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Freeway Bottleneck Removals: Workshop Enhancement and Technology Transfer

Final Report

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16. Abstract

As transportation improvement projects become increasingly costly and complex and as funding sources are not keeping pace with needs in highly urbanized areas, it becomes critical that existing freeway systems be fine-tuned to maximize capacity. One of the most cost-effective solutions is implementation of lower-cost improvements to improve mobility where bottlenecks occur during peak periods on freeways. This subject is gaining national attention, partly because bottleneck locations are highly visible; failure to fix them has political as well as congestion costs. The Federal Highway Administration (FHWA) is advancing on this front both in research and outreach efforts.

This project enhanced and improved an existing Freeway Bottleneck Workshop by: (1) gathering further data on implemented bottleneck removals both in Texas and throughout the United States (U.S.) to add to the case study database; and (2) improving the communications aspect of the workshop through better graphics, video, and overall professional appearance. Four of the enhanced Freeway Bottleneck Workshops were presented to enthusiastic participants in Atlanta (Georgia), Austin, Houston, and San Antonio. Each half-day workshop allowed participants from various disciplines (design, operations, and planning) and agencies (city, county, state, and federal) to learn about bottleneck identification, causes, low-cost solutions, analysis and evaluation, case studies, and guidelines for successful projects. Workshop participants also had the opportunity to work in teams to analyze a real-world freeway bottleneck and to discuss opportunities for bottleneck removal in their metropolitan area. The final component of the project developed a website and educational module for university students and professors that will continue the technology transfer component. The long-term implications of this work are elevated awareness of the extremely high benefits relative to costs and development of professional capacity to recognize opportunities and to analyze and select appropriate measures for successful bottleneck removal projects.

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Executive Summary

This report summarizes the enhancement and pilot delivery of a Freeway Bottleneck Workshop designed to teach participants how to develop low-cost solutions to improve bottlenecks on freeway facilities. Studies have shown that implementing relatively minor improvements on existing freeways to remove bottlenecks produces significant operational benefits (typical benefit-cost ratios from 3:1 to 400:1) and safety benefits (average crash reduction of approximately 35 percent). This project enhanced and improved an existing workshop by: (1) gathering further data on implemented bottleneck removals both in Texas and throughout the U. S. to add to the case study database; and (2) improving the communications aspect of the workshop through better graphics, video, and overall professional appearance.

The enhanced Freeway Bottleneck Workshop was presented to enthusiastic participants in Atlanta (Georgia), Austin, Houston, and San Antonio. Each half-day workshop allowed participants from various disciplines (design, operations, and planning) and agencies (city, county, state, and federal) to learn about bottleneck identification, causes, low-cost solutions, analysis and evaluation, case studies, and guidelines for successful projects. Workshop participants also had the opportunity to work in teams to analyze a real-world freeway bottleneck and to discuss opportunities for bottleneck removal in their metropolitan area. The workshop evaluation showed that almost 91 percent of participants rated all workshop elements (e.g., modules, instructors, workbooks, etc.) as either excellent or very good.

The final component of the project developed a website (http://www.bottleneckworkshop.org) and educational module for university students and professors that will continue the technology transfer aspect of this work. The long-term implications of this project are elevated awareness of the extremely high benefits relative to costs and development of professional capacity to recognize opportunities and to analyze and select appropriate measures for successful freeway bottleneck removal projects.

The transportation profession needs a boost of confidence amidst the ever-present funding challenges. For years, transportation leaders have been saying “we’ll never build our way out of congestion,” which makes the profession irrelevant in the eyes of the traveling public. In fact, some congestion is unnecessary, and relieving it with low-cost improvements can enhance our image as necessary professionals. Implementing minor improvements on existing freeways in order to remove bottlenecks typically achieves high benefits yet is not routinely done by many agencies. The enhanced Freeway Bottleneck Workshop is now a resource that can be used to train and energize transportation agencies and their partners to make low-cost bottleneck removal a part of their normal routine for implementing projects that safely and reliably mitigate traffic congestion on freeways.

Introduction: Overview of Problem

Providing safe and efficient roadways are two of the key objectives of any transportation agency. Many agencies are currently struggling with funding shortfalls and are unable to improve the roadway system in order to keep up with the pace of growth and development. Projects that can improve both the safety and efficiency of the roadway system without expenditure of major resources should be highly desirable. One type of project that is getting more attention nationwide is low-cost freeway bottleneck removal projects that can be quickly implemented. These projects mitigate congestion and improve travel reliability and safety by reducing crash rates. Bottleneck improvements typically involve solutions such as:

- restriping merge/diverge areas to better serve demand,
- converting a short section of shoulder to travel lanes,
- modifying weaving areas or ramps, and
- adding auxiliary lanes.

The Texas Transportation Institute (TTI) has a long history of research and evaluation of the effects of relatively small, low-cost geometric and operational improvements at freeway bottleneck locations in Texas. Bottleneck evaluations have primarily been performed under interagency contracts with the Texas Department of Transportation (TxDOT) in Dallas, Fort Worth, and El Paso dating back to 1986. Other TTI urban offices (Austin, Houston, and San Antonio) have performed similar evaluations of bottleneck removal projects. This wealth of real-world project experience led to the development of a basic training workshop in 2003. This current project, funded by the University Transportation Center for Mobility ™ at Texas A&M University, took this basic workshop and performed a series of enhancements. This final report summarizes the pilot delivery of an enhanced Freeway Bottleneck Workshop designed to teach participants how to develop low-cost solutions to improve bottlenecks on freeways.

Summary of Texas Transportation Institute Bottleneck Research

This section provides a summary of the more than 20 years of experience by TTI on the subject of low-cost freeway bottlenecks. In 1992, Walters et al. produced a research report for TxDOT entitled *Methodology for Assessing the Feasibility of Bottleneck Removal* (*1*). This research was one of the first to advocate that the constriction to traffic flow at bottlenecks can often be removed through a relatively low-cost improvement to a short section of freeway, within existing right-of-way (ROW), perhaps requiring only a conversion of a shoulder to a driving lane and/or a slight narrowing of lanes. In addition to the TxDOT report, the results of this study were also published in *Transportation Research Record 1360* (*2*) and the compendium of technical papers from the 1992 Institute of Transportation Engineers (ITE) annual meeting in Washington, D.C. (*3*). As far back as 1978, the TTI Houston office performed research to test the concept of increasing roadway capacity on urban freeways by restriping the mainline pavement to create narrower lane widths and encroaching on the shoulder to create additional lanes for travel (*4*). This research, and a subsequent 1983 study (*5*), found that low-cost shoulder conversions and lane restriping can produce major traffic operations benefits with significantly improved crash rates.

In 1996, Walters et al. addressed the energy and air quality benefits of freeway bottleneck improvements (*6*). This research investigated the relationships between traffic operating characteristics and environmental factors such as fuel consumption and emissions. The total reduction in fuel usage ranged from 0 to 5.2 percent for bottleneck removal projects included in the study, with an average reduction of 2.2 percent. Attempts to quantify air quality benefits were less successful, and further research was required.

In 1997, Walters et al. focused their research on enhancing the understanding and approach to bottleneck improvements in three distinct tasks:

1. observation of driving behaviors in congestion,
2. refinement of the analytical methodology to evaluate bottlenecks, and
3. improvement of the methodology used to estimate their benefits (*7*, *8*).

Driving behaviors in congestion (e.g., queue jumping, weaving in congestion, and shoulder driving) were observed and videotaped at several sites on freeways in Dallas. These observations furthered the understanding of freeway operations in congested urban areas and helped to refine future bottleneck improvements. The study also found that traditional tools have proven inadequate for analyzing highly congested traffic flow. Several adaptations to the use of FRESIM were identified and tested, and these refinements allow for better analysis of congestion and bottleneck improvements. The final finding of the study was that the ability to fully assess the benefit bottleneck removal provides to the motorists remains incomplete. In some cases, benefits due to the reduction in delay can be estimated as an increase in speed. However, in cases where significant latent demand is present in the system, the benefits to motorists are not as easily measured. Speeds may not increase, but higher volumes indicate that diversion from less attractive routes is occurring.

In 1999, Cooner and Middleton conducted further research to evaluate the use of simulation models for congested Dallas freeways (*9*). The CORSIM, FREQ, and Integration models were selected for evaluation based on the state-of-the-practice review. Three different freeway sections with bottlenecks that caused recurrent congestion were selected for testing and evaluation of model performance. Before and after operational data (i.e., speeds and volumes) at each of the sites were used in an attempt to calibrate and validate the chosen models. Cooner and Middleton determined that all models performed relatively well for uncongested conditions; however, performance became sporadic and mostly unreliable for congested conditions. None of the models was successfully calibrated and validated for all of the test sites; however, CORSIM had the best overall performance.

In 2000, Walters et al. performed research to gain a better understanding of roadway factors and characteristics of the driving environment that induce irritation and contribute to aggressive driving and road rage (*10*). Based on results of a literature review, focus groups, and telephone survey, Walters and Cooner identified three promising mitigation measures and performed an evaluation of each:

1. freeway bottleneck improvements,
2. use of photogrammetry to expedite incident clearance, and
3. the late merge work zone traffic control (*11*).

The evaluation of benefits of bottleneck improvements produced the following results:

1. Feedback from commuters revealed that a majority recognized reduced aggressive behaviors (e.g., preventing merge, cutting across solid lines, tailgating, etc.) and commute time after improvements were made at a bottleneck location in Dallas.
2. Almost 50 percent of the commuters also indicated an improvement in their personal stress level after the implementation of improvements.
3. Operational data collected at the bottleneck site such as increased volumes, increased speeds, and decreased queue lengths supported the feedback from commuter surveys.

Another important aspect of bottlenecks on freeways has also been addressed by TTI: screening for potential bottlenecks while freeway improvements are being planned and designed. This aspect has been addressed in long-term research projects and also via participation in the Major Investment Study (MIS) process on numerous freeway corridors.

Walters et. al. performed research in the mid-1990s to develop a system-planning methodology in conjunction with TxDOT, North Central Texas Council of Governments, and Dallas Area Rapid Transit (*12*). Further research enhanced the methodology and produced a spreadsheet-based tool called the System Plan (*13*). The System Plan is a corridor and system analysis tool that bridges the gap between regional planning and detailed design. It allows for the examination of peak-hour person movement for different facility types (e.g., general purpose versus high-occupancy vehicle [HOV] lanes) within a corridor and estimates associated public costs such as

ROW, construction, operation, congestion, and environmental costs. The objective of the System Plan is to find the lowest total public cost alternative. The peak-hour capability is important for screening potential bottlenecks.

TTI has worked closely with TxDOT during the MIS process on numerous freeways to ensure that adequate information is available to the design team regarding existing and projected future peak-hour demand volumes by direction. Use of the standard 24-hour projections and generic "K factors" and directional splits to arrive at peak-hour volumes can lead to under-designed merges and weaving areas (*14*).

