Guide to Project Coordination for Minimizing Work Zone Mobility Impacts

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16. Abstract

Under the Every Day Counts (EDC) program, the Federal Highway Administration (FHWA) is promoting technologies and practices that can shorten the project delivery process, enhance durability and safety, reduce congestion, and improve environmental sustainability. The focus is on providing efficiency through technology and collaboration. This includes strategies for Project Coordination (PC) which can be applied to a single project, or more commonly, among multiple projects within a corridor, network, or region, and possibly across agency jurisdictions, to minimize work zone impacts and produce time and cost savings.

The purpose of this document is to provide guidance on implementing PC in the planning, design, and delivery phases of projects. It summarizes key steps for successfully implementing PC, using a systematic approach to meet a specific set of clearly defined objectives. The steps include:

- establishing the PC vision,
- developing details of how PC will occur,
- educating and informing personnel and stakeholders,
- implementing the PC process, and
- refining the process.

Two case studies are included to demonstrate successful application of the approach.

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APPROXIMATE CONVERSIONS TO SI UNITS

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
		NOTE: volumes greater than 1000 L shall be shown in m^3		
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

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m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
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m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
°C	Celsius	1.8C+32	Fahrenheit	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

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LIST OF ABBREVIATIONS

AADT	Annual Average Daily Traffic
AASHTO	American Association of State Highway and Transportation Officials
ATRs	Automatic Traffic Recorders
BGE	Baltimore Gas & Electric
CTIS	Construction Traveler Information System
DC Water	District of Columbia Water and Sewer Authority
DDOT	District of Columbia Department of Transportation
EDC	Every Day Counts
EDC-3	Third Round of EDC
FDOT	Florida Department of Transportation
FHWA	Federal Highway Administration
GIS	Geographic Information System
I-35	Interstate 35
LCAS	Lane Closure Assessment System
MCTD	Motor Carrier Transport Division
MOUs	Memorandums of Understanding
MPC	Mobility Policy Committee
OBDP	Oregon Bridge Delivery Partners
ODOT	Oregon Department of Transportation
OTIA	Oregon Transportation Investment Act
P2P	Peer-to-Peer
PC	Project Coordination

PEPCO	Potomac Electric Power Company
SHRP-2	Strategic Highway Research Program
TMPs	Transportation Management Plans
TRANSCOM	Transportation Operations Coordinating Committee
TRB	Transportation Research Board
TTI	Texas A&M Transportation Institute
TxDOT	Texas Department of Transportation
WISE	Work Zone Impacts and Strategies Estimator
WZTA	Work Zone Traffic Analysis

CHAPTER 1. INTRODUCTION AND BACKGROUND

Under the Every Day Counts (EDC) program, the Federal Highway Administration (FHWA) is working with the American Association of State Highway and Transportation Officials (AASHTO) to speed up the delivery of road projects and address challenges caused by limited budgets. EDC is a state-based model to identify and quickly deploy innovations that can shorten the project delivery process, enhance roadway safety, reduce congestion, and improve environmental sustainability. (1) One of the strategic innovations being explored in the third round of EDC (EDC-3) is "Smarter Work Zones," which includes techniques for Project Coordination (PC). PC strategies can be applied to a single project, or more commonly, among multiple projects within a corridor, network, or region, and possibly across agency jurisdictions, to minimize work zone impacts and produce time and cost savings. Beyond EDC-3, promotion of PC as an operational strategy is also an ongoing focal point for FHWA's Work Zone Management Team.

WHAT IS PROJECT COORDINATION?

Almost everyone has experienced a specific instance (or more) where it was clear that multiple projects or project tasks occurred on a road or within a region in an uncoordinated manner which caused significant delays and frustration to the traveling public. In many cases, it appears clear to everyone what should have been done from a Project Coordination (PC) standpoint to reduce the impacts that were experienced. However, trying to actually describe comprehensively how PC can be accomplished, and the benefits of efforts to coordinate, is more difficult. Likewise, identifying and addressing the various challenges that can hamper PC efforts, and how those challenges can be overcome, can also be difficult.

PC involves various strategies and actions, with the intent to improve a transportation agency's ability to better manage and interact with multiple construction projects along a corridor or within a region toward the objective of improved safety and mobility:

- Improved *safety* through a reduction in crashes and reduced crash severity.
- Enhanced *mobility* in the form of travel time reliability and reduced delay.

The measure of effectiveness for PC efforts is determined through a comparison with the estimated impacts that would have occurred if the projects had not been coordinated in some fashion. PC can occur along a corridor, across a network of local streets, or within a broad region. It may be an internal function for managing multiple projects within an agency, or it may involve collaboration across agency jurisdictions to mutually achieve time and cost savings. (2) Among these various "dimensions" of PC there is no single best approach. Rather, the state-of-the-practice has seen the evolution of a variety of strategies and tools to facilitate coordination given the specific circumstances faced by agencies, with subsequent efforts building on the successes and challenges of those past.

The desire to better coordinate projects also goes beyond simply limiting the public's exposure to highway work zones. The same tools and business processes that enable proactive PC also facilitate information sharing and improved agency functions for project management. Even where active inter-agency coordination of project schedules is not a specific objective, “passive” PC can occur when agencies implement tools for tracking project schedules and locations, and open these databases up to other agencies (such as utility companies) with need to access public rights-of-way. While such a mechanism may not technically meet the definition of PC as described in this report, such early steps toward integrating project information between agencies nevertheless serves a similar function in minimizing the collective impact of road work upon road users. While sharing of schedules and plans amongst stakeholders can indeed be beneficial, additional opportunities exist to more actively coordinate projects in a way that will yield consistent and measureable reductions in impacts relative to what would have occurred if those coordination efforts had not occurred. Through the efforts of the FHWA Work Zone Management Team and the EDC-3 Smarter Work Zone initiative, it is hoped that PC efforts will expand and improve nationally.

It should be noted that a clear demarcation of what constitutes PC within the context of work zone safety and mobility impact mitigation does not always exist. For example, strategies implemented to reduce the potential of utility conflicts that can cause delays once a project has been initiated on a roadway can be viewed as having a safety and mobility benefit. (3,4) On the other hand, other utility conflict and coordination strategies that have been documented in the past primarily address the reduction of delays in starting a project to the owner agency and/or the elimination of conflict between agencies and utility owners over damages. In these instances, the benefits of utility coordination may fall outside the realm of work zone safety and mobility impact reduction. Also, other project management strategies exist that agencies and contractors use to reduce total project durations or durations of critical phases (i.e., accelerated construction techniques, innovative contracting strategies that consider proposed work times in the project bid, etc.). Fortunately, a significant amount of guidance already exists regarding these particular strategies. (5,6) Although important to minimizing work zone safety and mobility impacts, these strategies focus on the impacts of a single project rather than on reducing the combined effect of two or more projects that more typically define what is meant by PC.

PAST EXAMPLES OF PROJECT COORDINATION EFFORTS

Efforts to coordinate projects in a corridor or region to achieve safety and mobility benefits can be traced back nearly 30 years, when major freeway reconstruction projects in several metropolitan areas led to the development and implementation of some of the first transportation management plans (TMPs). (7,8) In these early examples, practitioners often identified widening, channelization, and signal timing projects to improve capacity and operating conditions on alternative routes to a major freeway. These projects were scheduled to occur prior to the reconstruction of that freeway, and were often paid for by the state DOT as part of the transportation management expenses allocated to the freeway reconstruction project. Routine maintenance activities of those alternative routes were then typically restricted to emergency repairs only for the duration of the major freeway reconstruction effort. By sequencing those other projects first and then restricting other non-essential work on the alternative routes, the impacts of the major freeway project were reduced. Diverted traffic from the freeway could be better accommodated on the alternative routes so that overall corridor delay was less than it would have been without the alternative route improvements. The importance of Project Coordination (PC) within the TMP development process continues to be emphasized today. The successes experienced by implementing TMPs in mitigating work zone impacts ultimately led FHWA to adopt rulemaking requiring TMPs for significant projects under the Work Zone Safety and Mobility Rule. (9) Current guidance on TMP development recommends the consideration of PC strategies within the overall plan. (10) More recent examples of efforts to develop TMPs and sequence projects in an optimum manner can also be found in the literature. (11)

Beyond the focused efforts to coordinate sub-projects to help mitigate the impacts of a single, larger project, there are also examples where agencies try to coordinate unrelated projects or other activities occurring within the right-of-way (particularly those involving the closure of travel lanes or other disruptions to normal traffic patterns) in a way that reduces their effects upon the traveling public, nearby residents, and/or businesses. For example, both California and Virginia reportedly employ a district or regional coordinator for lane closures on the state system. (11) Lane closure requests are submitted to the coordinator, who reviews their locations and times and approves or rejects the requests depending on what other lane closures may be scheduled for the same time. Similarly, some local agencies manage project activities through a permitting process, requiring requests for work in the agency right-of-way prior to the entity beginning work in or around the roadway. (12,13) In other examples, multiple agencies share with each other current and upcoming project schedules and tasks that will impact traffic on their part of the transportation system. (14,15,16) In these instances, the emphasis is on ensuring that all stakeholders in a corridor or region are aware of each other's upcoming activities. Points of contact for each project are readily available in case any of the other agencies has a question or needs to discuss details. In some cases, this sharing of information also provides data for publicizing upcoming work within the corridor or region so that travelers know what to expect and can adjust their travel plans accordingly. (17)

INTENT OF THIS REPORT

Previous attempts to develop Project Coordination (PC) guidance have taken a fairly broad brush to the topic, typically combining many of the other strategies that comprise TMP development with PC activities. This approach makes it difficult to understand how exactly PC can be improved by an agency to achieve safety and mobility benefits relative to a no-coordination alternative. The sections that follow in this report focus on improving this understanding and illustrating how better PC can be achieved.

CHAPTER 2. KEY CONCEPTS OF PROJECT COORDINATION (PC)

DIMENSIONS OF PROJECT COORDINATION

As suggested in Figure 1, effective Project Coordination (PC) can be viewed as an integration of three interdependent questions that need to be answered:

- Who is involved?
- When can or should it occur?
- What does it accomplish?

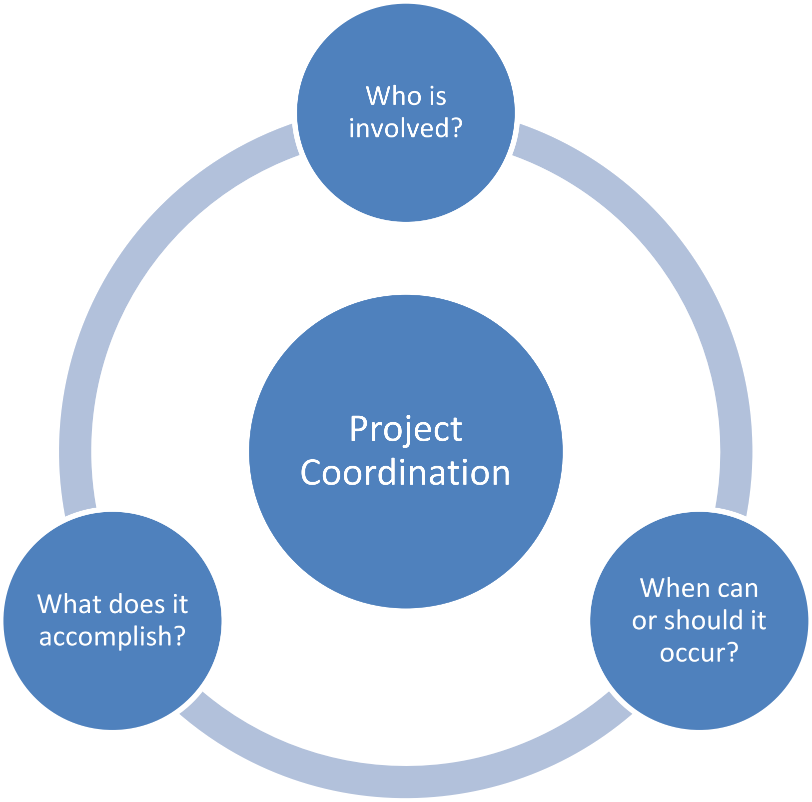


Figure 1. Illustration. Project Coordination Dimensions.

Who Should Be Involved in Project Coordination?

There are opportunities for Project Coordination (PC) to occur within a single agency, such as when multiple projects are being performed along a single route or across multiple routes all under the agency's control. In the same manner, PC can also occur between two or more agencies. Requiring and granting access permits for entities to work within another agency's right-of-way are examples of this type of coordination, as are multi-agency regional committees and teams specifically established to share project information and work to resolve potential work activity conflicts across a corridor or regional network.

When Should Project Coordination Occur?

Project Coordination (PC) can occur during project planning and design. Coordination during these phases of project development typically focus on scheduling and sequencing of projects in a more impact-minimizing way. Conversely, coordination can also occur during actual project delivery when work operations are occurring. In this phase, PC activities emphasize the identification and monitoring of the day-to-day work activities that adversely impact the transportation network and finding ways to mitigate the combined effects of those activities across multiple projects. It can be beneficial to think of these two dimensions of PC in a matrix format, as depicted in Table 1.

Table 1. Project Coordination Matrix.

		Examples of Project Coordination Activities by Project Phase	
		Project Planning and Design	**Project Delivery**
Agencies Involved	**Single**	• Compiling a database of agency planned projects over the next 3-5 years • Developing a map showing project locations in the region, possibly color-coded to illustrate current, near-term, and long-term schedules • Determining and executing the sequence of the projects that will minimize total delays and disruptions to the traveling public in the corridor or region	• Developing and implementing a regional transportation management plan that encompasses the various agency projects that are ongoing in a corridor or region • Conducting regular coordination meetings between staff of various projects going on simultaneously in a corridor or region to identify and eliminate potential lane closure conflicts, combine compatible lane closures into a single coordinated lane closure where possible, etc. • Establishing business processes to coordinate agency maintenance activities with nearby construction project efforts when possible • Linking an agency’s lane closure permitting approvals with agency construction and maintenance coordination efforts
	Multiple	• Expanding project database and mapping tools to include other agencies in region, utility companies, and private-sector developer projects that will impact the roadway system • Establishing a web-based approach to sharing and providing appropriate access to the database and map	• Developing and implementing regional transportation management plan that considers and addresses projects being performed by all agencies and other stakeholders in the region • Conducting regular regional coordination meetings between stakeholders to resolve lane closure conflicts as they arise

What Does Project Coordination Accomplish?

The third dimension of Project Coordination (PC), what is being accomplished, is perhaps the most important to understand conceptually. Given the overall objective of minimizing the work zone safety and mobility impacts of multiple projects, PC actions themselves should be capable of being described in terms of how they can or will accomplish this impact mitigation objective. Some of the ways that work zone impacts can be mitigated through coordination include:

- Sequencing the order in which multiple projects are completed to incrementally build additional capacity into the travel corridor or network, so that each completed project provides the greatest amount of benefit to travelers during each successive project.

- Combining projects or project tasks along a travel route segment so that the impact to traffic occurs for the collective tasks at one time instead of individual impacts for each activity.

