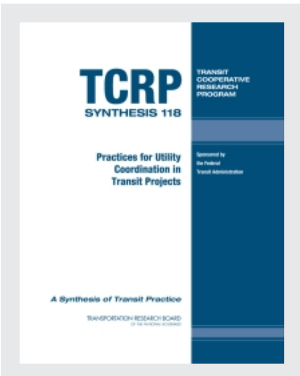

Practices for Utility Coordination in Transit Projects

DETAILS

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TRANSIT COOPERATIVE RESEARCH PROGRAM

TCRP SYNTHESIS 118

Practices for Utility Coordination in Transit Projects

A Synthesis of Transit Practice

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SUBJECT AREAS
Public Transportation • Terminals and Facilities

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TRANSPORTATION RESEARCH BOARD

WASHINGTON, D.C.
2015
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TRANSIT COOPERATIVE RESEARCH PROGRAM

The nation's growth and the need to meet mobility, environmental, and energy objectives place demands on public transit systems. Current systems, some of which are old and in need of upgrading, must expand service area, increase service frequency, and improve efficiency to serve these demands. Research is necessary to solve operating problems, to adapt appropriate new technologies from other industries, and to introduce innovations into the transit industry. The Transit Cooperative Research Program (TCRP) serves as one of the principal means by which the transit industry can develop innovative near-term solutions to meet demands placed on it.

The need for TCRP was originally identified in *TRB Special Report 213—Research for Public Transit: New Directions,* published in 1987 and based on a study sponsored by the Federal Transit Administration (FTA). A report by the American Public Transportation Association (APTA), *Transportation 2000*, also recognized the need for local, problem-solving research. TCRP, modeled after the longstanding and successful National Cooperative Highway Research Program, undertakes research and other technical activities in response to the needs of transit service providers. The scope of TCRP includes a variety of transit research fields including planning, service configuration, equipment, facilities, operations, human resources, maintenance, policy, and administrative practices.

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The TCRP provides a forum where transit agencies can cooperatively address common operational problems. The TCRP results support and complement other ongoing transit research and training programs.

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FOREWORD

Transit administrators, engineers, and researchers often face problems for which information already exists, either in documented form or as undocumented experience and practice. This information may be fragmented, scattered, and unevaluated. As a consequence, full knowledge of what has been learned about a problem may not be brought to bear on its solution. Costly research findings may go unused, valuable experience may be overlooked, and due consideration may not be given to recommended practices for solving or alleviating the problem.

There is information on nearly every subject of concern to the transit industry. Much of it derives from research or from the work of practitioners faced with problems in their day-to-day work. To provide a systematic means for assembling and evaluating such useful information and to make it available to the entire transit community, the Transit Cooperative Research Program Oversight and Project Selection (TOPS) Committee authorized the Transportation Research Board to undertake a continuing study. This study, TCRP Project J-7, "Synthesis of Information Related to Transit Problems," searches out and synthesizes useful knowledge from all available sources and prepares concise, documented reports on specific topics. Reports from this endeavor constitute a TCRP report series, *Synthesis of Transit Practice*.

This synthesis series reports on current knowledge and practice, in a compact format, without the detailed directions usually found in handbooks or design manuals. Each report in the series provides a compendium of the best knowledge available on those measures found to be the most successful in resolving specific problems.

PREFACE

By Donna L. Vlasak
Senior Program Officer
Transportation Research Board

This synthesis summarizes utility coordination practices at transit agencies around the country. It focuses on utility coordination issues that transit agencies undertake during typical phases of project development and delivery, which involve planning, designing, and constructing civil infrastructure facilities. It is intended for transit agency staff and utility stakeholders.

Although utility issues in highway construction have been documented in recent initiatives, very little exists for documenting transit projects. Most utility relocation appears to be associated with rail and streetcar projects, and very rarely, bus projects. The topic panel and consultant chose to work closely with the American Public Transportation Association (APTA) to extract information about general trends around the country as reported here and to identify the potential agencies with whom to conduct more detailed interviews.

A literature review and detailed survey responses from eight of ten transit agencies interviewed for detailed case examples, yielding a response rate of 80%, are provided. These case examples offer specific details on project management, engineering challenges, and conflicts and resolution.

Cesar Quiroga, Edgar Kraus, and Lauren Cochran, Texas A&M Transportation Institute, College Station, Texas, collected and synthesized the information and wrote the report, under the guidance of a panel of experts in the subject area. The members of the topic panel are acknowledged on the preceding page. This synthesis is an immediately useful document that records the practices that were acceptable within the limitations of the knowledge available at the time of its preparation. As progress in research and practice continues, new knowledge will be added to that now at hand.

CONTENTS

PRACTICES FOR UTILITY COORDINATION IN TRANSIT PROJECTS

SUMMARY

Transit projects frequently affect utility facilities (both above and below ground) that exist along project corridors. Relatively little has been documented on the topic of utility issues or the use of successful practices to facilitate utility coordination in transit projects. This synthesis provides a summary of utility coordination practices at transit agencies around the United States. The report includes a literature review, a survey of selected transit agencies, documentation of lessons learned, and identification of information gaps and research needs.

The literature review included references that discuss utility practices at transit agencies and, for completeness, references that discuss relevant highway-related reports, guidelines, and research. Most utility relocations at transit agencies are associated with rail and streetcar projects. Bus projects rarely involve utility relocations. Statistics showing capital expenditures spent on utility relocations are not easily available. Having access to these statistics could facilitate a number of applications, including project planning and scoping, project cost monitoring, and risk management.

Some FTA guidelines include information related to utilities. For example, the *Project and Construction Management Guidelines* assist with the development of transit capital projects in areas related to project scope, function, schedule, cost, and quality. Regardless of project delivery method, the guidelines highlight the importance of identifying utility conflicts during project development. The guidelines also stress the importance of executing master agreements with utility owners to outline each party's responsibilities during design and construction. FTA also published a series of lessons learned based on feedback received from FTA Project Management Oversight Program contractors, transit agencies, and FTA regional managers. However, utility issues were mentioned only incidentally in some of the lessons learned.

A survey of transit agencies was conducted to better understand utility coordination practices. A two-tier approach was followed in which a preselection survey was distributed to transit agencies nationwide, and based on the results of this preselection survey, a targeted round of phone interviews was conducted with selected transit agencies. In total, ten transit agencies were selected based on the results of the preselection survey and invited to participate in phone interviews. Of this total, eight agencies responded (80% response rate), and phone interviews were scheduled with each of them.

Lessons learned from the preselection survey and the follow-on telephone interviews include the following:

- Utility conflicts result in significant impacts to transit projects, particularly during design and construction.
- Transit agencies strive to involve utility owners early in the project development process.
- Successful utility coordination requires experience, partnerships, diligence, and accurate and complete utility data.
- Existing records research, survey of visible utility appurtenances, utility location services, and test holes are standard utility data collection techniques.

- Transit agencies rarely collect quality level B (QLB) or quality level A (QLA) utility data in accordance with ASCE 38-02 standard for the collection and depiction of underground utility facilities.
- Using three-dimensional technologies for project development and delivery is still uncommon.
- Utility conflict matrices are useful for managing utility conflicts during project development and delivery, but their use is inconsistent.
- Some utility conflicts require unique engineering solutions.
- Transit agencies apply risk assessment and risk management principles, but there is little information on specific risk assessment techniques for handling utility issues.
- There is a wide range in cost-sharing agreements for utility relocations.
- Compliance with Buy America provisions is a significant issue affecting transit agencies and utility companies.
- There is a need for guidance documents at transit agencies to help utility stakeholders during the project development and delivery process.

Based on the information gathered for this synthesis, the following research needs have been identified:

- Effective utility investigation protocols for transit projects.
- Improved methodology for identifying and managing utility conflicts.
- Templates and model master utility agreements.
- Framework and architecture for database of utility coordination and relocation costs in relation to total project costs.
- Effective practices for compliance with Buy America provisions.
- Guidelines for utility relocation practices in transit projects.
- Utility coordination effective practices for different delivery methods.
- Feasibility of a strategic transit research program to address urgent transit issues.

CHAPTER ONE

INTRODUCTION

BACKGROUND AND CONTEXT

Transit projects frequently involve planning, designing, and building transportation facilities, such as rail or streetcar projects, that affect other modes of transportation and various kinds of utility facilities (both above and below ground) that exist along the project corridors. As part of the transportation infrastructure improvements, utilities may be forced to relocate horizontally, vertically, or both. As Figure 1 shows, utilities that are located in dense, urban corridors are particularly affected and difficult to manage, significantly increasing the complexity of the project because of the confined space and number of utility facilities competing for accommodation.

Two critical factors that contribute to inefficiencies in the management of utility issues are (1) the lack of accurate, complete information about utility facilities that might be in conflict with the project and (2) deficiencies in the identification and implementation of effective strategies to resolve those conflicts. These inefficiencies can result in problems, such as the following:

- Disruptions when utility installations are encountered unexpectedly during construction, either because there was no previous information about the installations or because their stated location on the construction plans was incorrect.
- Damage to utility installations leading to disruptions in utility service, environmental damage, and risks to the health and safety of construction workers and the public.
- Delays that can extend the period of project development and/or delivery and increase total project costs through higher bids, change orders and/or damage or delay claims, redesign, and litigation by utility owners or agencies. These delays also result in frustration by the traveling public and negative public perception about the project.
- Unplanned environmental corrective actions.
- Unnecessary utility relocations and project delivery inefficiencies that occur because adequate information about existing utility facilities was not available to enable stakeholders to apply alternative utility conflict resolution strategies, such as modifying the transportation project design or protecting the utility facilities in place.