Previous TxDOT Freeway Bottleneck Workshop

TTI staff took all of the bottleneck research and project case studies and developed a basic workshop to teach to transportation professionals in the Dallas-Fort Worth metropolitan area in Texas (Figure 1). The workshop was taught on three different occasions and received positive evaluations from the approximately 70 participants. Even though the evaluations were primarily positive, there was a reasonable amount of feedback indicating that the course materials needed to be polished and enhanced to make the workshop more professional and successful.

Figure 1. Photograph of Previous Freeway Bottleneck Workshop (Dallas, May 2007).

Project Approach: Objectives

The research team developed three primary objectives to guide the project:

1. expand the state-of-the-practice on implementation of successful freeway bottleneck removal projects by synthesizing available data and anecdotal information from agencies across the nation,
2. develop an enhanced freeway bottleneck workshop that is relevant and appealing, and
3. educate and increase awareness of existing and future transportation professionals on the benefits of bottleneck removal projects.

Project Methodology: Tasks

The research team developed the project work plan to fulfill the primary objectives listed in the previous section. The work plan consisted of nine tasks:

1. performing a state-of-the-practice literature review on freeway bottleneck removals,
2. developing a project website,
3. planning for pilot workshops,
4. enhancing the existing freeway bottleneck workshop,
5. conducting pilot workshops in Texas,
6. conducting a pilot workshop in a national venue,
7. developing a funding plan and support for national workshop delivery,
8. producing a freeway bottleneck educational module for university professors, and
9. preparing the final report documenting the project results.

State-of-the-Practice Literature Review: Summary of Findings

The subject of freeway bottleneck analysis and removal has not received a significant amount of published attention, outside of studies concentrating on theoretical aspects of bottleneck formation, flow rates, and shockwave analysis. In the last 10 years, the focus has shifted from the theoretical/academic analysis side to the more practical side focused on low-cost removal strategies for freeway bottlenecks.

The research team performed a state-of-the-practice literature review to gather and synthesize available freeway bottleneck removal experiences and case studies to potentially add to the enhanced workshop materials. Researchers used a variety of methods to gather this information, including telephone interviews, e-mail and web-based surveys, and Internet searches.

Overview of Key Federal Initiatives

This section highlights several of the key national programs and reports with the practical, low-cost freeway bottleneck removal focus.

Localized Bottleneck Removal Program

In May 2006, the U.S. Department of Transportation (USDOT) announced the National Strategy to Reduce Congestion of America's Transportation Network (a.k.a., the Congestion Initiative). The goal is to make meaningful and near-term reductions in congestion. Working through the federal aid apportionment and Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) processes, the Federal Highway Administration (FHWA) and its state partners are engaged in many programs related to congestion impact. A few of the many mitigation efforts that FHWA is engaged in include:

- tolling and pricing;
- HOV legislation and enablement;
- urban partnerships;
- freight-specific analysis;
- special events;
- work zone congestion mitigation;
- traffic incident delay mitigation; and
- other driver behavior solutions such as ridesharing incentives, car sharing, and telecommuting.

Within the Office of Operations, the Localized Bottleneck Reduction (LBR) Program serves to bring attention to the root causes, impacts, and potential solutions to traffic chokepoints that are recurring events, ones that are wholly the result of operational influences (*15*). The LBR website (http://www.ops.fhwa.dot.gov/bn/index.htm) contains a wealth of good information including a Bottleneck Impact Matrix table and a sampling of successful efforts nationwide as to how they have attacked a bottleneck problem.

Bottleneck Primer

In June 2009, FHWA published a second edition of a document, *Traffic Bottlenecks: A Primer—Focus on Low-Cost Operational Improvements*, which explores the opportunity for near-term operational and low-cost construction opportunities to correct bottlenecks (*16*). The primer is intended to be a work in progress that is updated based on feedback received via the LBR Program website. It provides an excellent overview of the subject of bottlenecks by addressing the following topics:

- understanding bottlenecks,
- what FHWA is doing,
- identifying and assessing bottlenecks,
- how bottlenecks disperse,

- understanding merging at recurring bottlenecks,
- merge principles,
- low-cost bottleneck improvement strategies,
- evaluating bottleneck improvement effectiveness,
- potential issues with bottleneck treatments,
- examples of how agencies are dealing with bottlenecks, and
- planning and programming bottleneck improvements.

According to the FHWA estimates of the sources of traffic congestion, 40 percent of congestion is caused by inadequate physical capacity—also commonly known as bottlenecks. Bottlenecks are the biggest source according to Figure 2.

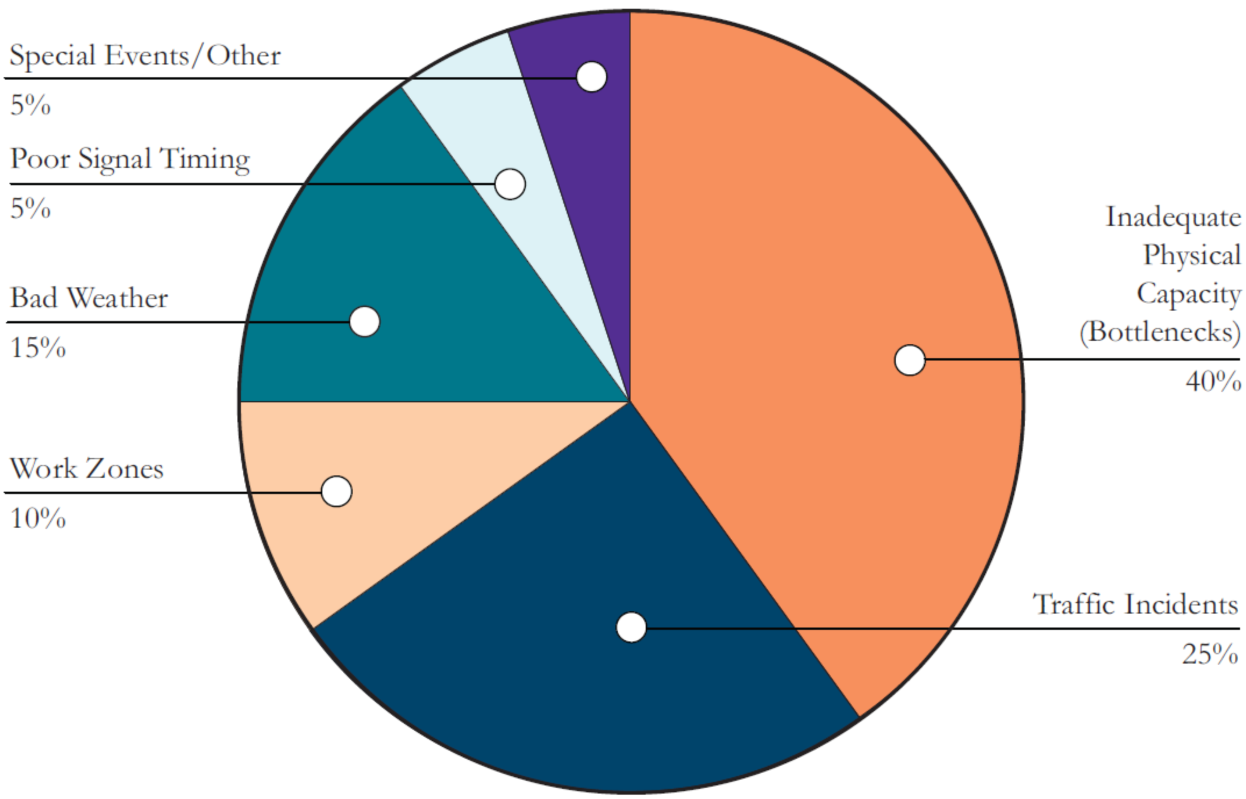


Figure 2. Sources of Traffic Congestion (*16*).
Source: http://www.fhwa.dot.gov/congestion/describing_problem.htm.

One of the other excellent graphics provided in the primer is a flowchart that lists the various types of freeway bottleneck causes (see Figure 3). This graphic indicates that freeway bottlenecks are either primarily capacity related or demand related, with specific causes under those two broad categories.

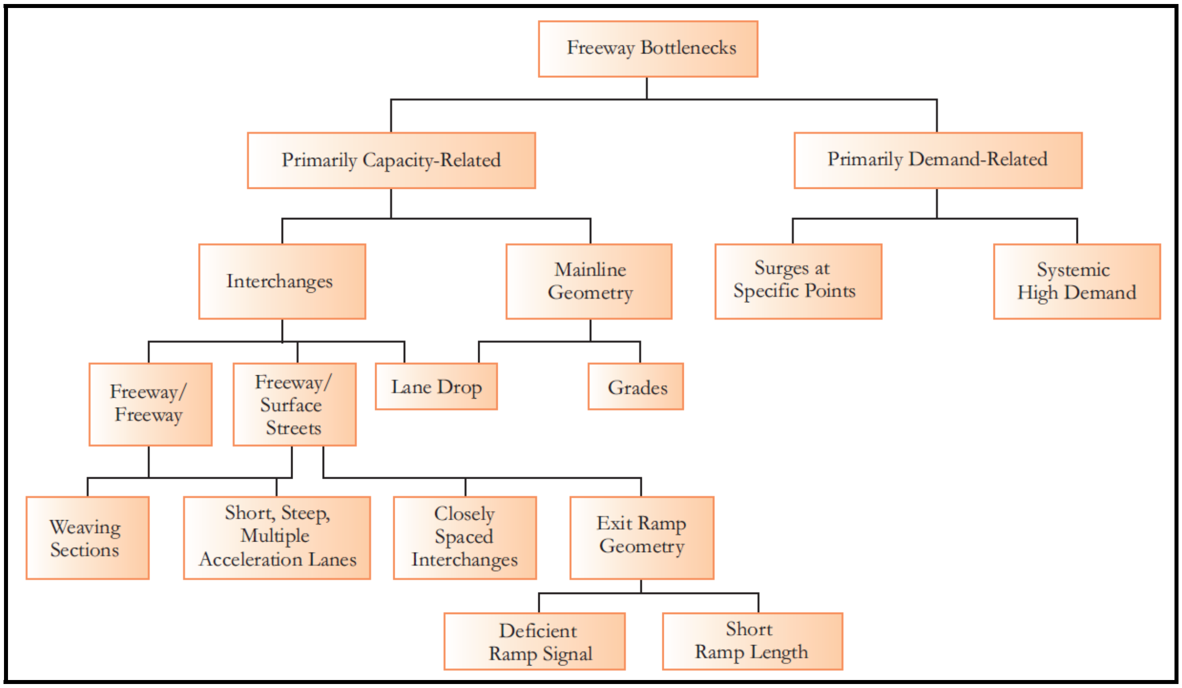


Figure 3. Types of Freeway Bottlenecks (*16*).