- Scheduling projects or project tasks to avoid having significant capacity restrictions on a single travel route or on multiple roadways that serve as convenient alternatives for travelers when they encounter work zone congestion and delays.

The previous discussion of early TMP efforts to implement projects on alternative routes prior to a major freeway reconstruction was one example of the benefits of project sequencing. More recently, work completed under the Transportation Research Board's (TRB) second Strategic Highway Research Program (SHRP-2) has yielded an optimization tool to help in the sequencing effort. The tool, Work Zone Impact and Strategy Estimator (WISE) software, is currently undergoing demonstration testing and is available to those interested in applying it to their situation. (18) Additional details about tools such as WISE and others that can facilitate PC efforts are provided later in this guide.

Another method of PC to mitigate work zone safety and mobility impacts relative to a no-coordination effort is the consolidation of several tasks from overlapping projects (or between project tasks and other maintenance or utility activities) into a single coordinated work effort. The intent of this particular action is to accomplish all of the necessary activities that may require access to travel lanes at the same time, and reduce the number of times that the travel lanes must be accessed. For example, two contractors working on adjacent sections of highway may coordinate tasks that require a lane closure to occur on the same day or night, and eliminate the need for two separate days or nights of a lane closure. Similarly, an agency may coordinate several maintenance and/or utility work tasks on a given route segment, and have all parties perform the work during a single lane or road closure. The Kentucky Transportation Cabinet successfully used this approach during rehabilitation and repair work on Interstate 65 in Louisville. (19)

The third way in which PC can accomplish work zone safety and mobility impact reductions is to avoid creating multiple work zone bottlenecks at the same time along a single corridor or across several roadways in a region. Work zone activities that cause congestion and delays will typically encourage most motorists to divert to other routes in the corridor. (20) Ultimately, this reduces the demand at the work zone and results in a lessening of the overall impacts of the work zone upon corridor travel times and delays. However, if work zones are also located on those routes where traffic chooses to divert, the overall corridor impacts may not be improved and may actually be worse than if no diversion had occurred. Consequently, striving to ensure that a project on one roadway is not creating a bottleneck at the same time that a project on an adjacent roadway is also creating a bottleneck can be a highly-effective PC strategy. Likewise, the cumulative delays experienced by motorists encountering multiple work zones along a single trip can be excessive. Although it may not be possible to reduce the overall total vehicle-hours of delay that the series of projects may generate over their entire project lives, the effect on an individual motorist for a given trip can be mitigated.

PROJECT COORDINATION CHALLENGES

Effective Project Coordination (PC) involves specific challenges and hurdles that agencies must work through in order to become proficient in PC execution. Some of the more significant challenges include the following:

- Competing missions and charters can impede efforts to obtain multi-agency cooperation for the coordination of projects. Each agency has its own mission and charter with respect to routes of responsibility, stakeholders, and users. From a regional perspective, some PC efforts may be viewed as less beneficial to an agency's users (i.e., upgrading capacity on an alternative route to allow more diverted traffic to utilize it may be viewed unfavorably by local residents who normally use that roadway).

- Varying institutional constraints regarding the availability of funds and when those funds must be spent can also raise issues with PC. These financial pressures can hamper efforts to schedule and otherwise coordinate projects in a more "optimal" manner. In some instances, projects must be performed when the money becomes available.

- Establishing and maintaining accurate information about project plans and day-to-day activities is also a challenge for agencies. Project activities and schedules change day-to-day due to weather, materials and equipment issues, delivery schedule changes, etc. Those most knowledgeable about the impact of these changes upon project activities are primarily concerned with getting the work completed on time and within budget. Methods of gathering project information at a frequency and detail necessary for certain PC activities are not always available. Even if they are available, staffing resources may not be adequate to support the information collection and maintenance effort.

- Scheduling of individual projects may be impacted by PC efforts. For those projects that are contracted out, such effects on schedule may be viewed by the contractor as cause for damages unless the coordination efforts are approached from a cooperative, mutually beneficial perspective with the contractor. In some cases appropriate contract language may need to be in place to obtain that necessary cooperation from the contractor regarding coordination activities. The potential does exist for these types of contractual requirements to result in slightly higher costs for a project.

- Quantifying the effect of PC quickly and effectively, or the negative effects if such coordination does not occur, is another challenge facing agencies. Estimates of the benefits of coordination can be strong incentive for justifying the coordination of projects in a corridor or region. Unfortunately, most agencies do not have the analytical tools in place to allow estimates to be computed and provide that incentive.

STEPS FOR ACHIEVING PROJECT COORDINATION

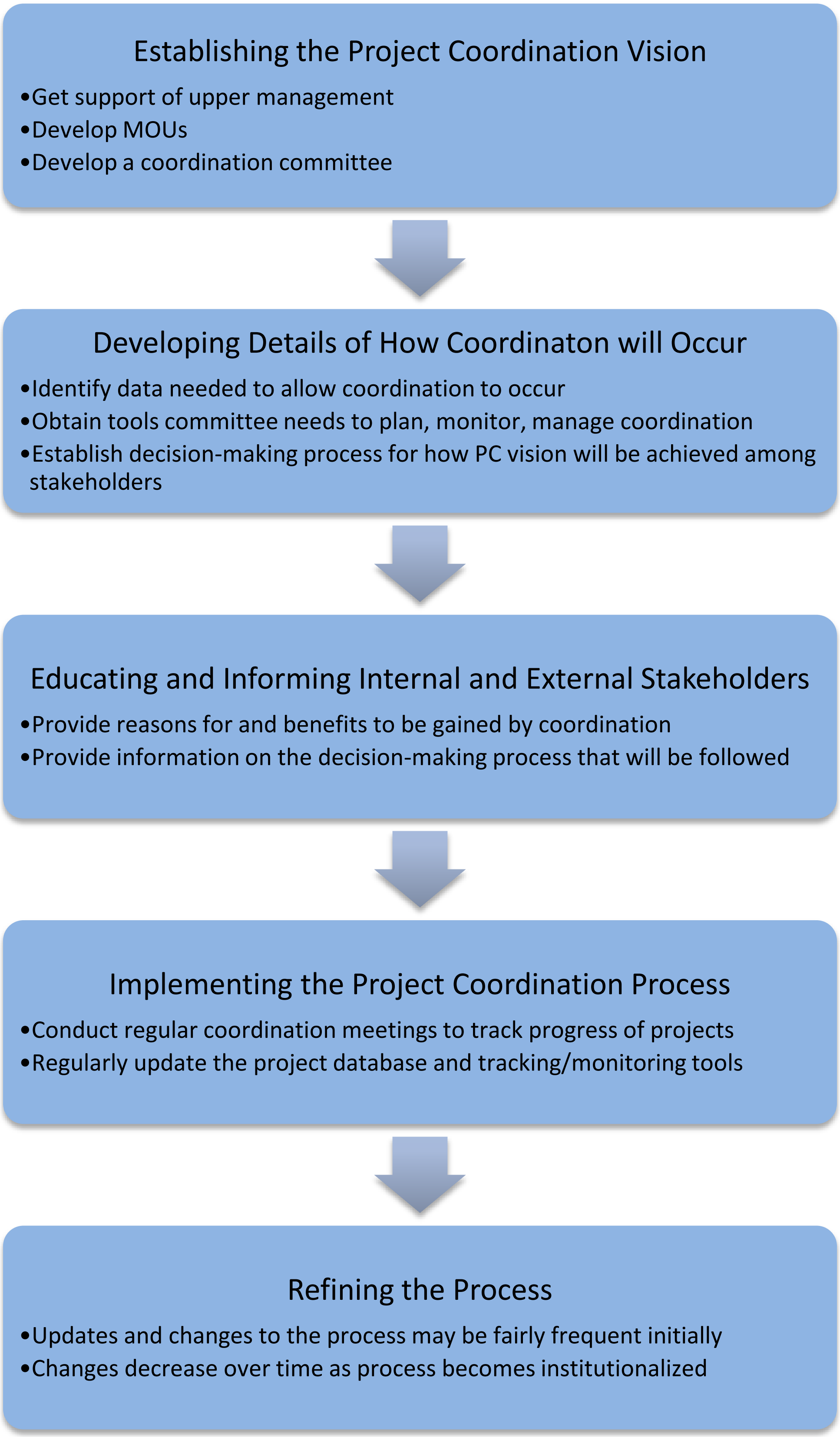
Some agencies have had very good success establishing a formal Project Coordination (PC) process. Developing that process typically consists of five major steps, with a feedback loop between the last two steps, as shown in Figure 2. As suggested in step 1, establishing a successful PC process first requires a clear vision of what the process is to achieve. This vision needs to begin, or at least be supported by upper management of the agency, as coordination efforts can sometimes require changes to existing contract language, reallocation of staff resources, and/or forging a cooperative relationship with other agencies and stakeholders in the region. Towards this end, it may be necessary to develop formal memorandums of understanding (MOUs) between stakeholders to obtain buy-in for the PC efforts. A coordination committee made up of decision-makers with authority to speak on behalf of their agency or entity is also needed. These individuals may come from several areas of the organization such as construction, maintenance, design, operations, traffic engineering, contract administration, and public information. Technical subcommittees may also be needed to identify and resolve specific technical issues that arise.

The next step is to develop the specific details of how PC will occur within this arrangement. The data or information that will be needed in order to accomplish PC must be identified. Roadway and traffic conditions that will exist and which may need to be considered within the projects are usually needed, such as travel times, traffic volumes and capacities, vehicle and load sizes that can be accommodated, etc. Tools that allow the committee to plan, monitor, and manage the projects will also be needed. These may include analytical tools to estimate expected traffic impacts, databases to log key information about each project or activity along a corridor or within a region, visualization tools such as geographic information system (GIS) programs that can map the projects in the database and make that map available to the various stakeholders in the region, and regular committee meetings. Also in this step, the committee will need to define the guidance that will be used to accomplish the PC vision. This could include strategies such as agreeing to a corridor or statewide TMP approach rather than a series of isolated project-level TMPs, establishing priorities to resolve conflicts between projects during construction, or methods of planning and scheduling projects for a particular construction season.

The third step towards achieving a PC process involves the education of agency personnel and personnel from other stakeholders about the PC process that will be followed. In particular, it is important that project staff understand the significance of the coordination efforts that will occur and why they are being implemented. It can also be helpful to explain the decision-making process that is going to occur (and the underlying data and analyses that are being used to drive the process).

The fourth step is actual implementation of the PC process. Regular coordination meetings should be held at the corridor/regional level of all the affected stakeholders. For state DOTs, this may involve multiple divisions and offices (i.e., planning, construction, maintenance, operations, permitting, public information). A focus of the meetings should be on tracking the various projects in the corridor or region as they move through the project development process. There can be a long-range assessment, where expected general traffic impacts and anticipated schedules are compared; a medium-range assessment activity, where the traffic impacts, expected project staging and sequencing, and anticipated letting dates are discussed and examined in greater detail; and a short-term or current project assessment where upcoming day-to-day scheduling of lane closures and other bottlenecks created are examined and coordinated to minimize travel impacts as best possible. Updates to the tracking databases and tools should occur regularly in this step as well.

The final step is then to refine the PC process as the stakeholders become more comfortable with the efforts, learn what is working well, and identify what needs to be revised. Early on, this refinement may be fairly extensive, and involve changes to committee and subcommittee structure and staff involvement. Over time, the refinements may become less frequent and less substantial.



Establishing the Project Coordination Vision

- Get support of upper management
- Develop MOUs
- Develop a coordination committee

Developing Details of How Coordinaton will Occur

- Identify data needed to allow coordination to occur
- Obtain tools committee needs to plan, monitor, manage coordination
- Establish decision-making process for how PC vision will be achieved among stakeholders

Educating and Informing Internal and External Stakeholders

- Provide reasons for and benefits to be gained by coordination
- Provide information on the decision-making process that will be followed

Implementing the Project Coordination Process

- Conduct regular coordination meetings to track progress of projects
- Regularly update the project database and tracking/monitoring tools

Refining the Process

- Updates and changes to the process may be fairly frequent initially
- Changes decrease over time as process becomes institutionalized

Figure 2. Process Flow. Steps to Establishing a Project Coordination Process in a Region.

CHAPTER 3. CASE STUDIES OF PROJECT COORDINATION

Case studies are an effective way of illustrating promising examples of successful Project Coordination (PC) and of highlighting the benefits, lessons learned, and best practices (where applicable) of PC. In this chapter, two PC case studies are described in detail:

- The Texas Department of Transportation (TxDOT) PC efforts during construction to minimize delays along the I-35 corridor.
- The Oregon Department of Transportation (ODOT) PC efforts during project planning and design of a major bridge replacement effort to minimize delays and better accommodate freight trucking crossing the state.

The case studies focus on the actions and strategies that were implemented to achieve the safety and mobility impact reductions desired of PC efforts, methodologies and business processes that were enacted. Key lessons learned are also summarized to aid others who desire to initiate or improve their PC efforts within their jurisdictions.

TEXAS CASE STUDY

Background and Project Coordination Objectives

Within Texas, Interstate 35 (I-35) is a major corridor stretching from the City of Laredo on the international border with Mexico to the Oklahoma state line. Over 30 million travelers per year use the corridor, including large trucks, which typically compose 25 to 35 percent of the traffic volume. Truck traffic volumes can be as high as 80 percent at night.

Starting in 2011, the Texas Department of Transportation embarked on a $2.1 billion project to widen I-35 to six lanes from Hillsboro to a location just south of Salado. This 96-mile segment (shown in Figure 3) consisted of 17 different projects located in the Waco District. Traffic volumes range from 55,000 to 111,000 vehicles per day along the segment, with approximately two thirds of the traffic being thru traffic, meaning that both the origin and destination of these vehicles are located outside of the segment. Construction is ongoing and, at the time of this writing, is expected to continue

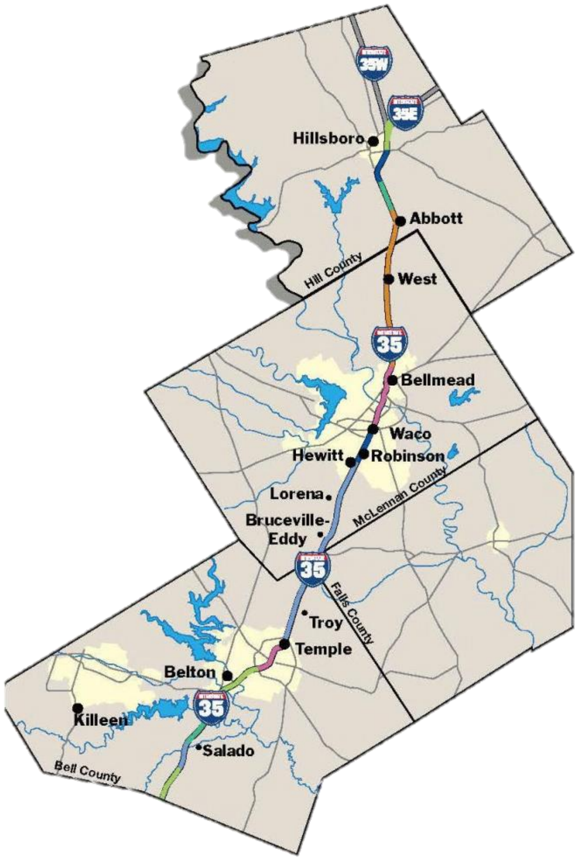


Figure 3. Map. I-35 Construction Limits.

through 2018. With numerous lane closures and freeway closures anticipated for the widening and related reconstruction of bridges, TxDOT assumed a proactive role in terms of managing construction impacts along the corridor. This construction management plan includes mitigation of lane closure mobility impacts during the operational phase of the project. Many types of lane closures are restricted to nighttime hours. However, with multiple projects occurring simultaneously, drivers traversing the corridor could be exposed to multiple individual lane closures on a single trip. While the impacts from a single lane closure may be tolerable, the cumulative delay from multiple closures could become intolerable. Thus, a means of evaluating corridor delay for individual trips was needed, as well as a mechanism for mitigating the cumulative impacts when multiple, simultaneous lane closures were expected to cause unacceptable impacts to travel times.

