technologies that facilitated the traffic management in the disaster areas.

   Connected with the Traffic Management Center, the EPI-Center is used only when an earthquake occurs to relieve some of the burden on the Traffic Management Center. The goal of the EPI-Center was to focus on communication between transportation and emergency officials and commuters, relaying important information directly to those affected. The EPI-Center was vital in coordinating the traffic management deployments and giving traffic engineers accurate and immediate information. This allowed them to make better decisions and to collect information about the changes in the traffic behavior during a disaster."
   Effects of Catastrophic Events on Transportation System Management and Operations: Northridge Earthquake

2. **"Examine Potential Sites to Place Advanced Technology to Help Better Communicate with the Public During an Emergency** – Immediately following the blackout, people tended to head for certain transportation centers without being told. One official suggested installing emergency powered signs outside of major transit hubs to better communicate transportation conditions and options when the hubs are closed.

   New York City officials are looking at the option of pre-designating certain pedestrian and vehicle routes in the case of an emergency. These routes would need to be identified and publicized alerting the public as to which route to take during an emergency."
   Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout New York City

3. **Keep Traffic Management Centers Open During the Incident, Use Alternative Power If Necessary** – "The California Department of Transportation traffic management center served as the center of decision-making efforts by the traffic management teams after the 1994 Northridge earthquake. Extensive traffic management capabilities were already in place on most of the major freeways well before the earthquake, including speed-monitoring loop detectors, closed circuit

television, on-ramp meters, and permanently mounted variable message signs. The traffic management center used backup electrical generators for power and relied on landline telephones for primary communications."
Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

5.2.3 Power

1. **"Allocate Ample Resources for the Restoration of Traffic Signals and Other Communications Devices** – A plan that prioritizes restoration activities, with available staff resources and placement of backup generators where they are most needed, would assist in this process. Representatives of the Michigan Department of Transportation and the Road Commission for Oakland County mentioned the significant amount of time involved in ensuring that when power was restored, signals were actually working properly. Rolling blackouts also caused signals to be re-timed more than once."
Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout Great Lakes Region

2. **"Establish Reliable Backup Power to Maintain Normal ITS Functions** – The agencies that used advanced technologies during the blackout had acquired independent power sources to support their equipment. Generators provided power and a holdover dialup modem filled in when the Internet service provider connection was lost."
Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout Great Lakes Region

3. **"Provide Power to ITS Equipment at Both the Traffic Management Center and in the Field** – The New York City Department of Transportation is looking at prioritizing critical intersections and installing backup capacity to the signals."
Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout New York City

5.3 Command and Control

1. **Brief Incoming Personnel Resources** – "Leaders thought it was effective to route all incoming resources in a way that ensured they got a quality briefing; understood intent, objectives, and risk guidance; and had the capability to establish lookouts, communications, escape routes, and safety zones."
Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

2. **Cache Vital Documents Off Site** – "The destruction of the World Trade Center wiped out or prevented access to crisis plans, documents, and drawings necessary for response and reconstruction. To ensure continuity of business and rapid recovery, copies of vital documents should be cached at several locations and should also be available online at secure, password-protected Web sites."
Saving City Lifelines: Lessons Learned in the 9/11 Terrorist Attacks

3. **Carry Out the Delegation of Authority and the Evacuation Order** – "The lack of preplanning sometimes made for unclear responsibilities when an evacuation took place. The lesson learned here was to be firm about their role in carrying out the Delegation of Authority, then help the local agency try to find other resources to carry out the evacuation order."

San Bernardino County Fire Chiefs' Association: Lessons Learned Report: Fire Storm 2003: "Old Fire"

4. **Delegate Decision Making Down** – "It was most effective for commanders to determine the top three or four priority objectives, communicating their intent, objectives, and risk criteria to all resources. They delegated tactical decision-making down to functional group level and gave the authority to adapt as the situation developed."
   Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

5. **Develop a Victim Notification System** – "Victim family notification is a key function that needs enhancement. Transit agencies should develop their own National Incident Management System (NIMS)-based plan to respond to transit-based events."
   Saving City Lifelines: Lessons Learned in the 9/11 Terrorist Attacks

6. **Maintain Close Ties with Law Enforcement Entities** – **"**Even with current improvements in the intelligence-sharing function, transportation operators cannot depend on timely warning of attacks. Operators can improve their situation somewhat by maintaining close liaison with police and federal authorities through NIMS planning/intelligence activities."
   Saving City Lifelines: Lessons Learned in the 9/11 Terrorist Attacks

7. **Monitor Assigned Resources** – "As Incident Management Teams started getting established, some incident commanders sent wranglers out to tie in with subordinate leaders and verify documentation to make sure everyone was accounted for and the Incident Management Team had situation awareness on assigned resources."
   Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

8. **Realize During the Initial Response to the Incident, a Strong, Centralized Command and Control System May Not Be Possible**—"Incidents overwhelmed established systems during the initial response, forcing incident managers into a reactionary mode and resources to have to be committed directly to the fire ground. Strong, centralized command and control was not possible."
   Southern California Firestorm 2003—Report for the Wildland Fire Lessons Learned Center

9. **Realize Recovery May Be Compressed into Days** – "Recovery planning may have to be compressed into days, sometimes hours. This, in turn, requires the flattening of hierarchies. This is a lesson of both the 1993 World Trade Center bombing and the 9/11 attacks."
   Saving City Lifelines: Lessons Learned in the 9/11 Terrorist Attacks

10. **Realize There May Be Traffic Restrictions** – "Security considerations and traffic control may necessitate restrictions on private automobile use for months after a terrorist attack. Increased use of public transportation should be anticipated."
    Saving City Lifelines: Lessons Learned in the 9/11 Terrorist Attacks

5.3.1 Community Protection Incident Management Teams

1. **Have Incident Management Teams Work with Infrastructure and Utility Personnel** – "The Incident Management Team worked with infrastructure and utilities people to coordinate activities: planning evacuation routes, assuring access and egress, and restoring services. They brought local fire departments into the planning process, incorporating their extensive knowledge of the area."
   Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

2. **Realize There May Be Conflict Between Entities Regarding the Incident** – "The natural conflict between damage caused by suppression activities and protection of natural resource values required better coordination between fire managers, line officers, and natural resource specialists earlier in the planning process for community protection projects during the incident."
   Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

3. **Use Incident Management Teams for the Incident** – The **"**fire potential was so large that a Type 1 Incident Management Team was assigned the role of community protection for a mountain area far ahead of the fire. The Incident Management Team was to create a fuel break, and coordinate preparation and evacuation."
   Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

5.3.2 Unified Command and Liaison/Emergency Operations Center Integration

1. **Establish Liaison with Local Emergency Operations Centers Early** – "Establishing liaison with local emergency operations centers as early as possible was effective in coordinating the integration of initial attack resources from multiple jurisdictions."
   Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

2. **Establish a Co-Location with Law Enforcement and Other Agencies** – "Co-locating with law enforcement and other agencies was effective in coordinating effective evacuations in concert with incident strategy and tactics."
   Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

3. **Establish Pre-Selected Incident Command Post Locations** – "The fires were so large and fast-moving that agencies established unified command, first as collaborative action, then transitioned later to centralized command. Pre-selected incident command post locations and evacuation choke points for law enforcement were found helpful."
   Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

4. **Integrate Local Personnel into the Command Team Early** – "Many times, municipal and county fire leaders were not integrated into incident command effectively, losing valuable local knowledge. Success came from integrating municipal and county fire liaisons with decision-making authority into the command team early."
   Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

5.4 Communication

5.4.1 Agencies

1. **Establish Agency Notification Procedures** – Additional areas where interviewees identified a need for improvement was in the notification process. "Many responding agencies first heard of the incident via the media, and implemented emergency response plans based on these media reports. Agency-to-agency notification procedures could have been better managed. The one area where communications were relatively successful was public information. The media also provided a valuable service in providing information about the crisis."
   Effects of Catastrophic Events on Transportation System Management and Operations: Howard Street Tunnel Fire, Baltimore City

2. **"Establish Direct Lines of Communication with Non-Transportation Agencies** – New York City Transit staff was able to more quickly make the decision to evacuate the subway system. It is important for agencies to have an established communications protocol with agencies, such as the energy company, private providers of equipment, and emergency responders, before an event occurs to allow for smoother communications during an emergency."
Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout New York City

3. **"Establish or Strengthen the Communication Among Agencies** – For the New York region, the Transportation Operations Coordinating Committee collects and disseminates current transportation condition information to over 100 member agencies and affiliates."
Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout New York City

4. **Improve Communication and Include Law Enforcement** – "Conducting evacuations in stages so residents of multiple parishes aren't all leaving at once. A key will be to improve communication among local and state officials through a conference call with local officials that would focus solely on traffic issues. The committee's chairman, Senator Robert Barham, Republican-Oak Ridge, said emergency officials must do a better job of keeping local law enforcement officials up to speed on evacuation plans. 'I'm hearing sheriffs scream bloody murder, 'We're not in the loop as we should be,' Barham said. Colonel Henry Whitehorn, head of the State Police, said the department is working to fix the problem and said the agency is hoping to replace its communication system with one that would allow law enforcement officers from across the state to access the same information at once."
Times-Picayune Online: "Communication Called Storm Evacuation Key"

5. **Resolve Communication Differences** – "In general, communications between responding agencies were not as effective as might be desired. This was due in large part to the differences in guiding priorities as well as the fact that the Incident Commander was initially concerned only about fire suppression. The Maryland Transportation Authority helped to resolve this by providing a mobile command post with state-of-the-art communications capabilities that in turn were used by all parties."
Effects of Catastrophic Events on Transportation System Management and Operations: Howard Street Tunnel Fire, Baltimore City

5.4.2 Alternative Means

1. **Physically Deliver Messages If Necessary** – "In some instances, tunnel staff had to physically go to the radio stations with tunnel information because some stations were without phone service."
Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout Great Lakes Region

2. **Use Alternative Means to Communicate, Such as Fax Systems** – "In New York City, the Transportation Operations Coordinating Committee set up a fax broadcast list that grew to 400 public and private agencies."
Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

3. **Use Other Means to Communicate to the Public, Such as Handouts and Maps** – "Transportation officials in New York City implemented a similar multiple action strategy to disseminate information. Agencies used maps, handouts, and personnel to disseminate public information on the street. The

Metropolitan Transportation Authority reported printing and distributing 1.5 million each of 'take-ones' (one page handouts noting changes in service) and black and white maps in two 12-hour shifts after September 11."
Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

4. **Use Face-to-Face Meetings to Supplement Other Means of Communication** – "Face-to-face meetings were far more effective at resolving conflict under stressful conditions than relying on radio or telephone, especially at the tactical level."
Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

5.4.3 Alternative Technology

1. **Develop Alternate Communication Technologies** – "There are two parts to communications: communication technology—the physical ability to send and receive a message; and social communication—the content of the message. Communication technology disasters overwhelm telephone networks, [so] provide alternate communication methods, use the internet, consider interoperability of radio equipment, use mass media as an alternate means of communication."
Oklahoma City: Seven Years Later: Lessons for Other Communities

"New technologies provided communication alternatives that proved successful in the emergency response efforts for internal agency decisions. In both cities, agencies reported that interactive pagers that use push technology, such as the Blackberry pager, were extremely useful on September 11 when other forms of communication were unavailable."
Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

2. **Use Alternative Communication Technology, but Also Realize It May Be Inadequate** – "Use of cell phones allowed better communication; although, it was also spotty. Trucks going back and forth also allowed the passage of messages across either side of the border. The Detroit–Windsor Truck Ferry staff, while in radio communication with Canadian Customs, lost the ability to transmit information through their advanced notification and reservation system that normally facilitates the movement of cargo across the border."
Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout Great Lakes Region

3. **Use Email for Internal Communication** – "Internal e-mail, for example, helped Port Authority staff communicate internal decisions to the various divisions of the agency when telephone communications were difficult. Both New York City Transit and New Jersey Transit had 'mobile' communications centers (transit buses equipped with satellite and computer technology), which were used as command posts for communications and decision-making."
Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

5.4.4 Equipment

1. **"Explore the Option of Joining the Government Emergency Telecommunications Service and Wireless Priority Service** – Emergency situations typically generate significant demand for telephone services, often overwhelming the capacity available within the national telecommunications network. The Government Emergency Telecommunications Service (GETS) and the Wireless Priority

Service (WPS) are two government-sponsored priority communications systems that provide pre-approved users with priority routing of landline (GETS) and wireless (WPS) calls during times of emergency and crisis, even during periods of peak demand."
Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout New York City

2. **Remember to Reset Equipment When the Power Comes Back On** – "Communicating with the public was often misleading or problematic. When the power came back on, the signs displayed messages based on pre-blackout assumptions and reported inaccurate lane closures. In the future, one transit provider is going to budget for purchasing commercial airtime for emergency announcements, as the public service announcements were not sufficiently informational."
Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout Great Lakes Region

5.4.5 Information Management

1. **Be Able to Activate the Emergency Alert System Early** – "Areas that activated the emergency alert system early were able to provide information to residents and facilitate evacuation planning more efficiently than those areas that waited to use the emergency alert system until later."
Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

2. **Be Prepared for Loss of Communication** – "Loss of communication capabilities was the single most consistent finding involving most of the Great Lakes agencies. Immediate lack of information was one reason everyone persisted in trying to leave work and get home, without realizing that all traffic signals were blackened, and gridlock was sure to ensue."
Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout Great Lakes Region

3. **Develop Convenient Communication Tools** – "[Develop] more convenient tools to communicate with each other."
Reverse Lane Standards and ITS Strategies Southeast United States Hurricane Study: Technical Memorandum Number 1: Final Report

4. **Ensure the Ability to Communicate** – "Communications technology was identified repeatedly as one of the weak points during the event. Cellular communications historically are poor in the area where the incident occurred. Connections were hampered further by the large number of people—motorists, police officers, firefighters, and Maryland State Highway Administration staff—trying to use their cell phones. Fire and police have an alternative—their 800 megahertz radios—but those airwaves, too, were jammed early in the response, and some of the key leaders did not have radios available immediately. Over time, the responders established small workgroups with each assigned specific radio channels for better connections."
I-95 Shutdown: Coordinating Transportation and Emergency Response

5. **Ensure Clear Communication** – "Warnings need to include information about the hazard, its location, what action people should take, when they need to do it and the source of the warning. It needs to be specific, consistent, certain (if something is not known it should be stated), clear and accurate. Several organizations can make a joint announcement. Information needs to be provided quickly for things that can kill or incapacitate them."
Homeland Response, "Evacuation: What We Can Learn—and Cannot Learn—from Hurricanes"

6. **Establish Emergency Communications SWAT Team** – "The members of this team would be trained in crisis communications and would serve to facilitate, not stem, the flow of information."
   Firestorm 2003: Provincial Review

7. **"Establish a Non-Communications Plan** – Because communication failures can and often do occur during the critical first minutes of an emergency, agencies should consider establishing emergency plans that do not depend on the communication of instructions. New Jersey Transit has designed emergency bus operations that its drivers know to implement in the event of an emergency. The New York Police Department, as a matter of routine, provides officers during the roll call with designated locations to cover in the event of an emergency."
   Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout New York City

8. **Keep Updated Paper Contact Lists** – Have a minimum of three contacts and share the lists outside the agency.
   Center for Urban Transportation Research, University of South Florida, Presentation to 4th Annual FDOT/FPTA/CUTR Professional Development Workshop

9. **Provide Up-to-Date Information and Inform Others** – "[During] social communication, avoid jargon, keep your workers informed, communicate among agencies; nothing will serve you better in the early stages of a disaster than comprehensive and up-to-date contact information."
   Oklahoma City: Seven Years Later: Lessons for Other Communities

10. **Realize "A Multimedia Approach to Communications Is Required** – Operators must be prepared for huge volumes of traffic on Web sites and able to provide vast quantities of printed material."
    Saving City Lifelines: Lessons Learned in the 9/11 Terrorist Attacks

11. **Understand Communications Can Be Difficult During the Incident** – "In New York City, and to a lesser extent Washington, DC, immediate communication with agency field staff and emergency responders was difficult because telephone landlines were damaged and cellular communications systems were overloaded."
    Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

5.4.6 Internal

1. **Keep Employees Informed** – "In retrospect, SA d'Economie Mixte des Transports Publics de Voyageurs de l'Agglomeration Toulousaine management said they had learned the following lessons: 'employees must be kept informed on a continuous basis.'"
   Synthesis of Transit Practice 27: Emergency Preparedness for Transit Terrorism

2. **Keep Families of Employees Informed** – In retrospect, SA d'Economie Mixte des Transports Publics de Voyageurs de l'Agglomeration Toulousaine management said they had learned the following lessons: "Families of employees must be included in the information flow and counseling."
   Synthesis of Transit Practice 27: Emergency Preparedness for Transit Terrorism

3. **Realize "Administrative Staff Can Be Effectively Employed as Front-Line Communicators** – This worked well in a city where many people use public transportation, but cities in which private automobile use is more common would face different problems. Circumstances in which persons

unaccustomed to using public transportation were suddenly forced to do so would require additional efforts."
Saving City Lifelines: Lessons Learned in the 9/11 Terrorist Attacks

5.4.7 Joint Information Center

1. **Develop a Joint Information Center** – "Where a joint information center was established, it had a positive effect on the timeliness and quality of the information campaign in the wildland-urban interface environment.

   These incidents received international attention, and the need for an information campaign reached a threshold much larger than any one agency could manage effectively. The joint information center combined the people and unique strengths of different agencies public affairs staffs.

   On several incidents, the information effort remained defensive. The joint information center allowed a unified message presented to the public and the media. The joint information center could communicate key fire management issues (the use of air tankers, the need for defensible space) and address these issues proactively through public information while fires held the public's attention."
   Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

2. **Develop a Joint Information Center Ahead of Time** – "Having a joint information center plan in place ahead of time was effective. Respondents identified the further need to pre-identify joint information center staff and expanded joint information center staff, and identify potential joint information center locations in the area."
   Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

3. **Develop Joint Information Center Locations Throughout Community** – "Develop pre-identified and pre-designated Joint Information Center locations throughout the County, a properly staffed Joint Information Center can provide timely, quality information to the community, public and the media, large fires receive national and international attention and the information requests exceed the ability of a single agency, a Joint Information Center can provide a unified message to the community, public and the media, a Joint Information Center can be used to dispense pro-active fire prevention messages through out the year."
   San Bernardino County Fire Chiefs' Association: Lessons Learned Report: Fire Storm 2003: "Old Fire"

5.4.8 Media

1. **Centralize Information to the Press** – "Other actions that facilitate success and can be adopted routinely in any large-scale operation include identifying the public information officers and a lead spokesperson to centralize the messages delivered to the press. The regular meetings of unit leaders kept everyone at the scene informed and marginalized information coming from multiple directions."
   I-95 Shutdown: Coordinating Transportation and Emergency Response

2. **Develop Ongoing Relationships with the Media and the Community** – "Ongoing contact programs made relationships with the community and the media more effective and efficient."
   Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

3. **"Establish Communications Relationships with Various Media Outlets** – Most of the public turn to the media (television, radio, or the Internet) to gain information during an emergency. Several

transportation agencies were frustrated on August 14 because they had difficulty getting the proper information to the media and the media was reporting inaccurate information."
Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout New York City

4. **Use the Media to Your Advantage—Determine Who Says What** – "You cannot over-plan for dealing with the media. Plan for a credentialing system, determine who says what, set a schedule for media briefings, use media to your advantage."
Oklahoma City: Seven Years Later: Lessons for Other Communities

5.4.9 Phone Service

1. **"Maintain Reliance on 'Old Technology,' Such as the 'Plain Old Telephone System' (POTS) and Portable Radios** – Low-tech options are sometimes more reliable. Some agencies found that text messaging was particularly effective for maintaining a communications link between the central office and maintenance people in the field. One of the problems with the blackout was that people did not have access to radio and TV. Only people with battery-operated radios in their homes were able to access any information. There are two options being considered in Cleveland as a potential solution to getting information to the public in times of emergencies. Reverse 911®, an automated telephone emergency broadcast system, is the first option. The second is a citywide or countywide highway advisory radio in the Cleveland area."
Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout Great Lakes Region

2. **Realize Cell Service May Be Spotty** – "During a previous disaster, the 1989 Loma Prieta earthquake in San Francisco, transportation officials found that cell phones proved to be invaluable as radio communications were damaged. As a result, California officials came to rely more on cell phone technology over radio. But because of the location of the Northridge earthquake, cell phone communications in the canyon areas was intermittent due to terrain and limited coverage, and the California Department of Transportation has now also incorporated satellite and radio communications to its system."
Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

3. **Realize Phone Service May Be Difficult** – "Communications immediately after the Northridge earthquake was difficult for both emergency workers and residents. Power was out for most of the area, which affected the operation of the central phone system."
Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

5.4.10 Public Education

1. **Develop a Public Education Program** – "A cooperative public education program is needed to inform residents about the risks of living in the wildland/urban interface and their personal responsibilities in preparing for and responding to interface fires. This should include the preventative and protective measures they can adopt to make their lives safer."
Firestorm 2003: Provincial Review

"This education campaign must inform residents about the risks and their responsibilities in planning and preparing for and responding to interface fires. The campaign should be delivered to school

children as well as adults. Municipal and regional governments should regularly distribute educational materials to residents. Insurance agents should distribute educational materials with each policy renewal of a dwelling."
Firestorm 2003: Provincial Review

2. **"Educate the Public About Contra Flow"**
A Study of the Impact of Nine Transportation Management Projects on Hurricane Evacuation Preparedness

3. **Educate the Public on Evacuation Routes** – "Educating the public on evacuation routes and distributing zone-specific maps so people can find the best way to evacuate from their homes."
Times-Picayune Online, "Communication Called Storm Evacuation Key"

4. **Increase Public Understanding of the Evacuation Process** – "The province should target greater resources at ensuring better awareness by the public about the stages of evacuation, including the procedures to be followed during an evacuation and after the lifting of the fire risk. The procedures and powers of the police should be clarified and the permit reentry process standardized so that all affected responders, evacuees, media, and others understand the process, its logic, and the location of the permit-issuing authority."
Firestorm 2003: Provincial Review

5. **Provide Better Education to the Public Regarding Their Vulnerability** – "Four important points with regard to understanding the public's response. (1) Evacuation orders are the most effective means for evoking a response from the public, as long as they are heard and understood by those who need to respond. (2) People must understand their own personal vulnerability. One problem is that the public tends to underestimate high risks and overestimate low risks, as evidenced during Floyd. (3) We need to tell and convince people they need to only go a certain distance to be safe. (4) We need to understand and use the public's sources of information to disseminate information. Recommendations for the future include: better education of the public regarding their vulnerability; wording evacuation notices to ensure they are not misinterpreted and effectively disseminating them, telling people what to do and why and not forgetting those who didn't leave but should have."
The Legacy of Hurricane Floyd—Inland Flooding and a Massive Evacuation

6. **Realize Homeowners Should Know Their Evacuation Routes – "**Homeowners should accept their obligations, preparing to evacuate if required during an interface fire emergency. This includes knowing where the evacuation routes are."
Firestorm 2003: Provincial Review

5.4.11 Public Notification

1. **Communicate the Need to Evacuate or Not to Evacuate –** People who do not need to evacuate and do so crowd the roads unnecessarily. Other people who may need to evacuate do not.
Miami Herald, "Are We Prepared for the Next Andrew?"

2. **Communicate Timely Information –** "[Communicate] timely information at all levels concerning road closures, road conditions, weather, expected travel times, incidents, lane closures, and availability of alternative routes."
Reverse Lane Standards and ITS Strategies Southeast United States Hurricane Study: Technical Memorandum Number 1: Final Report

3. **"Consider [the] Use of an Automated Public Information System** to provide a voice-mail telephone system to relay consistent and trusted messages to the public."
   Compendium: Graduate Student Papers on Advanced Surface Transportation Systems: Application of ITS Technology to Hurricane Evacuation Routes

4. **"Consider [the] Use of a World Wide Web Site** that contains both general and real-time information."
   Compendium: Graduate Student Papers on Advanced Surface Transportation Systems: Application of ITS Technology to Hurricane Evacuation Routes

5. **"Consider [the] Use of Traveler Information** kiosks at key places such as rest areas along evacuation routes."
   Compendium: Graduate Student Papers on Advanced Surface Transportation Systems: Application of ITS Technology to Hurricane Evacuation Routes

6. **"Use a Public Information Coordinator** who provides information to the media. Use law enforcement officers with sirens and public announcement systems as needed."
   Compendium: Graduate Student Papers on Advanced Surface Transportation Systems: Application of ITS Technology to Hurricane Evacuation Routes

7. **Develop Convenient Public Communication Tools –** "[Develop] more convenient tools to communicate with the public."
   Reverse Lane Standards and ITS Strategies Southeast United States Hurricane Study: Technical Memorandum Number 1: Final Report

8. **Keep the Public Informed Through Use of a Public Information Campaign –** "To better disseminate updates and status reports on the transportation impacts of the Northridge earthquake, the California Department of Transportation implemented an extensive campaign to keep the public informed. Cooperating with Los Angeles Department of Transportation and the California Highway Patrol, they produced about 200 each of Los Angeles County road closure reports and special bulletins. In addition, they distributed over 2.6 million copies of *Accelerate, California Department of Transportation's Action Plan to Get All our Freeways Moving Again*."
   Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

   "Keeping the public informed requires a multimedia, high-volume effort. Deploying administrative staff to be front-line public information officers was especially effective during the 9/11 crisis and would be essential in cities where the population is not accustomed to using public transportation. The emergency public information function is an essential element of the National Incident Management System (NIMS), established by Homeland Security Presidential Directive/Homeland Security Presidential Directive 5 on February 28, 2003."
   Saving City Lifelines: Lessons Learned in the 9/11 Terrorist Attacks

5.4.12 Radio

1. **Achieve Emergency Radio Interoperability –** "Develop and implement a provincial strategy for emergency communications technology focused on moving over time to total interoperability across agencies throughout the province."
   Firestorm 2003: Provincial Review

"A provincial strategy for emergency communications technology is required to achieve total radio interoperability between all agencies. It should include a provincial inventory for all fire, police, ambulance, and forestry radio frequencies."
Firestorm 2003: Provincial Review

2. **If Using Ham Radio Operators, Have Enough Ham Radio Operators to Provide Communication –** "Remember, two operators is a minimum. You will likely be running 24 hour operations—for every location you will need six to ten operators per day! If you don't have an operator at the site, everyone will be in the dark. But getting operators through police lines is now a major issue.