NCHRP 3-83 Project

The National Cooperative Highway Research Program (NCHRP) has recently sponsored a project concentrating on the subject of freeway bottlenecks entitled "Low-Cost Improvements for Recurring Freeway Bottlenecks." This project is still ongoing; however, an interim report published in December 2006 is available on loan from NCHRP (*17*). The primary product of this national research effort will be a technical guide that outlines the bottleneck project process, illustrates its use through case studies, and aids in the selection of analysis tools. The technical guide should also discuss the composition of the project development team, the proper documentation of design exceptions, and other institutional issues associated with implementing the bottleneck project process.

Overview of Key State and Local Initiatives

This section highlights several of the key state and local programs and reports with the practical, low-cost freeway bottleneck removal focus.

Minneapolis-St. Paul, Minnesota

The Minnesota Department of Transportation (MnDOT) monitors traffic congestion on the Minneapolis/St. Paul freeway system, producing an annual report (*18*). MnDOT recently conducted a Congestion Management Planning Study to set the groundwork for the development of a comprehensive Congestion Management Plan and recommend a list of specific congestion mitigation projects for implementation in the next 10-year project cycle

(*19*). Among these projects were smaller-scale investments in targeted areas where capacity improvements would have significant benefits. Three of these bottleneck removal projects have been recently completed, and they have successfully reduced congestion on over 19 miles of freeway (see Table 1, Figure 4, Table 2, and Table 3) (*19*, *20*). Additionally, MnDOT estimates that the projects resulted in an annual reduction of over 1.2 million hours of congestion, worth about $16 million in yearly travel time benefits. Over the estimated project service lives, the combined travel time benefit exceeds $148 million. When compared to the $20.2 million outlay for the three projects, the benefits greatly outweigh the costs (7.4 benefit-cost ratio).

Table 1. Descriptions of Minneapolis-Area Bottleneck Removal Projects (*15*).

Project	Problem Statement	Action Taken	Desired Outcome
#1 **I-394**	The section of westbound (WB) I-394 from east of MN-100 exit to US 169 has been congested since opening in 1994. The merging and weaving traffic reduced the functionality of this segment to a single lane freeway, with PM congestion being a persistent problem. The roadway has been studied extensively, and an auxiliary lane has been considered for a number of years. Recent changes in the development of the HOV/high-occupancy toll (HOT) lane made it imperative to add an auxiliary lane.	Metro District agreed to addition of an auxiliary lane starting at the Louisiana Bridge and ending at the US 169 exit. This additional lane provided the capacity necessary to allow for merging and weaving traffic in the new lane opening up the center lane for through traffic. The additional traffic had enough throughput capacity to eliminate congestion, reducing crashes.	The rationale behind the project was reducing congestion in the Louisiana Avenue area, which in turn would reduce crashes. A modest increase of 1,000-1,500 additional vehicles during the four-hour peak period was expected.
#2 **I-94**	WB I-94 in the vicinity of Century Avenue and McKnight Road near 3M Corporation headquarters has been plagued with congestion for many years. This section of I-94 was a four-lane divided section of interstate freeway in between two six-lane divided sections. The morning commute into St. Paul was stalled at this location as a result of severe congestion. The roadway also had a congestion-induced crash issue.	Metro District converted the four-lane to a six-lane section to increase the existing capacity and throughput and to reduce crashes. Further, the McKnight Road interchanges were reconfigured to correct substandard ramp entrances. Construction was completed in the fall of 2005.	The outcome of the project was to reduce congestion in the immediate area, thus reducing crashes. The localized outcome was not expected to have a major increase in traffic throughput because of downstream bottlenecks.
#3 **TH100**	The section of Trunk Highway (TH) 100 from 36th Street to I-394 was the last remaining segment of the original 1937 construction. The road segment, a four-lane section of freeway, is sandwiched between two six-lane segments. The older portion of the roadway caused congestion during both the AM and PM peak periods in both northbound (NB) and southbound (SB) directions. A recent MnDOT study states that this part of TH 100 is congested for the longest amount of time per day. Also, recent studies indicate several substandard ramps cause an unacceptable number of correctable crashes.	Metro District converted shoulders of this road segment to general purpose lanes. These lanes were used to increase existing capacity and throughput until the future full build project can be accomplished. The existing interchanges would then be reconfigured to correct substandard ramp entrances. Construction was completed in the fall of 2006.	It was expected that this temporary improvement would increase throughput to 3,000-4,500 additional vehicles during the peak period and substantially reduce the intensity and duration of congestion. Two other benefits were likely: bypass relief for the I-35W/TH 62 reconstruction and reduced traffic on the local road system with improved overall safety.

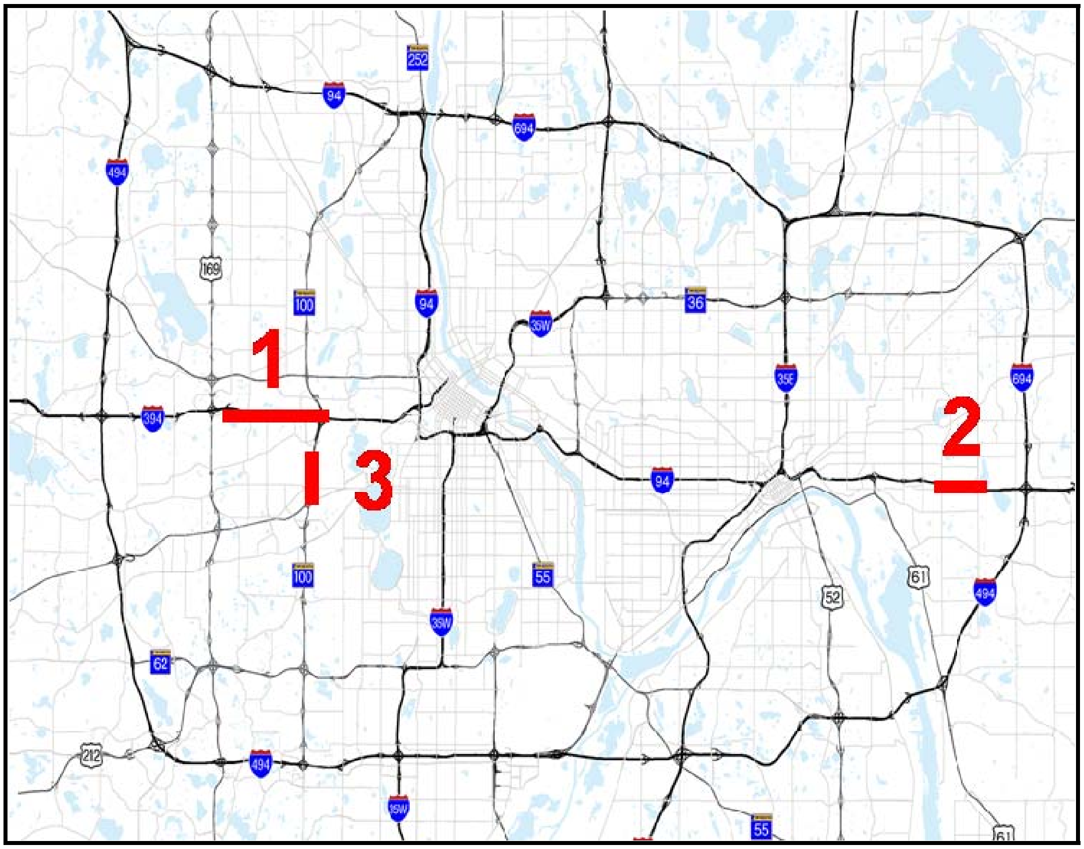


Figure 4. Map of Minneapolis-Area Bottleneck Removal Projects (*20*).

Table 2. Cost and Travel Time Benefit of Minnesota Bottleneck Removal Projects (*19*).

Project	Project Cost (Millions)	Reduction in Annual Hours of Delay	Estimated Annual Travel Time Benefit (Millions)	Project Service Life (Years)	Estimated Travel Time Benefit over Project Service Life (Millions)	Estimated Travel Time Benefit-Cost Ratio
I-394	$2.6	87,000	$1.1	20	$21.6	8:1
I-94	$10.5	139,000	$1.7	20	$34.6	3:1
TH 100	$7.1	1,063,000	$13.2	7	$92.3	13:1
TOTAL	$20.2	1,289,000	$16.0	—	$148.5	—

Table 3. Other Benefits of Minnesota Bottleneck Removal Projects (*19*).

Project	Peak-Period Flow Increase	Decrease in Miles of Congestion	Increase in Peak-Period Speeds	Preliminary Safety Impacts
I-394	4,650	6.0	30 mph in PM	60% reduction of property damage crashes, no change in injury crash rate
I-94	3,200	2.5	40 mph in AM 25 mph in PM	Modest reduction in number of mainline crashes
TH 100	14,450	10.75	45 mph in AM 30 mph in PM	30% reduction of property damage crashes, 70% reduction in injury crashes

Phoenix, Arizona

The Arizona Department of Transportation (ADOT) and the Maricopa Association of Governments (MAG) have teamed together to implement low-cost bottleneck projects in Phoenix. MAG sponsored a freeway bottleneck study using data obtained from an aerial survey of regional freeways (*21*). The study purpose was to identify and analyze bottlenecks, to evaluate freeway level of service (LOS), and to rank improvement projects. According to ADOT, most of the bottleneck removal projects in the Phoenix metropolitan area have been in the form of (*22*):

- auxiliary lanes between closely spaced interchanges through restriping and low-cost widening;
- widening of exits from single to dual lane to improve storage approaching the cross street;
- implementation of intelligent transportation systems (ITS) (ramp meters and dynamic message signs) to improve traffic flow;
- elimination of mainline freeway lane drops where possible via lane extensions to provide better lane balancing through restriping and mainline widening; and
- HOV lane implementation to improve corridor capacity, thereby easing general purpose lane capacity.

ADOT did not collect before and after data or calculate any benefit-cost ratio to evaluate the performance of these bottleneck removal projects. However, anecdotal information indicates that many of these projects have yielded good results, particularly the auxiliary lane projects that have smoothed out mainline freeway flows in many segments.

Austin, Texas

The TxDOT Austin District used a collaborative approach to identify, analyze, and evaluate bottleneck removal projects in their jurisdiction (*23*). A bottleneck committee consisting of engineers and planners from the department of transportation, university research centers, FHWA, city, and metropolitan planning organization (MPO) helped to implement 10 bottleneck removal projects on I-35, eight on Loop 1 (MOPAC), and two on US 183. Table 4 provides basic descriptions for seven projects including their location and implemented improvements.

Dallas-Fort Worth and El Paso, Texas

The TxDOT districts in Dallas, Fort Worth, and El Paso all utilized interagency contracts to identify, analyze, and evaluate bottleneck removal projects in their jurisdiction. The following subsections provide detailed descriptions of two case study bottleneck removal projects and summary tables showing operational and safety benefits for an additional 11 projects.