OBJECTIVES AND METHODOLOGY

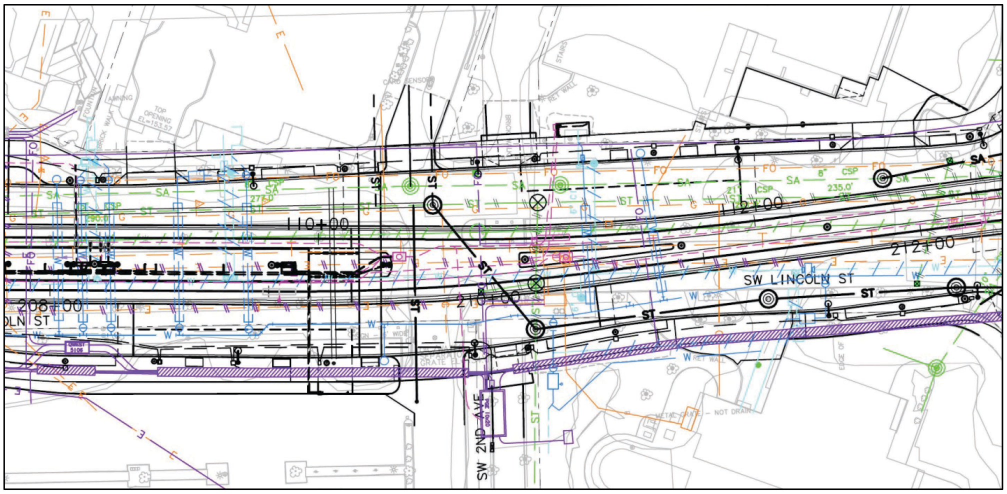
Relatively little has been documented on the topic of utility issues or the use of successful practices to facilitate utility coordination in transit projects. By comparison, numerous initiatives have been undertaken to address utility issues in highway projects. To address the knowledge gap on utility issues in transit projects, Synthesis J-07, Topic SG-13, *Practices for Utility Coordination in Transit Projects* reports on utility coordination practices at transit agencies around the United States. The synthesis report includes a literature review; results of a preselection survey of and follow-on phone interviews with selected transit agencies; documentation of lessons learned; and identification of successful experiences and effective practices, challenges, and gaps in information. The report also suggests potential research ideas.

The synthesis focused on utility coordination issues during typical phases of project development and delivery that transit agencies undertake and that involve planning, designing, and constructing civil infrastructure facilities. Typical examples of these types of projects include light rail, heavy rail, streetcar, and bus rapid transit (BRT) routes. To keep the focus manageable, the synthesis did not address coordination with utility owners for other initiatives, such as requesting utility service for buildings or other installations, or in relation to the conversion to or use of natural gas or electricity to power bus fleets. Topics the synthesis covered included, but were not limited to, project development and delivery phases, impact of utility issues on project delivery, utility data collection techniques and practices, identification and resolution of utility conflicts, strategies to improve or streamline utility coordination activities, and training and professional development.

REPORT ORGANIZATION

This report describes the procedures and findings of the project and is organized as follows:

- Chapter one is the introductory chapter.
- Chapter two provides a literature review on the topic of utility coordination and management of utility issues during transit project development and delivery.



Courtesy of TriMet. The plan view shows a section of a light rail project in downtown Portland, Oregon, depicting the rail alignment and existing and proposed underground installations. Some of the facilities shown are as follows:

Existing installations:

Green (SA label):	Existing sanitary sewer. A dashed line indicates the sewer will be abandoned or removed.
Green (ST label):	Existing storm sewer. A dashed line indicates the sewer will be abandoned or removed.
Cyan:	Existing water main or lateral.
Orange:	Other existing utility differentiated by letter: E = electric, G = gas, FO = fiber optic.
Light grey:	Other existing facilities.

Proposed installations:

Magenta:	TriMet duct banks and vaults, generally under the track slab or in the guideway.
Black (bold, SA label):	Proposed sanitary sewer.
Black (bold, ST label):	Proposed storm sewer.
Blue:	Proposed water main or lateral.
Purple (hash):	Joint utility trench for electric and communication utilities.

FIGURE 1 TriMet light rail project in downtown Portland, Oregon: Design plan with future surface improvements and utility installations.

- Chapter three provides an overview of the case example selection survey results.
- Chapter four provides a summary of eight case examples and lessons learned. In total, eight of ten transit agencies responded to the invitation to participate (an 80% response rate).
- Chapter five provides conclusions and suggestions for future research.
- Appendix A shows the preselection survey instrument.
- Appendix B shows the interview guide for the case examples.
- Appendix C provides a listing of the agencies.

CHAPTER TWO

LITERATURE REVIEW

INTRODUCTION

This chapter summarizes lessons learned from a literature review on the topic of utility coordination and management of utility issues during transit project development and delivery. The literature review includes a summary of transit agencies in the United States, followed by a summary of references that discuss utility practices at transit agencies. It also includes a review of relevant highway-related reports, guidelines, and research.

TRANSIT SYSTEMS IN THE UNITED STATES

According to the APTA Fact Book, approximately 8,000 public transportation systems operated by 7,100 agencies are in service in the United States (*1*). Providers range in size and service from large, urban, multimodal systems to single-vehicle, demand-response systems. In 2011, passengers took 10.3 billion trips on public transit. Buses carried 51% of all passengers, rail vehicles carried 45% of all passengers, and demand-response and other modes accounted for the remaining 4%. Of the 7,100 public transportation agencies in the United States, 825 systems operate in urbanized areas, and 1,440 systems operate in rural areas. The remaining 4,835 systems correspond to demand-response systems that may be urban or rural.

Table 1 provides a summary of public transportation systems in the United States. In 2011, there were 7,865 roadway mode systems in the United States. The most numerous systems were demand-response service systems (6,600), followed by bus-based systems (1,078). The remaining 187 roadway systems included BRT, commuter bus, Público (in Puerto Rico), vanpool, and trolleybus. Roadway mode systems provided 5.6 billion unlinked passenger trips per year, of which bus systems accounted for the highest number of annual passenger trips (5.2 billion), followed by demand-response systems (191 million).

In 2011, there were 96 rail mode systems in the United States, including 27 commuter rail systems, 27 light rail systems, and 15 heavy rail systems. Rail mode systems provided 4.6 billion unlinked passenger trips per year, of which heavy rail systems accounted for the highest number of annual passenger trips (3.6 billion), followed by commuter rail systems (466 million).

In 2011, U.S. transit agencies spent $38 billion on operations and $17 billion on capital expenditures (*1*). As Table 2 shows, capital expenditures included approximately $10 billion on facilities (i.e., guideway, stations, administration buildings, and maintenance facilities); $4.8 billion on rolling stock; and $2.2 billion on fare revenue collection equipment, communication and information systems, and other. Nationwide, funding for capital expenditures was provided by federal (43%), local (19%), and state (13%) sources, and was directly generated (25%). Federal funds increased from $4.5 billion to $7.2 billion from 2000 to 2011 but decreased from 47% of all capital revenue to 43%. At the same time, directly generated and local funds increased from 42% of all capital funds in 2000 to 43% in 2011, and state assistance increased from 11% in 2000 to 13% in 2011.

From the information gathered, it is not straightforward to identify how many capital transit projects or what amount or percentage of capital expenditures are directly associated with utility relocations. Nor is it straightforward to identify the total cost of utility relocations nationwide because of the wide range in funding sources throughout the country. As described in more detail in chapter four, the distribution of federal, state, local, and directly generated funds varies widely among transit agencies. Nonetheless, a preliminary analysis indicates that most utility relocations probably are associated with rail and streetcar projects and, to a much lesser extent, bus projects. As a reference, a 1996 study included an evaluation of capital costs for light rail projects (*2*) in Baltimore, Los Angeles, Pittsburgh, Portland, Sacramento, St. Louis, San Diego, and San Jose. For the study, the analysts assumed 8% to 10% of the project capital cost to be associated with utilities, betterments, and mitigation measures.