   Hospitals continue to be a major oversight of amateur radio operators. Hundreds of relatives will go there if there are widespread injuries. Hospital communications is one of the first areas to break down, yet one of the last to be manned. If you have a disaster, every major hospital must be staffed—even if it is just on speculation."
   Hot Bananas: Oakville, Canada Amateur Radio Club Monthly Newsletter, "Canada's Largest Evacuation"

3. **Include Amateur Radio Operators in Emergency Response –** "All Emergency Operation Centers should include a provision for amateur radio operators, including power and antenna space, in case they are needed."
   Firestorm 2003: Provincial Review

5.4.13 Strategy

1. **Develop a Communication Strategy and Include All Stakeholders –** "There should be a provincial strategy for public major emergency events. The strategy should include the participation of all key stakeholders, especially the news media."
   Firestorm 2003: Provincial Review

2. **Develop a Crisis Communications Strategy –** "Include the participation of all key stakeholders including the media. Establish clear principles and protocols about the release of information. Identify how the media and the Internet can be used in times of emergency as a technical resource and to disseminate information to the public."
   Firestorm 2003: Provincial Review

3. **Develop a Historical Record –** Keep a record and journal of events in order to provide a log of historical events. Tell the "story of public transit services importance and role in emergency events. Take pictures."
   Center for Urban Transportation Research, University of South Florida, Presentation to 4th Annual FDOT/FPTA/CUTR Professional Development Workshop

5.4.14 Systems Interoperability

1. **Ensure Interoperable Communications Equipment –** "The 800 MHz communications system is not compatible with the VHF and UHF systems, lack of communications caused command and control to be severely disrupted and firefighter safety was jeopardized, face-to-face meetings provided a reasonable effective means to resolve the part of the communication issue, but did not allow Group Leaders to stay in communication with subordinates, command vehicles with VHF and UHF radios allowed leaders to be more effective than those without, the use of cell phones was somewhat

effective in resolving communications problems; but they were unreliable if power failed or cell towers burned, some cell phone networks became overloaded, which prevented calls, and some Units had Handi-Talkies but did not know how to program them."
San Bernardino County Fire Chiefs' Association: Lessons Learned Report: Fire Storm 2003: "Old Fire"

"The lack of interoperability between the communication systems of different agencies was a major obstacle to inter-agency cooperation during the blackout."
Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout Great Lakes Region

2. **Realize Equipment Can Become Critical –** "Because of the radio incompatibility, municipal and county department command vehicles with VHF capability allowed leaders to be far more effective than those without."
Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

3. **Realize Normal Workarounds Can Be Insufficient –** "Because the 800 MHz municipal and county communications system is not compatible with the state and federal VHF systems, command and control was severely disrupted and firefighters faced dramatically increased risk because of communications problems. Normal workarounds for incompatible communication systems were not sufficient for these incidents."
Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

4. **Use Creative Ways to Communicate When Systems Are Not Interoperable –** "Leaders began running incoming resources through a choke point to brief and pair or cross level communications so that each division or group supervisor, crew leader, or strike team leader could reliably communicate."
Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

   "Cell phones were effective in overcoming communications problems because of the complete coverage in the region but were unreliable when power failed or cell towers burned. Some cell networks were overloaded, preventing calls."
Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

5. **Use Face-to-Face Communication When Necessary When Systems Are Not Interoperable –** "Face-to-face coordination was the most effective means to resolve problems in the absence of communication interoperability, but had a direct impact on leaders' abilities to stay in communication with subordinates."
Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

5.4.15 Traveler Information

1. **Provide Lodging Information –** "Of particular interest to evacuees is the location of available lodging. Long-range traffic information—Due to the rural area and large spacing between interchanges, the evacuees will need to be informed of traffic conditions many miles upstream."
ITE Journal, "Implementing ITS for Hurricane Evacuations in Florida"

5.5 Cooperation

1. **"Practice Cooperation During Normal Times –** One interviewee noted that its long-standing rivalry with another agency made it almost impossible for the two to collaborate in even a basic way; although, their collaboration might have eased congestion during the blackout period."
   Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout Great Lakes Region

2. **Practice Interagency Cooperation –** "Strong interagency cooperation practiced by many agencies in southern California had a direct, positive impact on the ability to manage these incidents."
   Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

3. **Use an Incident Command System to Facilitate Cooperation –** "The Incident Command System was rated invaluable as the common doctrine to facilitate interagency cooperation and establish and exercise effective unified command."
   Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

5.6 Coordination

1. **Be Able to Activate Mutual Aid –** "The Department must improve its ability to assess the needs of the rest of the city during major incidents and deploy necessary resources to meet those needs. Among other operational needs, the Department should have a formal, flexible procedure for recalling off-duty firefighters and for activating mutual aid from agencies in surrounding areas."
   Increasing (Fire Department of the City of New York) FDNY's Preparedness

2. **"Conduct a Collaborative Post-Incident Review –** Following any kind of emergency, it is vital that the partner agencies that worked together to respond to the emergency find a way to review and evaluate their performance and cooperation during the emergency."
   Effects of Catastrophic Events on Transportation System Management and Operations—August 2003 Northeast Blackout—Great Lakes Region

3. **Develop Better Coordination**—"[Develop] better coordination between various evacuation agencies [such as transportation, law enforcement, and emergency management agencies] at the local, county, multi-county, and multi-state levels during an emergency."
   Reverse Lane Standards and ITS Strategies Southeast United States Hurricane Study: Technical Memorandum Number 1: Final Report

4. **"Establish Emergency Procedures That Will Be Easy and Efficient to Implement –** Some agencies reported encountering unexpected obstacles in the implementation of their emergency procedures, particularly obstacles centered on multi-agency coordination. Multi-agency response requires pre-planning that will establish clear chains of authority during emergencies."
   Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout Great Lakes Region

5. **"Establish Internal Coordination –** Internal coordination is essential for all agencies, but especially for those with many different operating entities. For example, during the blackout, staff within the Connecticut Department of Transportation's highway, transit, commuter rail, and airport divisions were in constant contact. Personnel had previously become familiar with each other through day-to-day operations and joint terrorism exercises."

Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout New York City

6. **Provide a Coordinated Public Information Campaign –** "The Mayor's office coordinated press conferences, which included transportation updates. Agencies utilized radio, TV, and newspapers to relay information on the changing conditions. Highway advisory radio broadcasts by INformation FOR Motorists and other transportation agencies in the New York City area gave up-to-date traveler information, and news stations ran INformation FOR Motorists and Transportation Operations Coordinating Committee reports on the morning and afternoon news shows. The Metropolitan Transportation Authority reported 10 million hits on its Web site in one day, five times the normal volume, one day after September 11 as people tried to obtain up to date information on conditions."
Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

7. **Realize Staff Need to Understand Their and Each Others Respective Roles –** "Transportation agencies typically have staff at multiple locations with multitudes of varying responsibilities. The Port Authority of New York and New Jersey, for example, operates tunnels, bridges, transit lines, airports and water ports within the New York/New Jersey region. The California Department of Transportation oversees a state highway system of 25,000 kilometers in length and has a staff of over 23,000 employees with 12 district offices located throughout the state. It is important that each of the different parts of an agency understand the scope of an emergency involving transportation and the agency's intended coordinated response."
Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

8. **Understand That Lack of Communication Among Entities Can Be Counter-Productive –** "Washington, DC had additional communication problems. There was no communication to Virginia Department of Transportation from agencies in DC, including the National Park Service and District of Columbia Division of Transportation, regarding transportation facility closures that affected traffic volumes into Virginia, although requests were made. This put Virginia Department of Transportation in a reactive mode.

   As one example, there was no communication between the Virginia Department of Transportation center in Northern Virginia, responsible for traffic operations in the area, and Washington Metropolitan Area Transit Authority, the region's transit provider. So in Northern Virginia, the local Smart Traffic Center reversed high occupancy vehicle lanes to facilitate movement of southbound traffic out of the District, thus preventing the use of these facilities as a route for Metrobuses to return to the District to pick up more transit-dependent travelers."
   Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

9. **Understand That Lack of Institutional Coordination Can Hinder the Process –** "The lack of existing institutional coordination was evident in several cases in Washington, DC. These examples of poor emergency coordination might be the result of the lack of day-to-day coordination among the agencies. As an example, at 10:46 a.m. on September 11, the Metropolitan Police Department requested that Metrorail cease operations due to the uncertainty of events. But Metrorail officials declined the request and decided to continue operations to aid in the evacuation of people leaving the city.

   At about the same time, both the Secret Service and the military were closing roads considered at risk, but the closures were not announced through any central coordinating agency like the Transportation

Operations Coordinating Committee in New York. In addition, the failure to coordinate the release of federal workers, such as would occur during a weather related incident, resulted in an unanticipated rush of commuters just as the region's transportation system was ending its morning peak rush service patterns."
Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

10. **Understand Rumors Can Be a Problem –** "Rumor control can be a real problem when trying to assure the public of the safety of facilities or the need to close certain facilities. This was certainly a problem across the country on September 11 as people were uncertain if there would be additional terrorist attacks. In Washington, DC, rumors of the closing of the Metrorail service kept many people out of the subway and instead on the street, which were congested by motorists trying to leave the city."
Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

11. **Use Both Internal and External Coordination –** "By their very nature, disasters require a coordinated response among multiple federal, state, regional, and local jurisdictions. This coordination needs to occur at several layers simultaneously: internal agency coordination and external coordination with other agencies as well as the public."
Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

12. **Use "Technology to Enhance Institutional Coordination –** Several agency representatives identified the lack of interoperability between the communication systems of different agencies as a major obstacle to inter-agency coordination during the blackout. Other interviewees discussed the importance of having pre-established modes and protocols of communication—telephone, fax, or Internet—for agencies to contact each other during emergencies, with particular attention paid to ensuring redundancy in the systems."
Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout Great Lakes Region

5.6.1 Agencies/Private Sector

1. **"Allow for a Multi-Agency Response to Any Type of Emergency as a Part of an Emergency Response Plan –** Representatives of several agencies in Cuyahoga County in Ohio, for instance, established a multi-agency response center in the early period of the blackout."
Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout Great Lakes Region

2. **"Cooperate Across Agencies to Share Resources and Equipment –** Emergency equipment can be costly to purchase and store, and agencies cannot always predict what sorts of equipment they will need during an emergency. The establishment of mutual aid agreements in advance of an emergency can make it possible for agencies and communities to share equipment as necessary and possible."
Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout Great Lakes Region

3. **Coordinate with Law Enforcement to Speed Up Evacuations –** "Fire resources were significantly slowed moving through evacuation areas until routes were cleared. Early coordination with law

enforcement as soon as the potential to evacuate was recognized was critical in preserving freedom of movement for fire resources."
Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

4. **Incorporate Evacuee Agencies into the Planning Process –** "Incorporating agencies that manage evacuees into the interagency planning process was effective in ensuring a smooth handoff from firefighters and law enforcement to supporting agencies like the Red Cross."
Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

5. **"Include the Private Sector [in Coordination Efforts] –** Through a memorandum of understanding between New Jersey Transit and private carriers, private fleets were available to assist in the movement of stranded commuters. New Jersey Transit staff had to work with other public sector agencies to ensure that the private carrier vehicles were granted access to the tunnels into Manhattan. As a result of the blackout, staff at New Jersey Transit and the Port Authority have agreed to coordinate with private carriers when implementing emergency response plans. In particular, Port Authority staff will coordinate with the long-haul carriers that operate out of their bus terminal. Some executives noted that there has to be more coordination with the public utilities."
Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout New York City

6. **"Involve Law Enforcement Agencies and Other Non-Traditional Agencies –** Members of several staffs from transportation agencies stressed the need to develop working relationships with others from agencies not considered transportation agencies. Bridges and Tunnels staff worked with the New York Police Department to manage traffic; the two agencies were in almost constant contact via the telephone and radio. Within a half hour's notice, Bridges and Tunnels crews modified traffic patterns on some of their facilities to accommodate buses trying to enter Manhattan. They reversed one lane so that there would be three lanes in and one out, rather than two in each direction. The Port Authority staff contacted an extremely 'non-traditional' player. They requested light towers from the New Jersey National Guard."
Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout New York City

7. **Use of a Multi-Jurisdictional Planning Organization Before the Incident Was Successful –** "The Mountain Area Safety Taskforce (MAST) was a very successful template for multi-jurisdictional planning in the interface. MAST planning was estimated to have cut two to three days off the time it took to establish effective unified command. Information is available at www.calmast.org.

   The MAST functioned using the Incident Command System in a unified command. This proved to be an effective rehearsal for the real thing. Tabletop rehearsals of evacuations were very effective in facilitating live evacuations.

   The MAST was an effective vehicle for distributing training and local knowledge to participating agencies.

   The MAST was effective at accomplishing projects by planning projects with the input of environmental and infrastructure agencies."
   Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

8. **Work "Closely with State and Local Emergency Management Centers –** During an emergency, the States of New York and New Jersey and New York City open emergency management centers.

Several interviewees highlighted that working closely with the staffs at these centers produced positive results."
Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout New York City

5.6.2 Relationships

1. **Be Able to Communicate with Other Entities, Have Pre-Established Relationships –** "Just as important as being able to communicate an agency's coordinated response internally, is the need to be able to communicate with outside agencies, both public and private. The pre-existence of well-established interagency relationships among the many transportation and emergency personnel in New York City was one of the most important success factors in managing the post-event situation.

   The agencies built working relationships through their day-to-day coordination. As one official remarked, they view the management of each daily commute as an event that relies on the coordination of officials from transportation agencies, fire, police, and the news media."
   Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

2. **"Be Aware of the Importance of Individual Relationships –** As important as official institutional emergency response plans and procedures are, the value of individual relationships was cited over and over again by the interviewees."
   Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout Great Lakes Region

3. **"Build on External Relationships with Other Transportation Agencies –** Interviewees stressed that coordination with other transportation agencies is essential. Throughout the blackout, all agency staffs were seeking traffic information and providing the information they had to others. The Transportation Operations Coordinating Committee staff tried to ensure that its member agencies and other parties had the most current information available."
   Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout New York City

4. **"Determine What Problems Are Not Solved by Strong Relationships –** The issue of transit agencies honoring tickets and passes from other transit agencies was raised. There was no uniform approach among the agencies. Some honored the tickets and passes, while others did not. Furthermore, some agencies suspended fares, while others continued to charge them. Interviewees noted that they are working to develop a consistent policy for suspending fares and cross-honoring passes and tickets of other agencies."
   Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout New York City

5. **Develop Strong Interpersonal Relationships with Other Entities –** "The primary key to success, however, was not a specific act on the night of the incident. 'Our success was marked by the rapport and relationships previously established among the police and fire departments, Maryland State Highway Administration personnel, medics, and engineers. All the personnel acted in the spirit of collaboration and partnership,' says Sergeant [Rick] Vecera [of the Maryland State Police].

   Professional training, cross-jurisdictional workgroups, and planned events in the area offer traffic management personnel numerous opportunities to work together under less pressing conditions.

When strong interpersonal relationships are supported by the appropriate technologies and pre-established response routines, the result is a comprehensive system on ready alert, nearly invisible to citizens but significant in its capabilities."
I-95 Shutdown: Coordinating Transportation and Emergency Response

5.7 Emergency Plans

1. **Develop Emergency Plans –** There is an "importance of an emergency plan for restoring the public trust, noting that the average citizen watching television on 9/11 was heartened by the obvious competence and courage of front-line service personnel (police, fire, rescue workers, environmental protection workers). The public was also impressed by the quick flow of disaster workers to New York City from all over the country. This happened because plans were in place: New York City had a plan; the State of New York had a plan; and the Federal government had a plan."
California Transportation Security Summits, March 28 and 29, 2002

2. **Make Local Emergency Plans Mandatory –** "Plans should be in a standardized format/template consistent across the province, and be made consistent with provincial plans. Plans should be developed from an 'all hazards' perspective. Plans must be practical and comprehensive, and plans must include mandatory mutual aid agreements among municipal and regional districts. Plans must incorporate clear obligations and personal responsibilities of residents living in interface fire hazard areas. Plans must have a communications element that incorporates local media into the disaster response effort."
Firestorm 2003: Provincial Review

3. **Recognize That Equipment May Not Be Available –** In retrospect, SA d'Economie Mixte des Transports Publics de Voyageurs de l'Agglomeration Toulousaine management said they had learned the following lessons: "Emergency plans must assume that computers will not be available."
Synthesis of Transit Practice 27: Emergency Preparedness for Transit Terrorism

4. **Test the Emergency Plan Using Small Planned Events –** Consider using contingency planning "for small planned events (a scheduled mass demonstration, sporting events) as exercises to test an agency's ability to handle a larger, unplanned emergency. These events allow agencies to practice working together, update communications plans (phone numbers and radio frequencies) and build trust with each other and the media. Adding that using special events or celebrity visits as practice exercises, allows staff members from different agencies to get acquainted on a face-to-face basis, so that in an emergency people will know whom to call. 'They will have confidence in each other because they have worked together in the past.'"
California Transportation Security Summits, March 28 and 29, 2002

5.8 Evacuations

5.8.1 Dispatch Organization

1. **Conduct Contingency Planning for Dispatch –** "One center had conducted contingency planning for power requirements, phones, and computer networks so that when expanded dispatch was required, everything could be set up and ready to go in modular units."
Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

2. **Have Dispatchers Cross-Train –** "Interagency cooperation significantly increases the ability to adapt and respond to a crisis. Conflicts had already been worked through and improvements implemented by the time the crisis occurred. Dispatchers had cross-trained in other agency dispatchers' duties on previous fires."
   Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

3. **Include Evacuation of Dispatch Center in Contingency Planning –** "Dispatchers said a lesson learned was that their center's contingency planning should include total evacuation and temporary operations at a remote location."
   Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

4. **Orientate Non-Local Dispatchers to the Local Area –** "The large number of dispatchers coming in to assist from outside the area made it important that staff from outside the area has an adequate orientation and access to local maps and information."
   Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

5. **Realize Dispatchers May Need to Have Minimum Distractions –** "The huge increase in activity and distractions at dispatch centers posed a safety threat to resources (due to dispatcher distraction) and delays in ordering. Dispatchers compartmentalized key functions to minimize distractions."
   Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

5.8.2 Evacuation Decision Making

1. **"Consider Use of a GIS Database Management System Model** to enhance evacuation operations by predicting the spatial and temporal characteristics of a region depending on the time of day an evacuation is issued."
   Compendium: Graduate Student Papers on Advanced Surface Transportation Systems: Application of ITS Technology to Hurricane Evacuation Routes

2. **"Use Available Tools to Aid the Decision to Evacuate**, for example, the National Oceanic and Atmospheric Administration Weather Radio; Emergency Alert System, Sea, Lake, and Overland Surges from Hurricanes; Emergency Managers Emergency Information Network; and HURRicane EVACuation program."
   Compendium: Graduate Student Papers on Advanced Surface Transportation Systems: Application of ITS Technology to Hurricane Evacuation Routes

5.8.3 Evacuation Management

1. **Be Prepared to Adjust Thinking –** "The values at risk in these fires placed firefighters in new risk and decision-making territory that current wildland firefighting doctrine and training have not necessarily prepared them for. Firefighters had to adjust their thinking to triaging city blocks and whole neighborhoods."
   Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

2. **Communicate with People Who Did Not Evacuate –** "Communicating with and involving residents who decide to stay behind were effective ways to mitigate the danger and distraction they presented to firefighters. It was important not to use language like "loser" to triage when residents could overhear."
   Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

3. **"Efficiently Utilize the Available Capacity to Reduce the Potentials for Operational Failures During Evacuation –** For example, review and terminate work zone closures where possible along the evacuation routes to maximize capacity of these routes and use transit services to the extent possible to optimize the use of available capacity. Operational failures can cause gridlock, long hours of delays, vehicle breakdowns, frustrated travelers, and significant risks to the evacuees."
   Disaster Response and Evacuation User Service: An Addendum to the ITS Program Plan

4. **"Ensure the Efficient, Safe, and Secure Reentry of the Evacuees to Their Counties –** This includes preventing unauthorized people from entering a disaster area, clearing dangerous debris, and restoring electricity. The reentry decisions must balance safety and security with the public's desire to return home."
   Disaster Response and Evacuation User Service: An Addendum to the ITS Program Plan

5. **Establish and Communicate Clear Engagement Criteria –** "There were incidents where engagement criteria concerning the increased values at risk did not reach the tactical level. A lack of clear engagement criteria concerning residents who would not evacuate led to firefighters placing themselves in extreme risk situations."
   Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

6. **"Improve the Efficiency of Detecting, Responding to, and Clearing Incidents on Evacuation Routes –** The drop in evacuation route capacities due to incidents could result in the failure of the evacuation process, even if the analysis performed during evacuation planning indicates that the routes can accommodate the traffic in non-incident conditions."
   Disaster Response and Evacuation User Service: An Addendum to the ITS Program Plan

7. **"Improve Management of the Evacuation Process –** Strategies to reduce the demand must be considered including identifying shelters near evacuation origins, increasing the use of transit, and evacuating in shifts rather than all at once."
   Disaster Response and Evacuation User Service: An Addendum to the ITS Program Plan

8. **"Improve Management of Evacuation Routes –** In order to accommodate evacuation for events of various severities ranging from small localized flood evacuations through large-scale weapons of mass destruction evacuations evacuation routes must be efficiently managed."
   Disaster Response and Evacuation User Service: An Addendum to the ITS Program Plan

9. **"Improve Management of Evacuation Termination under Emergency Circumstances –** This includes decision support to determine when to terminate an evacuation; communication of salient emergency public information to motorists; and roadway management including interchange shutdown, traffic diversion, and the opening of 'refuges of last resort' or other safe havens."
   Disaster Response and Evacuation User Service: An Addendum to the ITS Program Plan

10. **"Improve Management of the Local Streets that Provide Access to and from Evacuation Routes –** The capacity of these streets should be increased and efficiently used to prevent creating bottlenecks at the access points. In recent evacuation operations, queues from surface streets extended to limited access facilities, resulting in a decrease in the capacities of evacuation routes."
    Disaster Response and Evacuation User Service: An Addendum to the ITS Program Plan

11. **"Improve the Warning and Preparation Information Provided to Evacuation Destinations –** Evacuee traffic information can be used by transportation management at the destination to pre-configure their systems to anticipate and better handle the increased demand."
    Disaster Response and Evacuation User Service: An Addendum to the ITS Program Plan

12. **"Maintain Emergency Services Access to the Disaster Area and the Evacuation Routes Themselves –** Provide for and manage emergency service access routes in the opposite direction and/or across the major evacuation routes where necessary."
Disaster Response and Evacuation User Service: An Addendum to the ITS Program Plan

13. **"Provide Shelter-in-Place Information and Use Transportation Resources to Expedite Relief –** When evacuation is not possible because little to no warning is provided and transportation resources are limited or severely impacted, shelter-in-place information and use of transportation resources must be provided to the endangered population."
Disaster Response and Evacuation User Service: An Addendum to the ITS Program Plan

5.8.4 Evacuation Plans

1. **"Coordinate [Evacuation] Plans That Cross State Lines"**
A Study of the Impact of Nine Transportation Management Projects on Hurricane Evacuation Preparedness

2. **Use Evacuation Data for Evacuation Plans –** "[Plan for] data collected and archived for the development of future evacuation plans and to ensure the validation of models used in developing plans."
Reverse Lane Standards and ITS Strategies Southeast United States Hurricane Study: Technical Memorandum Number 1: Final Report

5.8.5 Evacuation Procedures

1. **Close the System Down When Necessary –** "The Tokyo attack was exacerbated by the unwillingness of transportation officials to close the system down; the trains kept running, exposing more and more people to the toxic agent."
California Transportation Security Summits, March 28 and 29, 2002

2. **Delegate Authority Levels Down –** "Training exercises for a variety of emergencies had proved that even low level transit employees must be given the authority to make on-the-spot decisions. So when the tower [World Trade Center—9/11 New York City terrorist attack] was hit, the station manage did not call up the chain of command. Instead, he pulled out a card in his shirt pocket and followed emergency instructions. As a result of his action and the actions of other employees, tens of thousands of lives were saved."
California Transportation Security Summits, March 28 and 29, 2002

3. **Develop Evacuation Strategies to Reduce Time Needed for Implementation –** "[Develop] evacuation strategies that reduce the time required for implementation, due to the short time period available for evacuation."
Reverse Lane Standards and ITS Strategies Southeast United States Hurricane Study: Technical Memorandum Number 1: Final Report

4. **"Develop Simple-to-Use Decision-Support Tools"**
A Study of the Impact of Nine Transportation Management Projects on Hurricane Evacuation Preparedness

5. **Use an Incident Command System –** "In operations, the FDNY needs to expand its use of the Incident Command System (ICS), a blueprint for emergency response widely used around the country. This will lead to the creation of a well-defined, flexible, and complete command and control structure for major incidents, with clear and consistent responsibilities and roles."
   Increasing (Fire Department of the City of New York) FDNY's Preparedness

6. **Throw Out the Procedures When Necessary –** "Another lesson underscored by 9/11, Jenkins says, is that 'In some case you need to throw out the procedures.' On 9/11, the subway attendant working beneath the World Trade Center ordered incoming passengers to remain on the trains, rather than allowing them to get off. As many additional passengers as possible were crammed aboard and the trains ordered to move out. By the time the buildings fell, the station had been empty for 40 minutes. This was accomplished because a low-level subway employee had been delegated the authority to suspend normal procedures as a result of lessons learned in the '93 World Trade Center bombing."
   California Transportation Security Summits, March 28 and 29, 2002

5.8.6 Evacuation Routes

1. **Develop [the] Capacity of Evacuation Routes –** "[Develop] capacity of evacuation routes, to reduce the potential for operational failures during evacuation; capacity of local streets that provide access to and from evacuation routes, increased and efficiently utilized to prevent bottlenecks at evacuation route access points."
   Reverse Lane Standards and ITS Strategies Southeast United States Hurricane Study: Technical Memorandum Number 1: Final Report

2. **"Identify Conflicting Needs" –** During Hurricane Floyd, South Carolina noted several problems with the hurricane evacuation routes, including "conflicting needs. The evacuation routes were developed from individual scenarios for each population area, so there was potential for conflicting needs during more wide scale evacuations."
   A Study of the Impact of Nine Transportation Management Projects on Hurricane Evacuation Preparedness

3. **"Identify Traffic Impediments" –** During Hurricane Floyd, South Carolina noted several problems with the hurricane evacuation routes, including "traffic impediments. Evacuation routes from different areas sometimes crossed, which impeded evacuating traffic at those points"
   A Study of the Impact of Nine Transportation Management Projects on Hurricane Evacuation Preparedness

4. **Lengthen Evacuation Routes as Necessary –** During Hurricane Floyd, South Carolina noted several problems with the hurricane evacuation routes, including "insufficient evacuation length. The evacuation routes only reached 50 miles inland"
   A Study of the Impact of Nine Transportation Management Projects on Hurricane Evacuation Preparedness

5. **Modify Evacuation Routes as Necessary –** "Evacuation route designs [need to be] examined and modified, if necessary, to accommodate evacuation management strategies."
   Reverse Lane Standards and ITS Strategies Southeast United States Hurricane Study: Technical Memorandum Number 1: Final Report

5.8.7 Evacuation Traffic Management

1. **"Adjust Signal Timings** to increase the green time and/or progression band for through movements leading out of an evacuation zone."
   Compendium: Graduate Student Papers on Advanced Surface Transportation Systems: Application of ITS Technology to Hurricane Evacuation Routes

2. **"Consider a Laptop Communications System** to help law enforcement personnel monitor the outgoing traffic and to respond quickly to incidents."
   Compendium: Graduate Student Papers on Advanced Surface Transportation Systems: Application of ITS Technology to Hurricane Evacuation Routes