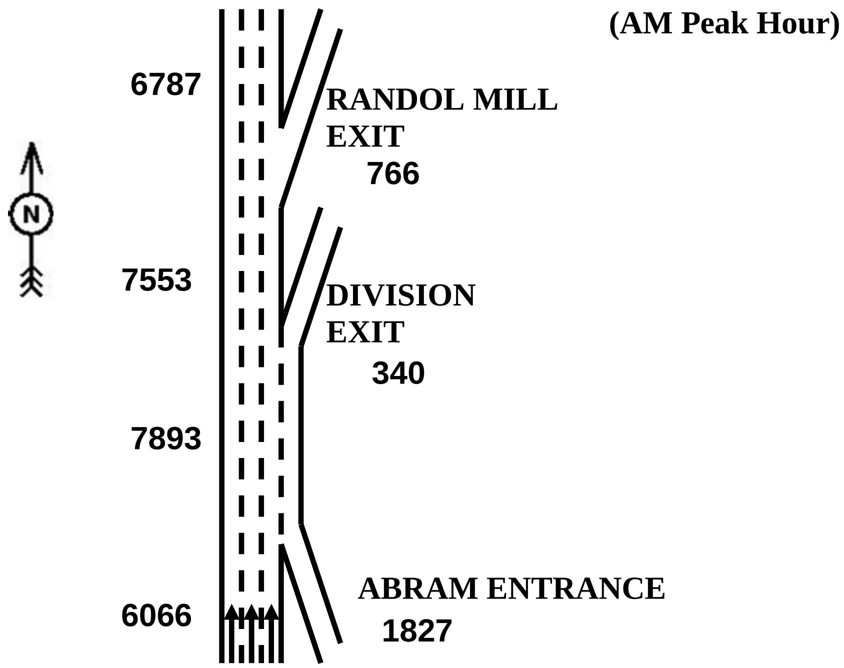
Table 4. Summary of Seven Bottleneck Removal Projects in Austin, Texas.

Project Location	Implemented Improvements
I-35 NB at Parmer Lane	Added supplemental lane from the Parmer Lane entrance to the Dessau exit and then extended to Wells Branch.
I-35 SB at Wells Branch	Closed Dessau Road entrance to SB I-35 and added auxiliary lane from the Wells Branch entrance to the Parmer Lane exit.
I-35 NB at US 183	Added auxiliary lane from US 183 to Braker Lane exit ramp.
I-35 SB at US 183	Began a fourth main lane for SB I-35 at the Rundberg entrance (rather than the US 183 direct connector) and extended the auxiliary lane from the US 183 frontage entrance to the US 290 exit upstream so that it began at the US 183 direct connector. The US 183 entrance from the SB I-35 frontage road was closed in order to facilitate flow along the auxiliary lane.
I-35 SB at Riverside	Added auxiliary lane from Riverside entrance to Oltorf exit.
Loop 1 SB at Far West	Added an auxiliary lane from Far West Boulevard entrance to the RM 2222 (Northland) exit ramp.
Loop 1 at Loop 360	Realigned the SB Loop 1 main lanes so that a lane drop would occur at the Loop 360 East (left-hand) exit rather than at the Loop 360 West (right-hand) exit ramp. Upstream of this lane drop are the high-volume Bee Caves entrance ramp and the relatively low-volume Barton Skyway entrance ramp to SB Loop 1.

Case Study Number 1

The location of this case study is in the TxDOT Fort Worth District, in Arlington, on NB SH 360, a six-lane freeway with intermittent auxiliary lanes. Morning NB traffic is high approaching I-30, where significant volumes interchange. Just over a mile south of this interchange there was a short weave (1,000 feet) on an auxiliary lane between Abram and Division (SH 180), a four-lane highway with signals. Traffic volume on the NB entrance ramp at Abram was very heavy, and it was under consideration for ramp metering, along with four other NB entrance ramps upstream on SH 360. The exit to Division had sharp curvature and a signal that frequently blocked the ramp. Traffic queued badly here, and TxDOT feared that any ramp-metering scheme was due to be unpopular and of limited usefulness, metering traffic into a bottleneck. The top half of Figure 5 shows the layout in the before case, along with AM peak-hour volumes. Not shown is that the Randol Mill exit was part of an X-ramp configuration so that traffic exiting there could get back to the freeway without going through a signal, and the entrance ramp at that point enjoyed a lane addition that lasted until the I-30 exit. Thus the bottleneck was clearly defined at the lane drop to Division. TxDOT elected to extend the auxiliary lane to the Randol Mill exit, thus effectively adding the use of a fourth lane to this bottlenecked section. This required use of the outside shoulder under Division because there was no inside shoulder. Despite some safety concerns, TxDOT decided to implement the 700-foot auxiliary lane on a trial basis; the cost was only $150,000; a contractor was already working in the area, installing fiber optic cable for the ITS system, known as TransVISION.

Before Study Lane Layouts and Volumes



After Study Lane Layout and Volumes

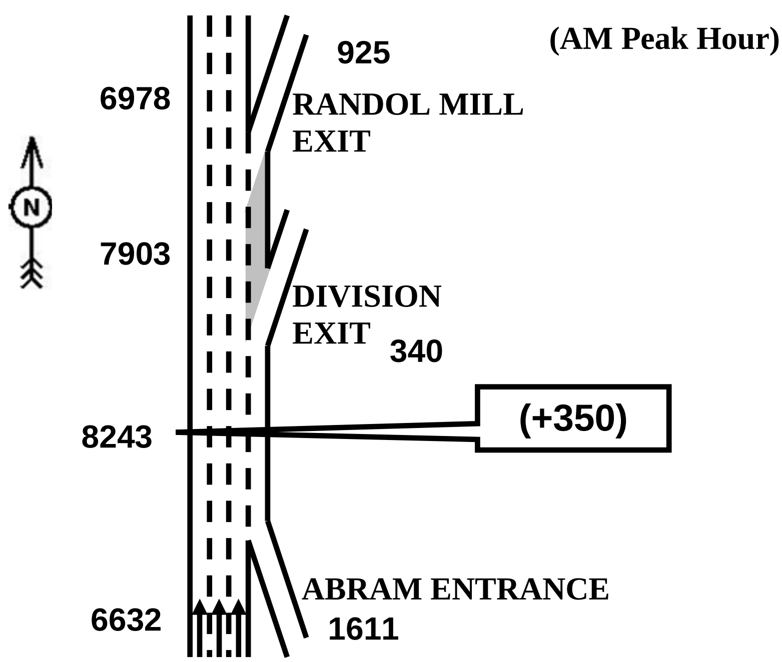


Figure 5. NB SH 360 at Division (SH 180): Before and After Diagrams.

This improvement was completed in two months, and initial summertime data collection showed an extremely high benefit. Data were collected again after school started again in the fall, as shown in the bottom half of Figure 5, along with the new lane layout. In this case, the improved speeds were only observed upstream as far as the top of the bridge over Abram, which creates a blind vertical curve with drivers slowing down expecting congestion on the other side. However, speeds through the bottleneck improved significantly, and volumes increased as well. The overall delay benefits were calculated as $200,000 per year, meaning that the improvement again paid for itself in a year. However, another significant benefit was improved safety. Comparing two years of before data with two years of after data, an injury crash reduction of 76 percent was sustained in this section after the improvement. In this case, loss of the outside shoulder over the short section was over-balanced by the improved traffic operations.

Case Study Number 2

The last case study to be examined was in El Paso, Texas, within the interchange between I-10 and US 54, which accesses the border of Mexico, at Juarez. As shown in Figure 6, the ramp from SB US 54 joined with the ramp from NB US 54, and the two enjoyed a lane addition onto eastbound (EB) I-10. Although built as a two-lane ramp, the US 54 SB-to-EB ramp was striped for one lane, and traffic queuing was extensive on the SB main lanes during both the morning and the evening peak periods. In addition, EB I-10 was experiencing slowdowns that seemed worse than the volumes being handled would suggest should be the case. Queue jumping was occurring upstream of the low-volume exit to Raynolds, with traffic cutting into I-10 at the last minute at the lane drop.

TxDOT implemented two improvements: first, the lane addition at the EB US 54 entrance was expanded to allow it to be a two-lane addition, with the auxiliary lane exiting at the Paisano exit. This required converting the inside shoulder on I-10 to a travel lane for a short distance. The two-lane entrance then allowed the two-lane ramp from the north to be restriped to the originally intended two lanes. The second improvement was to stripe out the outside lane on I-10 at the US 54 exit, forcing a lane drop to serve the two-lane ramp to the north. This allowed a lane addition at the Copia entrance, with that lane dropping at the Raynolds exit.

There had been some concern that a weaving problem might be set up between EB I-10 traffic exiting to Paisano and the entrance ramp from US 54. However, since micro-simulation indicated it could work adequately, TxDOT decided to proceed with implementation, and if a problem developed, traffic wishing to access Paisano from the west would be signed to take the Raynolds exit.