UTILITY ACCOMMODATION, RELOCATION, AND COORDINATION

Federal Guidelines for Transit Projects

The FTA developed the *Project and Construction Management Guidelines* (*3*) to assist with the development of transit capital projects in areas related to project scope, function, schedule, cost, and quality. FTA originally published the guidelines in 1990 and updated them in 1996, 2003, and 2011. FTA intends the guidelines for use by transit agencies (also known as grantees) and their consultants, as well as FTA staff and project management oversight contractors. FTA provides grant oversight, but delegates grant administration and project

TABLE 1
PUBLIC TRANSPORTATION SYSTEMS STATISTICS, REPORT YEAR 2011

Roadway-Based National Totals								
Statistical Category	**Bus**	**Bus Rapid Transit**	**Commuter Bus**	**Demand Response**	**Público[1]**	**Transit Vanpool**	**Trolleybus**	**Total**
Number of systems	1,078	5	92	6,600	1	84	5	7,865
Lane-miles on exclusive or controlled right-of-way[2]	2,183	13	630	N/A	N/A	N/A	128	2,954
Vehicle miles (million)	2,339	2	72	1,612	40	195	12	4,272
Unlinked passenger trips (million)[3]	5,191	6	37	191	39	34	98	5,596

Rail and Ferryboat National Totals								
Statistical Category	**Commuter Rail**	**Heavy Rail**	**Hybrid Rail**	**Light Rail**	**Streetcar**	**Other Rail Modes[4]**	**Ferryboat**	**Total**
Number of systems	27	15	4	27	7	16	38	134
Directional route miles	8,536	1,617	207	1,398	136	30	N/A	11,924[5]
Vehicle miles (million)	345	655	2	89	5	5	4	1,105
Unlinked passenger trips (million)	466	3,647	6	436	43	44	80	4,722

Source: *2013 Public Transportation Fact Book* (*1*).
Note: N/A = not applicable.
[1]Público is a privately operated shuttle service of vans or small buses in Puerto Rico.
[2]The number of lane-miles on roads and streets in mixed service is not available.
[3]An unlinked passenger trip represents each time a person boards a vehicle, whether starting the transit trip or transferring from another transit vehicle.
[4]Includes aerial tramway, automated guideway transit, cable car, inclined plane, and monorail.
[5]Without including ferryboat miles.

management responsibilities to grantees. FTA regional offices fulfill the responsibility for oversight of most capital grants.

The guidelines assume the following transit capital project development phases:

- Systems planning,
- Alternatives analysis,
- Preliminary engineering,
- Final design,
- Construction and equipment/materials procurement,
- Testing and start-up, and
- Revenue service.

Figure 2 provides a graphic representation of the process, which corresponds to the traditional design-bid-build

TABLE 2
U.S. TRANSIT CAPITAL EXPENDITURES IN 2011 ($US MILLIONS)

Type	Heavy Rail	Light Rail/ Streetcar	Commuter/ Hybrid Rail	Bus and Trolleybus	Demand Response	Other	Total
Guideway	1,928	2,232	979	246	0	3	5,388
Passenger stations	1,816	430	418	452	5	115	3,236
Administrative buildings	18	6	8	176	40	2	250
Maintenance facilities	129	131	122	677	39	11	1,109
Facilities subtotal	3,891	2,798	1,528	1,550	84	131	9,983
Rolling stock	442	270	741	2,548	506	236	4,744
Service vehicles	17	20	10	31	3	1	82
Rolling stock subtotal	459	290	751	2,579	509	237	4,826
Fare revenue collection equipment	21	21	11	105	1	6	166
Communication and information systems	671	140	170	292	65	14	1,351
Other	432	13	50	186	35	17	732
All other subtotal	1,124	174	231	583	101	36	2,249
Total	5,474 (32%)	3,263 (19%)	2,510 (15%)	4,712 (28%)	694 (4%)	404 (2%)	17,057 (100%)

Source: *2013 Public Transportation Fact Book* (*1*).
Note: Expenditures, including totals, are rounded to the nearest million.

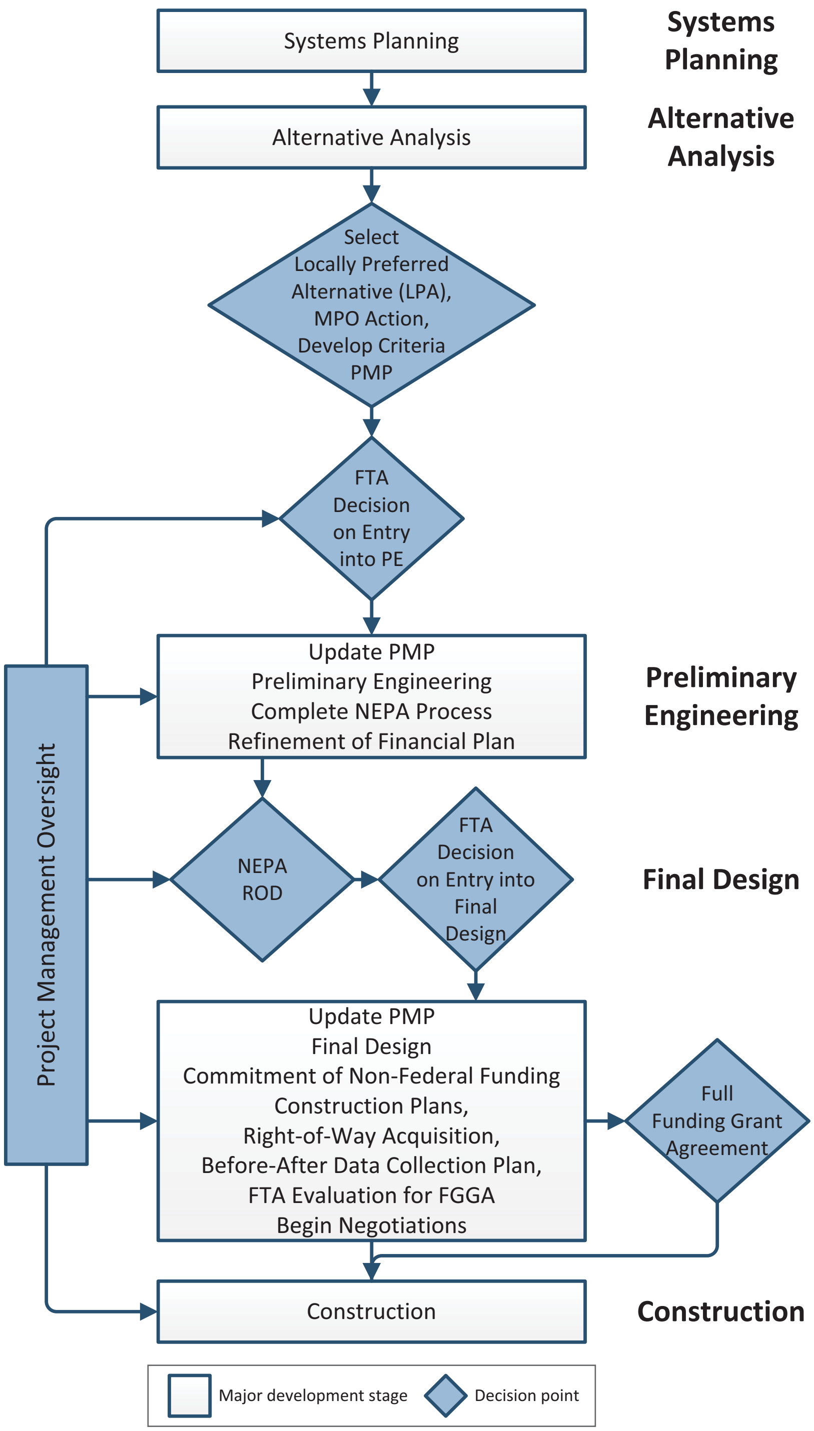


FIGURE 2 Transit Capital Project Development process [adapted from Campion et al. (*3*)].

project delivery method. Alternate project delivery methods mentioned in the FTA guidelines include design-build, design-build-operate-maintain, concession, and construction manager/general contractor (CM/GC) delivery methods. For major capital projects (MCPs), FTA requires transit agencies to prepare a project management plan (PMP), which is an overarching document that usually starts no later than the completion of the alternatives analysis phase and continues through the close-out of the capital project grant. Although not required, FTA recommends agencies to prepare a PMP for non-MCPs, such as rail modernization, bus facilities, vehicles, and intelligent transportation system projects.

In 2012, the Moving Ahead for Progress in the 21st Century Act (MAP-21) introduced some changes to the project development and delivery phases (*4*). More specifically, MAP-21 grouped alternative analysis and preliminary engineering into a single project development phase and renamed "final design" as "engineering." FTA is in the process of implementing these changes throughout the country. As of this writing, the agency has not yet updated the guidelines to reflect the changes in federal legislation.

The guidelines include an example PMP outline, which includes two sections that explicitly consider utilities: right-of-way program management (which focuses on the acquisition and relocation of property interests, including utilities) and construction program management (which includes a subsection on utility coordination). The right-of-way program management section accounts for interfaces with design and construction.

The guidelines recommend that agencies consider utilities during the preliminary engineering phase, with the goal of identifying major utilities that could affect the project. Part of this phase is also to identify "requirements risks" (i.e., risks from early planning to alternatives analysis, such as those that deal with the identification of funding sources). The risk checklist in the guidelines includes an item for existing and new utility installations. For MCPs, FTA requires agencies to prepare a risk assessment before proceeding with the final design. The purpose of the risk assessment is to determine if the preliminary engineering process has fully mitigated the project requirement risks and to identify design, market, and construction risks. The analysis would also include determining whether the project delivery method and cost estimate reflect an effective allocation of risks among the parties.

Expected utility-related deliverables during the preliminary engineering phase include the following:

- Design-bid-build projects: Preliminary utility plans and identification of required utility agreements.
- Design-build projects and public–private partnerships: All utility requirements identified, utility agreements in place, and ideally, utility relocations completed. As a side note, it is not clear how, by the end of the preliminary engineering phase, a typical transit agency would be able to complete utility relocations if certain critical design-level activities have not been completed.