3. **"Consider Reversible Flow** for short sections of roadways under extreme situations, such as the approach of a Category 4 or 5 hurricane with limited time to evacuate the public."
   Compendium: Graduate Student Papers on Advanced Surface Transportation Systems: Application of ITS Technology to Hurricane Evacuation Routes

4. **"Consider Suspension of Tolls** to encourage people to use toll roads, which in turn reduces bottlenecks at toll collection booths."
   Compendium: Graduate Student Papers on Advanced Surface Transportation Systems: Application of ITS Technology to Hurricane Evacuation Routes

5. **"Consider Tow Truck Usage** at key bottleneck locations along evacuation routes to help detect and clear minor accidents and help maintain traffic flow and capacity."
   Compendium: Graduate Student Papers on Advanced Surface Transportation Systems: Application of ITS Technology to Hurricane Evacuation Routes

6. **"Consider Use of a Bus System** to provide transportation for special needs members of the community (e.g., elderly, handicapped, etc.) and take them to shelters that provide special needs."
   Compendium: Graduate Student Papers on Advanced Surface Transportation Systems: Application of ITS Technology to Hurricane Evacuation Routes

7. **"Consider Vehicle Restrictions** for oversize cargoes and mobile homes."
   Compendium: Graduate Student Papers on Advanced Surface Transportation Systems: Application of ITS Technology to Hurricane Evacuation Routes

8. **Coordinate Traffic Signals –** "Changing traffic lights on alternate routes, such as Airline Highway or US 190, to keep traffic moving."
   Times-Picayune Online, "Communication Called Storm Evacuation Key"

9. **"Establish and Maintain Communications** among agencies. Use systems such as the Public Information Emergency System in Texas and Emergency Satellite Communications in Florida, which have proven to be reliable. Have a back-up system available."
   Compendium: Graduate Student Papers on Advanced Surface Transportation Systems: Application of ITS Technology to Hurricane Evacuation Routes

10. **Develop Immediate Improvements to Highway System as Necessary –** "Immediate Improvements—(a) better coordination of evacuation process (staged evacuations among parishes facilitated through separate conference call and coordinate contra flow initiation with evacuation announcements), (b) immediately suspend bridge tolls, (c) more and better signage (additional variable message board equipment and targeted installation of permanent dynamic message signs at critical alternate evacuation routes), (d) manage Interstate access at key locations, (e) extended green/flashing yellow on major routes, (f) stage tow trucks at strategic locations, and (g) establish

Louisiana Department of Transportation and Development and Louisiana State Highway Patrol Traffic Control Center)."
Testimony to State of Louisiana State Legislature on Hurricane Ivan, 2004

11. **"Locate Your Bottlenecks"**
A Study of the Impact of Nine Transportation Management Projects on Hurricane Evacuation Preparedness

12. **"Minimize Left-Turning Movements** along evacuation routes and on roads leading to evacuation routes."
Compendium: Graduate Student Papers on Advanced Surface Transportation Systems: Application of ITS Technology to Hurricane Evacuation Routes

13. **"Need Time to Set Up for Contra-Flow Lanes"**
Reverse Lane Standards and ITS Strategies Southeast United States Hurricane Study: Technical Memorandum Number 1: Final Report

14. **"Operate an Emergency Operations Center** to coordinate all of the evacuation activities."
Compendium: Graduate Student Papers on Advanced Surface Transportation Systems: Application of ITS Technology to Hurricane Evacuation Routes

15. **Plan for Long-Term Improvements to the Highway System** – "Long Term Objectives—(a) improve loading/distribution of traffic and make contra flow more effective (task force studying alternatives within infrastructure/manpower limits, calibrate computer modeling program to 9/14-9/15 traffic conditions, model new configuration and work with local officials to better coordinate school closings, government offices and businesses at appropriate times to relieve traffic bottlenecks and (b) better educate public on evacuation routes and alternate routes (public affair campaign to distribute state maps and newly developed easy-to-read evacuation maps with alternate routes, partner with print media to print zone-specific maps, partner with a the media on plans to give public realistic expectations and public service announcements on evacuation plans)."
Testimony to State of Louisiana State Legislature on Hurricane Ivan, 2004

16. **"Promote High-Occupancy-Vehicle Lane Usage** to encourage motorists to evacuate in groups."
Compendium: Graduate Student Papers on Advanced Surface Transportation Systems: Application of ITS Technology to Hurricane Evacuation Routes

17. **Provide for a New Traffic Control Center as Necessary** – "Providing a new traffic control center with up-to-the-minute reports on traffic patterns and communicating directly with the broadcast media to let motorists know about conditions and alert them to alternate routes. New message boards along evacuation routes will also provide news about traffic conditions and alternate routes."
Times-Picayune Online, "Communication Called Storm Evacuation Key"

18. **Review Toll Policies** – "[Review] policies regarding the lifting of toll fees."
Reverse Lane Standards and ITS Strategies Southeast United States Hurricane Study: Technical Memorandum Number 1: Final Report

"Suspend toll-taking on the Crescent City Connection and the Causeway when an evacuation is called. (State of Louisiana Senator Robert) Barham recalled an angry call he received from a friend stuck in traffic near the Crescent City Connection. 'When that mandatory evacuation was issued for Plaquemines [Parish], they were still collecting tolls for six hours or more,' Barham said. 'That's one of the things we've got to cure.'"

Times-Picayune Online, "Communication Called Storm Evacuation Key"

19. **Station Tow Trucks at Strategic Locations** – "Station tow trucks at strategic points so that accidents and broken-down vehicles can be quickly cleared."
Times-Picayune Online, "Communication Called Storm Evacuation Key"

20. **"Use Traffic Counters** to assess traffic flow and the volume of vehicles evacuating."
Compendium: Graduate Student Papers on Advanced Surface Transportation Systems: Application of ITS Technology to Hurricane Evacuation Routes

21. **"Use Changeable Message Signs** to help convey timely and useful information."
Compendium: Graduate Student Papers on Advanced Surface Transportation Systems: Application of ITS Technology to Hurricane Evacuation Routes

22. **"Use Channeling Devices** as a part of traffic control."
Compendium: Graduate Student Papers on Advanced Surface Transportation Systems: Application of ITS Technology to Hurricane Evacuation Routes

23. **"Use Closed Circuit Television Cameras** to monitor traffic flow and to manage incidents."
Compendium: Graduate Student Papers on Advanced Surface Transportation Systems: Application of ITS Technology to Hurricane Evacuation Routes

24. **"Use Highway Advisory Radio** to provide information pertaining to the weather, evacuation routes, incidents, and construction."
Compendium: Graduate Student Papers on Advanced Surface Transportation Systems: Application of ITS Technology to Hurricane Evacuation Routes

25. **"Use Lane Control Signals** in critical areas to help direct traffic."
Compendium: Graduate Student Papers on Advanced Surface Transportation Systems: Application of ITS Technology to Hurricane Evacuation Routes

26. **"Use Static Signs** to provide general information. Consider the use of flip-down signs."
Compendium: Graduate Student Papers on Advanced Surface Transportation Systems: Application of ITS Technology to Hurricane Evacuation Routes

5.8.8 Exercising of Individual Initiative

1. **Allow for Individual Initiative** – "Individual initiative and independent action at the tactical level was critical to success in the first 36 hours of the incidents. Respondents made a distinction between this and freelancing.

   Respondents felt independent action had pros and cons, but taking action that was in the best interest of their leaders had a far better outcome than when respondents took no action and waited for further guidance."
   Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

2. **Allow Others to Speak Up** – "Speaking up to offer alternatives or break error chains contributed to the overall ability of senior leaders to make better decisions under stress and prevents accidents."
Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

3. **Delegate Responsibility within the Guidance Provided** – "From the top, leaders enabled safe and effective independent action by giving leader's intent, objectives, risk criteria, and limitations, and delegated responsibility to act within that guidance."
   Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

5.8.9 Guiding Priority

1. **Determine a Guiding Priority for the Incident** – "As indicated previously, the tunnel fire created a unique situation where agency functions at times seemed to be at cross-purposes. The initial response to the incident quickly established at least three competing guiding priorities—fire suppression, maintaining transportation mobility, and containment of a potential environmental hazard. With respect to transportation mobility, the priority was to restore transportation infrastructure and services and to ensure movement of people out of the area impacted by the event."
   Effects of Catastrophic Events on Transportation System Management and Operations: Howard Street Tunnel Fire, Baltimore City

2. **Realize Guiding Priorities Shift** – "This incident demonstrates the changing nature of incident response—first responders (fire fighters) initially moved into the tunnel, but then had to delay response until the Maryland Department of the Environment, the Environmental Protection Agency, and CSX identified the chemical contents of trapped cars and determined the appropriate response. The prompt response by the Maryland Department of the Environment in identifying the potential environmental impact of the fire in the cars containing hazardous materials helped to resolve the differences between this priority and the transportation and fire suppression priorities."
   Effects of Catastrophic Events on Transportation System Management and Operations: Howard Street Tunnel Fire, Baltimore City

5.8.10 Route Control

1. **Conduct Route Control Planning** – "Route control planning was an important part of evacuation. Poor planning resulted in clogged ingress/egress routes and lesser priority evacuations blocking the routes of high-priority evacuations."
   Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

2. **Establish Route Control with Plan Evacuations** – "Route control was reported as critical in maintaining freedom of movement for fire resources during evacuations. Areas that had planned evacuations reported more success than areas with no planning. This included educating residents on what actions to take prior to evacuating their home and what routes to follow. MAST issued an Incident Action Plan covering these items. In areas without planning, respondents said that trigger points set to initiate voluntary and then mandatory evacuations were not defined in advance, so they came within 30 minutes of each other.

   So many evacuees on the road at once added to the confusion and to traffic jams. In areas where routes were not well controlled, residents were flowing out of neighborhoods on all streets, and firefighters reported swimming upstream to get to areas most threatened by the fire. Some areas did not impose one-way traffic restrictions, so evacuees were moving in two directions on the same streets, adding to the problem."
   Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

3. **Identify Evacuation Routes and Keep Them Cleared** – "In planned evacuations, evacuations were based on pre-established trigger points. Law enforcement moved to known choke points and controlled routes with one-way traffic restrictions and clearing certain streets for ingress."
Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

5.9 Operations

1. **Be Flexible** – In retrospect, SA d'Economie Mixte des Transports Publics de Voyageurs de l'Agglomeration Toulousaine management said they had learned the following lessons: "Be flexible—be prepared to change your plans."
Synthesis of Transit Practice 27: Emergency Preparedness for Transit Terrorism

2. **"Conduct Transportation System Assessments Periodically** and include temporary system conditions, such as construction activity."
Compendium: Graduate Student Papers on Advanced Surface Transportation Systems: Application of ITS Technology to Hurricane Evacuation Routes

3. **"Coordinate Current Work Zone Activities** – Current work zone activities must be coordinated so they do not all impact traffic at the same time for parallel routes in case of a terrorist incident or other incident with no forewarning."
Disaster Response and Evacuation User Service: An Addendum to the ITS Program Plan

4. **Document Resources Assigned** – "From the bottom, leaders at the tactical level established incident command system, exercised command, and began documenting resources assigned when no guidance was available."
Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

5. **Establish the Unified Command Quickly** – "Limitations of current communications technology during a large incident continue to be reviewed. The frequent face-to-face meetings held in the command center helped address the problems and further confirmed the importance of establishing a unified command quickly."
I-95 Shutdown: Coordinating Transportation and Emergency Response

6. **Expect Chaos** – "People will tend to stay until the last minute. People tend to evacuate whenever another group is told to evacuate. People will not listen if they perceive it will not improve their safety. Telling some to shelter and asking others to leave has not worked in the past. In the case of an incident of mass destruction, even thought it may affect a small part of the community, it could spark panic, traffic jams and increase the exposure risk for everyone."
Homeland Response, "Evacuation: What We Can Learn—and Cannot Learn—from Hurricanes"

7. **Go with the Flow** – "Plans need to be based on where the roads go. Once people start moving they will move. Need to figure out how to communicate, find a point where they can be taken off the road and decontaminated in case of an incident."
Homeland Response, "Evacuation: What We Can Learn—and Cannot Learn—from Hurricanes"

8. **Identify Incidents Early**—"[Develop] methods and strategies to maximize the efficiency of detecting, responding to and clearing incidents on evacuation routes."
Reverse Lane Standards and ITS Strategies Southeast United States Hurricane Study: Technical Memorandum Number 1: Final Report

9. **Know Where You Are Going and How to Get There** – "A key to rapidly moving people out of an area is to know how far they need to go, speed them to the safety perimeter and provide shelters once they get there. New Orleans has approximately 25 percent of the population without cars and moving the 100,000 even with a three day warring is a chore. They have looked at mass transit, school buses and trains to move people."
   Homeland Response, "Evacuation: What We Can Learn—and Cannot Learn—from Hurricanes"

10. **Overcome the Need to Take Action without Planning** – "The extreme conditions made everyone feel a sense of urgency to commit and take action. It was even more important under those circumstances to do a proper and deliberate size-up and make contingency plans.

    It was very difficult to maintain situation awareness of the fire activity as it moved through urban areas and split into multiple heads. Air resources were most effective to overcome this problem."
    Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

11. **"Prepare for Emergencies in Advance to Make Day-of-Event Decisions Easier** – Because the Ohio Turnpike was well prepared for a power outage, managers were able to oversee seamless conversion to backup power systems with few decisions that deviated from protocol. In contrast, the Road Commission for Oakland County staff encountered the prospect of a countywide signal outage for the first time during the blackout. They had to make decisions about which intersections were most important to try to maintain with backup power and how to check signals throughout the county as power was restored."
    Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout Great Lakes Region

12. **Remember Pets and/or Livestock Need to Be Evacuated or People Assured of Their Evacuations**
    Reno/Tahoe Blog (online Web journal), "Pleasant Valley Fire"

13. **"Set Your Priorities as Quickly as Possible** – Once they learned more about the event, they were better able to respond to it. Most set their priority to be public safety and, as one interviewee described, traffic was secondary for the first couple of hours.

    During the evacuation of the New York City subway system, operators identified passengers with special needs. In some cases, these passengers, such as two pregnant women, stayed in the cars until medical help arrived. In another instance, a passenger was provided special assistance—New York City Transit crews carried a wheelchair-bound passenger from a train stuck on a bridge to the roadway below. All agreed that [women], children, the elderly, and the sick should board the buses and ferries first."
    Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout New York City

14. **Understand the Limits of Shelter in Place** – "Sheltering or evacuation depend on the nature of the incident and the time duration of the incident—[with] minutes (to respond to the incident), maybe shelter [-in-place]—[with] hours maybe evacuate."
    Homeland Response, "Evacuation: What We Can Learn—and Cannot Learn—from Hurricanes"

15. **"Understand the Options Available in Your Transit System** – Because of the heavy use of transit in the region and its dependence on electricity, the blackout obviously had a major effect on the public transportation systems. Since the events on September 11, people became accustomed to using the ferries. Transit managers had to decide if they should shift everyone over to ferries or establish an

alternative bus operation in conjunction with the ferries. They decided that they had to utilize the capacity of both modes.

The closing of the Port Authority Bus Terminal caused a major disruption. Commuters waiting for buses were forced to evacuate the building and move onto the surrounding streets. To alleviate as much congestion and confusion as possible, managers from New Jersey Transit decided on a load-and-go solution. As buses entered the bus terminal area, commuters were loaded onto buses regardless of their final destination. The buses went to a staging area that was set up at the Meadowlands. At that location, commuters would then board buses to reach their final destination. Similarly, passengers disembarking from the ferries in New Jersey were met by buses that took them to the Meadowlands.

New Jersey Transit managers also had to deal with loss of the light rail system. They created a bus bridge and used private carriers with whom they already have signed memoranda of understanding.

Early in the blackout, many decisions concerning re-routing within the New York City Transit Bus were handled at the local division level. When communications was restored within the agency, managers in the main office provided more input on routing.

Once they decided that the blackout would last more than 30 minutes, they began following established policies to react to the situation. They issued a directive for all trains to discharge passengers and secure the train if it was in a station and to begin the process of evacuating those not in a station."
Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout New York City

16. **"Use Equipment and Personnel Resource Lists** to keep tabs on available equipment and personnel and update the lists in real time."
Compendium: Graduate Student Papers on Advanced Surface Transportation Systems: Application of ITS Technology to Hurricane Evacuation Routes

5.9.1 Advanced Technology

1. **Develop a Priority for Backup Generators** – "Prioritize where backup generators are deployed. To keep emergency vehicles on the road, backup power is essential at fueling facilities. When an outside contractor performs generator maintenance, in-house staff should retain maintenance capability for emergency situations."
Learning from the 2003 Blackout

2. **Maintain Older Communications Technology** – "'Old' technologies, such as landline telephones and battery-operated radios, become very important when a crisis is widespread. Officials recommend maintaining some older technology, which may be less susceptible to power outages, in the traffic management center. As for backup power, even quadruple redundancy is not foolproof."
Learning from the 2003 Blackout

3. **Maintain the Signal System** – "The ability to maintain the signal system is key, unlike with freeways, which will operate reasonably well without power. A response plan for priority signals should be based on an evaluation of intersection safety, sight distance, and traffic volumes. Several agencies are now examining the costs of providing backup power supplies to ITS field equipment along key corridors and intersections. Emergency power for the computers controlling the centralized

traffic signals—those run from a traffic management center—should be provided by multiple backup batteries."
Learning from the 2003 Blackout

4. **Schedule Generator Maintenance** – "Regular generator maintenance should be scheduled as standard operating procedure. The ability to maintain toll collection using backup power allows large volumes of traffic to be handled at toll booths with few customers aware of the blackout until they leave the tollway."
Learning from the 2003 Blackout

5.9.2 Highway

1. **"Develop a Consistent Policy for Toll and Fare Collection** – Different authorities and operating agencies suspended tolls and fares, while others did not."
Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout New York City

2. **"Establish and Disseminate a Policy for Displaying Messages on Variable Message Signs** – Members of the I-95 Corridor Coalition have developed some consistent messages for message signs. Permanently mounted variable message signs operated by INFORM staff lost power. Staff, however, deployed 28 portable signs and changed the messages on others."
Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout New York City

3. **Know Your Infrastructure and Reengineer as Necessary** – "Use of contra-flow lanes, removable barriers, electronic signs for the contra-flow lanes, (and) station workers with wreckers to remove cars that breakdown."
Homeland Response, "Evacuation: What We Can Learn—and Cannot Learn—from Hurricanes"

4. **"Leverage the United States Geologic Service (USGS) Streamgaging Programming"**
A Study of the Impact of Nine Transportation Management Projects on Hurricane Evacuation Preparedness

5. **Reduce the Impact of Work Zones** – "A historically overlooked issue in evacuation planning and preparedness has been highway work zones. In 1998, during the evacuation for Hurricane Georges, the States of Alabama, Mississippi, and Louisiana all had construction zones on evacuation routes. In Louisiana, evacuation traffic on westbound I-10 out of New Orleans was limited to a single lane.

   Since the need for maintenance and construction during the hurricane season is unavoidable, some Departments of Transportation's have made attempts to avoid conflicts by adding special provisions in construction contracts to accommodate evacuation traffic through work zones. The most common way to do this has been to add clauses that require a contractor to cease all construction activities once an evacuation is declared, clear all equipment, and open all lanes of traffic including those under construction."
   National Review of Hurricane Evacuation Plans and Policies

6. **"Understand the Function of Your Roadway System** – Transportation managers made several key decisions throughout the blackout. One was to close some lanes of traffic within some tunnels. Because the tunnels' ventilation systems did not have backup power, managers had to reduce the number of cars to reduce the amounts of pollutants.

At the same time, however, it was imperative that the tunnels remain open to allow the passage of emergency vehicles. Other facility operators modified the lane configuration for some bridges and tunnels. They reversed one lane so that there would be three lanes for traffic leaving Manhattan and one used to enter the area. This action helped address the amount of vehicles leaving Manhattan.

New York Police Department supervisors instructed their 2,000 traffic agents to stop issuing summons and assigned all of them to direct traffic. This action was possible because there was less congestion on the freeway system than on the arterial streets.

INFORM staff also had to decide whether to operate the drawbridges under their jurisdiction. Some were in the up position when the blackout occurred. They set a priority of ensuring that evacuation routes remained open. Therefore, they lowered the bridges using emergency power generators, locked them down, and notified the Coast Guard, who then notified boaters."
Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout New York City

5.9.3 Procedures

1. **"Develop Clear Procedures for Evacuations** – When New York City Transit Subway managers determine that the loss of power will be a long event, they begin the process to evacuate the subway system. In many cases, the train crews were on their own—they needed to make their own decisions for the best means of evacuation. New York City subway managers relied on their own staff and their own equipment to remove people and escorted them to the nearest stations. Some supervisors were sent to areas that were the most difficult to evacuate.

   Train crews had to walk through the train to inform passengers of what was happening. They walked the passengers to the last car and instructed them on how to get off the train. Train crews also notified the control center of people with special needs. Subway crews successfully evacuated 413 trains in approximately three hours.

   Staff at the Port Authority Trans-Hudson Corporation line faced similar situations. Once managers ceased attempts to restore power, they ordered a full evacuation of the trains and stations. They had 19 stranded trains, 16 of which were in tunnel sections. In two hours, all stations were evacuated and secured.

   The Port Authority Bus Terminal managers had previously made a decision that in cases of emergency the terminal would be evacuated rather than made partially operational. Once the decision was made, the terminal was evacuated in 15 minutes. Stranded commuters were ushered into the surrounding streets to wait for buses."
   Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout New York City

2. **"Develop Procedures Detailing When to Restart Your System** – Several interviewees noted that precautions had to be taken when restoring power to equipment and resuming operations."
   Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout New York City

5.9.4 Resources

1. **Stage Resources Out of the Incident Zone** – "Once the motorists nearest the scene were evacuated, emergency response and road maintenance equipment were on standby and ready for action as needed. Maryland State Highway Administration personnel ensured that ambulances, tow trucks, salt and sand equipment, and machinery to repair pavement were staged out of the way but within easy access to the site. At about 7 p.m., the fire units informed the Maryland State Police that two of the four lanes of southbound I-95 could be reopened."
   I-95 Shutdown: Coordinating Transportation and Emergency Response

2. **Use "Resources Located in Non-Vulnerable Areas"**—if resources are located in the incident zone.
   Using ITS in Helping Florida Manage Evacuations

5.9.5 Staff

1. **Develop an Emergency Action Pocket Guide for Staff** – "Develop pocket guide identifying transportation emergency actions."
   Evacuations Management Emergency Preparedness

2. **"Empower the Relevant Staff to Make Decisions and to Communicate Them** – The opening of an Emergency Operations Center in the Detroit area required one person's authorization, who was on a plane when the blackout hit. A lesson learned for Emergency Operations Center staff was that other people should be authorized to open the Emergency Operations Center, when necessary. Depending on the organization, it may be useful to empower many people in the agency to make independent decisions."
   Effects of Catastrophic Events on Transportation System Management and Operations – August 2003 Northeast Blackout Great Lakes Region

3. **"Maintain a Policy of Empowering Employees to Make Decisions** – The Metropolitan Transportation Authority maintained this policy. On September 11, station managers and train drivers became frontline commanders."
   Saving City Lifelines: Lessons Learned in the 9/11 Terrorist Attacks

5.9.6 Volunteers

1. **Keep Volunteers Informed** – "As much as possible, volunteers should be kept fully informed of policies, event status, and expectations in recognition of their value as team members."
   Firestorm 2003: Provincial Review

2. **Use Volunteers as Field Observers or in a Support Role** – "Retired firefighters, law enforcement, and citizens were used as field observers to provide leaders with situation awareness of the fire behavior in urban areas. Observers were mobile or placed on high ground, towers, or tanks."
   Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

   "Rather than trying to fight the wildfires, a more appropriate role for volunteers in emergency situations would be to help deliver a whole range of social and community-based services, especially for people evacuated from their homes."
   Firestorm 2003: Provincial Review

5.10 Redundancy and Resiliency of Systems

1. **"Adopt a Mindset of Resiliency"**
   Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout Great Lakes Region

2. **Assess Extended Loss of the Primary System** – "Assess the needs of an extended loss of the primary system versus a temporary interruption."
   Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout Great Lakes Region

3. **"Consider the Failure of Even Quadruple Redundancy"**
   Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout Great Lakes Region

4. **Have a Redundant System of Trained Agency Personnel** – "It is crucial to have a redundant system of trained personnel in place who are able to make good, accurate, and timely decisions in the face of rapidly changing circumstances. With two of the cases (New York City and Northridge), the recovery response effort lasted for several months. Maintaining staff on emergency status for this length of time can take a toll on personnel and highlights the need to have multiple people trained for each job.

   With New York City, the need for redundancy in personnel was highlighted when a number of key transportation decision makers were lost or temporarily missing in the attack. Critical decisions were made by personnel in the field who, at times, were cut off from communications with headquarters."
   Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

5. **"Rethink the Definition of Redundancy"**
   Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout New York City

5.10.1 Backup Facilities and Power

1. **Conduct an Inventory of Backup Resources** – "Conduct an inventory of resources that might be needed in an emergency."
   Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout New York City

2. **Connect/Establish Backup Power** – "Connect backup power to the right systems."
   Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout Great Lakes Region

   "Have backup power."
   Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout Great Lakes Region

3. **Consider Redundancy in Emergency Response and Recovery Plans** – "At a minimum, emergency response planners should consider designing redundancy into emergency response and recovery plans in several areas: the regional transportation network, agency personnel, communications, utilities, control centers, and equipment and supplies."

Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

4. **"Determine the Benefits and Costs of Purchasing and Maintaining Backup Power** – The amount of backup generation power available varied widely among agencies as each agency weighed the benefits and costs of maintaining backup power and equipment."
   Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout New York City

5. **Determine the Components on Backup Power** – "Reexamine what components of the system are on backup power."
   Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout New York City

6. **"Locate Redundant Facilities Remotely"**
   Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout Great Lakes Region

7. **"Test and Maintain [the] Backup Systems"**
   Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout Great Lakes Region

8. **Use Alternative Emergency Operations Centers/Redundant Control Centers** – "Emergency operations centers may be destroyed or rendered inaccessible in a major catastrophe. Alternative sites should be identified and prepared in advance. While emergency operations centers might be lost or impaired, knowledge acquired and networks built on personal relationships created in exercises will survive."
   Saving City Lifelines: Lessons Learned in the 9/11 Terrorist Attacks

   "Redundant control centers helped when the New York City Office of Emergency Management Command Center was destroyed. The Port Authority was able to move to a backup control center in New Jersey. Both New Jersey Transit and New York City Transit were able to deploy mobile command centers. In response to the events of September 11, Mayor Bloomberg has proposed constructing and opening five "Help Centers," with one in each borough that brings together representatives from city, state, and federal agencies."
   Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

9. **Use Redundant Utilities to Ensure Powe**r – "In New York City, the loss of electricity severely hampered operations and recovery efforts. When the Brooklyn Battery Tunnel lost electrical power, its lights and ventilation systems failed forcing hundreds of motorists to abandon their vehicles in the tunnel and run towards Brooklyn as smoke and debris filled the tunnel. Redundant mobile generators allowed for the restoration of power to emergency control centers and allowed agencies to begin flood prevention efforts to preserve subway tunnels and communications networks from extensive water damage."
   Effects of Catastrophic Events on Transportation System Management and Operations—Cross-Cutting Study

5.10.2 Communication

1. **Maintain a Mix of Options** – "Maintain a variety of old and advanced communications options."
   Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout Great Lakes Region

2. **Use Multiple Communications Technologies and Types** – "It is crucial that agencies be able to utilize multiple technologies to communicate with staff and the public. By having a redundant set of communications technologies available, agency personnel can shift from one technology to another depending upon the emergency scenario, geography of the land, or other unforeseen outside forces. Technologies used in the four areas included landline telephones, wireless telephones, two-way radio, satellite link ups, and e-mail.