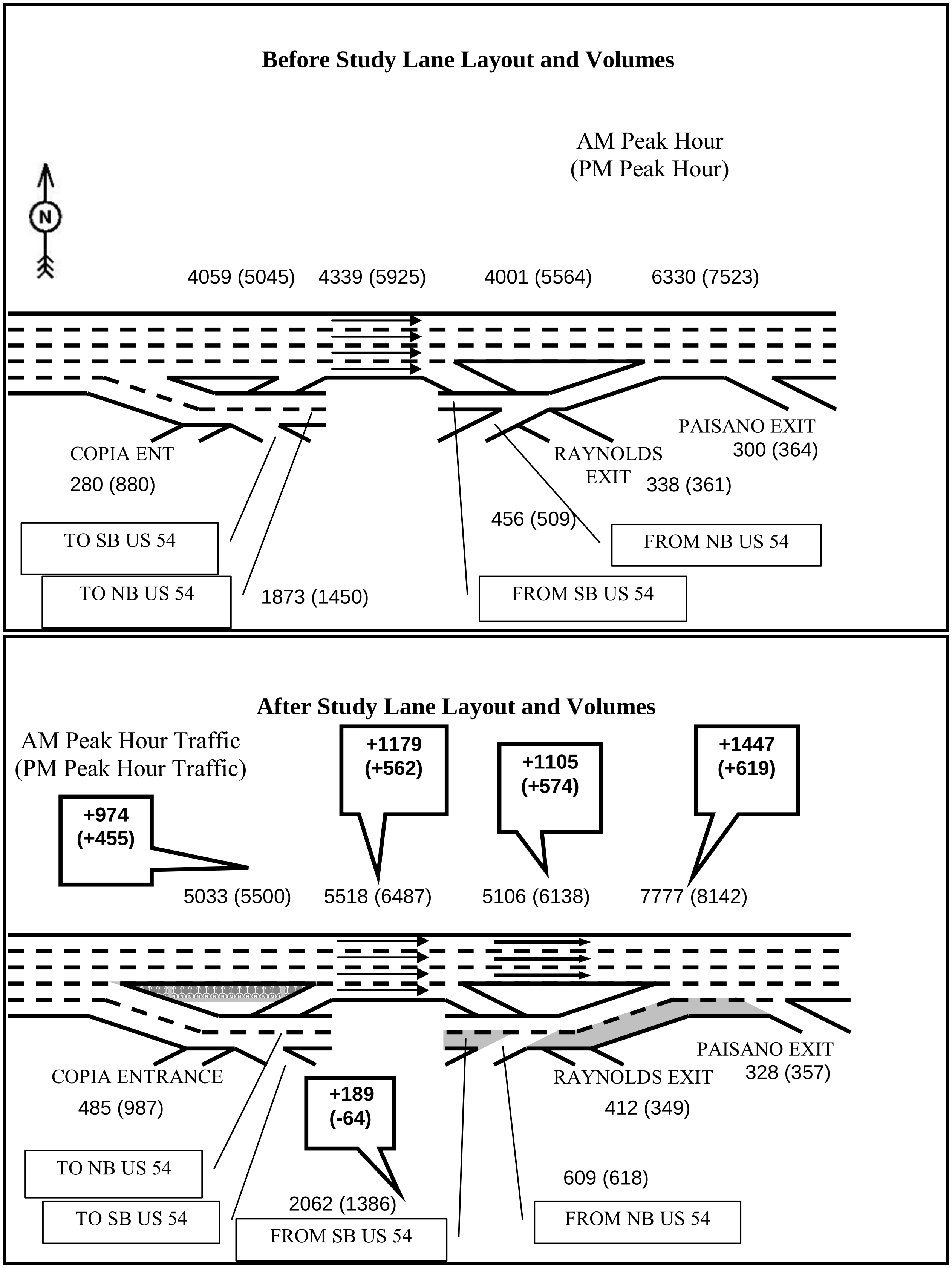


Figure 6. EB I-10 at US 54 in El Paso: Before and After Diagrams.

The cost for the improvement was $530,000, accomplished in 1997. Figure 6 shows the improved lane configuration and the resulting volumes, both morning and evening peak hours. Subsequent evaluation determined the resulting operations were clearly beneficial. Queuing disappeared on the SB US 54 approach, and speeds picked up on I-10 as well, during both peak periods. As shown in Figure 6, main lane volumes increased on I-10, even though a main lane was striped out, since it had mainly been used as a queue-jumping lane, to the great irritation of motorists interviewed. Additionally, injury crash rates declined substantially on US 54 and were slightly reduced on I-10. Overall annual benefits were estimated at $1.3 million.

Summary Tables for Dallas-Fort Worth and El Paso Bottleneck Removal Project Evaluations
Table 5 shows the operational evaluation of 13 bottleneck removal projects implemented in the Dallas-Fort Worth and El Paso areas with benefits in recurrent delay reduction and the resulting benefit-cost (B-C) ratios. Table 6 shows comparisons of before and after crash rates by movement for these same projects. Site 5 lacks crash statistics because it was the last one implemented, and insufficient "after" crash data were available for a worthwhile comparison.

Table 5. Operational Evaluation Summary of 13 Bottleneck Projects in Texas.

Site	District	Freeway(s) and Limits	Improvement Type	Annual Benefit	Cost	B-C Ratio **
1*	FTW	NB SH 360 @ Division (SH 180)	Shoulder conversion (outside) + auxiliary lane addition	$200,000	$150,000	10:1
2*	ELP	EB I-10 @ US 54	Restriping + ramp modification + auxiliary lane addition	$1.3 million	$530,000	20:1
3	DAL	EB I-30, I-35E to I-45	Ramp reversal (exit converted to entrance) + auxiliary lane addition	$700,000	$660,000	9:1
4	DAL	NB I-35E, I-30 to Dallas North Tollway	Shoulder conversion (inside) + auxiliary lane additions	$600,000	$130,000	37:1
5	DAL	EB SH 190 to SB US 75	Restriping + ramp modification	$500,000	$11,000	374:1
6	DAL	NB I-35E ramp to Dallas North Tollway	Restriping + ramp modification	$300,000	$20,000	132:1
7	DAL	NB-SB I-35E, Loop 12 to I-635	Shoulder conversion (inside) + removal of two inside merges	$11.0 million	$1.9 million	47:1
8	DAL	WB I-30 ramp to SB I-35E	Restriping + ramp modification	$200,000	$5,000	324:1
9	FTW	EB I-20 to NB SH 360	Restriping + ramp modification + removal of through lane inside interchange	$500,000	$10,000	400:1
10	FTW	SB SH 360 to WB I-20	Restriping + ramp modification + removal of through lane inside interchange	$30,000	$8,000	32:1
11	FTW	SB SH 360 @ Division (SH 180)	Ramp closure + auxiliary lane addition	$1.0 million	$440,000	18:1
12	DAL	EB I-635 to NB US 75	Restriping and widening left-side ramp from one to two lanes	$3.6 million	See #13	See #13
13	DAL	SB US 75 to WB I-635	Shoulder conversion (inside) on I-635 to allow ramp from US 75 its own lane	$3.8 million	$2.45 million	24:1

* These two sites are described in detail in this final report.
** The B-C ratio is based on 10-year project life with a 4 percent discount rate.

Table 6. Safety Evaluation Summary of 13 Bottleneck Projects in Texas.

Site	District	Freeway(s) and Limits	Crash Rate Change[(a)]/100 MVMT	Safety Benefit
1	FTW	NB SH 360 @ Division (SH 180)	SH 360 (NB)—72.8 to 17.7	NB (+76%)
2	ELP	EB I-10 @ US 54	US 54 (SB)—61.9 to 28.4	SB (+54%)
			I-10 (EB)—51.7 to 48.7	EB (+6%)
3	DAL	EB I-30, I-35E to I-45	I-30 (EB)—93.0 to 64.5[(b)]	EB (+31%)
			I-30 (EB - WEAVE)[(c)]—36.2 to 20.7	EB (+43%)
			I-30 (EB - WEAVE)[(d)]—12.9 to 5.2	EB (+60%)
4	DAL	NB I-35E, I-30 to Dallas North Tollway	I-35E (NB) —112.1 to 72.2	NB (+36%)
5	DAL	EB SH 190 to SB US 75	No after data for analysis	Not applicable
6	DAL	NB I-35E ramp to Dallas North Tollway	Not on state system	Not applicable
7	DAL	NB-SB I-35E, Loop 12 to I-635	I-35E (NB)—84.0[(e)] to 78.2[(f)]	NB (+7%)
			I-35E (SB)—66.4[(g)] to 43.8[(h)]	SB (+34%)
8	DAL	WB I-30 ramp to SB I-35E	I-30 (WB)—84.1 to 68.3	WB (+19%)
9	FTW	EB I-20 to NB SH 360	I-20 (EB)—51.2 to 45.0	EB (+12%)
10	FTW	SB SH 360 to WB I-20	SH 360 (SB)—65.9 to 30.3	SB (+54%)
			I-20 (WB)—35.9 to 34.1	WB (+5%)
11	FTW	SB SH 360 @ Division (SH 180)	SH 360 (SB)—48.6 to 16.2	SB (+67%)
12	DAL	EB I-635 to NB US 75	I-635 (EB)—19.5 to 25.6	EB (-31%)
13	DAL	SB US 75 to WB I-635	I-635 (WB)—78.6 to 30.8	WB (+61%)

NOTES: Crash Rate = (number of crashes)/((vehicle miles of travel)/(100×10^6)).	
Crash Rate Change:	(*a*) The construction year(s) may consist of one or two calendar years depending on whether construction overlapped two calendar years.
	(*b*) Data include all vehicles.
	(*c*) Data include all truck types in weave section only.
	(*d*) Data include only semi-trailer truck types in weave section only.
	(*e*) The first number is the average of the three calendar years *before* construction implementation.
	(*f*) The second number is the average of the three calendar years *after* construction completion.
	(*g*) The first number is the average of the two calendar years *before* construction implementation. This applies to all other locations in the table.
	(*h*) The second number is the average of the two calendar years *after* construction completion. This applies to all other locations in the table.
Crash data were obtained from the Texas Accident Data Files for the years 1989 to 2001.	

FTW = Fort Worth District, TxDOT
ELP = El Paso District, TxDOT
DAL = Dallas District, TxDOT
MVMT = million vehicle-miles traveled

Project Website: Summary of Findings

One of the project tasks involved the creation of a project website. The research team secured the bottleneckworkshop.org domain name for the project website and utilized a simple design. Figure 7 provides a screen capture of the homepage for the project website—http://www.bottleneckworkshop.org/.

