Integrating the Priorities of Transportation Agencies and Utility Companies

DETAILS

0 pages | null | PAPERBACK
ISBN 978-0-309-42966-5 | DOI 10.17226/23037

AUTHORS

The Second
STRATEGIC HIGHWAY RESEARCH PROGRAM

SHRP2 REPORT S2-R15-RW

Integrating the Priorities of Transportation Agencies and Utility Companies

Final Report from Renewal Project R15

RALPH ELLIS
Professor at the University of Florida and R15 Co-Principal Investigator

MARIE VENNER
Principal, Venner Consulting, Inc. and R15 Co-Principal Investigator

CHRIS PAULSEN
Senior Associate, ICF International

JIM ANSPACH
Principal, So-Deep

GINGER ADAMS
Principal-in-Charge, Advantage Facilitation Services

KATHLEEN VANDENBERGH
Graduate Candidate at the University of Florida

TRANSPORTATION RESEARCH BOARD

WASHINGTON, D.C.
2009
www.TRB.org

The Second Strategic Highway Research Program

America's highway system is critical to meeting the mobility and economic needs of local communities, regions, and the nation. Developments in research and technology—such as advanced materials, communications technology, new data collection technologies, and human factors science—offer a new opportunity to improve the safety and reliability of this important national resource. Breakthrough resolution of significant transportation problems, however, requires concentrated resources over a short time frame. Reflecting this need, the second Strategic Highway Research Program (SHRP 2) has an intense, large-scale focus, integrates multiple fields of research and technology, and is fundamentally different from the broad, mission-oriented, discipline-based research programs that have been the mainstay of the highway research industry for half a century.

The need for SHRP 2 was identified in *TRB Special Report 260: Strategic Highway Research: Saving Lives, Reducing Congestion, Improving Quality of Life,* published in 2001 and based on a study sponsored by Congress through the Transportation Equity Act for the 21st Century (TEA-21). SHRP 2, modeled after the first Strategic Highway Research Program, is a focused, time-constrained, management-driven program designed to complement existing highway research programs. SHRP 2 focuses on applied research in four focus areas: Safety, to prevent or reduce the severity of highway crashes by understanding driver behavior; Renewal, to address the aging infrastructure through rapid design and construction methods that cause minimal disruptions and produce lasting facilities; Reliability, to reduce congestion through incident reduction, management, response, and mitigation; and Capacity, to integrate mobility, economic, environmental, and community needs in the planning and designing of new transportation capacity.

SHRP 2 was authorized in August 2005 as part of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU). The program is managed by the Transportation Research Board (TRB) on behalf of the National Research Council (NRC). SHRP 2 is conducted under a memorandum of understanding among the American Association of State Highway and Transportation Officials (AASHTO), the Federal Highway Administration (FHWA), and the National Academy of Sciences, parent organization of TRB and NRC. The program provides for competitive, merit-based selection of research contractors; independent research project oversight; and dissemination of research results.

SHRP 2 Report S2-R15-RW

ISBN: 9780309128834
Library of Congress Control Number: 2009929568

Copyright Permission

Note: SHRP 2 report numbers convey the program, focus area, project number, and publication format. Report numbers ending in "w" are published as Web Documents only.

NOTICE

The project that is the subject of this report was a part of the second Strategic Highway Research Program conducted by the Transportation Research Board with the approval of the Governing Board of the National Research Council. Such approval reflects the Governing Board's judgment that the program concerned is of national importance and appropriate with respect to both the purposes and resources of the National Research Council.

The members of the technical committee selected to monitor this project and to review this report were chosen for recognized scholarly competence and with due consideration for the balance of disciplines appropriate to the project. The opinions and conclusions expressed implied are those of the research agency that performed the research, and, while they have been accepted appropriate by the technical committee, they are not necessarily those of the Transportation Research Board, the National Research Council, the Federal Highway Administration, U.S. Department of Transportation, or the American Association of State Highway and Transportation Officials.

Each report is reviewed and accepted for publication by the technical committee according to procedures established and monitored by the Transportation Research Board Executive Committee and the Governing Board of the National Research Council.

Note: The Transportation Research Board of the National Academies, the National Research Council, the Federal Highway Administration. The American Association of State Highway and Transportation Officials, and the individual states participating in the second Strategic Highway Research Program do not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of this report.

SHRP 2 reports

are available by subscription and through the TRB online Bookstore at
www.TRB.org/bookstore

Contact the TRB Business Office
by telephone at 202-334-3213.

More information about SHRP 2 is available at:
www.TRB.org/SHRP2

THE NATIONAL ACADEMIES

Advisers to the Nation on Science, Engineering, and Medicine

The **National Academy of Sciences** is a private, nonprofit, self-perpetuating society of distinguished scholars engaged in scientific and engineering research, dedicated to the furtherance of science and technology and to their use for the general welfare. On the authority of the charter granted to it by the Congress in 1863, the Academy has a mandate that requires it to advise the federal government on scientific and technical matters. Dr. Ralph J. Cicerone is president of the National Academy of Sciences.

The **National Academy of Engineering** was established in 1964, under the charter of the National Academy of Sciences, as a parallel organization of outstanding engineers. It is autonomous in its administration and in the selection of its members, sharing with the National Academy of Sciences the responsibility for advising the federal government. The National Academy of Engineering also sponsors engineering programs aimed at meeting national needs, encourages education and research, and recognizes the superior achievements of engineers. Dr. Charles M. Vest is president of the National Academy of Engineering.

The **Institute of Medicine** was established in 1970 by the National Academy of Sciences to secure the services of eminent members of appropriate professions in the examination of policy matters pertaining to the health of the public. The Institute acts under the responsibility given to the National Academy of Sciences by its congressional charter to be an adviser to the federal government and, on its own initiative, to identify issues of medical care, research, and education. Dr. Harvey V. Fineberg is president of the Institute of Medicine.

The **National Research Council** was organized by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and advising the federal government. Functioning in accordance with general policies determined by the Academy, the Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in providing services to the government, the public, and the scientific and engineering communities. The Council is administered jointly by both the Academies and the Institute of Medicine. Dr. Ralph J. Cicerone and Dr. Charles M. Vest are chair and vice chair, respectively, of the National Research Council.

The **Transportation Research Board** is one of six major divisions of the National Research Council. The mission of the Transportation Research Board is to provide leadership in transportation innovation and progress through research and information exchange, conducted within a setting that is objective, interdisciplinary, and multimodal. The Board's varied activities annually engage about 7,000 engineers, scientists, and other transportation researchers and practitioners from the public and private sectors and academia, all of whom contribute their expertise in the public interest. The program is supported by state transportation departments, federal agencies including the component administrations of the U.S. Department of Transportation, and other organizations and individuals interested in the development of transportation. **www.TRB.org**

www.national-academies.org

SHRP 2 STAFF

Neil F. Hawks, *Director*
Ann M. Brach, *Deputy Director*
Kizzy Anderson, *Senior Program Assistant, Safety*
Stephen Andrle, *Chief Program Officer, Capacity*
James Bryant, *Senior Program Officer, Renewal*
Kenneth Campbell, *Chief Program Officer, Safety*
JoAnn Coleman, *Senior Program Assistant, Reliability*
Walter Diewald, *Senior Program Officer, Safety*
Jerry DiMaggio, *Implementation Coordinator*
Charles Fay, *Senior Program Officer, Safety*
Ralph Hessian, *Visiting Professional*
William Hyman, *Senior Program Officer, Reliability*
Linda Mason, *Communications Officer*
Michael Miller, *Senior Program Assistant*
David Plazak, *Senior Program Officer, Capacity and Reliability*
Robert Raab, *Senior Program Officer, Renewal*
Monica Starnes, *Senior Program Officer, Renewal*
Noreen Fenwick, *Senior Program Assistant, Renewal*
Chrystyne Talley, *Financial Associate*
Charles Taylor, *Special Consultant, Renewal*
Hans van Saan, *Visiting Professional*
Pat Williams, *Administrative Assistant*
Connie Woldu, *Administrative Coordinator*
Patrick Zelinski, *Communications Specialist*

AUTHOR ACKNOWLEDGMENTS

This work was sponsored by the Federal Highway Administration in cooperation with the American Association of State Highway and Transportation Officials. It was conducted in the second Strategic Highway Research Program, which is administered by the Transportation Research Board of the National Academies. The report was prepared for the Renewal Technical Coordinating Committee of SHRP 2. The project was managed by Monica A. Starnes.

The report was prepared by ICF International, Fairfax, VA and The University of Florida, Gainesville, FL with support from Advantage Facilitation, Ft. Collins, CO and Jim Anspach, So-Deep, Manassas Park, VA.

FOREWORD

Monica A. Starnes, Ph.D., *SHRP 2 Senior Program Officer*

This report documents current practices, opportunities for improvement, and anticipated barriers for integrating utility and transportation agency priorities in highway renewal projects. Thirteen best practices that span the whole project life cycle are also documented in a tool box format. Finally, the report provides a plan for future research in this field.

Issues related to utilities are among the major causes of construction delays in highway construction projects. Because of the frequency with which utilities occupy existing highway rights-of-way, highway renewal projects are prone to setbacks related to mismanaged relocation of existing utilities. Lack of accurate information on the location of underground or overhead utility assets, inadequate estimation of the time and budget needed to conduct utility relocation activities, and insufficient coordination and cooperation between transportation agencies and utility companies are among key factors that contribute to construction delays. The demand for accelerated project delivery while minimizing the impact to the traveling public further highlights the need for adequate coordination and cooperation between highway agencies and utilities for many highway renewal projects.

Under SHRP 2 Project R15, a research team led by Marie Venner of ICF International and Ralph Ellis of the University of Florida investigated how to improve coordination between utility companies and transportation agencies to reduce the negative impacts to both and to the public. The research was divided into two distinctive, although not explicit, phases. The first phase of the project focused on data gathering to identify existing institutional issues and processes that contribute to delays in planning, designing, and constructing highway renewal projects, as well as identifying proven innovative practices, policies, and procedures to mitigate these delays. As part of the data gathering activities the research team conducted a series of surveys and interviews, in addition to a detailed survey of printed and electronic literature.

The second phase of the project focused on data analysis and development of recommendations. Analysis of the literature, surveys, and interviews yielded a list of the most common coordination problems between transportation agencies and utility companies and examples of best practices from the interviews. In order to enhance the analysis activities, the research team also established an internal advisory panel of nine DOT members and eight utility company members. The team's findings and developed strategies for improving coordination between public agencies and utility companies were shared with this internal advisory panel in order to refine the recommended best practices and strategies. Based on the results, the research team developed a tool box of best practices and a set of recommendations for future research projects that could relieve the institutional barriers for effective utility relocation activities.

CONTENTS

Executive Summary

Traditionally, state departments of transportation (DOTs) construct, maintain, and operate highways for the benefit of the public; however, their role as right-of-way (ROW) managers has not been in the forefront of their responsibilities. In today's changing priorities and increased public expectations, state DOTs are rethinking priorities. Since the advent of the highway system, DOT ROWs now serve more than people and vehicular traffic; states have extended the use of highway ROWs to utility companies (UCs) to save public resources and serve the public interest. The number of utilities and the complexity of the coordination required to serve both DOT and UC interests and needs has grown exponentially. This report summarizes the Strategic Highway Research Program (SHRP 2) Project R15 concerning the issues, opportunities, and barriers that DOTs and UCs face in coordinating and achieving their goals and priorities.

State DOTs are facing pressure to accelerate and substantially increase the efficiency of the design and construction process. Time is a crucial yardstick for measuring the performance of construction contractors on highway projects. Costs for both highway users and highway agencies resulting from delayed completion are substantial, and the public unwillingly bears most of these costs. The price of new ROWs continues to rise and current ROWs are crowded; at the same time, DOTs and UCs are striving to make maximum use of available capacity in existing facilities and ROWs. The need for careful coordination between state DOTs and UCs in setting priorities and planning is obvious.

The challenges posed by DOT–UC coordination are significant. Half of all highway and bridge projects eligible for federal funding involve the relocation of utility facilities, and construction generally takes longer and costs more when utilities need to be relocated. The primary causes of delay on highway renewal projects are locating and protecting, or relocating, underground utilities.

The SHRP 2 Project R15 investigated the issues, opportunities, and barriers that DOTs and UCs face in coordinating and achieving their respective goals and priorities and identified four primary areas of focus:

- Strategies that utilities and highway agencies can use to work cooperatively and reduce delays;
- Institutional barriers that impede implementation of strategies;
- Evaluation of strategies; and
- Framework for effective utility management in the project development process, a generically applicable process using the identified strategies.

The research team used a literature survey and interviews with representatives from 28 state DOTs and UCs to reveal the scope of coordination challenges between DOTs and UCs and strategies that have been used. The findings show the key problems listed on the following pages and opportunities for change and improvement.

Coordination—Recognizing Each Other's Needs

Overall, DOTs and utilities agree that inadequate coordination is a frequent problem. Both DOTs and utilities report insufficient communication, scheduling, and coordination in planning, ROW acquisition, design, and construction phases of road construction projects. These difficulties, in turn, affect timely relocation of utilities.

The following brief list summarizes the issues that DOTs and UCs encounter:

- Lack of understanding of the roles, responsibilities, and priorities of the transportation agency, utility companies, and contractors;
- Lack of agreed-upon policies, procedures, practices, and responsibilities for state or local government units, utility companies, One Call utility locators, and contractors concerning utility location;
- Inaccurate or missing information on the locations of existing facilities owned by utility companies, communication companies, and local governments; and
- Misunderstood or improperly used procedures for design and utility location requests, resulting in inadequate space for utility relocations (on the roadway or private ROW) and insufficient time to buy supplies, obtain additional ROW, and meet existing customer contracts that stipulate sufficient lead time.

Issues

Utility industry input to the investigation focused primarily on delay issues. Analysis from interviews with utility engineers and coordinators suggests that the following top issues contribute to coordination problems and resulting relocation delays:

- Utilities have limited resources. Although most utilities have dedicated resources for relocation activities, these resources are not unlimited. Abrupt changes in DOT work program volumes and changes in individual project schedules may cause demands in excess of UC resources. Extreme weather events take precedence over normal business, and resources may be pulled away to fulfill disaster resource-sharing commitments.
- Utility relocation is not the primary focus of DOT designers. DOT designers are focused on designing transportation facilities; utilities are a secondary consideration. Generally, DOTs recognize the need to identify conflicts and required relocations; however, changes to their designs to minimize relocation costs typically must originate with the UC, and UCs are not members of the design team.
- Coordination among UCs occupying the same facility or characterizing the same space is suboptimal. In many locations, UCs have inadequate coordination processes to handle large-scale coordination of different utilities supported on or in a common structure or a One Call locator system to deliver sufficiently reliable and comprehensive markings of existing utilities, including in difficult areas such as old facilities with no current owner.
- DOTs have short time frames to deliver projects, and must be responsive to changing program priorities and budgets, political initiatives, and transportation commission preferences.
- Delayed coordination between the DOT and UCs results in ROW problems if initial design estimates were based largely on the DOT roadway project requirements without consultation with the UCs.
- UCs have inaccurate information on existing utilities because One Call locators have failed to provide sufficient timely information.
- UCs or construction contractors fail to meet schedule commitments, frequently because roadway construction and utility relocation are not synchronized. When one party changes the sequence of work or fails to meet schedule commitments, the entire work process is delayed.

Utility Company Challenges That Affect DOT Design and Construction

Investigators on the SHRP 2 R15 project found the following top issues faced by UCs that affect DOT design and construction:

- Limited financial and personnel resources,
- Difficulty coordinating with other utility agencies and government entities, and
- Utility companies' internal maintenance issues and needs for service upgrades and the priority demand on resources.

UCs' relocation resources are also strained by severe in-state or out-of-state weather events; UCs pledge to share resources to help each other respond to these emergencies. DOTs' increasing work programs and acceleration of critical projects also strain UC relocation resources.

Because DOT projects do not usually include utility relocation as an integral part of transportation design, UCs typically bear the responsibility for coordinating with DOTs after project plans are already 30% complete, planning and executing relocations, and coordinating with contractors.

DOT Utility Engineering Challenges That Affect Relocation Delays

Investigators on the SHRP 2 R15 project found the following top issues faced by state DOT utility engineers that affect relocation design:

- Short plan and design time frames;
- Project design changes requiring changes to utility relocation;
- Delays in obtaining utility ROWs;
- Inaccurate locating, marking, and mapping of existing utility facilities; and
- Limited UC resources for maintenance, service upgrades, and relocation that may not be adequate to meet the demands of DOT designs.

Conclusions and Recommendations

The R15 team of investigators believes the listed delay issues are systemic and indicate fundamental problems in DOT–UC coordination. Although the research team found individual examples of success, it also found nearly universal core deficiencies. To improve performance, DOTs and utilities need to resolve the fundamental issues. The research team identified strategies for management techniques, process structure, and application of technology. Successful implementation of the strategies will require the following initiatives:

1. **Operate as a team.** DOTs and UCs need to operate as a team, interacting and cooperating in a partnership with a commitment to common goals, continuous communication, and organizational leadership. All other coordination improvement initiatives depend on this key improvement.
2. **View utilities in highway ROWs as a DOT responsibility.** DOTs need to redefine their role to include being custodians of corridors that transport vehicles, people, power, communications, and other essential service to the public. As a unit of government, DOTs have a greater obligation than UCs to protect and provide for the interests of all citizens.
3. **Understand and learn the technology and business processes of the other half of the DOT and UC team.** Utility systems are complex; the highway design and construction process is multilayered. DOTs and UCs need to be able to speak the other's language and know how they do business.
4. **Improve location methods and mapping technologies.** The current utilities location process is inaccurate and insufficient. Improvements in location precision and comprehensiveness,

plus cost-efficient improvements, would significantly improve utility coordination. Complete and timely information is essential.

CHAPTER 1

Overview

State departments of transportation (DOTs) are responsible for efficient construction, maintenance, and operation of state highways for the benefit of the public. States extend the use of highway rights-of-way (ROWs) to utility companies (UCs) to save public resources and serve the public interest. As the costs of acquiring new ROWs continue to rise and current ROWs become more crowded, DOTs and UCs are striving to make maximum use of all available capacity in existing facilities and ROWs. The need for careful coordination between state DOTs and UCs in setting priorities and planning is obvious.

The second Strategic Highway Research Program (SHRP 2) Renewal Project R15 Phase 2 investigated the issues, opportunities, and barriers that DOTs and UCs face in coordinating and achieving their respective goals and priorities and identified four primary areas of focus:

- Strategies that utilities and the highway agencies can use to work together more cooperatively and reduce delays;
- Institutional barriers that impede implementation of strategies;
- Evaluation of strategies; and
- Framework for effective management in the project development process, a generically applicable process for using the strategies.

Costs to highway users and highway administration resulting from delayed road project completion are substantial, and the public bears most of those costs. State DOTs face increased pressure to deliver construction projects faster and more efficiently. Clearly, reducing construction project time provides substantial benefits. Shortening construction time minimizes the negative effects on motorists and local businesses. Road construction can seriously hurt adjacent businesses because traffic avoids work zones as much as possible to escape congestion and hazards associated with road work. For traffic that does travel through highway work zones, access to businesses can be difficult, such as elevation differences between existing travel lanes and newly constructed travel lanes.

Reducing the time to complete highway construction reduces traffic delays and associated costs, decreases the number of collisions and injuries construction causes, and lowers capital costs for maintaining traffic flow. Travelers generally accept construction projects and the inconveniences they cause as a fact of life; however, in California, road users clearly express their resentment about construction delays, and on at least one occasion, residents agreed to suffer harsher construction conditions over a shorter time rather than a long, drawn-out set of moderate impacts (*1*).

Time is a crucial yardstick for measuring the performance of construction contractors on highway projects. As a result, accelerated highway construction has emerged as a solution to major highway reconstruction with minimum delay and community disruption. The American Association of State Highway and Transportation Officials (AASHTO) Technology Implementation Working Group defines "accelerated construction" for planning as "a process to encourage the use of innovative technologies and techniques to accelerate the construction of major highway projects with extended service lives for the purpose of reducing user delay and community disruption" (*2*).

At the same time as the size and number of projects that state DOTs plan to construct annually have increased significantly, AASHTO and the National Cooperative Highway Research Program (NCHRP) have conducted significant research on project acceleration. The research shows that the result of accelerated highway construction and the volume of projects significantly challenges coordination between DOTs and UCs, slowing projects and increasing costs.

A report by the AASHTO Technology Implementation Working Group lists the following different techniques and technologies to foster DOT–UC collaboration, all of which require nontraditional implementation plans and actions extending across multiple phases and functional areas (*2*):

- Formal national and local information exchange processes on the application of new techniques and technologies to specific corridors and projects,
- Identification and communication of the new concepts applied in one project that may have general application, and
- Development of national guidelines and associated training materials on the application of innovative processes.

The committee expects these techniques and technologies to produce noticeably reduced construction times for major highway projects, reduce project life cycle costs, and improve service and safety during and after construction.

Construction Project Acceleration Milestones

October 1997

Federal Highway Administration (FHWA) and the National Asphalt Pavement Association (NAPA) conducted a workshop on improving safety, reducing delays, and minimizing disruption in highway construction and maintenance work areas. With representation from a broad cross section of the highway community, the workshop focused on the need for highway agencies and contractors to work together to achieve reductions in construction time and developed a set of action items to affect current practices.

February 1998

FHWA and the Transportation Research Board (TRB) organized a 4-day workshop during which teams of experts examined a specific urban freeway segment as a representative reconstruction project and developed innovative alternative approaches for pavement renewal aimed at reducing costs and delays to road users.

June 1998

Selected workshop participants met in a follow-up session to review preliminary cost estimates and drawings for the implementation of these approaches, prepared by Caltrans. Several states began making plans for similar workshops.

2002

TRB Task Force A5T60 held the first Accelerated Construction Workshops in Indiana and Pennsylvania.

2003–2006

FHWA and DOTs coordinated Accelerated Construction Technology Transfer workshops at most state DOTs (*3*).

Background

Recognizing the need to improve safety, reduce delays, and minimize disruptions caused by highway construction, FHWA and NAPA in 1997 conducted a workshop that focused on the need for highway agencies and contractors to work together to achieve reductions in construction time. The workshop produced a list of action items.

TRB joined the effort in 1998, and workshops focused on ways to expand the concept of accelerated construction. From the first Accelerated Construction Technology Transfer (ACTT) Workshops in Indiana and Pennsylvania in 2002, most state DOTs had held ACTT workshops by 2006.

In the past 10 years states have emphasized project and agency stewardship and accountability (financial and environmental) and increased efficiency by streamlining the complex DOT processes. An example is the Texas Transportation Commission. In 2001 the commission set a goal to streamline project delivery from conception to ribbon cutting. The result was a 15% decrease in time to complete projects in a 5-year span (*4*).

Factors Influencing Delays

Several relocation factors have raised the stakes for state DOTs and utilities over the past decade:

- DOT construction letting volumes have been rising, more than doubling over the past decade in some states. Likewise, the number of utility adjustments per year has increased. In some states, the number of reimbursable adjustments per year has tripled.
- State DOTs are reacting to accelerated construction with increased interest in compressing relocation schedules.
- Overhead utility lines are becoming a thing of the past except in rural areas, and underground space in corridors is becoming more congested; the urban underground increasingly resembles a spiderweb of utility lines—phones, electricity, gas, cable television, fiber optics, traffic signals, street lighting circuits, drainage and flood control facilities, water mains, and wastewater pipes. The deregulation of utility services is adding to the problem because multiple service providers seek to place their networks underground.
- Recent consolidation in the utility industry makes addressing concerns at the state level more difficult when utilities are structured regionally and nationally.
- Utility asset relocation during construction has become increasingly complex.
- When utility relocation problems occur during a project construction phase, they cause contractors major concerns. Many relocation problems result from a breakdown in communications and a lack of a timely coordination of the right parties, especially early in the project development process, but also during construction.

Current practices and strategies in many states are inadequate to address these problems. Although many excellent working relationships have been built over the years, coordination, knowledge, and tools still fall short. Many DOT design engineers do not know how much time is required for relocations. With the loss of experienced personnel to retirement and turnover at DOTs, the lack of knowledge could be exacerbated unless DOTs provide training and foster comprehensive understanding of the factors involved in utility relocations.

Project Objectives

The FHWA/TRB Research and Technology Coordinating Committee noted that "achieving dramatic reductions in highway construction project times requires a broader, more comprehensive approach to the problem than looking for marginal improvements in existing techniques" (*5*). Gains are likely to require improved coordination and cooperation in multiple areas, across multiple phases. This is particularly true for DOT–UC coordination.

To reduce the number of time delays and achieve cost savings on construction projects, DOTs and UCs need a deeper knowledge of the risks and opportunities. Coordination between DOTs and UCs and the procedures needed to manage the collaboration can be complex.

As Hamilton and Gibson noted, decisions made early in a project can have large effects on the risks encountered and the cost and duration of the projects, and such decisions should therefore be made carefully so as not to foreclose any opportunities to include innovations and advanced technologies that could ultimately lead to lower project costs and reduced project times (*6*).

Both DOTs and utilities have clear goals in their road construction projects: save time and money and avoid problems and delays. These goals can be accomplished by identifying and implementing strategies to integrate their highway renewal project priorities. Recognizing the critical importance of utility issues to the SHRP 2 Renewal Program, the Technical Coordinating Committee (TCC) initiated Project R15: *Strategies for Integrating Utility and Transportation Agency Priorities in Highway Renewal Projects.* This report summarizes the SHRP 2 Project R15 concerning the issues, opportunities, and barriers that DOTs and UCs face in coordinating and achieving their goals and priorities.

References

1. Coopers & Lybrand, LLP Opinion Research Corporation. National Highway User Survey, 1997. Prepared for the National Quality Initiative Steering Committee. Cited in *Dramatically Reducing Highway Construction Project Times: Suggestions for Research,* TRB, National Research Council, Research and Technology Coordinating Committee (FHWA), Washington, D.C., 1998, p. 2. ops.fhwa.dot.gov/wz/docs/m21_redu.pdf.
2. Technology Implementation Group. *Accelerated Construction Technology Transfer*. AASHTO, Washington, D.C., March 2006. tig.transportation.org/?siteid=57&pageid=695. Accessed Aug. 30, 2007.
3. *Focus: Accelerating Infrastructure Renovations.* FHWA, U.S. Department of Transportation, Aug. 2002.
4. Texas Transportation Commission 2001 Meetings, Texas Department of Transportation. 2001. http://www.txdot.state.tx.us/transcom/default.htm?pg=meet01
5. Research and Technology Coordinating Committee (FHWA). *Dramatically Reducing Highway Construction Project Times: Suggestions for Research,* TRB, National Research Council, Washington, D.C., 1998.
6. Hamilton, M. R., and G. E. Gibson, Jr. Benchmarking Preproject-Planning Effort. *ASCE Journal of Management in Engineering,* Vol. 12, No. 2, 1996, pp. 25–33.

CHAPTER 2

Research Approach

The research methodology in this study included the following specific tasks:

- **Task 1:** Identify institutional issues and processes pertaining to utility asset relocation that cause or contribute to delays in planning, designing, or constructing highway renewal projects and identify barriers that apparently prohibit or inhibit potentially effective remedies.
- **Task 2:** From organizations, both public and private, that have proven innovative and effective in managing utility asset relocation issues, gather insights and details about policies, practices, procedures, and techniques that mitigate the sources of delay identified in Task 1. Produce a Summary Report on the findings of Tasks 1 and 2.
- **Task 3:** Develop a prospective generic strategy from an analysis of the findings of Tasks 1 and 2 using current best practices and suggested innovations to mitigate or eliminate causes of delay.
- **Task 4:** Develop a plan for evaluation of these strategies that could include their application to actual pilot renewal projects.
- **Task 5:** Produce a Draft Final Report documenting the work conducted in Tasks 1 to 4. Following review, submit a Final Report.

In the first phase of the project, researchers conducted a detailed survey of all published—print and web—information to provide the necessary background for the next step, which was to conduct structured interviews with department of transportation (DOT) and utility company (UC) relocation engineers and coordinators. An analysis of the interviews yielded a list of the most common coordination problems faced by DOTs and UCs. The researchers also obtained examples of best practices from the interviews, and a synthesis of the common problems and best practices produced a preliminary set of recommended best practices. Researchers then sought experienced industry professionals to put the issues in perspective and established an industry volunteer team. Chapter 3 includes summaries of the information collected and strategies for improvement. Chapter 4 includes a plan for industry evaluation of the preliminary strategies.

Literature Review

The research team conducted a comprehensive search for information on institutional issues and processes contributing to utility-related delays in planning, design, and construction of highway renewal projects. The purpose of the literature review was mainly for background information and to ensure up-to-date familiarity with different innovative techniques and potential streamlining opportunities.

The review included compilations from all areas of government, including FHWA, the AASHTO Highway Committee on Right-of-Way (ROW), DOT manuals, conference proceedings, brochures, teleconferences, periodicals, and other resources. It also included technical reports, published and unpublished articles, studies, presentations, industry journals, Internet sources, periodicals, and the following additional sources:

- Utility industry guidebooks and literature;
- TRB and Transportation Research in Progress databases;
- International literature on utility relocations;
- Presentations at AASHTO utility and ROW meetings;
- Utility relocation-related presentations at other AASHTO meetings;
- Studies engaged and resources developed by state transportation agencies and DOT–utility partnering groups;
- DOT–utility accommodation policies and coordination guidance (plus evaluation of how these have evolved);
- Industry papers and presentations;
- AASHTO ROW committee surveys on utility relocations;
- DOT conferences, presentations, and white papers on utility relocation issues; and
- DOT handbooks, guides, and manuals.

Researchers also used the literature review for the following purposes:

- To develop the annotated bibliography contained in Appendix A;
- To comprehensively identify issues and strategies (practices) and cross-reference the information on institutional issues, strategies, and barriers to utility relocation for transportation projects; and
- To provide information for question development before the focus interviews. Interview questions were developed for DOT utility engineers and utility industry relocation engineers.

The literature review focused on utility conflicts, effects, and problem sources that DOTs and UCs commonly cite as institutional barriers and strategies to surmount those barriers and problems. Researchers also looked for methods in use to avoid and mitigate utility delays, including guidebooks developed by DOT–utility coordination committees, DOTs, and UCs. The information sought also included prospective and in-use technological tools. Researchers requested information from each state.

The research team reviewed 27 DOT utility manuals, which generally provide the process and rules for utility use of DOT ROWs. Some manuals also specifically address construction coordination issues. (See Tables 1, 2, and 3 in chapter 3 for a process overview of the states that were examined in detail.) In general, the manuals addressed the following subjects:

- Procedures for utilities to obtain access to DOT ROW (application, permits, computer-aided design submission requirements),
- Lease provisions,
- Utility obligations when relocation is required, and
- Guidance for DOT managers and engineers on managing utility coordination.

These documents defined when relocation is required, gave background on the regulatory and procedural structure for utility relocations in the states, and described the roles and responsibilities of DOTs and utilities for initial occupancy of ROWs. Critical issues include permitting requirements, management of location information, engineering for relocation, and reimbursement. Reimbursement is addressed in accommodation agreements and, in some cases, state statutes.

Survey of DOTs and Utilities

To grasp the nuances of the problems, issues, barriers, and practices that affect DOT–UC coordination, the research team conducted in-depth interviews with DOT utility engineers and industry utility relocation coordinators. A quantitative survey and interview guide for open-ended questions was built from professional insights of team members, utility contacts, and DOT utility engineers, plus information from the literature review. SHRP 2 and the Technical Coordinating Committee (TCC) reviewed the interview guides.

State DOT Utility Engineers

Researchers sent personal e-mails to state DOT utility engineers seeking information because they are most familiar with the issues and processes associated with utility relocation. This simple, short initial contact minimized time and inconvenience for recipients while efficiently gathering data. The e-mail explained the purpose of the study and sought opinions on the issues, processes, and barriers most often responsible for utility relocation delays. The e-mails sought the following information:

- Feedback on utility relocation issues and strategies on how to avoid and minimize delays in planning, design, and construction;
- Critical institutional processes and factors in DOT–utility coordination that affect delays, interests, and priorities; and
- Barriers to effective change.

Specifically, researchers asked for the following information:

- Resources used or developed—written policies and procedures on DOT–utility coordination and conflict resolution;
- Utility industry contacts—names of utility company contacts and others in the organization who might provide information;
- Descriptions of successful DOT–utility efforts to avoid or minimize utility-related delays and integrate utility and DOT priorities into transportation renewal projects; and
- A time when the research team could conduct an interview.

The researchers also indicated a need for information on constraints, factors in success, institutional issues in implementing changes, and cost-effectiveness and solicited additional useful questions to include in the interviews.

From these initial contacts, the researchers received 11 volunteers to discuss issues, barriers, and best practices, and ultimately they held discussions with contacts from 22 DOTs. The interviews focused on 16 DOTs, many with the most advanced programs, to obtain in-depth information. Researchers interviewed at least one utility engineer from each DOT, typically the state utility engineer, and any other contacts he or she recommended or included. These in-depth interviews lasted up to 2 hours each and sometimes involved follow-up.

DOT utility engineers from the following states provided in-depth information about their state processes, obstacles, and practices:

- Alabama DOT
- Arizona DOT
- California DOT (Caltrans)
- Colorado DOT
- Delaware DOT
- Indiana DOT
- Michigan DOT
- New York State DOT
- North Carolina DOT
- Oregon DOT
- Pennsylvania DOT
- South Carolina DOT
- Tennessee DOT
- Virginia DOT
- Washington State DOT
- Wisconsin DOT

Utilities Representatives

Interviews with utilities and utility company representatives of DOT–utility coordinating committees were central to gaining an understanding of the issues. Members of the Florida Utility Coordinating Committee and state DOT utility engineers identified potential interviewees in the utility industry, and TCC members also gave recommendations.

Utility companies provided 13 contacts from the following organizations to give information about their processes with state DOTs, their needs, obstacles, and practices:

- Florida: Hillsborough County Progress Energy
- Georgia: Utility Support System
- Indiana: Vectren
- North Carolina: Progress Energy Charlotte-Mecklenburg Utility Department
- Oregon: Northwest Natural Gas Company
- Pennsylvania: First Energy Corporation UGI Verizon
- Tennessee: MLGW
- Wisconsin: Alliant Energy

Utility Coordinating Groups

Many states have DOT–industry groups that are working together on utility issues. These groups are closely aligned with the objectives of the SHRP 2 R15 research effort, and a number of DOT–utility coordinating committees have invested significant resources into understanding and documenting current processes. Some committees have made significant progress in identifying and addressing the institutional issues and processes involved in utility asset relocation that cause or contribute to delays in planning, designing, or constructing highway renewal projects. In some cases, coordinating groups have developed or reviewed resources outlining new policies or procedures to address areas that historically presented primary barriers.