Regardless of project delivery method, the guidelines emphasize that utility conflicts be identified during the preliminary design phase. The guidelines also stress the importance of executing master agreements with utility owners during the preliminary engineering phase to outline each party's responsibilities during design and construction. More specifically, the master agreements address the following:

- Scope of work and obligations and rights of both parties;
- Responsibility for design, construction, and relocations;
- Responsibility for inspection;
- Responsibility for job site safety and security;
- Procedures for billing and payments;
- Dispute resolution procedures;
- Preparation and terms of detailed agreements;
- Salvage materials and credits;
- Responsibility for the acquisition of substitute easements;
- Substitutions and betterments;
- Acceptance of improvements criteria (short of agreeing on "betterments");
- Conflict resolution procedures;
- Improvement and replacement standards; and
- Parameters for scheduling work.

Compared with the amount of documentation related to preliminary design, the guidelines are relatively brief with respect to design and construction recommendations and requirements. During the final design phase, the guidelines include requirements for the submission of utility-related deliverables at the 30%, 60%, and 90% design levels, generally in the form of drawings in electronic format and/or specifications. Agencies could also develop specific agreements with utilities during the design phase and ensure that contractors coordinate utility relocation and project service requirements with their own schedule during construction, with a focus on aggressive monitoring of all interfaces to avoid project delays. The guidelines also recommend protecting existing utility installations during construction. Appendix C in the guidelines provides additional information on the process to develop utility agreements with utility owners in compliance with 23 Code of Federal Regulations (CFR) 645 (*5*).

In an effort to increase the effectiveness of transit capital expenditures around the nation, FTA published a series of lessons learned based on feedback received from FTA Project Management Oversight Program contractors, transit agencies, and FTA regional managers (*6*). FTA grouped the lessons learned into four categories:

- Cost (five lessons learned);
- Management (41 lessons learned);
- Schedule (five lessons learned); and
- Scope (14 lessons learned).

Utility issues were mentioned only tangentially in some of the lessons learned.

Buy America Provisions

In 2010, TCRP published *Legal Research Digest 31* to provide guidance on the application of Buy America requirements (*7*). The digest focused on special requirements that apply to manufactured products and rolling stock. It did not specifically tackle or even mention utility relocations. However, it did provide a comprehensive account of Buy America provisions going back to 1875, and thus is an excellent reference document that could be disseminated widely to help stakeholders understand the history and evolution of Buy America provisions. Because the digest was published in 2010, it does not include changes to Buy America provisions that MAP-21 introduced in 2012 (*4*). Important events highlighted in the digest include, but are not limited to, the following:

- 1875 (legislation related to preferential treatment of American material in contracts for public improvements). It applied only to materials purchased by the Department of War.
- 1933 (legislation popularly referred to as the "Buy American" Act). This legislation was enacted in part in response to the unemployment crisis of the Great Depression. It applies to purchases by federal agencies but not to grants made by federal agencies. Purchases by state and local governments with federal funds are not subject to the Buy American Act. The act requires all goods for public use to be produced in the United States. It also requires the cost of domestic components to exceed 50% of the cost of all components.
- 1964 (Urban Mass Transportation Act). This act authorized federal aid to cover as much as 80% of the cost of transit equipment. In 1965, the Housing and Urban Development Act repealed provisions to mirror the Buy American Act provisions in the 1964 Urban Mass Transportation Act.
- 1978 [Surface Transportation Assistance Act (STAA)]. This act included a Buy America provision applicable to the Urban Mass Transit Administration (UMTA) program. The provision established a preferential treatment for products made in the United States but applied only to UMTA grantees exceeding $500,000.
- 1982 (Surface Transportation Act). This act strengthened Buy America provisions by precluding the use of UMTA-managed funds used in transit projects unless steel, cement, and manufactured products used in transit projects were produced in the United States.
- 1987 [Surface Transportation and Uniform Relocation Assistance Act (STURAA)]. This act made additional changes to Buy America requirements for buses and other rolling stock.
- 1991 [Intermodal Surface Transportation Efficiency Act (ISTEA)]. This act amended Buy America requirements by adding iron to the products covered.
- 2005 [Safe, Accountable, Flexible, Efficient Transportation Equity Act—A Legacy for Users (SAFETEA-LU)]. This act included several Buy America provisions, including requiring a detailed justification as to why a waiver based on a public interest determination serves the public interest.
- 2009 [American Recovery and Reinvestment Act (ARRA)]. This act required that public building or public work projects use American iron, steel, and manufactured goods, with certain exemptions.

After MAP-21 was enacted, FHWA and FTA began to inform state and local transportation agencies that Buy America requirements applied to utility relocation agreements. To that point, Buy America requirements had applied to construction contracts but not to utility relocation agreements because the resulting payments to utilities were the equivalent of compensation payments to affected property owners (*8*). With the change in policy, agencies and utility owners began to experience difficulties complying with Buy America provisions. A problem commonly cited by utilities is that the purchasing environment at a typical utility is highly dynamic. Because utilities rely on a wide range of suppliers, and the supply chain in the international market fluctuates depending on factors such as price variations for individual components, identifying which components are manufactured in the United States at any given point in time can be challenging. A related difficulty is that many utility materials are complex component-based assemblies, each one having its own supply chain.

Recognizing the impact resulting from the implementation of the broadened application of Buy America provisions, FHWA issued a memorandum in July 2013 providing a transition period through December 31, 2013, for nonfederally funded utility relocations as part of highway construction projects (*9*). FTA did not issue a similar memorandum for transit projects. FTA's position was that Buy America requirements have always applied to the entire scope of an FTA-funded project, including utility work (*10*).

Project Delivery Methods

In 2005, TCRP published *TCRP Web-Only Document 31* to document strategies, tools, and techniques to better estimate, contain, and manage capital costs (*11*). The report highlighted several case studies in which utility relocations were a cause for delay and cost escalations, indicating that projects with a high degree of complexity, including those with substantial utility relocations or unforeseen site conditions, were most prone to cost escalations.

In 2009, TCRP published *Report 131*, which contains a guidebook for the evaluation of transit project delivery methods (*12*). The research examined a variety of issues that affect the delivery of transit projects, including project-level issues, agency-level issues, public policy and regulatory issues, and life cycle issues. One of the issues examined was agreements between the transit agency and third parties, such as political entities, utilities, and railroads. In particular, the report recognized that right-of-way, utilities, and environmental approvals represent major challenges.

In 2012, TCRP published *Legal Research Digest 39* to summarize lessons learned from seven case studies in connection with competition requirements of design-build, construction manager at risk, and public–private partnership contracts (*13*). The review focused on overall project delivery performance and costs, and mentioned utility relocations only tangentially. However, it is interesting to note the following in connection with specific projects:

- Bay Area Rapid Transit (BART) Extension to San Francisco International Airport. The design-builder was responsible for the cost of relocating utilities, obtaining all necessary approvals and permits, and coordinating with all stakeholders.
- Dallas Area Rapid Transit (DART) Green Line Project. Preconstruction services include utility identification and conflict management. Construction services include utility relocations.
- Dulles Corridor Metrorail Project. To manage risk levels, the project owners determined that right-of-way acquisition and utility relocations would be handled under a comprehensive agreement on a cost reimbursable basis, instead of being part of the design-build contract. As part of the comprehensive agreement, the Metropolitan Washington Airports Authority (MWAA) would have financial responsibility and control for right-of-way and utility relocations, but the private developer would serve as MWAA's representative in performing the work.
- AirTrain JFK System. The design-builder was responsible for relocating utilities.
- Portland Southern Corridor–Portland Mall Segment. The design-builder was responsible for relocating utilities. The contractor encountered challenges primarily because of unanticipated utility relocations and differing subsurface conditions.
- River Line (Southern New Jersey Light Rail Transit System). The design-builder was responsible for relocating utilities. Delays, cost overruns, and disputes were the result of several factors, including identifying, protecting, or relocating utilities throughout the project.

RELEVANT HIGHWAY-RELATED REPORTS, GUIDELINES, AND RESEARCH

Utility Coordination Practices

Utility accommodation policies, rules, and guidelines around the country provide minimum requirements relative to the accommodation, location, installation, relocation, and maintenance of utility facilities within the roadway right-of-way. In some cases, these documents describe applicable laws and regulations and include references to industry standards and specifications that require utility owners to provide a higher degree of protection (*14*). Many state rules and guidelines are based on utility accommodation policies and guides developed by AASHTO (*15–17*). Other guidelines available include publications by FHWA (*18*).

In 1974, the American Public Works Association (APWA) and ASCE published guidelines for the accommodation of utility facilities within the right-of-way of urban streets and highways (*19*). The study included the participation of municipalities and utility owners across the country, as well as state departments of transportation (DOTs) and FHWA. The report noted that one way to address the problem of overcrowding of the underground space in central city areas was through cooperation, coordination, compromise, and compulsion (i.e., four Cs). Cooperation and willingness to work together and compromise in an effort to improve coordination was the first requirement for addressing utility issues. Another vital requirement was the establishment of cooperative relationships between government agencies and utility owners, as well as partnerships between regulating agencies and all other units of government involved in or affected by utility activities. The last component was governmental compulsion through laws and regulations to protect the public interest. Strategies to improve coordination practices included the following:

- Notify all utility owners about projects that affect uses of the right-of-way and conduct planning conferences to discuss such projects.
- Give utility owners adequate lead time to adjust their facilities.
- Establish utility coordinating committees to serve as the focal point for all utility facilities in the public right-of-way. When possible, coordinating committees are to be structured on a regional basis.
- Establish One Call damage prevention programs to reduce damage to existing utilities during construction. These programs rely on a protocol that requires excavators to notify a call center, which forwards the notification to utility owners with a request to mark the approximate location of their underground facilities using markings on the ground.
- Encourage or require joint trenching and consider the use of ducting systems to decrease the demand for underground space.