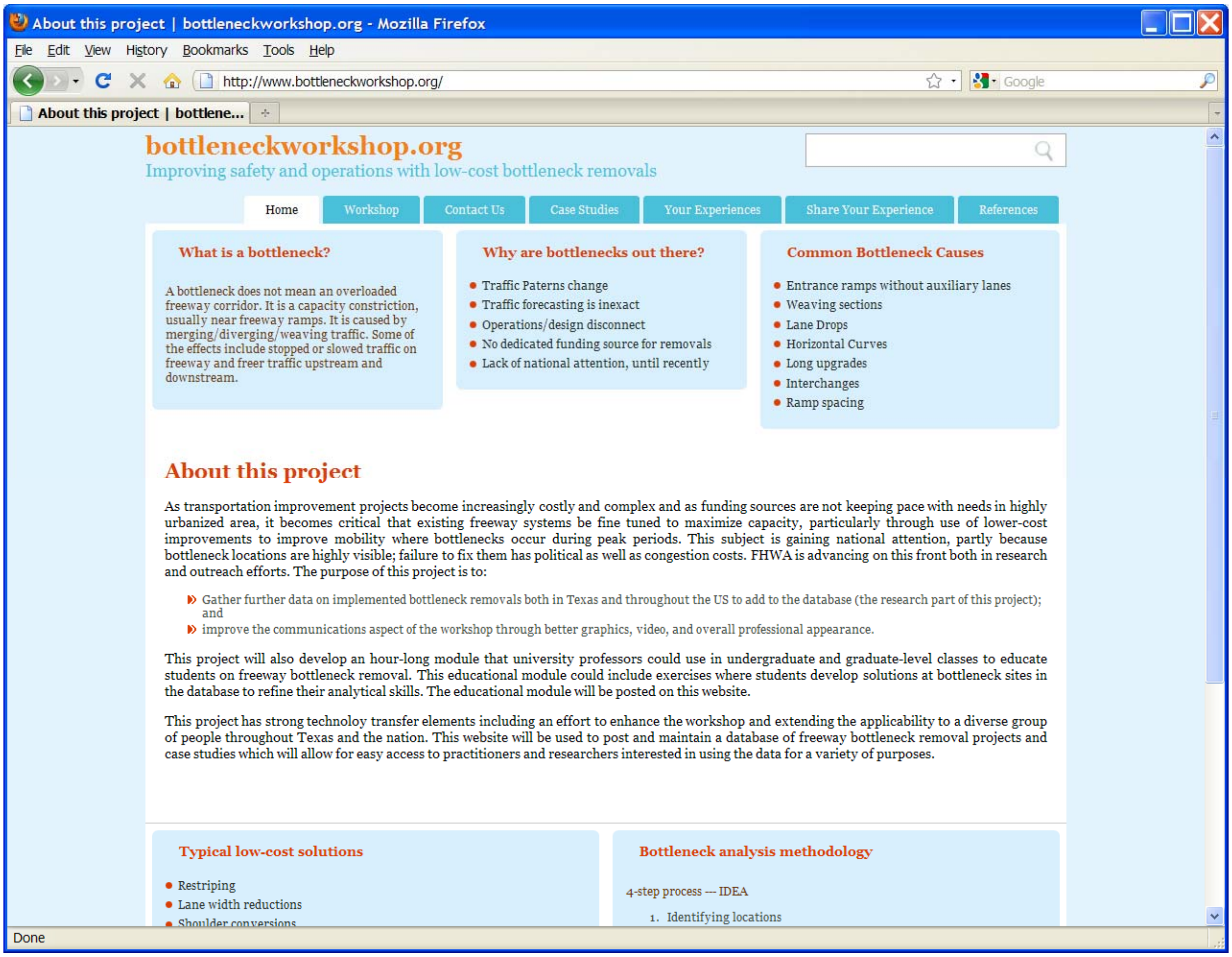


Figure 7. Screen Capture of Homepage for Project Website.

The project website had two primary functions:

1. serve as a repository for project information, and
2. provide a means for information exchange for project stakeholders and transportation professionals.

Information Repository

The project team designed the website to host a wealth of information on the subject of low-cost freeway bottleneck removal. The website provides information on the following subjects:

- what a bottleneck is,
- why bottlenecks are out there,
- common bottleneck causes,
- project description,
- typical low-cost solutions,
- bottleneck analysis methodology, and
- bottleneck references.

Information Exchange

The project team also included several website features where visitors can interact with members of the project team. The first interactive feature allows site visitors to share their experiences about successful low-cost freeway bottleneck treatments. The second interactive feature lets site visitors contact the webmaster if they have any questions or comments.

Freeway Bottleneck Workshop Enhancement: Summary of Findings

This portion of the final report documents the development of an enhanced freeway bottleneck workshop. An existing freeway bottleneck workshop utilized a half-day format with a PowerPoint slideshow and corresponding participant notebook. Evaluations of this workshop showed generally good acceptance of the technical content; however, participants desired the addition of more interactive elements. The project team decided to focus on three primary enhancements:

1. addition of national freeway bottleneck removal experiences to Texas case studies;
2. upgrading of the participant notebooks:
    a. inclusion of key handouts and
    b. inclusion of a compact disc (CD) containing all of the workshop materials (PowerPoint slideshow, supporting reference documents, and case study data); and
3. addition of interactive elements and better design of group exercises.

In addition to these three primary enhancements, researchers formatted the workshop to be consistent with adult training guidelines for workshops sponsored by the National Highway Institute (NHI). NHI typically divides workshops into distinct modules that include learning outcomes and reviews to determine that the outcomes have been adequately covered and are understood by participants. Table 7 provides the NHI-style design for the enhanced Freeway Bottleneck Workshop, which included 10 modules. Table 8 shows an example of the learning outcomes and review questions for Module 2, Bottleneck Identification.

Table 7. Enhanced Freeway Bottleneck Workshop Course Design.

Module	Description	Timeframe
Welcome	Participant and Instructor Introductions	9:00-9:20 AM
1	Course Overview	9:20-9:25 AM
2	Bottleneck Identification	9:25-9:45 AM
3	Bottleneck Causes	9:45-9:55 AM
BREAK (10 minutes)		
4	Low-Cost Solutions	10:05-10:20 AM
5	Bottleneck Analysis and Evaluation	10:20-10:35 AM
BREAK (10 minutes)		
6	Bottleneck Case Studies	10:45-11:30 AM
7	Working Lunch/Group Problem Solving	11:30-12:00 PM
8	Local Bottlenecks	12:00-12:15 PM
9	Guidelines for Successful Projects	12:15-12:45 PM
10	Course Review	12:45-12:50 PM
Wrap-Up	Course Evaluation and Feedback	12:50-1:00 PM

Table 8. Example Learning Outcomes and Review Questions from Module 2.

Learning Outcomes: At the completion of this workshop module, you will be able to:
1. Define what a bottleneck is
2. Relate the two types of traffic congestion
3. Understand the contribution of bottlenecks to traffic delays
Module Review
1. List the two types of traffic congestion: ____________________ and _________________________
2. Bottlenecks are ___________________ congestion
3. What percentage of delay is estimated to be caused by bottlenecks

The project team designed the workshop for a half day, a total of four hours. Course participants were provided with certificates of completion at the end of the workshop. Course completion provides the participants with three professional development hours, which can be used to fulfill continuing education requirements.

Addition of National Bottleneck Removal Experiences

The project team gathered information from several states outside of Texas regarding experiences with low-cost freeway bottleneck removal projects. Information from the Florida and Minnesota Departments of Transportation was synthesized for inclusion in the workshop materials in order to complement the existing Texas-based information.

Upgraded Participant Notebook

The project team developed an upgraded participant notebook as the primary deliverable for workshop participants. Each participant workbook contained the following items:

1. cover (see Figure 8);
2. workshop agenda;
3. evaluation form;
4. freeway bottleneck analysis methodology handout;
5. CD with supporting reference materials; and
6. workshop slides, printed two per page (see Figure 9).

The participant workbooks contained approximately 65 color pages with the module slides presented by the course instructors.

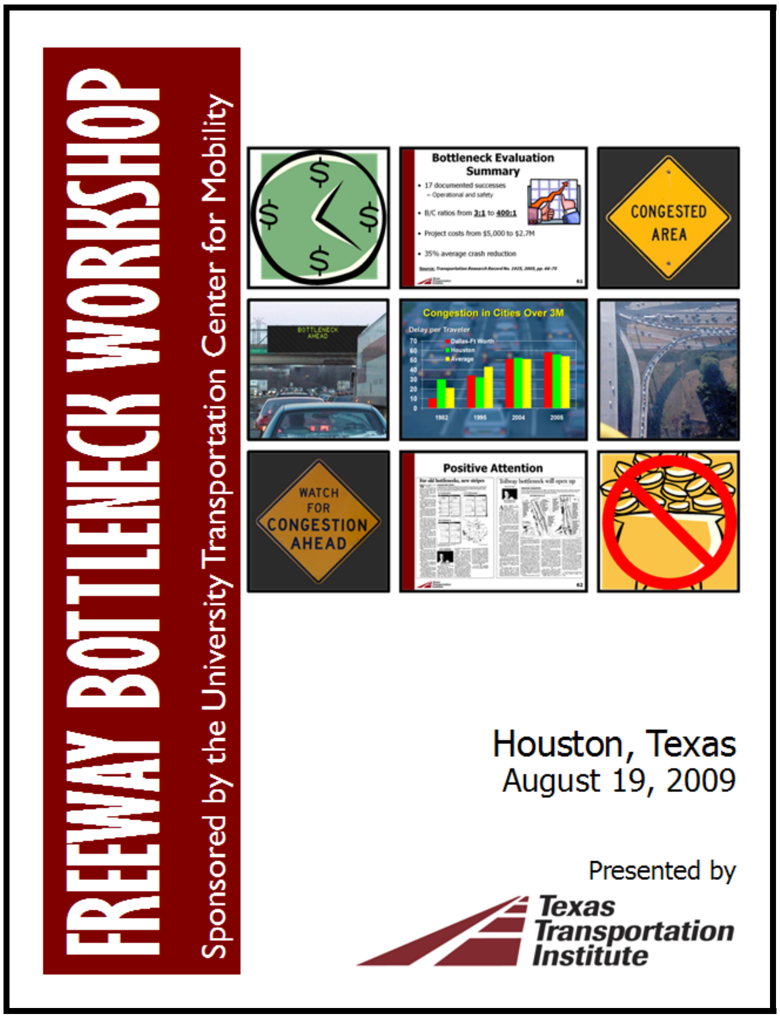


Figure 8. Example of Participant Notebook Cover.

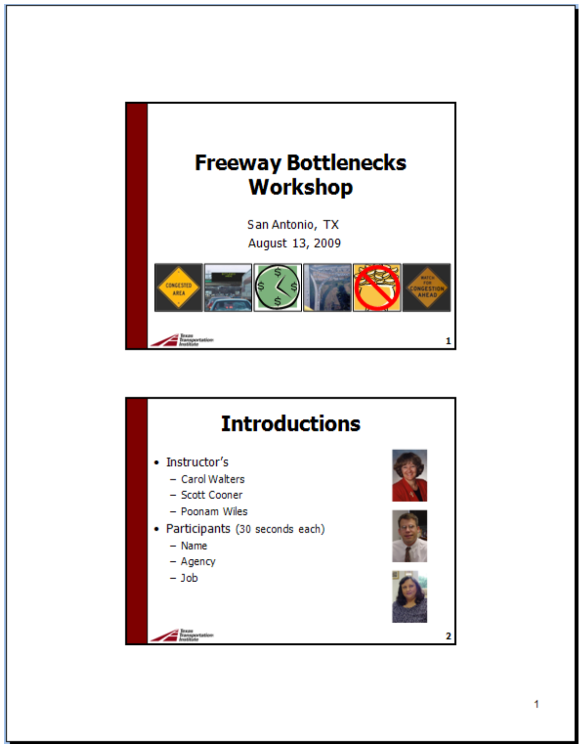


Figure 9. Example of Module Slides in Participant Workbook.

Addition of Interactive Elements

The project team also worked hard to enhance the workshop with the addition of interactive elements. The three primary enhancements to interactivity included:

1. improvement of group problem-solving exercise and handouts used in Module 7,
2. addition of Module 8 on local freeway bottleneck successes and opportunities, and
3. addition of animation features to key PowerPoint slides to make before-versus-after site layouts come to life.

Group Problem-Solving Interactivity

The instructors designed Module 7 of the workshop to provide participants with the opportunity to solve real-life bottlenecks in small groups. Instructors divided each workshop into four smaller groups and provided each participant with a handout with information on their bottleneck case study, including:

- location;
- existing conditions (aerial photograph, observed problems/congestion, and site geometrics); and
- site layout showing traffic volumes (freeway main lanes and ramps), number of lanes, and relevant distances (see Figure 10).