   As seen in the four case studies, landline telephone communications were disrupted by the vibrations of the California earthquake and severely affected in New York City because of the location of a Verizon substation in the World Trade Center area. Overwhelming customer demand on September 11 also taxed the portions of the system that were not destroyed. The Baltimore rail tunnel contained major trunk lines of fiber optic cable, disrupting Internet communications across the country when the fire spread."
   Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

   "Ensure that an agency has multiple types of communications technology."
   Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout New York City

5.10.3 Regional Transportation Network

1. **Realize the "Regional Transportation Network is Part of a Redundant Transportation System** – Transportation agencies, both public and private, had to work together to provide alternative travel options to the public. But the level of complexity and the alternatives used varied. The solutions depended on the circumstances presented to decision makers. And the solutions shifted over time in response to changes in travel behaviors of the public to the options presented to them.

   In the case of New York City, Lower Manhattan has a dense set of redundant transportation infrastructure. The infrastructure consists of a pattern of local streets connected to arterials along the perimeter, a multitude of subway lines, on-street bus service, water ferries, and pedestrian accommodations. Because of that, people have multiple options for getting around on a daily basis.

   The Los Angeles highway system in the urban area has a fairly extensive set of redundant arterial and local streets. At the time of the earthquake, the Los Angeles Department of Transportation was implementing a "Smart Corridor" project that had identified parallel arterials as an important option for commuter traffic. This system has the ability to divert freeway traffic onto the arterial streets during times of heavy congestion. Being able to implement this after the earthquake allowed the agencies to minimize some of the traffic congestion that occurred as a result of the closing of the damaged interstate segments.

   But to the north, the canyons and valleys restricted the number of alternative roads that are feasible. Because of this officials were presented with fewer options for rerouting traffic and these areas experienced the heaviest traffic backups in the weeks and months after the earthquake."

Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

2. **Realize the Transit System Can Provide Redundancy** – "In addition to roadway redundancy, the transit system helped alleviate some of the initial congestion caused by reconstruction. With an already extensive bus system, the Los Angeles County Metropolitan Transportation Authority increased Metrobus service following the earthquake to respond to the demands of commuters.

   In Washington, the highway departments were able to take advantage of reversible lanes to help increase the volume of traffic that could exit the Washington, DC, area that morning. Washington Metropolitan Area Transit Authority had the ability to reroute its subway lines to avoid crossing the Potomac River Bridge. One of the major infrastructure improvements that Washington Metropolitan Area Transit Authority has considered is the construction of a second rail tunnel through the central rail system to provide redundancy in case of problems to the main line."
   Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

5.10.4 Supplies

1. **Ensure a Supply of Redundant Equipment and Supplies** – "In both Baltimore and New York, agency officials spoke of the need to have redundant supplies of equipment. But even more important is maintaining a good inventory of where supplies are kept or could be readily purchased. Bridge and tunnel officials talked about the heavy volume of filters, batteries, and other routine supplies the agencies used in the days after September 11."
   Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

2. **Stockpile Equipment and Supplies** – "The Bay Area Rapid Transit District (BART) was designed in the early 1960s to earthquake standards more stringent than the equivalent highway standards at the time. BART has stockpiled equipment and supplies at fault crossings to repair the system."
   Riding Out Future Quakes: Ideas for Action: Improving Planning of Transportation Providers, Government, Utilities and Businesses for Post-Earthquake Transportation Disruptions In the San Francisco Bay Region

5.11 Training

1. **Adapt Response Plans to the Incident** – "Response plans can be adapted to different circumstances. Plans for natural disasters and contingencies addressed in tabletop exercises were applied to new circumstances on 9/11. Similarly, plans and exercises focused on response to terrorist attacks will apply to other kinds of disasters."
   Saving City Lifelines: Lessons Learned in the 9/11 Terrorist Attacks

2. **Conduct Annual/Frequent Training Exercises** – "The key to effective emergency preparedness is to hold training exercises, urging agencies to conduct three kinds of exercises: (1) annual tabletop exercises to introduce or review functional procedures; (2) annual controlled simulations for Emergency Operation Centers, including 'partnership' review exercises where representatives of all agencies and functions, including nongovernmental agencies, can evaluate and review their plans together. These exercises should include transit representatives. Finally, (3) hold a full-scale field exercise, including active responders, every two years."

California Transportation Security Summits, March 28 and 29, 2002

"The single most important lesson of 9/11 is the importance of crisis planning and frequent response exercises, both tabletop simulations and field exercises. The City of New York and its public transportation system responded remarkably well on 9/11 despite the loss of emergency operations centers, the inaccessibility of vital documents, and communications difficulties, because they had devoted continuing attention to crisis management planning and exercises."
Saving City Lifelines: Lessons Learned in the 9/11 Terrorist Attacks

3. **Conduct Exercises and Test the Plan** – "A clear theme is identified from this tragedy—planning. Planning—have a plan, test your plan, share your plan, and repeat exercises. And then do it again, if you can't afford repeated exercises, at least review your plans, forge relationships as part of the planning process, and prepare lists of vendors and service providers."
Oklahoma City: Seven Years Later: Lessons for Other Communities

4. **"Conduct Training (Table Top Exercises)** to adequately prepare personnel and volunteers. Conduct tabletop exercises as a part of the training to improve coordination and to pinpoint strengths and weaknesses."
Compendium: Graduate Student Papers on Advanced Surface Transportation Systems: Application of ITS Technology to Hurricane Evacuation Routes

5. **Include Public Transit in the Training Exercises** – "It was essential to include transit agencies in training exercises. 'When we did a study in the [San Francisco] Bay Area, we learned that in an earthquake 1,400 road segments could be taken down.' Only by planning ahead with transit agencies can planners come up with the substitutions and rerouting needed to cope with a large-scale incident."
California Transportation Security Summits, March 28 and 29, 2002

6. **Practice Together** – "If relationships are not already built on exercise and training, the communications can be too complicated and the decisions too fast."
Homeland Response, "Evacuation: What We Can Learn—and Cannot Learn—from Hurricanes"

7. **Provide Consistent Training** – "There is clearly a need for consistent training across the province in all aspects of emergency planning. It has been said that practice makes perfect. Simulations and exercises are required on an ongoing basis to ensure that people remain current in their skills."
Firestorm 2003: Provincial Review

8. **Review and Update Crisis Plans with Training** – "Crisis plans, once completed, cannot be put on the shelf to gather dust, but must be periodically reviewed and updated. Exercises should be conducted frequently."
Saving City Lifelines: Lessons Learned in the 9/11 Terrorist Attacks

9. **Train Staff** – "Training surface transportation employees saved lives, with the sarin nerve agent attack on Tokyo's subway, where lack of training (and a reluctance to challenge normal operating procedures) increased the number of casualties. Conforming to an ill-conceived commitment to stay in operation even though they knew something was seriously amiss, subway personnel kept trains containing lethal sarin moving back and forth through the system for several hours. A clean-up crew committed to pristine floors no matter what, actually swept up the Sarin debris, spreading the impact of the toxic agent. However, even in the Tokyo incident, a security-trained maintenance worker [who discovered an additional device planted in a washroom] was able to prevent a second incident from occurring."
California Transportation Security Summits, March 28 and 29, 2002

10. **Train First, Second, and Third String Staff for Emergencies** – It is necessary to be able to rely on agency staff at all levels to make good and timely decisions, often without complete knowledge of all of the mitigating circumstances. It is critical that staff at all levels be able to respond to situations and make decisions. "As one public official commented 'emergencies do not happen at convenient times, therefore it is important to train not just your first string but also your second and third string for emergencies.' In New York City, an official at one of the Port Authority's tunnels responded that he was not able to check with headquarters because 'it was not there.' The Port Authority's headquarters were located in the World Trade Center and were destroyed in the attack."
Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

5.11.1 Interagency Training

1. **Cooperate on Training** – "Intensify interagency training efforts, including the use of large-scale interface wildfire simulations to improve communications."
Firestorm 2003: Provincial Review

2. **Develop and Provide Interagency Cooperation and Training** – "Pre-fire interagency cooperation set the stage and had a direct positive impact on the ability to manage the fire, the Incident Command System (ICS) worked as it was designed to function, and proved to be a valuable tool in facilitating interagency cooperation and establishing an effective unified command, agencies that had trained together functioned more effectively as a unified command team, at the tactical level, and pre-incident planning and tabletop and simulation exercises proved to be a cost-effective way for incident preplanning and to build good working relationships."
San Bernardino County Fire Chiefs' Association: Lessons Learned Report: Fire Storm 2003: "Old Fire"

   "Interagency training with cooperators provided valuable pre-incident planning as well. Tabletop and walk-through exercises were cost-effective ways to plan for incidents and build relationships."
Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

   "Agencies that trained together were able to function more effectively as a unified command team. This was true at the tactical level as well."
Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

3. **Incorporate Specific Training** – "Structural units and leaders who had received wildland training were more effective and safer as single resources or part of a strike team operating in the wildland-urban interface. Those without the training were not proficient in wildland tactics."
Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

6 Best Practices

This section of the literature search addresses information found on best practices. These best practices were identified from the southern California wildfires of 2003, the 9/11 terrorist attacks, the 2003 blackouts, hurricanes, and other incidents. This section is subdivided into areas based on publications with specific sections addressing best practices and publications, with best practices identified throughout the report.

When reviewing this section, some of the best practices may seem similar because they share common themes. However, we have included them all because there are subtle, but important, variations among them.

Some common themes in the best practices by the various entities include:

- Distribute maps and route evacuation information
- Inform the community of the dangers before an incident
- Practice cooperation between entities
- Practice coordination between entities
- Practice training and drills
- Prepare evacuation plans
- Use an incident command system
- Use incident planning
- Use ITS to monitor the situation
- Use various means to communicate.

Best practices are organized into the following areas:

- Advanced Preparation and Planning
- Advanced Technology
- Communication
- Cooperation
- Coordination
- Evacuations
- Operations
- System Redundancy and Resiliency
- Training and Planning
- Transportation Emergency Response Checklist.

6.1 Advanced Preparation and Planning

1. **Develop Action Plans to Include the Use of Buses to Transport People Who Do Not Drive and for Situations Where Roads Are Congested or Fuel Supplies Limited**
   Emergency transportation action plans can include:

a. Communication and support networks that serve the most vulnerable people. This involves a system to identify and contact vulnerable people, provide individualized directions for their care and evacuation, and establish a chain of responsibility for caregivers.
b. Planning to allow quick deployment of buses, vans, and trains. This requires an inventory of such vehicles and their drivers, and well-established arrangements for their use.
c. A system to prioritize who should be evacuated first, based on factors such as geographic location and individual needs.
d. Information on pickup locations and routes distributed to at-risk populations and all officials. This information should be distributed regularly, not just during major emergencies.
e. Instructions on what evacuees should bring, and help for carrying baggage.
f. Coordination of fuel, emergency repair, and other support services.
g. Priority given to buses and other high-occupancy vehicles where bottlenecks occur or critical resources are limited.

Lessons from Katrina: What a Major Disaster Can Teach Transportation Planners

2. **Develop Effective Community Outreach to Persons without Transportation** – "Each neighborhood should have an inventory of people who may need assistance, ways to contact them, directions for their evacuation, and a list of their friends and family who can provide emergency support. If possible, social service agency staff or volunteer community leaders should travel with vulnerable evacuees to provide information and reassurance to people who may be frustrated and frightened. Implementing such a system requires that planning professionals work with a broad range of community groups, professionals and social service organizations."
Lessons from Katrina: What a Major Disaster Can Teach Transportation Planners

3. Have Call Out Procedures and Contact Lists – "Ninety-eight responding agencies (approximately 92 percent) have formal call-out procedures in place for responding to traffic incidents. Eighty-eight responding agencies (approximately 82 percent) have developed a multi-agency contact list for their regions which contains the names, phone numbers, pager numbers, and other pertinent information for the appropriate response personnel."
Emergency Transportation Operations: Freeway Traffic Management Center Capabilities and Needs

4. **Have Multiple Agencies Participate in Statewide Emergency and Traffic Incident Response Planning** – "Eighty-one responding agencies (74 percent) participate in a team that meets on a regular basis to evaluate and improve coordinated incident response and to address traffic problems as well."
Emergency Transportation Operations: Freeway Traffic Management Center Capabilities and Needs

5. **Have Pre-Planned Alternate Routes for Traffic** – "The majority of these respondents have established criteria to direct the implementation of alternate route plans, including incident type and duration, incident location, number of lanes involved in incident, and time of day."
Emergency Transportation Operations: Freeway Traffic Management Center Capabilities and Needs

6. Learn from Previous Events and Incorporate into Response Plans – "First, an agency needs to learn from previous events and incorporate that learning into an agency's response plans. The events of September 11 have served as a wake-up call to cities and towns across the country about the need to prepare for the unexpected."
Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

7. **Proactively Plan for and Coordinate Activities Related to Special Events** – "The majority of these agencies coordinate their participation through multi-agency teams and interagency agreements."

Emergency Transportation Operations: Freeway Traffic Management Center Capabilities and Needs

8. **Rely on Staff to Make Good Decisions** – "Second, there is a need to rely on agency staff at all levels to make good and timely decisions, often without complete knowledge of all the mitigating circumstances. Emergencies do not occur at convenient times and it is important that staff at all levels are able to respond to situations and make decisions, often without immediate input from headquarters."
   Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

9. **Remember to Practice for the Expected and Unexpected** – "Third, there is a need to practice for the expected and the unexpected. Knowledge gained and relationships developed through day-to-day contact are extremely useful when catastrophes strike. In both New York and Los Angeles, existing traffic control centers and organizations whose main function was coordinating daily transportation operations were able to quickly implement emergency procedures."
   Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

6.2 Advanced Technology

1. **Advance Technology Can Provide Important Information** – "Once a catastrophic event has occurred, advanced technologies can aid in providing information on existing conditions to decision makers. This information can then be used to make better-informed decisions on when and how to open or restrict facilities. Examples of this included the use of closed circuit television and traffic monitors to gauge traffic volumes on key facilities."
   Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

2. **Information Can Be Shared Using ITS** – "It can facilitate better communications with other agencies involved in the emergency response. Traffic management centers were able to share information on current conditions with other agencies. It can also assist in communicating with the public by providing accurate information on the status of the transportation system. This included variable message signs, highway advisory radio broadcasts, 1-800 telephone lines, and web based video feeds of traffic. Through the coordination of Transportation Operations Coordinating Committee and the I-95 Corridor Coalition, variable message signs all along the East Coast were displaying warnings to the traveling public about avoiding New York City/Pentagon area."
   Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

6.3 Communication

1. **Be Able to Communicate Among Entities** – "South Carolina emergency personnel and law-enforcement agencies also now have better communications tools, with improved two-way radio equipment and coordination among agencies. 'We'll be able to talk to who we need to, when we need to,' says [Captain] Stubblefield [of the South Carolina Highway Patrol]."
   Coastal Heritage, "Floyd Follies: What We've Learned"

2. **Communicate and Cooperate with Other Entities** – "Local nuclear plant operators need to communicate and work with local officials. Coordinate with other entities regarding emergencies and the need for evacuation and/or sheltering. [Provide] annual communication on emergency information regarding a nuclear incident."
   US Nuclear Regulatory Commission Publication: *State and Local Response Actions*

3. **Communicate to a Wide Audience** – "During an evacuation event, it is important to communicate to many audiences, such as potential evacuees, nursing homes, hospitals, health centers, schools, transportation officials, emergency shelters, large employers, friends and relatives of evacuees, and the media. The communicated message should include who should evacuate, when they should do so, where evacuees should go, and what they should bring."
   Synthesis of Transit Practice 27: Emergency Preparedness for Transit Terrorism

4. **Determine How the Public Perceives the Public Messages Regarding Evacuations. Have an Outreach Program for Specific Target Populations. Engage the Public in Emergency Preparedness Programs** – "I have learned [Gary Vickers—Director, Pinellas County Emergency Management] many valuable lessons from these recent storms [hurricane season 2004] and feel there are many things we can do to improve the preparedness of our county. Among these are conducting a behavioral analysis to determine how the public perceived our messages and what they did in response to them. We plan to target specific segments of our population, such as our mobile home communities, for outreach programs. Most important, we want to engage our residents as an integral component of our emergency preparedness programs. Without public participation, we have no hope of success."
   St. Petersburg Times Online, "Letters to the Editor: Evacuation Unpleasant But Necessary"

5. **Develop Public Information Plans** – "Identify specific actions for communicating emergency information to evacuees en route including:

   a. Host shelter locations, shelter openings and closings, and directions to the shelters from major evacuation routes
   b. Ensuring hotel/motel capacity and status information is incorporated into emergency public information procedures
   c. Pre-developed messages for release to the media
   d. The placement of variable message signs and procedures for updating their messages
   e. The placement of portable radio transmitters and procedures for updating their messages
   f. Providing maps, fliers or other shelter information to local and state law enforcement/traffic control personnel, rest areas, and other key locations along major evacuation routes (restaurants, gas stations) both prior to and during the event
   g. The location and operation of host shelter information centers/staging areas; and
   h. Integrating county public information operations and messages with Florida Highway Patrol Troops and Department of Transportation District Public Information Officers."

   State of Florida Regional Evacuation Procedure

6. **Have a Lead Individual Provide Information** – "During most evacuation events, the emergency services press officer (e.g., police press officer) would coordinate dissemination of information to the media during the emergency phase of an evacuation. In larger evacuation events, the appropriate government press officer would take the lead with the media, in close liaison with emergency services press officers.

"All organizations, including transit agencies, responding to the emergency event should coordinate their media response to ensure that a coherent picture emerges. Individual organizations may deal directly with media regarding their own functional responsibilities, as long as the overall media coordinator is aware and there is agreement on the message and information to be released. Individuals in organizations, who are approached by the media for information or an interview, should always refer the inquiry to their organizational press officer or the overall press coordinator."
Synthesis of Transit Practice 27: Emergency Preparedness for Transit Terrorism

7. **Make the Community Aware of Flood Incidents** – "There is a realization, however, that the best warnings will fall on deaf ears unless the community is aware of the flood threat in the local area and has given some thought to the problem of managing floods. The State Emergency Service is extensively involved in community education and the production of flood safe guides is happening in conjunction with flood plan reviews. The State Emergency Service continues to make progress on flood warning services, an extremely important component of flood management activities."
Flood Warnings: Recent Lessons Learned and Developments Under Way

8. **Notify the Public in Advance of Potential Problems** – "In this case, the possibility of flooding. Have maps available of areas prone to flooding. Use the internet to distribute information. However, it needs to be kept up to date. Provide one-page document for citizens to take with them providing information."
Ribble Valley Borough Council, England (Internet) publication, *Flood Warning*

9. **Provide Accurate, Timely Information** – "The demand for accurate, timely information increases dramatically after an emergency. Often this increased demand comes at a time when the technology needed to provide that information is most compromised.
Agency officials need accurate information to be able to best allocate resources and set agency priorities in responding to an emergency. There is also a heightened interest by the public at large for information about the event. In the New York, Washington, and Los Angeles events, immediate communication with agency field staff and emergency responders was difficult because telephone landlines were damaged and cellular communications systems were overloaded or did not provide adequate coverage."
Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

10. **Provide Pre-Evacuation Notices to Home Owners in Fire-Prone Areas** – These were provided for residents with homes near the Biscuit wildfire in Oregon during 2002, thus notifying them of the dangers associated with living in wildlands.
Seattle Post Intelligence, "Evacuation Notice Lifted for Some Tiny Oregon Towns"

11. **Provide Evacuation Information on the Internet** – The Rancho Santa Fe Fire Protection District of California posts information on its Web site on preparation for an evacuation and other evacuation information. It states "Evacuation routes should be based on the direction the wildfire is moving. Identify a minimum of two (2) main exit routes from your neighborhood. Map out alternative routes in the event main routes are blocked. Know the location of designated Public-Safe Zones (areas of refuge) during wildfire or other disaster situations. Plan how you will transport your pets. Make arrangements far in advance for the transportation and lodging of large animals, like horses and livestock. If you are unable to drive a car, develop a network of neighbors, friends and/or caregivers who can help you prepare for and assist you during a disaster."
Getting Out Alive: Preparing for and Protecting Yourself During a Wildfire Evacuation

12. **Technology and Software Could Be Used to Provide Information to the Public**

ICDN Newsletter, "Interactive Web Site to Aid Travelers During Marquette Interchange Project"

13. **Use New Communication Technologies** – "On September 11, new technologies proved successful in supplementing communications during the emergency response efforts when landline telephones were either damaged or overwhelmed with demand. Data transmissions using fax machines, e-mails, and interactive pagers that use 'push' technology were effective in supplementing communications. On September 11, several transportation agencies activated their 'mobile communications centers,' which are buses equipped with satellite and computer technology to allow multiple forms of communications."
Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

14. **Use Multiple Ways to Communicate with the Public** – "During the weeks after the attack, New York City Transit used its Web site to help keep customers informed. It posted updated maps and service changes. It used its geographic information systems mapping capabilities to produce and distribute changes both electronically and by handing out paper 'take-one' maps of service changes several times a day."
Emergency Transportation Operations: Stakeholders, Functions and Automated Tool

"Media are an important ally in getting information across to the public in an evacuation. The specific information strategy will depend on circumstances. Means of communicating with the general public during an evacuation include television, radio, and newspapers; leaflet distribution; Web sites; and teletext."
Synthesis of Transit Practice 27: Emergency Preparedness for Transit Terrorism

15. **Use Real-Time Information with Law Enforcement, Fire and Rescue Agencies**
Emergency Transportation Operations: Freeway Traffic Management Center Capabilities and Needs

16. **Variable Message Boards Need to be Used When Necessary or People Will Ignore Them** – "People were complaining to the author regarding the variable message sign example 'The Caltrans (California Department of Transportation) signs warning 'WET ROADWAY, REDUCE SPEED' increased our already horrible commute Tuesday on Highway 101 in Morgan Hill and on Highway 85 near Almaden Expressway. We know the roads were wet! It was raining! We don't need a sign to tell us! Why are these signs not restricted for emergencies? Why are they backing up an already horrible commute with obvious information? This sign and others aren't going away. Caltrans has plans to add about 100 more in the region, and over time we can hope that drivers keep their foot on the gas and keep driving."
San Jose Mercury Times, "Electronic Road Signs Staying, Caltrans Says"

6.3.1 Maps

1. **Distribute Evacuation Maps** – "When each hurricane season begins on June 1, the South Carolina Emergency Management Division disseminates 500,000 evacuation maps, offering route guidance for each coastal region. In a voluntary evacuation, travelers can take any road they wish. But once the governor announces a mandatory evacuation, law enforcement will likely guide many travelers to predetermined routes."
Coastal Heritage, "Floyd Follies: What We've Learned"

2. **Provide Maps to the Public on Evacuation Routes** – "Mississippi, Alabama, Georgia, and South Carolina used federal grants from the Federal Highway Administration to develop and implement a

public information program/brochures/maps concerning lane reversal plans during a hurricane evacuation."
A Study of the Impact of Nine Transportation Management Projects on Hurricane Evacuation Preparedness

3. **Provide Evacuation Maps on a Single Sheet** – "Citizens of Georgia mentioned they appreciated the fact that all the pertinent hurricane evacuation information was on a single sheet."
A Study of the Impact of Nine Transportation Management Projects on Hurricane Evacuation Preparedness

4. **Suggest Placement of Evacuation Maps in the Car** – Five evacuation routes were identified, and it was suggested that the evacuation routes be placed in the car for use.
Evacuation Routes by Ward for the Borough of Monaca in the Event of an Incident at the Beaver Valley Power Station (Nuclear Facility)

6.4 Cooperation

1. **Cooperate with Other Entities** – "Respondents also reported the need to cooperate with ancillary agencies such as the Red Cross and animal control. Those agencies are instrumental in taking care of the evacuees and dealing with pets and livestock. They felt that fire agencies working closely with law enforcement can effect an evacuation, but that far more was involved afterward."
Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

2. **Have Agreements for Electronic Connectivity** – "Thirty-six agencies (30 percent) reported that they have formal agreements in place to establish and/or systematically maintain the ability to share information with other systems or agencies. These agreements have been used to facilitate connection between Traffic Management Center systems and local E-911 centers and law enforcement Computer-Aided Dispatch (CAD) systems."
Emergency Transportation Operations: Freeway Traffic Management Center Capabilities and Needs

3. **Work with Other Entities in Evacuations** – "Residents who delayed leaving and the rubbernecking factor also created challenges for firefighters trying to move into the area. Leaders said that evacuations of less threatened neighborhoods clogged critical ingress and egress routes from neighborhoods that were most threatened in areas without good route control and planning. Respondents indicated that in the smoothest evacuations, law enforcement moved to predetermined choke points when evacuation trigger points were reached."
Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

6.5 Coordination

1. **Conduct Interagency Planning and Rehearsals** – "The Mountain Area Safety Task Force organization had conducted significant planning and tabletop rehearsals for the mountain communities in San Bernardino and Riverside counties. Because of this interagency preparation, the evacuations in these areas were reported as timely and without major incident."
Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

2. **Co-Locate Entities Responsible for Evacuations** – "As soon as firefighters recognized the potential for evacuation, the need to coordinate with law enforcement became paramount. Leaders said the

most effective method was to have a sheriff's representative co-located in the Incident Command Post to facilitate decisions to get routes cleared into the upper ends of wildland-urban interface neighborhoods. It was extremely difficult for fire resources to maneuver around evacuees, and early support from law enforcement allowed fire resources to get on scene as soon as possible."
Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

3. **Coordinate with Others in Evacuation Planning** – "Federal, state, and local transportation, emergency, and law enforcement agencies can be involved in evacuation planning, depending on the scale of the disaster and the evacuation. The evacuation plan may evacuate the affected population in shifts, use more than one evacuation route, maximize use of transit, and include several evacuation destinations to spread demand and thereby expedite the evacuation, where possible. All affected jurisdictions (e.g., states and counties) at the evacuation origin, evacuation destination, or along the evacuation route must be informed of the plan."
Disaster Response and Evacuation User Service: An Addendum to the ITS Program Plan

4. **Coordinate with Others Regarding Evacuation or Sheltering** – "Coordinate with other entities regarding emergencies and the need for evacuation and/or sheltering."
State and Local Response Actions

5. **Have a Pre-Established Internal Coordination Plan and System for External Coordination** – "Each agency needs to have a pre-established internal coordination plan as well as a system for external coordination with other agencies, the press, and the public. Transportation agencies typically have staff at multiple locations with multitudes of varying responsibilities. The Port Authority of New York and New Jersey, for example, operates bridges, tunnels, transit lines, airports, and water ports within the metropolitan area. The California Department of Transportation (Caltrans) oversees a highway system of 25,000 kilometers in length and a staff of over 23,000."
Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

6. **Integrate Emergency Service Centers with Various Functions** – "To date in most cases, regions have developed separate, basically independent, emergency service centers to coordinate public safety activities, and separate transportation centers to coordinate and manage traffic. These have proved effective in their individual domains. Currently, a handful of regions are integrating these centers into joint facilities, resulting in the further improvement of transportation management."
Vision 2010: Enhanced National Capabilities for Emergency Transportation Operations

7. **Use an Incident Command System** – "A requirement for ensuring this institutional coordination is to have an established chain of command through a pre-existing command system. The Incident Command System (ICS), developed in California during the 1970s, is one example of a structure that a region can adopt to help ensure a coordinated response among the various agencies."
Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

6.6 Evacuations

6.6.1 Evacuation Management

1. **Provide "Evacuation Resource Sharing** – An effective information sharing service is implemented that keeps all agencies in all affected jurisdictions apprised of the evacuation plan and evacuation status. Resources are coordinated through the same information sharing capability. Resource

requirements are accurately forecast based on the evacuation plans, and the necessary resources are located, shared between agencies if necessary, and deployed at the right locations at the appropriate times. Current status of all resources is tracked so that resource status is known at all times."
Disaster Response and Evacuation User Service: An Addendum to the ITS Program Plan

2. **Provide "Evacuation Traffic Management** – Special traffic control strategies are implemented to control evacuation traffic, including traffic on local streets and arterials as well as the major evacuation routes. Reversible lanes, shoulder use, closures, special signal control strategies, and other special strategies may be implemented to maximize capacity along the evacuation routes. Incident management on the evacuation route is paramount with critical need for service patrols to minimize the traffic flow impact of minor incidents. Transit resources play an important role in an evacuation, removing many people from an evacuated area while making efficient use of limited capacity. Additional shared transit resources may be added and managed in evacuation scenarios. Toll and transit agencies must also be notified so that tolls and fares are eliminated during an evacuation. Traffic control strategies are also implemented to facilitate reentry to the evacuated area."
Disaster Response and Evacuation User Service: An Addendum to the ITS Program Plan

3. **Provide "Evacuation Traveler Information** – The public must be provided with real-time evacuation guidance including basic information to assist potential evacuees in determining whether evacuation is necessary. Once the decision is made to evacuate, evacuation times, one or more evacuation destinations, the evacuation route (tailored for the evacuee), available transit services, expected travel times, expected evacuation durations, and other information are provided that are necessary for an orderly evacuation.