These groups have developed some of the following resources:

- Flow diagrams for process steps,
- Manuals,
- Checklists,
- Lists of identified responsibilities,
- Technical advisory committees to address issues, and
- Training.

The research team attended the annual meetings of the Florida Utility Coordinating Committee, conducted interviews with members, and made a presentation on the research effort to the membership.

Best Practices Research

In Task 2, the ICF–University of Florida research team identified insights and innovative and effective practices, policies, procedures, and techniques for mitigating sources of utility relocation delays. The researchers consulted public and private organizations known for innovative and effective practice in managing utility asset relocation issues. Through detailed interviews conducted in Task 1, the research team developed an understanding of the policies, practices, procedures, and techniques in use and obtained written procedures and policies.

Then the researchers identified factors in success, institutional processes, supporting tools, and the contextual framework in which the innovation was applied, including relevant contractual, organizational, and regulatory environmental factors. The research team also looked at shortfalls of approaches and gathered the following standard information:

- Policies and procedures in place,
- Practices and techniques used,
- Factors in success (particularly institutional processes and supporting tools),
- Changes sought and implemented,
- How changes were achieved and implemented (with implementation insights and recommendations),
- Contextual framework (organizational, contractual, and regulatory environment),
- Constraints and shortfalls,
- Cost-effectiveness,
- Benefit to the public, and
- Practice-specific questions.

Analysis and Evaluation

The researchers analyzed the information gathered in Tasks 1 and 2 to determine the root causes of utility delays and organized a panel of industry representatives to provide review and feedback and develop a core toolbox including implementation requirements, barriers, solutions, management issues, examples, and evaluation considerations.

The information obtained in Task 2 provided the following knowledge:

- Understanding of the utility relocation process and its variations as practiced in different states,
- Determination of problem areas and preliminary identification of the root causes, and
- Identification of best practices.

The researchers identified core principles that are the foundation for the successes found in Task 2. In Task 3, the researchers developed and refined strategies for applying the best practices, identified in Tasks 1 and 2, to mitigate or eliminate causes of delay. Such practices or innovations include model agreements, schedules and coordination points, partnering arrangements, training programs, and certification programs for professionals involved in utility asset relocation. The analysis included barriers to the implementation of the practices and suggested innovations.

The purpose of Task 4 was to outline a framework for evaluating the potential benefit and feasibility of the strategies developed in Task 3. Researchers identified potential evaluation factors for each of the recommended practices. Because the organizations involved in DOT–utility coordination are the appropriate evaluators of the strategies, the research team sought feedback on practices and submitted the recommended strategies and the feedback form to all state DOTs. The effort was coordinated and refined with the SHRP 2 project manager.

DOTs were asked to get feedback from utilities in their states on practices and evaluation. The researchers also sought input from some representative construction contractors. For example, Ginger Adams, a nationally known value analysis specialist with experience in working on DOT–utility coordination issues, contributed to design of an evaluation tool, tailored to each practice.

The input of experienced industry professionals from state DOTs and UCs was critical to providing a quality research product for this study. In the first phases of the study, researchers conducted structured interviews with DOT and UC coordinating engineers to understand the significant utility coordination problems and gain insights into best practices. The researchers then formed a volunteer industry team of nine DOT members and eight UC members from the previously interviewed group of DOT and UC experts. SHRP 2 approved the volunteer membership. The industry review team reviewed research summaries and recommended practices, participating in their identification and expansion through a series of e-mail contacts and, in some cases, phone requests.

The research team developed and refined the strategies in concert with this group of industry experts, providing them with background information, identifying best practices and preliminary strategies at repeated intervals throughout the process, and soliciting and incorporating their feedback. The researchers asked DOTs (in turn, coordinating with utility companies in their states) about interest in implementing strategies and participating in evaluation pilots. Few DOTs expressed interest, although the research team continues to follow up with those that did. Suggested evaluation factors or measures of effectiveness for each strategy are included in the best practices in Appendix B.

CHAPTER 3

Findings and Applications

The underlying basis for state department of transportation (DOT) utility accommodation within highway rights-of-way (ROWs) (23 CFR 645.205) is from the finding by the Federal Highway Administration that it is in the public interest for utility facilities to be accommodated on the ROW of federal aid or direct federal highway projects, provided certain conditions are met. This finding, issued by the administrator, is the prerequisite for permitting nonhighway use of the ROW on federal aid or direct federal highway projects.

Each state is required to control utility use in ROWs on federal aid projects to preserve the operational safety and the function and aesthetic quality of the highway facility [FHWA 23 CFR 645.205(c)]. States have the authority to develop their own policies and practices, and each state operates under a utility accommodation policy that has been approved by the FHWA. States can decide which utilities to allow in the ROWs, permitting some and excluding others, and they can determine permitting requirements, fees, and relocation obligations.

ROW Accommodation Policies

Permitting Policies

State representatives who were interviewed by the research team said the agency in their state requires that utilities apply for and obtain a permit to place utilities in a highway ROW. The permitting process varies from state to state, but the basic procedures typically involve submission of an application package that includes engineering drawings of the proposed installation. Many states, however, do not require inspection or certification to determine whether the facilities were installed according to the engineered drawings.

The process of ROW acquisition is a cornerstone of the project development process. Utilities are particularly interested in the status of ROW space acquisition and its direct effect on their utility permit request. Some states have developed an information management system to support permitting, track acquisition process and property management, and show when property owners have been contacted and when the parcel is needed for utility relocation.

Relocation and Reimbursement Policies

All state accommodation policies reviewed by the research team require utility companies (UCs) to relocate utility facilities if the facilities conflict with transportation renewal projects. A few state policies request that project designers attempt to minimize utility relocations. Most state policies provide general guidance on the relocation process, and some policies provide specific guidance on timing requirements to meet certain schedule targets.

Reimbursement is a distinguishing issue among state accommodation policies. Some states provide blanket reimbursement for all utility relocations. Others provide reimbursement only under certain circumstances, such as when the utility has prior rights to the ROW. In most states, reimbursement is a legal issue, rather than a coordination issue; however, a few states are using reimbursement as a tool to facilitate relocation.

It is noteworthy that federal aid funds can be used for utility relocation costs to the extent that the state is obligated for reimbursement. Table 1 summarizes the reimbursement policies for a representative number of states.

Right-of-Way Acquisition Policies

FHWA guidance provides that ROWs must be devoted exclusively to public highway purposes. FHWA has formally found that utility accommodation in the ROW is in the public interest. Implicit in the public interest finding is that adequate space must be available to locate utilities in a manner that does not interfere with the safe and efficient operation of the highway. This is not always the case. Currently, federal funds

Reimbursement Policy	AL	AZ	CA	CO	DE	FL	GA	IN	MI	NY	NC	TN
Reimbursable: Utility on private ROW	✔		✔	✔	✔			✔	✔	✔		
Reimbursable: Facilities owned by governmental subdivision of state (municipalities)				✔	✔		✔	✔	✔	✔		
Reimbursable: Interstate projects	✔							✔		✔		
Reimbursable: All projects (DOT purchases necessary permanent utility easements)	✔				✔						✔	
Reimbursable: Federal aid projects, if the gross receipts of the utility involved are less than $75 million annually	✔						✔					
Reimbursable: State projects, if the utility involved is certified by the DOT's external audit section to be a "pauper"	✔			✔					✔	✔		
Reimbursable: Facilities exist to serve a highway purpose (e.g., rest stop)				✔					✔			
Reimbursable: All projects, if following requirements are met: (1) the utility must submit relocation plans in accordance with TCA 54-5-854 within 120–165 days; (2) the utility must have permissive rights to be on public ROW; (3) the utility executes a contract for reimbursement and (a) moves before the specified date, or (b) includes the utility relocation in the state contract				✔								✔
Reimbursable: Expected that utility will incur "extraordinary costs"				✔				✔				✔
Reimbursable: Relocation of service facilities that are customer-owned may be eligible for reimbursement				✔				✔				✔
Reimbursable: Utility holds "prior rights"			✔		✔		✔		✔			
Reimbursable: DOT requires a second relocation of the same facility within 10 years of initial move			✔		✔							
Reimbursable: DOT changes design or plan of construction before project completion, requiring additional relocating					✔				✔			✔
Reimbursable: DOT requests a temporary alteration or relocation of the nongovernmental public utility facility					✔							
Reimbursable: DOT cancels or does not start a relocation project within 2 years of authorizing utility work			✔		✔							

Table 1. State Utility Relocation Reimbursement Policies

cannot be used to acquire ROWs exclusively for utility accommodation; however, when a state routinely dedicates a portion of the ROW for utility use, that portion of the ROW would be eligible for federal fund reimbursement.

Often space is a critical issue. The application of the policies on permitting and relocation and reimbursement sometimes sparks controversy between states and utility organizations. Aerial systems are particularly problematic. For example, distribution poles may be relocated to the outside edge of the ROW. Theoretically, the DOT is accommodating the electrical distribution utility; however, the proposed new location may cause mandatory clearance problems with existing structures outside of the ROW, forcing the utility to acquire additional ROW or to compensate property owners for the relocation of structures. Table 2 provides a summary of the ROW acquisition policies for a representative number of states.

DOT–Utility Coordination Processes

Coordination Processes in Planning and Design Phases

Until DOTs reach the 25% to 30% design completion stage, they often believe they have little to provide the utility company. DOTs try to get utilities involved as early as possible. For example, a progressive DOT may designate all overhead and underground utilities at the 15% design stage. At the 30% stage, the state DOT's design plans are distributed to all utilities, and the utilities are asked to start looking for conflicts. DOT designers generally know that they need to contact utilities during the design process to obtain location information; however, the timing of this contact and its format vary substantially.

ROW Policy	AL	CA	CO	GA	MI	NC	OR	TN
Utility relocation work done in public ROW; acquired by DOT	✔	✔		✔	✔			✔
DOT purchases necessary permanent utility easements.	✔	✔				✔		✔
DOT may, if a utility requests, acquire utility ROW and easements in conjunction with DOT ROW acquisition with proper coordination and scheduling; cost responsibility for this service is based on prior rights.	✔	✔			✔	✔	✔	
DOT acquires ROW for a reimbursable utility; the rights and title are vested in the DOT.	✔							
If a utility facility is located on the owner's private ROW, the DOT may find it in the public interest to reestablish the facility on the utility's ROW (rather than on the public ROW); the utility may, with prior DOT approval, purchase replacement ROW.	✔				✔			
All free-owned property is acquired by ROW contract and deed; terms of the ROW contract depend on whether the property is vacant or improved, and whether it is a site or a corridor.	✔	✔						
Utility-occupied easements are usually for transmission or distribution of the owner's product; if a replacement ROW is needed, the state or the owner may acquire an easement.	✔	✔			✔			
Except as noted below, the state is not obligated to provide a replacement ROW for utility facilities installed under a franchise or permit.	✔	✔			✔			
If the utility owner has superior occupancy rights, the state can acquire the needed replacement right of way.	✔	✔			✔			
The DOT may acquire a replacement property interest for the utility or reimburse the utility for the reasonable cost of acquiring its own replacement interest; the reasonableness is determined by the department, after consultation with the utility.	✔		✔		✔			
Where it is not necessary because of the type of transportation project to relocate the utility's facilities, DOT may enter into a common use agreement or other type of agreement with the utility that allows the utility's property interest to exist within state highway ROW.	✔		✔		✔			
If the relocation of a utility's facilities is necessitated by a transportation project and the utility elects to relocate its facilities in the state highway ROW, DOT may enter into a common use agreement or a utility permit that allows reimbursement for future relocations of the utility's facilities if the utility vacates its property interest in the state highway ROW.	✔		✔					
If the utility must relocate in the state highway ROW and if a replacement interest is not acquired, the utility may be justly compensated to the extent allowable in accordance with eminent domain law and precedent for the value of its real property interest.	✔		✔					

Table 2. State Utility ROW Policies

Initial contact most often occurs around the 30% design stage, at which point utilities are formally advised of the project and the intended alignment and asked to locate their facilities on the site. Most DOTs use state One Call systems to obtain field marking. The DOT then surveys utilities in the field, using the One Call markings. Surveyed location information is entered into the design, and the DOT designers proceed with developing the design. At approximately the 60% stage, when preliminary drawings are available, most DOTs send preliminary drawings to the utility and request the UC to identify conflicts and design any required relocations. The UC responds by redline marking of the DOT's design drawings. Sometimes the DOT will do the relocation design for the UC; sometimes the UC uses a consultant to do the design, or the UC does its own relocation design.

In many cases, the utility engineer and the DOT design engineer never meet; the communication between the DOT and the UC is completed electronically and by mail. The quality and timing of the required communication varies, depending largely on the initiative of the individual designer. Some DOTs conduct sit-down, face-to-face meetings with the utility at key design milestones to actively seek UC input and encourage greater connection and more assured communication and responsiveness.

Utility companies start design before or after the 60% design stage, depending on the need for pot-holing data (vertical locates). At that time, DOTs also ask the UCs to present documentation for prior rights. The design consultant reviews the utility's redesign plans of UC facilities to ensure there are no outstanding conflicts with the planned transportation improvement. The DOT prepares a relocation contract if

there are prior rights. UCs receive authorization to start their work with the contract, or before, if the schedule is tight. UCs notify the DOT when they will complete their work, which becomes part of the clearance letter and the bidding documents. That scenario, however, is not always the case. One UC said the DOT does not provide notification of the project until the 60% to 80% design stage. Earlier involvement is more common on large projects. DOTs often involve UCs later on smaller projects, including National Environmental Policy Act categorical exclusions projects, which comprise the bulk of DOTs' highway renewal work. Involving utilities at such a late stage in the project can hinder relocation later.

The DOT design development process is focused on solving a transportation need. Problems may lie in the weak structure of the coordination process; the transportation design proceeds for the most part without input from the utilities. The transportation project is designed on the premise that utilities can and will be relocated if a conflict exists. Designing to *avoid* utility conflicts is the exception rather than the rule. However, some UCs report that some states and project engineers are "very good at including our representatives on the project team. . . . We are able to remain in the loop and to participate in decisions as needed." Table 3 summarizes the coordination processes used by a representative number of DOTs.

Coordination Processes in Construction Phase

Uniformly, DOTs invite UCs to attend project preconstruction meetings. Separate utility preconstruction meetings are also held on projects with significant utility issues. Utilities rarely attend project partnering workshops. A utility relocation schedule usually is developed during the design phase. Utility representatives also are invited to attend project progress meetings during the period in which they are involved with the project; however, coordination often requires more than a weekly meeting—daily communication is needed. Utilities generally assign a relocation engineer/project manager and a superintendent to each project. In most states, the DOT project engineer has responsibility for utility coordination, but in some states, the contractor is given that responsibility. In other situations, the DOT may use a consultant to provide utility coordination during construction.

When project conditions permit, some DOTs can achieve utility relocation before the start of construction. This, of course, eliminates coordination issues during construction. Relocation before construction requires accomplishment of the following tasks:

- Advance approval from the utility relocation engineer,
- Acquired ROW, and
- Cleared ROW (if required).

Coordination issues during construction include the following complications:

- UC compliance with relocation schedules,
- Contractor changes in planned work schedules, and
- Resolution of previously unknown utility conflicts.

Reimbursement, if used, provides additional administrative requirements for both the DOT and the UC. Generally, reimbursement requires that cost records of the utility relocation be recorded and documented, which places an additional record-keeping and verification burden on the project managers.

Critical Issues

Results of Interview Surveys

Table 4 summarizes the results of the telephone interviews with utility relocation engineers. From the utility viewpoint, many of the same issues in the following list affect both design and construction:

- Limited financial and personnel resources,
- Coordination with other utility agencies in the same proximity and government entities,
- Internal maintenance issues, and
- Internal service upgrades.

Further explanation by utility engineers revealed the following factors that strain their relocation resources:

- Severe weather events can strain resources. Even events out of state can drain resources because of resource-sharing agreements across state lines.
- DOT's increasing work program and acceleration of critical projects strain resources.
- Utility relocation is not an integral part of transportation design. On the construction end, coordination with contractors is a problem.

Table 5 shows the following five most frequent issues causing relocation delays in design, as cited by DOT utility engineers in telephone interviews:

1. Short time frame for states to plan and design project,
2. Project design changes required changes to utility relocation,
3. Delays in obtaining ROW for utility relocation,
4. Inaccurate locating and marking of existing utility facilities, and
5. Utility companies giving low priority to relocations.

The first three issues are directly within the DOT's work processes. Issues 4 and 5 are more directly related to the utility's

Process	Sub-process	AL	AZ	CA	CO	DE	FL	GA	IN	MI	NY	NC	OR	PA	SC	TN	WA	WI
Long-range plan and communication with UCs		✔			✔	✔	✔	✔		✔		✔		✔				
Utility coordinating committee					✔		✔	✔				✔	✔		✔		✔	
Utilize joint-use agreements		✔		✔	✔	✔		✔								✔		
Training program for project design engineers on utility relocations				✔	✔			✔						✔				
Statewide utility mapping system												✔		✔		✔		
Identify utilities in conflict (percent design stage)	30%, 60%, or 90% design stage	30	30		30	30	30	30	30	60	30	30	30	30	60	30	30	30
Location information from utilities (percent design stage)	30%, 60%, or 90% design stage	30	30		30	30	30	30	30	30	30	30	30	30	60	30	30	30
Utilities begin relocation design (percent design stage)	30%, 60%, or 90% design stage	60	60	30	60	30	60	60	60	90	60	30	60	60	60		60	60
Use of One Call system		✔			✔	✔	✔		✔		✔	✔	✔	✔	✔	✔	✔	
Conduct field survey		✔		✔					✔		✔		✔	✔		✔		
Use of SUE		✔			✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Utility coordination meeting		✔	✔	✔		✔	✔	✔	✔	✔		✔	✔	✔		✔	✔	✔
Provide UC contact list		✔	✔			✔			✔				✔	✔		✔	✔	✔
Outsource relocation design	UC can use design consultants	✔	✔	✔	✔	✔		✔		✔				✔		✔		
	DOT can act as UC's design consultant			✔	✔					✔		✔		✔				
Preconstruction meeting		✔	✔	✔	✔	✔	✔	✔	✔	✔			✔	✔	✔	✔	✔	✔
Utility preconstruction meeting		✔				✔		✔					✔	✔			✔	
Partnering meetings		✔				✔				✔		✔	✔	✔				
Relocation work performed before construction, when feasible		✔		✔	✔	✔			✔	✔	✔		✔	✔		✔		✔
Relocation work	UC performs relocation	✔	✔	✔	✔	✔		✔	✔	✔	✔	✔		✔		✔	✔	
	Use of sub-contractors	✔	✔	✔	✔	✔		✔	✔	✔	✔	✔		✔		✔	✔	
	Use of DOT's contractors	✔	✔	✔	✔	✔		✔	✔	✔	✔	✔		✔		✔	✔	
Field conflict resolution process				✔				✔					✔					
Postconstruction meeting													✔					
Process for unexpected utility conflicts during construction				✔	✔													
As-built requirements	Provided by UCs	✔														✔		
Design–build contracts																		

Table 3. DOT Coordination Processes

Phase	Frequency Ranking	Issue	Very Frequently	Frequently	Some-times	Rarely	Never	Score
Design	1	Limited financial and personnel resources	1	3	1	2	0	17
	2	Utility relocation not an integral part of design	3	0	0	0	0	12
	3	Coordination with other utility agencies in the same proximity or government entities	0	4	0	1	1	12
	4	Maintenance issues (internal)	0	0	4	3	0	11
	5	Service upgrades (internal)	0	0	3	4	0	10
	6	New customer demand (internal)	0	1	2	3	1	9
	7	System improvements (internal)	0	1	2	3	1	9
	8	Changes to DOT design or schedule	0	2	0	0	0	6
	9	Large turnover at DOT	0	1	1	0	0	5
	10	Acquiring ROW reimbursements	0	1	0	0	0	3
	11	Involving utilities late in design phase	0	1	0	0	0	3
	12	Ease of exchanging drawing files electronically	0	1	0	0	0	3
	13	Lack of communication between DOT and UC	0	1	0	0	0	3
	14	Development and predictability of overall project plan	0	1	0	0	0	3
	15	UC given too many projects at once	0	1	0	0	0	3
	16	DOT does not follow its own procedures	0	0	1	0	0	2
Construction	1	Limited financial and personnel resources	1	3	1	2	0	17
	2	Coordination with contractor to establish project plan to avoid relocating more than once for the same project	1	0	4	1	0	13
	3	Coordination with other utility agencies in the same proximity and government entities	0	4	0	1	1	12
	4	Maintenance issues (internal)	0	0	4	3	0	11
	5	Service upgrades (internal)	0	0	3	4	0	10
	6	New customer demand (internal)	0	1	2	3	1	9
	7	System improvements (internal)	0	1	2	3	1	9
	8	Contractor not following specified work plan	0	2	0	0	0	6
	9	Lack of coordination between DOT and contractor	0	0	3	0	0	6
	10	Utility relocation not an integral part of contractor's work plan	1	0	0	0	0	4
	11	Material shortages	0	1	0	0	0	3
	12	Insufficient notice given to schedule the relocation	0	1	0	0	0	3
	13	Unable to relocate before construction begins	0	1	0	0	0	3
	14	Natural disasters such as hurricanes	0	0	1	0	0	2
	15	Rework required	0	0	0	1	0	1

Table 4. Primary Reasons for Delay Cited by UCs

Phase	Ranking	Issue	Very Frequently	Frequently	Some-times	Rarely	Never	Score
Design/ Planning	1	Short time frame for states to plan and design project	1	3	6	1		26
	2	Project design changes required changes to utility relocation	3		6	2		26
	3	Delays in obtaining rights-of-way for utility	1	2	5	3		23
	4	Inaccurate locating and marking of existing utility facilities	1	1	4	5		20
	5	UCs give low priority to relocations		2	6	2		20
	6	Obtaining accurate design plans early in design phase		5				15
	7	Obtaining environmental permits		2	3	1		13
	8	Identifying utilities late in the design process		3	1			11
	9	No utility coordination meeting held			2			4
	10	Hazardous waste issues			1	1		3
	11	Disagreements between DOT and UC on engineering solution		1				3
	12	High internal turnover at the DOT, personnel shortage		1				3
	13	Miscommunication between the design and construction teams in the UC			1			2
	14	Poor design of utility work plan			1			2
	15	UCs merging, relocating, or downsizing			1			2
	16	Utility relocation costs not given proper weight in selecting preferred design			1			2
Construction	1	Increased workload on utility relocation crews due to increase in highway and bridge construction		7	3	1		28
	2	Utility lacked financial and personnel resources to execute relocation	1	4	5	1		27
	3	Inadequate coordination or sequencing among utilities using common poles and ducts		4	3	4		22
	4	UCs give low priority to relocations		2	6	2		20
	5	Phasing of construction and utility relocation work out of sequence		1	6	4		19
	6	Delays in starting utility relocation work because utilities will not start until construction contract is advertised or let	2	2	1	4	2	18
	7	Utilities are slow to respond to contractor's request to locate and mark underground utilities		1	2	6	2	11
	8	Material shortage		1	2			7
	9	Natural disasters such as hurricanes			3			6
	10	Shortages of labor and equipment for contractor			2	5	4	5
	11	UC didn't follow own work plan (wrong location, schedule, additional work)			1			2
	12	UCs merging, relocating, or downsizing			1			2
	13	Inexperienced people involved on project			1			2
	14	Union labor issues				1		1

Table 5. Primary Reasons for Delay Cited by DOTs

work processes. DOTs cited the following factors in these issues:

- Increased workload on utility relocation crews due to an increase in highway and bridge construction,
- Utility's lack of financial and personnel resources to execute relocation,
- Inadequate coordination or sequencing among utilities using common poles and ducts,
- Utility companies giving low priority to relocations, and
- Phasing of construction and utility relocation work out of sequence.

Typical input from utilities can be summed up as "increased transportation workload" and "limited utility resources to respond." It is not surprising that utilities do not agree with the fourth bulleted factor. UCs unanimously report giving relocations a high priority; however, the contrasting opinions demonstrate that communication could improve.

Another remarkable aspect of the DOT and utility issues list is the high number of different issues that affect utility relocations. Clearly, this is a complex process affected by communication, work processes, organization structures, resource limitations, and relationships.

Utilities also listed "inadequate coordination" as a frequent problem. Both DOTs and utilities reported lack of sufficient communication, scheduling, and coordination in the planning, ROW acquisition, design, and construction phases of road construction projects, in turn inhibiting the timely relocation of utilities. UCs need a place to relocate (on the roadway or private ROW) and sufficient time to move. Advanced UC planning is needed for buying supplies and possible ROW, and customer contracts often require a significant lead time. UCs need transportation agencies at all levels of government to recognize this early coordination responsibility, particularly for major utility relocations. Consultants, as extensions of DOT staff, also need to do more early coordination.

Preliminary Strategies for Improving DOT-UC Coordination

The researchers' interviews uncovered a number of issues and strategies (listed below) from the perspective of both UCs and DOTs. In almost all issues identified, increased communication, knowledge, and understanding would help alleviate or prevent the problems; indeed, in some problem areas, the only identified solution is communication, knowledge, and understanding. Such areas include the large turnover rates at the DOTs and UCs and late design changes that, in turn, may affect relocation design and schedule.

While coordination meetings and data sharing (resolving compatibility issues) have addressed these problems and needs, more support is needed to encourage the necessary cooperation. Some entities are achieving this through training, whether internal to DOTs and their consultants and contractors, as in the example of Georgia DOT, or by the UC, as in the example of Verizon. A next step is integrated decision support, communication, scheduling, and data transfer systems.

Issue: Coordinating at the Project Design Phase

The timing and format of DOTs' first contact with utilities varies substantially, with an average at about 30% design completion. Because the DOT design development process focuses on solving transportation needs, and the coordination process is weakly structured, transportation design typically proceeds with little or no input from UCs. Generally, designers recognize the need to identify utility conflicts and required relocations; however, changes to their designs to minimize relocation cost typically must originate with the UC staff, who are not members of the design team. In many cases, the utility engineer and the DOT design engineer never meet. The quality and timing of the required communication varies and depends largely on the initiative of individual designers. Some DOTs have been trying to infuse greater consistency into this process, with a series of forms and types of letters to be used at each stage.

The technical complexity of utility systems has increased, but DOT design engineers and construction contractors have little or no formal training in the technical aspect of utility systems. Utility relocation engineers employed by utilities have little formal training in transportation system design and construction. This absence of technical knowledge is a further obstacle to coordination.

Strategies

- Conduct the design stage as a team including appropriate staff from DOTs and UCs.
- Strive for early communication between DOTs and UCs and use sound project management practices.
- Provide training for design and relocation engineers and constructors to create awareness of utility relocation processes.

Best Practices

- The UC, PA-Verizon, provides annual training sessions to DOT designers to create process awareness, which helps avoid relocations.
- PA-Verizon pays for redesign to avoid relocations.
- New York State DOT uses a series of forms and letters to create a consistent process for coordinating with UCs.
- The Georgia DOT offers program training for designers.
- Multiple state DOTs and UCs hold annual or periodic meetings to discuss issues and upcoming projects.

Issue: Coordination Between Contractor and UC

It is possible that the DOT and the contractor might not coordinate with the utility during construction. Occasionally, the contractor chooses a work schedule that conflicts with the utility relocation requirements. To UCs it seems that general contractors often have the attitude that everyone must "get out of the way." Further complicating the matter or delaying resolution, DOTs often do not participate in a conflict between the contractor and the UC during construction.

STRATEGIES

- Perform utility relocation work before construction begins.
- Hold preconstruction and progress meetings with the contractor and the UC.
- Position state DOTs as a liaison to coordinate communication between contractors and UCs.
- Use sound project management practices.

Issue: Coordination Between Utilities

In many locations, UCs lack adequate coordination processes to deal with multiple utilities supported on or in a common structure, and the One Call locator system does not deliver sufficiently comprehensive and reliable markings of existing or abandoned utilities. Electrical distribution poles may serve various utilities, such as telephone and cable. Poles cannot be relocated until all utilities have been relocated. Utilities typically are placed on a first-come, first-served basis. A utility plan from one company that follows another utility may result in conflicts and, therefore, be rejected. Although this process generally works, it may not create optimal placement.

BEST PRACTICE. North Carolina DOT's SAP PMii program directs how utilities coordinate, shown in a flowchart of production networks with activities and activity elements.

Issue: Internal Coordination Across Phases

UCs and DOTs both experience internal coordination problems among phases and functional areas. The departments in the utility companies that are responsible for design, rather than subcontractor One Call locators, usually have different priorities and understanding of a project than the other functional areas of the company. For DOTs, in the words of one representative, "a few big problem areas" exist, such as, (*a*) the designer finishes the plan, and nobody looks at it before the project begins; (*b*) the DOT should be monitoring utility relocations, but sometimes the utility drops the ball internally and does not get work done; and (*c*) contract design and construction people are not talking.

Coordination issues have been reported across phases and functional areas, as described in the examples below:

- Project management—A Pennsylvania DOT representative noted that one of the biggest problems has been the availability of design plans that the headquarters can send to utilities to start the utility process; project managers often are unaware of the involvement or time required to coordinate utility issues and the critical need for utility coordination.
- Designers—Design staff often need training in utilities accommodation; a Wisconsin DOT representative noted that reminders to designers were helpful, telling them when certain things were needed.
- Construction—A Delaware DOT representative noted difficulty getting people from construction involved early and inconsistent time estimates provided by designers and construction engineers. Delaware recently started using the team approach to force construction to assign an engineer early in the process.

STRATEGY. Many state DOTs have tried to implement cradle-to-grave oversight. For example, at the Colorado DOT, a resident engineer is responsible for all aspects of a project from beginning to end; all designers, utility specialists, and construction managers work under the supervision of the resident engineer on the project, allowing for cross-training between disciplines and increased awareness of utility issues.

Issue: Coordinating ROW Acquisition

Initial ROW requirement estimates may be based largely on the roadway project requirements. Contact with UCs typically occurs much later in the project development process. Consequently, ROW needed for utilities may be delayed, in turn delaying relocations. Many DOTs cannot purchase ROWs in advance for utility relocations. In Wisconsin, for example, this inability seriously hinders implementation of the state statute and process, Trans 220, which spells out a formal timeline for utility coordination.

Clearance Issues

If trees scheduled for removal by the DOT are not cleared in time for the UC to begin work, the utility appears to be at fault. UC relocation cost estimates typically do not include the cost of removing trees in a new ROW; the removals usually are noted on the highway drawings as a contractor responsibility.

STRATEGY. Treat tree removal as a separate project with a separate deadline to be completed before the utility's scheduled work and clarify the responsibility.

Increasing Demands and Limited Resources

DOTs are under pressure to accelerate project delivery, and, for various reasons, program priorities can change. Projects scheduled for immediate design and construction can be postponed, while projects scheduled for future execution can be moved up. This variability can strain utility coordination efforts.

Although most utilities have dedicated resources for relocation activities, these resources are limited. Abrupt changes in DOT work program volumes and changes in individual project schedules may cause demands in excess of UC resources. Also, because extreme weather events take precedence over normal business, resources may be pulled away to fulfill disaster resource sharing commitments.

Additional stresses result from attempting to minimize initial project cost by setting project limits unrealistically small. As this underestimation is discovered during the project development process, extra costs and time are incurred. Underestimating the project may render the previous design irrelevant or inefficient if additional space is available in the new project scope.

Strategy. Correctly estimating project limits can minimize the extra costs of extending the survey limits. Generous, early identification of the project's limit area allows utilities to get an idea of the potential project scope. It is better to err on the side of a larger design or construction footprint than a smaller one to address necessary space requirements for anticipated, but not yet determined, new ROW, utility easements off the ROW, or unanticipated design changes during the project.

Working the Process

Many DOTs emphasized there is no magic formula or easy fix. Things work, or will work better, if all parties work the process that is in place and stay on top of the tasks to meet schedule requirements. UCs and DOTs have noted that, "If any of the parties involved fails to do its part, the process can falter or fail." As one UC noted, the "DOT does not always follow its own procedures. Because of pressure to bid jobs, some projects are given to construction without complete designs. Remaining design issues must be solved during construction."

In particular, UCs identified the following barriers to working the process and applying best practices:

- Communication between DOT and UCs is insufficient, including DOTs' failure to incorporate the UC early in the planning and design phases.
- DOT support for UCs is insufficient to conduct preliminary locates and utility analysis.
- Concurrent work is required to solve technical issues on some projects, such as bridges.
- Legislative issues preclude payment provisions in some states.
- Employee turnover in DOTs and UCs hinders the coordination process.
- The DOT utility coordinator position is stressful and challenging due to the workload. The position is not easy to fill, and it does not offer obvious opportunities for advancement. As with most jobs, the position of utility coordinator requires experience. Like the position of "specialist," the utility coordinator position is one that many engineers consider a sidetrack.
- The tendency to cut corners if a schedule gets tight, rather than pull a project, causes problems down the line. For example, if a DOT does not complete project plans until late in the process, utilities receive the plans late and are expected to complete work plans in a compressed schedule.

Even states with clear coordination processes experience difficulties. In a state with a formal timeline for utility coordination on major projects, one UC reported that plans, specifications, and estimates may be due in the DOT before the specified due date for the utilities' work plans.

Issue: DOT Design Changes

Design changes produce delays that are magnified when coordination with other processes is required, such as with environmental and utilities processes. Design changes are a primary source of delay at state DOTs. One UC representative said, "In my experience, our companies have caused very few delays. We are very good at engineering and constructing projects. It's when we have to redo our engineering because of changes not anticipated by the DOTs that scheduling becomes a problem."

Strategy. A few DOTs have tackled the issue of design changes to seriously reduce their occurrence and explicitly manage the risk factors that may result in design changes. Caltrans was one of the first state DOTs to study the issue and substantially reduce design changes in the past 10 years. The agency has also undertaken a risk management initiative.

