

Coordinating, Planning and Managing the Effects of Roadway Construction with Technology

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The American Recovery and Reinvestment Act of 2009 (Recovery Act) allocates \$26.7 billion to state transportation agencies for highway infrastructure investment projects. These funds are being used to rehabilitate roadway surfaces, build new capacity, and deploy Intelligent Transportation Systems (ITS) and other applications to improve operations. In a typical year, work zones for these types of projects affect about 25 percent of the National Highway System during the peak construction season each summer.¹ For example, in the summer of 2003, states spent approximately \$33 billion on roadway infrastructure construction² resulting in roughly 7,200 work zones and 480 million vehicle-hours of delay. As a result, given that as much as 50 percent (\$13.4 billion) of the highway infrastructure investment funds could be obligated in time for the 2009 summer construction season in addition to the already planned construction projects, it is likely that there will be an unprecedented volume of work zones occurring this summer.

Construction projects can increase traffic delays and lead to more crashes, putting travelers and workers at risk.³ It will be crucial for state and local DOTs to coordinate work zone planning and operations to avoid undue burdens on the traveling public and ensure safe and efficient traffic flow through or around individual work zones. Already, the U.S. DOT has developed guidance on the selection and use of work zone modeling and analysis tools that can assist construction project leaders in designing more efficient work zones as well as choosing among the various ITS options for work zone operations. In fact, there are numerous cost-effective technology applications available to state and local DOTs that can be rapidly deployed to improve work zone safety and mobility. This paper highlights work zone ITS solutions and identifies resources for more information on work zone ITS.

Portable and permanent ITS applications are available to many state and local DOTs. One option, portable ITS applications, can be rapidly deployed to improve work zone safety and mobility regardless of the work zone location. Another option is that state and local DOTs can readily leverage existing ITS infrastructure such as 511 traveler information systems, detection equipment, and variable message signs where locations permit. A third option is to accelerate the ITS infrastructure installation portion of construction projects where ITS is part of the design. By deploying ITS prior to the start of the roadway construction, agencies will be able to better manage work zone safety and mobility during the project's life. For example, the New Mexico State Highway and Transportation Department installed ITS infrastructure prior to the start of the reconstruction of the "Big I" interchange in Albuquerque in order to use the technology throughout the work zone duration (two years). Following project completion, the system became part of the permanent system for freeway management.⁴

ITS applications are one possible component of a larger work zone transportation management plan used to facilitate the coordination of multiple work zone projects as well as the planning, design, and operation of individual work zones. On average, the cost to deploy and operate ITS work zone applications is 2 to 6 percent of total construction costs.⁵ Benefits are more difficult to monetize but are in the order of 2:1 to

¹ Wunderlich, K., *Characterizing Nationwide Work-Zone Activity: Key Findings from Website Content Analyses, 2001-2003*. Presented at the 2005 TRB Annual Meeting, Washington DC. January 2006. In Summer 2003, approximately 480 million vehicle-hours of delay were attributable to work zones. There were a total of 1,095 traffic fatalities occurring within a work zone and 72 construction workers were killed as a result of a transportation-related accident in a work zone.

² FHWA Highway Statistics 2003. Table SF-2 (<http://www.fhwa.dot.gov/policy/ohim/hs03/hm/sf2.htm>). The total money spent in 2003 was \$50 billion. Approximately 2/3 of work zones occurred during the 2003 summer construction season. Thus, \$33 billion was assumed spent during the summer construction season.

³ There were 835 fatalities in work zones in 2007; 1 out of 5 were workers. http://safety.fhwa.dot.gov/wz/wz_facts.htm

⁴ More information on the reconstruction of the "Big I" interchange is available here: <http://www.ops.fhwa.dot.gov/wz/docs/ITSWorkzones.pdf>

⁵ The range of smart work zone costs in the ITS Costs Database is from two to six percent of total construction costs. <http://www.itscosts.its.dot.gov/>

6:1 depending on the ITS technology being used.⁶ Specific benefits include construction schedule compression; reductions in traffic volumes, vehicle speeds, queue lengths, and crashes in the work zones; fewer and shorter periods of congestion. For example:

- The North Carolina Department of Transportation deployed a smart work zone information system on I-95 which resulted in fewer crashes, a significant reduction in vehicle queuing (56 percent), and less traveler delay (55 percent).
- The Maryland State Highway Administration used a work zone modeling tool to redesign a work zone as part of the Woodrow Wilson Bridge reconstruction to reduce construction time from a planned six months to two months.
- The Virginia Department of Transportation found that speed-activated dynamic message (DMS) signs with warning messages reduced the number of vehicles speeding by 50 percent or more in work zones.