   This function will also provide guidance for returning to evacuated areas, information regarding clean-up, and other pertinent information to be distributed from federal, state, and local agencies.

   Information on the services (shelters, medical services, hotels, restaurants, gas stations) along the evacuation route and at the evacuation destination are also important to the evacuee and should include real-time information on availability and address special needs (disabilities, the elderly, pets/livestock, etc.). Real-time information on traffic conditions, closures, road and weather conditions, and incident information are also provided along with information on alternative routes so that evacuees can better anticipate their travel times and select alternate routes where available."
   Disaster Response and Evacuation User Service: An Addendum to the ITS Program Plan

6.6.2 Evacuation Plan

1. **Develop an Evacuation Plan** – "The evacuation plan includes all phases of the evacuation: the event; warning, informing, and moving people; shelter and services for evacuees; and recovery, reconstruction, and return. An important component of the evacuation plan is information about when an evacuation is warranted; there is a discussion of the benefits of shelter in place as an effective response in many emergency situations."
   Synthesis of Transit Practice 27: Emergency Preparedness for Transit Terrorism

6.6.3 Evacuation Procedures

1. **"Coordinate Refuge-of-Last-Resort Procedures** – These procedures should address the possibility that evacuees may be stranded on evacuation routes."
   State of Florida Regional Evacuation Procedure

6.6.4 Evacuation Routes

1. **Inform the Public of What to Do in an Emergency and Provide Evacuation Information. Encourage the Public to Know Their Evacuation Route.**
   The Jacksonville State University Police – Jacksonville, Alabama, for the Chemical Stockpile Emergency Preparedness Program (CSEPP)

2. **Use Contra-Flow Lanes for Evacuations** – "The State of Florida has developed a multi-agency plan to convert several limited-access roadways to one-way operation in the event of a major evacuation. These roadways will be converted on an as-needed basis depending on expected traffic needs."
   ITE Journal: "Implementing ITS for Hurricane Evacuations in Florida"

6.7 Operations

1. **Address Potential Traffic Impediments** – "The Florida Division of Emergency Management will coordinate with the County Emergency Operations Center to ensure that all toll booths, draw bridges, and other known impediments to facilitated traffic flow along regional evacuation routes have been removed, closed, or otherwise addressed."
   State of Florida Regional Evacuation Procedure

2. **Develop a Reporting and Incident Tracking Scheme That is Understood by All** – "Many regions struggle in maintaining up-to-date information regarding the decisions and actions of emergency responders, and their likely impacts on the transportation system. In addressing this challenge, some regions have identified classification systems… which support a reporting and incident tracking scheme that is understood by both transportation personnel and emergency responders. Implementation of such a classification system requires regional stakeholders to recognize that major incidents and special events usually require assistance from, and coordination among, many transportation and public safety agencies across jurisdictional boundaries, and that this coordination cannot be managed solely on an ad hoc, agency-by-agency basis."
   Vision 2010: Enhanced National Capabilities for Emergency Transportation Operations

3. **Evacuate People Quickly Out of the Incident Area to Locations Where Family Members Can Pick Them Up** – "Former US Department of Transportation Deputy Secretary Mort Downey commended Washington DC's metro system for doing a 'terrific job' getting frightened people out of town on 9/11—and worrying later about how people would get to a preferred final destination. Metro told passengers 'we'll get you out of town.' Meanwhile, Metro rerouted buses to suburban stations in order to transport passengers to shopping malls where families could pick them up later. Downey believes that America's cities should benefit from Washington's experience and develop their own well-thought out evacuation capability, which can be used 'not just for terrorism, but for hurricanes.'"
   California Transportation Security Summits, March 28 and 29, 2002

4. **Have an On-Scene Agency-In-Charge** – "In the majority of cases, state law enforcement is the lead agency in charge during a major event which affects the freeway system. Other agencies that may lead the transportation response include local law enforcement and fire and rescue (when there is a hazardous materials event or smoke conditions)."
   Emergency Transportation Operations: Freeway Traffic Management Center Capabilities and Needs

5. **Have Emergency Transportation Operation Systems in Place Prior to an Emergency Event**

a. *"Mission* – Document what the freeway Traffic Management Center can contribute during regional emergencies.
b. *Stakeholders* – Identify Traffic Management Center partners, communication protocols, and contact information.
c. *Planning* – The freeway transportation system is an active partner in the regional emergency planning process.
d. *Routing* – Emergency evacuation routes and markings, alternate routes and markings, traffic control points, and reception centers and evacuee support facilities are identified prior to an actual event, based on the most current traffic network data available.
e. *Resources* – Pre-determined and pre-designated resources to support emergency transportation operations are identified and shared prior to an incident."

Vision 2010: Enhanced National Capabilities for Emergency Transportation Operations

6. **Have Emergency Transportation Operations, Event Awareness, Operations, and Recovery Systems in Place**
a. *Awareness: Weather-Related Warning System* – An effective system is in place to convey road weather information and storm warning information to transportation agencies and the regional emergency planning and response community.
b. *Awareness: Security Threat Warning System* – Threats are effectively conveyed to the transportation system and universally understood protocols are put in place to address heightened threat levels.
c. *Awareness: Secure Area Surveillance System* – An effective system is in place to alert transportation personnel regarding attempted and actual penetrations of transportation infrastructure.
d. *Notification* – A system is in place to ensure the rapid notification of transportation agencies that may be affected by an emergency event.
e. *Situation Assessment* – A system is in place that supports the activities of transportation agencies to determine the condition of the transportation network.
f. *Coordinate Field Response* – Freeway Traffic Management Centers are able to manage and coordinate response activity with other transportation agencies and local responders using integrated data, voice, and video sharing networks.
g. *Event Stabilization* – A system is in place to ensure that that the response transitions effectively to a controlled traffic management plan for resolving or recovering from the disruption.

Vision 2010: Enhanced National Capabilities for Emergency Transportation Operations

7. **Have One Route in for Responders and No Mixing of Evacuee Traffic** – "Neighborhoods were emptied by allowing traffic out but not in. Eventually this strategy provided the freedom of movement that fire response resources needed. One very effective technique involved law enforcement keeping one street cleared for incoming emergency traffic, prohibiting outgoing evacuation traffic on that street. This allowed firefighters into the upper neighborhoods earlier to prepare structures."
Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

8. **ITS Technology Can Be Used to Monitor Traffic Conditions After an Evacuation** – "Data from traffic sensors also played an important role. Traffic along key sections of the roadway system including bridges leading to Manhattan was measured, and the information was used to help determine changes in the hours of the lower Manhattan crossings single-occupancy-vehicle ban."
Emergency Transportation Operations: Stakeholders, Functions, and Automated Tool

9. **Stage Resources Along Evacuation Routes** – "Implementation of a regional evacuation will require substantial personnel, equipment, and supplies at various locations along the evacuation routes and at facilities designated as risk and host shelters:

a. Programmable electronic public information signs/displays
b. Local/small area radio broadcast stations
c. Wreckers, tow trucks, and other heavy equipment for clearing roadways
d. Gasoline tankers for replenishing fuel supplies at gas stations on regional routes
e. Ambulances, medical personnel
f. Shelter management personnel and supplies
g. Buses for transport of evacuees without other means
h. Sampling/testing equipment and personnel."
State of Florida Regional Evacuation Procedure

10. **Use ITS Technologies to Monitor Evacuations** – "The state has expanded its traffic-monitoring capabilities with 34 closed-circuit television cameras on hurricane routes, aircraft, and automated speed detectors. Traffic information will be relayed to the state emergency operations center. From there, emergency managers can send messages via cell phone to solar powered highway signs, which guide evacuees to less congested routes, according to Dick Jenkins, an engineer with the South Carolina Department of Transportation. The state will roll out portable roadside radio transmitters that provide detailed traffic information."
Coastal Heritage, "Floyd Follies: What We've Learned"

6.8 System Redundancy and Resiliency

1. **Develop Redundancy in Several Areas** – "Redundancy, the ability to utilize backup systems for critical parts of the system that fail, is extremely important to consider in the development of a process or plan for emergency response and recovery. In each of the four cases, the portions of the system that failed or required backup were dependent upon the specific nature and scope of the emergency. At a minimum, emergency response planners should consider designing redundancy into the system in several areas: the regional transportation network, agency personnel, communications and utilities, control centers and equipment and supplies."
Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

2. **Recognize that Solutions Change** – "In each of the four cases, transportation agencies had to work together to provide alternative travel options to the public. These alternatives shifted over time in response to changes in travel behaviors of the public."
Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

3. **Have Additional Trained Staff** – "Because emergencies can occur at any time, it is crucial to have a redundant system of trained personnel in place who are able to make good, accurate, and timely decisions. With the New York and Los Angeles cases, the recovery effort lasted for several months. Maintaining staff on emergency status for this length of time can take a toll on personnel and highlights the need to have multiple people trained for each job."
Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

4. **Have Redundant Equipment and Supplies** – "It is important that agencies be able to utilize multiple technologies to communicate with staff and the public. This allows an agency to shift among technologies depending on the demands on the system, the topography of the land, or the amount of

destruction to any one type of technology. In New York, the loss of electricity hampered operations and recovery efforts. Redundant mobile generators allowed for the restoration of power to command centers and to emergency responders. Redundant control centers were needed in New York City when existing centers were destroyed. Los Angeles had to build a new center to increase its capacity to respond to the recovery effort. In both Baltimore and New York, agency officials spoke of the need to have redundant supplies of equipment. It was also important to maintain a good inventory of where supplies are kept or could be readily purchased when needed."
Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study

6.9 Training and Planning

1. **Conduct Training Exercises** – "Training is extensive [for Paris Metro staff]. Each employee has a designated role in an emergency and exercises are regularly conducted by the Paris Fire Brigade (BSPP) in the Reseau Express Regional (RER) and Metro in which Regie Autonome des Transports Parisiens (RATP) personnel participate, especially the 'Rolling Stock Lifting Team.' Coordination is facilitated by the fact that many members of the RATP safety team are former firemen. In addition, the RATP conducts 10 to 12 exercises a year involving all management and staff. Some of these are conducted during normal service; others are conducted at night when the system is shut down. At least once a year, there is a 'major exercise' which simulates an explosion, fire, or collision at a station or in a tunnel. The RATP has a history of dealing with terrorism so plans were in place and personnel were prepared. Remarkably, just twelve hours after the explosion, regular train service was restored and the terrorists' goal, to create an atmosphere of uncertainty and turmoil, was denied. The experience of the St Michel bombing proves that planning and training pay off."
   Protecting Surface Transportation Systems and Patrons from Terrorist Activities: Case Studies of Best Security Practices and a Chronology of Attack

2. **Prepare and Practice** – "In fact, the report's major conclusion is that New York's transportation network worked as well as it did on September 11 because city and transportation authorities had taken an all-hazards approach to emergency preparedness, recognized the threat of terrorism, and continued the effort to prepare and practice for possible terrorist attacks."
   Saving City Lifelines: Lessons Learned in the 9/11 Terrorist Attacks

3. **Use Pre-Incident Planning** – "Evacuation and Homeowners—Pre-Incident Planning—Respondents reported that pre-incident planning was the biggest factor in determining the efficiency and effectiveness of evacuations. Frequently, streams of evacuees congested the roads and made both evacuation and response difficult. They said that evacuations were more chaotic and dangerous in areas that lacked a plan. Respondents reported that even in areas that had conducted pre-incident planning, that there were incomplete plans for managing evacuation centers, reinstating utilities, or letting residents return to their homes. This caused unexpected problems for Incident Management Teams."
   Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center

6.10 Transportation Emergency Response Checklist

The Institute of Transportation Engineers has published a Transportation Emergency Response Checklist. The categories include emergency transportation plans, inter-jurisdictional and intermodal cooperation, training preparedness, and transportation system. The checklist is summarized as follows:

1. Develop an **emergency transportation plan**
2. **Make sure transportation is working hand-in-hand with emergency managers** and law enforcement
3. **Conduct "table-top" exercises**, practice a wide range of scenarios, and ensure that transportation managers are full participants
4. **Ensure transportation responders are technically prepared**: training, communication interoperability, and use of modeling tools
5. **Be prepared to use the full capability of the transportation system for response and recovery**: use freeway and arterial management (integrate information with Emergency Operations Center; update timing signals and coordinate with adjacent jurisdictions; use cameras, radios, Web sites, message signs, and highway advisory radio)
   Transportation for Emergency Response and Recovery

7 Potential Tools

The intent of this section is to identify available tools for use in evacuations and/or areas where further research and development may be useful to develop tools to respond to evacuation issues. Tools were found during the literature search, but there was no focused research effort to identify every applicable tool. Later in this project, there will be a more focused effort to identify appropriate tools to assist with evacuations.

7.1 Integrated Corridor Management

Transit can be used as a redundant transportation system that can transport evacuees out of and transport first responders into the incident area. After the incident, public transit can also relieve congestion and provide mobility around the incident area.

Public transit systems are not necessarily perceived this way and, in rural areas, may not be perceived as a tool for evacuations. The Federal Transit Administration is addressing the integration of public transit into the transportation network with its involvement in the Integrated Corridor Management (ICM) System currently under development. While this system does not appear to be specifically targeted to the transportation of evacuees, it could possibly be used during an evacuation situation.

According to the *Overview of ITS Initiatives: What Do They Mean to Transit*, presented at the Transportation Research Board 84th Annual Meeting Public Transportation Forum, surface transportation systems are made up of several independent networks—freeways, including managed lanes; arterials; bus routes; and rail transit. These parallel networks overlay to form transportation corridors. To date, congestion reduction efforts have focused on optimizing the individual networks. However, the capability to respond to demand from other networks is lacking, including:

- Institutional Integration – Lack of operational capability and technology that supports cross-network distribution of responsibilities and sharing of control
- Operational Integration – Lack of integrated cross-network operational strategies and analysis capabilities
- Technical Integration – Lack of cross-network device-to-device data, communication, and procedure integration.

Overview of ITS Initiatives: What Do They Mean to Transit reports: “ICM offers an opportunity to operate and optimize the entire system as opposed to the individual networks.” The purpose of ICM is “to demonstrate that ITS technologies can be used to efficiently and proactively manage the movement of people and goods in major transportation corridors by facilitating integration of the management of the networks in a corridor.”

The presentation lists the following goals for ICM:

- Provide guidance to agencies in implementing integrated corridor operations
- Create supporting analysis tools, approaches, and technical standards
- Demonstrate the value of integrated corridor management.

Transit’s contribution to the roadway is that it offers increased capacity. In addition, ITS increases transit flexibility, efficiency, and coordination. As a result, transit is a more convenient and attractive alternative.

According to the presentation, "Transit can assist in managing demand in corridors during normal operations, and during planned and unplanned events."

7.2 Evacuation Planning

The necessity of evacuation planning is an important lesson learned. According to the ContraCostaTimes.com article "Chlorine Spill Forces Evacuations," entities that had planned for emergencies and/or evacuations felt that, as a result, the situations were handled well. During the evacuation of residents of Graniteville, South Carolina, due to a train derailment, the article reported "local emergency officials said Friday that they were able to move quickly to the collision scene, aided by practice drills and heightened planning since the September 11, 2001, terrorist attacks." Planning appears to be critical to a successful evacuation.

The following tools can support evacuation planning:

Oak Ridge Evacuation Modeling System (OREMS) – OREMS is a software program developed by the Oak Ridge National Laboratory in Oak Ridge, Tennessee, "to analyze and evaluate large-scale vehicular emergency evacuations, conduct evacuation time estimation studies, and develop evacuation plans," as reported on the Oak Ridge National Laboratory Web site.

Possible uses of the OREMS software include:

- Modeling large transportation networks (covering emergency planning zones of thousands of square miles)
- Determining the feasibility of evacuation without detailed route planning
- Identifying best evacuation routes
- Identifying bottlenecks that would constrain the flow of traffic
- Assessing the effectiveness of alternative traffic control strategies
- Assessing the effectiveness of different evacuation strategies
- Estimating traffic speed and other measures of effectiveness on specific roads or potions of the network
- Estimating clearance times for the network or portions of the network.

Evacuation Traffic Information System – The Evacuation Traffic Information System is a Web-based system tool for sharing information among states and agencies.

According to the *TR News* article "Emergency Evacuation: Ensuring Safe and Efficient Transportation out of Endangered Areas," ETIS (Evacuation Traffic Information System) was developed in response to the evacuation for Hurricane Floyd. "The ETIS (Evacuation Traffic Information System) graphically displays the evacuation status of coastal counties, counties, contra-flow segments in use, and the number of vehicles expected to cross state lines. The ETIS (Evacuation Traffic Information System) is the first step in using technology to improve coordination among the various state and federal agencies involved in hurricane evacuations."

The ETIS tool is designed to help state and local managers anticipate state-to-state traffic. It is not a modeling simulation tool, but rather a tool to share information during an evacuation that may help decision makers make adjustments in their evacuation routing.

MitigationPlan.com System – VisualRisk developed this tool to assist in evacuation planning. It was designed to assist emergency management agencies in meeting Federal Emergency Management Agency requirements. However, the tool can be used by officials to review other community mitigation plans—identifying hazards in other areas that could impact their community and the need for an evacuation.

According to the Web site (www.mitigationplan.com), "One of the key features of the MitigationPlan.com is the ability to collate information. That is, all local community mitigation plans are integrated into the appropriate county mitigation plan, which in turn can be rolled-up into a unified, standardized and complete State Hazard Mitigation Plan. The Plan produced from MitigationPlan.com allows state officials and emergency managers to:

- Evaluate and compare unrelated hazards in different areas
- Assign ranking priorities
- Allocate financial resources for specific mitigation projects."

This tool allows emergency officials to understand potential hazards near their community and helps them plan for the consequences of disasters.

Planning Action Checklists – The Association of Bay Area Governments developed this checklist as a tool that can be used for post-disaster transportation and utility disruptions planning. It includes planning actions for transportation, utility, and emergency service providers to examine methods to keep providing transportation services or to plan around expected transportation interruptions during earthquakes.

As reported by the Association of Bay Area Governments on their earthquake preparedness Web site: "Transportation disruption planning is critical. Employees, customers, and suppliers will need to use roads to get to work, as well as to gain access to key facilities that need repair. Everyone should anticipate transportation disruptions in areas through which they generally travel."

The Association has developed several checklists including:

- General checklist
- Transportation providers checklist
- Utilities checklist
- Emergency service providers checklist
- Local government checklist
- Private companies and residents checklist.

The checklists can be used to assist in the recovery after an evacuation and the restoration of normal operations.

Micro Simulation Programs – There are multiple micro simulation programs that can be used to support evacuation planning. One example is **Dynasmart-X**, which "combines advanced network algorithms and models of trip-maker behavior in response to information in a simulation-based framework to provide: reliable estimates of network traffic conditions, predictions of network flow patterns over the near and medium terms in response to various contemplated traffic control measures and information dissemination strategies, as well through the network," (www.umd.edu).

A second program is **CORSIM**, which "is a comprehensive microscopic traffic simulation, applicable to surface streets, freeways, and integrated networks with a complete selection of control devices (i.e., stop/yield sign, traffic signals, and ramp metering). CORSIM simulates traffic and traffic control systems

using commonly accepted vehicle and driver behavior models. CORSIM combines two of the most widely used traffic simulation models, NETSIM for surface streets, and FRESIM for freeways," as reported at http://ops.fhwa.dot.gov/trafficanalysistools/corsim.htm.

7.3 Evacuation Routing

Evacuations involve the movement of evacuees in their automobiles, and increasing the capacity of roadways to move the volume of evacuees is beneficial.

One current tool for this is lane-based routing. According to the Pergamon-Transportation Research Part A 37 (2003) 579–604 article "A Network Flow Model for Lane-Based Evacuation Routing," lane-based routing "increases intersection approach capacities in directions favorable for evacuating a defined area. Lane-based routing can also be used to reduce [or eliminate] intersection crossing and merging conflicts."

In addition, lane-based routing increases the throughput of the roadway during a time of need, much like the use of contra-flow lanes.

According to the article: "The 2000 Cerro Grande Fire evacuation in Los Alamos provided a valuable example of lane-based routing (LAC, 2001). Evacuees north of the main transportation artery in Los Alamos, Diamond Boulevard, were instructed to enter the westbound right lane of this Boulevard and remain in that lane. Evacuees originating south of Diamond Boulevard were instructed to enter the westbound left lane and remain in that lane. For this reason, vehicles north of Diamond did not merge with vehicles from the south. Furthermore, major intersections were placed in a state of uninterrupted flow. This allowed emergency managers to evacuate more than 11,000 residents in a few hours with only one major exit, a feat that would have taken many more hours under normal traffic control."

7.4 Identification of Hazardous Materials and Manifest

First responders on the scene of incidents may be unaware of hazardous materials being transported. They need to know immediately if an evacuation order needs to be issued due to the accident. For example, during the derailment of a car carrying chlorine gas, the first responders immediately start evacuating nearby residents. However, taking the time to ascertain the nature of the "spill" could impact whether to evacuate or shelter-in-place.

Operation Respond Emergency Information System (OREIS) – OREIS is a tool to assist first responders regarding the transport of hazardous materials.

As reported in the *Columbus Dispatch* article "Rails Bring Danger to Town, But Threat Hard to Quantify," OREIS, created by the Operation Respond Institute, is a "computer system that allows local responders in an emergency to see a railroad company's cargo list and identify hazardous materials by container number, trailer number, and carrier name." Currently, the City of Columbus, Ohio, Division of Fire is equipped with this system.

According to the Operation Respond Institute press release, "OREIS is a software program that provides first responders with time and lifesaving real-time information about hazardous materials and passenger railroad incidents. OREIS transmits real-time information about the hazardous materials contents of freight railcars and motor carriers and schematics for passenger railcars and locomotives."

The press release also reported: "In September 2004, it teamed with Qualcomm to demonstrate an emergency response system that allows emergency responders to respond more quickly and effectively to motor carrier safety and security incidents along the nation's highways. Operation Respond is to integrate its OREIS emergency response software with Qualcomm's OmniTRACS satellite-based mobile communications and position location system to demonstrate the ability to track the movement and contents of vehicles as they travel the highways, and provide this information to first responders in the case of an incident or security breach. Operation Respond has partnered with Emergency Services Information Network (ESINC) to allow emergency responders to quickly and accurately receive information about the presence of hazardous materials, and respond accordingly. ESINC (www.esinc.info) is an electronic network of OREIS users who receive emergency messages and alerts via fax, cell phone, pager, and email."

Transportation Security Administration Truck Security Pilot – The Transportation Security Administration is proposing to develop a pilot contract to monitor trucks in all 50 states and provide this data to governmental officials and first responders. The Administration is seeking competitive offers to develop a proposed pilot contract that "include(s) the ability to: continually track truck locations and load types in all 50 states; and develop a set of protocols capable of interfacing with existing truck tracking systems, a truck tracking center, a Government intelligence operations center, state, local and Federal law enforcement agencies, and first responders," as reported on the Federal Business Opportunities – Transportation Security Administration Web site, under "Truck Security Pilot."

7.5 Identification of Infrastructure Utilizing GIS

The identification and location of infrastructure could be beneficial during evacuation planning and actual evacuations. It could alert emergency officials to avoid certain streets or areas due to the existing infrastructure.

As reported in the *American City and County* article "Community Evacuation: Ensuring Safe Passage," "'to enhance planners' foresight, Denver is expanding its geographic information system (GIS) to show the locations of HAZMAT storage facilities and transportation routes. 'We've requested that the city add mapping levels that we can use for evacuation planning,' says [David Sullivan, acting director for Denver's Office of Emergency Management]. 'With this system, we [will be able to] map areas surrounding possible spills and figure out how many people must move and what routes they should take. We can also plan the numbers of shelters people will need.'"

In addition, the article reported: "Like Denver, other cities are employing technology as a silent, yet indispensable partner in expanding planning, tracking and communication capabilities. For example, in Grand Forks, North Dakota, planners use GIS to map electrical power lines, fire hydrants, sluice gates and other infrastructure that must be shut down as floodwaters rise and the potential for evacuation increases."

7.6 Identification of Evacuation Routes

Evacuees fleeing an incident need information as to the fastest and shortest route to take to flee. While people may be familiar with local streets around their homes or work locations, they may be unfamiliar with the larger street network in their community. Having information on routes to take could be invaluable.