Issue: Variability in Transportation Funding

A lack of funding for some transportation projects has resulted in a project being shelved after utilities provide plans. This stop–start project funding situation creates coordination issues because of the time span (up to 3 years) in utility relocation plan submittal, review, approval, and authorization for the utility to go to work to relocate utilities.

It is understandable that utilities do not want to invest time, effort, and financial resources in planning for or executing relocations that turn out to be unnecessary if the DOT decides not to build the project. DOTs are coordinating earlier than ever with utilities, sometimes sharing plans 5 to 10 years in advance, but project funding can be more uncertain at this early stage. Funding situations can change and projects can be reprioritized. Interviews revealed that sometimes "the utility (still) does not trust DOT, and is not sure that DOT will really build the project." This lack of trust can cause delays because the UC waits until later in the process to initiate its portion of the work.

Strategy. To deal with this issue, some DOTs have made substantial efforts to increase the predictability of their transportation program so that UCs and municipalities can count on projects that are included in the Transportation Improvement Program, the 4- to 6-year program of budgeted projects. At least one DOT has addressed the issue by requiring that construction work not be let until utility relocations are complete.

Issue: Systems for Invoicing and Payment

DOTs frequently lack sufficient support systems for invoicing and payment. For example, Alabama DOT uses a database for invoice status; however, no electronic system exists for payment, which slows down operations. The problem extends across many states. A representative from one UC noted in an interview, "It is a constant delay in obtaining payment when private rights are in question. A question I would raise is—why are there delays in payment and obtaining agreements for payment, when a utility has not delayed the highway construction project?"

Strategy. Enabling utilities and contractors to be paid in a timely manner could make bids more competitive, decreasing costs to the DOT. Currently, utility relocation contractors may factor into their bid that they will need to wait for payment.

Best Practice. One state DOT identified a lack of communication about deadlines between the departments for design and construction in a UC. The DOT offered to conduct a workshop with the UC to resolve the issue. The UC accepted the offer, and the DOT helped resolve the UC's internal coordination issue, improving the situation for all parties.

Issue: Insufficient Accountability

Utilities often are not held accountable for relocation commitments. In most situations, even if the DOT incurs delay costs because utilities miss relocation schedules for utility facilities, no reimbursement can be obtained from the UC. In general, utility permitting agreements require the UC to relocate utilities when required by a DOT improvement to the transportation facility. Most agreements provide a specific process for handling UC noncompliance; however, typically no specific language concerns reimbursement for delay damages.

The following wording from the Florida DOT's *Utility Accommodation Manual* illustrates typical wording that leaves negotiation or litigation as the only alternative to costs caused by missed deadlines (*1*):

> For FDOT construction permit non-compliance issues: The District Design or Utility Office shall give written notice, by Certified Mail with return receipt, to the utility or its agent advising of the specific deficiencies and/or violations and requesting compliance with the permit provisions within 30 days per Section 337.403(1), F.S. except as provided for in paragraphs (a), (b), and (c).3.8.2.
>
> If deficiencies and/or violations have not been corrected within thirty (30) days, a second notification shall be sent by Certified Mail with return receipt. This second notice shall advise the Permitee of the FDOT's intent pursuant to Section 337.403(3), F.S.
>
> The FDOT shall document all acts of non-compliance that have occurred with regard to each permit, including failure to respond to notifications of non-compliance. A copy of all permit documentation, written correspondence, memoranda or notes, certified mail receipts, etc., maintained in the District Office shall be forwarded to the Office of the General Counsel and the Secretary of Transportation in Tallahassee, if an administrative hearing is requested.

The process, as illustrated above, usually applies to utility issues that occur during the design phase of a project. A DOT may pursue collection of damages if no contractual provision is made for reimbursement. Negotiation or litigation becomes the only available remedy. During construction, the process is initiated by the contractor submitting a notice of intent to claim for delay damages. Contractor delay claims are forwarded to the UC and also must be resolved through negotiation or litigation.

Issue: Reimbursement Rules

DOT utility engineers deal with multiple sets of rules for reimbursements, based on project type, location, and size, and the gross revenues of the utility. In 2003, Tennessee Chapter 86 tried to address this issue by allowing utility reimbursements to occur based on the discretion of the commissioner. The rule established that any grade and drain project with ROW acquisition or bridge replacement is eligible, although smaller projects (e.g., safety projects) with limited state and federal funds are not eligible for Chapter 86 reimbursement. For a qualified Chapter 86 reimbursement, the utility must meet three conditions in the state statute to receive reimbursement,

addressing areas that the DOT identified as substantial issues related to utility delays: (*a*) the utility must submit plans within 120 to 186 days, as provided in state statute; (*b*) the utility must have a valid permit for the existing facility; and (*c*) the utility must relocate before letting, or work must be included in the state contract.

Although Chapter 86 relieved utilities of the responsibility for relocations by including them in the state contractor work plan, when this is done, state statute requires utility inspections, which the DOT does not reimburse on public relocations. The DOT's Construction Office relies on the utility's inspectors for their expertise in overseeing the utility facility construction. This has been a problem in some cases "because the utility inspector ends up directing the work, and then the contractor does not meet the specifications in the contract with the DOT. Resulting work that was not authorized in the state contract then has to be negotiated and paid directly between the utility and the state contractor." The DOT expects these situations to decline as the work forces are educated on the proper procedures.

Need for Critical Information Complicates Project Coordination

DOT and UC interviews identified the need for information as a barrier that affects timely relocation of utilities. While significant DOT effort has gone into involving UCs earlier in DOT processes and accomplishing utility relocations before initiating project construction (North Carolina for example, coordinates with UCs up to 6 to 10 years in advance) many opportunities for improvement remain in acquiring and sharing information.

Issue: Need for Base Information on New Locations for Utilities

One challenge to DOT–utility coordination is the lack of base knowledge needed by DOTs and UCs. Utilities are just one item that must be dealt with and designed for by DOTs. Locations for utilities to be moved may be identified, but other unknown objects, ground conditions, and geotechnical conditions in the new location can preclude them. The lack of good base data magnifies other problems.

Issue: Information About Project Area and Subsurface Conditions

Knowledge of the project character and limitations of space is essential for both DOT and UC designers. "Character" refers to the space occupied by the existing utilities and ground conditions that may affect the relocation of existing utilities (e.g., bedrock, large boulders, depth to water table, debris and rubble from past use, unstable ground). Also, some areas might be unusable (e.g., cemeteries, areas with hazardous materials).

Issue: Subsurface Utility Engineering and State-Specific Cost–Benefit Information

A number of states are conducting research and implementing programs to promote subsurface utility engineering (SUE). SUE is an engineering process used to accurately identify the quality of subsurface utility information needed for highway plans and acquisitions and management during development (*2*). In states where SUE is not standard, or a SUE program does not exist, the process can still be used in exceptional circumstances. For example, Alabama recently acquired a new industry that produces railcars, and the Alabama DOT is using SUE in a rush project to improve an intersection to provide better access to the site.

Quality and Effectiveness of SUE Services

Many DOT engineers consider SUE services to be expensive and, therefore, do not include SUE services in the budget. To encourage the use of SUE as needed, a few states offer SUE services through a program budget allocation.

SUE providers have proliferated and, to a certain extent, SUE is now treated as a commodity instead of a professional service. This has led to problems in some cases:

- Some SUE providers do not use adequate location equipment.
- SUE services are underprocured to cut costs or meet other goals and limits.
- Personnel interpreting SUE data lack sufficient skills or experience.

Strategy. Some DOTs have started to address these issues through prequalification of SUE providers.

Issue: Difficulty Getting Design Ticket Locates from One Call Centers and Locators

The limited level of service that One Call centers and locators can provide, particularly during the design phase, affects DOTs and utilities. The One Call system was instituted for safety during construction, not for design purposes. Most states have legislation or practices that preclude UC reliance on the system, which frees utility ratepayers from supplementing the design costs that should be covered by other stakeholders.

Only 12 or 13 states allow utility locates ("design ticket") and field marking for design. No one entity is responsible for

looking for abandoned or unknown utilities or other underground obstacles or for assessing how many cables go from one vault to another. The process is inefficient and limits complete assessments.

Issue: Inaccurate and Incomplete Field Markings, Risks with Multiple Locators, and Process Inefficiencies

In states that allow utility owners to mark for design, utilities generally have protected themselves from liability by seeking statutory language that absolves them of responsibility for the accuracy or completeness of the marks. This statutory protection reduces the incentive to utilities for accurate or timely locates. DOTs rarely recover redesign or contractor delay claims from utilities for wrong design markings.

In addition, significant problems arise when utility owners mark utilities but do not perform a subsequent survey that transfers data from the ground to a computer-assisted drafting (CAD) file. This process typically begins with the DOT surveyor; however, because the surveyor has no control over the process of making the field marks, the timing of the follow-up survey is in question. The surveyor has no way to know when the marks have been made in the field, resulting in multiple trips to the field to survey.

The diverse ways in which locates are done and the number of parties involved can cause multiple problems and result in an inefficient process with potential quality concerns. The issue, however, is not who does the locating; it is more a question of the quality of the locating and characterization of the utilities. Many of these issues are eliminated when the entities making the marks and the surveyor of the marks are the same responsible party.

Strategy. Clarify and streamline responsibilities for conflict identification.

A single entity (such as a subsurface utility engineer) marking all utilities and other underground obstacles in the project limits enables marking of utilities on the ground surface with greater reliability than during One Call operations because of the dispersal of and gaps in responsibilities and timelines. With utility locations shown correctly and comprehensively (where possible through the selection, use, and interpretation of the surface geophysics), and with task designers considering this information to try to avoid utilities, it is easier to identify conflicts with more confidence.

Current practice in most states is to ship the project plans back to utility owners, making them responsible for determining their own conflicts. Although this may reduce labor and costs for the DOT, the DOT as project owner relinquishes a measure of control over quality, time, and even cost, because it is not paying for the conflict identification. This is another example of a ratepayer versus project owner issue where the public pays for the inefficiencies.

Having a single entity identify all conflicts (with the utility owners performing quality assurance) offers several benefits. For example, in relocation, the work of one owner may conflict with that of another owner. A single trained and competent person can perform this function more efficiently than a mixture of many utility owners on their own timetables with limited resources. Each project requires a certain amount of time for a locator to become familiar with the project and area. It may be more efficient to allocate this responsibility and investment to one person than to 10 people, even when the 10 individuals are more familiar with their own utility system.

Ultimately the designer has the responsibility to develop solutions for identified conflicts. It is the role of the SUE engineer to provide the designer with the required location and characterization information.

The following items could be controlled by the project owner to create further project efficiencies:

- Identification and procurement of utility easements;
- Utility relocation design;
- Environmental permitting;
- Coordination with other agencies affecting utilities (parks, federal lands, railroads); and
- Utility inspection, as-builts, and refreshing of utility data after relocations.

Increased DOT Responsibility for Information Collection

DOTs need base knowledge of ROW and relocation areas for the design process. Information is collected from geotechnical investigations, utilities, and reviews of old project plans and construction notes. SUE can provide DOTs with additional information for the relocation process.

Strategy. One coordination strategy is to put the DOT and the DOT project manager (or the DOT's design consultant) in control of the utility location process with funding to manage it and the timing, comprehensiveness, and efficiency. Under a proactive DOT model for horizontal utility mapping on project plans, the DOT has the following responsibilities:

- Make regional subsurface utility mapping contracts directly with service providers, including horizontal utility mapping directly into the statewide and regional topographical survey contracts. This enables the DOT to move collection of comprehensive, accurate horizontal utility data into the planning stages of the project and use those data for planning and preliminary design decisions.

- Reimburse municipally owned utilities for their entire relocation costs. Other utility owners are reimbursed depending on prior rights.
- Reimburse all utility owners for their relocation design costs. Utility owners can do this design themselves or get permission to use a consultant.
- Rely on regional utility relocation design contracts in place. This allows the DOT to directly perform municipal utility relocation designs or provide designs for other utility owners.
- Negotiate and obtain required utility easements directly with land owners affected by the highway project.
- Provide utility owners and consultants with licenses for their project CAD platforms to ensure efficiency.
- Coordinate utilities through consultant design contracts or outside consultants under direct contract with the DOT. These consultant services can be responsible for conflict identification.
- Use the regional SUE contracts for Quality Level A data for conflict verification.

This strategy ensures that (*a*) the mapping scope includes utilities not typically marked by utility owners or their One Call contractors, such as unknown utilities, abandoned utilities, out-of-service utilities, privately owned utilities, multiple direct-buried cables, cathodic protection systems, and empty conduits; (*b*) the timing of data collection is in accordance with project needs; (*c*) DOT is protected against errors or omissions in the utility mapping data; and (*d*) the survey and CAD mapping of the data is efficient.

All of these services, controlled by the DOT, minimize the burden on UCs, which are still included in correspondence and meetings and can take control of aspects of these services when they desire. One DOT reported a 20% reduction in the time to take a project from planning to construction using these procedures. The strategy also decreases institutional wariness and conflict between the agencies and organizations. State statutes may need changes such as the negotiation of required utility easements for utility owners at the same time other easements are located and authority for utility easements to be in place earlier so relocations can proceed.

Issue: Information System Capacity and Availability

Numerous DOTs use project management systems such as Primavera to manage projects. Such systems are very data intensive, and DOTs report that the amount of data in the system makes it cumbersome to use. This discourages project managers from frequently entering data so they wait until they have large amounts of data to input. In the last few years, a number of DOTs have engaged in serious and expensive efforts (up to $15 million in Washington State) to upgrade and integrate management systems for project development. However, few are geographic information system (GIS) enabled, particularly as they relate to ROW information systems. *NCHRP Research Results Digest 310* reported that no systems are available at DOTs for enterprise ROW management in GIS.

STRATEGY. Improve information management systems and DOT-facilitated statewide GIS for utilities.

ROW activities are extremely information intensive. Almost every activity requires documenting what was done; collecting parcel, owner, or lease information; or tracking the large volume of required paperwork. Even a simple information system can provide substantial benefits for the personnel responsible for that information. An in-place, comprehensive enterprisewide system can improve project delivery, save resources, and improve interactions with the public.

DOT ROW information systems are beginning to address a number of the challenges that DOTs face. Improved DOT information systems, data integration, and project management systems extending to ROW coordination can address some of the following needs:

- **Develop cost estimating and cost management systems to increase predictability.** Variability in the transportation program and project scheduling, due to changes in available funding and reprioritization of projects because of cost overruns on some projects, presents major challenges for utility companies and causes DOTs to lose credibility and trust with their UC partners. A number of states have made major strides in their on-time, on-budget performance through process improvements and better information systems. The improvements ease coordination problems with utilities, which understandably do not want to be caught having invested time, effort, and financial resources in planning for or executing relocations that turn out to be unnecessary because the DOT decided not to build the project after all.
- **Improve coordination tracking.** DOTs voiced issues about lack of awareness of coordination needs and UCs claimed that DOTs tend to try to cut corners rather than pull a project if a schedule gets tight. An example is project plans not being completed until late in the process. The plans are sent to utilities late and the utility is then asked to try to complete its work plans ahead of schedule. Better project management systems and integrated management systems in the DOT can help prevent this.
- **Use project management systems to improve utility-to-utility coordination.** For example, North Carolina DOT's SAP PMii program sets forth how utilities will be coordinated together, using a flowchart of production networks with activities and activity elements.

- **Reconcile internal coordination issues.** DOTs reported that timely availability of design plans for utilities is often a challenge; project managers are often unaware of the involvement or time required to coordinate utility issues and the critical need for utility coordination. In other cases, DOTs have noticed regular time inconsistencies between estimates provided by designers and construction estimates.
- **Communicate promptly on DOT design changes.** Design changes are a primary source of delay at state DOTs. A relatively small number of DOTs have tackled the issue of design changes to seriously reduce their number and explicitly manage the various risk factors that may result in design changes. Minnesota DOT, Virginia DOT, and Caltrans are among the agencies that have developed improved scoping processes, which minimize design changes and ensure prompt communication regarding such changes, when they occur.
- **Update invoicing and payment system.** Lack of an electronic system for payment slows operations, increases costs, and may erode good relations with utilities; conversely, systems for prompt invoicing and payment in turn encourage prompt services by those paid.
- **Transfer knowledge and orient new staff during turnovers.** DOTs and UCs noted that employee turnover in both the DOTs and the UCs hinders the coordination process from being fully and properly executed.

High-capacity project management systems offer the potential for improvements; however, some DOTs fail to regularly update data-intensive systems. The transition to new, higher-capacity management systems requires top-level leadership and communication of expectations, along with the requisite training. As NCHRP Project 8-55 noted, "The underlying complexities involved in the business processes associated with transportation ROW activities are substantial" (*3*). For example, Virginia measured the benefits it realized from its information management system through improved schedule commitments, reduced staffing costs, and increased productivity. Electronic access to information improved public relations, enabling any staff member to respond to a query through the ability to access the complete customer file. "Technology is no longer the stumbling block to implementing enterprise information systems. Organizational structure, communication lines, and moving the behemoth of the status quo are often the more difficult challenges to overcome" (*3*).

NCHRP Project 8-55 identified data elements to be included in a data model for a ROW information system. As noted in *NCHRP Research Results Digest 310,* while many state transportation agencies use technology such as computer-aided drafting and design (CADD) to draft ROW plans, the approved final plans are often manually recorded and filed on paper or Mylar (*3*):

> Posting and storing such data by hand is obsolete, inefficient, and unresponsive to the demands of modern project management, encumbering multiple users from conveniently accessing real-time ROW information and resulting in undue delay and cost overruns. Moreover, paper and Mylar records are more vulnerable to damage or destruction in the event of fire, flooding, or other catastrophic events. Manually recorded ROW information includes agency ownership, appraisal information, acquisition status, and property management functions that are important for addressing real estate issues, utilities, environmental permitting and mitigation, access management, maintenance, and programming.

CADD files and electronic plans are efficient; however, utilities often do not have compatible software; therefore, much of the work, including redlining each other's plans, is still currently done on paper. DOTs and utilities have extensive mapping resources, including general ones that are used at project inception and detailed ones that are created in the course of a project, which could be made more widely available at completion. Compiling these resources and making them available in a central location could be a boost to DOTs and UCs for permitting utilities and for planning for future projects. As NCHRP Project 8-55 notes (*3*):

> Electronic management of this information improves the coordination and consistency of data, leading to reduced project delivery delays caused by ROW acquisition. In addition, the ability to retrieve these data electronically provides fast, convenient, and consistent access to all users, reducing the time and expense needed to ship documents, eliminating repetitive entries, minimizing data entry errors caused by multiple formats, and ultimately saving money for transportation agencies. Electronic management of real estate information could improve coordination with local jurisdictions and provide appropriate data to the public on agency ownership of property. The automation of ROW functions and development of data integration models using existing technology, including geospatial applications (generally referred to as geographic information systems or GIS), are needed to enable multiple users to access the ROW information quickly and easily.

Most DOTs have ruled out such an effort because of the barriers. Most utility entities, with a large range of sizes and capabilities, are installing utilities constantly. DOTs and UCs believe it would be nearly impossible to maintain a generally held map of this work. Funding and Homeland Security restrictions are also issues in making a statewide utility network map. Frequently, DOTs retain information in project

files on paper or in electronic format. Although DOTs often have as-built files, in most states only recent projects are in electronic format. Both Florida DOT and Georgia DOT have developed protocols for Electronic Plan Transfer, the use of electronic files and file transfer protocols to communicate highway project status to affected utility companies and to maintain archives.

Increasingly ROW information systems are designed and developed with GIS accessibility in mind. The following paragraphs summarize examples of ways in which states manage utilities-related documents and coordination activities.

Examples of State DOT–UC Management Systems

Wisconsin DOT—Transportation Utility Management System

Wisconsin has developed a statewide common Transportation Utility Management System (TUMS) for tracking, locating, and management systems that came online in the last half of 2007. The system facilitates efficiencies by having standard letters and forms and a GIS for location of surface territories. The GIS uses a 1-mi^2 grid to indicate a utility company in the square mile being disrupted by a project.

Wisconsin DOT cell phones can access system maps on hand-held locators. Also, Wisconsin DOT earthmoving equipment has Global Positioning Systems (GPS) on the blades. Grades are determined by GPS, which eliminates slope and construction staking. Survey information is entered directly into survey equipment and transported as a design layer.

PennDOT—Utility Relocation Electronic Document Management System

PennDOT has a utility relocation electronic document management system with electronic workflow support. District staff complete a form and the workflow system routes it to the appropriate headquarters staff. It also gives external business partners access to the system. Now in Phase III, the system took 2.5 years to develop. PennDOT can notify a utility (but not contractors) of a project in the system and send plans for download.

Tennessee DOT—Utility Relocation Information System

On its Utility Relocation Information System, Tennessee DOT keeps project information, plans sent and received, contracts issued, and reimbursable billings in a database with an Access front interface and an Oracle back-end.

Texas DOT—Utility Permitting and Right-of-Way Information System

Texas DOT (TxDOT), in conjunction with the Texas Transportation Institute, developed a GIS-based system to automate the utility permitting process. This permitting system enables exchange of information and tracking:

- Upload of engineering drawings and other supporting documentation, which can include utility quality-level depiction data (in accordance with CI/ASCE 38-02);
- Conversion of uploaded documents into PDF files;
- Permit locations in a GIS-based visualization (map);
- System to track permits through the approval process; and
- Notification and reporting.

TxDOT also developed a tool showing each activity of the ROW acquisition and utility adjustment process with the corresponding responsible parties separated into three categories: TxDOT ROW Division, TxDOT ROW district, and project associates. This tool helps in planning activities and informs participants in the process. It offers a method and format for recording data. NCDOT is collecting similar data (*4*).

The purpose of the system is to provide a comprehensive inventory of utilities in the TxDOT ROW. Controlling data on new utilities is the first step. Adding data on existing utilities can occur project by project.

To facilitate future ROW acquisition duration analyses, TxDOT will track and document several additional fields of information in a single location, preferably in its ROW information system. The following information is readily accessible:

- ROW release date;
- Appraisal date from real estate appraisal report based on the recorded date of the appraiser (signature and date of the initial appraiser);
- Appraisal approved date when the district engineer approves the DOT tabulation of values form;
- Negotiations end date based on the ROW Final Offer Letter and the deadline for response by the property owner;
- Date eminent domain begins, based on an interoffice memorandum when the ROW district sends the request for eminent domain proceedings to the ROW division;
- Prepare-and-submit request for eminent domain, a memorandum from the ROW division legal section to the Office of the Attorney General regarding eminent domain proceedings;
- Minute order for eminent domain approved by the transportation commission, an interoffice communication from the Office of Attorney General (AG) acknowledging receipt of the eminent domain request (case number and assigned legal filing), generally defined as the date the AG's Office

responds to the eminent domain request and begins processing hearings;
- Possession of deed by eminent domain (condemnation) parcels (the possession of deed date is based on a notice of deposit from the court); and
- Possession by negotiation of a negotiated parcel—this is the title company closeout date on the DOT document.

Florida DOT—Right-of-Way Management System

Initial Florida DOT (FDOT) efforts to create base maps from CADD maps were far out of proportion to the benefits. Despite automated routines, the process of creating the necessary georeferenced structures often required more than 40 hours of labor for a single project. FDOT right-of-way managers concluded that the agency's system did not provide significantly greater ability to manage projects compared with previously available text lists.

As the need increased for improved capability in data analysis, FDOT redesigned the basic data maintained to manage ROW projects, which took 2.5 years and $2.5 million. FDOT managed development of the Right-of-Way Management System (RWMS) in-house. The state legislature funded $2.5 million for the system because the ROW program in Florida is budget intensive and FDOT could not readily and easily provide the state legislature with program information. RWMS accumulates data through many data layers, and reports are developed quickly with current information available to management. FDOT is developing an Enterprise GIS application to interface with RWMS for better accessibility through a software translation layer that responds to queries and integrates data from several databases. The FDOT enterprise GIS can display road attribute and work program data through a map as an index to text data. A query capability provides text data when a user highlights a section. The FDOT Enterprise GIS uses a base map digitized at 1:24,000, which is adequate for displaying generalized information but not survey-level right-of-way accuracy. Attempts to display data with survey-level accuracy can result in unexpected and misleading conclusions, an issue that FDOT is addressing. The person closest to the event is expected to enter fundamental design data. Data integrity is improved through business rules that control the timing of data entry.

Florida Turnpike Enterprise Right-of-Way Management System

The Florida Turnpike Enterprise (FTE) is a system of toll roads and an entity of FDOT, staffed mostly by contract employees, that does not use state or federal gas taxes. The Florida legislature passed legislation allowing FTE to bypass many rules and procedures that FDOT must follow.

FTE uses property appraiser data sets from 16 counties. FTE contacts the property appraiser, receives the data set and process, inserts the data set into the geodatabase, completes the metadata, and updates data annually. The electronic system tracks key activities and generates standard reports. It has streamlined ROW production and is user friendly; data entry is simple and compatible with the FDOT RWMS. It is accessible to all team members, enabling them to work with fewer resources. The system reduces research and response time and provides accurate information for negotiation preparation.

Database components are active project list, cost estimate, contract summaries, parcel information, litigation status, market research data, and special studies. Database information includes parcel schedule, ownership, location, assigned appraiser, review appraiser, and approved compensation. Electronic appraisal reports available online are full text, charts, graphics, and photos.

Following is a list of example advantages that FTE has found:

- The system created a standardized format for data input from the numerous source databases and documents involved.
- The system is comprehensive. Users input their data and have the capability of viewing data entered by other users.
- The system is based on a relational database management system that stores and generates information as needed.
- ROW maps are submitted electronically using the correct latitude and longitude. These maps can be used in the GIS system to link parcel and ownership data.

County information and aerial data are updated at least every 2 years. Older photos are from rural areas. Microstation is used to create ROW maps, and, in the design phase when ROW maps become available, it is possible to see a parcel layer with ROW lines. This system allows FTE to respond to a legislator or inquirer to explain costs and how and what resources are being affected. New maps are entered in the system as they are developed. Because ROW maps and designs are generated by the same entity, FTE circumvents the issue of mapping, design blaming, and waiting for others.

Virginia DOT—Right-of-Way and Utilities Management System

Virginia DOT (VDOT) developed a software system to accomplish the following tasks:

- Provide management with at-a-glance status of a highway project;
- Allow management to focus on key highway project dates and shift resources to ensure the completion of ROW and utility activities before those dates;

- Help ROW and utilities agents generate, customize, store, and retrieve appraisal forms, letters of correspondence, and other documentation;
- Have an intuitive user interface simple enough for a new user to learn easily and powerful enough for an advanced user to quickly navigate to specific information;
- Automate the assignment and reassignment of work to division agents; and
- Interface with the DOT mission-critical project and program management system.

Implemented in early September 1999, the client-server Right-of-Way Utilities Management System (RUMS) solution has met and exceeded the division's desires. RUMS provides management with up-to-the-minute highway project status through ad hoc queries and reports served over a secure intranet. In addition, management can easily batch assign and reassign work to the appropriate field agents. Division agents have found their workload reduced because data entered into RUMS can be fed to myriad letters and other documents that RUMS stores in a centralized Oracle database.

RUMS enables forms processing and web-based reporting. The system is being enhanced through an expanding user base, based on system success and understanding of capability. VDOT has developed a web-enabled version with flexible system architecture that allows more than 200 system enhancements and expansions. VDOT copyrighted the system and has responded to inquiries from a number of states.

References

1. Florida Department of Transportation. *Utility Accommodation Manual,* Aug. 2004. www.dot.state.fl.us/rddesign/utilities/files/UAMRuleChange/UAM101905MYERS.pdf.
2. FHWA. *Subsurface Utility Engineering.* www.fhwa.dot.gov/programadmin/basicinf.cfm.
3. *NCHRP Research Results Digest 310: Integrating Geospatial Technologies into the Right-of-Way Data-Management Process.* Transportation Research Board of the National Academies, Washington, D.C., Dec. 2006, p. 13.
4. *Audit of the Springfield Interchange*. U.S. Department of Transportation, Office of the Inspector General, Washington, D.C., Nov. 2002.

CHAPTER 4

Analysis of Practices and Development of Evaluation Approach

In the first phases of the study, the researchers conducted structured interviews with department of transportation (DOT) and utility company (UC) coordinating engineers. The purpose of these interviews was to develop a clear understanding of the most significant utility coordination problems and insights into best practices. (Appendix B provides resources gleaned from the interviews for the 13 best practices.) The researchers then formed a volunteer industry review team of some of the most active and interested members of the group of DOT and UC experts who were interviewed in the first phase, building on their familiarity with the study issues, process, and purpose. This team consisted of nine DOT members and eight UC members. The industry review team reviewed research summaries and provided feedback on practices, participating in their identification and expansion through a series of e-mails and, in some cases, phone calls.

Analysis of Recommended Practices

During the work on Tasks 1, 2, and 3, the researchers identified both issues and recommended practices. Recommended practices were identified based on two criteria: demonstrated success and alignment with solving the most commonly identified delay issues.

The value of these practices can be found primarily in the amount of delay avoided, such as the cost per day of wasted construction time, redesign costs and time factors, and costs for inefficiencies in the coordination process. As DOTs and UCs are aware, this information is very difficult to get and varies widely among projects. Cost and time are huge issues for DOTs. Delays typically cause cost overruns. Cost overruns in turn influence the rest of the transportation program and the expectations of local, regional, and state governments. For example, according to the 2002 audit of the Springfield Interchange project in Northern Virginia, Virginia DOT postponed or canceled 166 projects because costs were underestimated (*1*).

The analysis of the data collected and cataloged in the issues matrix suggests the following specific best practices.

Best Practice #1: Advance Relocation of Utility Work

Either the state's contractor or the utility company involved in the relocation may relocate the conflicting utilities before highway construction begins. This is done to alleviate possible coordination conflicts between UCs and contractors and minimize delays during the construction phase. Advance relocation also limits delays in projects due to budget delays while the utility company tries to find the funding for relocation.

Several states reported using this best practice successfully. The following example is from Tennessee's Chapter 86 Provisions that require utility relocation to be performed before construction begins or to be included in the state contract so the utility can be reimbursed (*2*):

> (2) The utility shall either:
>
> A. Enter into a written agreement with the commissioner to include the relocation as a part of the department's highway construction contract; provided that such agreement may provide that the utility shall perform certain relocation work with its own union employees as required under a negotiated organized labor contract but, in such case, the utility shall be required to reimburse the department for all relocation costs if it fails to timely perform its relocation work as provided in the agreement with the commissioner; or
>
> B. Enter into a written agreement with the commissioner to remove all utility facilities that conflict with the highway construction, as determined by the department, prior to the letting of the department's construction contract, and otherwise perform and complete the utility relocation in accordance with approved relocation plans and schedule of calendar days; provided that such agreement may provide that, in the event that the department does not undertake the highway construction project within a specified time, the utility shall be reimbursed for such relocation work as it has timely performed in accordance with the approved plans and schedule.

Another example comes from North Carolina, where the DOT has started to examine utility corridors and plans 6 to

12 years in advance of construction, although the UC may not be approached until the 30% design stage.

Potential Obstacles or Barriers to Advance Relocation

Any of the following circumstances may present obstacles or barriers to advance relocation:

- Clearing and grubbing work must be complete and sufficient right-of-way (ROW) must be acquired.
- In some cases, construction is incredibly expensive. For example, in big cut (or fill) areas the utility would need to dig down 30 or 40 ft to relocate in advance; if the utility waits until construction has started, the utilities may need to dig only 10 ft.
- It is not always acceptable to subject a particular area to work zone delays twice (once for utilities, once for highway construction), when the work might otherwise be accomplished concurrently. Busy urban streets, congested ROWs, and community functions can limit the time period during which construction can take place.
- Sometimes the delivery of materials is such that the utility cannot get the materials before the time highway construction starts. Earlier completion of designs can alleviate this concern.

Other barriers may be presented by work sequencing; not all utilities can be relocated beforehand, or it may not make sense to relocate some utilities. In addition, the start schedule for the DOT construction project must be reliable. UCs are reluctant to relocate and then find out that the start of construction has been significantly delayed. In some states, legislative action may be required to allow the use of advance relocation. Finally, advance relocation may not be a good fit for design–build projects.

Implementation Requirements

Supporting state legislation is one of the most important implementation requirements to advance relocation policy. After the legislation is in place, several other elements enable the policy to be implemented and successful.

Advance notice from DOTs to UCs concerning projects is necessary to allow for schedule and budget planning for the relocation work. To implement advance relocation, sufficient ROW must be acquired before relocation, and ROW clearing and grubbing must be performed. Often, DOTs need a mechanism to handle clearing and grubbing of the ROW; that is, the DOT hires a subcontractor to do the work or the utility is reimbursed for performing clearing and grubbing work.

Designs must be completed in time to allow advance relocation. Plans must be completed and sent to the utilities in time to do their design work, order materials, and schedule the work crews. In northern states, utility work is generally not undertaken in winter, so utility work is done during the fall before the year of highway construction, which requires sending plans to utilities in late winter or early spring of the year before highway construction begins. UC personnel performing relocations must be able to read plans and survey relocation layouts.

Supportive Skills and Training

Certain skill sets are necessary to implement advance relocation. UC personnel or subcontractors must be able to lay out relocated work from plans and field surveys. UC personnel and subcontractor personnel would also benefit from training in how to read basic transportation plans.

Evaluation and Continuous Improvement

After an advance relocation policy has been implemented, ongoing evaluation can provide guidance, identify areas where the process could be tweaked, and encourage improvement. At a minimum, UCs and DOTs should document and assess whether advance relocation of utilities has reduced utility conflicts during construction and whether the new process has improved interactions between the DOT and the UC and between the UC and the contractor. Delays (and avoidance of delays, wherever possible) should be documented and evaluated in relation to cause. Any other observations of UCs, DOTs, or contractors on the effectiveness of the practice or opportunities for improvement should also be recorded and evaluated.

Best Practice #2: Early Involvement of Utilities in Planning and Design Phase

Utility companies cited early involvement of the UCs in the planning and design processes as a best practice that has worked very well. The definition of “early” may vary across states, but it is obvious that utilities must be notified of potential involvement in the beginning of the planning and design phase to avoid utility-related delays. Most commonly, DOTs performed what representatives called “early” notification at the 30% design stage. Early involvement of utilities increases coordination and design time. The sooner the UC is made aware of a potential conflict, the sooner planning can start and the UC can incorporate the project into its own schedules. Also, with increased coordination and partnering time between the designers and utilities, relocation can sometimes be avoided altogether. Although a face-to-face meeting is preferred, it may not be appropriate for all projects. For simple projects with few utility issues, a formal meeting may not be needed.