In 1984, *NCHRP Synthesis 115* documented the results of a review of practices to reduce conflicts between highway projects and utility installations (*20*). A motivation for the study was the recognition of the wide disparity in utility adjustment costs in relation to transportation project costs around the country and the need to reduce utility-related claims. The report concluded with a strong recommendation for the implementation of formal liaison committees as a mechanism for improving coordination between state DOTs and utility owners, noting that formal committees were more likely to be successful than informal committees.

In 1993, FHWA published the *Highway/Utility Guide* in an effort to provide guidance for state DOTs, local jurisdictions, and utility owners on highway and utility issues (*21*). The guide included the following recommendations for highway agencies to improve coordination between highway agencies and utility owners:

- Share the highway improvement program with all relevant stakeholders;
- Include all construction and maintenance work in the highway improvement program;
- Hold meetings (at least annually) with utility owners to discuss upcoming project development and construction activities;
- Notify utility owners of projects before the design phase;
- Route plans of highway projects to utility owners for comment during the design phase;
- Determine the impact of all projects on other facilities in or adjoining the right-of-way;
- Convene meetings with utility owners before each major phase of a transportation project, including planning, design, and construction;
- Identify and resolve conflicts before construction;
- Share construction schedules with utility owners;
- Provide one point of contact at the agency to work with utility owners on a project from inception to completion;
- Publish maps each year showing municipality, county, state highway agency, and utility projects; and
- Publish detailed descriptions of projects, including project schedules, managers, and contact information.

The guide also included the following recommendations for utility owners:

- Develop a utility master plan in conjunction with other public planning efforts;
- Provide capital improvement programs to highway agencies;
- Provide updated utility system plans every 2 to 5 years to highway agencies;
- Meet with local or state agencies to discuss projects, determine impacts, and explore alternatives to avoid potential conflicts;
- Provide one point of contact to work on utility conflict resolutions; and
- Seek to minimize the impact of utility facilities on highways with high traffic volumes, few alternative routes, or limited right-of-way.

In 2001, NCHRP Project 20-24(12) reported on the results of a survey of state DOTs, highway contractors, design consultants, and other user groups concerning the most frequent causes of delays in highway projects (*22*). Across all categories of respondents, the top five causes of delay mentioned were delays in utility relocations, differing site conditions (utility conflicts), environmental planning delays, permitting issues, and insufficient work effort by contractor. Responses varied among different stakeholders, highlighting differences in perspective. For example, state DOTs and contractors listed weather as one of the top causes of delay, but designers listed delays in environmental planning as one of the top causes of project delays. Overall, delays in utility relocations and differing site conditions (utility conflicts) were ranked first or second by all groups.

In 2004, the AASHTO Subcommittee on Right-of-Way and Utilities in cooperation with FHWA published a set of recommended strategies and effective practices to optimize right-of-way and utility processes (*23*). Utility-related recommendations, which included lessons learned from the 2000 European international scan on right-of-way and utilities (*24*), covered use of technology, coordination with utility owners, and corridor use optimization. Of particular interest are recommended practices in the area of coordination, including the following:

- Provide utility owners with long-range highway construction schedules.
- Host meetings with utility owners to discuss future highway projects and recognize the importance of long-range highway/utility coordination.
- Use long range-planning meetings as a forum to discuss other relevant issues. What begins as a series of informal planning meetings could eventually evolve into a local, regional, or statewide utility coordination committee.
- Organize periodic (monthly, quarterly, annual) meetings with utility owners within a municipality, county, or planning region.
- Solicit information on utility owners' capital construction programs, particularly where the planned expansion or reconstruction of utility facilities might overlap a planned highway project. Look for opportunities to coordinate overlapping projects to minimize costs and public impact.
- Provide earlier preliminary notice to utility owners to facilitate adjustment planning.
- Involve utility owners in the design of transportation projects for which major utility relocations are anticipated. Examples of strategies include the following:
  – Conduct on-site or plan-in-hand meetings with utility owners to determine utility conflicts and appropriate resolutions.
  – Conduct monthly coordination meetings on major projects with all stakeholders.
  – Invite utility owners to preconstruction meetings and encourage or require utility owners, contractors, and project staff to hold regular meetings as needed during construction.
  – Meet individually with all utility owner representatives.

 – Involve utility owners in the determination of right-of-way needs to ensure there is adequate room for utility facilities.
 – Participate in local One Call notification programs to the maximum extent practicable per state law.

In September 2008, a scan team composed of representatives of several state DOTs, FHWA, private industry, and academia visited Australia and Canada to learn about innovative practices for right-of-way and utility processes that might be applicable for implementation in the United States (*25*). This scanning study complemented a 2000 scanning study of European countries, which covered Germany, the Netherlands, Norway, and the United Kingdom (*24*). The scan team identified approximately 20 potential implementation ideas, including a few that addressed utility-related topics, including the following:

- Promote incentive-based reimbursement for utility adjustments;
- Establish a standard protocol and lease template for utility attachments to roadway structures;
- Implement multilevel memoranda of understanding structures among transportation and utility interests;
- Promote the use of effective practices in utility coordination during construction; and
- Develop methodology for preliminary utility adjustment cost estimates.

Identification and Resolution of Utility Conflicts

As mentioned, two critical factors that contribute to inefficiencies in the management of utility issues are (1) the lack of accurate, complete information about utility facilities that might be in conflict with the project and (2) deficiencies in the identification and implementation of effective strategies for resolving those conflicts. These inefficiencies can result in problems, such as disruptions when utility installations are encountered unexpectedly during construction; damage to utility installations that leads to disruptions in utility service, environmental damage, and health and safety risks; delays and cost overruns; negative public perception; and unplanned environmental corrective actions.

The potential for utility conflicts exists at most transportation projects; such conflicts include the following:

- Interference between utility facilities and transportation design features (existing or proposed);
- Interference between utility facilities and transportation construction activities or phasing;
- Interference between planned utility facilities and existing utility facilities;
- Noncompliance of utility facilities with utility accommodation policies; and
- Noncompliance of utility facilities with safety regulations.

Detection of utility conflicts as early as possible during the project development process can help to identify the optimum application of strategies for resolving those conflicts. Strategies normally available include one or more of the following options (*23, 26, 27*):

- Remove, abandon, or relocate utility facilities in conflict;
- Change the horizontal and/or vertical alignment of the proposed transportation facility;
- Implement an engineering (protect-in-place) countermeasure that does not involve utility relocation or changes to the transportation project alignment; and
- Accept an exception to policy.

The traditional approach for resolving utility conflicts at many highway agencies is to relocate the affected utility facilities—often at great expense to the utility owner and/or the agency—or to allow an exception to policy. An alternative is to design and construct the transportation facility in such a way as to leave the affected utility facilities in place. However, if improperly managed, this approach could (1) result in design changes that have a negative impact on total project schedule and/or cost or (2) degrade the value of the existing utility installation in a manner unacceptable to the facility owner.

In 2012, the Second Strategic Highway Research Program (SHRP 2) published the results of Research Project R15B, which dealt with the use of utility conflict matrix (UCM) approaches for identifying and managing utility conflicts (*28*). A UCM is a table or series of tables in a spreadsheet or database format that enables users to organize, track, and manage utility conflicts. This project, which took place from March 2009 to July 2011, resulted in three products:

- Product 1 (standalone UCM). This is a standalone product in spreadsheet format that includes a main utility conflict table and a supporting worksheet to analyze utility conflict resolution strategies.
- Product 2 (utility conflict data model and database). This standalone product is a scalable UCM representation that facilitates managing utility conflicts in a database environment. The data model included a logical model, a physical model, and a data dictionary. The data model was tested in a desktop database environment to replicate sample utility conflict tables from across the country.
- Product 3 (one-day UCM training course). This standalone product includes a lesson plan and presentation materials to assist with the dissemination of UCM management strategies.

In December 2011, the SHRP 2 Oversight Committee authorized a follow-on project, SHRP 2 R15C, which involved a pilot implementation of the R15B products at the Maryland State Highway Administration (*29*). The pilot implementation took place from September 2012 to March 2014. The Maryland State Highway Administration identified six sample projects, which provided a wide range of project types and field conditions. Project deliverables included updated versions of the R15B products and a report that summarized lessons learned from each of the six projects as well as recommendations for future implementations.

Utility Data Collection and Management

Collecting accurate utility data from utility owners can be challenging. Typically, highway agencies send project drawings to utility owners with a request to mark up those drawings with relevant utility information. In some cases, utility owners request electronic copies of those drawings in computer-aided design (CAD) format. Sometimes, utility owners provide electronic as-builts. However, available as-builts are rarely scaled or georeferenced and come in a variety of formats, making it necessary to convert the files to a usable format and adjust their scale and alignment to match the project files.