511 – A tool currently available to over a quarter of the population is 511 service. The 511 service is an Internet/phone service that provides information to travelers, including traffic and transit information. 511 can assist drivers in selecting routes during an incident.

According to the *Implementation and Operational Guidelines for 511 Services*, the "Virginia Department of Transportation found that 511 is a welcome asset during incident and traffic management situations. The 511 service is being used in conjunction with permanent and portable changeable message signs to relay critical information to travelers during major incidents, typically hazardous material spills that can close an Interstate. Because changeable message signs are limited to three lines of text on three panels, multiple detour listings and describing complex situations is generally not possible."

The Transportation Research Board's *Intelligent Transportation Systems Program: 2005 Update* reported: "As of November 2004, 511 is available to 77 million Americans—26 percent of the US population. In 2005, the 511 Coalition activities to focus on targeted metropolitan areas and E911 'calls' from any communication or networked devices."

Automated Calling System to Emergency Planners – The State of California has an automated calling system that alerts local emergency planners; however, the system did not work as intended in June 14, 2005 when it failed to alert some people about a tsunami off the west coast. The system is intended to alert emergency planners who in turn alert the public to the need to evacuate.

Cell Phone and Local Authorities – Cell phones have been used by the traveling public to alert officials to accidents that lead to an evacuation effort. According to *I-95 Shutdown: Coordinating Transportation and Emergency Response*, "Within minutes of the [tanker] explosion [on I-95], the Maryland State Police began receiving calls about the incident from motorists dialing #77 on their cellular phones, and fire and police departments from multiple jurisdictions reported to the scene and its vicinity."

Cell phones with video capabilities also have the potential to assist the authorities during times of emergencies. During the London bombing of 2005, a passenger recorded a video image of the incident. While this may not assist authorities during the incident, it may help afterwards when analyzing the incident.

During times of crisis, people with cell phones tend to use them to contact others. Government entities have the potential to tap into this occurrence with the ability to map cell phone use in a community. While unable to detect the type of incident, this mapping should alert authorities to potential incidents or events that generate cell phone usage.

Cell Phone Television Screen – A future tool is a cell phone that can receive evacuation orders and information, such as evacuation routes to be used or areas to avoid during an evacuation.

The Japan Times Online article "Disaster Broadcasts Via Cell Phone Eyed" reported: "KDDI Corp. and Hitachi Ltd. have gotten together to develop a phone where the phone's liquid crystal screen automatically changes to a TV screen, and information appears on the lower part. The terminal is equipped with a global positioning system. The developers want terrestrial digital broadcasting and mobile phone technology combined to send evacuation orders and disaster information during large-scale disasters."

CLEER (Catastrophic Level Event and Emergency Response) – A future software tool may be available for local authorities allowing for a visual display of disaster events as they unfold. The CLEER program should be able to provide "police and fire officials a real-time graphic display of an unfolding

disaster," thus assisting in the identification of evacuation routes as reported in the *London Free Press* article "Software Firm Can Model Disasters."

eCall – This tool is an automatic emergency call system using global positioning software to identify vehicles. It can be used to assist evacuees fleeing an incident who may be involved in accidents along the way. These accidents have the potential to impact evacuation routes and create additional congestion. Knowing the location of the accidents could be beneficial to government officials.

In Europe, all new cars are to have the eCall systems installed by 2009. According to the Carconnection.com article "EU to Use New Emergency Call System," eCall would report "exact coordinates and any other information it can collect about the crash to a Public Service Answering Point (PSAP), which would report the information in a standardized way to the proper local emergency dispatch crews. The exact coordinates and standardized form will help reduce response times, and direct access to other information will help with EMT preparedness."

Radio Frequency Identification (RFID) Tags – A tool currently being deployed by the Orlando/Orange County Expressway Authority is using a RFID-based traffic monitoring system for vehicle transponders to create an average trip time and then disseminating the information to the public.

According to the *RFID Journal* article "RFID Drives Highway Traffic Reports," "information about commute times will be sent to the public on dynamic message signs, installed at motorists' decision points around the roadway system to provide up-to-date traffic information. Motorists will also be able to access traffic information by calling 511 (the national travel information telephone number currently in use by 21 states) or by accessing a Web site that has not yet activated."

The traffic information could assist an evacuation situation by providing drivers with traffic and route information.

Real-Time Traffic Information by Cell Phone – Services are now available for cell phone users to alert them to real-time traffic information. As reported in the *San Jose Mercury News* article "Stuck on the Freeway? Your Cell Phone Will Guide You," in February 2, 2005, Rand McNally launched a traffic information service (www.randmcnally.com/traffic) for $3.99 a month for customers of AT&T, Sprint PCS, and Verizon Wireless. "Rand McNally Traffic puts highway maps on your phone's screen with color coding to show driving speed. The maps also display icons to indicate the location of accidents, construction, and other commute killers. You can click the icons, using the keypad on your phone, to get details of why you're stuck in traffic." According to the article, there are at least three other companies offering similar services: MapQuest Traffic (http://www.mapquest.com/mobile/), Pharos Science & Applications (www.pharosgps.com), and Vindigo Traffic (www.vindigo.com/traffic). In addition, there is another tool, the Palm Traffic for Treo Smartphones.

Satellite Traffic Communication – A tool currently available is the receipt of traffic conditions by satellite radio. General Motors is offering satellite traffic information to drivers. The *ITS International News* article "Real-Time XM Satellite Traffic Powered by NAVTEC" reported: "This new technology, offered exclusively by XM Satellite Radio, is fully integrated with the vehicle's on-board global positioning software navigation system to display current information about traffic incidents and average traffic speed along specific roadways. A driver can enter a destination into the navigation system, and then, aided by a colourcoded display, obtain instant traffic data on the preferred route. Once received, the information is then merged with Navteq maps and continuously broadcast via XM's network of satellites and ground-based repeaters, ensuring that the latest information is available to the driver." In addition, beginning November 2005, "NAVTEC and Sirius Satellite Radio will broadcast traffic data for 22 major US metropolitan areas."

Short Message Service – Short message service systems allow for cell phone users to receive messages such as text messages, electronic mail, pages, and voice mail to alert them of potential dangers. The Dutch government is testing a mobile phone alert system that sends text messages to cell phone users of potential incidents and targets cell phone users in a particular area impacted by the incident.

Text Messaging: Orion Information Services – A tool available nationwide is text messaging. In conjunction with TrafficCast, Orion Information Services is offering a comprehensive traffic management system that uses text messaging.

As reported in the Orion Information Services press release, "it is the first comprehensive traffic management system available using text messaging. Orion is offering this service in conjunction with TrafficCast (www.trafficcast.com) and it is the only true national network that provides personalized, route-specific, real-time and predictive speed and travel time information. Unlike its competitors, [it] monitors traffic flows on all routes in major US cities, predicts traveling times, and factors in the effects that local weather patterns and special events will have on transit times."

This service may have the ability to communicate to evacuees in real time regarding routes and traffic on the routes. It may also be useful to emergency planners to adjust evacuation routes in real time.

Wireless Traffic Sensor Network – The Maryland State Highway Administration signed an agreement with Traffic.com (traffic data collection and reporting firm) to construct a network of wireless roadside traffic sensors. According to the *ITS America* article "Maryland Signs Traffic.com to Construct Wireless Traffic Sensor Network in Maryland," "The completion of this project will provide Traffic.com with sensor coverage from north of Baltimore in Maryland to south of Washington, D.C. in Virginia, including the stretch of Interstate 95 that connects the two Beltways. The new sensors will provide vehicle speed, congestion levels, and travel times to Baltimore and Washington, D.C. based operations centers staffed and managed by Traffic.com, which distribute reports and incident/event information to Traffic.com's broadcast media affiliates, commercial customers, and to the public through its Web site at www.traffic.com. Traffic.com currently provides vital traffic information to Baltimore Beltway-area drivers through several media affiliates including TV stations … and to radio listeners," and also through AM radio stations.

These tools provide information to motorists that could be useful during an evacuation. However, the use of text messaging or information by cell phone needs to be tempered with the knowledge that cell lines may be unavailable due to an overloading of the phone lines.

7.7 Informing People of the Need to Evacuate

People are not always informed of the need to evacuate during an incident. For example, during the evacuation of Graniteville, South Carolina, although 5,400 residents were evacuated, many were left behind.

In addition, the *San Francisco Chronicle* article "Deadly Chlorine Gas Gone—But Fear Hangs Over Hard-Hit Town: Some Residents Warily Return Home After Train Wreck" reported: "Rhonda Smith described gazing out at emergency workers whizzing back and forth in safety suits, and waking her children to tell them she loved them. She had no car at her house and was waiting for somebody to stop by to ask if she was safe; no one came until more than 18 hours after the crash. 'I don't even know how to explain the feeling,' she said."

The following are some of the tools that can be used to inform the public of the need to evacuate.

Cable Television – Local cable services can be a tool to provide notification of an evacuation.

The *Compendium: Graduate Student Papers on Advanced Surface Transportation Systems: Application of ITS Technology to Hurricane Evacuation Routes* reported that in Galveston, Texas, "the Emergency Management Coordinator has access to the only cable provider on the island. He has the power to override all programming to alert the public of a recommended evacuation."

Not all potential evacuees may have access to cable television, but this is one of several existing low-cost tools for notification.

Email Notification and Phone Alert Rings – Another tool is the use of email notification and a telephone alert ring. When there is a need to evacuate and people have signed up for an email emergency notification service, an email message notifying the need to evacuate could be sent quickly. Phone alert rings also serve the same purpose, except phone numbers in a geographic area can be targeted

For example, according to the Federal Highway Administration Transportation Evacuation Planning and Operations Workshops 2004 presentation "How the Big Easy Became the Worst Possible Hurricane Disaster," the State of Louisiana has "identified 180 key decision makers who need weather information, [with] automatic emails alerting them of the weather and alert rings selected by them" for phone calls that need to be made.

Emergency Alert System – Emergency alert systems can use a variety of ways to communicate with people needing to evacuate, such as transmitting messages via television, radios, pagers, and other digital devices.

For example, the City of Denver uses an emergency alert system to communicate to the public. According to the *American City and County* article "Community Evacuation: Ensuring Safe Passage," the Office of Emergency Management uses the emergency alert system, which replaced the conventional emergency broadcast system. Using digital technology, the emergency alert system can transmit live or recorded messages to broadcast media and to specially equipped consumer televisions, radios, pagers, and other digital devices. The emergency alert system also allows unattended media to receive and transmit emergency messages automatically.

Reverse 911® – According to the 2004 Annual Hazards Research and Applications Workshop: Natural Hazards Center presentation "Transportation and Evacuation Issues in Emergencies: S04-3," "A relatively new type of public warning, Reverse 911®, is tailored to communicate a warning message to as many as 11,000 telephones in 30 seconds. [Joe] Golden suggested that this technology enables focused targeting to citizens directly impacted by the hazard and allows an alert to be communicated at hours when individuals may have turned off traditional mass media. The Reverse 911® technique will be tested in two cities, New Orleans, Louisiana, and Houston, Texas, to communicate flash flood and tornado warnings."

7.8 Interoperable Communications

Communication systems at times may be unable to communicate with one another due to separate channels or technology. Having the ability for entities to communicate with one another using their existing systems should assist in the identification of evacuation routes. As reported in the *ARINC News* article "ARINC Wins Nation's First Communications Contract Based on SAFECOM Guidelines from

DHS," "It is the first project of its kind in the US, and the first ever to follow the guidelines for interoperability established by the US Department of Homeland Security's SAFECOM program. ARINC will deploy its AWINSSM interoperability technology to enable more than 40 separate police, fire, emergency medical, and government agencies to communicate with one another while retaining their existing radio systems."

There are other commercial communication systems available providing interoperable communications. Some of these systems identified in *Top Priority: A Fire Service Guide to Interoperable Communications* to provide communication interoperability include:

- Cellular service with push-to-talk capability
- Nextel Direct Connect radio communication network, which is a nationwide wireless voice and data system
- One- and two-way paging services using cellular phones and/or Internet-ready phones
- Console integration providing an integrated communications system by connecting several disparate communication systems into one interoperable system
- Global position systems enabled cellular phones
- Commercial global position systems location and tracking systems
- Interoperability directory of emergency response services
- Database look-up applications to provide emergency services with remote access to key information databases
- Patient tracking systems such as Emergency Patient Tracking System using handsets or personal digital assistants
- Nextel emergency response team (ERT), which responds to state and federally declared disasters.

7.9 Location of Public Transit Buses and Rail Systems

In an evacuation situation, public transit equipment can be used to transport evacuees. While vehicles may remain on schedule, at other times they may not. Buses can be re-routed or dispatched as needed. Having agency staff that can provide information on the location of a bus is very beneficial, but there may be times when staff is unavailable. Information on bus arrival times can be important to evacuees and may assist in their evacuation.

MyBus – MyBus is a tool that can assist evacuees in knowing the location of public transit buses. According to the American Public Transport Association *Passenger Transport* article "Bus Advances Are Fueling Changes in Perception," MyBus "provides estimated departure times of buses from specific geographic locations; the listings can be read on a mobile phone outfitted with a wireless application. BusView maps out bus locations on a personal computer, so riders can determine how long they have to get to the stop."

The article reported: "King County Metro uses two vehicle location technologies developed by the University of Washington, called tracker systems. The university developed MyBus and BusView as part of Smart Trek, a model deployment initiative project for Intelligent Transportation Systems, with funding from the US Department of Transportation. A similar program, TransMart, is in use by Long Beach Transit in Long Beach, California; a radio and text messaging system that connects bus drivers with the communication center and provides real-time location updates. The system can track each bus as an icon traveling on a wall-mounted map in the communication center."

Evacuees may use public transport to flee an incident, as was the case during the 9/11 terrorist attacks in both New York City and Washington, DC. Evacuees may need to transfer between the bus and rail system, and knowing when the next vehicle will arrive could be beneficial.

A tool is currently available that utilizes GPS technology to minimize passenger waiting times when interchanging between the two services. The system, being pioneered by the Greater Copenhagen Authority, allows for "public transport users in Copenhagen, Denmark [to] know exactly how long they have to connect from buses to trains, and vice versa, with [a] seamless real-time communications system," as reported in the *ITS International News* article "World First Claimed for Bus/Train Communications System."

According to the article: "Buses and trains will be able to communicate with each other in real time using a city wide digital communication architecture, and thus report to drivers the location and time of arrival of corresponding services. Passengers on board trains and buses will be informed by way of on-vehicle screens the status of their next corresponding service."

The article reported: "Integration of bus and train systems will undoubtedly eradicate what could amount to hours of waiting time and provide our passengers with security and a positive traveling experience."

7.10 Traffic Monitoring in Rural Areas or Blackout Areas

Traffic monitoring tends to occur on key facilities generally located in urbanized areas, not in rural areas. However, not all evacuations occur in urbanized areas. For example, the rail derailment that resulted in the release of chlorine gas occurred in the community of Graniteville, South Carolina. In addition, during blackout events, electricity may not be available to traffic monitoring devices, thus preventing traffic management centers from monitoring the situation.

A wireless traffic monitoring system tool is being developed by AirSage to provide real-time traffic data that could be used in rural areas and during blackouts, as well as in urbanized areas and during non-blackout situations.

As reported in the AirSage press release, "AirSage is producing real-time traffic data from wireless phone signaling data. Its patent-pending technology assures individual privacy and offers states a fast, affordable way to extend ITS benefits without additional roadway work zones to install traditional sensors. Signaling data between moving wireless phones and the carrier network are collected and anonymized at secure carrier sites, then converted to real-time traffic speed information and delivered as a live web-based service to government and commercial customers.

"AirSage, Inc. announced that it was granted a patent for its unique method of extracting operational data from the wireless carrier network, matching it with computerized street maps and calculating travel times and speeds on specific road segments. The data is made available as a streaming web feed that can be turned into traffic maps for local news broadcasts, data for transportation planners and congestion alerts for busy commuters and mobile sales personnel. This wireless solution allows AirSage to provide an affordable option to transportation agencies and commercial firms in creating local traffic data for the traveling public.

"It is particularly promising in rural areas, where the application of traditional sensor technologies becomes prohibitively expensive. One key aspect of the patent addresses AirSage's technique for ensuring the privacy of cellular customers—a critical requirement to meet strict privacy policies of wireless carriers and laws in the US and abroad. Another addresses the advanced systems architecture that

allows AirSage to work directly with mobile phone carrier systems to passively extract the required signaling data needed to produce quality traffic information."

Appendix A: Literature Search

Source	Title	Author	Date	Nature of Evacuation	Web Site Address
2001 ITS America 11th Annual Meeting and Exposition: Miami Beach, Florida	Utilization of Florida's Existing and Future Intelligent Transportation Systems for Enhancing Statewide Transportation System Management During and After Hurricane Evacuations	Daniel H. Baxter, P.E., PB Farradyne,	March 8, 2001	Hurricane	http://www.pbworld.com/news_events/publications/technical_papers/2001.asp
The 2004 Annual Hazards Research and Applications Workshop, Natural Hazards Center, University of Colorado, Boulder, Colorado	Emerging Issues in Risk Communication	Proceedings from Workshop	July 2004	Any	http://www.colorado.edu/hazards/workshop/archives/2004/S04-9.html
The 2004 Annual Hazards Research and Applications Workshop, Natural Hazards Center, University of Colorado, Boulder, Colorado	From the Ashes of the 2003 California Wildfires: Perspectives on the Future: S04-13	Proceedings from Workshop	July 2004	Wildfires – Southern California, 2003	http://www.colorado.edu/hazards/workshop/archives/2004/S04-13.html
The 2004 Annual Hazards Research and Applications Workshop, Natural Hazards Center, University of Colorado, Boulder, Colorado	Transportation and Evacuation Issues in Emergencies: S04-3	Proceedings from Workshop	July 2004	Any	http://www.colorado.edu/hazards/workshop/archives/2004/S04-3.html
2004 ITS Conference for Planned Events, New Orleans, December 1, 2004, Booz Allen Hamilton, McLean, Virginia	Evaluation of Intelligent Transportation Systems for the Planning and Operations of Olympic Events	Osama Tomeh and Georges Darido	December 1, 2004	Large Event – Olympics	http://ops.fhwa.dot.gov/program_areas/conf1204/breakout_session4.htm
42nd Annual Conference of the Floodplain Management Authorities of New South Wales, Kempsey, Australia	Flood Warnings: Recent Lessons Learned and Developments Under Way	Neil Pfister, Planning and Research Officer and Allen Rutledge, Assistant State Planning Coordinator New South Wales, Australia State Emergency Service	2002	Flood	http://www.ses.nsw.gov.au/multiattachments/2482/DocumentName/Flood_warnings.pdf
511 Deployment Coalition Washington, DC	America's Traveler Information Number: Deployment Assistance Report #3: 511 and Homeland Security	511 Deployment Coalition	June 2002	Any	http://www.its.dot.gov/511/511secur.htm
511 Deployment Coalition Washington, DC	Implementation and Operational Guidelines for 511 Services	511 Deployment Coalition	Version 2.0—September 2003	Any	http://www.its.dot.gov/511/511ver2.htm

Source	Title	Author	Date	Nature of Evacuation	Web Site Address
ABCNews.com	Rescuers Search for Mudslide Survivors	ABC News	January 11, 2005	Mudslides – Southern California – La Conchita, California January 10, 2005	http://archive.newsmax.com/archives/articles/2005/1/11/100931.shtml
ABCNews.com	US on Guard for Tsunami Risks: West Coast Prepares with Warning Systems and Drills	Ned Potter	December 28, 2004	Tsunami	http://abcnews.go.com/WNT/Weather/story?id=366863
ABC24.com Memphis, Tennessee	Air Quality Deemed Safe, Residents Return Home	Unknown	January 4, 2005	HazMat Fire – El Dorado, Arkansas, January 2005	Not available on the Web
American City and County	Community Evacuation: Ensuring Safe Passage	Michael Fickes	December 1, 2002	Any	http://www.americancityandcounty.com/mag/government_community_evacuation_ensuring/
American City and County	Real-Time GIS Assists Hurricane Evacuation	Unknown	February 1, 2000	Hurricane	http://www.americancityandcounty.com/mag/government_realtime_gis_assists/
American Public Transport Association: Passenger Transport	Bus Advances Are Fueling Changes in Perception	Michael Salmon	November 8, 2004	Any	http://www.apta.com/
ARINC News	ARINC Wins Nation's First Communications Contract Based on SAFECOM Guidelines from DHS	Stephen E. Means	April 6, 2005	Any	http://www.arinc.com/news/2005/04-06-05.html
American Radio Relay League Inc.	Hams Staffing Shelters, Nets as Floyd Nears	Unknown	September 15, 1999	Hurricane Floyd 1999	http://www.arrl.org/news/stories/1999/09/14/4/?nc=1
Association of Bay Area Governments (ABAG) Oakland, California	Riding Out Future Quakes: Ideas For Action: Improving Planning of Transportation Providers, Government, Utilities and Businesses for Post-Earthquake Transportation Disruptions in the San Francisco Bay Region	Association of Bay Area Governments (ABAG) Oakland, California	October 1997, updated in March 1999	Earthquake	http://quake.abag.ca.gov/eqtrans/tran2toc.html
Booz Allen Hamilton McLean, Virginia	Evaluation of Intelligent Transportation Systems for the Planning and Operations of Olympic Events	Georges Darido, Osama Tomeh,	December 2004	Large Event – Olympics	http://ops.fhwa.dot.gov/program_areas/conf1204/breakout_session4.htm#olympic_events

Source	Title	Author	Date	Nature of Evacuation	Web Site Address
Borough of Monaca, Pennsylvania, Emergency Management Agency	Evacuation Routes by Ward for the Borough of Monaca in the Event of an Incident at the Beaver Valley Power Station (Nuclear Facility)	Jeffery S. McKay, Emergency Management Agency Coordinator	November 2001	Power Station Incident	Not available on the Web, but PEMA has a Beaver Valley evacuation route map at http://www.pema.state.pa.us/pema/cwp/view.asp?A=200&Q=221308
The Business Journal of Kansas City, Missouri	KC Scout Officially Hits The Highway	The Business Journal of Kansas City	September 27, 2004	Any	http://kansascity.bizjournals.com/kansascity/stories/2004/09/27/daily9.html
The CarConnection.com	EU to Use New Emergency Call System	Bengt Halvorson	February 4, 2005	Any	http://www.thecarconnection.com/Industry/Daily_Edition/Daily_Edition_Feb_4_2005.S173.A8082.html
Center for Urban Transportation Research, University of South Florida, Presentation to 4th Annual FDOT/FPTA/CUTR Professional Development Workshop	Florida's 2004 Hurricane Season	Amber Reep and Jay Goodwill	June 2005	Any	http://www.cutr.usf.edu/pdf/Hurricane Report - Combined 10_26_2005.pdf
The Charlotte Observer Charlotte, South Carolina	Train Crash Kills 8; Thousands Flee	Henry Eichel and Sarah Jane Tribble	January 7, 2004	Chlorine Gas Derailment, Graniteville, South Carolina, January 6, 2005	Not available on the Web
The Columbus Dispatch Columbus, Ohio	Rails Bring Danger to Town, But Threat Hard to Quantify	Tim Doulin	January 20, 2005	Any	http://www.dispatch.com
Chicago Tribune Chicago, Illinois	Gates Would Cut Access to Loop in Terror Attack	Jon Hilkevitch	May 18, 2005	Any	http://pqasb.pqarchiver.com/chicagotribune/access/840981621.html?dids=840981621:840981621&FMT=ABS&FMTS=ABS:FT&type=current&date=May+18%2C+2005&author=Jon+Hilkevitch%2C+Tribune+transportation+reporter&pub=Chicago+Tribune&edition=&startpage=1&desc=Gates+would+cut+access+to+Loop+in+terror+attack
CNN.com	Dutch Trial SMS Disaster Alert System	Julie Clothier	November 10, 2005	Any	http://www.cnn.com/2005/TECH/11/09/dutch.disaster.warning/index.html
CNN.com	Evacuees Returning as Chemical Fire Rages	Associated Press	January 15, 2005	Chemical Fire – Anderson, Indiana, January 14, 2005	Not available on the Web
CNN.com	Thousands Evacuated Near Indiana Plant Fire	Associated Press	January 15, 2005	Chemical Fire – Anderson, Indiana, January 14, 2005	Not available on the Web

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CNN.com	Toxic Chemical Spill Forces Thousands to Evacuate	Associated Press	March 7, 2005	Chemical Railcar Leak, Salt Lake City, Utah, March 6, 2005	Not available on the Web
Coastal Heritage, Volume 17, Number 1, Summer 2002	Floyd Follies: What We've Learned	John Tibbetts	Summer 2002	Hurricane Floyd 1999	http://www.scseagrant.org/Content/?cid=202
ContraCostaTimes.com Contra Costa County, California	Chlorine Spill Forces Evacuations	Stephen Braun and Jenny Jarvie – Los Angeles Times	January 8, 2005	Chlorine Gas Derailment, Graniteville, South Carolina, January 6, 2005	Not available on the Web
ContraCostaTimes.com Contra Costa County, California	Frantic Search for Survivors Gives Way to Grief	Patrick May – Knight Ridder	January 16, 2005	Mudslides – Southern California, La Conchita, California, January 10, 2005	Not available on the Web
ContraCostaTimes.com Contra Costa County, California	New Software Helps Commuters Dodge Traffic	Michael Regan – Associated Press	August 28, 2005	Any	Not available on the Web
ContraCostaTimes.com Contra Costa County, California	Rescue Ends with Missing Located Alive	Greg Risling and Robert Jablon – Associated Press	January 14, 2005	Mudslides – Southern California, La Conchita, California January 10, 2005	Not available on the Web
ContraCostaTimes.com Contra Costa County, California	Tiny Wave Reveals Gaps in Tsunami Readiness	Alicia Chang – Associated Press	July 18, 2005	Any	http://www.livescience.com/environment/050718_ap_tsunami_warning.html
DisasterRelief.org	Floyd-Hit States Ready for Hurricane Season	Stephanie Kriner	2000	Hurricane Floyd 1999	Not available on the Web
DisasterRelief.org	Hayman Wildfire Breaks Lines, Forces More Evacuations	Cynthia Long	October 8, 2004	Wildfire – Hayman, Colorado, October 2004	http://www.redcross.org/news/ds/fires/020618Hayman.html
DisasterRelief.org	Hurricane Floyd: Filled with Sound and Fury, Signifying—Traffic?	Stephanie Kriner	October 8, 2004	Hurricane Floyd 1999	Not available on the Web
Disaster News Network	Fire Lessons Learned in California	Susan Kim	July 14, 2004	Wildfires	http://www.disasternews.net/news/article.php?articleid=1821
eMediaWire	Event-Responsive (and Traffic-Responsive) Driving Direction Can Be Your Immediate Answer to Transportation Security Issues	Trafttools Press Release	November 17, 2004	Any	http://www.directionsmag.com/press.releases/index.php?duty=Show&id=10634&trv=1&PRSID=5a2844b6360bab09fc5af0479fd9b598