Some states have a requirement for early coordination between the DOT, the UCs, and contractors involved in the utility relocation process. In Wisconsin, each project is handled by a utility coordinator from start to finish. An operational planning meeting is held with the UCs to discuss any issues that may be related to the construction. After the UC receives notice of the project from the DOT, it has 60 days to provide facility maps to identify their locations. When the DOT provides the UC with 60% design plans, it has from 60 to 120 days to provide complete work plans, depending on the complexity of the project.

In Delaware, the state legislature passes an annual bill to approve funding of the 6-year capital program, which is published so the utilities can plan and budget accordingly. In addition, Delaware DOT's annual and monthly schedules are shared with the UCs. Delaware DOT's coordination process includes kickoff meetings at project start for major projects. Coordination meetings occur at preliminary, semifinal, start of construction, and as necessary in between.

Early notification begins the coordination process between DOT designers and the UC, and early input from the UC enhances the opportunity for the designer to avoid utility relocation and possible rework due to late comments from the UC. It also allows the utilities to plan ahead and provides more time for the permitting process, which can reduce delays in the construction phase.

Potential Obstacles or Barriers

Any of the following circumstances can present potential obstacles or barriers, preventing early coordination:

- If any of the parties involved fail to do their part in planning and coordination, the process can falter or fail.
- Employee turnover in both the DOT and the UCs tends to hinder the coordination process from being fully executed properly.
- The DOT may try to cut corners rather than pull a project if a schedule gets tight. For example, if the DOT does not complete project plans until late in the process, it may send them to the utilities and ask the UCs to complete their work plans ahead of schedule.
- The ROW acquisition process can be lengthy.
- The utility is not sure that the DOT will really build the project.
- Implementation of the process does not occur. (Involvement is recommended, but the design team does not make it a priority.)
- The design decision-making process can be slow.
- Some DOTs do not want utilities to do their final plans based on preliminary highway plans and, therefore, do not involve utilities until later.

Implementation Requirements

DOTs can benefit from standard processes for utility coordination, including appointing a dedicated utility coordinator who serves as the liaison between the DOT and UCs. Early coordination with UCs allows the coordinator to work directly with them to coordinate the project schedule and the time frame for UC review of DOT plans and develop final relocation plans. DOT management support is needed to take the time for early coordination and for personnel to be willing to follow the process.

Supportive Skills and Training

The DOT design project manager and the utility coordinator must be able to discuss technical utility relocation issues with UCs. The design personnel should have basic training in utility relocation technical issues to incorporate the UCs' needs in the project design.

Evaluation and Continuous Improvement

After a standard coordination process is in place, ongoing evaluation can provide lessons learned and guidance to improve continuously. At a minimum, utilities and DOTs should document and assess whether the early coordination process allows adequate time for the UCs to develop the relocation plan and meet the project schedule. The assessment should include whether early coordination improved interactions between the DOT and the UC, interactions between the UC and the contractor, the quality of the project design, and the efficiency of the design process. Delays (and avoidance of delays, where possible) should be documented and evaluated in relation to cause. Any other observations of UCs, DOTs, or contractors on the effectiveness of the practice or opportunities for improvement should also be recorded and evaluated.

Best Practice #3: Training of DOT Designers on Utility Relocation Process

Several state DOTs and UCs said many designers are not sufficiently knowledgeable of the utility relocation process and technical issues and suggested training programs to inform them. High turnover rates at DOTs have led to inexperienced people doing design. Utility networks can be very complex. A belief in the utility industry is that if DOT designers understood the complexity of some utility systems, a greater effort would be made to avoid utility relocation during highway design. Advancements in technology are also being made, providing new information that could be useful in the design and relocation process. Training would help designers and

UCs use this information correctly. The training should occur before the design phase.

Designers with a comprehensive understanding of the utility system and the relocation process can better consider utilities during the design process, increasing the potential for cost savings through innovative designs that avoid utility relocations. The development of a consistent procedure and better coordination with UCs can increase timely relocations and reduce utility delay claims.

Potential Obstacles or Barriers

Inadequate budgets at DOTs can result in the DOT and FHWA giving a low priority to training programs that design engineers need to understand the complex utility relocation process. Without the necessary training, inexperienced designers are limited to on-the-job training. Alternatively, even when training is available, aggressive project schedules may leave designers reluctant to invest time in optional training unless certification is required by the DOT or FHWA.

Implementation Requirements

Training materials and a training program are needed for engineers to gain a basic understanding of the utility relocation process. It is important for the training organization to have the required curriculum knowledge to inform designers on the complex process of utility relocation.

Supportive Skills and Training

Designers need to be skilled in project management fundamentals and must understand utility system technology, including subsurface utility fundamentals, and the utility relocation process.

Evaluation and Continuous Improvement

After a training program is in place, ongoing evaluation can provide lessons learned and guide improvement. At a minimum, the training process should be documented and assessed to determine it whether improves the quality of project design and the efficiency of the design process. The assessment should include whether early coordination improved interactions between the DOT and the UC and between the UC and the contractor, improved the quality of the project design, and improved the efficiency of the design process. Delays (and avoidance of delays, where possible) should be documented and evaluated in relation to cause. Any other observations of UCs, DOTs, or contractors on the effectiveness of the practice or opportunities for improvement should be recorded and evaluated.

Best Practice #4: Development of a Geographic Information System Database

Computer-aided design (CAD) files and plans are efficient; however, utilities often do not have compatible software. Therefore, much of the work, including redlining each other's plans, is still done on paper. State DOTs and utilities have extensive mapping resources, including general ones used at project inception and detailed ones created in the course of a project. CAD files can capture this information and make it more available at completion. Compiling these resources and making them available in a central location could be an advantage to state DOTs and UCs alike for permitting utilities and planning future projects. This process should be implemented before design and review for ongoing use in those phases.

Potential Obstacles or Barriers

Although CAD capability adds efficiency, it also can present drawbacks:

- Numerous utility entities with a large range of capabilities constantly install utilities. DOTs and UCs agree that it would be nearly impossible to maintain a central map of all this work. Two primary issues are funding constraints and security concerns. More commonly, DOTs retain information in project files on paper or electronically.
- DOTs often have as-built files, but in most states, it is only recently that projects are filed in electronic format.
- Some UCs have yet to invest in current technology or training.
- Some UCs have lobbied against the use of CAD.
- The use of geographic information system (GIS) databases is not universal.
- Not all utilities are below ground.
- Funding is an issue.
- Addressing security issues is a concern for utility companies.
- Without a national or state law requiring software compatibility, conversion and accuracy of data, and background mapping compatibility, it is difficult to reach consensus.
- Telecoms are reluctant to share proprietary information because other companies might gain a competitive advantage.
- As-built utility plans require accuracy to within 6 in. Getting that level of accuracy will be difficult.
- It is difficult to deal with the large volume of data.

Implementation Requirements

State DOTs and UCs need an adequate budget to implement a fully functional electronic document management system to

allow file sharing of DOT as-built drawings. The UCs as well as the DOTs will also need sufficient funding to purchase software licenses for all users, develop servers and outside firewalls that are secure but accessible to multiple entities, and provide training to teach employees how to use GIS and related equipment.

State DOTs and UCs need to collaborate to develop a plan for mapping the large backlog of historical utilities data and to establish a process for acquiring as-built utility plans of sufficient accuracy.

Supportive Skills and Training

Users must be trained in the use of the GIS software application.

Evaluation and Continuous Improvement

After a GIS system is in place, ongoing evaluation will provide lessons learned and guide improvement. At a minimum, utilities and DOTs should document and assess whether the GIS system has improved the quality of project design and the efficiency of the design process. The assessment should include whether use of the system has improved interactions among the DOT, UCs, and contractors; improved the quality of the project design; and improved the efficiency of the design process. Delays (and avoidance of delays, where possible) should be documented and evaluated in relation to cause. Any other observations of UCs, DOTs, or contractors on the effectiveness of the practice or opportunities for improvement should also be recorded and evaluated.

Best Practice #5: Preconstruction and Progress Meetings

Holding preconstruction and progress meetings throughout the construction phase allows discussion of utility-related issues with timely resolution. It also encourages partnering among the utilities and contractors. On complex projects, it is particularly beneficial to hold a preconstruction meeting devoted to utility issues. Regular meetings with the UC can improve communications and relationships between the utilities and contractors, and schedules can be coordinated.

Potential Obstacles or Barriers

Utility companies may not have the time to attend one or more scheduled meetings. The DOTs also may have time constraints that make it difficult to decide if such a meeting is justified considering the uncertain attendance by UCs.

Implementation Requirements

DOTs and UCs need to cooperate to identify projects or project thresholds when preconstruction meetings are appropriate. Mutual agreement among the DOT, the utilities, and contractors is needed to set meeting schedules and develop procedures to make the best use of the time.

Supportive Skills and Training

DOT construction managers could benefit from a fundamental knowledge of utility relocation technology and processes.

Evaluation and Continuous Improvement

Ongoing evaluation of preconstruction and progress meetings will yield lessons learned, identify areas where the process needs adjusting, and provide guidance to improvement. At minimum, DOTs, utilities, and contractors should document and assess whether preconstruction and progress meetings improve the quality of project design and increase the efficiency of the design process. The assessment should include whether the new process has improved interactions between the DOT and the UCs and between the UCs and contractors. Delays and avoidance of delays should be documented and evaluated to reveal cause. Any other participant observations on the effectiveness of the practice or opportunities for improvement should be recorded and evaluated.

Best Practice #6: Incentive for Early Relocation

Some state DOTs allow the opportunity to reimburse a utility for the cost of relocating its facility. For example, in 2003, Tennessee amended its state code (Public Act Chapter 86) and allowed utility reimbursements to occur based on the discretion of the commissioner. The policy established that any grade and drain project with ROW acquisition or bridge replacement is eligible. Smaller projects (e.g., safety projects) with limited state and federal funds are not eligible for Chapter 86 reimbursement. If a project is qualified for Chapter 86, then the utility must meet three conditions to receive reimbursement: (*a*) the utility must submit plans within 120 to 186 days as provided in state statute, (*b*) the utility must have a valid permit for the existing facility, and (*c*) the utility must relocate before letting or work must be included in the state contract.

Potential Obstacles or Barriers

Any of the following circumstances may present obstacles or barriers and prevent reimbursement for early relocation incentives:

- Only specific project types are eligible for reimbursement.
- Decisions or thresholds on the types of projects to include must be developed, ideally with support and agreement from the utility industry.

- UCs may not be able to perform the work before construction.
- UCs may be reluctant to allow a state contractor to perform the work.
- Reimbursement for early relocation of utilities requires legislative approval in most states.
- Early relocation of utilities requires additional funding.
- Resource and regulatory agencies may still prefer to hold DOTs responsible for work occurring in the DOT ROW.

Implementation Requirements

In most states, reimbursement for early relocation of utilities will require supporting state legislation to provide the necessary funding. Whether it is approved by policy or legislation, an agreement on project thresholds for inclusion in utility relocation reimbursement is necessary. The policy should provide specific guidance of the relocation process, including timing requirements, limitations for reimbursement, permit requirements, and whether the UC's or DOT's contractor will perform the work. Training on state-specific policy and specific project types is eligible for reimbursement.

Supportive Skills and Training

No additional training is required other than an audit review of reimbursement requests.

Evaluation and Continuous Improvement

Ongoing evaluation can yield lessons learned, identify areas where the process could be tweaked, and give guidance for improvement. To evaluate the use of utility reimbursement policies, DOTs and UCs should document and assess whether reimbursement for early relocation improved the efficiency of the design process and reduced potential utility delays during construction. The assessment should include whether the new process improved interactions between the DOT and the UCs and between the UCs and the contractor. Delays and avoidance of delays should be documented and evaluated for cause. Observations of UCs, DOTs, or contractors on the effectiveness of reimbursing a utility for the cost of relocating its facility or opportunities for improvement should also be recorded and evaluated.

Best Practice #7: Development of Utility and ROW Management Systems

Several state DOTs have implemented the use of ROW and utility and management systems to manage the utility relocation process more efficiently. The complexity of the management system varies between states, but the overall objective is to help DOTs manage and track all the information provided throughout the project's phases. Critical milestones can be identified and the management system can be used throughout all project phases.

Potential Obstacles and Barriers

Any of the following circumstances may present obstacles or barriers to the development of ROW and utility management systems:

- Inadequate investment budget,
- Time to test new software,
- Time to train employees, and
- Lack of proper training on how to use the ROW and utility management system effectively.

Implementation Requirements

Business processes must be revised to include the use of the information management tools, and DOT personnel must be willing to use the system to the full extent of its functionality. The management system needs the capability to contain a large volume of as-built information, use graphics to depict information, and have the ability to connect to other databases containing related information. Before implementation, requirements regarding data ownership, data stewardship, and data standards should be clearly articulated. The plan needs a process to control the quality of archived data and preserve the security of the system. Additional funding may be needed to provide training on how to use the system.

Supportive Skills and Training

Users must be trained in use of the ROW and utility management system software.

Evaluation and Continuous Improvement

Evaluation of the management system should be continuous to document lessons learned, identify areas that need improvement, and provide guidance for improvement. To evaluate the ROW and utility management system, DOTs and utility companies should document and assess whether the system improved the efficiency of the design process, increased productivity, and saved time. The assessment should include whether the new process improved interactions between the DOT and the UCs and between the UCs and the contractor. Delays and avoidance of delays should be documented and evaluated for cause. Observations of DOTs, UCs, and contractors on the effectiveness of the use of ROW and utility and management systems to manage the utility relocation process or opportunities for improvement should also be recorded and evaluated.

Best Practice #8: Inclusion of Utility Relocation Work in DOT Construction Contract

Inclusion of the utility relocation work in the scope of the contractor's work avoids many of the coordination issues and scheduling conflicts between the utility relocation and the DOT contractor's work. Under this arrangement, funding agreements may provide for reimbursement to the state by the UC. The efficiency of the contractor may be increased when the contractor is in control of the facilities and the schedule.

Potential Obstacles or Barriers

Any of the following circumstances may present obstacles or barriers, preventing utility relocation work from being completed by the construction contractor:

- The UC must allow the highway contractor to perform the work.
- The highway contractor might not have experience with the type of utility work in question.
- Utility relocation work may add more time to the contract.
- Additional utility relocation work increases costs.
- The DOT has increased liability and scope of responsibility.

Implementation Requirements

The UC must be willing to allow the DOT's contractor to perform the work. In some states, this may require supporting state legislation because of the DOT's increased liability. The DOT must be willing to accept the increased scope of responsibility and develop an agreement structure and process to ensure that the state's contractor has the knowledge, skill level, and resources to be able to perform the utility relocation work alone.

Supportive Skills and Training

When utility relocation work is included in the construction contract, DOT construction staff will have responsibility for overseeing and inspecting the contractor's work process. DOT construction staff will need training in the technical issues involved in relocation of utilities.

Evaluation and Continuous Improvement

Ongoing evaluation can yield lessons learned, identify areas where the process needs improving, and provide guidance to improvement. To evaluate the effectiveness of incorporating utility relocation work in the DOT construction contract, DOTs and UCs should document and assess if the new process avoids scheduling conflicts between the contractor and UCs, and whether the overall efficiency of the contractor is improved when the contractor is in control of the facilities and the schedule. The assessment should include whether the new process met the UC's requirements and improved interactions between the DOT and UCs and between UCs and the contractor. Delays (and avoidance of delays) should be documented and evaluated for cause. Observations of DOTs, UCs, and contractors on the effectiveness of including utility relocation work in the scope of the contractor's work or opportunities for improvement should also be recorded.

Best Practice #9: Subsurface Utility Engineering

Subsurface utility engineering (SUE) can be used to locate existing underground utilities and identify potential conflicts. SUE determines underground utility locations through records, surface features, surface geophysical methods, and excavation. Various levels of effort can be used to manage risks associated with incomplete or inaccurate utility information. CI/ASCE 38-02, "Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data," is a basis for developing a scope of work for utility mapping. Best Practice #3 discusses training programs to teach employees when and how to use SUE information.

Potential Obstacles or Barriers

The use of SUE can provide valuable information, but at a cost. Other barriers also affect its use:

- There may be an increased budget when SUE is not available as a non-project-specific service.
- It may be difficult to document cost-effectiveness of SUE.
- It may be difficult to evaluate the benefits of SUE.
- Qualified SUE providers may not be available.
- Guidance is lacking on when and where SUE should be used for maximum cost-effectiveness.
- Understanding of the importance of SUE may be lacking.
- Training is needed to use SUE services effectively.
- Expectations of the precision of SUE may be unrealistically high.

Implementation Requirements

Additional money and training are needed to use SUE services effectively. Guidelines need to be developed on the requirements for SUE providers so DOTs can determine where and when it should be used and at what level. Training on the effective use of SUE is necessary for employees, and designers must be willing to use the information provided.

Supportive Skills and Training

DOT design engineers must be skilled in the use of SUE to determine where and when SUE should be used.

Evaluation and Continuous Improvement

Ongoing evaluation of the use of SUE can provide lessons learned, identify areas for improvement, and guide improvement. To evaluate the use of SUE, DOTs should document and assess whether the use of SUE improves the efficiency of the design process, if it provides accurate utility information, and if it results in time savings and a reduction of utility relocation costs by allowing the designer to avoid potential utility conflicts. The assessment should include whether the new process improved interactions between the DOT and the UCs and between the UCs and the contractor. Delays (and avoidance of delays) should be documented and evaluated for cause. Observations of UCs, DOTs, or contractors on the effectiveness of the use of SUE should also be recorded.

Best Practice #10: Utility Coordination Meeting Held During Design Phase

Several state DOTs and UCs stated that a utility coordination meeting is held during the project design phase to determine conflicts, analyze alternative design options, and open the lines of communication between the DOT and UCs. The interviewees highly recommended a face-to-face meeting as a valuable communication tool; however, ultimately, this practice was dropped as part of industry review team feedback.

Best Practice #11: Utility Impact Matrix

Georgia DOT uses a utility impact matrix on every project involving utilities. All utility conflicts are listed and a SUE consultant provides a resolution recommendation. Resolutions may include relocating the utility or adjusting the highway design. This management tool identifies potential conflicts and analyzes for the best solution. Utility relocation costs may be reduced by allowing the designer to make informed design decisions around potential utility conflicts.

Potential Obstacles or Barriers

The use of a utility impact matrix can clarify project conflicts and indicate solutions. At the same time, using a utility impact matrix is not simple:

- Design engineers must be trained in the use of a matrix.
- A utility impact matrix may not be justified for all projects; simple low-impact utility projects may not require this activity.

Implementation Requirements

A SUE consultant may be needed to identify every utility conflict and recommend a resolution, which requires additional time and funding.

Supportive Skills and Training

DOT designers must be trained in the use of the utility impact matrix to make informed decisions about potential utility conflicts.

Evaluation and Continuous Improvement

Ongoing evaluation can yield lessons learned, identify areas for improvement, and guide improvement. To evaluate the effectiveness of a utility impact matrix, DOTs should document and assess whether use of the tool improved the quality of project design and reduced utility conflicts during construction and whether the process improved interactions between the DOT and the UCs and between the UCs and the contractor. Delays and avoidance of delays should be documented and evaluated for cause. Observations of DOTs, UCs, or contractors on the effectiveness of a utility impact matrix should be recorded.

Best Practice #12: SUE Rating Procedures

Many state DOTs cited the use of SUE as a best practice, but also noted as a barrier not knowing where and when to use the SUE process. Some states have created tools and guidelines to help determine how SUE should be used on certain projects and which level of SUE quality should be used.

Potential Obstacles and Barriers

SUE can provide valuable information, but certain circumstances may not warrant its use:

- Newly developed tools and guidelines may not be all-encompassing. A situation might occur that is not considered in the guidelines; therefore, it is still a judgment call on the part of the designer.
- Some training is required for designers to know when and where to use SUE.

Implementation Requirements

Guides or forms need to be developed by the DOT or adapted for use by design engineers to help determine if the SUE process should be used on a certain project. Design engineers must be trained in the use of forms or guides.

Supportive Skill and Training

DOT design engineers must have basic training in SUE fundamentals and be trained in the use of the SUE impact rating form.

Evaluation and Continuous Improvement

Ongoing evaluation of the forms can yield lessons learned, identify areas where the process needs improving, and guide improvement. To evaluate the effectiveness of SUE impact rating forms, DOTs should document and assess whether use of the rating form improved the efficient use of SUE and resulted in reduced design cost and time. The assessment should include whether the use of a rating form improved the quality of project design and reduced utility conflicts during construction and whether the process improved interactions between the DOT and the UC and between the UC and the contractor. Delays and avoidance of delays should be documented and evaluated for cause. Observations of UCs, DOTs, or contractors on the effectiveness of the use of SUE rating procedures should be recorded.

Best Practice #13: Work Site Utility Coordination Supervisor

Georgia DOT requires a work site utility coordination supervisor on every project that uses SUE. The state's contractor must hire this supervisor to coordinate utilities during the construction phase and create an Emergency Response Plan for every project and foreseeable event, such as knowing where the nearest cutoff valve is in case of a water main break.

Potential Conflicts or Barriers

Employing a worksite utility coordination supervisor may require consideration of certain constraints:

- Amendments to the construction specifications may be needed to require the contractor to develop a comprehensive emergency response plan.
- DOT funding will be required for the contractor to provide a work site utility coordinator.
- There may be a lack of available qualified personnel with sufficient understanding or training in UC needs and processes.
- DOT may remain in facilitation or conflict resolution role.

Implementation Requirements

The DOT will need to identify and hire contractors who can provide competent utility coordination supervisors who are knowledgeable of the utility relocation process and have a good relationship with the UCs. The roles and responsibilities of the utility coordination supervisor will have to be clearly articulated and included in the construction contract.

Supportive Skills and Training

The work site coordination engineer must be a skilled project manager with an understanding of the utility relocation technology and processes and technical survey and utility location processes.

Evaluation and Continuous Improvement

Ongoing evaluation of work site supervisors should occur in order to learn from weaknesses, identify areas where the process could be tweaked, and continuously improve. To evaluate the effectiveness of the use of a work site utility coordination supervisor, DOTs should document and assess whether use of the supervisor improved interactions between the DOT and the UC and between the UC and the contractor. Delays and avoidance of delays should be documented and evaluated in relation to cause. Any other observations of UCs, DOTs, or contractors on the effectiveness of a work site utility coordination supervisor or opportunities for improvement should also be recorded.

Toolbox of Practices

Practices in the toolbox cover the whole project life cycle, as shown in Figure 1. The recommended practices that have been included in the toolbox are organized for each tool or practice with the following information:

1. Best practice title
2. Detailed description
3. Source (who has implemented this)
4. History (when started, results)
5. Implementation requirements
6. Possible barriers
7. Expected benefits
8. Potential evaluation factors and considerations

This toolbox, including a detailed summary of each best practice, appears in Appendix B. The industry review team helped to develop and identify implementation issues.

Evaluation of Practices

DOT and Industry Comments

The research team developed a one-page form for DOT and industry comments on the recommended practices. The request for comments was sent to all DOTs and previously identified utility industry contacts. DOTs were asked to obtain input from the utilities in their state. A summary of the results is provided in Table 6.

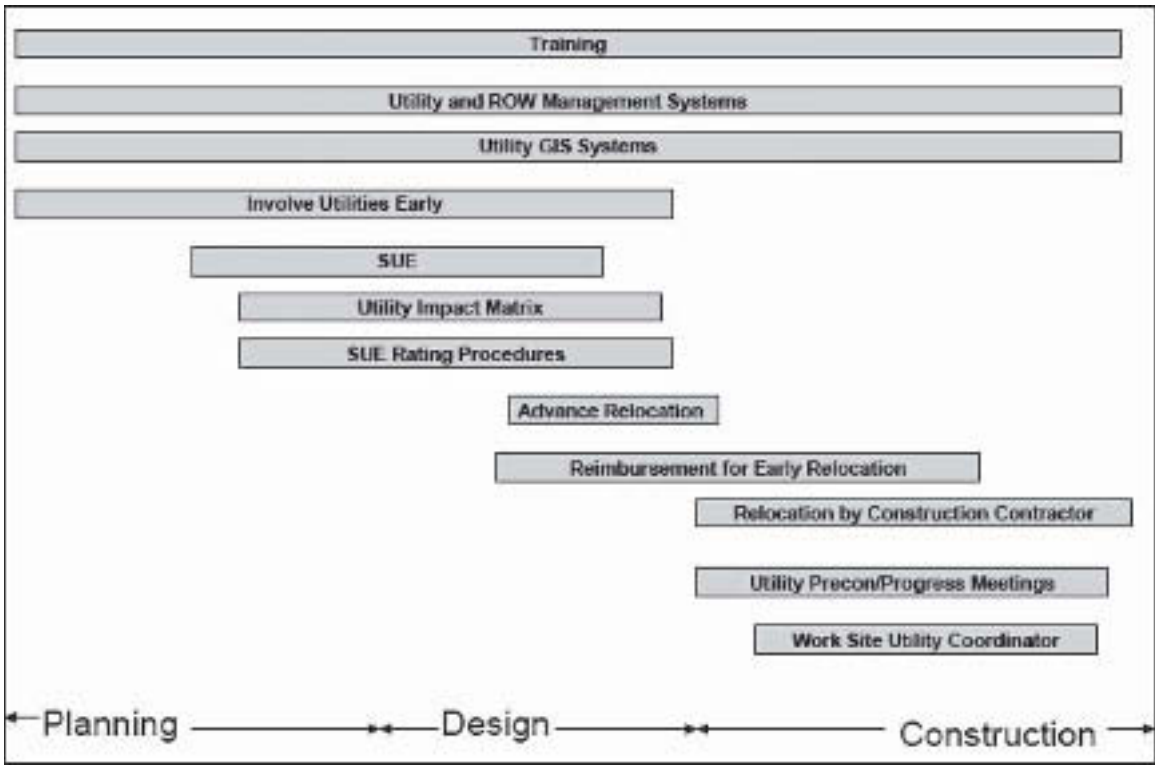

Figure 1. Recommended practices by phase.

Respondents ranked "Advance Relocation of Utilities" highest in value provided and "Providing a Work Site Utility Supervisor" as the least valuable. The remaining recommended practices ranked closely in value ratings. Following is the list of rankings from most to least valuable:

- Advance relocation of utilities;
- Data server with DOT as-built information, linked to GIS;
- Statewide GIS layers with all utilities;
- Electronic information-sharing system for plans, redlining, and comments;
- Preconstruction meetings;
- DOT ROW/utility management systems;
- Utility relocation work included in DOT construction contract;
- Subsurface utility engineering; and
- Use of utility impact matrix.

A second set was ranked slightly less valuable:

- Early notification of UCs (e.g., 30% design or earlier);
- Education for designers on other organization's (DOT or UC) needs and processes;
- Progress meetings during construction;
- DOT reimbursement of utility relocation; and
- Guidance when and where to use SUE, such as impact rating.

DOTs and UCs indicated that the most helpful practice for improving the quality of design would be education for designers on each other's needs and processes. This was also gauged as the practice that would most improve the efficiency of the design process. Early notification of UCs (at 30% design or less) was estimated to be the practice with the best potential for improving the relationship between the DOT and the UC. A work site utility coordination supervisor or engineer was judged to be the best practice to reduce delays in the construction phase, closely followed by advance relocation of utilities.

To varying degrees, DOTs indicated their interest in implementing and evaluating best practices that they were not currently using. DOTs were most interested in implementing information systems. Most DOTs were interested in implementing an electronic information-sharing system for plans, redlining, and comments. Statewide GIS layers with all utilities and data servers with DOT as-built information linked to GIS were also of interest.

Respondents were also asked to suggest evaluation factors for the best practice implementation. Identified factors were

	Do You Use this Practice/ Strategy % Yes	Which Are Best, Given the Effort? (# from 1-least to 15-most benefit)	Improve the Quality of Project Design?	Improve Efficiency of the Design Process?	Improve Relationship between the DOT and UC?	Reduce Delays in the Construction Phase?	If Not Using the Practice, Are You Interested in Implementing It? % Interested and Very Interested
Advance relocation of utilities	100.0%	9.4	1.6	2.6	2.0	3.5	0.0%
Early notification of UCs (e.g. 30% Design or earlier)	100.0%	8.5	2.0	2.4	2.8	2.4	33.3%
Education for Designers on other organization's (DOT or UC's) needs and processes	66.7%	8.8	3.0	3.3	2.7	2.0	33.3%
Data server with DOT as built information, linked to GIS	16.7%	8.9	NA	NA	NA	NA	50.0%
Statewide GIS layer(s) with all utilities	0.0%	8.9	NA	NA	NA	NA	50.0%
Electronic information sharing system for plans, red-lining, and comments	0.0%	8.9	2.2	2.8	2.5	2.6	66.7%
Pre-construction meetings	100.0%	8.9	2.2	2.8	2.5	2.6	NA
Progress meetings during construction	83.3%	8.8	2.4	2.8	2.6	2.4	NA
DOT reimbursement of utility relocation	66.7%	8.8	2.4	2.9	2.6	2.4	0.0%
DOT Utility/ROW Management Systems	50.0%	8.9	2.3	2.8	2.5	2.5	16.7%
Utility relocation work included in DOT Construction Contract	66.7%	8.9	2.3	2.8	2.5	2.5	0.0%
Subsurface Utility Engineering (SUE)	100.0%	8.9	2.3	2.8	2.5	2.5	NA
Use of Utility Impact Matrix	50.0%	8.9	2.3	2.8	2.5	2.5	33.3%
Guidance when and where to use SUE; e.g. impact rating	50.0%	8.8	2.3	2.8	2.6	2.5	0.0%
Worksite Utility Coordination Supervisor/Engineer	16.7%	4.0	1.0	1.0	2.0	4.0	16.7%

Table 6. Summary of DOT and Industry Comment on Recommended Practices

considered in the development of the following evaluation assessments.

Innovation

Many of the best practices are not new. In fact, they are well-proven management principles and continue to be valid tools for improvement. For example, continuous and early communication is a fundamental project management principle. Some of the practices are becoming common, as word of their effectiveness spreads, including advance relocation of utilities, early notification of UCs (e.g., 30% design or earlier), and SUE. DOT reimbursement for utility relocation and inclusion of utility relocation work in DOT construction contracts are becoming more common. DOTs and UCs are also stepping up educating their designers on each other's processes.

Newer developments include guidance on when and where to use SUE, use of utility impact matrices, and data servers with DOT as-built information linked to GIS. Some areas still require much work, investment, and innovation. SUE may have evolved from an innovation to a standard practice; however, the engineering and management tools for using SUE require additional innovation. The information technology tools suggested for ROW/utility management systems are still emerging and under development in some cases. GIS data management is also emerging.

The suggested paradigm of the DOT and UC working as partners would chart new territory, especially in changing the role of the DOT to the custodian of a transportation corridor that transports many different commodities (vehicles, people, and utilities).

Development of Suggested Evaluation Framework

The evaluation and testing strategy used a qualitative evaluation instrument to provide results feedback from key project participants, with specifics structured to address the main features of the particular strategy and expected outcomes. Preliminary prototypes of these assessments were developed on the general outline shown in Figure 2.

Has the practice been implemented?	☐ Yes	☐ No								
How frequently is the practice used?										
Implementation problems (address more specifically in Part 3 below)?	☐ Yes	☐ No								
PART 2 – EVALUATION SPECIFIC TO BEST PRACTICE										
On a scale of 1 to 10, with 1 being a negative effect, 5 being no effect, and 10 being significant improvement over previous practices, rate the effect of this Best Practice on the following:										
	1	2	3	4	5	6	7	8	9	10
Communication between DOT and Utility										
Overall relationship between DOT and Utility										
Relationship between DOT/Utility and Contractor(s)										
Design Efficiency										
Consistency in Design Process										
Information Sharing Among Internal Stakeholders (DOT, Utility, Contractor)										
Information Sharing Among External Stakeholders (Facility Users, Public, Other Agencies)										
Avoidance of Utility Conflicts										
Construction Operations										
Overall Project Quality										
Overall Project Cost										

Figure 2. Sample assessment/evaluation form.

(continued on next page)

PART 3 – QUESTIONS/DISCUSSION
1. What worked well as this Best Practice was utilized?
2. Describe problems encountered during implementation of this specific Best Practice *(without regard for simultaneous implementation of any other Best Practice).*
3. Do you believe change orders were avoided by employing this Best Practice? ☐ Yes ☐ No Describe:
4. Did utilization of this Best Practice alter the project construction schedule? ☐ Yes ☐ No Specify how advance relocation of utilities affected this particular project schedule:
5. What would you recommend be changed to improve the effectiveness of this Best Practice?
6. Do you believe this Best Practice is generally applicable to all projects? ☐ Yes ☐ No Discuss reason(s) for your answer:

Figure 2. (Continued).

Recommended Procedures for Typical Utility Relocation

Planning

Recommended Practice: Involve Utilities Early in the Planning and Design Phase

The following actions support cooperation during project planning:

- Provide utility companies with long-range highway construction schedules.
- Host meetings with utility companies to discuss future highway projects.
- Recognize the importance of long-range highway/utility coordination. The better utilities can foresee potential impacts on highway projects to their systems, the more responsive they will be to transportation agency needs and the better they can account for such impacts in their capital construction programs. Conversely, transportation agencies will improve the quality of project scoping, budgeting, and design efforts if they can obtain early information on utility construction programs and potential conflicts.
- Furnish information on the DOT long-range highway schedule, such as annual budgets, 5- or 10-year plans, projected advertisement dates, or other information available to provide early notice. Be prepared to discuss ROW corridor or other major projects and their potential impacts on existing utilities. Identify probable conflicts and ensure this information is communicated to the project designer and reflected in the project scope.
- Solicit similar information on utility owner's capital construction programs, particularly where a utility's planned expansion or reconstruction may encroach on and coincide with a planned highway project. Look for opportunities to coordinate overlapping projects so that costs and public impact may be minimized. Through schedule changes, try to avoid situations such as where a new buried utility line disrupts a newly reconstructed highway.