Questions about the completeness and quality of existing utility as-builts prompted the emergence of the national standard guideline ASCE/Construction Institute (ASCE/CI) 38-02 (*30*). This standard guideline outlines typical activities in connection with the collection and depiction of utility data and describes a quality level attribute for individual utility features identified, as follows:

- Quality level D (QLD): Collection of data from existing records or oral recollections, such as records provided by utility owners, existing permit records, and preliminary field observations.
- Quality level C (QLC): Surveying and plotting of visible utility appurtenances (e.g., manhole covers, valve boxes, hydrants). It also includes making inferences about underground linear utility facilities that connect those appurtenances (e.g., if two sanitary sewer manhole covers are visible and an inference is made about the alignment of the sewer that connects the two manholes).
- Quality level B (QLB): Use of surface geophysical methods [e.g., electromagnetic (EM) pipe and cable locators and ground-penetrating radar (GPR)] to determine the approximate horizontal position of subsurface utilities.
- Quality level A (QLA): Determination of accurate horizontal and vertical utility locations by exposing underground utility facilities at certain locations through test holes using minimally intrusive excavation equipment.

For utility data to be certified at one of these quality levels, the data must meet the requirements identified in the ASCE/CI 38-02 standard and be approved by a registered professional.

Collecting data from existing records or oral recollections and surveying and plotting visible utility appurtenances is a routine practice at highway agencies. However, certifying the data as QLD or QLC is much less common. In any case, it is common for a utility investigation at this level to miss many existing underground installations, which is one of the reasons conducting QLB and QLA investigations is critical in those situations.

In the case of QLB data, practices vary substantially across the country, even within the same state. Some highway agencies collect QLB data routinely, whereas other highway agencies collect QLB data sporadically, on a case-by-case basis, or not at all. In the case of QLA data, exposing underground utility facilities by using test holes is not common. However, when it happens, it is usually on a case-by-case basis at the discretion of the project manager. Some highway agencies use test holes to expose and survey underground utility facilities at critical locations but do not certify the resulting utility facility data as QLA.

When applied correctly, empirical evidence indicates that utility investigations involving QLB and QLA can find 80% to 90% of all underground utility installations that were suspected to exist in the area (*31*). The Virginia Department of Transportation noticed that QLB investigations identified 10% to 50% more utility installations than did investigations at the QLD or QLC level (*32*). Despite these numbers, highway agencies still do not recognize the benefits of accurate and comprehensive utility mapping to project design and delivery. A clear indication of this need is the result of a recent research effort in Texas, which discovered that more than half of all agency officials contacted were not able to quantify an approximate return on investment on QLB and QLA investigations (*33*).

One Call Systems

One Call systems started in the 1970s as a mechanism for preventing damage to underground utility installations by providing excavators with ground information about utility facilities that might be located within the immediate vicinity of a proposed excavation site. Although systems vary from state to state, laws and regulations typically define member utility types, purpose and application of system activities, and certain exemptions.

One Call notification centers maintain records of underground utility facilities provided by the member utility owners. Although utility owners are encouraged or required to provide up-to-date map information to the notification centers, in practice there is considerable variability in the coverage and quality of the information they provide to the notification centers. Some utility owners provide electronic copies of their facilities, whereas other utility owners provide only buffer area files. The centers use whatever information is provided to them to identify potentially affected utility installations by overlaying the proposed excavation location provided by callers.

Depending on the level of urgency, One Call notification centers often have different categories of job tickets: for example, routine, priority, or emergency. Although most tickets are associated with imminent excavation activities, survey or design tickets are also possible. Approximately 15 states allow survey or designer tickets. In practice, most One Call systems do not allow designers or state highway agencies to call for information. Because of the prioritization of service tickets, utility owners tend to respond slowly to low-priority survey tickets that originate from highway agencies. In addition, there is no responsibility for markings to be correct in the case of designer tickets, as there is for construction tickets.

Despite these shortcomings, many highway agencies use the One Call system as a means to get utility information on their plans because it is a "free" service to the agencies (paid by ratepayers rather than taxpayers). Although the data provided by the One Call systems is typically not accurate or complete enough to make design decisions during project development, it does provide valuable information about utility installations at earlier stages of the project development process. However, highway agencies that rely exclusively on One Call information during project design often experience significant utility issues as projects progress (*34*).

CHAPTER THREE

CASE EXAMPLE SELECTION SURVEY RESULTS

INTRODUCTION

This chapter describes the process followed to conduct a preselection survey to identify potential agencies with whom to conduct the phone interviews. The preselection survey also provided an opportunity to extract information about general trends that could be generalized to other transit agencies around the country.

METHODOLOGY AND SURVEY INSTRUMENT

To achieve the TCRP goal of 80% to 100% return rate, a two-tier approach was followed, in which an initial preselection survey was distributed to transit agencies nationwide, and based on the results of the initial survey, a targeted round of phone interviews was conducted with selected transit agencies. The agencies identified for the phone interviews provided the basis for measuring the return rate. As described in chapter four in more detail, ten transit agencies were selected based on the results of the preselection survey and invited to participate in phone interviews, yielding case examples. Of this total, eight agencies responded, and phone interviews were scheduled with each one of them; thus, there was a response rate of 80%.

Appendix A shows the instrument used for the preselection survey. The questionnaire included nine questions designed to identify potential agencies with whom to conduct the detailed phone interviews for case examples. However, the questions also provided an opportunity to extract information about trends that could be generalized to other transit agencies around the country. The preselection survey covered the following five topics:

- Phases of transit project development, including how different stakeholders interact with the agency, at what point transit agencies engage utilities, and differences in coordination practices between city-owned utilities, franchised utilities (i.e., privately owned utilities operating under a franchise agreement with a local public agency,) and other entities;
- Data collection processes, including responsible party for collecting data, protocols and procedures, effective practices, and challenges;
- Identification and resolution of utility conflicts;
- Utility ownership and operation (public or private) and interagency coordination, including differences between city-owned utilities, franchised utilities, and other entities; and
- Staff professional capacity, with a focus on available training programs for agency staff. The survey did not cover prequalifications for consultants (which was outside the scope of the synthesis).

The preselection survey implementation relied on a website application that TRB frequently uses to conduct online surveys. APTA agreed to disseminate the preselection survey hyperlink to its member agencies. In total, APTA sent the invitation e-mail to 301 transit agencies in the United States and Canada, one e-mail per agency, and then a reminder e-mail a week later. APTA sent the e-mails to the main contact at the transit agency, typically the director or general manager. The invitation e-mail included a request to forward the e-mail to officials who worked on capital improvement programs, design, and construction, and in general, officials who dealt with issues such as utility coordination and utility conflict analysis and management during project development and delivery.

APTA did not agree to disclose its list of member agencies (therefore it was not possible to confirm with certainty what agencies were sent the invitation e-mail) but did indicate that APTA member agencies provide more than 90% of all transit trips in the United States. APTA also indicated that the 40 largest agencies (by ridership) in the United States and the ten largest transit agencies in Canada are APTA members. From the literature review in chapter two, it is reasonable to assume that the preselection survey was sent to most if not all of the 96 transit agencies that operate rail mode systems, as well as many bus-based systems in the United States, therefore covering the population of interest to this synthesis.

LESSONS LEARNED

Phases of Transit Project Development and Delivery, Operations, and/or Maintenance

Seventeen representatives of transit agencies in 12 states completed the preselection survey. Table 3 shows the participation of preselection survey respondents in various transit-related activities. Survey participants were engaged primarily in transit project development activities, rather than transit operations or maintenance activities. Most of the participants were directly involved in utility coordination and relocation

TABLE 3
PARTICIPATION IN TRANSIT PROJECT ACTIVITIES

Phase	Count
Planning, feasibility studies, and programming	15
Preliminary/conceptual design	17
Environmental process	14
Right-of-way acquisition	15
Utility coordination and relocation	15
Design	17
Letting/invitation for bid	11
Construction	17
Bus or paratransit operations or maintenance	8
Light rail or streetcar operations or maintenance	4
Metro rail operations or maintenance	3
Commuter rail operations or maintenance	1
Communications and other intelligent transportation system (ITS) operations or maintenance	4
Other	3

Source: Preselection survey results.

activities. However, respondents were also involved in other project development phases. Respondents typically worked at offices with names such as engineering and construction, capital projects, or capital programs.

Overall Impact of Major Utility-Related Issues at the Agency

Participants were asked to rate the level of impact of individual utility-related issues at their agencies on a numerical scale from 1 to 5 (with 5 being the greatest negative impact). Table 4 summarizes the results. In the table, each entry under each of the numbered columns indicates the number of responses associated with that particular impact level. For example, nine respondents indicated that not identifying utility conflicts during design had an impact level of 5 at their agency (i.e., the negative impact level was the highest). Likewise, only one respondent indicated that not identifying utility conflicts during design had an impact level of 2.

The results in Table 4 indicate that utility issues have a higher impact during design and construction than during earlier project development phases. Changes to utility relocation plans resulting from late project design changes were also identified as having a significant impact. These observations appear to confirm the validity of strategies that encourage the identification and management of utility conflicts earlier in the process.

Agencies indicated that impact because of the difficulty getting utility owners to participate in discussions is more significant during design and construction than earlier in the process. Agencies also indicated that conducting utility coordination activities with franchised utilities and other utility operators is slightly more problematic than with municipality-owned utilities.

Agencies indicated that inadequate utility relocation cost estimates were a problem, in particular owing to the lack of identification of utility conflicts and not updating cost estimates regularly during project development.

Overall, agencies did not consider that issues related to hiring, retaining, and training personnel with experience on utility coordination matters were particularly critical. In particular, staff turnover was not reported as a significant issue.