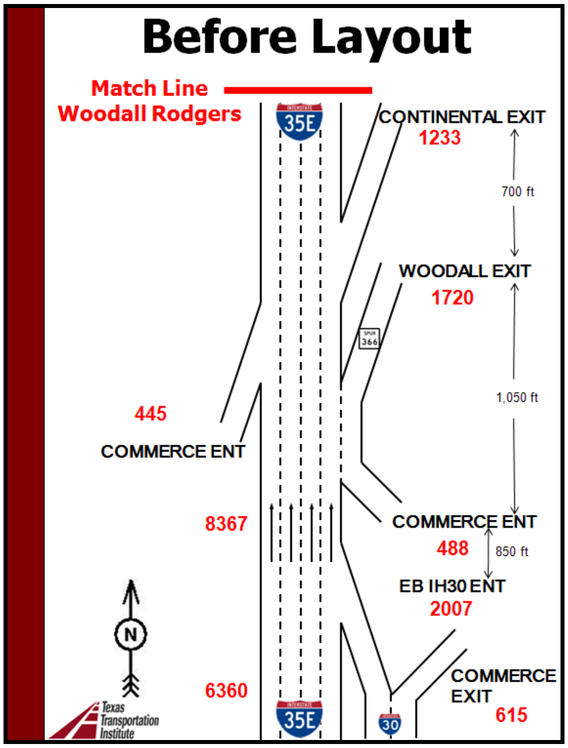


Figure 10. Example Site Layout for Group Problem-Solving Exercise.

The instructors provided participants with lunch during the group problem-solving exercise module in order to further stimulate discussion and interaction as they were developing potential solutions (Figure 11). Each of the four groups nominated a spokesperson that presented the group's findings and assessment of potential low-cost bottleneck improvements.

Figure 11. Interactive Group Problem Solving over Lunch.

Local Bottleneck Module

The project team also added a module to the workshop to allow participants to discuss local freeway bottlenecks in their metropolitan region. This module was designed for participants to be able to first discuss where they had successfully implemented low-cost improvements to remove freeway bottlenecks. Secondly, the course instructors facilitated a discussion of sites where bottlenecks still exist that have the potential for low-cost improvements. The module instructor used a map of the local freeway system—see Figure 12 for an example—to facilitate the participant interaction during this workshop module.

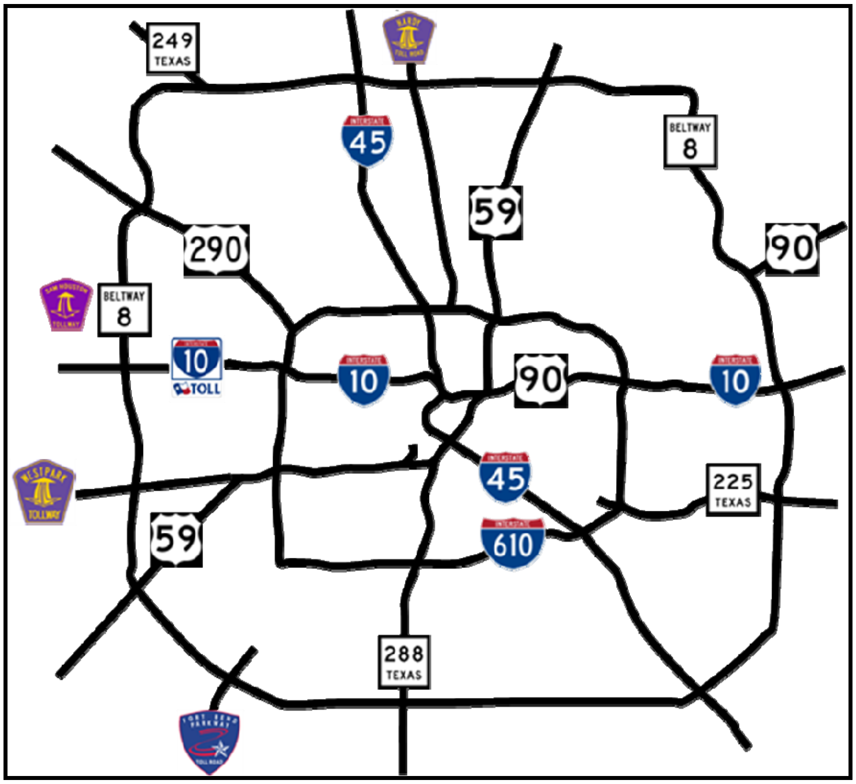


Figure 12. Example of Freeway Map Used to Facilitate Discussion of Local Bottlenecks.

Pilot Workshops: Summary of Findings

The University Transportation Center for Mobility™ (UTCM) at Texas A&M University sponsored the delivery of the enhanced Freeway Bottleneck Workshop. The project team presented the Freeway Bottleneck Workshop to enthusiastic participants in four locations:

1. San Antonio, Texas;
2. Houston, Texas;
3. Atlanta, Georgia; and
4. Austin, Texas.

Each half-day workshop allowed participants from various disciplines (design, operations, and planning) and agencies (city, county, state, and federal) to learn about bottleneck identification, causes, low-cost solutions, analysis and evaluation, case studies, and guidelines for successful projects. The following subsections summarize each of the four Freeway Bottleneck Workshops conducted during this project.

San Antonio Workshop

The project team conducted the first pilot workshop in San Antonio, Texas, on August 13, 2009, at the TxDOT TransGuide Transportation Management Center (see Figure 13). Twenty-six professionals attended this workshop representing four different agencies. Table 9 summarizes the evaluation of the San Antonio Freeway Bottleneck Workshop based on the 24 completed course evaluation forms. The evaluation form asked participants to rate each individual course module, the instructors, workshop length, interactivity, and the participant workbook based on the following scale:

- excellent = 5 points,
- very good = 4 points,
- average = 3 points,
- fair = 2 points, and
- poor = 1 point.

The project team used this rating scale to calculate average ratings for each individual workshop element and a total for the overall workshop based on the aggregate of all elements. The San Antonio Freeway Bottleneck Workshop had the following performance summary:

- highest-rated module: tie between Module 6 (Bottleneck Case Studies) and Module 7 (Working Lunch/Group Problem Solving),
- lowest-rated module: Module 1 (Course Overview), and
- overall average rating = 4.23

The two course instructors received high ratings for the workshop as indicated in Table 9. Over 90 percent of participant ratings for this workshop were either in the excellent or very good categories.

Figure 13. Review of Bottleneck Case Study at San Antonio Workshop.

Table 9. Summary Evaluation for San Antonio Workshop.

EVALUATION FORMS (N = 24)						AVERAGE RATING
Workshop Element	Excellent (5 points)	Very Good (4 points)	Average (3 points)	Fair (2 points)	Poor (1 points)	
Module 1	3	15	5	1	0	3.83
Module 2	5	16	3	0	0	4.08
Module 3	8	13	3	0	0	4.21
Module 4	8	12	4	0	0	4.17
Module 5	7	15	2	0	0	4.21
Module 6	9	13	2	0	0	4.29
Module 7	9	13	2	0	0	4.29
Module 8	2	17	5	0	0	3.88
Module 9	7	15	2	0	0	4.21
Module 10	4	16	4	0	0	4.00
Instructor 1: Carol Walters	16	8	0	0	0	4.67
Instructor 2: Scott Cooner	16	8	0	0	0	4.67
Length	9	15	0	0	0	4.38
Interactivity	11	11	2	0	0	4.38
Participant workbook	6	18	0	0	0	4.25
TOTAL	120	205	34	1	0	**4.23**
Percentage	33.3%	57.0%	9.4%	0.3%	0%	

Houston Workshop

The project team performed the second pilot workshop in Houston, Texas, on August 19, 2009, at the TxDOT Houston District headquarters (see Figure 14). Twenty-six professionals attended this workshop representing two different agencies. Table 10 summarizes the evaluation of the Houston Freeway Bottleneck Workshop based on the 21 completed course evaluation forms. The Houston Freeway Bottleneck Workshop had the following performance summary:

- highest-rated module: Module 6 (Bottleneck Case Studies),
- lowest-rated module: Module 8 (Local Bottlenecks), and
- overall average rating = 4.41.

The two course instructors received high ratings for the workshop as indicated in Table 10. Almost 93 percent of participant ratings for this workshop were either in the excellent or very good categories.

Figure 14. Participants Learn about Typical Low-Cost Solutions at Houston Workshop.

Table 10. Summary Evaluation for Houston Workshop.

EVALUATION FORMS (N = 21)						AVERAGE RATING
Workshop Element	Excellent (5 points)	Very Good (4 points)	Average (3 points)	Fair (2 points)	Poor (1 points)	
Module 1	8	10	3	0	0	4.24
Module 2	9	11	1	0	0	4.38
Module 3	9	12	0	0	0	4.43
Module 4	12	9	0	0	0	4.57
Module 5	12	8	1	0	0	4.52
Module 6	15	5	1	0	0	4.67
Module 7	10	10	1	0	0	4.43
Module 8	8	6	6	1	0	4.00
Module 9	10	10	1	0	0	4.43
Module 10	8	12	1	0	0	4.33
Instructor 1: Scott Cooner	12	8	1	0	0	4.52
Instructor 2: Poonam Wiles[1]	3	8	1	0	0	4.17
Length	7	12	2	0	0	4.24
Interactivity	14	6	1	0	0	4.62
Participant workbook	10	10	1	0	0	4.43
TOTAL	147	137	21	1	0	**4.41**
Percentage	48%	44.8%	6.8%	0.3%	0%	

[1] Only 12 responses were received on evaluation forms for Instructor 2.

Atlanta Workshop

The project team accomplished the third pilot workshop in Atlanta, Georgia, on August 25, 2009, at the StreetSmarts corporate headquarters (see Figure 15). Thirty-eight professionals attended this workshop representing 13 different agencies. Table 11 summarizes the evaluation of the Atlanta Freeway Bottleneck Workshop based on the 36 completed course evaluation forms. The Atlanta Freeway Bottleneck Workshop had the following performance summary:

- highest-rated module: Module 7 (Working Lunch/Group Problem Solving),
- lowest-rated module: Module 5 (Bottleneck Analysis and Evaluation), and
- overall average rating = 4.17.

The two course instructors received high ratings for the workshop as indicated in Table 11. This workshop also featured a third guest instructor, Marsha Anderson Bomar, who taught the Local Bottlenecks module and provided local insight throughout the day (see Figure 16). Over 90 percent of participant ratings for this workshop were either in the excellent or very good categories.

Figure 15. Participants in Atlanta Workshop Discuss National Bottleneck Case Studies.

Table 11. Summary Evaluation for Atlanta Workshop.