- Consider using the long-range planning meeting as a convenient forum to discuss other highway/utility issues, such as accommodation policies and reimbursement. What begins as a series of informal planning meetings could eventually evolve into a local, regional, or statewide utility coordination committee.
  - Florida DOT provides a 5-year work program to utility companies semiannually and is exploring ways to make more use of the web to keep UCs current.
  - In Nevada, monthly meetings with local utility companies and local entities are held in the Las Vegas area to enable participants to address upcoming project needs and identify better ways to improve future projects when dealing with utility relocations. These meetings provide an opportunity for Nevada DOT to better coordinate efforts with county officials and utilities to prevent project delays and costly mitigation.
  - Montana DOT provides 5-year long-range project schedules to all utility companies. These schedules are segregated by geographical area.
- Consider providing earlier preliminary notice to utility companies to allow the utility companies to budget for relocations and have sufficient personnel available to do the work.
- Provide utility companies with a notice of proposed highway improvements and preliminary plans as early in the development of highway projects as possible. Ensure that utility companies understand that the dates on which the work may actually take place are subject to change, the preliminary plans are subject to many changes, and no relocation work should begin until firm letting dates have been established, plans have been substantially completed, and the DOT provides notification that work can begin.
  - In Wisconsin, all utility facilities that the DOT is reasonably able to recognize are included in such a notice. Within a reasonable time, usually about 60 days, utility companies are expected to respond to the notice and provide a description of facilities in the vicinity of the improvements, including specific reasons or needs for those facilities to remain in place or be relocated. After each utility responds to the notice, the DOT mails the utility at least one set of preliminary project plans. These plans should show all existing utility facilities known to the DOT in areas where they will conflict with the improvements. This process is followed by the Wisconsin DOT in accordance with a state law enacted to prescribe minimum utility coordination requirements to prevent utility relocations from delaying highway projects [Sec. 84.063, Wis. Stats. Utility Facility Relocations and related Administrative Rule Trans 220].
  - In Missouri, the DOT furnishes microstation plan files to utility companies to reduce the drafting work by the utility companies. This process expedites development of utility relocation plans on a project.
  - In Florida, the DOT provides utility companies with advance notice of proposed highway improvements and furnishes preliminary route plans.
    - The DOT also submits 30%, 60%, and 90% plans to utility companies as part of the design process.
    - At least one Florida DOT district sends the utilities a monthly mail-out listing all projects in the production and letting cycle. This practice typically gives the utilities about 18 months of advance notice on planned projects.
    - Twice yearly, the DOT sends its 5-year work program to all utility companies in the state.
    - The Florida Utility Coordination Committee meets quarterly at different locations in the state.
    - The DOT maintains a utility web page containing its 5-year work program; names, addresses, and contact numbers of district utility engineers; advice on obtaining permits; and permit forms and agreements.
  - Georgia and South Carolina DOTs also host regular meetings with utility companies to advise them of pending projects and to review and submit preliminary plans to utility companies.

Design

Recommended Practices: Involve Utilities Early in the Planning and Design Phase and Hold Utility Coordination Meetings During the Design Phase

The following actions support cooperation in the design phase:

- Involve utility companies in the design phase of highway projects where major relocations are anticipated, to reduce conflict. Cost-effective advance planning is essential to utility companies because they must now compete under deregulation. The DOT's help and cooperation is needed more than ever. It is not good business, and may have negative political consequences, if DOTs attempt to dictate to utility companies.
  - Meet often with utility owners and highway designers, throughout the development of projects to coordinate ongoing activities.
  - Conduct onsite meetings or plan-in-hands with utility companies to determine utility conflicts and appropriate resolutions.
  - Conduct monthly detailed meetings on major projects, at a minimum, for all parties to keep abreast of the project status and changes.

  - DOT project engineers should meet individually with representatives from every utility company to minimize the possibility the DOT will reject utilities' relocation plans and require redesign of the relocation. Early involvement can decrease the cost and impact of projects by identifying conflicts that can be avoided.
  - Involve utility companies in the right-of-way design phase to ensure utility companies have room between the construction limits and the new ROW where facilities will relocate.
    - Pennsylvania DOT holds onsite meetings with utility companies in all 11 of its engineering districts. This produces valuable information for and from involved utilities and has not appeared to affect the time frame of projects.
    - Virginia DOT contacts utility owners during the design phases of projects where major relocations are anticipated. This allows planners to understand relocation needs and to identify major ROW corridor requirements for anticipated relocations. This has worked particularly well for major power transmission and petroleum pipeline relocations. Virginia DOT has had only limited success involving utilities on projects where few relocations are anticipated because utility owners seem to prefer to wait until after the design has been essentially completed to discuss relocations. Virginia DOT strives to avoid or minimize relocations through application of its SUE program.
    - Some states such as Iowa design ROW limits at least 8 m beyond the construction limits to allow utility companies room to relocate facilities.
- Conduct onsite utility meetings or utility plan-in-hands with utility companies to determine utility conflicts and resolution.
- Participate in local One Call notification programs to the maximum extent practicable according to state law. "Utility companies in Germany are responsible for identifying all of their underground facilities and making this information known to highway contractors prior to excavation. Highway contractors in The Netherlands are required to call a national information center to obtain pertinent information about underground utilities in the area before they begin excavation activities. Highway contractors in United Kingdom must notify all affected utilities before they begin to dig. Despite these activities, damage to underground utilities continues to occur. Extensive One Call notification programs have been developed in the United States to reduce damage to underground utilities caused by excavation activities. Even so, damage continues to occur. In order to protect underground utilities from unnecessary damage, state DOTs should utilize One Call notification centers at an appropriate level of participation, and should provide sufficient oversight to assure that highway contractors fully participate in One Call notification programs" (*3 at 37*). FHWA considers damage prevention to be a two-part process involving subsurface utility engineering during the early development of a project and One Call notification during the construction phase of a project.
  - Require contractors to fully participate in local One Call notification programs whether required by state law or not. (DOTs in several states are specifically excluded from One Call requirements, but contractors are not). This would include contacting the local One Call center before digging, waiting for the site to be marked before beginning to excavate, protecting the markings after they are placed, and hand digging within 2 ft on either side of marked lines.
  - DOTs should provide oversight to ensure compliance. Penalties should be assessed for noncompliance.
  - Contractors should be held responsible for damage caused by noncompliance.
  - State DOTs own or manage many underground utilities—sometimes vast, statewide networks for traffic signalization, lighting, intelligent transportation systems, and other purposes. Some DOTs are specifically exempted by state law from having to participate in local One Call activities. Montana DOT is securing proposals for a locating services company to locate state-owned facilities for all One Call requests.

Recommended Practice: Use Subsurface Utility Engineering Where Appropriate

The appropriate use of SUE is necessary to obtain the critical information needed for quality designs. SUE can be used to locate existing underground utilities and identify potential conflicts. SUE determines underground utility locations by using records, surface features, surface geophysical methods, and vacuum excavation. Various levels of SUE can be used to find the degree of precision needed. CI/ASCE 38-02, "Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data," serves as a basis for development of a scope of work regarding utility mapping.

Recommended Practice: Use a SUE Rating Tool

Designers must apply SUE resources judiciously. It is important to determine what quality level of SUE effort is needed at different locations in a project. Many state DOTs cited the use of SUE as a best practice but also noted not knowing where and when to use SUE as a barrier. Some states have created tools and guidelines to help determine whether SUE should

be used on a certain project and what quality level of SUE effort should be used.

Recommended Practice: Use a Utility Impact Matrix

This is a management tool for identifying potential utility conflicts and analyzing the best solution for each problem. Utility relocation costs may be reduced by allowing the designer to make informed design decisions around potential utility conflicts. Georgia DOT uses a utility impact matrix on every project involving utilities. Every utility conflict is listed, and a SUE consultant provides a resolution recommendation. Resolutions may include relocating the utility or adjusting the highway design.

Recommended Practice: Develop a GIS Database

Develop a GIS database as a tool to facilitate management and transfer of critical location and characterization information. State DOTs and utilities have extensive mapping resources, including general ones that are used at project inception and detailed ones that are created during a project and that could be made more widely available at completion. Compiling these resources and making them available in a central location would benefit state DOTs and UCs alike for permitting utilities and planning future projects. This process should be implemented before design and review. Because of the high development cost, a pooled fund approach may be necessary.

Recommended Practice: Develop a Utility and ROW Management System

Several state DOTs have implemented the use of ROW and utility management systems to manage the utility relocation process more efficiently. The complexity of the management system varies between states, but the overall objective is to help DOTs manage and track all the information provided throughout the project's phases. Critical milestones can also be identified. The management systems can be used throughout all phases of the project. As noted above, this practice is a candidate for a pooled development effort.

Construction

Recommended Practice: Schedule Advance Relocation of Utility Work

When possible, completing utility relocations before the start of construction can help avoid delays. Either the state's contractor or the utility company involved in the relocation may relocate the conflicting utilities before highway construction begins. This practice may not always be possible due to work sequencing issues or other factors discussed below. Several states reported using this best practice successfully.

Recommended Practice: Provide Reimbursement Incentives for Early Relocation

Some states have successfully participated in providing incentive reimbursement to utilities for early relocation. These DOTs have determined that for certain project situations the benefit of obtaining early relocation more than offsets the reimbursement cost. This may be a project-specific issue. Also, reimbursement may require legislative change.

Recommended Practice: Hold Preconstruction and Progress Meetings

Invite utility companies to preconstruction meetings and encourage or require utility companies, contractors, and project staff to hold regular meetings, as appropriate, during the construction phase of a project.

- Encourage or require all utility owners who must coordinate their relocation work with the highway construction to attend the project preconstruction conference. The purpose of their participation is the following:
  - Establish contact with the DOT project manager and the contractor's organization.
  - Confirm the utility's physical relocation plans.
  - Verify the utility's relocation schedule and notification and coordination requirements as described in the project specifications.
  - Resolve other coordination details, such as signing and traffic control and site preparation by highway contractor.
  - Give utility owner representatives sufficient advance written meeting notice to facilitate their attendance.
  - Confirm their planned attendance by follow-up telephone call.
  - Designate a specific time during the preconstruction meeting to address utility issues.
  - Honor that meeting schedule and allow the utility representatives to be present only as needed during the reserved time period.
  - Depending on the number and complexity of the utility conflicts, reserve separate times for individual utility owners.
  - At the discretion of the DOT's utility engineer or utility liaison, hold a separate preconstruction meeting with utility representatives and utility subcontractors. This

sometimes provides a more comfortable setting for utilities to address their coordination needs. If potentially serious concerns are identified, the DOT representative can then provide liaison between the utility and the highway contractor. A separate meeting with utility representatives may also avoid tying up the time of other DOT and contractor representatives who may have little direct involvement with the utility issues.

- Wyoming recommends that utilities affected by project construction attend the preconstruction conference. The Wyoming DOT assigns levels of utility involvement with a project so that utility companies and contractors are familiar with the extent of each utility company and contractor coordination work that is necessary. Wyoming also invites utility companies affected by a project to attend partnering meetings.
- The Virginia DOT encourages or requires regular meetings between the contractor, utility owners, and others on major projects.

Recommended Practice: Include Utility Work in the Construction Contract

Inclusion of the utility relocation work in the scope of the contractor's work avoids many of the coordination issues and scheduling conflicts between the utility relocation and the DOT contractor's work. Under this arrangement, funding agreements may provide for reimbursement to the state by the UC. The efficiency of contractors may be increased when they have control of the facilities and the schedule. The UC must be willing to allow the DOT's contractor to perform the work. In some states this may require supporting state legislation because of the DOT's increased liability, and the DOT must be willing to accept the increased scope of responsibility and develop an agreement structure and process to ensure that the state's contractor has the knowledge, skill level, and resources to be able to perform the utility relocation work alone.

Recommended Practice: Use a Work Site Utility Coordination Supervisor

Complex projects may warrant the assignment of a project utility coordinator. This person would serve as an additional resource, coordinating utility issues during construction. Georgia DOT requires a work site utility coordination supervisor on every project that uses SUE. The state's contractor must hire this supervisor to coordinate utilities during the construction phase. This person must also create an emergency response plan for every project and foreseeable event (e.g., where the nearest cutoff valve is in case of a water main break).

Other Value-Adding Procedures

Recommended Practice: Provide Training for DOT Designers

Develop a complete basic and advanced training program for new employees and continuing education for experienced staff. Several state DOTs and UCs claimed that many designers are not sufficiently knowledgeable of the utility relocation process (and technical issues) and suggested that training programs be held to teach them. High turnover rates at DOTs have led to inexperienced people doing design, and utility networks can be very complex. There is a feeling in the utility industry that if DOT designers understood the complexity of some utility systems, a greater effort would be made to avoid utility relocation during highway design. Advancements in technology are also being made, providing new information that could be used in the design and relocation process. Training must be done to get designers and UCs to use this information correctly. This practice should be employed before the design phase.

When designers have a comprehensive understanding of the utility system and the relocation process, consideration of utilities during the design process will increase the potential for cost savings with innovative designs that avoid utility relocations. The development of a consistent procedure to follow and better coordination with the UC can increase timely relocations, reduce utility delay claims, and gain the confidence of the people with whom you are working. Additional training needs include basic project management fundamentals and training in the best use of SUE as a design aid.

Take the lead in developing and supporting utility coordinating committees. It is important to enhance cooperation, coordination, and communication with utility companies. "According to the U.S. GAO, the states that have active utilities coordinating committees that meet on a regular basis to discuss common problems have fewer utility-related problems than other states. The team recommends that state DOTs continue and intensify efforts to meet with utility company representatives regularly. DOTs should take the lead in developing and supporting utilities coordinating committees" (*3 at p. 35*).

- The Florida Utilities Coordinating Committee meets quarterly at various locations around the state. It is well attended by state DOT and utility company personnel. Many common problems are discussed and many issues are resolved. In addition, these 2-day meetings provide sufficient time for networking and social interaction, both of which contribute significantly to better understanding and better working relationships.

- The North Carolina and South Carolina Utilities Coordinating Committees meet annually for a 2-day joint meeting, alternating each year from state to state. Both have many chapters that meet regularly at locations around the states.

Consider Standardizing the Qualifications of Utility Coordinators

Utilities and the technical aspects of their relocation engineering have become significantly more complex. Utility coordinators employed by DOTs, contractors, or UCs need a strong knowledge and experience foundation. This area of practice has had little structure for training and experience qualifications. A national certification process may be the logical outcome of the development of training and experience standards. Although many issues must be resolved, the researchers recommend that this subject be given further consideration and development. A suggested research proposal has been included for further investigation of the feasibility of a national certification program.

Roles and Responsibilities

In addition to procedures, clear roles and responsibilities are essential. The following sections list generic functions and responsibilities.

Generic DOT Functions Related to Utilities

The DOT utility agreements and permits unit

- Ensures that state statutes and rules regarding utility relocation are followed,
- Implements the accommodation policy,
- Issues notice and orders,
- Executes utility agreements (payable and receivable), and
- Issues permits for permanent utility installations.

The utilities engineer

- Oversees the activities of the utility agreements and permits unit;
- Approves utility agreements;
- Issues notices, orders, and permits on behalf of the commissioner of transportation;
- Enforces the DOT's utility accommodation policy, if one exists;
- Helps resolve outstanding utility issues; and
- Coordinates utilities, including municipally owned facilities, on design–build projects.

The utility agreement writer

- Reviews district plans and recommends changes,
- Prepares and sends all notices and orders,
- Prepares and processes utility relocation agreements, and
- Acts as a liaison between the district and the utility owners and serves as a central resource for utility issues.

The utility permit writer

- Reviews and processes all applications for long-form utility permits to install permanent facilities on highway ROW,
- Suggests changes to applications if necessary, and
- Issues permits (often with special provisions) for any utility work to be performed in state ROW.

DOT Municipal Agreements

A municipal agreements section or unit prepares and administers municipal agreements, which include cooperative construction agreements, landscape partnership agreements, detour agreements, and signal agreements with cities, counties, soil and water conservation districts, and state and federal agencies.

The municipal agreements engineer

- Administers and coordinates agreements with municipalities for municipally owned utility facilities that are affected by construction or utility betterments as a result of construction, cooperative construction elements in state-let or locally let contracts, or other agreements as needed;
- Encumbers funds to pay local units of government or coordinates invoices to pay the state for construction elements;
- Develops and implements policies and procedures to address current laws and regulations; and
- Distributes information to provide guidance for continuous improvement of agreement procedures.

The municipal agreement writer

- Provides engineering expertise and acts as a liaison to the district to assist with the development of the agreements necessary for highway construction projects;
- Verifies that elements of a construction project comply with the DOT's policy and procedure for cooperative construction projects with local units of government, if one exists; and
- Writes the municipal agreements with the coordination and assistance of the project manager.

DOT Office of Contract Management

The DOT Office of Contract Management

- Prepares legal documents, with the preparatory negotiations and receipt of signatures conducted by district staff;
- Provides a legal review of all utility agreements; and
- Holds authority to sign utility agreements of up to $1 million on behalf of the Department of Administration.

DOT Office of Land Management or Right-of-Way

ROW professionals assist other DOT staff by obtaining necessary right-of-way and preparing quitclaim deeds on transportation projects that require additional right-of-way.

DOT Office of Bridges and Structures

The Office of Bridges and Structures

- Reviews preliminary plans and highlights conflicts between utility facilities and bridges;
- Sends highlighted plans to the project manager, who collects all of the information, confirms relocation issues with utility owners, and requests accommodation;
- Designs the accommodation elements for an attachment to or design into a bridge after receiving an accommodation request;
- Prepares cost estimates for accommodations and forwards them to the utility agreements and permits unit to use in a utility agreement; and
- Receives permit requests from districts to accommodate utility facilities on bridges and evaluates these requests and reviews, comments, and approves the plans that the utility owners send with their requests to determine if the proposed accommodation is possible.

Generic DOT District Functions Related to Utilities

The district design team

- Identifies utilities early in the design phase,
- Conducts utility information meetings and utility design meetings,
- Communicates project design and coordinates utility relocation with affected operators, and
- Reviews utility relocation plans and permits.

The district engineer or assistant district engineer

- Sets the priorities and budgets for transportation projects in the district,
- Oversees the district's transportation projects and supports the work of those who are involved in the different parts of the process at the district level, and
- Signs utility agreements and permits.

The project manager

- Is responsible for the overall project during the plan development process, or is part of a group of individuals who are responsible for a particular stage of project development in the plan development process;
- Is responsible for overseeing activities to ensure their proper coordination, whether or not the project manager completes the task or delegates the responsibility for the task to another; and
- Oversees many important roles on utility coordination, including:
  - Identifying utilities that a project will impact,
  - Conducting utility meetings, and
  - Leading review of permits.

The design engineer, design project manager, or district utility coordinator may oversee or complete all or some of the utility coordination responsibilities of the project manager. The design project manager may also oversee all of the responsibilities on consultant-designed projects, making sure the consultant understands and completes all tasks satisfactorily.

The construction group includes construction resident engineers, construction project engineers, field engineers, inspectors, and field crews. This group

- Assists with the review of utility relocation plans,
- Coordinates the placement and relocation of utilities during construction, and
- Coordinates daily inspection of work to ensure compliance with plans and specifications and for monitoring progress as a means for justifying payment.

The right-of-way/land management group assists other DOT staff by obtaining the ROW necessary for a project. The surveys team collects data on utility facilities in the proposed project for the project manager. The data include detailed, accurate information on aboveground appurtenances. This team may gather horizontal locations of underground utilities that may be provided through One Call field locates.

The permits team

- Processes many different types of permits, including access, drainage, and short-form utility permits for temporary installations and maintenance projects;
- Checks the accuracy of long-form utility permits;
- Verifies field location;
- Reviews requests for exceptions to the accommodation policy and provides input;
- Reviews utility permits and provides comments or changes or adds special provisions;
- Ensures that appropriate district units review utility permits;
- Determines additional bond requirements; and
- Ensures that utilities complete restoration.

Generic Non-DOT Functions

Legal Counsel

The attorney general assigns an assistant attorney general to act as counsel to the DOT on utility-related issues.

One Call

One Call, which is part of the Department of Public Safety, is the statewide One Call notification system for underground utilities. It provides information about the utility facilities that excavation may affect. State law typically requires any organization or individual whose plans include excavation to contact One Call before digging.

Government Agencies

Governing authorities such as municipalities, townships, counties, park boards, other states, or state agencies other than the DOT are government agencies. Utility relocation on DOT projects may impact these agencies; therefore, it is important to include them early in the utility coordination process.

Utility Owner

The utility owner

- Verifies the company's facilities on preliminary plans;
- Reviews plans;
- Participates in design and related meetings and attends mandatory meetings with all utility owners as part of the design process, including utility information meetings and utility design meetings;
- Submits relocation plans and schedules;
- Coordinates the company's relocation work with the DOT and its contractors;
- Gets permits when performing work in the right-of-way of an interstate, U.S., or state highway. The work may consist of, but is not limited to,
  - Excavating
  - Placing fill materials
  - Grading
  - Paving
  - Surveying
  - Boring under a highway
  - Installing an overhead line
  - Blocking traffic
- Acquires utility permits to construct, operate, or maintain a utility facility. This includes, but is not limited to, gas, electric, phone, cable, cellular, fiber optics, water, and sanitary sewer.

Necessary Additions for Effective Utility Issue Management

The following results are from a synthesis of the research team's in-depth discussions with industry professionals, from both DOTs and UCs, who are actively engaged in addressing utility coordination issues. People are our most important resource, and people are a common element in each of the recommendations below. Training and motivating people at each step in the process requires organizational investment, commitment, and leadership.

A Partnering Relationship

The most successful DOT–utility–contractor working relationships are based on partnering principles. During this study, the research team interviewed a broad selection of DOT utility engineers and their utility company counterparts. The best-of-class examples maintained an operational relationship defined by

- Commitment to common goals,
- Clear definition of roles and responsibilities,
- Early and continuous communication, and
- Commitment to resolve issues at the lowest possible level.

Each party can be faced with unexpected challenges that appear to make performance less than promised; however, working as a team, solutions to the hard problems can be found.

This contextual background is the prerequisite foundation for all other technical and management initiatives. Organiza-

tional leadership at the highest levels should be applied to this objective.

Application of Sound Project Management

In the researchers' discussions with practitioners, a common theme arose. What was needed most was not a new tool such as an information management system or new design software, although such tools could be helpful. Universally, the application of basic project management to the project delivery process and, more specifically, to utility issues, was strongly recommended. Design engineers are by definition trained in engineering. This provides strengths that can be applied to project management. For example, they are trained to solve problems in a logical and structured manner. However, project management involves a much broader scope of skills and knowledge. Following are just a few of the key knowledge areas that come under the project management heading:

- Project integration management,
- Project scope management,
- Project time management,
- Project cost management,
- Project quality management,
- Project human resource management,
- Project communication management, and
- Project risk management.

Competent project management is an essential element in improving the utility coordination process during project development and delivery. Training for this is one of the recommended practices, and this assessment indicates that an investment in project management training may significantly improve the utility coordination process.

Use of Best-of-Class Technical Tools

The cornerstone of developing effective engineering solutions to utility issues is the location information. The quality of the information about the utility location and characterization affects the quality of all subsequent engineering decisions. The smart application of SUE is essential. Budgets are not unlimited; therefore, SUE resources must be applied based on an informed analysis of the project site situation. New tools for managing the application of SUE have emerged and are suggested as recommended practices in this study. Designers must make more effective use of the SUE information provided to them. Roadway designers do not need to be SUE engineers, but they do need training in how to make the best use of SUE technology and the information it provides.

Managing as-built utility location information is an overwhelming endeavor for DOTs and UCs. The challenges are great. The accuracy of much of the historical location information is questionable and its format precedes current digital formats. The first order of business is to see that new as-built information is appropriately managed. Clearly this is an area for the application of state-of-the-art information management tools. Several examples of new initiatives in this area are referenced in this study as best practices. In general, software development requires significant investment. Because most DOTs share this common issue, a pooled effort to produce a tool available to many might make sense.

Roadway design engineers would also benefit from a more complete knowledge of the technical issues involved in relocating the various utility systems that occupy ROWs. In general, DOT engineers do not have a technical background in utility engineering. Many DOTs have somewhat resolved this issue by providing a DOT utility engineering coordinator as a resource. This specialist assists the design team with technical issues and facilitates coordination with the UCs. However, the insight gained from this study is that DOT design engineers would benefit from additional knowledge in the technical aspects of utility relocation. Communications and design quality would be improved.

Next Steps and Recommended Research

In subsequent SHRP 2 Renewal program work, there are three areas that offer particular potential:

- Development of a suite of training tools specifically aimed at utility coordination
  - Effective use of SUE in project development (e.g., Georgia DOT)
  - Utility relocation engineering for roadway designers
  - Project management for engineers
- Development of qualification criteria for utility coordinators and exploration of the feasibility of a national certification process
- Development of the criteria for advanced information systems for managing utility and ROW engineering

States and UCs believe training could improve designs and that improved support for information systems has the most potential in reducing delay. Most of the states expressed interest in information systems, but cited funding as an obstacle.

The initial phase of this study involved detailed discussions with many DOT and UC utility engineers and coordinators. From these structured interviews, the research team identified the most common utility coordination problems. Recommended practices were identified and investigated. The recommended practices that have been suggested in this

report were selected based on their effectiveness in resolving the utility coordination problems. The team believes that all but two of these recommended practices are sufficiently defined in this report to facilitate broader implementation, but the areas for potential development listed above require additional work before implementation can be started. No doubt remains that quality training, appropriately directed, will produce significant improvements in this critical area of the highway renewal process.

The task of managing utility information is becoming exponentially more difficult. Current and past technology simply cannot do the job. We need to apply our best state-of-the-art tools to this critical function. An organized, focused approach to developing the direction of this essential initiative is needed, as well as other key areas for potential improvement. The final chapter of this report includes research statements recommended by the R15 research team.

References

1. U.S. Department of Transportation, Office of the Inspector General. *Audit of the Springfield Interchange Project*, Washington, DC. November 2002.
2. Tennessee's Chapter 86 Provisions: Section 2. Tennessee Code Annotated, Title 54, Chapter 5, Part 8.
3. *Transportation Infrastructure: Impacts of Utility Relocations on Highway and Bridge Projects*, GAO/RCED-99-131. 1999.

CHAPTER 5

Recommendations for Future Research in the SHRP 2 Renewal Program

This chapter presents sample problem statements for recommended future research in several key areas.

Information Management Systems to Support Utility Relocation and Right-of-Way Management

Renewal Focus Area

The overall goal of the SHRP 2 Renewal Program is to develop a consistent, systematic approach to performing highway renewal that is rapid, causes minimum disruption, and produces long-lived facilities. The renewal scope applies to all classes of roads.

Project Background and Problem Statement

State departments of transportation (DOTs) construct, maintain, and operate highways for the benefit of the public, and that has been their traditional charge and focus. DOT rights-of-way (ROWs) now transport much more than people. Since the advent of the highway system, states have extended the use of highway ROWs to utility companies to save public resources and serve the public interest. Now the number of utilities involved and the complexity of the coordination required have grown exponentially.

Utilities occupying DOT ROW have increased in number and type. Accurate location information is critical to the transportation design process. ROW managers and DOT designers are overwhelmed by the volume and complexity of utility location data. The problem is made worse because much of the data are not available in digital format. The difficulty in accessing reliable ROW and location information is an obstacle to improving the transportation renewal process. This universal problem is faced by every DOT and municipal government. An urgent need is to apply the best information management technology to this problem. The development costs are significant, making this product an ideal candidate for a pooled development effort. The necessary first steps are the investigation of feasibility, development of product criteria, and a plan for pooled product development.

Objectives

The objectives of the project are to

- Develop a comprehensive assessment of the information management needs of DOTs concerning ROW and utility location information,
- Research current efforts in this area and identify the most promising,
- Write criteria for development of one or more software tools to support management of ROW and utility location information management, and
- Devise a plan for pooled development of the product.

Tasks

Task descriptions are intended to provide a framework for conducting the research. SHRP 2 is seeking the insights of proposers on how best to achieve the research objective. Proposers are expected to describe research plans that can realistically be accomplished within the constraints of available funds and contract time. Proposals must present the proposers' current thinking in sufficient detail to demonstrate their understanding of the issues and the soundness of their approach to meeting the research objective.

Task 1

Identify the information management needs of DOTs concerning ROW and utility location information. This will include an assessment of the range of existing data formats

and transfer needs. Also, this task must clearly map the data on what information is needed and how it is used.

Task 2

Investigate the current information management initiatives in this area and review current information management technologies appropriate to this area.

Task 3

Write the functional requirements and criteria for this software tool.

Task 4

Devise a plan for a pooled development of the product, including suggestions for acquisition, testing, budget, and schedule.

Task 5

Produce a draft final report documenting the work conducted in Tasks 1 to 4. Following review, submit a final report.

Deliverables

Deliverables include an interim report, a draft final report, and a final report. Funds required are $150,000. Contract time is 12 months, including 3 months for review of the final report.

(***Special Note:*** Proposers should review the final report on SHRP 2 R01, "Encouraging Innovation in Locating and Characterizing Utilities.")

Model Curriculum in Utility Relocation Engineering for Transportation Designers

Renewal Focus Area

The overall goal of the SHRP 2 Renewal Program is to develop a consistent, systematic approach to performing highway renewal that is rapid, causes minimum disruption, and produces long-lived facilities. The renewal scope applies to all classes of roads.

Project Background

State DOTs construct, maintain, and operate highways for the benefit of the public, and that has been their traditional charge and focus. DOT ROWs now transport much more than people. Since the advent of the highway system, states have extended the use of highway ROWs to utility companies to save public resources and serve the public interest. Now the number of utilities involved and the complexity of the coordination required have grown exponentially.

Utilities occupying DOT ROW have increased in number and type. The technical complexity of utility systems has increased. DOT design engineers and DOT construction contractors have little or no formal training in the technical aspect of utility systems. There is a general shortage of experienced designers and the engineering shortage in the United States continues to increase. This absence of technical knowledge is an obstacle to coordination. DOT designers are handicapped in their efforts to design for minimizing utility relocation conflicts because of their limited training in utility engineering.

To improve the efficiency of highway renewal effort there is a need to develop a core curriculum in utility relocation engineering that can be applied in various educational and training settings. This instructional tool will guide the delivery of effective training and educational programs for existing and future highway design professionals.

Objectives

The objectives of the project are to

- Develop a set of core competencies required by the DOT designer for effectively addressing utility relocation issues in the transportation design process;
- Develop a model education and training curriculum based on, but not limited to, the core competencies;
- Conduct a pilot test of the curriculum in an appropriate setting; and
- Develop guidelines for curriculum deployment covering multiple educational and training settings.

Tasks

Task 1

Identify core competencies and indicated learning needs of DOT transportation designers concerning utility relocation engineering. Develop specific learning objectives.

Task 2

Given the indicated core competencies developed in Task 1, develop a model educational and training curriculum. The curriculum will include a clear designation of learning objectives and an organizational structure designating instructional modules and sequencing. Each module will be fully developed, including selection of teaching method, instructional materials, and methods for assessing student learning. Also develop a methodology for curriculum evaluation and a plan for a test pilot.

Task 3

Submit an interim report summarizing the work of Tasks 1 and 2. A revised interim report will be submitted addressing comments received.

Task 4

Conduct the pilot training program, including evaluation of the model curriculum. Address lessons learned and make appropriate revisions to the curriculum.

Task 5

Develop guidelines for implementing the curriculum. The guidelines will describe how to use the curriculum for a variety of learning settings. These settings may include, but are not limited to, distance learning, workshops, short courses, and university courses. Also, describe how the curriculum can be deployed for educational purposes such as certificate programs, degree programs, and on-the-job-training (e.g., federal, state, and local governments and the private sector).

Task 6

Produce a draft final report documenting the work conducted in Tasks 1 to 5. Following review, submit a final report.

Deliverables

Deliverables include the following:

- Interim report,
- Draft final report and final report,
- Training curricula, and
- Evaluation and modification of training curricula.

The funds required are $200,000. Contract time is 18 months, including 3 months for review of the final report.

Onsite Utility Construction Coordinator

Renewal Focus Area

The overall goal of the SHRP 2 Renewal Program is to develop a consistent, systematic approach to performing highway renewal that is rapid, causes minimum disruption, and produces long-lived facilities. The renewal scope applies to all classes of roads.

Project Background

Utilities are marked on the ground surface during highway construction activities as a result of state One Call statutes. Not all utilities may be marked because not all utility owners are required to belong to the One Call System or may not be required to mark their facilities. Marks may be incomplete or incorrect for various reasons. In almost all cases, multiple parties will show up on site to mark individual utility owner facilities. Highway constructors typically are required to build the project in accordance with the project plans and specifications, but also be responsible for protection of the existing utility facilities. When the utilities as shown on the plans and specifications are different from those as marked on the ground, opportunities for change orders, claims, and even damages are created. Addressing discrepancies between field and plans is traditionally the responsibility of the constructor, but there may not be sufficient incentive to resolve these opportunities for change orders.

At least one state (Georgia) has addressed this issue by creating a functional position of an onsite utility construction coordinator. This required changes to the state One Call statute and Georgia DOT construction contracts. Georgia DOT instituted a training and certification program for this position and requires the highway constructor to retain this certified person during construction. Other states may benefit from such a program and position.

Objectives

The objectives of the project are to

- Determine the cost- and time-effectiveness of an onsite utility construction coordinator,
- Determine barriers to implementation of an onsite utility construction coordinator,
- Determine training and certification requirements for an onsite utility construction coordinator, and
- Determine available delivery methods for an onsite utility construction coordinator.

Tasks

Task 1

Investigate the use of onsite utility coordinators. Identify DOTs that are using onsite utility coordinators. Research the following areas:

- Criteria for use,
- Project mechanism for implementation,
- Cost and benefit of use, and
- Lessons learned.

Task 2

Determine barriers to implementation of an onsite utility construction coordinator.

Task 3

Determine training and certification requirements for an onsite utility construction coordinator.

Task 4

Develop guidelines for use of onsite utility construction coordinators.

Task 5

Produce a draft final report documenting the work conducted in Tasks 1 to 5. Following review, submit a final report.

Deliverables

Deliverables include an interim report, a draft final report, and a final report. Funds required are $200,000. Contract time is 12 months.

Utility Conflict Identification and Solutions

Renewal Focus Area

The overall goal of the SHRP 2 Renewal Program is to develop a consistent, systematic approach to performing highway renewal that is rapid, causes minimum disruption, and produces long-lived facilities. The renewal scope applies to all classes of roads.