Project Coordination Efforts

To better coordinate project activities and reduce potential traffic impacts along this corridor, TxDOT employed mobility coordinators whose primary function was to watch for potential traffic mobility issues and find ways to resolve those issues before they actually occurred. Much of the coordinators' job duties involved door-to-door communication with local residents and businesses about upcoming project tasks that would affect access. However, another key job duty was to monitor upcoming lane closure activities planned in the corridor, and work with the contractors if expected traffic impacts on a given night or weekend would likely exceed what was deemed tolerable by TxDOT.

To accomplish this, a system was established for contractors to submit advance notification of plans to close one or more freeway lanes. An overall Construction Traveler Information System (CTIS) was designed and implemented for this construction effort. It included a subsystem (termed the Planned Closure Notification System) that allowed contractors, TxDOT staff, and mobility coordinators to enter lane closure information into a database. Contractors were encouraged to submit advance notification of closures at least seven days prior to the closures. Lane closures were not permitted during daytime hours, so contractor lane closures were limited to the period from 7:00 pm to 7:00 am. The database stores all details of the closures, such as proposed time, date, duration, location, length, etc. Entries could be flagged for immediate publication on a project website or remain private until after certain analyses were performed. Once per minute, the database published an updated data stream which is then polled by other subsystems to perform specialized analyses/functions.

For each lane closure submitted, the CTIS performed an analysis of expected traffic impacts. This occurred within a subsystem termed the Lane Closure Assessment System (LCAS). The LCAS was used to forecast queues and delays for each main lane closure, based on recent traffic volumes acquired through non-intrusive traffic volume and speed sensors located at strategic locations throughout the corridor. The LCAS applied an input-output analysis of expected hourly traffic demands to the estimated work zone capacity of each requested lane closure. When demands exceeded capacity, a queue was predicted, the length of which was estimated based on the number of vehicles estimated to be stored in queue each hour. A traffic flow relationship was used to estimate delays caused by the queue.

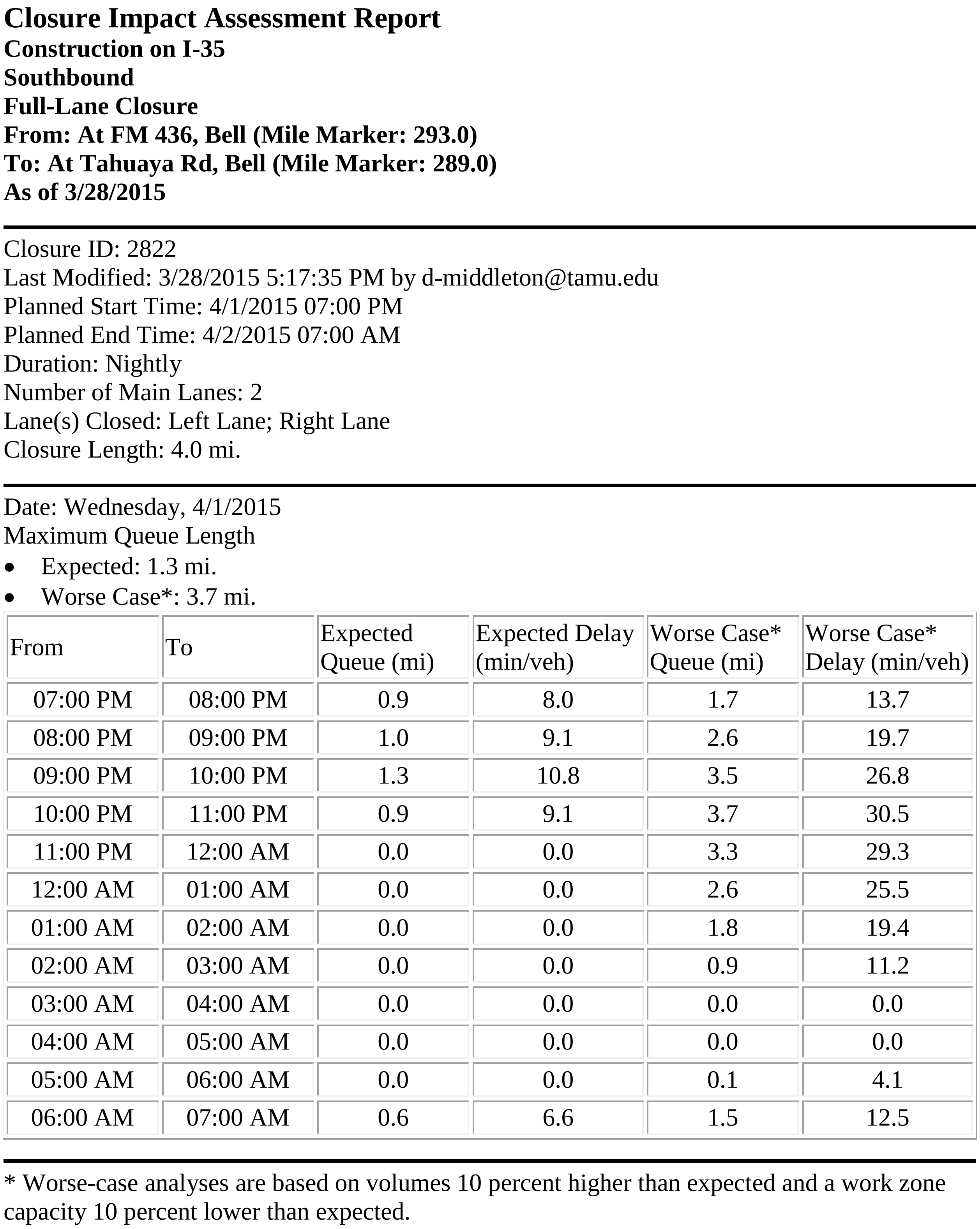
For each lane closure in the database, an LCAS report was generated. As shown in Figure 4, the LCAS output included expected queue lengths and delays for individual lane closures. In this case, the LCAS showed that the queue from this closure was expected to reach 1.3 miles in length during the 9:00 pm hour and that the expected delay would be approximately 10.8 minutes per vehicle during that same hour. Because traffic volumes and work zone capacity can vary from expected values on a given day, a “worse-case” scenario was also computed using a 10 percent increase in traffic volume and a 10 percent decrease in work zone capacity. This provided an indication of the possible range of impacts that might be expected. In this example, worse-case queues could possibly be as long as 3.7 miles and worse-case delays may exceed 30 minutes. The impacts of any other lane closures anticipated each night were calculated in a similar manner.

Personnel at the Texas A&M Transportation Institute (TTI) developed an automated system to calculate corridor travel time by direction for various departure points and times each day or night. The system took into account the travel time between lane closures and estimated the expected delay associated with each lane closure corresponding to the calculated arrival times. A segment from mile marker 370 to mile marker 270 was used based on the location of sensors and ease of calculations. Assuming a 60 mph travel speed, the typical corridor travel time was 100 minutes when no lane closures were present.

Figure 5 shows how the system computed cumulative travel times for southbound drivers over the 100 mile segment on April 1, 2015 through four successive lane closures (located at mile markers 336, 297, 293, and 285) scheduled that night. For a trip beginning at 8:00 pm, the estimated corridor travel time was 131.1 minutes which represents a total cumulative delay of 31.1 minutes.

A threshold value of 30 minutes was selected for the maximum allowable corridor delay. Any time that corridor delays in excess of 30 minutes were forecast, mitigation plans were explored. Mitigation plans typically included requesting one contractor to begin work later in the evening or rescheduling for another night when corridor mobility impacts would be reduced. When several different lane closures were requested, consideration is given to the type of work planned, the duration of the work, the distance between the closures, the impacts relative to other requests, the critical nature or priority of the planned work, and the order in which the lane closure requests were received.

Once a mitigation plan was developed and agreed upon, the individual lane closure request was modified and the corridor delay report was regenerated to confirm that the changes would, in fact, reduce predicted motorist delay below 30 minutes. For the example shown in Figure 4, the contractor who requested lane closure number 2822 was asked to delay their lane closure from a 7:00 pm start time to 9:00 pm, when anticipated traffic volumes would be lower, reducing the cumulative delays and trip times directly contributed by this lane closure. Upon agreement by the contractor, TTI personnel regenerated the LCAS Report, shown in Figure 6. In this example, the time shift resulted in a reduction of expected delay for this closure throughout the evening (as compared to Figure 4).



Closure Impact Assessment Report
Construction on I-35
Southbound
Full-Lane Closure
From: At FM 436, Bell (Mile Marker: 293.0)
To: At Tahuaya Rd, Bell (Mile Marker: 289.0)
As of 3/28/2015

Closure ID: 2822
Last Modified: 3/28/2015 5:17:35 PM by d-middleton@tamu.edu
Planned Start Time: 4/1/2015 07:00 PM
Planned End Time: 4/2/2015 07:00 AM
Duration: Nightly
Number of Main Lanes: 2
Lane(s) Closed: Left Lane; Right Lane
Closure Length: 4.0 mi.

Date: Wednesday, 4/1/2015
Maximum Queue Length

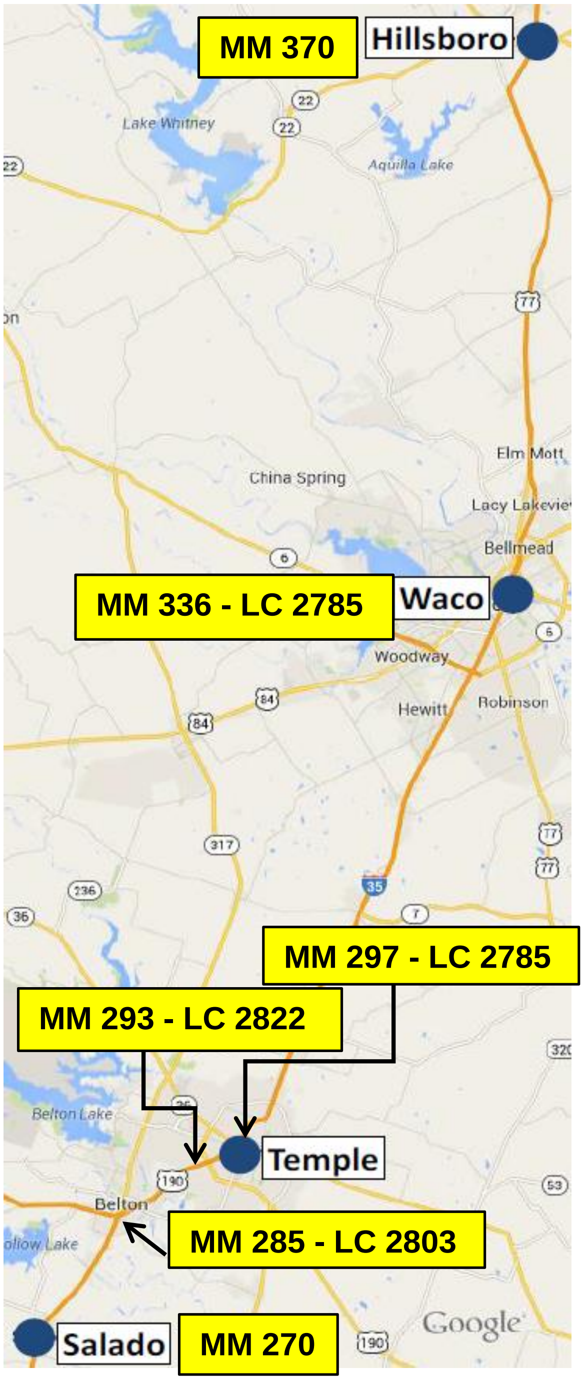
- Expected: 1.3 mi.
- Worse Case*: 3.7 mi.

From	To	Expected Queue (mi)	Expected Delay (min/veh)	Worse Case* Queue (mi)	Worse Case* Delay (min/veh)
07:00 PM	08:00 PM	0.9	8.0	1.7	13.7
08:00 PM	09:00 PM	1.0	9.1	2.6	19.7
09:00 PM	10:00 PM	1.3	10.8	3.5	26.8
10:00 PM	11:00 PM	0.9	9.1	3.7	30.5
11:00 PM	12:00 AM	0.0	0.0	3.3	29.3
12:00 AM	01:00 AM	0.0	0.0	2.6	25.5
01:00 AM	02:00 AM	0.0	0.0	1.8	19.4
02:00 AM	03:00 AM	0.0	0.0	0.9	11.2
03:00 AM	04:00 AM	0.0	0.0	0.0	0.0
04:00 AM	05:00 AM	0.0	0.0	0.0	0.0
05:00 AM	06:00 AM	0.0	0.0	0.1	4.1
06:00 AM	07:00 AM	0.6	6.6	1.5	12.5

---

* Worse-case analyses are based on volumes 10 percent higher than expected and a work zone capacity 10 percent lower than expected.

Figure 4. Report. Lane Closure Assessment System Report for Lane Closure 2822 on April 1, 2015.



Map data ©2016 Google.