Data Collection Techniques

Participants were asked to provide an indication of the frequency of use of specific utility data collection techniques at their agencies. Table 5 summarizes the results.

Agencies indicated that they routinely use One Call system marks on the ground. During the phone interviews, selected agencies confirmed that they use the One Call system primarily as a damage prevention tool before excavation. Using One Call design tickets as a data collection tool during project development is performed by some agencies but is not a commonly accepted practice.

Agencies indicated that they frequently use EM pipe and cable locators but only rarely GPR locators. During the phone interviews, agencies indicated that the use of EM pipe and cable locators takes place both in connection with One Call damage prevention tickets and by utility location service subcontractors during the preliminary design and design phases. For the most part, utility data collection during project development involves a review of existing records, survey of visible appurtenances, and test holes. Agencies indicated that they rarely conduct QLB or QLA utility investigations. They also rarely use electromagnetic induction or GPR arrays.

Use of Three-Dimensional Technologies

Participants were asked to provide examples of projects or initiatives that have involved the use of three-dimensional (3D)

TABLE 4
IMPACTS DUE TO UTILITY-RELATED ISSUES

Issue	No. of Responses for Each Impact Level				
	5	4	3	2	1
Not identifying utility conflicts during:					
Planning, feasibility studies, and programming	2	2	**7**	5	1
Preliminary/conceptual design	2	6	**8**	1	0
Environmental process	1	**8**	5	3	0
Design	**9**	6	1	1	0
Letting and construction	**13**	1	1	2	0
Inadequate utility relocation cost estimates due to:					
Failure to identify and characterize utility conflicts	**5**	**5**	**5**	1	1
Not updating utility relocation estimates at regular intervals during the project development process	2	**8**	4	2	1
Inadequate identification of utility cost reimbursement eligibility	2	4	**7**	2	2
Changes to utility relocation plans due to late project design changes	**5**	4	3	**5**	0
Difficulty hiring and retaining staff with adequate utility coordination experience	2	2	3	**5**	4
Difficulty providing training opportunities in utility issues	0	3	5	**6**	3
Utility staff turnover	0	2	4	5	**6**
Difficulty getting utility owners to participate in discussions during:					
Planning, feasibility studies, and programming	1	2	6	**8**	0
Preliminary/conceptual design	2	1	**8**	6	0
Environmental process	1	2	**6**	**6**	2
Design	4	3	4	**6**	0
Letting and construction	**4**	**4**	2	**4**	3
Difficulty conducting utility coordination activities with:					
Municipality-owned utilities	2	4	3	3	**5**
Franchised utilities	2	4	**7**	4	0
Other utility operators	2	2	**10**	2	1
Difficulty identifying and resolving utility issues for:					
Design-bid-build projects	3	2	**6**	4	2
Design-build projects	3	2	**5**	4	2
Lump sum projects	2	3	**6**	2	2
Other project delivery methods	2	1	**8**	2	2

Source: Preselection survey results.
Note: 5 = most impact; 1 = least impact. Shaded cell = greatest number of responses.

TABLE 5
FREQUENCY OF USE OF UTILITY DATA COLLECTION TECHNIQUES

Technique and Practice	Frequency of Use			
	Always	Frequently	Rarely	Never
One Call system marks on the ground	**14**	3	0	0
EM pipe and cable locators	1	**12**	1	2
GPR locators	0	4	**11**	1
EMI arrays	0	2	**7**	**7**
GPR arrays	0	1	**7**	**7**
Existing records	**14**	2	1	0
Survey of visible utility appurtenances	**15**	2	0	0
Test holes	4	**8**	5	0
Use of geophysical techniques and certified deliverables at QLB (according to ASCE 38-02)	1	2	**6**	3
Exposing existing underground facilities and certified deliverables at QLA (according to ASCE 38-02)	0	4	**7**	2

Source: Preselection survey results.
Shaded cell = greatest number of responses.

technologies, such as digital terrain models, surface models, 3D models, light detection and ranging (lidar) point clouds, building information modeling, or 3D animations, to support the transit project development and delivery process. For the most part, participants indicated that their agencies did not use 3D technologies. In some isolated instances, respondents provided examples in which their agencies had begun to use 3D technologies, mainly for public outreach during the preliminary design phase. In one case, the agency reported the use of 3D models to identify conflicts with water, sanitary sewer, and stormwater systems. In another case, an agency reported using lidar to survey their track and right-of-way.

Innovative Strategies to Improve or Streamline Utility Coordination Activities

Participants were asked to provide examples of strategies or innovative approaches that their agencies have implemented or plan to implement to improve or streamline utility coordination activities. Examples of strategies mentioned include the following:

- Continued coordination and communication with utility companies.
- Start coordination with utilities early during the preliminary design phase.
- Meet with utilities and other stakeholders at regional utility coordination meetings.
- Host weekly utility coordination meetings in advance of contractor construction meetings for projects for which extensive utility relocations have the potential to cause additional impacts.
- Attend citywide project coordination meetings to help with coordination of city projects.
- Emphasize attention to detail, perseverance, and a focus on developing relationships.
- Hire experienced staff who can keep projects on track. In one case an agency hired an official who had many years of experience working for an electric utility. His knowledge of the industry and his professional relationships with utility providers and city officials were critical.
- Prepare composite utility drawings and share data and CAD files with stakeholders.
- Set and monitor utility and project schedules.
- Develop work orders for each utility company separately.
- Use tracking spreadsheets to monitor individual utility conflicts.
- Use cooperation agreements for partial reimbursement of utility relocations.
- Hire in-house designers to help utility companies keep up with aggressive project schedules. Designers are paid by the project and could work either at the transit agency or at the utility company office.
- Implement utility action plans for each individual utility company. Concurrence letters formalize decisions with local jurisdictions.
- Anticipate that utilities may have long lead times for design and scheduling of work.

Training and Professional Development

Participants were asked to provide examples of training and professional development activities at their agencies on utility topics. For the most part, respondents indicated a complete lack of formal training opportunities. In some instances, respondents indicated that training is provided on the job or through mentoring from senior staff to junior staff. In other situations, officials might be encouraged to attend workshops or damage-prevention conferences.

Availability of Relevant Policies, Manuals, Specifications, and Other Documents

Participants were asked to provide names and hyperlinks (if possible) of relevant policies, manuals, specifications, and other documents that describe utility accommodation and coordination practices and requirements at their agencies. In most cases, respondents ignored the question or indicated that such documents did not exist or were not available. In a couple of instances, respondents indicated that policy and specification documents might be provided upon submission of a public disclosure request.

In general, these responses appear to point to a need for the development and/or dissemination of documents that explain policies and requirements, as well as provide additional information, such as through manuals and specifications.

CHAPTER FOUR

CASE EXAMPLES

INTRODUCTION

This chapter describes the process followed to conduct detailed phone interviews with a sample of agencies that had completed the preselection survey described in chapter three. The chapter also summarizes lessons learned from each of the phone interviews completed.

METHODOLOGY AND INTERVIEW GUIDE

As discussed in chapter three, a two-tier approach was followed in which an initial preselection survey was distributed to transit agencies nationwide, and then a targeted round of phone interviews was conducted with selected transit agencies. In total, ten transit agencies were selected, based on the results of the preselection survey, and invited to participate in phone interviews. Of this total, eight agencies responded, and detailed phone interviews took place with all eight of them; thus the survey had a response rate of 80%. Appendix B provides a copy of the phone interview guideline. A standard protocol for conducting the phone interviews was followed, which included contacting a designated representative at each of the agencies selected, discussing the purpose of the phone interview, scheduling the phone interview at an agreed upon date and time, conducting the phone interview, compiling the results, and following up with the agency representative for clarifications as needed.

The eight transit agencies case examples were as follows (Appendix C):

- California: Sacramento Regional Transit District;
- California: San Joaquin Regional Transit District;
- North Carolina: Charlotte Area Transit System;
- Ohio: Greater Cleveland Regional Transit Authority;
- Oregon: TriMet, Portland, Oregon;
- Pennsylvania: Port Authority of Allegheny County;
- Utah: Utah Transit Authority; and
- Washington State: Sound Transit, Seattle.

Table 6 provides basic information about each of these agencies.

LESSONS LEARNED

California: Sacramento Regional Transit District

The Sacramento Regional Transit District (RT) directly operates 69 fixed bus routes, including express service, three light rail lines covering 39 miles of track, and general public demand response and taxi service in the urbanized area of Sacramento, California (*35*). The service area population is 1.4 million and covers 418 square miles. RT provides 27 million passenger trips per year. Approximately 50% of passenger trips are bus, 49% are light rail, and 1% is demand response. The revenue vehicle fleet includes 76 light rail vehicles, 252 buses, and 27 shuttle vans. Passenger amenities that RT operates include 50 light rail stations, 31 bus and light rail transfer centers, and 18 park-and-ride lots.

RT's fiscal year (FY) 2014 operating budget was $142 million, and the capital budget was $19 million. Fare revenues provide approximately 20% of the operating funding. Federal and state government, developer fees, and a half-cent local sales tax provide for the remaining operating and capital funding (*35*).