Project Background

Selection of utility locations where utility quality level A (QLA) data are prudent is an inexact science. Regardless of the initial QLA, potential utility conflicts with design exist on most projects. Some state DOTs have developed forms and tables that identify potential conflicts. Some states have developed general criteria for selecting methods to alleviate potential conflicts, generally through the use of test holes to obtain QLA data. Some states have no guidance and leave it up to the individual engineer to develop the criteria. States are looking for guidance on when and where to best use test holes to obtain QLA data.

Objectives

The objectives of the project are to

- Identify existing state DOT utility conflict matrix formatting,
- Develop guidance tools on when and where to use test holes to determine actual utility conflicts, and
- Develop flexible but complete utility conflict matrix formats that incorporate the above guidance tools.

Tasks

Task 1

Investigate utility conflict resolution methods and tools in use. Contact state DOTs and determine which methods are being used. Follow up and obtain detailed documentation on the practices.

Task 2

Investigate the effectiveness of these methods.

Task 3

Develop recommended conflict matrix formats and procedures.

Task 4

Develop guidelines for when and where to use deferent conflict resolution tools.

Task 5

Produce a draft final report documenting the work conducted in Tasks 1 to 5. Following review, submit a final report.

Deliverables

Deliverables include an interim report, a draft final report, and a final report. Funds required are $250,000. Contract time is 12 months.

(***Special Note:*** Proposers should review the final report on SHRP 2 R01, "Encouraging Innovation in Locating and Characterizing Utilities.")

Subsurface Utility Engineering Qualifications

Renewal Focus Area

The overall goal of the SHRP 2 Renewal Program is to develop a consistent, systematic approach to performing highway renewal that is rapid, causes minimum disruption, and produces long-lived facilities. The renewal scope applies to all classes of roads.

Project Background

Many states have an existing subsurface utility engineering (SUE) program in place. The advent of CI/ASCE 38-02, which was developed as a national engineering standard, is increasing

the use of SUE in states where the DOT already has some program in place, and also in states where no formal program exists. The rapid growth of SUE has produced the typical problems with qualifications of consultants associated with such growth. States are looking for guidance on how to qualify SUE consultants that can comply with CI/ASCE 38-02. Some states have qualification programs in place and are looking to upgrade them; others do not and are looking to begin such a program.

Objectives

The objectives of the project are to

- Investigate state DOT qualification programs and requirements for SUE consultants and
- Develop minimum nonsubjective requirements that demonstrate the competence of SUE firms and their ability to comply with CI/ASCE 38-02.

Funds required are $150,000. Contract time is 12 months.

(***Special Note:*** Proposers should review the final report on SHRP 2 R01 "Encouraging Innovation in Locating and Characterizing Utilities.")

Model Certification Program for Utility Relocation Coordinators

Renewal Focus Area

The overall goal of the SHRP 2 Renewal Program is to develop a consistent, systematic approach to performing highway renewal that is rapid, causes minimum disruption, and produces long-lived facilities. The renewal scope applies to all classes of roads.

Project Background

State DOTs construct, maintain, and operate highways for the benefit of the public, and that has been their traditional charge and focus. DOT ROWs now transport much more than people. Since the advent of the highway system, states have extended the use of highway ROWs to utility companies to save public resources and serve the public interest. Now the number of utilities involved and the complexity of the coordination required have grown exponentially.

Utilities occupying DOT ROWs have increased in number and type. The technical complexity of utility systems has increased. Responsibility for coordinating the technical and management aspects of utility relocations is generally assigned to a utility relocation coordinator. In current practice, DOTs, contractors, and utilities all may employ a utility relocation coordinator; however, there is no current standard for the training and experience qualifications for this key person.

To improve the efficiency of the highway renewal effort a model qualification criteria for utility relocation coordinators is needed. Also, an investigation of the feasibility of a national certification process is needed.

Objectives

The objectives of the project are to

- Develop a set of core competencies required by utility relocation coordinators for effectively addressing utility relocation issues in transportation renewal projects;
- Develop model training and experience qualification criteria based on, but not limited to, the core competencies; and
- Investigate the feasibility of a national certification process for utility relocation coordinators.

Tasks

Task descriptions are intended to provide a framework for conducting the research. SHRP 2 is seeking the insights of proposers on how best to achieve the research objective. Proposers are expected to describe research plans that can realistically be accomplished within the constraints of available funds and contract time. Proposals must present the proposers' current thinking in sufficient detail to demonstrate their understanding of the issues and the soundness of their approach to meeting the research objective.

Task 1

Identify core competencies and indicated training and experience qualifications criteria concerning utility relocation coordinators.

Task 2

Given the indicated core competencies developed in Task 1, develop a model standard for qualification criteria for utility relocation coordinators, including training, experience, and assessments.

Task 3

Investigate the necessary components and requirements for a national certification process. Who would administer the program? Who would be required to participate? How would the qualification assessments be administered? It is anticipated that this task would involve soliciting input from a representative component of interested parties.

Task 4

Develop guidelines for implementing the qualification standards and recommendations concerning a certification process.

Task 5

Produce a draft final report documenting the work conducted in Tasks 1 to 5. Following review, submit a final report.

Deliverables

Deliverables include an interim report, a draft final report, and a final report. Funds required are $130,000. Contract time is 12 months, including 3 months for review of the final report.

(***Special Note:*** Proposers should review the final report on SHRP 2 R01, "Encouraging Innovation in Locating and Characterizing Utilities," and the NHI Highway/Utilities Course.)

APPENDIX A

Annotated Bibliography

Alabama Department of Transportation. *Alabama Utilities Manual,* 1999. www.dot.state.al.us/Bureau/Design/utilities/Utilities%20Manual/utman.html (as of August 29, 2007).

This manual provides rules and policies in regard to relocating, installing, and maintaining utilities within right-of-way (ROW) with as little interference to highway safety, operations, and maintenance as possible. The manual outlines general guidelines and procedures, legal aspects, permits and agreements, planning and design, construction, and reimbursements. The purpose of this manual is to provide the utility company with guidelines on how to proceed with utility work within highway ROWs without disrupting the highway operation.

Alsop, S. R. Legal and Procedural Issues Related to Relocation Assistance: Supplementary Material. In *Selected Studies in Highway Law*, TRB, National Research Council, Washington, D.C., Vol. 2, Nov. 1991, 13 pp.

This article describes the effects of the Uniform Relocation Act (URA) amendments of 1987. The basic structure of the URA requires that "federal acquiring and/or displacing agencies comply with its provisions, and that state and local acquiring and/or displacing agencies give 'satisfactory assurances' that they will comply as a condition of receiving federal financial assistance." The URA grants FHWA lead agency authority to issue uniform government-wide federal regulations and protects businesses and individuals who are displaced due to construction projects.

American Association of State Highway and Transportation Officials. *Utility Survey Responses on Recouping the Costs of Utility Delays from Utility Owners.* AASHTO, Washington, D.C., 2003, 13 pp.

This document includes survey responses from state departments of transportation (DOTs) and FHWA regarding recouping the costs of utility delays from utility owners and successful practices in assuring timely utility relocation. Best practices discussed include: early coordination, annual meetings with utility companies (UCs), and the incorporation of utility relocation work into the construction contract.

Anson, A. Timely Coordination of Utility Relocation for Highway Purposes. *Proc., Fifth National Highway/Utility Conference*, Phoenix, Ariz., Oct. 1996, pp. 39–49.

This presents a UC perspective on the utility coordination process in Vermont. Annette Anson, Manager of ROW for NYNEX, speaks about the relationship between the Vermont Agency of Transportation, NYNEX (a large telephone company), and the electric companies (some large and some small) in the state. She discusses the regulations that provide the groundwork for the current utility relocation process, which allow the agency to purchase ROW for utility relocations. She then discusses the steps being taken (at the time of publication) to ensure effective coordination between UCs and the agency.

Arcand, L., and H. Osman. Utilization of Subsurface Utility Engineering to Improve the Effectiveness of Utility Relocation and Coordination Efforts on Highway Projects in Ontario. *Proc., Annual Conference of the Transportation Association of Canada,* Charlottetown, Prince Edward Island, Sept. 2006, 15 pp.

This paper is a summary of two case studies in Ontario, Canada, where subsurface utility engineering (SUE) was used prior to utility relocation necessitated by highway construction projects. The report estimates that SUE had a high return on investment of approximately 2.5.

Arizona Department of Transportation, Utility and Railroad Engineering Section, and W. R. Briscoe. *Arizona Guide for Accommodating Utilities on Highway ROW*, June 12, 1998, 104 pp.

This manual describes policies for utility work done within the highway right-of-way by utility companies. The manual is separated between policies for controlled access highways and policies for uncontrolled access highways. Policies are then broken down by utility type including electric lines, water and sewer lines, gas and product lines, telephone and television cable, and irrigation lines. Abandonment of utility facilities and general requirements are also outlined in this guide.

Arkansas State Highway and Transportation Department, Arkansas State Highway Commission. *Arkansas Utility Accommodation Policy*, http://www.arkansashighways.com/ROW/Utility%20Accommodation%20Policy.pdf?Record_Number=50

This manual provides utility companies with guidelines and procedures for installing, adjusting, relocating, and removing utility facilities within the highway right-of-way. This manual outlines policies for general considerations, underground utility installations, overhead utility installations, installations on highway structures, irrigation and drainage facilities, permitting procedures, and miscellaneous items. It also discusses procedures for obtaining reimbursements for utility relocations and adjustments, cost estimates, and billing procedures.

Arkansas State Highway and Transportation Department. *Special Provision: Utility Adjustments by Highway Contractor*, http://www.arkansashighways.com/info/FOI/FOIRequestForm.asp?Record_Number=11

This provision allows the contractor on a highway project to remove, relocate, or adjust existing utilities himself or by subcontracting the work out. This work is done under separate contracts. This provision lists requirements that the contractor must complete.

Baril, A., and S. Messager. New Approaches in the Management of Public Utilities in the Right-of-Way. *Proc., Transportation Association of Canada Annual Conference*, Charlottetown, Prince Edward Island, Sept. 2006, 10 pp.

This paper discusses the consultative and collaborative approach developed by the Ministry of Transportation of Quebec for relocating public utilities in the ROW. This approach supports business relationships between the Ministry of Transportation and UCs called "framework agreements." These agreements also help to determine the allocation of project costs.

Blair, J. S. Utility Relocations on Construction Projects—A Contractor's Perspective. *Proc., 89th Annual Purdue Road School*, Purdue University, Lafayette, Ind., March 25, 2003, 6 pp.

This paper provides a contractor's perspective on the effect of utilities on construction projects including: the prebid preparation process, the preconstruction phase, the utility conflicts during the construction phase, and the best practices for mitigating utility conflicts.

Brown, A. Utility Coordination Concepts on Highway Projects. *Proc., National Highway Utility Conference*, Louisville, Ky., April 14, 2000, pp. 151–165.

This is a bulleted presentation discussing the importance of early coordination with UCs. The presentation includes utility relocation elements (coordination, design, construction), coordination elements (predesign, design, preconstruction, construction), a case study presenting the delays associated with highway design impacts (estimated 110 days of delays), a discussion of the coordination of plan phasing and utility design, and a design time frame.

California Department of Transportation. Utility Relocation. In *California's ROW Manual*, Ch. 13. July 2005, 350 pp.

This manual describes policies and procedures for the coordination of utility relocation during the construction of highway projects. It outlines requirements throughout each phase of a project. These include planning, design, liability determination, certification, construction, and payment. It also outlines report of investigation, notice to owner, utility agreements, property rights conveyances, local public agency projects, nonproject-related responsibilities, and federal aid procedures.

Childs, W. Utility Consultant Coordinator. *Proc., AASHTO/FHWA Right-of-Way and Utilities Conference*, Baltimore, Md., May 1, 2006, 3 pp.

This presentation discusses the definition of a utility consultant coordinator. According to the presentation, it is someone who provides utility coordination and engineering design expertise. Key responsibilities of the utility consultant coordinator are outlined in this presentation.

Chou, C., C. Caldas, and J. O'Connor. Developing a Group Decision-Support Model and System for Combined Transportation and Utility Construction. *Proc., Applications of Advanced Technology in Transportation, 9th International Conference*, Chicago, Ill., Nov. 14, 2006, 17 pp.

This paper provides a general discussion of the combined transportation and utility construction approach and a decision-making framework determining when this approach should be utilized by state DOTs.

Cisneros, L. Timely Coordination of Utility Relocation for Highway Purposes. *Proc., Fifth National Highway/Utility Conference*, Phoenix, Ariz., Oct. 1996, pp. 35–38.

This presentation by Lester Cisneros, Railroads & Utilities Section Manager for the New Mexico State Highway and Transportation Department, discusses the problem of rural communities in New Mexico that do not have the tax base for generating the required finances to fund utility relocations. The current system in New Mexico (at the time of the presentation) allows these communities to apply for financial assistance from the state.

Collins, J. Utility Issues. *Proc., AASHTO/FHWA Right-of-Way Conference*, New Orleans, La., July 2, 1997, pp. 84–85.

This brief paper provides a description of the Louisiana Department of Transportation and Development's (DOTD) process for utility relocation, including a description of DOTD's relationship with UCs.

Colorado Department of Transportation. *Highway Utility Manual*, Jan. 2007.

This manual outlines key administrative and accommodation standards used by the Colorado Department of Transportation to regulate the accommodation of utilities within highway ROWs. Utility coordination procedures are also identified in this document. The purpose of this manual is to provide guidelines in order to ensure accurate implementation of the DOT code.

Cooper, J. Combining Transportation and Utility Construction. *Proc., AASHTO/FHWA Right-of-Way and Utilities Conference*, Baltimore, Md., May 1, 2006, 3 pp.

This presentation proposes a solution to avoiding long durations for utility adjustments. The solution is called combined transportation utility construction and it allows the contractor on the project to perform the necessary utility adjustments, providing that the contractor is qualified and obtains consent from utility companies. However, some limitations do exist.

Cunliffe, R. W. Payments to Public Utilities for Relocation of Facilities in Highway ROW: Supplementary Material. In *Selected Studies in Highway Law*, TRB, National Research Council, Washington, D.C., Vol. 2, June 1988, 12 pp.

This paper discusses court cases pertaining to the payment of public utilities to relocate from highway ROW. The discussion includes one case decided by the U.S. Supreme Court. The result of the Supreme Court decision was that a utility was not a "displaced person" and, therefore, was not entitled to federal reimbursement under the Relocation Act. If a state reimburses a UC, then that state may be entitled to reimbursement from federal funds.

Delaware Department of Transportation. Utility Adjustments for Highway Construction. In *Utilities Design Manual*, http://regulations.delaware.gov/AdminCode/title2/2000/2400/2401.shtml#TopOfPage, Ch. 4.

This manual outlines procedures for coordinating utility adjustment work for highway construction projects. It describes procedures for preconstruction and construction coordination. It also describes reimbursable and nonreimbursable work and payment for work.

Florida Department of Transportation.*Utilities Accommodation Manual*, Aug. 2004.

This manual provides policies, criteria, and regulations regarding any utility work within the Florida DOT highway right-of-way. It describes obtaining utility permits, applying criteria, standards, specifications and policies, accommodation standards, special requirements, maintenance of vegetation and traffic, general requirements, utility surveys, and criteria for limited and nonlimited access. This manual provides utility companies with Florida's policies and procedures on this issue.

Idaho Transportation Department. Control of Work. In *Contract Administration Manual*, Ch. 5, July 2007.

This manual provides responsibilities of the engineer regarding control of work. It outlines the procedures to be followed by the engineer for utility adjustment on a project, including notice to proceed, preparation, construction, and postconstruction phases.

Indiana Department of Transportation. Utilities. In *Design Manual*, Ch. 10, Sept. 7, 2005.

This manual describes utility procedures and provides utility coordination guidelines and a utility accommodation policy used by the Indiana Department of Transportation to regulate accommodation of utilities within highway ROWs. It is intended for parties involved in the utility accommodation process, including utility owners and Department of Transportation employees.

Jeong, H. S., D. M. Abraham, and J. J. Lew. Evaluation of an Emerging Market in Subsurface Utility Engineering. *Journal of Construction Engineering and Management*, Vol. 130, No. 2, 2004, pp. 225–234.

This paper presents a comprehensive evaluation of SUE to facilitate a better understanding of the emerging industry. The topics investigated include quality levels in SUE, incorporation of SUE strategy at different stages in the construction project, and a cost–benefit analysis of 71 actual construction projects where SUE was employed. This paper also includes the analysis of a questionnaire of state DOTs and members of the SUE industry.

Johnson, C. Avoiding Utility Relocations. *Proc., AASHTO/FHWA Right-of-Way and Utilities Conference*, Newport, R.I., May 2003, 3 pp.

This presentation describes the FHWA manual that has been created to help highway designers avoid unnecessary utility relocations. To implement a system change, states should look at planning, design, construction, maintenance, and communication. To implement an operational change, states must analyze using nontraditional designs or design alternatives, reward designers for avoiding utility relocations, and emphasize the value in it.

Kansas Department of Transportation, Bureau of Construction and Maintenance. *KDOT Utilities Accommodation Policy*, 2002, 91 pp.

This manual provides policies and regulations for utility work done in highway ROWs. It outlines general policies, utilities on permitted highways, utilities on fully controlled access highways, and attachments to bridges and other structures. It is intended for utility owners.

Kranc, S. C., and W. A. Miller. A Computer Model for Evaluating Utility Placement in the Right-of-Way. *Proc., AASHTO/FHWA Right-of-Way and Utilities Conference*, Newport, R.I., May 2003, 22 pp.

This paper reports on a preliminary study for the Florida Department of Transportation to help determine the best placement of utility facilities during the planning stages for new transportation corridors and modification of corridors either by the addition of new facilities or relocation of existing facilities. The paper describes a model that considers minimum cover, clearance, and vertical and horizontal position, in order to minimize the sum of all utility location-dependent costs.

Kranc, S. C., and W. A. Miller. *Optimum Placement of Utilities Within FDOT R/W*. Florida Department of Transportation and Federal Highway Administration, Dec. 2005, 101 pp.

This paper develops a methodology to help identify the global optimum for the placement of utility facilities during the development stages for new transportation corridors and during planning for modification of corridors either by the addition of new facilities or relocation of existing facilities. The global optimum is determined by minimizing present and future costs.

Louisiana Department of Transportation and Development. *Louisiana Administrative Code, Part II: Utilities*, Dec. 2005.

This manual provides standards for regulating the locations, design, installations, adjustments, accommodations, and maintenance of utilities on highway ROWs. It is provided for representatives of the Louisiana Department of Transportation and Development to regulate these standards. It outlines requirements for applications, general considerations, standards of utility installation, and specific policies.

Maine Department of Transportation.*Utility Coordination Process.* http://www.maine.gov/mdot/utilities/coordination/utilitycoordinationprocess.php

This guide outlines the utility coordination process, giving both general and specific descriptions. It also identifies responsibilities of the utility coordinator.

Marti, M. M., K. L. Knutson, and J. Corkle. *Utility Relocation: A Communication and Coordination Process for Local Governments.* Minnesota Department of Transportation, St. Paul, Minn., June 2002, 40 pp.

This document summarizes the results of a research implementation study conducted by the Local Road Research Board aimed at defining the scope and range of problems regarding utility relocation and developing materials for use by Minnesota's local units of government in order to facilitate efficient utility relocation.

Memory, R. Avoiding Utility Delays. *Proc., AASHTO/FHWA Right-of-Way and Utilities Conference,* Baltimore, Md., May 2006, 4 pp.

This presentation provides guidelines for avoiding utility delays in highway construction. Early coordination, both internally and externally, implementing subsurface utility engineering technology and ONE DOT, and becoming more proactive rather than reactive are suggestions for minimizing utility-related delays.

Michigan Department of Transportation. Utilities. In *Design Manual: Road Design*, Ch. 9. http://mdotwas1.mdot.state.mi.us/public/design/englishroadmanual/

This manual outlines the utility relocation policy adopted by the state of Michigan for both private and municipal utility companies. It also provides design guidelines and utility coordination procedures for utility relocations.

Minnesota Department of Transportation. *Position Statement: Accommodation of Utilities on Highway Right-of-Way*, Nov. 8, 2005, 61 pp.

This document outlines the policies adopted by the state of Minnesota for accommodation of utilities within highway ROWs. Its purpose is to inform its reader of these policies in order to regulate utilities within these boundaries.

Minnesota Department of Transportation. *Utilities Manual*, May 2007.

This manual provides specific procedures and guidelines for the utility accommodation process. It outlines the roles and responsibilities of every party involved in the utility relocation process, provides relevant laws and regulations, and describes a step-by-step process to follow regarding the accommodation of utilities within highway ROWs. The purpose of the manual is to inform Department of Transportation employees on the utility coordination process.

Minnesota Department of Transportation. *Utility Relocation Study Report to the 2000 Minnesota Legislature.* Minnesota Department of Transportation, St. Paul, Minn., Feb. 2000, 65 pp.

The 1999 Minnesota Legislature directed the Minnesota DOT (Mn/DOT) to study issues related to relocating or removing utility facilities from highway construction projects. Mn/DOT used a collaborative process with about 40 participants, including construction contractors, UCs, utility associations, local and state road authorities, and Gopher State One Call. Participants met four times to gain a mutual understanding of issues, potential solutions, and barriers. Recommendations and implementation strategies were then developed and discussed.

Najafi, F. T., and J. Martin. Design-Build Approach for Utility Relocations in Highway Right-of-Way. *Proc., 85th Annual Meeting of the Transportation Research Board*, Washington, D.C., Jan. 2006, 14 pp.

This report identifies states with design–build statutory authority and effective design–build techniques for utility relocation. A survey conducted as part of this paper identified 30 states with design–build authority and five states exhibiting extensive experience with design–build projects in highway corridors.

The survey identified five common techniques and case studies from Florida and North Carolina that demonstrate that the design–build approach successfully relocated utilities in the highway right-of-way.

Najafi, F. T., and J. Martin. Strategies for Utility Relocation in Highway Right-of-Way. *Proc., 85th Annual Meeting of the Transportation Research Board,* Washington, D.C., Jan. 2006, 15 pp.

This paper summarizes the results of a survey conducted of state highway departments to identify emerging issues concerning utility relocations. The survey revealed that utility conflict and project delays in the right-of-way result from safety issues, uncooperative utilities, insufficient resources, inaccurate utility locations, and deliberation over reimbursement and general unit costs.

Najafi, F. T., and L. Millman. A Survey of Utility Companies in Assessing Utility Relocation and Joint Use in Highway Right-of-Way. *Proc., 85th Annual Meeting of the Transportation Research Board,* Washington, D.C., Jan. 2006, 14 pp.

This paper presents a perspective of prevailing issues as identified by the UCs with respect to relocation of utility poles, maintenance, liability and utility fees for joint usage, utility inspections, temporary utilities, advanced coordinating meetings, training and education, and exception policies that benefit the public.

New York Department of Transportation. Extract. In *New York Highway Design Manual,* Ch. 13, June 6, 2003, 5 pp.

This guide provides laws regarding time schedules for relocating utilities. It states that no utility can interfere or delay work on highway construction projects by not meeting predetermined time schedules. It outlines all the laws regarding this issue.

North Carolina Department of Transportation. *Policies and Procedures for Accommodating Utilities on Highway Rights of Way,* April 1, 1993.

This document outlines policies adopted by the state of North Carolina for the accommodation of utilities in highway ROWs. The policies are separated by utility type, including utilities on freeways, pipelines, overhead power and communication lines, underground electric power and communication lines, plowed-in cable, and lighting. This manual is intended for use by Department of Transportation employees and utility companies involved in utility accommodation.

O'Connor, J. T., G. E. Gibson, S. M. Hedemann, et al. *Duration Quantification and Opportunities for Improvements in TXDOT's Utility Adjustment Process.*Texas Department of Transportation, Austin, Tex., May 2006, 164 pp.

This report documents an investigation of the Texas DOT's utility adjustment process, the development of a model of the overall process, and the identification of possible improvements in the utility adjustment process. In addition, the report quantifies the duration of utility adjustments on highway projects.

Ohio Department of Transportation. *Manual of Procedures—Utilities.* http//www.dot.state.oh.us/divisions/local/projects/documents/1pa%20manual/7/utilities.pdf

This manual describes the procedure for relocating utilities on highway construction projects. It is intended for state utility coordinators and describes the steps that must be taken in order to coordinate utility relocation correctly and efficiently.

Oregon Department of Transportation. *Utility Guide and Procedures for Utility Relocation,* April 17, 2006.

This utility guide provides procedures to be followed in order to successfully coordinate utility work on highway construction projects. It breaks down the procedures into the design and planning phases and is intended for state utility coordinators, project managers, and utility specialists. The guide also outlines procedures for utility relocation on federally funded local public agency projects and utility coordination services that should be provided by the contractor.

Pennsylvania Department of Transportation. Utility Relocation. In *Design Manual,* Pt. 5, Oct. 2004.

This document provides utility coordination and accommodation polices for utility relocation within highway ROWs. It specifically describes coordination policies during the design phase of a utility relocation project.

Pickering, B. Alternative Approaches to Utility Relocation (Construction Contractor Claim Avoidance). *Proc., AASHTO/ FHWA Right-of-Way Conference,* New Orleans, La., May 14, 1997, pp. 79–83.

This presentation (including text from the regulations) summarizes the Pennsylvania Department of Transportation (PennDOT) utility relocation process.

Remer, M. Minimizing Utility Delays. *Proc., AASHTO/FHWA Right-of-Way and Utilities Conference,* Baltimore, Md., May 1, 2006, 4 pp.

This presentation lists several key concepts to help minimize utility delays. It describes the roles of state employees in the coordination process, some key aspects of the utility coordination process and their benefits, revisions made to the *Minnesota Utility Manual and Utility Accommodation Policy* that will benefit the process, other important initiatives, and utility coordination in design–build projects.

South Carolina Department of Transportation. *A Policy for Accommodating Utilities on Highway Rights-of-Way,* Aug. 2005.

This document outlines policies adopted by the state of South Carolina for the accommodation of utilities in highway ROWs. The policies are separated by utility type, including pipelines, overhead power and communication lines, underground electric power and communication lines, irrigation, drainage pipes, canals, and ditches. This document regulates the location, installation, and adjustment of utilities within highway ROWs.

South Carolina Department of Transportation. *Utility Involvement in South Carolina Design–Build Projects,* 2007.

This web page provides an overview of projects involving utilities in South Carolina that utilize design–build and innovative financing concepts. South Carolina is one of the few DOTs that have included utilities in its design–build projects, such as the Conway Bypass and the Greenville Southern Connector. The document provides lessons learned and a sample scope of work for design–build utilities.

Stayer, K. The Katy Freeway Reconstruction Program—Managing Utilities. *Proc., AASHTO/FHA Utilities Right-of-Way Conference,* Austin, Tex., May 2005, 8 pp.

This presentation describes the Katy Freeway Reconstruction Program, which is one of Texas's largest highway construction projects to date. There was a utility adjustment cost of $318.4 million dollars. A general engineering consultant (GEC) was hired for design and construction inspection, including utility coordination. Key aspects of the GEC's roles and responsibilities are discussed further in this presentation.

Stevens, R. L. Adding Value Through the Innovations of Subsurface Utility Engineering (SUE). *Proc., Society of American Value Engineers Conference,* Scottsdale, Ariz., June 2003,4 pp.

This paper describes the technologies (geophysical prospecting, vacuum excavation techniques, computer mapping) that comprise SUE. In addition, this paper describes the three primary components (designation, locating, and data management) of SUE, the four SUE data quality levels, and the reasons that SUE can save money for contractors.

Tennessee Department of Transportation. *Rules and Regulations for Accommodating Utilities Within Highway Rights-of-Way,* Ch. 1680-6-1, Feb. 2003.

This document outlines procedures to be followed regarding utility relocation, design, and installation within highway ROWs. This manual is intended for use by Department of Transportation employees and affected utility companies.

Texas Department of Transportation. *Utility Manual,* July 2005, 238 pp.

This manual describes procedures for coordinating utility relocation as well as procedures for performing this work. It describes rules and regulations regarding utility relocation and outlines procedures to be followed in the planning, design, and construction phases. It also describes cost and billing issues.

Thomas, L. W. Payments to Public Utilities for Relocation of Facilities in Highway ROW. In *Selected Studies in Highway Law,* TRB, National Research Council, Washington, D.C., Vol. 2, Dec. 1980, 36 pp.

This paper discusses whether the utility or the state must pay the cost of utility relocations required because of highway construction or improvements. The paper has three primary findings: 1) the state covers the cost if the utility is located on ROW owned by the UC, 2) the UC covers the cost if the utility is located within the state-owned ROW (majority of situations), and 3) the state can be reimbursed by federal funds for utility relocations in certain situations.

Thorne, J., D. Turner, and J. Lindly. *Highway/Utility Guide: Final Report,* Federal Highway Administration, Washington, D.C., June 1993, 312 pp.

This report is a comprehensive history of how federal, state, and local activities in ROW and regulation of the ROW have evolved.

U.S. Federal Highway Administration. *Cost Savings on Highway Projects Utilizing Subsurface Utility Engineering,* FHWA, Washington, D.C., Dec. 1999, 16 pp.

This is a Purdue University study of 71 projects from Virginia, North Carolina, Texas, and Ohio on the costs savings for state DOTs that routinely utilize SUE while producing contract drawings.

U.S. Federal Highway Administration, *European Right-of-Way and Utilities Best Practices: Chapter Five: Utilities Relocation and Accommodation,* FHWA, Washington, D.C., Aug. 2002, pp. 17–25.

This document presents the findings by FHWA regarding utility practices in European countries. This document identifies and describes seven worthwhile utility practices concerning cooperation, coordination, and communication; underground utilities; utility corridors; recognizing pipelines as a mode of transportation; avoiding unnecessary utility relocations; utilities in design–build contracts; and master utility agreements.

U.S. Federal Highway Administration. *Program Guide: Utility Relocation and Accommodation on Federal-Aid Highway Projects,* FHWA, Washington, D.C., Jan. 2003, 100 pp.

This program guide was developed by the FHWA for use by individuals implementing federal aid highway programs that used federal highway funds for the relocation and adjustment of utility facilities and the accommodation of utility facilities and private lines on federal aid highway ROW. The document clearly defines what is eligible for federal compensation and to what extent. In addition, the document defers to state definitions in many instances.

U.S. Federal Highway Administration. *Summary of International Scanning Program for Right of Way and Utilities,* FHWA, Washington, D.C., March 2000, 8 pp.

This report is a summary of a European scanning tour conducted by FHWA and state DOTs to review and document procedures and best practices in several European countries for the major functional work areas involved in highway ROW and utilities processes. The goal of the tour was to discover methods that may improve the utility relocation process in the United States.

U.S. General Accounting Office (GAO). *Transportation Infrastructure: Impacts of Utility Relocations on Highway and Bridge Projects,* GAO, Washington, D.C., June 9, 1999, 35 pp.

The Transportation Equity Act for the 21st Century (TEA-21) directed the GAO to assess the impact that delays in relocating utilities are having on the delivery and cost of federal aid highway and bridge projects. This report documents the GAO's findings.

Utah Department of Transportation. *Accommodation of Utilities and the Control and Protection of State Highway Rights of Way,* Administrative Rule R930-6, 2003, 98 pp.

This manual outlines policies and procedures to be followed for construction of utility facilities within highway ROWs. It outlines ROW uses, utility permits, and installation requirements. It is intended for utility owners and contractors.

Washington State Department of Transportation, Environmental and Engineering Service Center, Design Office. *Utility Accommodation Policy,* M 22-86, April 2002, 60 pp.

This manual describes procedures to be followed for utility adjustments within highway ROWs. It is intended for utility owners.

Washington State Department of Transportation. *Project Utility Coordination Process.* http://www.wsdot.wa.gov/Publications/Manuals/M22-87.htm

This is a flowchart describing procedures to efficiently facilitate utility coordination. It outlines each phase of a project and where the responsibilities lie, as well as what the responsibilities are.

Weldon, K. E. *Development of Improved Strategies for Avoiding Utility Related Delays During FDOT Highway Construction Projects—Appendix M: State of the Utilities,* Florida Department of Transportation, July 2003.

This document describes current and future utility issues applied nationwide and compares practices with those of the Florida Department of Transportation. The document addresses construction delays, relocation practices and incentives, reimbursement practices, new standards of practice, new technology and research, and cooperation.

West Virginia Division of Highways. *Accommodation of Utilities on Highway Right of Way and Adjustment and Relocation of Utility Facilities on Highway Projects,* Dec. 2003, 78 pp.

This manual outlines policies and regulations for accommodating utilities in highway ROWs and adjusting and relocating utility facilities. It breaks down the policies by utility type, including television cables, pipelines, electrical and communication lines, highway structures, and scenic enhancement. It also outlines the planning and coordination process required.

Williams, R. L. Expediting Utility Adjustments on Highway Projects. *Right of Way,* Vol. 33, No. 1, 1986, pp. 16–18.

This document outlines the main contributors to utility conflicts. Ronald Williams, utilities engineer for the West Virginia Department of Highways, describes causes of delays associated with utility relocations and adjustments.

Wisconsin Department of Transportation. *Administrative Code,* Chapter Trans 220: Utility Facilities Relocation, Aug. 1996.

This manual provides procedures for utility coordination and avoiding utility conflicts and delays. It is intended for state utility coordinators, project managers, and utility owners.

Wisconsin Department of Transportation. *Guide to Utility Coordination,* State Statute 84.063, Jan. 5, 2000.

This guide provides procedures to follow in order to successfully facilitate the relocation and adjustment of utility facilities. It is very similar to the Wisconsin Administrative Code described above.

Wisconsin Department of Transportation. *Utility Accommodation Policy,* March 1, 2005.

This manual provides policies and procedures to be followed by any utility that occupies any DOT highway ROW. It details all the requirements for making utility adjustments, installing or removing utilities, or relocating utilities. It is intended for utility owners.

Zembillas, N. M. Subsurface Utility Engineering: A Technology-Driven Process That Results in Increased Safety, Fewer Claims, and Lower Costs. New Pipeline Technologies, Security and Safety. *Proc., ASCE International Conference on Pipeline Engineering and Construction,* Baltimore, Md., July 2003, pp. 1422–1428.

This paper describes SUE as a combination of civil engineering, surveying, geophysics, nondestructive excavation, and other technologies that provides accurate mapping of underground utilities in three dimensions. The use of SUE during the early design phase can result in increased safety, fewer claims, and lower construction costs. It also places the risk of erroneous utility location information firmly on the subsurface utility engineer.