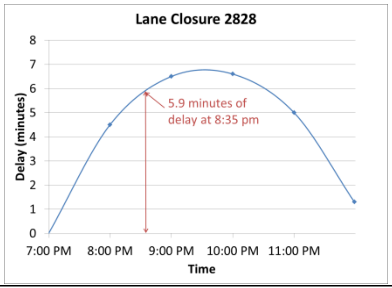
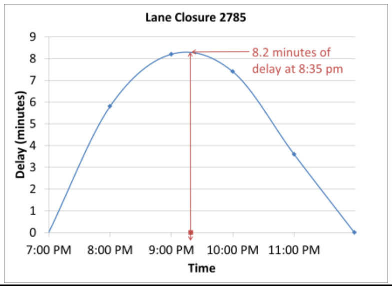
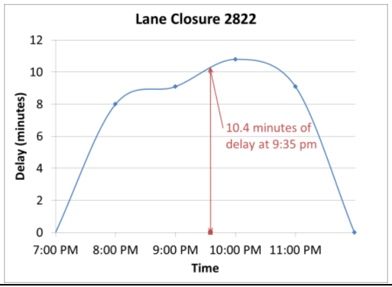
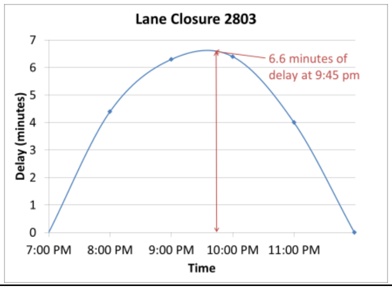
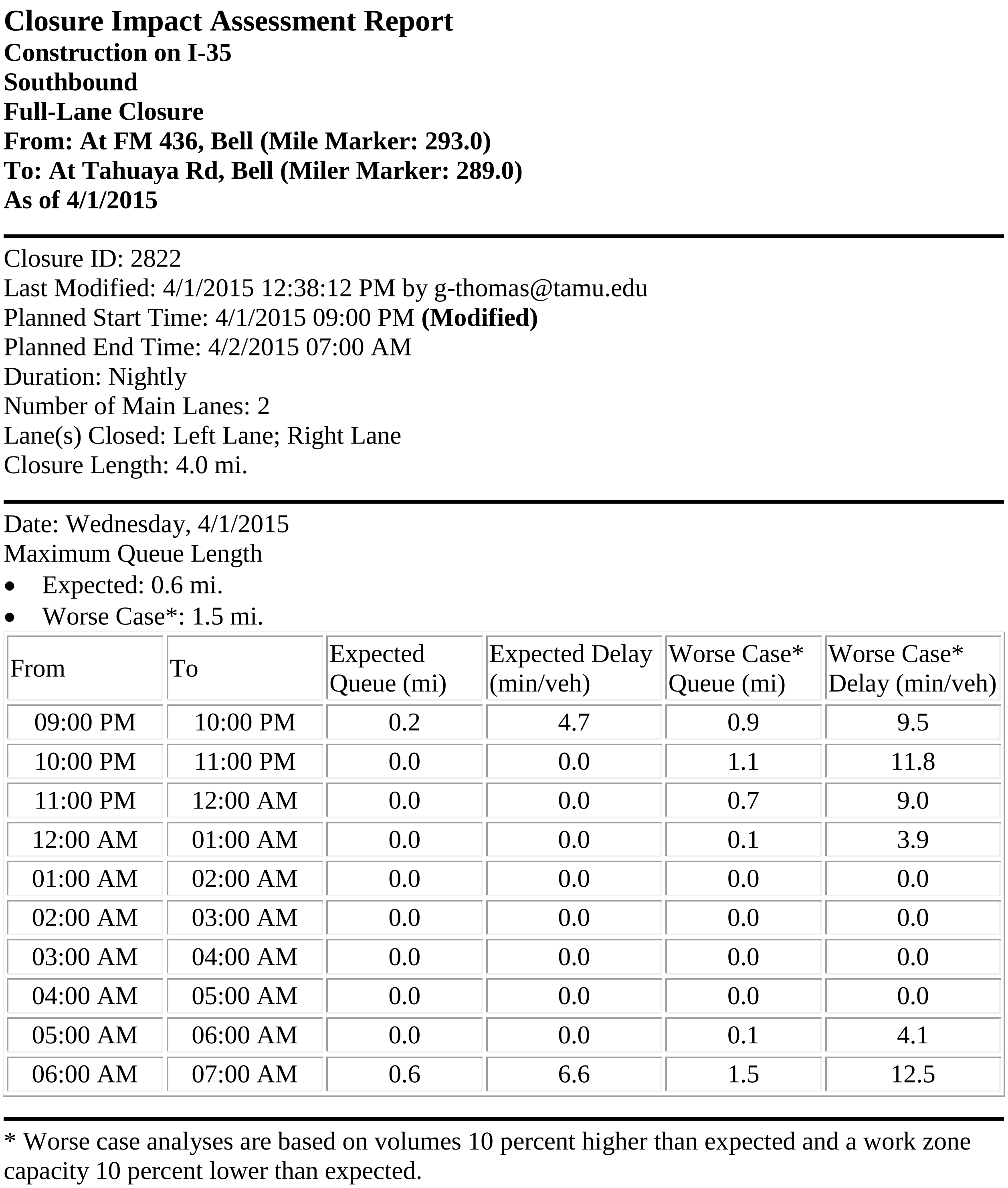
<table>
<tr><th>Time Stamp</th><th>Mile Marker</th><th>Activity</th></tr>
<tr><td>8:00 pm</td><td>370</td><td>Begin SB trip</td></tr>
<tr><td>8:35 pm</td><td>336</td><td>Arrive Lane Closure 2828

</td></tr>
<tr><td>8:41 pm</td><td>335</td><td>End of 5.9 min delay</td></tr>
<tr><td>9:19 pm</td><td>299</td><td>Arrive Lane Closure 2785

</td></tr>
<tr><td>9:27 pm</td><td>297</td><td>End of 8.2 min delay</td></tr>
<tr><td>9:35 pm</td><td>293</td><td>Arrive Lane Closure 2822

</td></tr>
<tr><td>9:45</td><td>289</td><td>End of 10.4 min delay</td></tr>
<tr><td>9:49</td><td>285</td><td>Arrive Lane Closure 2803

</td></tr>
<tr><td>9:56</td><td>285</td><td>End of 6.6 minute delay</td></tr>
<tr><td>10:11</td><td>270</td><td>End SB trip</td></tr>
<tr><td colspan="3">Total Corridor Travel Time = 131.1 minutes</td></tr>
</table>

Figure 5. Chart. Southbound Corridor Travel Time Calculation for 8 pm Departure without Coordination.



Closure Impact Assessment Report

Construction on I-35
Southbound
Full-Lane Closure
From: At FM 436, Bell (Mile Marker: 293.0)
To: At Tahuaya Rd, Bell (Miler Marker: 289.0)
As of 4/1/2015

Closure ID: 2822
Last Modified: 4/1/2015 12:38:12 PM by g-thomas@tamu.edu
Planned Start Time: 4/1/2015 09:00 PM **(Modified)**
Planned End Time: 4/2/2015 07:00 AM
Duration: Nightly
Number of Main Lanes: 2
Lane(s) Closed: Left Lane; Right Lane
Closure Length: 4.0 mi.

Date: Wednesday, 4/1/2015
Maximum Queue Length

- Expected: 0.6 mi.
- Worse Case*: 1.5 mi.

From	To	Expected Queue (mi)	Expected Delay (min/veh)	Worse Case* Queue (mi)	Worse Case* Delay (min/veh)
09:00 PM	10:00 PM	0.2	4.7	0.9	9.5
10:00 PM	11:00 PM	0.0	0.0	1.1	11.8
11:00 PM	12:00 AM	0.0	0.0	0.7	9.0
12:00 AM	01:00 AM	0.0	0.0	0.1	3.9
01:00 AM	02:00 AM	0.0	0.0	0.0	0.0
02:00 AM	03:00 AM	0.0	0.0	0.0	0.0
03:00 AM	04:00 AM	0.0	0.0	0.0	0.0
04:00 AM	05:00 AM	0.0	0.0	0.0	0.0
05:00 AM	06:00 AM	0.0	0.0	0.1	4.1
06:00 AM	07:00 AM	0.6	6.6	1.5	12.5

* Worse case analyses are based on volumes 10 percent higher than expected and a work zone capacity 10 percent lower than expected.

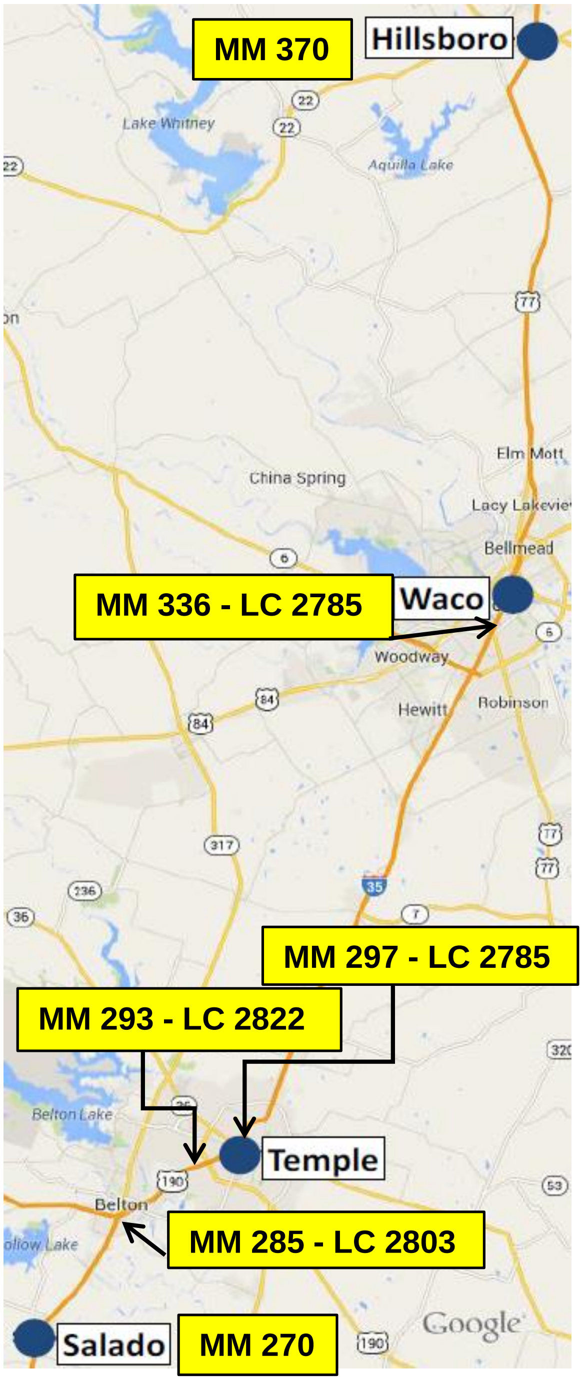
Figure 6. Report. Modified Lane Closure Assessment System Report for Lane Closure 2822 on April 1, 2015.

The corridor travel time was also recomputed and is shown in Figure 7. As expected, shifting the start time of just one of the four planned lane closures resulted in a reduction of expected delay for the entire corridor.

The corridor is well covered with sensors that read and registered timestamps from wireless device signals. By matching signal pairs, speed and travel time data were calculated and stored in a database. For the example on April 1, delays computed from the wireless device data were compared to the expected delays with and without PC for various southbound trip departure times. The results are shown in Figure 8.

The blue line represents the amount of delay expected without any PC at various departure times from Hillsboro in the southbound direction. The maximum delay of 31 minutes was expected for departures beginning between the 8:00 pm and 9:00 pm timeframe. The red line shows the expected delay after delaying one lane closure by two hours (9:00 pm instead of 7:00 pm). Under these conditions, a maximum delay of 24 minutes was expected for vehicles departing just after 8:00 pm. The green line shows the actual delay derived from measured travel times. The net effect of the adjusted start time for one lane closure was a significant reduction in delay. In addition, there was a shift in the peak delay to a time when traffic volumes were lower.

Using this approach, TXDOT had a tool to better manage traffic operations through multiple lane closures and to take corrective measures when projected delays exceed acceptable thresholds. The frequency with which this type of scenario occurred was not well documented, but estimated to be approximately once per month during the construction period. One of the main reasons that this more formalized level of coordination did not have to occur more frequently was because a significant amount of verbal coordination was continually occurring throughout the project. For example, reports of upcoming lane closures were emailed to the contractors on a daily basis. If several lane closures were already planned for a particular night, a contractor may decide not to make his or her request for the same night. In addition, project mobility coordinators attended regular construction meetings and could often avert closure requests for the same night through those conversations. These proactive measures tended to reduce the frequency with which the corridor delay became a more significant issue. Overall, the mobility monitoring program was an effective means of fostering PC between many different projects on I-35 and reducing delay to motorists.



Map data ©2016 Google.

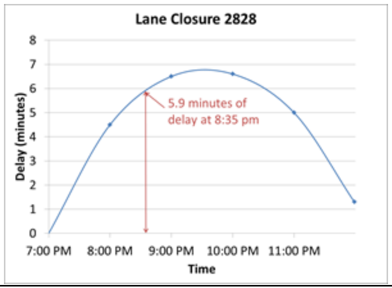
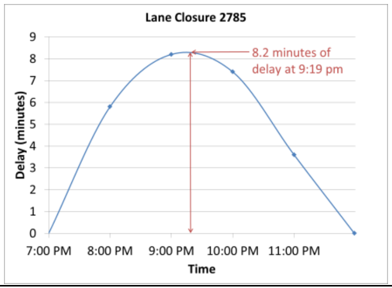
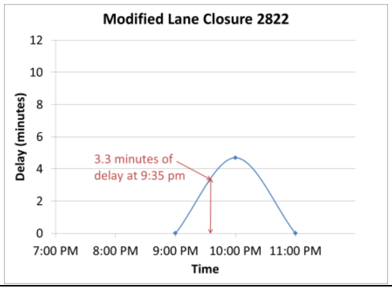
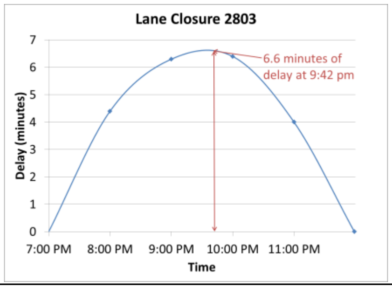
Time Stamp	Mile Marker	Activity
8:00 pm	370	Begin SB trip
8:35 pm	336	Arrive Lane Closure 2828 
8:41 pm	335	End of 5.9 min delay
9:19 pm	299	Arrive Lane Closure 2785 
9:27	297	End of 8.2 min delay
9:35	293	Arrive Modified Lane Closure 2822 
9:38	289	End of 3.3 min delay
9:42	285	Arrive Lane Closure 2803 
9:49	285	End of 6.6 minute delay
10:04	270	End SB trip
Total Corridor Travel Time = 124.0 minutes		

Figure 7. Chart. Southbound Corridor Travel Time Calculation for 8 pm Departure with Coordination.