EVALUATION FORMS (N = 36)						AVERAGE RATING
Workshop Element	Excellent (5 points)	Very Good (4 points)	Average (3 points)	Fair (2 points)	Poor (1 points)	
Module 1	10	23	3	0	0	4.19
Module 2	10	23	3	0	0	4.19
Module 3	6	26	4	0	0	4.06
Module 4	13	15	8	0	0	4.14
Module 5	9	22	4	1	0	4.03
Module 6	12	21	2	0	1	4.19
Module 7	14	19	3	0	0	4.31
Module 8	9	22	5	0	0	4.11
Module 9	8	24	4	0	0	4.08
Module 10	8	23	5	0	0	4.06
Instructor 1: Carol Walters	17	19	0	0	0	4.47
Instructor 2: Scott Cooner	14	22	0	0	0	4.39
Length	8	22	5	1	0	4.03
Interactivity	6	30	0	0	0	4.17
Participant workbook	7	25	4	0	0	4.08
TOTAL	151	336	50	2	1	**4.17**
Percentage	28.0%	62.2%	9.2%	0.4%	0.2%	

Figure 16. Instructors for the Atlanta Workshop.

Austin Workshop

The project team presented the final pilot workshop in Austin, Texas, on November 12, 2009, at the TxDOT Austin District headquarters. Thirty professionals attended this workshop representing eight different agencies. Table 12 summarizes the evaluation of the Austin Freeway Bottleneck Workshop based on the 25 completed course evaluation forms. The Austin Freeway Bottleneck Workshop had the following performance summary:

- highest-rated module: tie Module 4 (Low-Cost Solutions) and Module 6 (Bottleneck Case Studies),
- lowest-rated module: Module 3 (Bottleneck Causes), and
- overall average rating = 4.37.

The course instructor received high ratings for the workshop as indicated in Table 12. Almost 91 percent of participant ratings for this workshop were either in the excellent or very good categories.

Table 12. Summary Evaluation for Austin Workshop.

EVALUATION FORMS (N = 25)						AVERAGE RATING
Workshop Element	Excellent (5 points)	Very Good (4 points)	Average (3 points)	Fair (2 points)	Poor (1 points)	
Module 1	13	8	3	0	1	4.28
Module 2	12	11	2	0	0	4.40
Module 3	11	13	1	0	0	4.00
Module 4	13	11	1	0	0	4.48
Module 5	13	10	2	0	0	4.44
Module 6	13	11	1	0	0	4.48
Module 7	10	9	5	0	1	4.08
Module 8	8	11	6	0	0	4.08
Module 9	12	11	2	0	0	4.40
Module 10	10	12	2	0	1	4.20
Instructor 1: Scott Cooner	16	9	0	0	0	4.64
Length	13	11	1	0	0	4.48
Interactivity	10	14	1	0	0	4.36
Participant workbook	13	10	2	0	0	4.32
TOTAL	167	151	29	0	3	**4.37**
Percentage	47.7%	43.1%	8.3%	0.0%	0.9%	

National Workshop Delivery Plan: Summary of Findings

One of the final project tasks involved the development of a delivery plan for offering the enhanced Freeway Bottleneck Workshop on a national scale. Neil Spiller participated in the Atlanta workshop and currently leads the Localized Bottleneck Reduction Program for FHWA. FHWA sponsored three LBR workshops in 2008 to bring together state and local transportation agency representatives to discuss programs to reduce bottlenecks. Workshops were held in Florida, Virginia, and Washington State in August and September of 2008. There is potential synergy between the existing LBR workshop and the enhanced Freeway Bottleneck Workshop developed under this UTCM™ project.

Target Sponsors

The project team developed a list of potential sponsors to target for funding of future delivery of the enhanced Freeway Bottleneck Workshop. Target sponsors include:

1. FHWA Office of Operations,
2. American Association of State Highway and Transportation Officials (AASHTO),
3. National Highway Institute,
4. Institute of Transportation Engineers,
5. individual state departments of transportation, and
6. MPOs in medium to large population areas.

Potential for Web-Based Delivery

The project team also discussed the potential for web-based delivery of the enhanced Freeway Bottleneck Workshop. Web seminars/briefings, commonly referred to as webinars, are becoming an increasingly popular way of delivering training and technical content to transportation professionals. Web-based delivery allows for multiple jurisdictions to be involved and reduces travel costs.

The project team piloted an executive summary version of the enhanced Freeway Bottleneck Workshop at a Flexible Design Workshop sponsored by MnDOT in July 2009 (*24*). The objective of the Flexible Design Workshop was to provide participants with an opportunity to learn about experiences with flexible highway design practices for managing congestion from national subject-matter experts. The hour-long executive summary version of the enhanced Freeway Bottleneck Workshop was delivered using web-based video conferencing software. Workshop participants in Minneapolis saw a video feed with corresponding PowerPoint slides and were allowed to interact and ask questions (see Figure 17 and Figure 18). The project team believes the successful delivery of the executive summary version in Minneapolis shows that web-based delivery is something worth pursuing. The same potential sponsors listed in the previous section would all still be applicable.

Figure 17. Video Feed for Flexible Design Workshop Allowing Remote Speaker Participation.

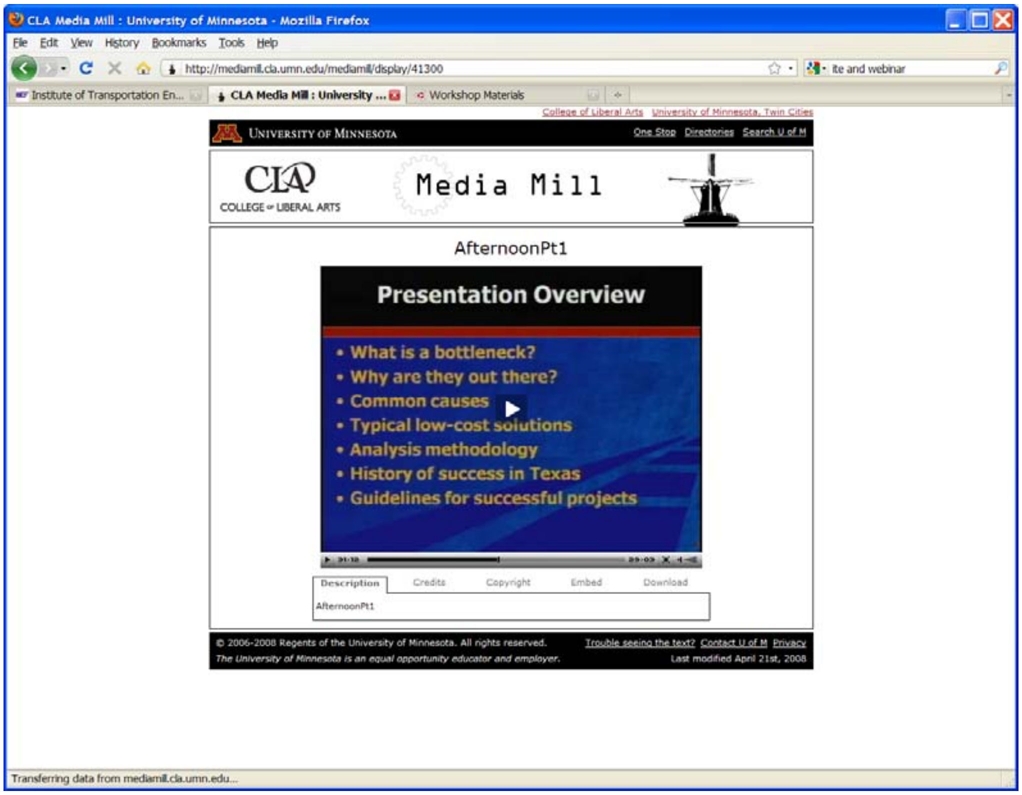


Figure 18. Screen Capture of PowerPoint Slides Displayed to Minneapolis Participants.

Educational Module: Summary of Findings

The final task in this UTCM™ project involved the development of an educational module for university professors to use in undergraduate- and graduate-level classes to teach students on freeway bottleneck removal. This project task had both technology transfer and educational components, which are important to the overall mission of the UTCM™ program.

Module Development

Several members of the project team collaborated on the development of the educational module. The module was designed to be approximately one hour in length and contain one case study exercise from Module 7 of the enhanced Freeway Bottleneck Workshop.

University Delivery

The pilot delivery of the educational module is planned for the spring 2010 semester at the University of Texas at Arlington. The pilot delivery will be evaluated, and the module slides, handouts, and script will be modified based on student and professor feedback. The final version of the educational module will be posted on the bottleneckworkshop.org website for use by professors. Initial promotion of the educational module will be accomplished by an e-mail to the faculty advisors of the various Institute of Transportation Engineers (ITE) student chapters in the U. S..

Project Summary: Conclusions and Recommendations

Conclusions

This report summarizes the enhancement and pilot delivery of a Freeway Bottleneck Workshop designed to teach participants how to develop low-cost solutions to improve bottlenecks on freeway facilities. Studies have shown that implementing relatively minor improvements on existing freeways to remove bottlenecks produces significant operational (typical benefit-cost ratios from 3:1 to 400:1) and safety benefits (average crash reduction of approximately 35 percent). This project enhanced and improved an existing workshop by: (1) gathering further data on implemented bottleneck removals both in Texas and throughout the United States to add to the case study database; and (2) improving the communications aspect of the workshop through better graphics, video, and overall professional appearance.

The enhanced Freeway Bottleneck Workshop was presented to enthusiastic participants in Atlanta (Georgia), Austin, Houston, and San Antonio. Each half-day workshop allowed participants from various disciplines (design, operations, and planning) and agencies (city, county, state, and federal) to learn about bottleneck identification, causes, low-cost solutions, analysis and evaluation, case studies, and guidelines for successful projects. Workshop participants also had the opportunity to work in teams to analyze a real-world freeway bottleneck and to discuss opportunities for bottleneck removal in their metropolitan area. The workshop evaluation showed that almost 91 percent of participants rated all workshop elements (e.g., modules, instructors, workbooks, etc.) as either excellent or very good. The final component of the project developed a website and educational module for university students and professors that will continue the technology transfer aspect of this work. The long-term implications of this project are elevated awareness of the extremely high benefits relative to costs and development of professional capacity to recognize opportunities and to analyze and select appropriate measures for successful freeway bottleneck removal projects.

Recommendations

The transportation profession needs a boost of confidence amidst the ever-present funding challenges. For years, transportation leaders have been saying “we’ll never build our way out of congestion,” which makes the profession irrelevant in the eyes of the traveling public. In fact, some congestion is unnecessary, and relieving it with low-cost improvements can enhance our image as necessary professionals. Implementing minor improvements on existing freeways in order to remove bottlenecks typically achieves high benefits yet is not routinely done by many agencies. The enhanced Freeway Bottleneck Workshop is now a resource that can be used to train and energize transportation agencies and their partners to make low-cost bottleneck removal a part of their normal routine for implementing projects that safely and reliably mitigate traffic congestion on freeways.

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