Zembillas, N. M., and B. J. Beyer. Proactive Utilities Management: Conflict Analysis and Subsurface Utility Engineering. *Proc., Pipelines 2004: What's on the Horizon?,* San Diego, Calif., Aug. 2004, 6 pp.

This document provides a general overview of the potential of SUE in conflict analysis. Nicholas Zembillas, Senior Vice President of the TBE Group, and Bryan Beyer of Louisiana State University discuss the connection between SUE and conflict analysis and the potential for savings.

APPENDIX B

Best Practice Summaries

Best Practice #1

TITLE: Advance relocation of utility work

DETAILED DESCRIPTION

Either the state's contractor or the utility company (UC) involved in the relocation should relocate the conflicting utilities before highway construction begins. This practice may not always be possible because of work sequencing issues or other factors discussed below. It is done in order to alleviate possible coordination conflicts/issues between UCs and contractors and to eliminate delays during the construction phase.

EXAMPLE SOURCE (current users)

Tennessee's Chapter 86 Provisions requires utility relocation to be performed before construction begins or to be included in the state contract in order for the utility to be reimbursed.

SOURCE REFERENCES (current users)

Alabama—DOT—Robert Lee, State Utility Engineer, 334-242-6155
Arizona—DOT—Bruce Vana, Manager Utility and Railroad Engineering, 602-712-7541
Delaware—DOT—Fran Hahn, Utility Engineer, 302-760-2269
Florida—Progress Energy—Art Gilmore, 727-893-9255
Indiana—Vectren—Marty Frederick, 812-491-4765
Indiana—DOT—Matt Thomas, Utility and Railroad Manager, 317-232-5308
Michigan—DOT—Mark Dionise, Utility Coordination and Permit Section Manager, 517-373-7682
North Carolina—DOT—Robert Memory, State Utility Agent, 919-733-7932
Oregon—Northwest Natural Gas—Gary Hyatt, Manager, 503-226-4211
Pennsylvania—First Energy—Dona Ritchey, 610-921-6580
Pennsylvania—Verizon—Jesse Guarneri, 640-280-5525
Tennessee—DOT—Joe Shaw, State Utility Coordinator, 615-741-2891
Tennessee—MLGW—Tom Word, Property Management Department, 901-528-4186
Wisconsin—DOT—Ernie Peterson, State Utility Engineer, 608-266-3589

ASSOCIATED RESOURCES (See Appendix C)

1. Florida Statutes—Section 337.403
16. Tennessee—Chapter 86 Provisions

HISTORY

Chapter 86 was implemented in 2003.
Florida Statutes Section 337.403, 2007

RELATED POLICIES AND PROCEDURES

Tennessee's Chapter 86 Provisions: SECTION 2. Tennessee Code Annotated, Title 54, Chapter 5, Part 8, is amended by deleting §54-5-804 in its entirety and by substituting instead the following language:

(2) The utility shall either:
(A) Enter into a written agreement with the commissioner to include the relocation as a part of the department's highway construction contract; provided that such agreement may provide that the utility shall perform certain relocation work with its own union employees as required under a negotiated organized labor contract but, in such case, the utility shall be required to reimburse the department for all relocation costs if it fails to timely perform its relocation work as provided in the agreement with the commissioner; or
(B) Enter into a written agreement with the commissioner to remove all utility facilities that conflict with the highway construction, as determined by the department, prior to the letting of the department's construction contract, and otherwise perform and complete the utility relocation in accordance with approved relocation plans and schedule of calendar days; provided that such agreement may provide that, in the event that the department does not undertake the highway construction project within a specified time, the utility shall be reimbursed for such relocation work as it has timely performed in accordance with the approved plans and schedule.

Implementation Requirements

1. Legislation must be created to support policy.
2. Sufficient right-of-way (ROW) must be acquired before relocation.
3. Clearing and grubbing of ROW must be performed before relocation.
4. DOTs need a mechanism to handle clearing and grubbing of the ROW (i.e., the DOT hires a subcontractor to do the work or the utility is reimbursed for performing clearing and grubbing work).
5. No knowledge and skills requirements are necessary.

Potential Obstacles or Barriers

1. It may not always be possible to relocate beforehand (i.e., clearing and grubbing work must be complete and sufficient ROW must be acquired).
2. Work sequencing issues: Not all utilities can be relocated beforehand or it just does not make sense to do so (particularly water and sewer).
3. State contractor may perform relocation work. This is mainly done with water and sewer.

Benefits

1. Minimizes contractor–utilities conflicts. (Construction Phase)
2. Reduces delays. (Construction Phase)
3. Advanced relocations limit delays in projects due to budget delays as utility company tries to find the funding for relocation. (Construction Phase)

Potential Evaluation Factors and Considerations

In order to evaluate each best practice, both DOT and utility industry members would be asked to rate potential benefits of utilizing the best practice. Those involved in the survey would be both current users of the practice and nonusers. A rating of rarely, sometimes, frequently, or very frequently would be given for each potential benefit, indicating the frequency with which it occurs during utility relocation projects.

Does/would the utilization of Best Practice #1:
Reduce potential utility conflicts during construction?
Improve the relationship between the DOT and UC?
Improve the relationship between the UC and the contractor?
Cause a reduction in delays during the construction phase?

Best Practice #2

Title: Early Involvement of Utilities in Planning and Design Phase

Detailed Description

Utilities cited this best practice the most frequently as a procedure that worked very well. The definition of "early" may vary across states, but it is obvious that utilities must be notified of potential involvement in the beginning of the planning and design phase in order to avoid utility-related delays. The most common early notification was 30% planning and design. Early involvement of utilities increases coordination and design time. The sooner the UC is made aware of a potential conflict, the sooner it can start planning and incorporating the project into its own schedules. Also, relocation could potentially be avoided because of increased coordination and partnering time between the designers and utilities.

Source References (current users)

Arizona—DOT—Bruce Vana, Manager Utility and Railroad Engineering, 602-712-7541
Colorado—DOT—Dahir Egal, State Utilities Engineer, 303-757-9344
Delaware—DOT—Fran Hahn, Utility Engineer, 302-760-2269
Georgia—Utility Support System—Tom Jackson, 770-544-0205
Georgia—DOT—Jeff Baker, State Utility Engineer, 404-635-8114
Indiana—Vectren—Marty Frederick, 812-491-4765
Michigan—DOT—Mark Dionise, Utility Coordination and Permit Section Manager, 517-373-7682
North Carolina—Charlotte-Mecklenburg—Bill Deal, 704-391-5150
North Carolina—DOT—Robert Memory, State Utility Agent, 919-733-7932
Oregon—Northwest Natural Gas Company—Gary Hyatt, Manager, 503-226-4211
Oregon—DOT—Howard Bergstrom and Matthew Caswell, ROW Section and State Utilities Engineer, 503-986-3658
Pennsylvania—DOT—Gary Fawver, Chief of Utility and ROW Section
South Carolina—DOT—Mark Attaway, State Utility Engineer, 803-737-1296
Tennessee—MLGW—Tom Word, Property Management Department, 901-528-4186
Tennessee—DOT—Joe Shaw, State Utility Coordinator, 615-741-2891
Washington—DOT—Tom Swafford, Utility, Railroad and Agreements Manager, 360-705-7237
Wisconsin—Alliant Energy—Gary Quade, 563-584-7395
Wisconsin—DOT—Ernie Peterson, State Utility Engineer, 608-266-3589

Associated Resources (See Appendix C)

2. Wisconsin—Trans 220
16. Tennessee—Chapter 86 Provisions

History

Chapter 86 Provisions, 2003
Wisconsin Trans 220, 1996

Related Policies and Procedures

Wisconsin Administrative Code, Trans 220:
Within Wisconsin's Administrative Code, Trans 220 outlines specific guidelines that are to be followed by the DOT, Utility Companies (UCs), and contractors involved in the utility relocation process. Each project is handled by a Utility Coordinator from start to finish. UCs are notified early on in the project's development phase for potential conflicts. An Operational planning meeting is held with UCs potentially involved in the project, to discuss any issues that may be related to the construction and to allow their input. Within 60 days of receipt of the initial notice of the project the UC must provide copies of its facility maps to identify their location. Once the UC receives the Project plans (60% design) from the DOT, it must provide its complete work plan within 60 days for rehabilitation projects, 90 days for minor reconditioning projects, and 120 days for major reconditioning, reconstruction, or new construction projects. An additional 30 days is given if the project requires the UC to coordinate with other utilities, such as joint-use, or has compensable facilities on the project.

Tennessee's Chapter 86 Provisions:
The Utility must submit relocation plans in accordance with TCA 54-5-854 within 120–165 days.

Implementation Requirements

1. A defined specific utility coordination process
2. Management attention to process
3. Personnel who are willing to follow the process
4. A utility coordinator who is responsible for coordinating with utilities on projects
5. No special knowledge and skills requirements needed

Potential Obstacles or Barriers

1. If any of the parties involved fail to do their part, the process can falter or fail.
2. Employee turnover within both the DOT and the UCs tends to hinder the coordination process from being fully executed properly.
3. The DOT may tend to try to cut corners rather than pull a project if a schedule gets tight. An example is as follows: The project plans are not completed until late in the process. The plans are sent to utilities late and the utility is then asked to try to complete its work plans ahead of schedule. In some cases, the plans, specifications, and estimates (PS&Es) may be due within the DOT before the Trans 220 due date for the utilities' work plans. The major cause of this would be the cutback in forces at the DOT does not match the program workload.
4. ROW acquisition process.
5. The utility does not completely trust the DOT and is not sure that DOT will really build project.
6. Implementation of the process does not occur.
7. Design decision-making process can be slow.
8. Some DOTs do not want utilities to do their final plans based on preliminary highway plans; therefore they do not involve utilities until later.

Benefits

1. Early notification allows utilities to plan ahead. (Design and Construction Phase)
2. Allows more time for the permitting process.
3. Begins the communication/coordination process between the DOT and UC. (Design and Construction Phase)
4. Potential for avoiding utility relocation because of increased coordination between designers and UC. (Design Phase)

Potential Evaluation Factors and Considerations

In order to evaluate each best practice, both DOT and utility industry members would be asked to rate potential benefits of utilizing the best practice. Those involved in the survey would be both current users of the practice and nonusers. A rating of rarely, sometimes, frequently, or very frequently would be given for each potential benefit, indicating the frequency with which it occurs during utility relocation projects.

Does/would the utilization of Best Practice #2:
Improve the quality of project design?
Improve the design process's efficiency?
Improve the relationship between the DOT and UC?
Reduce potential utility delays during construction?

Best Practice #3

Title: Training of DOT Designers on Utility Relocation Process

Detailed Description

Several DOTs and UCs claimed that many designers are not sufficiently knowledgeable of the utility relocation process and suggested that training programs be held in order to educate them. High turnover rates at DOTs have led to inexperienced people doing designs. Utility networks can be very complex. There is a feeling in the industry that if DOT designers understood the complexity of some utility systems, a greater effort would be made to avoid utility relocation during highway design. Advancements in technology are also being made, providing new information that could be utilized in the design and relocation process. Training must be done in order to get designers and UCs to utilize this information correctly. This practice should be employed before the design phase.

Source Examples (current users)

Verizon-PA holds training programs for the Pennsylvania DOT (PENNDOT) designers.

Georgia DOT has a training program intended to teach designers about the benefits of using subsurface utility engineering

(SUE). It explains how and when to request SUE services within the DOT.

Florida Utilities Coordinating Committee (FUCC) developed a Utility Certification Training Program. The objective is to have all personnel who deal with utility coordination be certified through this training. The purposes of the training are

1. To teach the people that are new to utility coordination the basic requirements for their job,
2. To implement new and improved concepts,
3. To develop consistency in process,
4. To ensure consistency in application,
5. To ensure accuracy of information,
6. To increase recognition and resolution of potential conflicts (Design and Construction), and
7. To minimize potential utility conflicts and delays.

Source References (current users)

Colorado—DOT—Dahir Egal, State Utilities Engineer, 303-757-9344
Pennsylvania—Verizon—Jesse Guarneri, 640-280-5525
Pennsylvania—DOT—Gary Fawver, gfawver@state.pa.us
Georgia DOT—Jeff Baker, State Utility Engineer, 404-635-8114

Associated Resources (See Appendix C)

3. Florida Utilities Coordinating Committee: Utility Coordination Certification Training Program PowerPoint Presentation
4. Georgia's SUE Education Program: www.dot.state.ga.us/dot/operations/utilities/documents/PDF/SUE/AvoidingUtilityProjectImpacts_GDOT_Portion_Only.pdf

History

FUCC: Program currently in development.
Georgia: Training program implemented in 2005.

Related Policies and Procedures

None found.

Implementation Requirements

1. Adequate budget
2. Development of training materials
3. Leadership from the DOT/FHWA to initiate the requirement of training programs
4. A responsible party for maintaining the records and providing training materials and instructors
5. Training organization must have required training curriculum knowledge.

Potential Obstacles or Barriers

1. Inadequate budget
2. Inadequate support from DOT and FHWA
3. Inadequate pool of qualified instructors

Benefits

1. Avoids utility relocations during design
2. Better understanding of the utility relocation process
3. Increased consideration of utilities during design
4. Potential cost savings due to more innovative designs
5. Develops consistency in following and interpret agency procedures
6. Reduces the delay in obtaining vital utility information
7. Better coordination on utility work schedules
8. Reduction in utility delay claims
9. Increase in timely relocations
10. Improves working relationships

Potential Evaluation Factors and Considerations

In order to evaluate each best practice, both DOT and utility industry members would be asked to rate potential benefits of utilizing the best practice. Those involved in the survey would be both current users of the practice and nonusers. A rating of rarely, sometimes, frequently, or very frequently would be given for each potential benefit, indicating the frequency with which it occurs during utility relocation projects.

Does/would the utilization of Best Practice #3:
Improve the quality of project design?
Improve the design process's efficiency?
Improve the relationship between the DOT and UC?
Reduce potential utility delays during construction?

Best Practice #4

Title: Development of a Geographic Information System (GIS) Database

Detailed Description

Computer-assisted drafting (CAD) files and electronic plans are efficient; however, utilities often do not have compatible software. Therefore, much of the work, including redlining each other's plans, is still currently done on paper. DOTs and utilities have extensive mapping resources, general ones that are used at project inception and detailed ones that are created in the course of a project and that could be made more widely available upon completion. Compilation of these resources and making them available in a central location could be a great boon to DOTs and UCs alike, for permitting utilities and for planning for future projects.

Source Examples (current users)

Tennessee DOT's construction office is working on an electronic workbook-field.
Wisconsin DOT cell phones can access system maps on handheld locators.
Wisconsin DOT earthmoving equipment has Global Positioning Systems (GPS) right on the blades. Grades are

determined by GPS, which eliminates slope/construction staking. Survey information is entered right into survey equipment and is transported as a design layer.

North Carolina DOT is looking at electronic permitting/encroachment for utilities.

Source Reference (current users)

North Carolina—Progress Energy—Bill Springer, Supervisor Distribution Eng, 919-468-6154

North Carolina—DOT—Robert Memory, State Utility Agent, 919-733-7932

Tennessee—DOT—Joe Shaw, State Utility Coordinator, 615-741-2891

Wisconsin—DOT—Ernie Peterson, State Utility Engineer, 608-266-3589

Associated Resources

None found.

History

Information system development is a recent activity. In many cases programs are currently under development.

Related Policies and Procedures

None found.

Implementation Requirements

1. Adequate budget
2. Training may be needed in order to teach employees how to use GIS and related equipment.

Potential Obstacles or Barriers

1. A very large number of utility entities, with a large range of sizes and capabilities, are installing utilities constantly. DOTs and UCs feel it would be nearly impossible to maintain a generally held map of this work. Funding and Homeland Security are also issues in making a statewide utility network map. More commonly, DOTs retain information in project files, on paper or electronically. While DOTs often have as-built files, in most states only recent projects are in electronic format.
2. Utilities have not invested in equipment or training.
3. Utilities have their own lobbyists.
4. Required of some but not all? Not all may be able to do it. How do you differentiate? New installations are a small percentage of what is out there. It would be beneficial to get all utilities in the ground.
5. Funding issues

Benefits

Improved precision and access to location and characterization information of ROW utility assets

Potential Evaluation Factors and Considerations

In order to evaluate each best practice, both DOT and utility industry members would be asked to rate potential benefits of utilizing the best practice. Those involved in the survey would be both current users of the practice and nonusers. A rating of rarely, sometimes, frequently, or very frequently would be given for each potential benefit, indicating the frequency with which it occurs during utility relocation projects.

Does/would the utilization of Best Practice #4:
Improve the quality of project design?
Improve the design process's efficiency?
Reduce potential utility delays during construction?

Best Practice #5

Title: Preconstruction and Progress Meetings

Detailed Description

Holding preconstruction and progress meetings throughout the construction phase allows for utility-related issues to be discussed and resolved in a timely manner. It also encourages partnering among the utilities and contractors. On complex projects, it is beneficial to have a utility preconstruction meeting to discuss only utility issues.

Source References (current users)

Arizona—DOT—Bruce Vana, Manager Utility and Railroad Engineering, 602-712-7541

Colorado—DOT—Dahir Egal, State Utilities Engineer, 303-757-9344

Georgia—DOT—Jeff Baker, State Utility Engineer, 404-635-8114

Florida—Progress Energy—Art Gilmore, 727-893-9255

Florida—Hillsborough County—Marcel Diaz, Utility Relocation Coordinator, 813-272-5081

Indiana—DOT—Matt Thomas, Utility and Railroad Manager, 317-232-5308

Indiana—Vectren—Marty Frederick, 812-491-4765

Michigan—DOT—Mark Dionise and Nick Lefke, Utility Coordinators, 517-373-7682

Oregon—DOT—Howard Bergstrom and Matthew Caswell, ROW Section and State Utilities Engineer, 503-986-3658

Pennsylvania—Verizon—Jesse Guarneri, 640-280-5525

Pennsylvania—UGI—Eric Swartley, Operation Manager, 717-234-5951

Pennsylvania—DOT—Gary Fawver, gfawver@state.pa.us

South Carolina—DOT—Mark Attaway, State Utility Engineer, 803-737-1296

Tennessee—DOT—Joe Shaw, State Utility Coordinator, 615-741-2891

Tennessee—MLGW—Tom Word, Property Management Department, 901-528-4186

Virginia—DOT—Greg Wroniewicz and Matt Reynolds, State Utility Engineers, 804-786-2928

Washington—DOT—Tom Swafford, Utility, Railroad and Agreements Manager, 360-705-7237
Wisconsin—DOT—Ernie Peterson and Julie DeBauche, State Utility Engineers, 608-266-3589
Wisconsin—Alliant Energy—Gary Quade, 563-584-7395

Associated Resources (See Appendix C)

5. Washington's Utility Coordination Process: Project Utility Coordination Process

History: N/A

Related Policies and Procedures

Several state DOTs have outlined the utility coordination process that should be followed. Included in this process is holding a preconstruction meeting. Specific utility coordination procedures can be found on DOT websites.

Implementation Requirements

1. Partnering
2. Willingness to participate
3. Willingness to cooperate
4. Time
5. No knowledge or skills requirements needed

Potential Obstacles or Barriers

Utilities may not attend scheduled meetings.

Benefits:

1. Improves communication with utilities.
2. Improves relationship between utilities and contractors.
3. UCs and contractor can exchange scheduling information.

Potential Evaluation Factors and Considerations

In order to evaluate each best practice, both DOT and utility industry members would be asked to rate potential benefits of utilizing the best practice. Those involved in the survey would be both current users of the practice and nonusers. A rating of rarely, sometimes, frequently, or very frequently would be given for each potential benefit, indicating the frequency with which it occurs during utility relocation projects.

Does/would the utilization of Best Practice #5:
Improve the relationship between the contractor and UC?
Reduce potential utility delays during construction?
Reduce potential conflicts between the contractor and UC?

Best Practice #6

Title: Incentive for Early Relocation

Detailed Description

In 2003, Tennessee's Chapter 86 allowed utility reimbursements to occur based on the discretion of the commissioner. The department policy established that any grade and drain project with ROW acquisition or bridge replacement is eligible. Smaller projects (e.g., safety projects) with limited state and federal funds are not eligible for Chapter 86 reimbursement. If a project is qualified for Chapter 86, then the utility must meet three conditions in the state statute to receive reimbursement: (1) the utility must submit plans within 120–186 days as provided in state statute, (2) the utility must have a valid permit for the existing facility, and (3) the utility must relocate prior to letting or work must be included in the state contract.

Source References (current users)

Tennessee—MLGW—Tom Word, Property Management Department, 901-528-4186
Tennessee—DOT—Joe Shaw, State Utility Coordinator, 615-741-2891

Associated Resources (See Appendix C)

16. Tennessee—Chapter 86 Provisions

History

The Chapter 86 Provision was implemented in 2003. According to the Chapter 86 Status Report, "Chapter 86 has provided an incentive to the utilities to meet the Department schedules for highway construction. Based on aggregate cost data of all projects let for contract excluding mowing and emergency lettings, the cost of Chapter 86 has been less than 4% of construction cost. The feedback from the Construction Office field personnel has indicated intrinsically that it has been a benefit, even though it has resulted in additional work with the utility relocations included in the state contract. The utilities do appear to be more cooperative. Construction can only identify three (3) projects that were documented as delayed for utility reasons."

Related Policies and Procedures

Chapter No. 86 PUBLIC ACTS, 2003

Implementation Requirements

1. Appropriate legislation
2. Funding

Potential Obstacles or Barriers

1. Only specific project types are eligible for reimbursement.
2. It may not be possible for UC to perform work before construction.
3. UC may be reluctant to allow state contractor to perform work.

Benefits

1. Utility companies are more likely to provide relocation plans in a timely manner.
2. Utilities are required to obtain necessary permits.
3. Prior to Chapter 86, utilities had no incentive to meet the department schedule for construction. Under Chapter 86, in order to receive reimbursement, utilities must

relocate prior to letting or work is included in the state contract.
4. Chapter 86 has forced joint-use utilities to cooperate in order to ensure reimbursement.

Potential Evaluation Factors and Considerations

In order to evaluate each best practice, both DOT and utility industry members would be asked to rate potential benefits of utilizing the best practice. Those involved in the survey would be both current users of the practice and nonusers. A rating of rarely, sometimes, frequently, or very frequently would be given for each potential benefit, indicating the frequency with which it occurs during utility relocation projects.

Does/would the utilization of Best Practice #6:
Improve the design process's efficiency?
Improve the relationship between the DOT and UC?
Improve the relationship between the UC and the contractor?
Reduce potential utility conflicts during construction?
Reduce potential utility-related delays?

Best Practice #7

Title: Development of Utility and ROW Management Systems

Detailed Description: Several DOTs have implemented the use of utility and ROW management systems in order to manage the utility relocation process more efficiently. The complexity of the system varies between states but the overall objective is to help DOTs manage and track all the information provided throughout the project's phases. Critical milestones can also be identified. The management systems can be utilized throughout all phases of the project.

Source Examples (current users)

Wisconsin: Transportation Utility Management System, a tracking, locating, and management system. It is online as of June 2007. The system facilitates efficiencies by having standard letters and forms and GIS for location of surface territories. The GIS is based on the 1-mi^2 grid used by the system, and it tells the user whether a utility company is in the square mile being disrupted by a project.

Pennsylvania: A utility relocation electronic document management system, with electronic workflow support. District staff can complete a form and the workflow system routes it to the appropriate headquarters staff. The system took 2½ years to develop and just recently implemented Phase III, which gives external business partners access to the system. PENNDOT can send a utility (but not contractors) notification of a project via the system, along with plans to download.

Tennessee: Tennessee DOT (TNDOT) keeps project information, plans sent and received, contracts issued, and reimbursable billings in a database with an Access front interface and an Oracle back end called the Utility Relocation Information System.

Texas: Texas DOT (TxDOT) has developed a tool showing each activity of the ROW acquisition and utility adjustment process with the corresponding responsible parties separated into three categories: TxDOT ROW Division, TxDOT ROW district, and project associates. This tool can be used to plan activities and provide education to participants in the process. It offers a method and format for recording data. In order to facilitate ROW acquisition duration analyses in the future, TxDOT needs to track/document several additional fields of information in a single location, preferably in their ROW information system.

Virginia: Created the ROW and Utilities Management System to provide a comprehensive view of project and land parcel status, track key dates, automated creation and storage of forms and letters, ad hoc reporting capabilities, and an interface with other Virginia DOT systems.

Source References (current users)

Michigan—DOT—Mark Dionise and Nick Lefke, Utility Coordinators, 517-373-7682
Pennsylvania—DOT—Gary Fawver, gfawver@state.pa.us
Tennessee—DOT—Joe Shaw, State Utility Coordinator, 615-741-2891
Wisconsin—DOT—Ernie Peterson and Julie DeBauche, State Utility Engineers, 608-266-3589
Virginia—DOT—Greg Wroniewicz and Matt Reynolds, State Utility Engineers, 804-786-2928

Associated Resources (See Appendix C)

6. Florida DOT ROW Management System Security Statutes: www2.dot.state.fl.us/proceduraldocuments/procedures/bin/575095010.pdf
7. *The Efficacy of Utility Database Management*, S. C. Kranc and Ali Yalcin, www.dot.state.fl.us/researchCenter/Completed_Proj/Summary_RD/FDOTBD544_27 rpt.pdf
8. Idaho DOT Utility/Railroad Tracking System: itd.idaho.gov/design/util_rail/policies.htm
9. Texas ROW Manuals: www.dot.state.tx.us/services/general_services/manuals.htm ftp://ftp.dot.state.tx.us/pub/txdot-info/sat/specinfo/sat-fms.pdf
10. Virginia RUMS Contact—Les Griggs—804-786-2917 www.virginiadot.org/business/row-rums.asp

History

ROW information management systems are recent developments. Many are still in the development stages.

Related Policies and Procedures

Business processes must be revised to include the use of the information management tools.

Implementation Requirements

1. DOT personnel must be willing to use system effectively.
2. System should contain as-built information.
3. System should utilize graphics to depict information.
4. System should have a formal, geographically enabled structure.
5. System should have the ability to connect to other databases containing related information.
6. Requirements regarding data ownership, data stewardship, and data standards should be clearly articulated.
7. Quality of archived data must be controlled.
8. Security of the system must be identified.
9. Training may be needed to learn and understand the functions of the program (i.e., how it works, how to use it, etc.).

Potential Obstacles or Barriers

1. Inadequate budget
2. Time to train employees
3. Without proper training, people may not use the system effectively.

Benefits

1. Provides DOTs with critical up-to-date information.
2. Personnel at all levels can view this information.
3. Management can shift resources as priorities change.
4. Improves work flow and expedits processes.
5. Allows web-based reporting capabilities.
6. Reduces staffing costs.
7. Improves scheduling commitments.
8. Centralizes information sharing.
9. Increases time savings and productivity.

Potential Evaluation Factors and Considerations

In order to evaluate each best practice, both DOT and utility industry members would be asked to rate potential benefits of utilizing the best practice. Those involved in the survey would be both current users of the practice and nonusers. A rating of rarely, sometimes, frequently, or very frequently would be given for each potential benefit, indicating the frequency with which it occurs during utility relocation projects.

Does/would the utilization of Best Practice #7:
Improve the design process's efficiency?
Reduce potential utility conflicts during design?
Reduce potential utility conflicts during construction?

Best Practice #8

Title: Inclusion of utility relocation work in DOT construction contract

Detailed Description

Utility relocation work should be included in the state contracts in order to avoid delays caused by utility companies. The state's contractor will be responsible for performing the utility relocation work.

Source Examples (current users)

Tennessee's Chapter 86 Provisions requires utility relocation to be performed before construction begins or included in the state contract in order for the utility to be reimbursed.

Florida DOT utilizes a number of different utility–DOT agreements. See

710-010-54 Utility Work Agreement (FDOT Participating in Expense) and
710-010-55 Utility Work Agreement (at UAO's Sole Expense).

Section 9.02.04 of Michigan's Road Design Manual describes the procedure to be followed when utility work is to be performed by Michigan DOT's contractor during construction.

Source References (current users)

Alabama—DOT—Robert Lee, State Utility Engineer, 334-242-6155
Arizona—DOT—Bruce Vana, Manager Utility and Railroad Engineering, 602-712-7541
Florida—Hillsborough County—Marcel Diaz, Utility Relocation Coordinator, 813-272-5081
Florida—FDOT—Vince Camp, District 2, Utility Engineer (386) 758-3732
Georgia—DOT—Jeff Baker, State Utility Engineer, 404-635-8114
New York—DOT—Michael Mariotti, Acting Director Design Support, 518-485-8960
North Carolina—Charlotte-Mecklenburg—Bill Deal, 704-391-5150
North Carolina—DOT—Robert Memory, State Utility Agent, 919-733-7932
Pennsylvania—DOT—Gary Fawver, gfawver@state.pa.us
Tennessee—MLGW—Tom Word, Tom Word, Property Management Department, 901-528-4186
Tennessee—DOT—Joe Shaw, State Utility Coordinator, 615-741-2891

Associated Resources (See Appendix C)

1. Florida Statutes Section 337.403
11. Michigan's Road Design Manual, Section 9.02.04
16. Tennessee—Chapter 86 Provisions

FDOT Agreements and Forms

History
Florida Statutes 337.403, 2007
Chapter 86 Provisions, 2003

Related Policies and Procedures
See Appendix C, # 1, #11, and #16.

Implementation Requirements
1. The UC must be willing to allow the contractor to perform the work.
2. The highway contractor must know how to perform the work.
3. The states' contractors must have the knowledge, skill level, and resources to be able to perform the utility relocation work by themselves.

Potential Obstacles or Barriers
1. UC will not allow highway contractor to perform work.
2. Highway contractor does not know how to perform work.
3. This requirement adds more time to the contract.

Benefits
1. Avoids scheduling conflicts between contractor and UC.
2. Keeps the contractor in control of the facilities and the schedule.

Potential Evaluation Factors and Considerations
In order to evaluate each best practice, both DOT and utility industry members would be asked to rate potential benefits of utilizing the best practice. Those involved in the survey would be both current users of the practice and nonusers. A rating of rarely, sometimes, frequently, or very frequently would be given for each potential benefit, indicating the frequency with which it occurs during utility relocation projects.

Does/would the utilization of Best Practice #8:
Improve the relationship between the contractor and UC?
Reduce potential utility delays during construction?

Best Practice #9

Title: Subsurface Utility Engineering

Detailed Description
Subsurface utility engineering can be used to locate existing underground utilities and identify potential conflicts. SUE determines underground utility locations through the use of surface geophysical methods and vacuum excavation. Various levels of SUE can be utilized to find the degree of precision needed. Best Practice #3 discusses training programs used to teach employees when and how to utilize SUE information.

Source References (current users)
Arizona—DOT—Bruce Vana, Manager Utility and Railroad Engineering, 602-712-7541
Colorado—DOT—Dahir Egal, State Utilities Engineer, 303-757-9344
Delaware—DOT—Fran Hahn, Utility Engineer, 302-760-2269
Georgia DOT—Jeff Baker, State Utility Engineer, 404-635-8114
Indiana—DOT—Matt Thomas, Utility and Railroad Manager, 317-232-5308
Michigan—DOT—Mark Dionise and Nick Lefke, Utility Coordinators, 517-373-7682
New York—DOT—Michael Mariotti, Acting Director Design Support, 518-485-8960
North Carolina—DOT—Robert Memory, State Utility Agent, 919-733-7932
North Carolina—Charlotte-Mecklenburg—Bill Deal, 704-391-5150
Oregon—DOT—Howard Bergstrom and Matthew Caswell, ROW Section and State Utilities Engineer, 503-986-3658
Pennsylvania—DOT—Gary Fawver, Chief of Utility and ROW Section, gfawver@state.pa.us
South Carolina—DOT—Mark Attaway, State Utility Engineer, 803-737-1296
Virginia—DOT—Greg Wroniewicz and Matt Reynolds, State Utility Engineers, 804-786-2928
Wisconsin—DOT—Ernie Peterson and Julie DeBauche, State Utility Engineers, 608-266-3589

Associated Resources (See Appendix C)
12. Federal Highway Administration's SUE website: www.fhwa.dot.gov/programadmin/sueindex.cfm

History
SUE began in the 1980s and has continued to evolve into what it is today. It began when a need for more accurate utility location information was identified. Virginia was the first DOT to utilize SUE services, and once the FHWA began to promote it in the 1990s, more states began to see its benefits. Today it is a widely used practice among DOTs.

Related Policies and Procedures
Georgia and Michigan have created policies to use when determining when, where, and what quality level of SUE to use. See Best Practices #11 and #12.

Implementation Requirements
1. There must be a sufficient budget.
2. Designers must be willing to use the SUE information provided.
3. DOTs need to determine where and when SUE should be used.
4. DOTs must understand the importance of SUE. This should begin with AASHTO emphasizing its importance. More money and training is needed to effectively utilize SUE services.

5. Training must be provided in order to teach employees how to use SUE effectively (Georgia DOT). See Best Practice #3.

Potential Obstacles or Barriers

1. Cost/Budget
2. Documentation of cost-effectiveness
3. Insufficient examination of the benefits
4. DOTs must understand the importance of SUE. This should begin with AASHTO emphasizing its importance. More money and training is needed to effectively utilize SUE services.
5. False expectations of SUE—it does not put a clear piece of glass over the earth.

Benefits

1. Time savings
2. Accurate utility information to the roadway designer
3. Possible reduction in utility relocation costs by allowing the designer to make informed design decisions around potential utility conflicts
4. Possible reduction in unexpected conflicts with utilities that can cause construction delays, damages, service disruptions, claims, and even injuries or lost lives

Potential Evaluation Factors and Considerations

In order to evaluate each best practice, both DOT and utility industry members would be asked to rate potential benefits of utilizing the best practice. Those involved in the survey would be both current users of the practice and nonusers. A rating of rarely, sometimes, frequently, or very frequently would be given for each potential benefit, indicating the frequency with which it occurs during utility relocation projects.

Does/would the utilization of Best Practice #9:
Improve the quality of project design?
Improve the design process's efficiency?
Reduce potential utility delays during construction?

Best Practice #10

Title: Utility Coordination Meeting Held During Design Phase

Detailed Description

Several DOTs and UCs stated that a utility coordination meeting is held during the design phase of the project to determine conflicts, analyze alternative design options, and open the lines of communication between the DOT and UC.