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Emergency Communications Research Unit Carleton University, Canada	Transportation in Emergencies: An Often Neglected Story	Joseph Scanlon, Director, Emergency Communications Research Unit, Carleton University, Canada	2003	Any	http://ariel.emeraldinsight.com/vl=2556094/cl=35/nw=1/rpsv/~1159/v12n5/s4/p428
FCW.com FCW Media Group	Intelligent Transportation Gets Rolling	Megan Lisagor	April 3, 2003	Any	Not available on the Web
Federal Highway Administration Washington, DC	2004 Hazards Research and Application Workshop: Natural Hazards Center	Federal Highway Administration	July 2004	Any	http://ops.fhwa.dot.gov/opssecurity/response/hazards_workshop.htm
Federal Highway Administration Washington, DC	The Hurricane Brett Experience Presentation	Ismael Soto, Texas Department of Transportation, Corpus Christi District	Unknown	Hurricane Brett 1999	Not available on the Web
Federal Highway Administration Washington, DC	I-95 Shutdown: Coordinating Transportation and Emergency Response	David Buck, Breck Jeffers, and Alvin Marquess	September/ October 2004	Tanker Explosion – I-95 Baltimore, Maryland, January 13, 2004	http://www.tfhrc.gov/pubrds/04sep/06.htm
Federal Highway Administration, Public Roads Washington, DC	Learning from the 2003 Blackout	Allan J. DeBlasio, Terrance J. Regan, Margaret E. Zirker, Kristin Lovejoy, and Kate Fichter	September/ October 2004	Blackout New York City and Detroit, Michigan, August 2003	http://www.tfhrc.gov/pubrds/04sep/04.htm
Federal Highway Administration, Federal Business Opportunities	Next Generation 9-1-1 Initiative: Request for Information	Federal Highway Administration	February 16, 2005	Any	http://www.its.dot.gov/ng911/ng911_rfi.htm
Federal Highway Administration Transportation Evacuation Planning and Operations Workshop 2004	Evacuating Florida in 2004	Paul Clark, Florida Department of Transportation (FDOT), Emergency Management Coordinator	April 5, 2004	Hurricane	http://www.rsip.lsu.edu/anb10-3/Resources/Clark-FHWA_NHC_Presentation.ppt
Federal Highway Administration Transportation Evacuation Planning and Operations Workshop 2004	How the Big Easy Became the Worst Possible Hurricane Disaster	George Gele – Louisiana Department of Transportation	April 2004	Hurricane	http://www.rsip.lsu.edu/anb10-3/Resources/Louisiana_2003.pdf
Federal Highway Administration Transportation Evacuation Planning and Operations Workshop 2004	Hurricane Evacuation Routes	Mississippi Department of Transportation (MDOT)	April 2004	Hurricane	Not available on the Web
Federal Highway Administration Transportation Evacuation Planning and Operations Workshop 2004	Reverse-Laning I-65 for Hurricane Evacuations	Alabama Department of Transportation (ALDOT)	April 2004	Hurricane	http://www.rsip.lsu.edu/anb10-3/Resources/Alabama_2003.pdf

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Federal Highway Administration Transportation Evacuation Planning and Operations Workshop 2004	South Carolina Hurricane Evacuation Program 2003	Brett Harrelson – South Carolina Department of Transportation (SCDOT)	April 2004	Hurricane	http://www.rsip.lsu.edu/anb10-3/Resources/South_Carolina_2003.pdf
Flextronics Software Systems web page	Short Message Service Center 5.0 from Flextronics Software Systems	Flextronics Software Systems	2005	Any	http://www.hssworld.com/commapps/smsc/faq.htm
FloridaDisaster.org	Hazardous Weather: A Florida Guide	**FloridaDisaster.org**		Hurricane	http://www.floridadisaster.org/kids/index2.htm
FloridaDisaster.org	Hurricane Awareness Brochure	**FloridaDisaster.org**		Hurricane	http://www.floridadisaster.org/hurricane_aware/pdf/Learn2.pdf
FloridaDisaster.org	Primary Evacuation Maps	**FloridaDisaster.org**	September 9, 2004	Hurricane	http://www.floridadisaster.org/PublicMapping/index.htm
General Accounting Office Washington, DC	Homeland Security—Effective Regional Coordination Can Enhance Emergency Preparedness	General Accounting Office	September 15, 2004	Any	http://www.gao.gov/new.items/d041009.pdf
Gordon Nelson, Assistant Secretary of Operations, Louisiana Department of Transportation and Development (DOTD), Baton Rouge, Louisiana	Testimony to State of Louisiana State Legislature on Hurricane Ivan, 2004	Gordon Nelson	January 5, 2005	Hurricane Ivan 2004 – missed New Orleans	Not available on the Web
Greenville.com Community News Internet Site Greenville, South Carolina	South Carolina Ready for Hurricane Evacuation	Unknown	1999	Hurricane	Not available on the Web
GreenvilleOnline.com Greenville, South Carolina	Charley Spared Us	Unknown	August 17, 2004	Hurricane Charley 2004	Not available on the Web
Guardian Unlimited Manchester, England	Leaked Rail Car Not Created for Chemicals	Leon D'souza	March 7, 2005	Chemical Railcar Leak, Salt Lake City, Utah, March 6, 2005	http://www.highbeam.com/doc/1P1-106092750.html
Guardian Unlimited Manchester, England	Utah Chemical Spill Forces Evacuation	Leon D'souza	March 7, 2005	Chemical Railcar Leak, Salt Lake City, Utah, March 6, 2005	http://www.highbeam.com/doc/1P1-106065816.html
The Herald Bulletin Anderson, Indiana	Magnesium Fire Forces Evacuation of 8,000	Ken de la Bastide	January 15, 2005	Chemical Fire – Anderson, Indiana, January 14, 2005	Not available on the Web
The Herald Bulletin Anderson, Indiana	Those Evacuated Return Slowly	Melanie D. Hayes	January 16, 2005	Chemical Fire – Anderson, Indiana, January 14, 2005	http://www.theheraldbulletin.com/story.asp?id=10049

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Homeland Response	Evacuation: What We Can Learn—and Cannot Learn—from Hurricanes	Alan Brown	Unknown	Hurricane	http://findarticles.com/p/articles/mi_hb4382/is_200409/ai_n15277729
Hot Bananas: Oakville, Canada Amateur Radio Club Monthly Newsletter	Canada's Largest Evacuation	C. H. Powers – VE3APK	March 2001	Rail Crash and Fire – Mississauga Canada, November 1979	http://www.amateurradio.ca/DL3%20Mississauga.doc
ICDN Newsletter	Interactive Web Site to Aid Travelers During Marquette Interchange Project	Wisconsin Department of Transportation	October 19, 2004	Any	http://www.dot.wisconsin.gov/projects/d2/marquette/index.htm
Indystar.com – Indianapolis Star Online Indianapolis, Indiana	Plant Fire Brings Call to Evacuate	John Tuohy and Terry Horne	January 15, 2005	Chemical Fire – Anderson, Indiana, January 14, 2005	Not available on the Web
Indystar.com – Indianapolis Star Online Indianapolis, Indiana	Review Finds Sprinklers Did Not Fuel Anderson Magnesium Fire	Associated Press	January 17, 2005	Chemical Fire – Anderson, Indiana, January 14, 2005	http://www.wave3.com/Global/story.asp?S=2818885
Institute for Public Opinion Research, School of Journalism and Mass Communication, Florida International University	Hurricane Floyd Evacuation	Dr. High Gladwin, Director, Institute for Public Opinion Research, Florida International University	1999	Hurricane Floyd 1999	http://www.fiu.edu/orgs/ipor/floydevac/
Institute of Transportation Engineers (ITE)	Transportation for Emergency Response and Recovery	Institute of Transportation Engineers	Unknown	Any	http://www.ite.org/security/ITE_emerg_response.ppt
ITE Journal	Implementing ITS for Hurricane Evacuations in Florida	Richard Morrow	April 2002	Hurricane	http://www.findarticles.com/p/articles/mi_qa3734/is_200204/ai_n9031715
ITE Journal	Improving Transportation Response and Security Following a Disaster	Nancy Okasaki	August 2003	Any	http://www.ite.org/membersonly/itejournal/pdf/2003/JB03HA30.pdf
ITE Journal	Planning for the Evacuation of New Orleans	Brian Wolshon	February 2002	Hurricane	http://www.findarticles.com/p/articles/mi_qa3734/is_200202/ai_n9045870
ITE Journal	Urban Evacuation in Seismic Emergency Conditions	Umberto Petruccelli	August 2003	Earthquake	http://www.findarticles.com/p/articles/mi_qa3734/is_200308/ai_n9297383
Intelligent Transportation Society (ITS) of America	Maryland Signs Traffic.com to Construct Wireless Traffic Sensor Network in Maryland	ITS America	August 23, 2005	Any	http://findarticles.com/p/articles/mi_m0EIN/is_2005_August_22/ai_n14929695
ITS America News of the Week	Ford Selects Sprint as Preferred Provider for Hands-Free Bluetooth Communication System	Intelligent Transportation Society of America	September 1, 2004	Any	http://newsreleases.sprint.com/phoenix.zhtml?c=127149&p=irol-newsArticle_newsroom&ID=608730&highlight=

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ITS America News of the Week	Hurricane Lili Provides Real-Time Test of Evacuation Technology	Intelligent Transportation Society of America	October 10, 2002	Hurricane	http://www.directionsmag.com/press.releases/index.php?duty=Show&id=5731&trv=1&PRSID=484935504fbc841798033a92c0ae8388
ITS America News of the Week	Key Roads to Get Message Boards	Gareth McGrath	September 17, 2002	Any	Not available on the Web
ITS America News of the Week	My NaviGAtor Traffic Alerts Literally at Your Fingertips	Intelligent Transportation Society of America	December 14, 2004	Any	http://www.itsga.org/News/My%20NaviGAtor%20Traffic%20Alerts%2012-10.pdf
ITS America News of the Week	WSDOT Answers the Call for a Push-Button 511 Option	Intelligent Transportation Society of America	December 6, 2004	Any	http://198.238.212.10/News/2005/01/Jan06_Pushbutton511.htm
ITS America News of the Week	Yahoo! Becomes First Online Maps Provider to Offer Real-Time Traffic Solution	Intelligent Transportation Society of America	December 16, 2004	Any	http://files.shareholder.com/downloads/YHOO/258194718x0x26165/2d2e2474-5c04-4243-9a83-37cbfc001d8f/YHOO_News_2004_12_16_General.pdf
ITS International	The Right Message	Daktronics Press Release	October 21, 2004	Any	http://www.itsinternational.com/Features/article.cfm?recordID=1515
ITS International	Sirius Introduces Navteq-Powered Traffic Data Service	ITS International	August 26, 2005	Any	http://www.itsinternational.com/news/article.cfm?recordID=7840
ITS International News	Real-Time XM Satellite Traffic Powered by Navteq	ITS International News	9-Feb-05	Any	http://www.itsinternational.com/news/article.cfm?recordID=70142/14/2005%2012:
ITS International News	World First Claimed for Bus/Train Communications System	ITS International News	December 24, 2004	Any	http://www.its-norway.no
International Association of Fire Chiefs	IAFC Releases Interoperability Handbook – Press Release	International Association of Fire Chiefs	May 5, 2005	Any	http://www.iafc.org/displayindustryarticle.cfm?articlenbr=27124
International Association of Fire Chiefs	Top Priority: A Fire Service Guide To Interoperable Communications	William L. Pessemier	2005	Any	http://www.iafc.org/displaycommon.cfm?an=1&subarticlenbr=126
Jacksonville State University Police Jacksonville, Alabama	Chemical Stockpile Emergency Preparedness Program (CSEPP)	Jacksonville State University Police		Chemical Weapon Incident	http://police.jsu.edu/csepp.html
James E. Clyburn University Transportation Center, South Carolina State University Orangeburg, South Carolina	Final Report: An Assessment of Emergency Transportation Management for the Rural Elderly	Eva M. Njoku and Innocent Nkwocha	June 2004	Any	http://www.utc.scsu.edu/Research/Reports/2003/emgmgt.htm
Japan Times Online	Disaster Broadcasts Via Cell Phone Eyed	Japan Times Online	December 14, 2004	Any	http://search.japantimes.co.jp/print/news/nn12-2004/nn20041214f4.htm
Japan Times Online	Cell Phones to Be Used as Data Sources in Disasters	Japan Times Online	January 24, 2005	Any	http://www.japantoday.com/

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KFSN-TV – 30 ABC Action News	Accessing Damage to Yosemite	KFSN-TV	May 18, 2005	Flooding in Yosemite National Park, California	Not available on the Web
KSL TV, Salt Lake City, Utah	Blame Game Continues Following Toxic Spill	KSL News	March 8, 2005	Chemical Railcar Leak, Salt Lake City, Utah, March 6, 2005	Not available on the Web
KSLA-TV, Shreveport, Louisiana	Arkansas Inmates Spend Night In Louisiana Because of Fire	Associated Press	January 4, 2005	HazMat Fire – El Dorado, Arkansas, January 2005	Not available on the Web
Latimes.com Los Angeles, California	Chemical Leak Forces Evacuation of 6,000	Leon D'souza	March 7, 2005	Chemical Railcar Leak, Salt Lake City, Utah, March 6, 2005	http://www.freerepublic.com/focus/f-news/1357511/posts
The London Free Press Ontario, Canada	Software Firm Can Model Disasters	Hank Daniszewski	May 7, 2005	Any	http://www.canoe.ca/NewsStand/LondonFreePress/Business/2005/05/07/1029438-sun.html
Louisiana State University, LSU Hurricane Center	National Review of Hurricane Evacuation Plans and Policies	Brian Wolshon, Elba Urbina and Marc Levitan	2001	Hurricane	http://hurricane.lsu.edu/&EvacuationReview.pdf
McKinsey and Company	Increasing FDNY's Preparedness	McKinsey and Company	August 2002	Terrorist Act – New York City 9/11	http://www.nyc.gov/html/fdny/html/mck_report/toc.html
Metro Magazine	Transit Steps Up Security	Leslie Davis	November/ December 2001	Terrorist Act – 9/11	http://www.metro-magazine.com/t_featpick.cfm?id=90502972
Miami Herald Florida	Are We Prepared for the Next Andrew?	Martin Merzer, Elinor J. Brecher, Daniel de Vise, William Yardley, Tim Henderson and Gregg Fields, with the assistance of Florida International University's International Hurricane Center and Institute for Public Opinion Research	August 24, 2002	Hurricane Andrew, 1992	Not available on the Web
Miami-Dade County, Florida	Evacuation Zone Maps and 2004 Hurricane Evacuation Bus Pick-Up Points	Miami-Dade County, Florida	2004	Hurricane	http://www.co.miami-dade.fl.us/oem/library/prepare_hurricane_04.pdf
Massachusetts Institute of Technology Web site	MIT Researchers Map City by Cell Phone	Denise Brehm, News Office	September 14, 2005	Any	http://web.mit.edu/newsoffice/2005/cellphones.html
MTI, Norman Y. Mineta International Institute for Surface Transportation Policy Studies San Jose, California	California Transportation Security Summits, March 28 and 29, 2002	Mineta Transportation Institute	April 2003	Any	http://transweb.sjsu.edu/mtiportal/research/publications/summary/s0104.html

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MTI, Norman Y. Mineta International Institute for Surface Transportation Policy Studies San Jose, California	National Transportation Security Summit, Washington, DC	Mineta Transportation Institute	October 2001	Any	http://transweb.sjsu.edu/mtiportal/research/publications/summary/s0102.html
MTI. Norman Y. Mineta International Institute for Surface Transportation Policy Studies San Jose, California	Protecting Public Surface Transportation Against Terrorism and Serious Crime: An Executive Overview	Mineta Transportation Institute – Brian Michael Jenkins	October 2001	Terrorist Act	http://transweb.sjsu.edu/mtiportal/research/publications/summary/0114.html
MTI, Norman Y. Mineta International Institute for Surface Transportation Policy Studies San Jose, California	Protecting Surface Transportation Systems and Patrons from Terrorist Activities: Case Studies of Best Security Practices and a Chronology of Attacks	Mineta Transportation Institute – Brian Michael Jenkins	December 1997	Terrorist Act – Bombing Paris Metro July 1995	http://transweb.sjsu.edu/mtiportal/research/publications/summary/9704.html
MTI, Norman Y. Mineta International Institute for Surface Transportation Policy Studies San Jose, California	Saving City Lifelines: Lessons Learned in the 9/11 Terrorist Attacks	Mineta Transportation Institute	September 2003	Terrorist Attack – 9/11	http://transweb.sjsu.edu/mtiportal/research/publications/summary/0206.html
MTI, Norman Y. Mineta International Institute for Surface Transportation Policy Studies San Jose, California	Terrorism in Surface Transportation: A Symposium	Mineta Transportation Institute – Brian Michael Jenkins, Frances Edwards-Winslow, Ph.D. CEM	March 1996, reprinted 2001	Any	http://transweb.sjsu.edu/mtiportal/research/publications/summary/9601.html
Nacion.com: Week In Review San Jose, Costa Rica	Floods Wreak Destruction	Unknown	January 13, 2005	Flood	www.nacion.com
Nacion.com: Week In Review San Jose, Costa Rica	Region Lacks Proper Tsunami Alert	Unknown	January 13, 2005	Tsunami	www.nacion.com
National Conference on Managing Travel for Planned Special Events, New Orleans, Louisiana, December 1-3, 2004	Evacuations Management Emergency Preparedness	James Austrich and Jamie Quarrelles, Washington DC Department of Transportation	December 2, 2004	Large Event – Super Bowl	http://ops.fhwa.dot.gov/program_areas/conf1204/breakout_session7.htm
National Conference on Managing Travel for Planned Special Events New Orleans, Louisiana, December 1-3, 2004	International Monetary Fund and World Bank Demonstrations: A Local, Regional and Federal Lesson in Event Planning	Douglas E. Noble, Traffic Services Administration, Washington, DC, Department of Transportation, and Lieutenant Steven Sund, Metropolitan Police Department, District of Columbia	December 1-3, 2004	Large Event – Demonstrations	http://ops.fhwa.dot.gov/program_areas/conf1204/breakout_session7.htm
National Fire Protection Association Quincy, Massachusetts	NFPA 1600 – Standard on Disaster/ Emergency Management and Business Continuity Programs	National Fire Protection Association	2004	Any	http://www.nfpa.org/PDF/nfpa1600.pdf?src=nfpa

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National Hurricane Center Miami, Florida	Family Disaster Plan	National Hurricane Center		Hurricane	http://www.floridadisaster.org/bpr/family%20preparedness/index.htm
National Hurricane Center Miami, Florida	Have a Place to Go	National Hurricane Center		Hurricane	http://www.floridadisaster.org/placetogo.htm
National Hurricane Conference, Washington, DC April 9, 2001	Hurricane Evacuation Decision Support Systems and Related Research and Development Recommendations	Richard Wagoner – National Center for Atmospheric Research	April 9, 2001	Any	Not available on the Web
National Oceanic and Atmospheric Administration Washington, DC	The Legacy of Hurricane Floyd—Inland Flooding and a Massive Evacuation	National Oceanic and Atmospheric Administration, Washington, DC	Unknown	Hurricane Floyd 1999	http://www.ofcm.gov/fp-fy01/pdf/sec1.pdf
National Oceanic and Atmospheric Administration Washington, DC	Frequently Asked Questions on Tsunamis	National Oceanic and Atmospheric Administration, Washington, DC	Last Updated May 2006	Tsunami	http://wcatwc.arh.noaa.gov/frequently.htm
National Oceanic and Atmospheric Administration Washington, DC	NOAA Recognizes City of Hampton, Va., Storm ready	National Oceanic and Atmospheric Administration	December 8, 2004	Any	http://www.publicaffairs.noaa.gov/releases2004/dec04/noaa04-r299-62.html
National Oceanic and Atmospheric Administration Washington, DC	Tsunami Bulletins (Information, Warning, Watch, Advisory)	National Oceanic and Atmospheric Administration, Washington, DC	Unknown	Tsunami	http://www.prh.noaa.gov/ptwc/
National Oceanic and Atmospheric Administration Washington, DC	Tsunami Ready: National Weather Service	National Oceanic and Atmospheric Administration	Unknown	Tsunami	http://www.tsunamiready.noaa.gov
National Transportation Library, Bureau of Transportation Statistics	SCDOT (South Carolina Department of Transportation) Evacuation Route Presentation: South Carolina Coastal Evacuation Directions, Route Maps and Reverse Plans and Maps	State of South Carolina	Unknown	Hurricane	http://www.dot.state.sc.us/getting/evacuation.shtml
National Transportation Safety Board Washington, DC	CSX Train Derailment and Subsequent Fire in the Howard Street Tunnel, Baltimore, Maryland, July 21, 2001(Railroad Accident Brief: Accident Number: DCA-01-MR-004)	National Transportation Safety Board	January 2005	Rail Tunnel Fire – Howard Street, Baltimore, Maryland, July 18, 2001	http://www.ntsb.gov/publictn/2004/RAB0408.htm
Natural Hazards Center, University of Colorado, Boulder, Colorado	Quick Response Report #118: Flash Flooding in Kansas: A Study of Emergency Response and Victims' Perceptions	Bimal Kanti Paul – Kansas State University, Manhattan, Kansas	July 23, 1999	Floods – Kansas 1999	http://www.colorado.edu/hazards/research/qr/qr118.html

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Natural Hazards Center, University of Colorado, Boulder, Colorado	Quick Response Research Report 171: Providing for Pets During Disasters: An Exploratory Study	Leslie Irvine	2004	Hurricane Charley, 2004	http://www.colorado.edu/hazards/research/qr/qr171/qr171.html
Natural Hazards Center, University of Colorado, Boulder, Colorado	Quick Response Research Report 172: Elderly Populations in Disaster: Recounting Evacuation Processes from Two Skilled-Care Facilities in Central Florida, August 2004	Michelle Kuba, Alina Dorian, Sarah Kuljian and Kimberly Shoaf	2004	Any	http://www.colorado.edu/hazards/research/qr/qr172/qr172.html
Natural Hazards Observer	What If Hurricane Ivan Had Not Missed New Orleans?	Shirley Laska – Center for Hazards Assessment, Response and Technology, University of New Orleans	November 2, 2004	Hurricane Ivan 2004 – missed New Orleans	http://www.colorado.edu/hazards/o/archives/2004/nov04/nov04c.html
NBC17.com	Nursing Homes Could Be Safe Havens in Disasters	NBC17.com	May 31, 2005	Any	Not available on the Web
NewPortNews.com Newport, Oregon	A Modest Proposal for the Event Center	Range Bayer	December 17, 2004	Tsunami	http://www.newportnewstimes.com/articles/2004/12/17/opinion/letters/letters10.txt
News10 Sacramento, California	Chemical Spill Forces Mass Evacuation Near Salt Lake City	Associated Press	March 7, 2005	Chemical Railcar Leak, Salt Lake City, Utah, March 6, 2005	Received as an email
Newsday New York City, New York	MTA Still Isn't Equipped to Cope with Disasters	Sally Kya-Hill	December 14, 2004	Any	http://www.railpage.com.au/f-p193633.htm
Newsweek	The Tsunami Threat	Jerry Adler and Mary Carmichael	January 10, 2005	Tsunami – Indian Ocean December 26, 2004	http://www.newsweek.com/id/48126
Newsweek	Tide of Grief	Evan Thomas and George Wehrfritz	January 10, 2005	Tsunami – Indian Ocean December 26, 2004	http://www.newsweek.com/id/48156
NewYorkTimes.com New York City, New York	8 Are Killed in Train Crash and Gas Leak	Ariel Hart	January 7, 2005	Chlorine Gas Derailment, Graniteville, South Carolina, January 6, 2005	http://www.nytimes.com/2005/01/07/national/07derail.html
NewYorkTimes.com New York City	Chlorine Gas Still Leaking from S.C. Train	Associated Press	January 10, 2005	Chlorine Gas Derailment, Graniteville, South Carolina, January 6, 2005	http://www.usatoday.com/news/nation/2005-01-10-train-wreck_x.htm

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NewYorkTimes.com New York City	Fateful Decisions as Deadly Gas from Train Wafted Toward Mill	Matthew L. Wald and Ariel Hart	January 7, 2005	Chlorine Gas Derailment, Graniteville, South Carolina, January 6, 2005	http://www.nytimes.com/2005/01/07/national/07cnd-train.html
NewYorkTimes.com New York City	Investigators Questioning Crew's Role in Train Crash	Matthew L. Wald	January 10, 2005	Chlorine Gas Derailment, Graniteville, South Carolina, January 6, 2005	http://query.nytimes.com/gst/fullpage.html?res=9F03EFDE1F39F933A25752C0A9639C8B63&scp=5&sq=Graniteville+chlorine&st=nyt
NewYorkTimes.com New York City	More People Exposed to Chlorine in Rail Accident Go to Hospital	Matthew L. Wald	January 9, 2005	Chlorine Gas Derailment, Graniteville, South Carolina, January 6, 2005	Not available on the Web
NewYorkTimes.com New York City, New York	Ninth Victim of Chlorine Leak Is Found	Matthew L. Wald and Ariel Hart	January 9, 2005	Chlorine Gas Derailment, Graniteville, South Carolina, January 6, 2005	http://query.nytimes.com/gst/fullpage.html?res=9C0DE7D71E39F93AA35752C0A9639C8B63
North Carolina A&T State University Transportation Institute	Modeling Transit Issues Unique to Hurricane Evacuations: North Carolina's Small Urban and Rural Areas	Judy A. Perkins, Ibibia K. Dabipi, Lee D. Han, Ph.D.	December 31, 2001	Hurricane	http://ntl.bts.gov/lib/11000/11900/11989/ncathurr.html
NWAnews.com, Northwest Arkansas New Source	Air Near Plant Safe; Residents Sent Home	Associated Press	January 4, 2005	HazMat Fire – El Dorado, Arkansas, January 2005	http://www.nwanews.com/adg/News/103811
NWAnews.com, Northwest Arkansas New Source	El Dorado Plant Familiar with Fires, Explosions, Fines	Arkansas Democrat-Gazette	January 3, 2005	HazMat Fire – El Dorado, Arkansas, January 2005	http://www.nwanews.com/adg/News/103760
Oak Ridge National Laboratory Oak Ridge, Tennessee	An Assessment of Future Demands for and Benefits of Public Transit Services in Tennessee	Frank Southworth, David P. Vogt and T. Randall Curlee	March 2002	Any	http://ntl.bts.gov/lib/24000/24100/24154/114617.pdf
Oak Ridge National Laboratory Oak Ridge, Tennessee	Fast Deployable System for Consequence Management: The Emergency Evacuation Component (Sands Paper)	Oscar Franzese and John Sorensen	Unknown	Any	http://www.ornl.gov/~webworks/cppr/y2001/pres/120065.pdf
Oak Ridge National Laboratory Oak Ridge, Tennessee	Oak Ridge Evacuation Modeling System (OREMS)	Oak Ridge National Laboratory	Unknown	Any	http://emc.ornl.gov/CSEPPweb/CSEPPOREMS.html