U.S. DOT studies⁷ show that when agencies use ITS tools in conjunction with sound planning, traffic control, coordination, communication, and impacts estimation, work zone operations can be improved by diverting up to 15 percent of traffic onto detour routes through the use of traveler information systems and improving safety by reducing vehicle speeds on the order of 10 mph and reducing speed variability by up to 70 percent. The construction projects using ITS that most successfully minimize hazards and congestion have two key characteristics. One, they conduct comprehensive work zone analysis and planning to identify and address safety and mobility impacts prior to the start of construction; and two, they take a holistic view of work zone operations and implement ITS applications such as traveler information, traffic management, and traffic incident management technologies as part of overall system management when warranted.

Summarized below are three categories of ITS applications applicable to work zones as well as a summary of work zone modeling and analysis tools that can be used to support sound planning.⁸ All of these are readily deployable by local and state agencies in order to mitigate the effects of roadway construction.

- 1. Work Zone Traveler Information Systems**—ITS applications such as 511 information systems and web-based project sites can inform motorists of construction activity and suggest alternate routes to avoid the work zone. For motorists who must travel through work zones, ITS technologies such as dynamic message signs and highway advisory radio can be used to disseminate travel time, delay, and queuing information to better inform motorists and manage expectations. Examples include:
 - **Automated Work Zone Information System:** In California, traffic demand through a work zone decreased such that the maximum average peak delay was 50 percent lower than expected. In Arkansas, there were fewer fatal crashes compared with similar sites without the technology.
 - **Smart Work Zone:** In North Carolina, a work zone equipped with traffic detectors, variable message signs, and a dynamic detour route indication system resulted in no fatal crashes, the maximum queue length decreased from 2.94 miles to 1.3 miles, maximum traveler delay decreased from 14.8 minutes to 6.6 minutes, and total user delay decreased from 21,955 hours per week to 5,476 hours per week—a reduction of 16,480 hours.
 - **Portable Traffic Management System (PTMS):** In Minneapolis/St. Paul, traffic volumes through a work zone increased 4 to 7 percent during peak periods due to smoother traffic flow by using a PTMS to control traffic and inform motorists of prevailing travel conditions in the work zone.

⁶ Estimating benefits are difficult because of the value judgments placed upon value of time, lives saved, or injuries avoided. The ITS Benefits and Costs databases (<http://www.itsbenefits.its.dot.gov> and <http://www.itscosts.its.dot.gov>) were used to estimate a B/C of 2:1 for a smart work zone system and 6:1 for a surveillance detection system.

⁷ U.S. Department of Transportation, Federal Highway Administration, *Benefits of Using Intelligent Transportation Systems in Work Zones: A Summary Report*. http://ops.fhwa.dot.gov/wz/its/wz_its_benefits_summ/index.htm

⁸ The examples listed below do not represent an exhaustive list of ITS work zone applications. Various ITS application applicable to work zones can be found in the documents listed in the resource section of this paper.

2. **Work Zone Traffic Management Systems**—ITS technologies such as variable speed limits and signal coordination can be used to better manage overall demand through the work zone. Examples include:
 - **Dynamic Lane Merge:** In Lansing, Michigan, smoother traffic flows resulted in reduced delays with average speeds increased by 15 percent and crashes reduced from 1.2 per month to zero.
 - **Speed Monitoring Displays:** In Nebraska, a pole mounted video detection camera and a portable dynamic message sign were used to monitor vehicle speeds and communicate messages to drivers. The camera and DMS were connected using wireless radio. The technology deployment resulted in the highest 15 percent of vehicle speeds being reduced by 5 mph as vehicles approached the work zone lane merge area.
 - **Performance Driven Traffic Management:** Arizona DOT provided incentives to a work zone contractor to carefully plan work on SR68 to maintain travel time below a prescribed maximum. License-plate reader technologies were used to confirmed consistent compliance with this limit and the work zone contractor realized 96 percent of the incentive pool. As a result, motorists were provided with a consistent average travel time of 27 minutes and unexpected delays were significantly reduced.