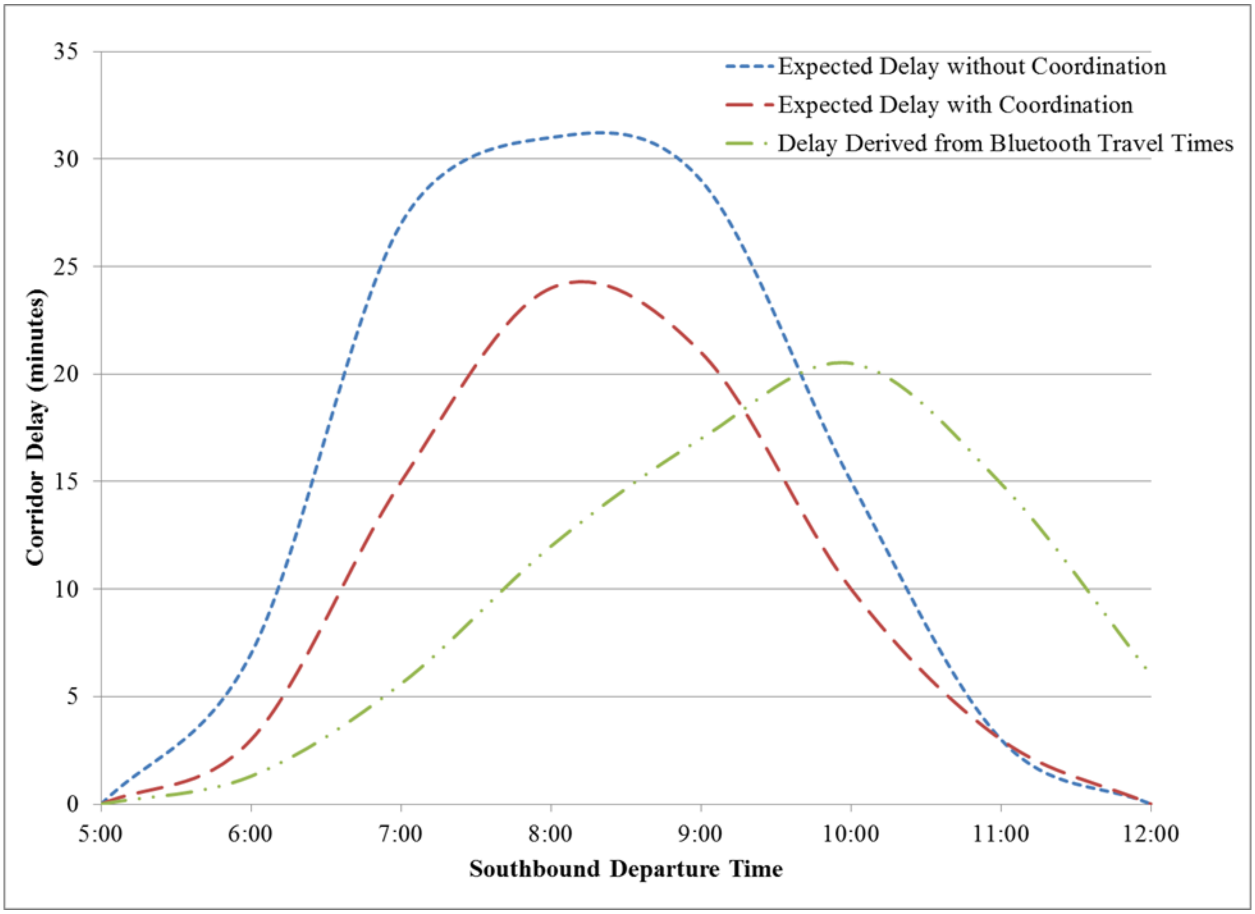


Figure 8. Graph. Southbound Corridor Travel Times on April 1, 2015.

Summary

The Texas case study provides an excellent example of PC strategies that other agencies can adopt and/or adapt to meet their needs. One can see how the various actions undertaken fall into the five basic steps described in Figure 2 to establish a PC process for minimizing delay, as shown below.

Establishing the Project Coordination Vision

TxDOT's support of PC was apparent when upper management gave directives to manage cumulative impacts to through traffic, as well as impacts to local residents and businesses. A cumulative delay threshold of 30 minutes was established for through traffic.

Developing Details of How Coordination Will Occur

To meet the coordination goals of the project, mobility coordinator positions were created. In addition, processes were established to collect and analyze the data needed to estimate anticipated cumulative mobility impacts. Contractor coordination was to be facilitated through the mobility coordinators.

Educating and Informing Internal and External Stakeholders

The mobility coordinators participated in weekly project meetings to address potential issues not already resolved a lower levels. In addition, the mobility coordinators maintained communication with local communities and key stakeholder groups.

Implementing the Project Coordination Process

The mobility coordinators made regular presentations to city councils, shipping companies, local businesses and residents to keep them informed of upcoming events in the corridor, address concerns, and receive information that may influence traffic control decisions. The coordinators individually contacted business owners prior to major access disruptions. Throughout construction, the mobility coordinators maintained cooperative resolution of multiple lane closure nights when excessive cumulative delays were anticipated.

Refining the Process

There was initially some hesitation by contractors to coordinate their lane closures. However, cooperation levels increased as trust between mobility coordinators and contractors increased.

OREGON CASE STUDY

Background and Project Coordination Objectives

Under the Oregon Transportation Investment Act (OTIA) III State Bridge Delivery Program, the Oregon Department of Transportation (ODOT) planned to repair or replace over 300 bridges throughout the state over a span of eight years and at a cost of over $1.3 billion. (21,22) The Bridge Delivery Program began in 2004. (23) The planned projects are shown in Figure 9.

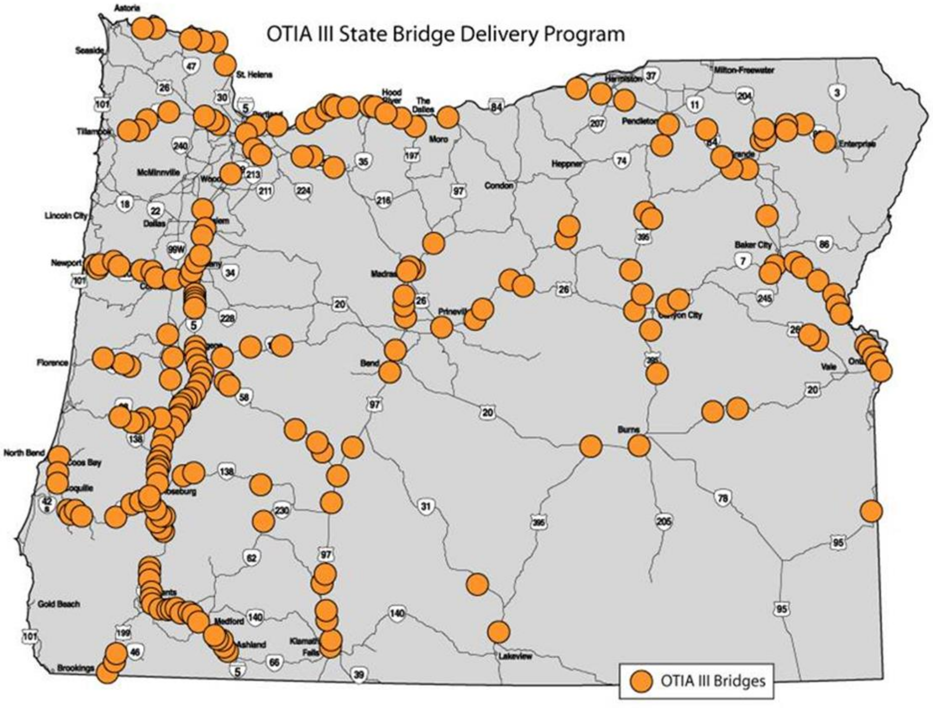


Figure 9. Map. Location of Bridges in the State Bridge Delivery Program. (21, 22)

Due to the age and weight limits of Oregon's older bridges, freight mobility would be significantly impacted if the sequencing of these projects were not coordinated in some fashion. To avoid major economic impacts of these mobility issues, the Oregon Bridge Delivery Partners (OBDP), a private management firm, was formed to manage mobility. OBDP worked closely with ODOT and other stakeholders to address mobility impacts through Project Coordination (PC) strategies. The structure of ODOT is divided into five main geographical regions. These regions are shown in Figure 10. While Region 1 is the smallest geographically, it is the most urbanized of the five regions and serves the Port of Portland. Maintaining mobility in this region was critical for freight routes. ODOT's goal was to maintain at least one major north–south and, at least, one major east-west corridor unrestricted for the freight industry and the traveling public. Regions 2 and 3 both include the I-5 corridor and the state's coastal highways. Regions 4 and 5 are more rural in nature, but both provide alternate routes for freight to move across the state from Portland. In order to keep traffic moving during the bridge projects, statewide, corridor, and regional mobility coordination would all be required.

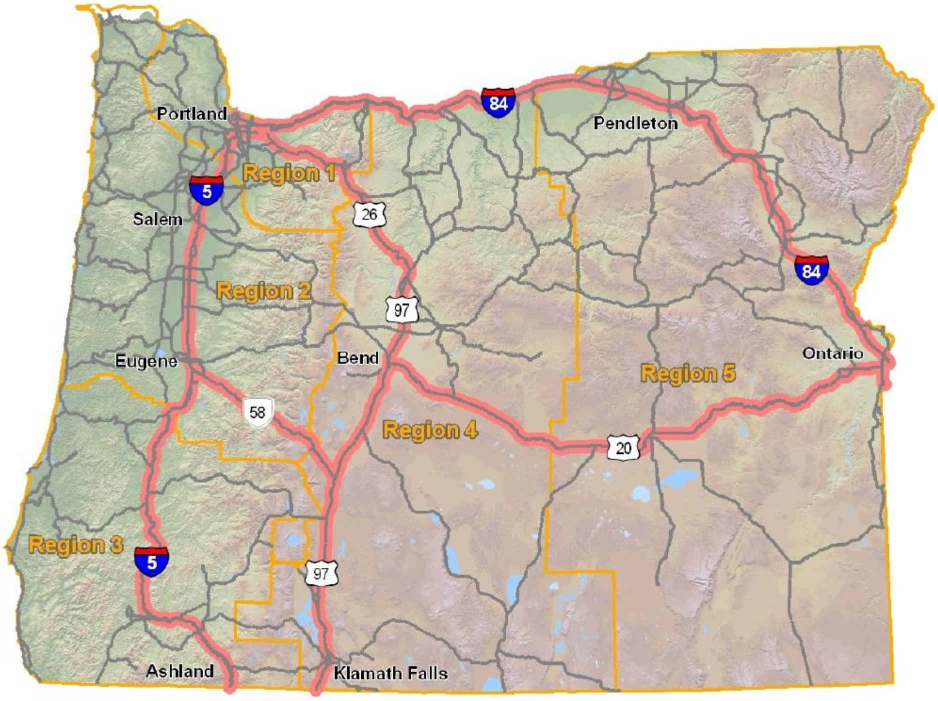


Figure 10. Map. Oregon DOT Regions. [(22)]

Project Coordination Efforts

OBDP took a two-fold approach to Project Coordination (PC) which included maximizing mobility from the standpoint of an assessment of physical restrictions (primarily for freight) and from a traffic delay standpoint (for the traveling public).

In order to maximize mobility from a physical restriction standpoint, the capacity of each network segment to handle permit loads (i.e., overweight, overwidth, overheight and overlength trucks) was required. In some cases, the terrain naturally limited viable detours, but the goal was to accommodate freight along corridors by identifying the significance of physical restrictions to each segment required by the necessary bridge projects.

In order to maximize mobility from a traffic delay standpoint, OBDP broke the roadway network into corridors and segments. With known pre-construction travel times, they calculated and aggregated the estimated delays anticipated during construction. The results of the delay analyses were used to make decisions about the choice of construction staging strategies and the construction schedule. The key corridors were divided into smaller segments. Delay and travel time thresholds were established for each segment. These thresholds were enforced 24 hours per day, 365 days per year.

Physical Restriction Analysis

Most freight movement (approximately 75 percent) in Oregon is by truck. With limited options for detours, keeping existing roads open in order to minimize impacts to freight was very important. Freight impacts could be caused by restrictions on the height, width, length or weight of vehicles that would be allowed to traverse the roadway through a particular project. ODOT wanted to ensure that freight movement was not cut off from entire sections of the state and that through freight traffic would still have a continuous route across the state during the construction effort. Collaboration with the trucking industry was critical during project development to ensure the design and staging solutions met the needs of the trucking industry and ODOT. (24)

Based on a detailed analysis of the aging bridges in Oregon, a prioritization strategy was recommended by the ODOT Economic and Bridge Options Team. The team strongly supported the concept of staging the bridge projects by starting with freight corridor alternatives in central and eastern Oregon and leaving the interstates for later. (25) The resulting construction staging map is shown in Figure 11. Stage 1 routes depict the alternate routes for I-5 and I-84 that were recommended to be completed first so that they could serve as alternate freight routes during the majority of the construction. The resultant route staging served as a basis for organizing the sequence of work. However, decisions still had to be made regarding the coordination of projects within each key corridor.

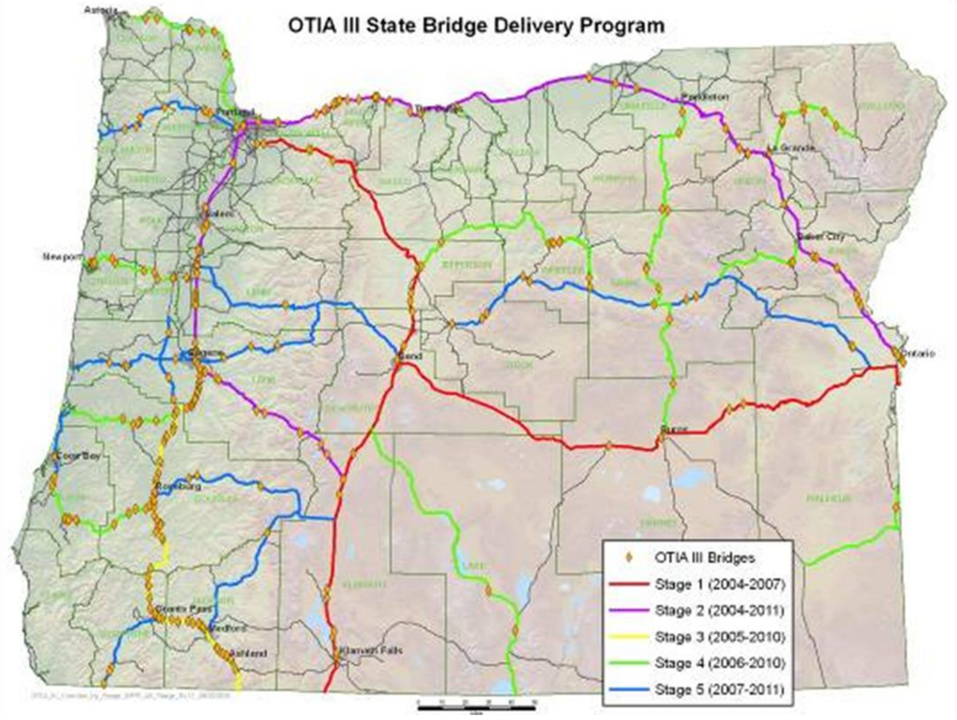


Figure 11. Map. Oregon Bridge Delivery Partners Construction Stages for Corridors. (26)

Within specific areas, the construction routing stages had some overlap. Therefore, ODOT's Motor Carrier Transport Division (MCTD) had to develop a means of tracking the unrestricted routes throughout the duration of all of the bridge projects. This tracking was accomplished with a freight mobility map, shown in Figure 12. The color-coded map was created to aid planners and other ODOT staff in keeping freight moving through and around work zones. The map displays routes and dimensions authorized by most over-dimension permits, display restricted routes, and aides in determining viable detour routes. Using this map, the MCTD could examine all oversize permit applications received, and quickly determine if the proposed route had physical restrictions that would not allow it to accommodate the load. An alternative route could also quickly be identified and provided back to the permit requestor.