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Oklahoma City National Memorial Institute for the Prevention of Terrorism (MIPT)	Oklahoma City: Seven Years Later: Lessons for Other Communities	MIPT, Oklahoma City National Memorial Institute for the Prevention of Terrorism	April 19, 2002	Terrorist Bombing, Oklahoma City, Oklahoma 1995	http://www.mipt.org/pdf/MIPT-OKC7YearsLater.pdf
Operation Respond® Institute	Press Releases	Operation Respond® Institute	Winter 2004/2005	Any	http://www.oreis.org/
Orion Information Services Press Release	Motorists Can Get Real-Time Local Traffic Updates Using Simple Text Messaging, Anywhere, Anytime!	Orion Information Services	October 27, 2004	Any	http://www.symbianone.com/content/view/1032/108/
Orlando Sentinel Orlando, Florida	Bush Offers Ways to Increase Gas Supply When Hurricanes Hit	David Royse	August 3, 2005	Hurricane	http://pqasb.pqarchiver.com/orlandosentinel/results.html?st=basic&QryTxt=Bush+Offers+Ways+to+Increase+Gas+Supply+When+Hurricanes+Hit
Orlando Sentinel Orlando, Florida	Offenders Banned From Shelters	Associated Press	August 8, 2005	Hurricane	http://pqasb.pqarchiver.com/orlandosentinel/results.html?st=basic&QryTxt=Offenders+Banned+From+Shelters
Orlando Sentinel Orlando, Florida	Killer Waves Worry Puerto Rico	Matthew Hay Brown	July 21, 2004	Tsunami	http://pqasb.pqarchiver.com/orlandosentinel/results.html?st=basic&QryTxt=Killer+Waves+Worry+Puerto+Rico
Orlando Sentinel Orlando, Florida	Quakes' Aftershocks Rattle Japan	Eric Talmadge	October 25, 2004	Earthquake	http://pqasb.pqarchiver.com/orlandosentinel/results.html?st=basic&QryTxt=Quakes'+Aftershocks+Rattle+Japan
Orlando Sentinel Orlando, Florida	Rain in Costa Rica, Panama Makes Thousands Evacuate	Unknown	January 12, 2005	Flood	http://pqasb.pqarchiver.com/orlandosentinel/results.html?st=basic&QryTxt=Rain+in+Costa+Rica%2C+Panama+Makes+Thousands+Evacuate
Orlando Sentinel Orlando, Florida	14,000 Warned to Stay in During Volusia 911 Goof	Alicia A. Caldwell	April 22, 2005	Any	Not available on the Web
Pergamon Transportation Research Part A 37 (2003) 579–604	A Network Flow Model for Lane-Based Evacuation Routing	Thomas J. Cova (corresponding author), Justin P. Johnson	2003	Any	http://www.geog.utah.edu/~cova/cova-johnson-2003.pdf
Planning Magazine	Danger! Coastal States Get Ready for a Really Rainy Day—By Cranking Up Their Evacuation Plan	Terry Plowman	December 2001	Hurricane Floyd 1999	http://www.intercom.net/~terrypl/evacuation-Planning.html
Popular Mechanics	Collision Course	David Noland	April 2005	Chlorine Gas Derailment, Graniteville, South Carolina, January 6, 2005	http://findarticles.com/p/articles/mi_hb241/is_200504/ai_n15074036

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Province of British Columbia, Canada	Firestorm 2003: Provincial Review	Honorable Gary Filmon	February 2004	Wildfires – British Columbia, Canada, 2003	http://www.2003firestorm.gov.bc.ca/firestormreport/FirestormReport.pdf
Rancho Santa Fe Fire Protection District, California	Wildfire Preparedness and Evacuation	Unknown	Unknown	Wildfire	http://www.rsf-fire.org/education/safety/widlfire.asp
Rancho Santa Fe Fire Protection District, California (San Diego area)	Getting Out Alive: Preparing for and Protecting Yourself During a Wildfire Evacuation	Rancho Santa Fe Fire Protection District	Unknown	Wildfire	http://www.rsf-fire.org/assets/documents/education/preparedness/RSFFD%20Getting%20Out%20Alive.2003.pdf
Rancho Santa Fe Fire Protection District, California (San Diego area)	Sheltering in Place During Wildfires	Rancho Santa Fe Fire Protection District	Unknown	Wildfire	http://www.rsf-fire.org/education/programs/adult_shelterinplace.asp
Reno/Tahoe Blog (on line web journal), Nevada	Pleasant Valley Fire	Pleasant Valley Fire: Breaking News	August 25, 2004	Wildfire – Pleasant Valley Fire, Nevada 2004	http://renotahoe.about.com/b/2004/08/25/pleasant-valley-fire.htm
RFID Journal	RFID Drives Highway Traffic Reports	Claire Swedberg	November 1, 2004	Any	http://www.rfidjournal.com/article/articleview/1243/1/1/
Ribble Valley Borough Council, England	Flood Warning	Ribble Valley Borough Council, England (Internet)	2003	Flood	http://www.ribblevalley.gov.uk/site/scripts/services_info.php?serviceID=31
SafetyLit Abstracts	Emergency Care Following the Terrorist Attack in Beslan, North Ossetia, Russian Federation, 2004 – International Journal of Disaster Medicine	Johan J von Schreeb, A Kalmykov, L Riddez, H Rosling	2004	Any	http://www.safetylit.org/citations/index.php?fuseaction=citations.viewdetails&citationIds[]=citjournalarticle_11613_4
Salt Lake Tribune Salt lake City, Utah	Blame Flies After Spill	Matthew D. LaPlante and Lisa Rosetta	March 8, 2008	Chemical Railcar Leak, Salt Lake City, Utah, March 6, 2005	Not available on the Web
San Francisco Chronicle San Francisco, California	3 Killed, 15 Homes Crushed by Tons of Rain-Soaked Mud: Death Toll in Southern California Storm Rises to 11 After Landslide	Michael Taylor, James Sterngold, and Wyatt Buchanan	January 11, 2005	Mudslides – Southern California, La Conchita, California, January 10, 2005	http://sfgate.com/cgi-bin/article.cgi?file=/c/a/2005/01/11/MNG5NAODFL1.DTL
San Francisco Chronicle San Francisco, California	5,400 Still Kept From Homes Near Train-Crash Site	Associated Press	January 10, 2005	Chlorine Gas Derailment, Graniteville, South Carolina, January 6, 2005	Not available on the Web
San Francisco Chronicle San Francisco, California	Deadly Chlorine Gas Gone—But Fear Hangs Over Hard-Hit Town: Some Residents Warily Return Home After Train Wreck	Ellen Barry – Los Angeles Times	January 16, 2005	Chlorine Gas Derailment, Graniteville, South Carolina, January 6, 2005	http://www.sfgate.com/cgi-bin/article.cgi?file=/chronicle/archive/2005/01/16/MNG0OAR7OJ1.DTL

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San Francisco Chronicle San Francisco, California	Despair Settles in at Slide Site: Rescuers Claw Through Muck the Consistency of Concrete: Hope of Finding Survivors of La Conchita Mudslide Dims	James Sterngold	January 12, 2005	Mudslides – Southern California, La Conchita, California January 10, 2005	http://www.sfgate.com/cgi-bin/article.cgi?file=/chronicle/archive/2005/01/12/MNGFNAOUJ71.DTL
San Francisco Chronicle San Francisco, California	Rail Spill Creates Ghost Town Survivors Tell How Chlorine Gas Killed Their Coworkers at South Carolina Plant	Ariel Hart, Matthew L. Wald – New York Times	January 8, 2005	Chlorine Gas Derailment, Graniteville, South Carolina, January 6, 2005	http://www.sfgate.com/cgi-bin/article.cgi?file=/chronicle/archive/2005/01/08/MNG63AN7DG1.DTL
San Francisco Chronicle San Francisco, California	Recent Accidents Highlight Dangers Posed by Rail Tank Cars Ruptured Containers Released Lethal Gas: Authorities Also Worry About Terrorist Plots	Walt Bogdanich and Christopher Drew – New York Times	January 9 , 2005	Chlorine Gas Derailment, Graniteville, South Carolina, January 6, 2005	http://www.sfgate.com/cgi-bin/article.cgi?file=/chronicle/archive/2005/01/09/MNG0AANGDF1.DTL&type=printable
San Francisco Chronicle San Francisco, California	Slide Area Notoriously Unstable Same Hillside Failed in '95: Locals Debated Danger	Alex Barnum	January 12, 2005	Mudslides – Southern California, La Conchita, California, January 10, 2005	http://www.sfgate.com/cgi-bin/article.cgi?file=/chronicle/archive/2005/01/12/MNGFNAOUIP1.DTL
San Jose Mercury News California	Electronic Road Signs Staying, Caltrans Says	Gary Richards	October 28, 2004	Any	http://www.mercurynews.com/archivesearch
San Jose Mercury News California	Stuck on the Freeway? Your Cell Phone Will Guide You	Mike Langberg	February 21, 2005	Any	http://www.mercurynews.com/archivesearch
San Jose Mercury News California	Real Options for Real-Time Traffic	Mike Langberg	February 21, 2005	Any	http://www.mercurynews.com/archivesearch
Scientific American Web site	Fleeing Floyd: Documenting the Largest Hurricane Evacuation in US History	Jim Reed	September 2000	Hurricane Floyd 1999	http://www.sciamdigital.com/browse.cfm?sequencenameCHAR=item2&methodnameCHAR=resource_getitembrowse&interfacenameCHAR=browse.cfm&ISSUEID_CHAR=8FB06272-23A8-4FF3-9229-C86EAF19071&ARTICLEID_CHAR=C6085D2E-6C45-4825-8D82-D26E7F7E683&sc=I100322
Seattle Post Intelligence (seattlepi.com) Washington	Evacuation Notice Lifted for Some Tiny Oregon Towns	Jeff Barnard – Associated Press	August 30, 2002	Wildfire – Biscuit Fire, Oregon 2002	http://seattlepi.nwsource.com/local/84919_orefires39.shtml?searchpagefrom=1&searchdiff=977
St. Petersburg Times Online St. Petersburg, Florida	Letters to the Editor: Evacuation Unpleasant But Necessary	Gary Vickers – Director, Pinellas County Emergency Management	October 6, 2004	Hurricane	http://www.sptimes.com/2004/10/06/Neighborhoodtimes/Evacuation_unpleasant.shtml

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State of Florida	State of Florida Regional Evacuation Procedure	State of Florida	June 1, 2002	Any	http://www.floridadisaster.org/EMIT/Accreweb/Documents/Operations/RegionalEvac/2002%20REVAC%20ROLR.doc
State of Florida, Division of Emergency Management, Tallahassee, Florida	Heads Up: Hurricane Evacuation Analysis and Decision Support Utility Program	State of Florida, Division of Emergency Management, Tallahassee, Florida	April 2004	Hurricane	http://www.rsip.lsu.edu/anb10-3/Resources/04-FHwA-HEADSUP-.ppt
State of Georgia Department of Transportation Web site	Hurricane Evacuation	State of Georgia Department of Transportation	2000-2003	Hurricane	http://www.georgia-navigator.com/hurricane/
TBO.com Tampa, Florida	Evacuation Right Call, Say Local Leaders	Andy Reid	August 15, 2004	Hurricane	http://nl.newsbank.com/nl-search/we/Archives?p_product=TT&p_theme=tt&p_action=search&p_maxdocs=200&p_text_search-0=Evacuation%20AND%20Right%20AND%20Call,%20AND%20Say%20AND%20Local%20AND%20Leaders&s_dispstring=Evacuation%20Right%20Call,%20Say%20Local%20Leaders%20AND%20date(all)&p_perpage=10&p_sort=YMD_date:D&xcal_useweights=no
Texarkana Gazette News – Texarkana, Texas-Arkansas	Fire Occurs at El Dorado Waste Plant	Associated Press	January 2, 2005	Haz Mat Fire – El Dorado, Arkansas, January 2005	Not available on the Web
Texas Transportation Institute, The Texas A&M University System, College Station, Texas	Compendium: Graduate Student Papers on Advanced Surface Transportation Systems: Application of ITS Technology to Hurricane Evacuation Routes	Renee Hulett	August 1999	Hurricane	http://swutc.tamu.edu/publications/technicalreports/472840-00003-4Abstract.htm
Texas Transportation Institute, The Texas A&M University System, College Station, Texas	Reversing the Flow: Corpus Christi Unveils New Hurricane Evacuation Plan	Unknown	Volume 38, Number 2 (2002)	Hurricane	http://tti.tamu.edu/publications/researcher/newsletter.htm?vol=38&issue=2&article=8&year=2002
Texas Transportation Institute, The Texas A&M University System, College Station, Texas	Role of Public Transportation Operations in Emergency Management: Research Report	Laura L. Higgins, Mark D. Hickman, and Cynthia A. Weatherby	March 1999, Revised: June 1999; September 1999; December 1999	Any	http://tti.tamu.edu/publications/catalog/record_detail.htm?id=3054

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TheState.com – Newspaper on the Internet	Hodges' Actions in Floyd Evacuation Irrelevant to Election	Unknown	September 18, 2002	Hurricane Floyd 1999	http://nl.newsbank.com/nl-search/we/Archives?p_product=CS&p_theme=cs&p_action=search&p_maxdocs=200&p_text_search-0=Hodges%20AND%20Actions%20AND%20in%20AND%20Floyd%20AND%20Evacuation%20AND%20Irrelevant%20AND%20to%20AND%20Election&s_dispstring=Hodges'%20Actions%20in%20Floyd%20Evacuation%20Irrelevant%20to%20Election&xcal_numdocs=20&p_perpage=10&p_sort=YMD_date:D&xcal_useweights=no
The Times Shreveportimes.Com Shreveport, Louisiana	Main Street, Other Areas Remain Evacuated in El Dorado After Chemical Fire	Associated Press	January 3, 2005	HazMat Fire – El Dorado, Arkansas, January 2005	Not available on the Web
Times-Picayune Online New Orleans, Louisiana	Communication Called Storm Evacuation Key	Jan Moller	December 3, 2004	Hurricane Ivan 2004 – missed New Orleans	Not available on the Web
Transit Cooperative Research Program Sponsored by the Federal Transit Administration Research Results Digest	Safety and Security Issues at All-Bus Systems in Small- to Medium-Sized Cities in Western Europe	Responsible Senior Program Officer – Gwen Chisholm	June 2003	Chemical Explosion	http://gulliver.trb.org/publications/tcrp/tcrp_rrd_58.pdf
Transit Cooperative Research Program Sponsored by the Federal Transit Administration Research Results	Synthesis of Transit Practice 27: Emergency Preparedness for Transit Terrorism	Annabelle Boyd and John Sullivan	1997	Any	http://gulliver.trb.org/publications/tcrp/tsyn27.pdf
Transportation Communications Newsletter	AirSage and Sprint to Provide Real-Time Traffic Data to Government Customers	AirSage Press Release	January 21, 2005	Any	http://www.airsage.com/pdf/pr-5-2-05-c.pdf
Transportation Communications Newsletter	AirSage Awarded US Patent for Wireless Traffic Monitoring System	AirSage Press Release	January 21, 2005	Any	http://www.airsage.com/pdf/pr-5-2-05-d.pdf
Transportation Research Board 84th Annual Meeting Washington, DC	US Department of Transportation, Intelligent Transportation Systems Program: 2005 Update	Jeffrey F. Paniati	January 10, 2005	Any	http://ops.fhwa.dot.gov/speeches/trb2005/trb05_itsprog.htm
Transportation Research Board 84th Annual Meeting Public Transportation Forum Washington, DC	Overview of ITS Initiatives: What Do They Mean to Transit	Yehuda Gross and Brian Cronin	January 9, 2005	Any	Not available on the Web

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Transportation Research Board, TR News	Emergency Evacuation: Ensuring Safe and Efficient Transportation out of Endangered Areas	Brian Wolshon and Brandy Hicks Meehan	January – February 2003	Any	http://gulliver.trb.org/news/blurb_detail.asp?id=1256
Tri-Valley Herald, Pleasanton, California	Cell Phone Cameras Aid TV News Coverage	David Bauder – Associated Press	July 8, 2005	Any	http://www.highbeam.com/doc/1P1-110866927.htm l
Tri-Valley Herald, Pleasanton, California	Survivors Jam Crowded Hospitals: Tsunami Relief Efforts Taxed As Powell Surveys Region	Lely T. Djuhari – Associated Press	January 5, 2005	Tsunami – Indian Ocean, December 26, 2004	http://www.highbeam.com/doc/1P2-1570535.html
United States Army Corps of Engineers	Northwest Florida Hurricane Evacuation Study Technical Data Report	Study funded by the Federal Emergency Management Agency, the US Army Corps of Engineers and the State of Florida Department of Community Affairs, Division of Emergency Management.	1999	Hurricane	http://www.csc.noaa.gov/hes/docs/hes/NW_FLORIDA_HES_TECHNICAL_DATA_REPORT.pdf
US Army Corps of Engineers, Federal Emergency Management Agency and US Department of Transportation Washington, DC	Reverse Lane Standards and ITS Strategies Southeast United States Hurricane Study: Technical Memorandum Number 1: Final Report	US Army Corps of Engineers, Federal Emergency Management Agency and US Department of Transportation, Washington, DC	June 2000	Hurricane	Not available on the Web
United States Department of Defense, American Forces Information Service Washington, DC	No Panic During Pentagon Evacuation	Jim Garamone – American Forces Press Service	September 11, 2001	Terrorist Attack – Pentagon 9/11 (2001)	http://www.defenselink.mil/news/Sep2001/n09112001_200109114.html
United States Department of Labor, Occupational Safety and Health Administration Washington, DC	How to Plan for Workplace Emergencies and Evacuations	US Department of Labor, Occupational Safety and Health Administration	2001 (revised)	Workplace	http://osha.gov/Publications/osha3088.pdf
United States Department of Transportation Washington, DC	Disaster Response and Evacuation User Service: An Addendum to the ITS Program Plan	National ITS Architecture Team	July 15, 2003	All but evacuation information based on Hurricane Floyd 1999	http://www.itsdocs.fhwa.dot.gov/JPODOCS/REPTS_PR/14064.html
US Department of Transportation, Federal Highway Administration, SAIC	A Study of the Impact of Nine Transportation Management Projects on Hurricane Evacuation Preparedness	Science Applications International Corporation (SAIC)	November 2003	Hurricane	http://www.itsdocs.fhwa.dot.gov//JPODOCS/REPTS_TE//13940.html
US Department of Transportation, Federal Highway Administration, SAIC	Concept of Operations for Emergency Transportation Operations	Science Applications International Corporation (SAIC)	January 9, 2004	Any	Not available on the Web

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US Department of Transportation, Federal Highway Administration, SAIC	Emergency Transportation Operations: Stakeholders, Functions and Automated Tools	Science Applications International Corporation (SAIC)	August 28, 2003	Terrorist Act—New York City 9/11	Not available on the Web
US Department of Transportation, Federal Highway Administration, SAIC	Emergency Transportation Operations: Freeway Traffic Management Center Capabilities and Needs	Science Applications International Corporation (SAIC)	September 30, 2003	Any	http://ops.fhwa.dot.gov/docs/eto_caps_needs/
US Department of Transportation, Federal Highway Administration, SAIC	Vision 2010: Enhanced National Capabilities for Emergency Transportation Operations	Science Applications International Corporation (SAIC)	January 9, 2004	Any	Not available on the Web
US Department of Transportation Internet Search Washington, DC	Using ITS in Helping Florida Manage Evacuations	Bob Collins – Florida Division of Emergency Management	Unknown	Hurricane – Other Natural Disasters	Not available on the Web
US Department of Transportation, John A. Volpe National Transportation Systems Center	Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout Great Lakes Region	Allan J. DeBlasio, Terrance J. Regan, Margaret Zirker, Kate Fichter, Kristin Lovejoy, Dan Morin	May 2004	Blackout – Detroit, Michigan, August 2003	http://www.itsdocs.fhwa.dot.gov//JPODOCS/REPTS_TE//14021.pdf
US Department of Transportation, John A. Volpe National Transportation Systems Center	Effects of Catastrophic Events on Transportation System Management and Operations: August 2003 Northeast Blackout New York City	Allan J. DeBlasio, Terrance J. Regan, Margaret Zirker, Kate Fichter, Kristin Lovejoy, Dan Morin	May 2004	Blackout – New York City, August 2003	http://www.itsdocs.fhwa.dot.gov//JPODOCS/REPTS_TE//14023.pdf
US Department of Transportation, John A. Volpe National Transportation Systems Center	Effects of Catastrophic Events on Transportation System Management and Operations: Cross-Cutting Study	Allan J. DeBlasio, Robert Brodesky; Margaret E. Zirker and Terrance J. Regan	January 2003	Terrorist Attack – New York City and Washington DC 9/ 11 (2001), Baltimore, Maryland Howard Street Rail Tunnel Fire (2001) and Northridge, California Earthquake (1994)	http://www.itsdocs.fhwa.dot.gov/JPODOCS/REPTS_TE/13780.html
US Department of Transportation, John A. Volpe National Transportation Systems Center	Effects of Catastrophic Events on Transportation System Management and Operations: New York City, September 11	Allan J. DeBlasio, Terrance J. Regan, Margaret E. Zirker, F. Brian Day, Michelle Crowder, Kathleen Bagdonas, Robert Brodesky, Dan Morin	April 21, 2002	Terrorist Attack – New York City 9/11 2001	http://ops.fhwa.dot.gov/opssecurity/case_studies/nycprelim.htm

Source	Title	Author	Date	Nature of Evacuation	Web Site Address
US Department of Transportation, John A. Volpe National Transportation Systems Center	Effects of Catastrophic Events on Transportation System Management and Operations: Northridge Earthquake, January 17, 1994	Allan J. DeBlasio, Terrance J. Regan, Margaret E. Zirker, F. Brian Day, Michelle Crowder, Kathleen Bagdonas, Robert Brodesky, Dan Morin	April 22, 2002	Earthquake – Northridge, California—January 17, 1994	http://www.itsdocs.fhwa.dot.gov/JPODOCS/REPTS_TE/13775.html
US Department of Transportation, SAIC	Effects of Catastrophic Events on Transportation System Management and Operations: Howard Street Tunnel Fire, Baltimore City, Maryland, July 18, 2001	Mark R. Carter, Mark P. Howard, Nicholas Owens, David Register, Jason Kennedy, Kelley Pecheux, Aaron Newton	July 2002	Rail Tunnel Fire – Howard Street, Baltimore, Maryland, July 18, 2001	http://www.itsdocs.fhwa.dot.gov/JPODOCS/REPTS_TE/13754.html
United States Nuclear Regulatory Commission Washington, DC	Nuclear Facility Response Plans	US Nuclear Regulatory Commission	Unknown	Nuclear Incident	http://www.nrc.gov/about-nrc/emerg-preparedness/nuclear-facility-response.html
US Nuclear Regulatory Commission Washington, DC	Protective Actions	US Nuclear Regulatory Commission	September 9, 2004	Nuclear Incident	http://www.nrc.gov/about-nrc/emerg-preparedness/protective-actions.html
US Nuclear Regulatory Commission Washington, DC	State and Local Response Actions	US Nuclear Regulatory Commission	September 9, 2004	Nuclear Incident	http://www.nrc.gov/about-nrc/emerg-preparedness/state-local-actions.html
US Nuclear Regulatory Commission Washington, DC	What Can I Do to Prepare for a Radiological Emergency?	US Nuclear Regulatory Commission	September 9, 2004	Nuclear Incident	http://www.nrc.gov/about-nrc/emerg-preparedness/prepare-for-radiological-emerg.html
University of South Carolina, Hazards Research Lab, Department of Geography	Hazard Laboratory Hurricane Floyd Evacuation Study: Preliminary Report	University of South Carolina, Hazards Research Lab, Department of Geography	Unknown	Hurricane Floyd 1999	Not available on the Web
University of South Carolina, Hazards Research Lab, Department of Geography	South Carolina's Response to Hurricane Floyd	University of South Carolina, Hazards Research Lab, Department of Geography – Kirstin Dow and Susan Cutter	2000	Hurricane Floyd 1999	http://www.colorado.edu/hazards/research/qr/qr128/qr128.html
Valley Times, Pleasanton, California	Derailment Blamed on Switch Error	New York Times	January 12, 2005	Chlorine Gas Derailment, Graniteville, South Carolina, January 6, 2005	Not available on the Web
Valley Times, Pleasanton, California	Train Carrying Chlorine Gas Derails; 8 Killed	Amy Geiger Edgar – Associated Press	January 7, 2005	Chlorine Gas Derailment, Graniteville, South Carolina, January 6, 2005	Not available on the Web

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Victoria Transport Policy Institute	Lessons from Katrina: What a Major Disaster Can Teach Transportation Planners	Todd Litman	September 20, 2005	Hurricane	http://www.vtpi.org/katrina.pdf
Virginian-Pilot	Norfolk-Based Railroad To Pay Damages For Chemical Spill	Tom Shean	August 18, 2005	Chlorine Gas Derailment, Graniteville, South Carolina, January 6, 2005	http://www.redorbit.com/news/technology/212813/norfolkbased_railroad_to_pay_damages_for_chemical_spill/index.html
Washington Post Washington, DC	Driving Christine	Washingtonpost.com	Received email on March 14, 2005 unsure of article date	Any	http://www.washingtonpost.com/wp-dyn/articles/A33457-2005Mar14.html
Washington Post Washington, DC	US Called Unprepared for Nuclear Terrorism	John Mintz	May 3, 2005	Nuclear Incident	http://www.washingtonpost.com/wp-dyn/content/article/2005/05/02/AR2005050201454_pf.html
Wildfire Lessons Learned Center, National Advanced Fire Resource Institute, Tucson, Arizona	San Bernardino County Fire Chiefs' Association: Lessons Learned Report: Fire Storm 2003: "Old Fire"	William Maxfield, Fire Chief Retired—9-1-1 Consulting Group, Inc.	2003	Wildfires Old Fire – Southern California 2003	http://www.myfirecommunity.net/documents/Old_Fire_Lessons_Learned_Report_2003.pdf
Wildfire Lessons Learned Center, National Advanced Fire Resource Institute, Tucson, Arizona	Southern California Firestorm 2003: Report for the Wildland Fire Lessons Learned Center	Mission-Centered Solutions	December 8, 2003	Wildfires – Southern California, 2003	http://www.wildfirelessons.net/documents/S_CA_Firestorm_2003_Command_Control.pdf
wnbc.com New York City, New York	Emergency Broadcast Test Mistakenly Calls for Evacuation	Associated Press	February 1, 2005	Any	http://www.cwalsh.org/isnd/archives/000204.html
www.mitigationplan.com	VisualRisk	www.mitigationplan.com	Unknown	Any	https://www.mitigationplan.com/Mitigation/DevDefault.asp
www.washlaw.org	Precedent-Setting Decision on Emergency Evacuations for People with Disabilities Issued in Maryland	Unknown	January 4, 2005	Any	http://www.washlaw.org/news/releases/010405.htm

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