3. **Work Zone Incident Management Systems**—Work zones are more susceptible to traffic incidents and should be designed with both worker and motorist safety in mind. With roadway capacity often reduced in work zones, incidents need to be detected and resolved quickly to minimize impacts on travel time, delay, and queuing. ITS technologies such as portable CCTV cameras and safety service patrols have been used effectively to identify and quickly respond to incidents. For example:
 - **Construction Traffic Management Center (CTMC):** In Albuquerque, the New Mexico State Highway and Transportation Department deployed a CTMC at the “Big I” work zone consisting of cameras and information dissemination equipment to quickly detect and respond to incidents, and inform motorists of traffic conditions. After approximately one year of operations, the average clearance time on the "Big I" was 20 minutes faster than the historical average clearance time of 45 minutes.

4. **Work Zone Modeling and Analysis Tools**—Work zone modeling and analysis tools can be used to help with comprehensive planning and analysis, better coordinate multiple work zone schedules, and design and test alternate work zone plans and mitigation strategies, including ITS applications where appropriate, before and during construction. Examples include:
 - **Sketch Planning Tools:** The Maryland State Highway Administration developed the Lane Closure Analysis Program (LCAP) to provide traffic engineers with a structured method to quickly analyze work zone impacts associated with volume variation and multiple lane closure scenarios. In 2008, LCAP was successfully used in 20 projects as a means to mitigate traffic impacts.
 - **Lane Closure Analysis Process:** The Wisconsin Department of Transportation established guidelines that include suggested procedures and methodologies to estimate the effects of roadway construction. To date, over 150 engineers have been trained in the use of the guidelines.

Resources

The U.S. Department of Transportation has numerous resources available to local and state transportation agencies on work zone planning, technology and operations:

- ITS for Work Zones—Deployment benefits and lessons learned from ITS and work zones.
<http://www.its.dot.gov/jpodocs/reports/14320.htm>
Contact: Tracy Scriba, FHWA Office of Operations, tracy.scriba@dot.gov
- Maryland State Highway Administration Lane Closure Analysis Program (LCAP)
<http://www.sha.state.md.us/safety/workzone.asp>
Contact: MdSHA Work Zone Safety and Mobility Program, (410) 787-5860
- QuickZone Traffic Impact Analysis Tool—Delay estimation tool for work zones.
http://www.ops.fhwa.dot.gov/wz/traffic_analysis/wzta.htm#tools
Contact: Daniel Grate, FHWA Resource Center, daniel.grate@dot.gov
- Smart Work Zone Deployment Initiative—Information on the use of smart work zone systems.
<http://www.ctre.iastate.edu/smartwz/index.cfm>
Contact: (515) 294-5798
- Work Zone Safety and Mobility Rule—Guidance on addressing work zone safety and mobility laws.
http://www.ops.fhwa.dot.gov/wz/resources/final_rule.htm
Contact: Tracy Scriba, FHWA Office of Operations, tracy.scriba@dot.gov
- Work Zone ITS Safety and Mobility Solutions—Guidance developed by ATSSA ITS Council
http://www.atssa.com/galleries/default-file/2008July21_ITS_Safety_and_Mobility.pdf
Contact: (800) 272-8772
- Work Zone ITS & Technology—FHWA Office of Operations work zone ITS website.
<http://www.ops.fhwa.dot.gov/wz/its/index.htm>
Contact: Tracy Scriba, FHWA Office of Operations, tracy.scriba@dot.gov
- Work Zone Traffic Analysis Strategies—Guidance on the use of work zone modeling tools.
http://www.ops.fhwa.dot.gov/wz/traffic_analysis/wzta.htm#tools
Contact: Chung Eng, FHWA Office of Operations, chung.eng@dot.gov