Source References (current users)

California—DOT—Lorrie Wilson, Office of Org. Development and Utility Relocations, 916-653-2132
Colorado—DOT—Dahir Egal, State Utilities Engineer, 303-757-9344
Florida—Hillsborough County—Marcel Diaz, Utility Relocation Coordinator, 813-272-5081
Florida—Progress Energy—Art Gilmore, Art Gilmore, 727-893-9255
Georgia—DOT—Jeff Baker, State Utility Engineer, 404-635-8114
Indiana—DOT—Matt Thomas, Utility and Railroad Manager, 317-232-5308
Michigan—DOT—Mark Dionise, Utility Coordination and Permit Section Manager, 517-373-7682
North Carolina—DOT—Robert Memory, State Utility Agent, 919-733-7932
Pennsylvania—DOT—Gary Fawver, Chief of Utility and ROW Section, gfawver@state.pa.us
Oregon—DOT—Howard Bergstrom and Matthew Caswell, ROW Section and State Utilities Engineer, 503-986-3658
Tennessee—DOT—Joe Shaw, State Utility Coordinator, 615-741-2891
Tennessee—MLGW—Tom Word, Property Management Department, 901-528-4186
Washington—DOT—Tom Swafford, Utility, Railroad and Agreements Manager, 360-705-7237
Wisconsin—DOT—Ernie Peterson and Julie DeBauche, State Utility Engineers, 608-266-3589

Associated Resources (See Appendix C)

2. Wisconsin—Trans 220 provisions
5. Washington's Utility Coordination Process: Project Utility Coordination Process

History

Wisconsin Trans 220, 1996

Related Policies and Procedures

Several state DOTs have outlined the utility coordination process that should be followed. Included in this process is holding a utility coordination meeting during the design phase. Specific utility coordination procedures can be found on DOT websites.

Implementation Requirements

1. All parties must be willing to participate.
2. All parties must be willing to cooperate and compromise.
3. UCs must have the personnel available to attend these meetings.
4. No knowledge or skills requirements are needed.

Potential Obstacles or Barriers

1. The utility companies do not attend the meetings.
2. Utility coordination meetings are only held on complex projects.
3. Having adequate staff is critical. Not all regions have that staff person. Coordinators are overworked; they have huge geographic areas.

Benefits

1. Relocation of utilities may be avoided.
2. Possible reduction in cost

3. Partnering among parties involved
4. Face-to-face communication
5. Helps create relationships between DOT designers and utility companies

Potential Evaluation Factors and Considerations

In order to evaluate each best practice, both DOT and utility industry members would be asked to rate potential benefits of utilizing the best practice. Those involved in the survey would be both current users of the practice and nonusers. A rating of rarely, sometimes, frequently, or very frequently would be given for each potential benefit, indicating the frequency with which it occurs during utility relocation projects.

Does/would the utilization of Best Practice #10:
Improve the quality of project design?
Improve the design process's efficiency?
Improve the relationship between the DOT and UC?
Reduce potential utility delays during construction?

Best Practice #11

Title: Utility Impact Matrix

Detailed Description: Georgia DOT utilizes a Utility Impact Matrix on every project involving utilities. Every utility conflict is listed and a SUE consultant provides a resolution recommendation. Resolutions may include relocating the utility or adjusting the highway design.

Source References (current users)

Georgia DOT—Jeff Baker, State Utility Engineer, 404-635-8114

Associated Resources (See Appendix C)

13. Georgia's Utility Impact Matrix Example: www.dot.state.ga.us/dot/operations/utilities/documents/PDF/SUE/AvoidingUtilityProjectImpacts_GDOT_Portion_Only.pdf

History: The system has been in place since 2005.

Related Policies and Procedures

None found.

Implementation Requirements

1. SUE consultant services
2. Time
3. Sufficient funding
4. No knowledge or skills requirements needed

Potential Obstacles or Barriers

Engineers must be trained in using new tools.

Benefits

1. Analyzes the best solution to each problem
2. Possible reduction in utility relocation costs by allowing the designer to make informed design decisions around potential utility conflicts
3. Eliminates possible delays

Potential Evaluation Factors and Considerations

In order to evaluate each best practice, both DOT and utility industry members would be asked to rate potential benefits of utilizing the best practice. Those involved in the survey would be both current users of the practice and nonusers. A rating of rarely, sometimes, frequently, or very frequently would be given for each potential benefit, indicating the frequency with which it occurs during utility relocation projects.

Does/would the utilization of Best Practice #11:
Improve the quality of project design?
Improve the design process's efficiency?
Reduce potential utility delays during the design and construction phases?

Best Practice #12

Title: SUE Impact Rating Procedures

Detailed Description

Several DOTs cited the use of SUE as a best practice but also listed not knowing where and when to use SUE as a barrier. Some states have created tools and guidelines to help determine whether SUE should be utilized on a certain project, and what level of SUE should be employed.

Source Examples (current users)

Georgia DOT utilizes a project utility rating on every project. A rating of low, medium, or high is given to each project in order to determine the complexity of the utility location information needed on the project. The level of SUE needed is determined by the rating. This rating is discretionary and can vary throughout a project depending on the complexity of the utilities.

Michigan DOT's 1804.02 document lists guidelines to consider when determining whether to use SUE on a certain project.

Source References (current users)

Georgia DOT—Jeff Baker, State Utility Engineer, 404-635-8114

Associated Resources (See Appendix C)

14. Georgia DOT SUE Utility Impact Rating Form: www.dot.state.ga.us/dot/operations/utilities/documents/doc/SUE/SUE%20impact%20Rating%20Form.doc
15. Michigan DOT Road Design Manual, Section 9.03.03

History
Georgia, 2005
Michigan, 2006

Related Policies and Procedures
See Appendix C, #15.

Implementation Requirements
Design engineers must be trained in use of the tools.

Potential Obstacles or Barriers
The guidelines may not be "all-encompassing." A situation might occur that is not considered in the guidelines; therefore it is still a judgment call on the part of the designer.

Benefits
More efficient utilization of SUE, **causing a reduction in cost and time.**

Potential Evaluation Factors and Considerations
In order to evaluate each best practice, both DOT and utility industry members would be asked to rate potential benefits of utilizing the best practice. Those involved in the survey would be both current users of the practice and nonusers. A rating of rarely, sometimes, frequently, or very frequently would be given for each potential benefit, indicating the frequency with which it occurs during utility relocation projects.

Does/would the utilization of Best Practice #12:
Improve the quality of project design?
Improve the design process's efficiency?
Reduce potential utility delays during construction?

Best Practice #13

Title: Work Site Utility Coordination Supervisor

Detailed Description: Georgia DOT requires a work site utility coordination supervisor on every project that utilizes SUE. The state's contractor must hire this supervisor to coordinate utilities during the construction phase. This person must also create an Emergency Response Plan for every project. For example, if a main sewer line breaks, where is the nearest cut-off valve?

Source References (current users)
Georgia DOT—Jeff Baker, State Utility Engineer, 404-635-8114

Associated Resources
None found.

History
Georgia, 2006

Related Policies and Procedures
None found.

Implementation Requirements
1. Must hire competent utility coordination supervisors.
2. Work site utility coordination supervisor must understand and be knowledgeable of the utility relocation process.

Potential Obstacles or Barriers
1. Construction specification must be amended.
2. Added cost to contractor's price
3. Availability of qualified personnel

Benefits
One point of contact for utility coordination during construction.

Potential Evaluation Factors and Considerations
In order to evaluate each best practice, both DOT and utility industry members would be asked to rate potential benefits of utilizing the best practice. Those involved in the survey would be both current users of the practice and nonusers. A rating of rarely, sometimes, frequently, or very frequently would be given for each potential benefit, indicating the frequency with which it occurs during utility relocation projects.

Does/would the utilization of Best Practice #13:
Improve the relationship between the contractor and UC?
Reduce potential utility delays during construction?

APPENDIX C

Supporting Reference Documents for Best Practices

1. Florida Statutes Section 337.403 **(Reference: Best Practices # 1 and # 8).** www.flsenate.gov/statutes/index.cfm?mode=View%20Statutes&SubMenu=1&App_mode=Display_Statute&Search_String=337.403&URL=CH0337/Sec403.HTM
2. Wisconsin Administrative Code Trans 220 **(Reference: Best Practices #2 and #10).** nxt.legis.state.wi.us/nxt/gateway.dll?f=templates&fn=default.htm&vid=WI:Default&d=code&jd=top
3. Florida Utilities Coordination Committee—Utility Certification Program PowerPoint **(Reference: Best Practice #3).**
4. Georgia DOT—Avoiding Utility Project Impacts Training Program **(Reference: Best Practice #3).** www.dot.state.ga.us/dot/operations/utilities/documents/PDF/SUE/AvoidingUtilityProjectImpacts_GDOT_Portion_Only.pdf
5. Washington DOT—Utility Coordination Process **(Reference: Best Practices #5 and #10):** Project Utility Coordination Process. www.wsdot.wa.gov/northwest/utilities/Forms/pdf/Proj_Util_Coord_Process.pdf
6. Florida DOT ROW Management System Security Statute **(Reference: Best Practice #7).** www2.dot.state.fl.us/proceduraldocuments/procedures/bin/575095010.pdf
7. *The Efficacy of Utility Database Management*, S. C. Kranc and Ali Yalcin **(Reference: Best Practice #7).** www.dot.state.fl.us/researchCenter/Completed_Proj/Summary_RD/FDOT BD544_27rpt.pdf
8. Idaho DOT Utility/Railroad Tracking System **(Reference: Best Practice #7).** itd.idaho.gov/design/util_rail/policies.htm
9. Texas ROW Manuals: **(Reference: Best Practice #7)** www.dot.state.tx.us/services/general_services/manuals.htm ftp://ftp.dot.state.tx.us/pub/txdot-info/sat/specinfo/sat-fms.pdf
10. Virginia RUMS **(Reference: Best Practice #7).** www.virginiadot.org/business/row-rums.asp
11. Michigan DOT Road Design Manual, Section 9.02.04 **(Reference: Best Practice #8).** http://mdotwas1.mdot.state.mi.us/public/design/englishroadmanual
12. Federal Highway Administration's SUE website **(Reference: Best Practice #9).** www.fhwa.dot.gov/programadmin/sueindex.cfm
13. Georgia's Utility Impact Matrix Example **(Reference: Best Practice #11).** www.dot.state.ga.us/dot/operations/utilities/documents/PDF/SUE/AvoidingUtilityProjectImpacts_GDOT_Portion_Only.pdf
14. Georgia DOT SUE Utility Impact Rating Form **(Reference: Best Practice #12).** www.dot.state.ga.us/dot/operations/utilities/documents/doc/SUE/SUE%20impact%20Rating%20Form.doc
15. Michigan DOT Road Design Manual, Section 9.03.03 **(Reference: Best Practice #12).**
16. Tennessee's Chapter 86 Status Report **(Reference: Best Practices #1, #2, #6, and #8).**

Before September 2003, existing utility facilities located outside of existing public rights-of-way were assumed to have property rights by fee or by easement and were reimbursed. By Tennessee case law established in 1970, if the utility's existing facilities were located inside the public rights-of-way, it was assumed to have permissive rights by the state, city, county, or local agency, and therefore had to relocate conflicts at no cost to the state. This is a common scenario in most states. There were no enforceable penalties if the utility did not comply with state statute or if they delayed the relocation of facilities during highway construction. A statute provision to fine utilities that had been enacted in 1999 and modified in 2000 has been difficult to administer and has not been effective.

In 2003, the department proposed legislation that resulted in Chapter No. 86 Public Acts 2003, referred to as "Chapter 86," as an incentive to utilities to coordinate utility relocations in accordance with the department schedule for highway construction projects. The legislation is at the commissioner's discretion and is not an entitlement to utilities.

Summary of Chapter 86 Provisions

Chapter 86 Provisions are summarized as follows:

- The commissioner is authorized, but not required, to reimburse the utility for the cost of relocation on a department project if it benefits the project.
- Qualified projects could be let for contract after September 1, 2003.
- The utility must submit relocation plans in accordance with TCA 54-5-854 within 120–165 days.
- The utility must have permissive rights to be on public ROW.
- The utility executes a contract for reimbursement and (*a*) moves before the specified date or (*b*) includes the utility relocation in the state contract.

The commissioner established a department policy to define which projects would be qualified for consideration of Chapter 86 procedures. This policy was based on disqualification of projects that had limited program funding resources, which, if qualified for Chapter 86, would deplete the program funding, limiting the ability to attain the goals for which the program was defined.

Summary of Chapter 86 Policy

The following projects are not qualified:

- Local Interstate Connectors (LIC);
- Resurfacing projects (state or federal aid funded);
- State industrial access (SIA) highways;
- Minor intersection improvement projects with no ROW acquired;
- Bridge repair projects;
- Safety projects (optional safety, railroad safety);
- Maintenance projects;
- Signal installation projects;
- Minor projects that have limited funding available; and
- Any project with a scheduled letting date for construction that is less than 9 months from the date that plans are sent.

The following projects are considered qualified:

- Grade and drainage projects with right-of-way acquisition, and
- Bridge replacement projects on the state highway system.

In addition, any project that involves local agency funding, which the department is administering, has the option to invoke Chapter 86. The local agency must notify the department in writing that they authorize local agency funds to reimburse utility relocations under provisions of Chapter 86 procedures.

Statistical Analysis

A statistical analysis is presented in Table 7.

Summation

Chapter 86 has provided an incentive to the utilities to meet the department schedules for highway construction. Based on aggregate cost data of all projects let for contract excluding mowing and emergency lettings, the cost of Chapter 86 has been less than 4% of construction cost. The feedback from the Construction Office field personnel has indicated intrinsically that that it has been a benefit, even though it has resulted in additional work with the utility relocations included in the state contract. The utilities do appear to be more cooperative. Construction can only identify three projects for which there is documentation that the delay resulted for utility reasons.

Fiscal Year	Move in		Move Prior		CH 86 Added Cost	Construction				Total Project Let[b]
						Total CH 86	Construction Complications	Construction Late	Utility Delay	
2003–2004	24	33%	48	66%	$7,668,903	72	28	12	2	$502,121,270
2004–2005	45	43%	60	57%	$23,981,834	105	37	11	1	$614,523,988
2005–2006	46	55%	38	45%	$21,704,554	84	23	2	0	$815,798,596
2006–2007[a]	46	37%	77	62%	$24,169,969	123	6	0	0	$225,304,474

[a]2006–2007 FY based on current project schedule through end of fiscal year.
[b]Total Projects Let data include maintenance projects, but remove special mowing and emergency lettings for the months that CH 86 has been in effect.

Table 7. Statistical Analysis of Tennessee's Chapter 86 Provisions

Chapter No. 86 PUBLIC ACTS, 2003
CHAPTER NO. 86

HOUSE BILL NO. 900

By Representatives Head, Shepard, Borchert, Mike Turner, Hackworth, Eldridge, Coleman, Maddox, McMillan, Pinion, McDonald, Tindell, Rinks, Fitzhugh, Harmon, McDaniel, McCord, Russell Johnson, Overbey, Harrison, Cobb, Fraley, Hargrove, Gresham, Bittle, Vincent, Wood, Hood

Substituted for: Senate Bill No. 588

By Senators Williams, Cooper, McNally, Fowler

AN ACT to amend Tennessee Code Annotated, Title 4; Title 54 and Title 55, relative to transportation.

BE IT ENACTED BY THE GENERAL ASSEMBLY OF THE STATE OF TENNESSEE:

SECTION 1. Tennessee Code Annotated, Title 54, Chapter 5, Part 8, is amended by deleting §54-5-802 in its entirety and by substituting instead the following language:

Section 54-5-802. As used in this part, unless the context otherwise requires:

(1) "Betterment" means any upgrading of the facility being relocated that is not attributable to the highway construction and is made solely for the benefit of, and at the election of, the utility;

(2) "Commissioner" means the commissioner of transportation;

(3) "Cost of relocation" means the entire amount paid by or on behalf of the utility properly attributable to the relocation after deducting from that amount any betterment of the new facility and any salvage value derived from the old facility. The cost of relocation may include, without limitation, engineering, removal and installation costs, but shall not include inspection costs or the cost of any betterment to the utility's facilities;

(4) "Department" means the department of transportation.

(5) "Public highway" means any highway included on the state highway system or interstate system and any highway, road or street that is owned, maintained or owned and maintained by a county or municipality, including the right-of-way for such highway, road or street;

(6) "Relocation" means the adjustment of a utility facility as the commissioner may determine is necessary or appropriate in connection with the construction or reconstruction of a public highway; relocation includes:

(A) Removing and reinstalling the utility facility, including necessary temporary facilities;

(B) Moving, rearranging or changing the type of existing facilities; and

(C) Taking any necessary safety and protective measures.

For the purposes of this part, relocation also includes the construction of a replacement facility that is both functionally equivalent to, but not a betterment of, the existing facility and necessary for continuous operation of the utility service, the project economy or sequence of highway construction;

(7) "Salvage value" means the amount received from the sale of utility property that has been removed or, if retained for reuse, the amount at which the recovered material is charged to the utility's accounts; and

(8) "Utility" means a privately, publicly or cooperatively owned line, facility or system used, available for use or formerly used to transmit or distribute communications, electricity, gas, liquids, steam, sewerage, or other materials to the public.

SECTION 2. Tennessee Code Annotated, Title 54, Chapter 5, Part 8, is amended by deleting §54-5-804 in its entirety and by substituting instead the following language:

Section 54-5-804.

(a) The commissioner is authorized to reimburse a utility for the cost of relocation, and to include such cost as a highway construction project cost, where the cost of relocation arises

from the relocation of a utility facility located on public highway right-of-way and the highway construction project is undertaken by the department, subject to the following conditions:

(1) The utility shall fully comply with all provisions of §54-5-854(b) including the preparation and submission to the department of the utility's relocation plan, cost estimate and schedule of calendar days for completing the relocation, within the time period specified or within such additional time as may be allowed under §54-5-854(b); and

(2) The utility shall either:

(A) Enter into a written agreement with the commissioner to include the relocation as a part of the department's highway construction contract; provided that such agreement may provide that the utility shall perform certain relocation work with its own union employees as required under a negotiated organized labor contract but, in such case, the utility shall be required to reimburse the department for all relocation costs if it fails to timely perform its relocation work as provided in the agreement with the commissioner; or

(B) Enter into a written agreement with the commissioner to remove all utility facilities that conflict with the highway construction, as determined by the department, prior to the letting of the department's construction contract, and otherwise perform and complete the utility relocation in accordance with approved relocation plans and schedule of calendar days; provided that such agreement may provide that, in the event that the department does not undertake the highway construction project within a specified time, the utility shall be reimbursed for such relocation work as it has timely performed in accordance with the approved plans and schedule.

(3) Notwithstanding any other provision of law to the contrary, the utility shall be responsible, at its own expense, to inspect all phases of the utility relocation to ensure that the removal, installation or removal and installation of the utility facility is done in accordance with all applicable specifications and safety codes.

(b) The cost of relocation for which a utility may be reimbursed under subsection (a) shall nevertheless be borne in full by the utility without reimbursement by the department where, if required by law, the utility does not have a valid permit to locate on the public highway right-of-way from the department or from the county or municipality having jurisdiction over the right-of-way.

(c) The department shall make no reimbursement payment to a utility as authorized under subsection (a) unless, and until, the commissioner is satisfied that the relocation has been performed in accordance with the relocation plans and schedule of calendar days approved by the department.

(d) To ensure that the department shall never pay any cost of relocation for which it cannot receive proportionate reimbursement under any federal aid highway act, if the United States department of transportation shall finally determine that the cost of relocation is not reimbursable to the department from federal funds, or that the cost of relocation is less than the amount reimbursed to the utility by the department, the utility so reimbursed shall repay to the department the difference between the amount so reimbursed to the utility and the cost of relocation finally determined by the department.

SECTION 3. The provisions of this act shall have no effect unless the estimated cost of this act is funded in the general appropriations act.

SECTION 4. No funds shall be obligated or expended pursuant to this act unless such funds are specifically appropriated by the general appropriations act.

SECTION 5. This act shall take effect on September 1, 2003, the public welfare requiring it.

PASSED: April 21, 2003

APPROVED this 5th day of May 2003

JIMMY NAIFEH, SPEAKER
HOUSE OF REPRESENTATIVES

JOHN S. WILDER
SPEAKER OF THE SENATE

PHIL BREDESEN, GOVERNOR

TDOT Go. DEPARTMENTAL POLICY State of Tennessee Department of Transportation	Policy Number : 340-07
	Effective Date: January 20, 2005
Approved By:	Supersedes:
SUBJECT: Utility Relocations from Public Highway Rights-of-Way Under TCA § 54-5-804	

RESPONSIBLE OFFICE: Right-of-Way Division, Utilities Office

AUTHORITY: TCA §§ 4-3-2303 and 54-5-804. If any portion of this policy conflicts with applicable state or federal laws or regulations, that portion shall be considered void. The remainder of this policy shall not be affected thereby and shall remain in full force and effect.

PURPOSE: The purpose of this policy is to identify categories of highway construction projects involving the relocation of utility facilities located on public highway rights-of-way that the Department will generally consider as qualified or as non-qualified for utility relocation reimbursement or inclusion in the Department's construction contract pursuant to TCA § 54-5-804 and to establish procedures for administering utility relocations under this statute.

APPLICATION: This policy applies to highway construction projects administered by the Department that require the relocation of utility facilities located on public highway rights-of-way.

DEFINITIONS:

1. Chapter 86 refers to TCA § 54-5-804 as amended by Public Chapter 86 of the 2003 Acts of the Tennessee General Assembly.

2. Qualified Project refers to a highway construction project involving the relocation of utility facilities located on public highway right-of-way which is within a category of projects that the Department will generally consider as qualified for utility relocation reimbursement or for inclusion in the Department's highway construction contract in accordance with this policy.

3. Non-Qualified Project refers to a highway construction project involving the relocation of utility facilities located on public highway right-of-way which is not within a category of projects that the Department will generally consider as qualified for utility relocation reimbursement or for inclusion in the Department's highway construction contract in accordance with this policy.

4. Eligible Utility refers to a utility that fully complies with the conditions established in Chapter 86 for utility relocation reimbursement or inclusion in the Department's highway construction contract.

Policy Number:340-07 _
Effective Date: 1/20/05

POLICY:

QUALIFIED PROJECTS:

The relocation of utility facilities from public highway rights-of-way will generally be considered as qualified for inclusion in the Department's highway construction contract or for reimbursement of utility relocation costs under Chapter 86, if the utility is an Eligible Utility, in the following types of projects:

- Grade and Drainage projects with right-of-way acquisition; and
- Bridge Replacement projects on the State highway system.

In addition, a project within one of these categories will generally be considered a Qualified Project only if the scheduled letting date for the construction contract is not more than nine (9) months after the date on which the project plans are sent to the utility as provided in TCA § 54-5-854.

NON-QUALIFIED PROJECTS:

The relocation of utility facilities from public highway rights-of-way will generally not be considered as qualified for inclusion in the Department's highway construction contract or for reimbursement of utility relocation costs under Chapter 86, even if the utility is an Eligible Utility, in the following types of projects:

- Local Interstate Connectors (LIC);
- Resurfacing projects (State or Federal-aid funded);
- State Industrial Access (SIA) highways;
- Minor intersection improvement projects with no right-of-way acquired;
- Bridge repair projects;
- Safety projects (Optional Safety, Railroad Safety);
- Maintenance projects;
- Signal installation projects;
- Minor projects that have limited project funding available; and
- Any project with a scheduled letting date for the construction contract that is less than nine (9) months from the date on which the project plans are sent to the utility as provided in TCA § 54-5-854.

LOCAL PROJECTS:

For local highway projects administered by the Department on behalf of a local government, the relocation of utility facilities from public highway rights-of-way will be considered as qualified for inclusion in the Department's highway construction contract or for reimbursement of utility relocation costs under Chapter 86, if the utility is an Eligible Utility, only in the following types of projects and only where (1) the local government requests to include the cost of relocating utility facilities from public highway right-of-way as a project cost, and (2) upon such request, the Department's Office of Local Programs determines that projects funds are available for this purpose:

Policy Number:340-07 _
Effective Date: 1/20/05

- Grade and Drainage projects with right-of-way acquisition; and
- Bridge Replacement projects on the local government's highway system.

In addition, a project within one of these categories will generally be considered a Qualified Project only if the scheduled letting date for the construction contract is not more than nine (9) months after the date on which the project plans are sent to the utility as provided in TCA § 54-5-854.

EXCEPTIONS:

This policy is to be used as a standard guideline for the administration of Chapter 86. The Commissioner retains the discretionary authority under Chapter 86 to stop or suspend the application of Chapter 86 to all projects, to modify this policy, or to make exceptions to this policy on a case-by-case basis.

PROCEDURE:

UTILITY ELIGIBILITY:

By law, Chapter 86 may be applied to a Qualified Project, as defined in this policy, only if the utility is an Eligible Utility as provided in Chapter 86. Failure to comply with one or more of the conditions prescribed in Chapter 86 will cause the utility's relocation of facilities on public right-of-way to be deemed ineligible for reimbursement or for inclusion in the Department's highway construction contract. The statutory conditions for utility eligibility include, without limitation, the following:

1. In accordance with TCA § 54-5-804(a)(1), the utility must be in full compliance with all provisions of TCA § 54-5-854(b), including submission of the utility's relocation plan, cost estimate and schedule to the Department within 120 days after receiving the Department's project plans, or within such additional time – not to exceed 45 days – as the Department shall allow when (1) coordination with other utility owners is required to prepare a relocation plan and schedule or (2) a change in the Department's project plans requires a change in the utility's relocation plan or schedule.

2. In accordance with TCA § 54-5-804(a)(2), the utility must either (1) enter into a written agreement to include the utility relocation in the Department's highway construction contract or (2) enter into and timely fulfill a written agreement to remove all utility facilities that conflict with the highway construction prior to the scheduled date for letting the Department's construction contract.

3. In accordance with TCA § 54-5-804(b), the utility must have a valid permit to locate on the public highway right-of-way from the Department or the local government having jurisdiction over the highway right-of-way.

Policy Number:340-07 _
Effective Date: 1/20/05

REQUIRED COMPLIANCE DOCUMENTATION:

The Regional Utility Office will notify the utility if the project is a Qualified Project in the letter providing the utility with project plans and authorizing utility relocation engineering, as provided in TCA § 54-5-854(a). When the utility submits its relocation plan, schedule, and cost estimate as required in TCA § 54-5-854(b), it must also submit documentation demonstrating its compliance with TCA 54-5-804, including as follows:

1. Documentation that the utility is in full compliance with TCA § 54-5-804(a)(1) in that the utility has returned its relocation plan, schedule, and cost estimate to the Department within 120 days after receipt of the Department's project plans, or within such additional time as shall be allowed in accordance with TCA § 54-5-854(b). If the utility documents the need for additional time beyond the 120 days based on either (1) the need to coordinate with other utility owners in order to prepare the utility's relocation plan and schedule, or (2) the need to alter the utility's relocation plan or schedule because of changes in the Department's project plans, then the utility shall be allowed additional time, not to exceed 45 days, in which to submit its initial or modified relocation plan or schedule as the case may be. The utility cannot be considered an Eligible Utility under Chapter 86 if the utility fails to submit its relocation plan, schedule and cost estimate to the Department within the time required under TCA § 54-5-854(b).

2. Documentation that the utility is in compliance with TCA 54-5-804(b) in that the utility has a valid permit to locate its utility facility on the public highway right-of-way. A separate permit must be documented for each separate utility facility for which Chapter 86 reimbursement or inclusion is requested, and for this purpose street lighting must be considered as separate from any other overhead utility installation. The utility may document compliance with this permit requirement for each separate utility facility (1) by submitting a copy of a current, valid permit for the utility facility issued by the Department or the local government having jurisdiction over the public highway right-of-way, or (2) where no such permit can be found, the utility may be presumed to have a valid permit where it can demonstrate that the utility facility has been installed in accordance with applicable permit conditions and there is no evidence sufficient to rebut this presumption. A utility that fails to provide documentation of a valid permit for a utility facility cannot be considered an Eligible Utility with respect to that utility facility.

UTILITY RELOCATION AGREEMENT:

If the project is a Qualified Project and the utility submits the required compliance documentation to demonstrate that it is an Eligible Utility, the Headquarters Utility Office will offer the utility the opportunity to enter into a standard written utility relocation agreement which provides either (1) that the utility relocation will be included in the Department's highway construction contract, with or without an exception for relocation work that must be performed by the utility's union employees under a collective bargaining agreement, as provided in TCA § 54-5-804(a)(2)(A), or (2) that the utility will timely remove all utility facilities that conflict with the Department's highway construction project prior to the date scheduled for the letting of that contract, as provided in TCA 54-5-804(a)(2)(B).

Policy Number:340-07 _
Effective Date: 1/20/05

To include the utility relocation work in the Department's highway construction contract, the utility must submit the following documentation to the Headquarters Utility Office by no later than sixteen (16) weeks prior to the scheduled letting date: (1) reproducible relocation plans, signed and sealed; (2) an estimate of the utility relocation construction cost in a format prescribed by the Department; (3) complete utility specifications; and (4) Department-prescribed documentation required to secure permits for the highway construction. Late submittals will not be accepted by the Department, and in such a case the utility relocation work cannot be included in the Department's highway construction contract.

TRB OVERSIGHT COMMITTEE FOR THE STRATEGIC HIGHWAY RESEARCH PROGRAM 2*

CHAIR: **Kirk T. Steudle,** *Director, Michigan Department of Transportation*

MEMBERS

H. Norman Abramson, *Executive Vice President (Retired), Southwest Research Institute*
Anne P. Canby, *President, Surface Transportation Policy Partnership*
Alan C. Clark, *MPO Director, Houston-Galveston Area Council*
Frank L. Danchetz, *Vice President, ARCADIS G&M, Inc.*
Dan Flowers, *Director, Arkansas State Highway and Transportation Department*
Stanley Gee, *Executive Deputy Commissioner, New York State Department of Transportation*
Michael P. Lewis, *Director. Rhode Island Department of Transportation*
Susan Martinovich, *Director, Nevada Department of Transportation*
John R. Njord, *Executive Director, Utah Department of Transportation*
Charles F. Potts, *Chief Executive Officer, Heritage Construction and Materials*
Pete K. Rahn, *Director, Missouri Department of Transportation*
Gerald Ross, *Chief Engineer, Georgia Department of Transportation*
George E. Schoener, *Executive Director, I-95 Corridor Coalition*
Kumares C. Sinha, *Olson Distinguished Professor of Civil Engineering, Purdue University*

EX OFFICIO

Jeffrey F. Paniatti, *Acting Deputy Administrator and Executive Director, Federal Highway Administration*
Michael F. Trentacoste, *Director of Safety, Research and Development, Federal Highway Administration*
Andrew T. Horosko, *Deputy Minister, Manitoba Infrastructure and Transportation*
John C. Horsley, *Executive Director, American Association of State Highway and Transportation Officials*

LIAISONS

John Pearson, *Program Director, Council of Deputy Ministers Responsible for Transportation and Highway Safety*
Jack D. Jernigan, *Legislation & Budget Analyst, Federal Highway Administration*

RENEWAL TECHNICAL COORDINATING COMMITTEE*

CHAIR: **Randell H. Iwasaki,** *Chief Deputy Director, California Department of Transportation*

MEMBERS

Rachel Arulraj, *Director of Virtual Design & Construction, Parsons Brinckerhoff*
Michael E. Ayers, *Director of PavementTechnology Services, American Concrete Pavement Association*
Thomas E. Baker, *State Materials Engineer, Washington State Department of Transportation*
John E. Breen, *Al-Rashid Chair in Civil Engineering, The University of Texas at Austin*
Daniel D'Angelo, *Director and Deputy Chief Engineer, Office of Design, New York State Department of Transportation*
Rocco A. DePrimo, *Manager of Quality Assurance, Utility Manager, Keith and Schnars, P.A.*
Steven D. DeWitt, *Chief Engineer, North Carolina Turnpike Authority*
Tom Donovan, *Senior Right of Way Agent, Utility Relocations, California Department of Transportation*
Alan D. Fisher, *Manager, Construction Structures Group, Cianbro Corporation*
Michael Hemmingsen, *Davison Transportation Service Center Manager, Michigan Department of Transportation*
Bruce Johnson, *State Bridge Engineer, Oregon DOT, Bridge Engineering Section*
Leonnie Kavanagh, *PhD Candidate, Seasonal Lecturer, Civil Engineering Dept., University of Manitoba*
Thomas W. Pelnik, III, *Director, Innovative Project Delivery Division, Virginia Department of Transportation*
Mary Lou Ralls, *Principal, Ralls Newman, LLC*
John J. Robinson, Jr., *Assistant Chief Counsel, Pennsylvania Department of Transportation, Governor's Office of General Counsel*
Michael Ryan, *Vice President, Michael Baker Jr., Inc.*
Ted M. Scott, II, *Director, Special Projects, American Trucking Associations, Inc*
Cliff J. Schexnayder, *Eminent Scholar Emeritus*
Gary D. Taylor, *Professional Engineer*
Thomas R. Warne, *President, Tom Warne and Associates, LLC*
Gary C. Whited, *Program Manager, Construction and Materials Support Center University of Wisconsin-Madison*

LIAISONS

James T. McDonnell, *American Association of State Highway and Transportation Officials*
Lance Vigfusson, *Canada (Manitoba)*
Steve Gai, Cheryl Richter, *Federal Highway Administration*
Amir N. Hanna, Frederick D. Hejl, *Transportation Research Board*

*Membership as of May 2009.

Related SHRP 2 Research

Encouraging Innovation in Locating and Characterizing Underground Utilities (R01)
Technologies to Support Storage, Retrieval, and Use of 3-D Utility Location Data (R01-A)
Multi-Sensor Platforms for Locating Underground Utilities (R01-B)
Innovation in Location of Deep Utilities (R01-C)
Strategic Approaches at the Corridor and Network Levels to Minimize Disruption from the Renewal Process (R11)
Identification of Utility Conflicts and Solutions (R15-A)

WWW.TRB.ORG/SHRP2

THE NATIONAL ACADEMIES™
Advisers to the Nation on Science, Engineering, and Medicine

The nation turns to the National Academies—National Academy of Sciences, National Academy of Engineering, Institute of Medicine, and National Research Council—for independent, objective advice on issues that affect people's lives worldwide.
www.national-academies.org