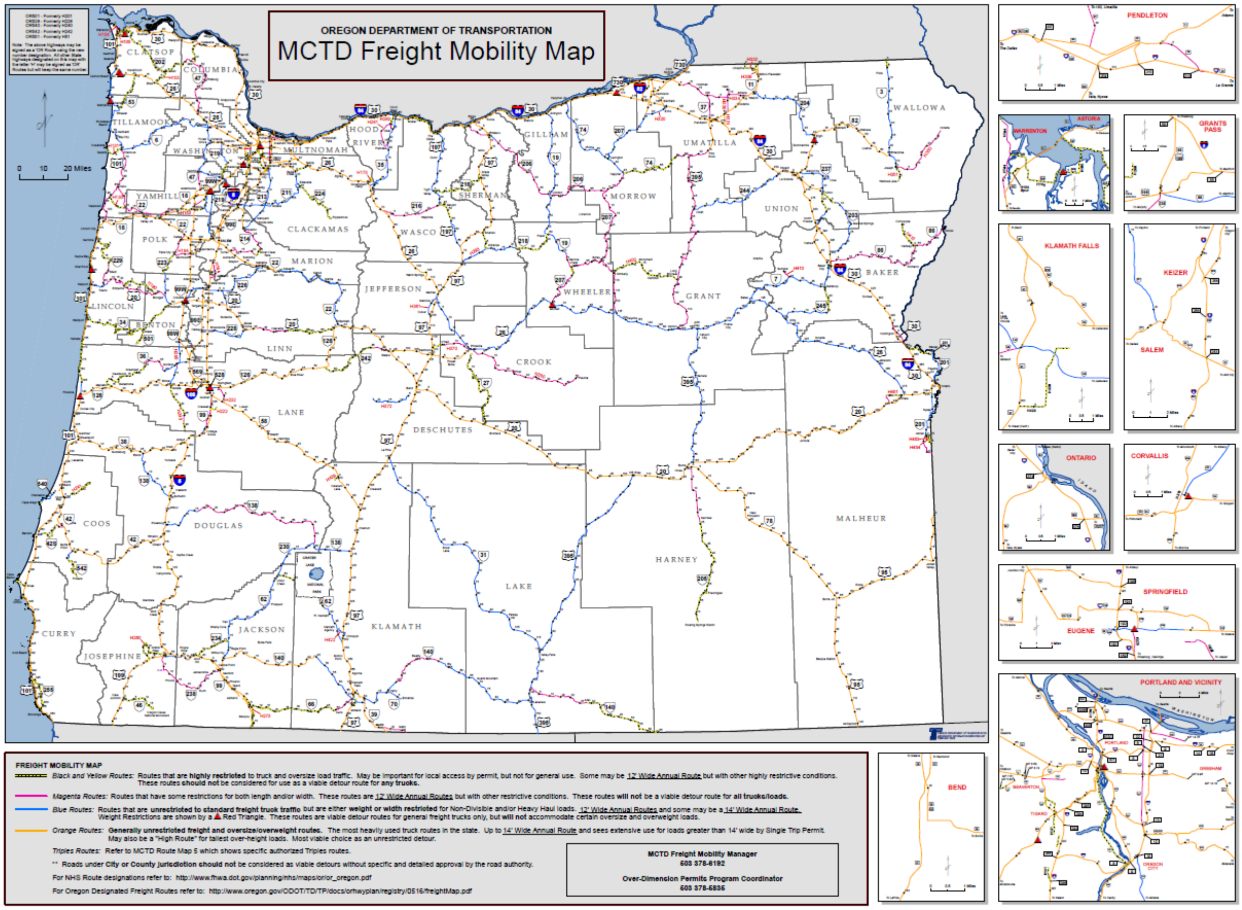


Figure 12. Map. Motor Carrier Transport Division Freight Mobility Map. (27)

Traffic Delay Analysis

In order to address the multi-level mobility coordination needs, ODOT established the position of Statewide Traffic Mobility Manager to oversee all of the mobility activities and processes throughout the state. This position is also responsible for resolving issues between parties within ODOT and with outside stakeholders at the statewide level. The processes established for maintaining mobility were developed and published in a document now known as the *Mobility Procedures Manual.* (28) The Manual explains how delays and physical restrictions are addressed statewide and provides a reference for traffic control designers to understand the requirements in each key corridor. Chapter 2 of the *Mobility Procedures Manual* defines how communication is to occur when addressing mobility issues, describes roles and responsibilities of the parties, and outlines a process for resolving mobility issues. (28)

For each key corridor, a Corridor Mobility Committee was formed. Chaired by the ODOT Statewide Traffic Mobility Manager, each committee included OBDP representatives and ODOT representatives from each region traversed by the corridor. Monthly meetings (or more frequently as needed) were used to focus on corridor-level mobility issues and inter-regional coordination. These committees were responsible for managing delay along each corridor through the use of delay thresholds established for each corridor. (22)

Region Mobility Liaisons were responsible for ensuring collaboration among the stakeholders within each of the five ODOT regions. Decisions regarding project scheduling were often dependent upon funding windows, the priority of the work needed, and contractor resources. Approximately 80 to 90 percent of delay conflicts were resolved at this level. (29)

Delay was defined as the additional time required to travel from one point to another as a result of work zones activities. (21) Establishing the delay thresholds in the early stages of the projects was important because the designers were required to consider them when developing the staging of their projects. (22) To accomplish this, the corridors were broken into segments and each segment was assigned a delay threshold. The delay thresholds were to be continuously enforced unless a delay exception was requested and granted by the ODOT Statewide Traffic Mobility Manager. Delay exceptions were requested as a last resort. Thus, over the entire eight years of the bridge program, exceptions were only requested about once per month. (29) The key corridors were divided into shorter travel segments ranging in length from six to 116 miles, but most were 40-70 miles in length. These corridors and segments are shown in Figure 13.

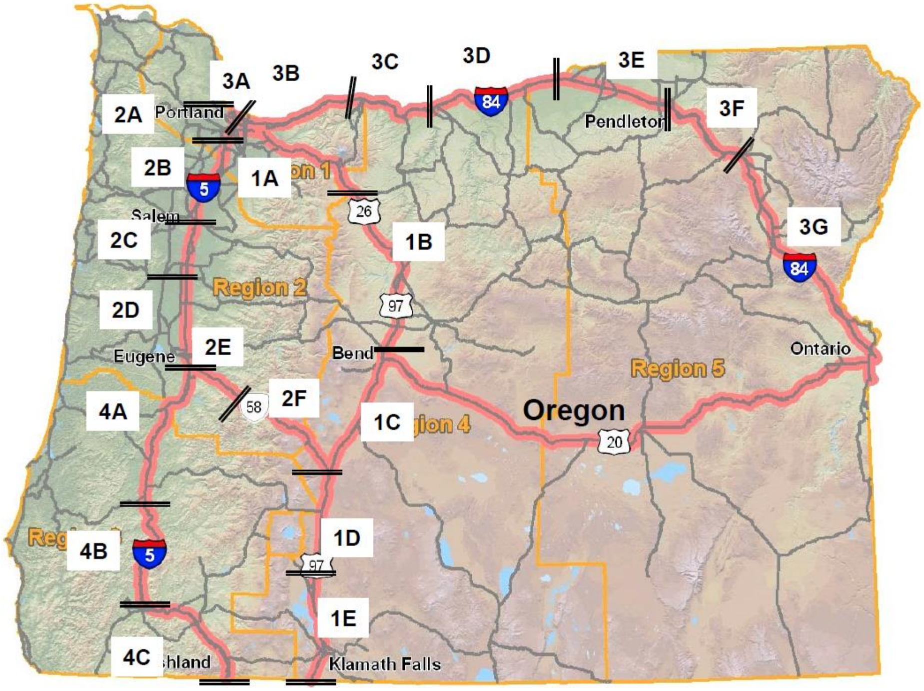


Figure 13. Map. Corridor Segments. (30)

Delay thresholds were established for each segment. These delays were based on factors such as the length of the segment and whether the area was urban, suburban, or rural. The goal was to keep the total delay along key corridors down to a tolerable level. The first step was to use the segment length and speed limits to calculate off-peak travel times for each segment. Next, travel times for peak travel conditions were estimated by increasing the off-peak travel times by particular percentages: 45 percent for urban areas, 30 percent for semi-urban (suburban), and ten percent for all other areas. The delay thresholds were then calculated to be ten percent of the peak travel times. For example, Segment 4C is located on the I-5 corridor and extends from U.S. Highway 199 to the California state line. The length of this segment is 55 miles. The assumed travel speed (in this case, the posted speed limit) is 65 mph. This segment is classified as semi-urban. During the peak commuting time with no construction, the travel time is 51 minutes. The estimated peak travel time is calculated to be 67 minutes (30 percent more than off-peak). Using a maximum allowable delay of ten percent, the calculated delay threshold was 6.7 minutes, which was rounded up to seven minutes. This delay threshold was a constant value held throughout the day. If multiple active work zones were scheduled in the segment, the cumulative delay for all could not exceed seven minutes. Corridor Level TMPs were developed for each corridor and documented the tabulated delay thresholds for each segment.

In the highly urbanized Region 1, which includes the Portland metropolitan area, roadway work is limited to overnight hours under almost all circumstances. Region 1 is unique because the traffic patterns are heavily influenced by commuters and congestion levels are much higher than anywhere else in the state. The ten percent delay maximum would be almost impossible to meet, even at night. Commuters in this area expect and tolerate more significant impacts to travel time than elsewhere in the state. Thus, a different threshold method was used for Region 1: maximum allowable travel time threshold. The maximum allowable travel time threshold was equal to the peak commuter travel time. Using travel time as the threshold for the purposes of mobility management was still restrictive enough to prohibit lane closures during peak hours while allowing additional flexibility during off-peak hours. (31)

Each region has a Region Mobility and Operations Committee that focuses on mobility issues of their projects and shares information with OBDP representatives. This includes their knowledge of maintenance projects that also need to be coordinated with the bridge projects. Project delays were estimated in the regions and then compared to the delay thresholds to determine how the projects would be scheduled. The expected segment delay was computed by aggregating the individual delays for all active projects within that segment. For example, Figure 14 shows three bridge projects scheduled during the same stage in segment 4A on I-5. The Corridor Level TMP for this segment shows that the calculated delay threshold for this segment is seven minutes. (32)

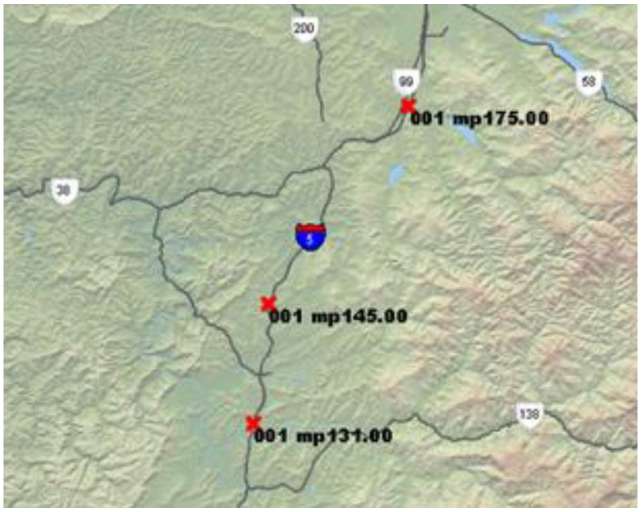


Figure 14. Map. Three Bridge Projects in Segment 4A. (32)

For each of the three projects, the expected delay was computed using ODOT's Work Zone Traffic Analysis (WZTA) tool. The tool is pre-loaded with roadway data such as route numbers, mile points, area type, related jurisdictions, roadway type, terrain, posted speed limit, number of lanes, paved surface width, and functional class. Traffic data includes Annual Average Daily Traffic (AADT) volumes, historic truck percentages, and horizontal and vertical grade information. The tool also has a Geographic Information System (GIS) interface that allows users to access data collected by and computed from nearby Automatic Traffic Recorders (ATRs), including seasonal trend data. The tool makes easy work of gathering the information required for calculating expected delay. For each of the three bridge projects, the individual delay was not expected to exceed three minutes. However, cumulatively, the predicted delay was estimated at around eight minutes, which exceeded the seven minute delay threshold.

Each project was assessed to determine if changes to the schedule were possible. In this case, potential conflicts with a limited, in-water work window would have been created, so a schedule shift was not possible. The remaining options included:

- Design change to maintain two lanes in each direction during construction.
- Construction of a temporary diversion structure in the median to maintain all lanes.
- Request of a delay exception.

After careful consideration, a diversion structure in the median was the chosen solution. All three projects were reconsidered to determine which project could more readily accommodate the temporary diversion structure, and that outcome was incorporated into the construction plans for that project. The result was that the expected cumulative delay under the new scenario would be less than seven minutes.

Overall the Oregon Bridge Delivery Program was a successful example of good PC. ODOT recognizes the benefits of their coordination efforts, including:

- Minimizing cumulative delays to individual travelers through multiple projects.
- Improving evaluations of the mobility trade-offs between project alternatives.
- Coordinating maintenance and construction work on parallel routes.
- Enhancing communication of delays and restrictions to the trucking industry and general public.
- Collaborating with the freight industry to address mobility issues was improved. (26)

Summary

The Oregon case study provides excellent examples that other agencies can adopt and/or adapt into their own systems. ODOT followed the steps described in Figure 2 to establish a PC process for minimizing delay and enhancing freight mobility.

Establishing the Project Coordination Vision

Oregon DOT's support of Project Coordination (PC) was clear in directives originating from the Director of ODOT, which included designation of an MCTD Mobility Coordinator to work with the trucking industry to address their concerns. A coordination committee was established, consisting of decision-makers from multiple divisions of the department (design, contracting, construction, maintenance, traffic, public information, etc.). The committee and established subcommittees worked to develop guidance on the overall coordination approach to be followed and required memorandums of understanding.

During the bridge projects, keeping traffic and freight moving was one of the top priorities of the Governor, Legislature, and the Director. The budget note to House Bill 2041 (OTIA III legislation) directed ODOT to develop a strategy that maximized the ease of traffic and freight movement throughout the state.

ODOT developed a statewide traffic mobility program which has been successfully responsible in coordinating efforts, forecasting potential conflicts, and resolving issues. In the ODOT Mobility Procedures Manual, specific notification requirements and communication processes are well-defined. In addition, roles and responsibilities are defined for the ODOT Mobility Policy Committee, the ODOT MCTD, each ODOT region mobility liaison and mobility committee, area managers, district managers, project managers, project staff, and consultants, etc.

Developing Details of How Coordination Will Occur

OBDP determined what data needed to be obtained and collected to support project coordination efforts, and developed a spreadsheet-based work zone delay analysis tool which served as the basis for development of the WZTA software currently in use by ODOT statewide. Most of the data needed to compute cumulative delay from multiple bridge projects could now be preloaded into the WZTA database to speed the calculation process. The MCTD Freight Mobility Map also proved to be an essential tool for maintaining freight routes statewide.

ODOT establish a decision-making process for how PC would be achieved amongst stakeholders by coordinating on three levels: At the program level, mobility coordinators were to maintain an unrestricted freight route for north–south and east–west traffic through Oregon. At the corridor-level, they monitored each corridor and didn't let delays exceed maximum limits. They also determined how many projects could be under way concurrently. At the project-level, coordinators ensured that each project observed the minimum mobility requirements for maintaining unrestricted freight routes.

Educating and Informing Internal and External Stakeholders

The primary reasons provided for minimizing delay and keeping freight moving were related to Oregon's economy. Because trucking is Oregon's dominant mode for freight transportation, maintaining mobility was focused on ensuring access to jobs, services, and markets. Efforts were made to ensure that agency staff understood what was expected of them relative to project coordination, and what they needed to do to ensure that coordination did occur. Staff were re-trained periodically as changes in procedures occurred and/or turnover in staffing occurred.

Staff actively addresses mobility early in the planning, design, and construction processes. The Mobility Policy Committee (MPC) of senior management was established to set process and policy direction. This committee consists of the administrators of Motor Carrier, Highway, and Transportation Development, as well as the Deputy Director for Operations. If issues were not resolved at lower levels within ODOT, the MPC would step in to resolve them.

Implementing the Project Coordination Process

A number of tools were developed to implement the coordination process, ranging from delay analyses to lane closure scheduling restrictions. Coordination meetings were held regularly to share information about what was planned and what was occurring. Any updates to the coordination process were also shared and vetted during these meetings. Potential conflicts (if any) were identified, and efforts taken as necessary (and as previously outlined in the coordination procedures) to resolve them. If the conflicts could not be resolved, a specific escalation process (also previously identified in the procedures) was initiated to be addressed at higher levels within the affected agencies and organizations.

Projects were tracked and incorporated into analyses at various levels of detail depending on where they were in the project development and delivery cycle. Projects several years out were incorporated based on general traffic impact expectations and schedule to the extent known. As project letting got closer, analyses were updated to consider the refined project staging and schedule to better estimate expected traffic impacts. Once the project was let and work was underway, efforts focused more on monitoring current construction activities and coordinating daily activities as needed between projects.

Refining the Process

The coordination committee reviewed and updated the coordination procedures several times during the early phases of implementation. Some necessary adjustments were identified during early reviews of the procedures, whereas others were uncovered during training and education efforts undertaken in step 3. Once these initial refinements were accomplished, updates or changes became less frequent, usually in response to an unusual conflict or challenge that arose.

CHAPTER 4. EXAMPLES OF USEFUL TOOLS TO FACILITATE PROJECT COORDINATION

INTRODUCTION

Good Project Coordination (PC) requires (1) the collection and sharing of timely, accurate project data, (2) an understanding of the potential impacts of each project, and (3) a defined and well thought-out coordination process that is followed by the stakeholders to accomplish PC objectives and thus minimize work zone safety and delay impacts. Project data includes basic information about the location, schedule, scope, cost, and project manager contact information. Quantifying the impact of a project on traffic mobility is more complex and often requires specialized software or skills. While sharing project data and understanding project impacts are both critical elements for good PC, agencies must take the third and final step of developing processes for coordinating projects based on the shared information. Without this final step, true PC does not occur.

TOOLS FOR COLLECTING AND SHARING PROJECT DATA

Collecting and sharing project data (locations, durations, expected impacts upon traffic conditions, and changes to those parameters as a project progresses) is an important element of Project Coordination (PC). Project data of this type is typically readily available within the agency responsible for the work at the beginning of a project, but often deviates somewhat from the initial plan due to various external events. Furthermore, these data from individual projects are not always collected or consolidated across a corridor or region.

Some agencies use consolidated databases which help them track project data across different regions or districts. These databases may be developed internally or purchased from a commercial vendor. In many cases, this information is used for internal coordination and may not be as readily available to stakeholders outside of the agency. In other cases, multiple agencies may share a single database which allows them to upload their project data and view project data from other organizations. One of the biggest challenges to agencies is to identify the proper framework or tool for sharing project data. Maintaining the data in such a database so that it continues to be viewed as relevant (and thus useful) is another challenge. Regular meetings with participants can reinforce the purpose of such a tool and thereby increase its effectiveness.

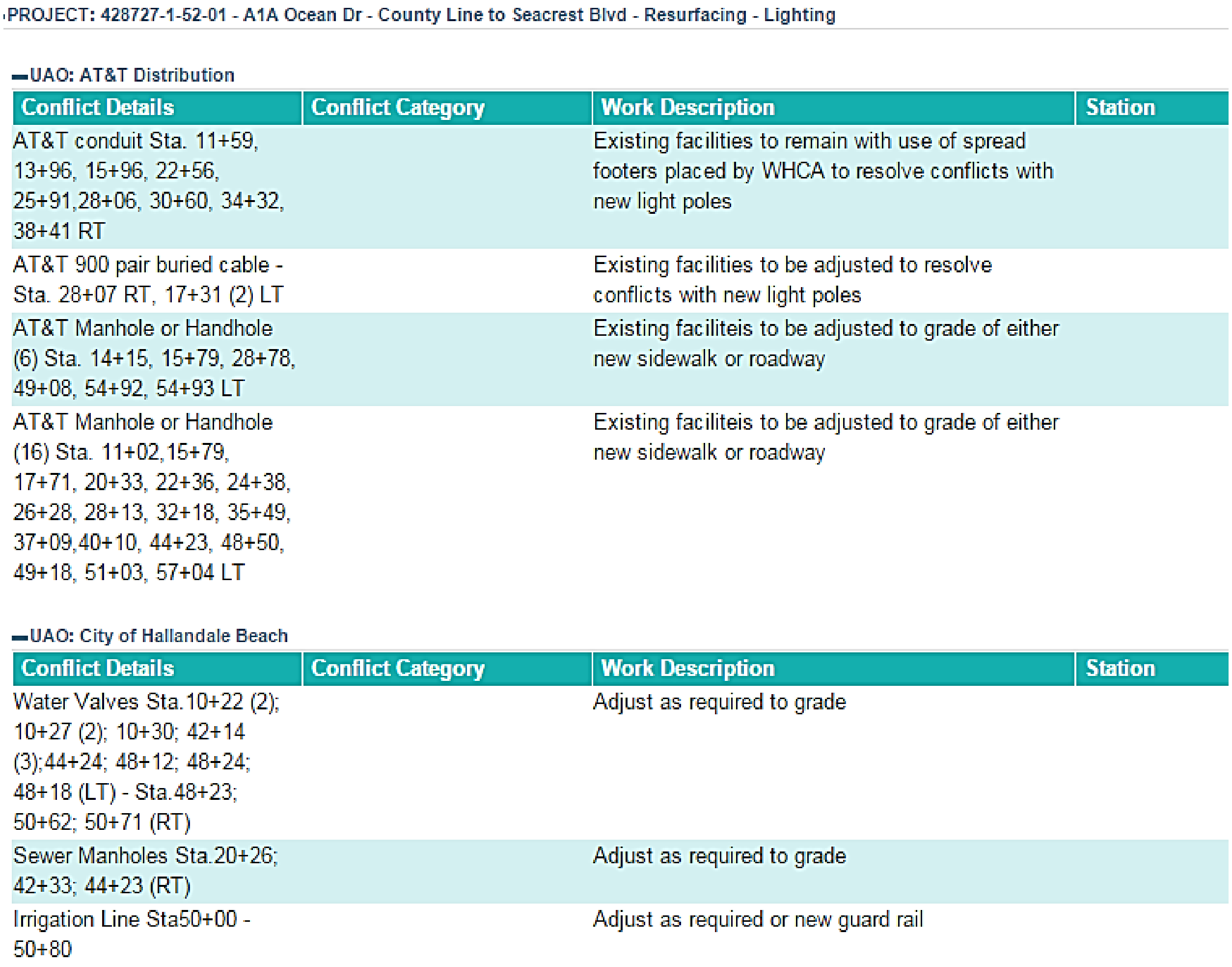
The following examples are presented to demonstrate the methods by which project data can be shared.

Internet Databases

Internet databases use a web browser interface to access project data. Some databases may be password protected while others are freely available to the public.

Florida Department of Transportation Utility Coordination Website

District 4 of the Florida Department of Transportation (FDOT) maintains a utility coordination web site for three regions within the district: Broward County, Palm Beach County, and Treasure Coast (Indian River, Martin, and St. Lucie counties). (33) Utility conflicts are determined for each project and listed according to the responsible utility company under the Contractor-DOT tab. As shown in Figure 15, the shared data includes the project number, project name, utility company name, conflict location (station & offset), and a work description. Contact information for the utility company is provided on a separate page. (34) Once the utility conflict is resolved, the line item is deleted from the website. This information is freely available to the public and allows all of the different utility companies to access information about other work required on each project. Presently, the impacts of each work effort are not known or tracked, nor is any formal coordination process defined that allows the utilities to work together to reduce those impacts. However, such processes could be established more easily with this type of database than would otherwise be possible.



PROJECT: 428727-1-52-01 - A1A Ocean Dr - County Line to Seacrest Blvd - Resurfacing - Lighting

UAO: AT&T Distribution

Conflict Details	Conflict Category	Work Description	Station
AT&T conduit Sta. 11+59, 13+96, 15+96, 22+56, 25+91,28+06, 30+60, 34+32, 38+41 RT		Existing facilities to remain with use of spread footers placed by WHCA to resolve conflicts with new light poles	
AT&T 900 pair buried cable - Sta. 28+07 RT, 17+31 (2) LT		Existing facilities to be adjusted to resolve conflicts with new light poles	
AT&T Manhole or Handhole (6) Sta. 14+15, 15+79, 28+78, 49+08, 54+92, 54+93 LT		Existing faciliteis to be adjusted to grade of either new sidewalk or roadway	
AT&T Manhole or Handhole (16) Sta. 11+02,15+79, 17+71, 20+33, 22+36, 24+38, 26+28, 28+13, 32+18, 35+49, 37+09,40+10, 44+23, 48+50, 49+18, 51+03, 57+04 LT		Existing faciliteis to be adjusted to grade of either new sidewalk or roadway	

UAO: City of Hallandale Beach

Conflict Details	Conflict Category	Work Description	Station
Water Valves Sta.10+22 (2); 10+27 (2); 10+30; 42+14 (3);44+24; 48+12; 48+24; 48+18 (LT) - Sta.48+23; 50+62; 50+71 (RT)		Adjust as required to grade	
Sewer Manholes Sta.20+26; 42+33; 44+23 (RT)		Adjust as required to grade	
Irrigation Line Sta50+00 - 50+80		Adjust as required or new guard rail	

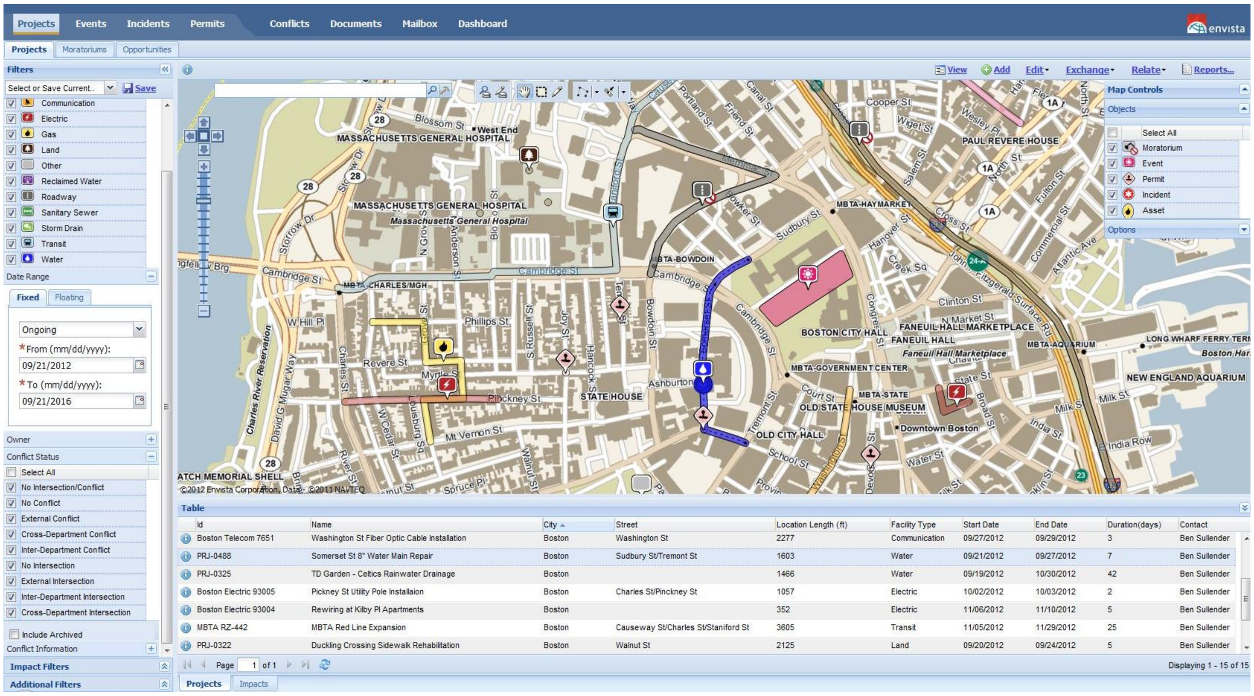
Figure 15. Screen Capture. Florida Department of Transportation District 4 Utility Coordination Information for Project 428727 in Broward County. (35)

Internet Geographic Information System (GIS) Databases

Geographic Information System (GIS) databases are similar in structure to the simpler internet databases described above, but with the ability to allow users to visualize project locations on a base map. This is particularly useful when considering the relative position of projects and their potential impacts to traffic flow. Several cities are using GIS-based software to track projects and reduce the number of pavement cuts required for planned utility work.

City of Baltimore

To encourage better coordination and communication for infrastructure projects, the City of Baltimore implemented a software-based PC system to track all capital and maintenance activities. The system selected by Baltimore to coordinate right-of-way activities was implemented over a two year period. It provides real-time information on infrastructure projects across the City via a web-based system accessible to all of the stakeholder groups. Each project is mapped via GIS data points. A clickable map provides key details such as location, timeline, scope, schedule, cost, and points of contact for each project, similar to the example shown in Figure 16.



☑ Communication
☑ Electric
☑ Gas
☑ Land
☑ Other
☑ Reclaimed Water
☑ Roadway
☑ Sanitary Sewer
☑ Storm Drain
☑ Transit
☑ Water

Date Range

Fixed

Ongoing

*From (mm/dd/yyyy): 09/21/2012

*To (mm/dd/yyyy): 09/21/2016

Conflict Status

☐ Select All
☑ No Intersection/Conflict
☑ No Conflict
☑ External Conflict
☑ Cross-Department Conflict
☑ Inter-Department Conflict
☑ No Intersection
☑ External Intersection
☑ Inter-Department Intersection
☑ Cross-Department Intersection

☐ Include Archived

☐ Select All
☑ Moratorium
☑ Event
☑ Permit
☑ Incident
☑ Asset

Id	Name	City	Street	Location Length (ft)	Facility Type	Start Date	End Date	Duration(days)	Contact
Boston Telecom 7651	Washington St Fiber Optic Cable Installation	Boston	Washington St	2277	Communication	09/27/2012	09/29/2012	3	Ben Sullender
PRJ-0488	Somerset St 8" Water Main Repair	Boston	Sudbury St/Tremont St	1603	Water	09/21/2012	09/27/2012	7	Ben Sullender
PRJ-0325	TD Garden - Celtics Rainwater Drainage	Boston		1466	Water	09/19/2012	10/30/2012	42	Ben Sullender
Boston Electric 93005	Pickney St Utility Pole Installaion	Boston	Charles St/Pinckney St	1057	Electric	10/02/2012	10/03/2012	2	Ben Sullender
Boston Electric 93004	Rewiring at Kilby Pl Apartments	Boston		352	Electric	11/06/2012	11/10/2012	5	Ben Sullender
MBTA RZ-442	MBTA Red Line Expansion	Boston	Causeway St/Charles St/Staniford St	3605	Transit	11/05/2012	11/29/2012	25	Ben Sullender
PRJ-0322	Duckling Crossing Sidewalk Rehabilitation	Boston	Walnut St	2125	Land	09/20/2012	09/24/2012	5	Ben Sullender

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Figure 16. Screen Capture. Geographic Information System-based Project Data Sharing.(36)

While other similar software tools may be available, the City of Baltimore uses a proprietary cloud-based enterprise suite of programs that consolidate and streamline data sharing. For a subscription fee, agencies can access project data planned by others and contribute their planned project data. Agencies who share information include:

- City of Baltimore Department of Public Works.
- City of Baltimore Department of Transportation.
- City of Baltimore Department of General Services.
- Baltimore Gas & Electric (BGE).
- Veolia Energy (provides business district heating and cooling services).
- Verizon (provides telecommunications services). (37)

The City of Baltimore has recognized numerous benefits with the system:

- Improved stakeholder engagement.
- Enhanced traffic management plans and earlier awareness of project impacts.
- Enriched data quality by having up-to-date information about planned work activities.
- Lengthened pavement life due to scheduling utility maintenance activities to occur prior to City resurfacing projects. (38)

Certainly, the availability of such a system could be coupled with traffic analytical tools to allow cumulative effects upon travel conditions to be estimated. Stakeholders could also work together to establish their set of business rules to follow in the event that project conflicts that exceed agreed-upon thresholds are encountered.

District of Columbia Department of Transportation (DDOT)

Similar to the City of Baltimore, the District of Columbia Department of Transportation (DDOT) is also using proprietary software to coordinate road projects—specifically to reduce pavement cuts. Agencies who share information in this user group include:

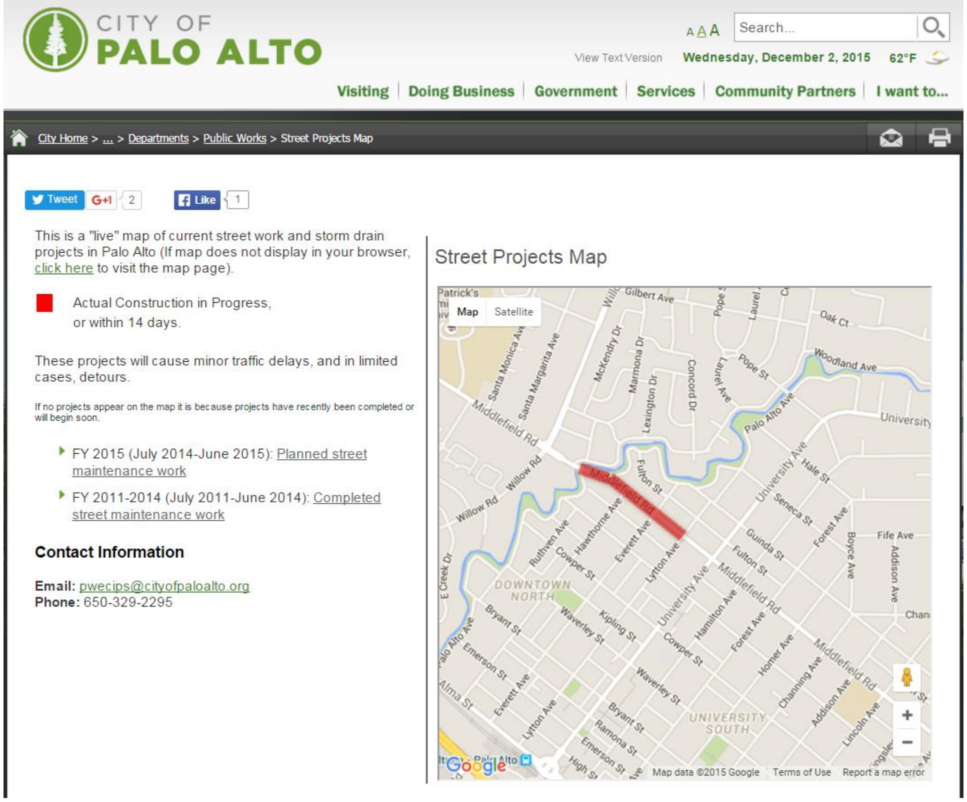
- DDOT.
- Potomac Electric Power Company (PEPCO).
- Washington Gas.
- District of Columbia Water and Sewer Authority (DC Water). (39)

DDOT created an ordinance in September 2010 requiring all utilities operating in the public right-of-way to use the online map-based service. (40)

City of Palo Alto

A 2006 audit of the City of Palo Alto, California street maintenance program found that street excavations degrade and shorten the life of the City streets. (41) The City Auditor determined that the City's Public Works Department and the (mostly city-run) utilities did not have cross-departmental information about project schedules and the moratorium status of streets. In addition, operations crews lacked access to GIS data to review, monitor, or record repair and maintenance work. As a result, there was no coordination between departments, resulting in operational conflicts and inefficiencies. One of the auditor's recommendations was that all departments that cut city streets use a GIS to coordinate their projects and summarize work completed in a timely manner.

In response to the audit, the Public Works Department developed an in-house, GIS-based program to coordinate right-of-way construction. Public Works and utility staff input construction schedules, routinely update project status, and check for conflicting work on street segments. The map, shown in Figure 17, displays pavement and storm drain construction projects that are active or planned within 14 days. (42) The map also shows projects planned for the next four years. As with the other examples in this section, access to current and upcoming project work that may conflict or cause excessive delays and motorist frustration, if performed simultaneously, provides the department with a good opportunity to enact processes that will develop estimates of project impacts and business rules that will guide coordination efforts should proposed project schedules result in estimates of excessive impacts to travelers.



This is a "live" map of current street work and storm drain projects in Palo Alto (If map does not display in your browser, click here to visit the map page).

🟥 Actual Construction in Progress, or within 14 days.

These projects will cause minor traffic delays, and in limited cases, detours.

If no projects appear on the map it is because projects have recently been completed or will begin soon.

- FY 2015 (July 2014-June 2015): Planned street maintenance work
- FY 2011-2014 (July 2011-June 2014): Completed street maintenance work

Contact Information

Email: pwecips@cityofpaloalto.org
Phone: 650-329-2295

Figure 17. Screen Capture. City of Palo Alto Geographic Information System-based Project Map. (42)

TOOLS FOR ASSESSING WORK ZONE MOBILITY IMPACTS

As suggested earlier in this report, the ability to reasonably estimate the impacts of projects individually, as well as their cumulative effect upon a corridor or region, is an important tool for PC efforts. The ability to identify if and when excessive delays are likely to occur, either individually or collectively due to project activities, provides the impetus to initiate the business processes in place that drive the coordination actions. These tools can also provide ammunition for justifying the required coordination actions, demonstrating the expected mobility and/or safety benefits that are likely to be achieved if the coordination efforts are successful.

A variety of tools are available for assessing work zone mobility impacts. Tools can be simple input-output type or may consist of more complex modeling. FHWA has compiled this information online in a series of Traffic Analysis Toolbox volumes. (43) Several of these documents focus on analysis of work zones. (44,45) A few examples of some additional tools not in the FHWA toolbox are summarized below.

Oregon Department of Transportation

Oregon DOT developed the Work Zone Traffic Analysis (WZTA) tool as a GIS-based data repository for project data with an analytical component that allows for traffic impact assessment. The WZTA was originally developed as a spreadsheet that combined ODOT’s lane restriction methodologies with traffic microsimulation analyses regressed to fit exponential curves. The spreadsheet required minimal input from the analyst to develop lane closure restrictions and estimated project delay. The spreadsheet was later transformed to allow online access and GIS mapping of projects.

The basic steps of Work Zone Traffic Analysis concepts are straightforward:

- Establish the volume of vehicles expected on the highway.
- Determine the appropriate traffic volume threshold for the roadway type, location, and proposed work zone staging strategy.
- Recommend the time windows during which the proposed lane restrictions can be safely applied if the volume is larger than the threshold.
- Estimate the delay based on the staging strategy to be applied and the traffic volumes expected during work hours.

This process results in two outputs:

- Lane restrictions, which are written into the project’s special provisions.
- Estimated delay, which is coordinated with the leaders of other projects on the highway corridor, the Region Mobility Liaison, and/or the Region Mobility Committee. (46)

ODOT’s Work Zone Traffic Analysis tool is available online upon request. The tool is unique in that it shares information about upcoming projects and estimates the traffic impacts of the projects. The framework for the PC process has been established on a statewide basis under the ODOT Mobility Procedures Manual. (28)

Work Zone Impacts and Strategies Estimator (WISE) Software

The Work Zone Impacts and Strategies Estimator (WISE) software tool was developed through the SHRP2 program to evaluate the impacts of various highway projects and compare alternatives. It is open-source software that is available from FHWA. (47) Software support includes a user's guide. (18) The WISE software analyzes the impacts on road users of multiple, concurrent work zones across a network or complex corridor. This tool is intended to help agencies actually optimize the sequencing of renewal projects and analyze the cost-effectiveness of strategies for the minimization, management, and mitigation of road user costs from safety or operational perspectives. The WISE tool can be used at a planning level as well as the operational level. WISE software provides an integrated framework for users to evaluate planning decisions and operational strategies, eliminating the need to use separate software for model-building. With the integrated framework, planning-level decisions can be based on network- and corridor-level impacts. Users can import traffic networks from existing travel demand models. In addition, the tool has an optimization routine that will recommend efficient staging strategies. WISE can evaluate the impact of changes in route choice behavior, as well as impacts from intelligent transportation systems. (48)

CHAPTER 5. SUMMARY AND CONCLUSIONS

As the information presented throughout this report has shown, road Project Coordination (PC) can involve various strategies and actions, with the intent to reduce the safety and mobility impacts relative to what would have occurred if the projects had not been coordinated. Three key questions define the opportunities for successful PC:

- Who should be involved?
- When can or should it occur?
- What does it accomplish?

PC by a single agency where multiple projects are ongoing along a particular route or parallel routes under the agency's control, is the starting point for many agencies. Establishing methods of collecting and analyzing the effects of expected project tasks upon safety and mobility is critical to PC efforts. Databases, traffic impact analysis and optimization models, and project location visualization tools can all assist an agency in identifying coordination needs and determining suitable coordination actions to mitigate the travel impacts of the projects. Examples of possible actions include (but are not limited to):

- Sequencing the order in which multiple projects are completed to incrementally build additional capacity into the travel corridor or network, so that each completed project provides the greatest amount of benefit to travelers during each successive project.

- Combining projects or project tasks along a travel route segment so that the impact to traffic occurs for the collective tasks at one time instead of individual impacts for each activity.

- Scheduling projects or project tasks to avoid having significant capacity restrictions on a single travel route or on multiple roadways that serve as convenient alternatives for travelers when they encounter work zone congestion and delays.

Once an agency has developed experiences with coordinating projects within its own jurisdiction and determined which business processes are most effective in resolving project conflicts with minimal contractual challenges and disruptions to project schedules, the next step is to take a regional perspective of PC. PC across multiple agencies is inherently more complex and challenging, given the number of agencies and companies that may be involved, their different missions and charters regarding transportation safety and mobility, separate funding sources and timelines, etc. However, the same types of tools and business processes that are effective in coordinating projects within a single agency can be molded to address multi-agency PC objectives as well. The complexity of databases, visualization tools, and analytical models to identify potential project conflicts and coordination needs may need to be higher, as may the determination and agreement upon the business processes that will be followed when coordination actions are required. However, the product of such efforts can be substantial reductions in work zone safety and mobility impacts, reduced traveler frustration, and increased project work productivity. A five-step approach towards developing a PC process has been documented in this report, and consists of the following:

- Establishing a PC vision for the corridor or system.
- Developing the details as to how PC will occur.
- Educating and informing personnel and stakeholders about the PC process.
- Implementing the PC process.
- Refining the process as needed.

Additional project coordination resources are available online. These are shown in the Appendix.

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APPENDIX.

RESOURCES FOR LEARNING MORE ABOUT PROJECT COORDINATION

Table 2. Resources for Learning More about Project Coordination.

Resource	Description	Webpage Address
Smarter Work Zones Interactive Tool Kit	Resources developed through the FHWA Smarter Work Zones EDC-3 Program	https://www.workzonesafety.org/swz/project_coordination
Coordinating Road Projects	Resources developed by FHWA	http://www.ops.fhwa.dot.gov/wz/construction/crp/index.htm
Peer-to-Peer (P2P) Program for Work Zones	Information on the WZ P2P program established to provide short-term assistance to agencies interested in the application of methods, tools, and strategies to improve work zone safety and mobility.	http://www.ops.fhwa.dot.gov/wz/p2p/index.htm
SHRP 2 Report S2-R11-RW-2: WISE Software Users Guide	The WISE tool is intended to be a decision support system to be used by planners and engineers to evaluate the impact of work zones and determine strategies to reduce these impacts.	http://onlinepubs.trb.org/onlinepubs/shrp2/SHRP2_S2-R11-RW-2.pdf
NCHRP Report 8-36(56): Highway Construction Coordination to Minimize Traffic Impacts	NCHRP report with examples of coordinated highway construction projects and recommendations for agencies interested in implementing enhanced construction coordination while maintaining reasonable levels of traffic flow.	http://planning.transportation.org/Documents/8-36/NCHRP8-36(56)FinalReport.pdf
NCHRP Synthesis 413: Techniques for Effective Highway Construction Projects in Congested Urban Areas	Identifies strategies and successful practices used by transportation agencies to deal effectively with the challenges and impacts of construction projects in congested urban corridors.	http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_syn_413.pdf

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