Utility Coordination

For all projects, RT tries to engage utilities as early as possible, typically during the preliminary engineering phase. This involves an initial outreach to start a conversation with the utility owners about the upcoming project and its potential impacts on utilities. Because the project at this stage is still undefined to some degree, this step focuses more on establishing a connection with the utility owner, talking about the general project development process, and discussing items to expect during the process. Once a project enters the detailed design phase, the agency follows the so-called ABC utility process to manage utility conflicts, which is a standard for public works infrastructure development in the Sacramento

TABLE 6
SUMMARY INFORMATION ABOUT TRANSIT AGENCIES SELECTED FOR CASE EXAMPLES

State	Agency	Bus	Commuter Bus	Bus Rapid Transit	Heavy Rail	Light Rail	Commuter Rail	Hybrid Rail	Streetcar	Trolley	Demand Response	Demand Response Taxi	Vanpool	Inclined Plane	Service Area Population (Million)	Service Area Land Area (Square Miles)	Annual Passenger Trips (Million)	Operating Budget (Million)	Capital Budget (Million)
California	Sacramento Regional Transit District	X		X		X					X	X			1.4	418	27	$142	$19
California	San Joaquin Regional Transit District	X	X								X				0.69	1,426	4	$31	$11
North Carolina	Charlotte Area Transit System	X				X					X		X		1.5	527	27	$106	$157
Ohio	Greater Cleveland Regional Transit Authority	X		X	X	X				X	X				1.3	457	50	$229	$33
Oregon	TriMet/Portland Streetcar[1]	X	X			X			X[1]		X	X			1.5	570	100	$489	$103
Pennsylvania	Port Authority of Allegheny County	X				X					X			X	1.4	775	59	$366	$126
Utah	Utah Transit Authority	X	X	X		X	X		X		X		X		2.2	751	43	$219	$157
Washington	Sound Transit		X			X	X		X						3.0	1,086	31	$322	$742

[1]The Portland streetcar system is owned and operated by the City of Portland in partnership with TriMet.

Area (*36*). This process involves monthly meetings with the public works groups of several local agencies, and the development of A-letters, B-letters, and C-letters for utility owners.

The A-letter includes a brief project description, site map, and possibly exhibits, and requests system maps or as-built information from utility owners. The transit agency sends A-letters to utility owners before the 30% design meeting as the initial project notification. According to the process description, utility owners have 15 calendar days to respond to the request for information.

Sometime around the completion of 75% to 90% of the detailed design, or usually 3 to 6 months after sending the A-letters, the agency sends B-letters to utility owners; these letters typically describe the project in more detail. If the utility has not proposed a relocation or protection for its facilities at this point, the B-letter includes a suggested remedy to resolve the utility conflict. This proposed remedy is not intended to be final, but it is a strategy to beginning the process of conflict resolution. The agency found that if there is no proposed remedy, some utility owners tend to wait until construction starts to begin the utility conflict resolution process. Upon delivery of the B-letter, utility owners have 30 calendar days to provide a construction schedule and 60 calendar days for planning and engineering of required relocations. If a utility owner needs more time, such as when a railroad permit or right-of-way acquisition is required, the utility must request that the transit agency allot more time within that response period.

Once the bid documents for the project are ready, the agency sends out C-letters, which notify the utility owners of the project specifics and dates, and confirm how utility conflicts are going to be resolved. Utility agreements are developed between the B- and C-letters, so the C-letter is also used as a confirmation that all necessary documents are in place and all parties agree on the way to resolve conflicts.

Utility Data Collection

The agency is involved in different types of data collection, from general to specific and detailed data, but leaves the decision for data collection mostly to the project designer. Although there is some data collection during the preliminary engineering phase, there can be a significant time gap until a project enters the detailed design phase, which can limit the usefulness of data collected during the preliminary design phase. The agency's overall goal is to capture about 75% of utility conflicts before the construction phase.

Most of the detailed data collection takes place toward the end of the detailed design to confirm specific design details. For a recent downtown project, the agency collected some QLB data using GPR. The results were somewhat mixed, partly because the designer was not sure what the subsurface utility engineering (SUE) provider would be able to deliver. Over the years, the agency has gained experience with utility data collection efforts and has established relationships with data collection consultants that have performed well in the past.

Utility Conflict Resolution

Key to conflict resolution is a good relationship with utility owners. If a utility relocation is required, it typically is easier to manage if the agency is responsible for the cost to relocate the utility. However, many utilities are relocated using cost share agreements. These agreements can be time consuming to negotiate, but they can be negotiated at any time, even without an active project. RT tries to negotiate these agreements ahead of projects to avoid project delays. If a utility requires new right-of-way, the agency might purchase right-of-way for the utility owner to speed up the overall process of right-of-way acquisition.

On larger projects, the agency prefers to hire local consultants that already have good working relationships with local utility owners to assist with utility coordination activities. The agency has hired out-of-state consultants previously but noticed that they would, in turn, hire local consultants as subcontractors to establish the key relationships.

RT manages utility conflicts during construction by meeting with the affected utility owners at the construction site and by developing an agreement as soon as possible to avoid construction delays. In the past, a recurring issue was that the board that oversees the agency had to approve all agreements, which could take 4 to 6 weeks. To expedite the process, the board has begun to delegate this authority at the project level to the agency's general manager, who can now execute relocation agreements up to a certain amount.

If the agency had a superior right, RT's policy in the past was simply to ask the utilities to move, without much concern for the utilities' perspective. This often resulted in years of conflict with utility owners and considerable project delay. With direction from funding partners, the agency's policy regarding utility relocation reimbursement has changed over the last few years. The current agency policy, with some exceptions, is to reimburse all utilities if the agency's project caused the relocation.

RT's current, more cooperative approach has been much more successful because it recognizes that utility relocation costs are significant but much less significant in relation to total project costs. To some degree, this policy has evolved out of necessity because the agency is required to meet certain deadlines to receive certain federal matching funds. For example, a recent project involved a gas utility provider that requested reimbursement for relocation costs. Estimated relocation costs for the gas line were about $4.3 million, with a total project budget of $275 million. Under the old policy, RT might have refused to pay for relocations costs, which would have resulted in lengthy arguments and caused project delays with the potential to affect the project budget. Under the current policy, RT considered the relocation cost as part of the overall project cost, avoiding utility delays and keeping the project on schedule.

Challenges

A major coordination issue is identifying the right person within a company's hierarchy to serve as the point of contact for utility coordination issues. In this regard, publicly owned utilities are typically much easier to deal with than are privately owned utilities. Privately owned utilities often use land agents and/or public works coordinators as the point of contact with the transit agency's coordinator, so decisions are often delayed and relocation details are difficult to discuss. Another challenge is that right-of-way acquisition typically occurs in parallel with design. Therefore, it is difficult to ask a utility to move if the right-of-way acquisition has not been finalized.

Buy America provisions also have caused delays. For example, the agency had a reimbursement agreement with a gas company for about $2.3 million, which was signed in 2012 and included Buy America provisions. Near the end of 2012, FTA asked the agency to review all agreements to ensure compliance with Buy America provisions. The agency provided a notification to the gas company, which put the relocation on hold until the new provisions could be clarified. The utility company completed the relocation more than a year later than originally scheduled (beginning of 2013), at a cost of $4.3 million, which was 87% higher than the original estimate. Another example involved the relocation of a valve lot, which included hundreds of different separate parts. A small number of valves were not Buy America compliant. Although the cost to manufacture a domestically produced replacement valve would be less than $100,000, RT learned that it would take at least 62 weeks to manufacture the valve and certify the valve's safety. On a $270 million project, a delay of that magnitude would likely result in a cost increase to the project of more than ten times the value of the part.

California: San Joaquin Regional Transit District

SAN JOAQUIN RTD

The San Joaquin Regional Transit District (RTD) operates 31 fixed bus routes: three BRT routes; one intercity fixed bus routes, 12 deviated fixed bus routes, 11 interregional bus routes, and demand-response services in the urbanized area of Stockton, California (P. Rapp, San Joaquin Regional Transit District, personal communication, June 2014). RTD directly operates the Stockton Metropolitan Area fixed-route and BRT service, and third party contractors provide all other services. The agency serves an urbanized population of 687,744 and area of 1,426 square miles. It provides more than 4.5 million passenger trips per year. Approximately 98% of passenger trips are bus mode, and 2% are demand response. The fleet includes 115 revenue vehicles. Passenger amenities include 1,100 bus stops, 67 shelters, 213 benches, ten park-and-ride lots (through lease agreements), and three transfer stations.

RTD's FY 2014 operating budget was $34 million, and the capital budget was $3.4 million. Fare revenues provide approximately 16% of operating funds. Federal and state government, local tax and cash grants, and interest and investment comprise the remaining operating and capital funding (P. Rapp, San Joaquin Regional Transit District, personal communication, June 2014).

RTD does not regularly engage in utility coordination on projects. Recent exceptions were the development of a downtown transit center in 2006 and a $51 million regional transportation center project that is currently under development with the help of federal, state, and local funds. Upon completion, the center will be a 10-acre facility for maintenance and fueling of the RTD bus fleet. RTD borrowed the plans for the center from a Southern California transit agency and then asked a consultant to redesign the transportation center, taking into consideration geological and other local differences. The agency then turned the design over to a design-build contractor. The facility initially was intended to be much larger (17 acres), but the agency was unable to acquire some required property, so the whole project was scaled back to fit into a smaller 10-acre footprint.

Between 2007 and 2013, there were mostly smaller projects that required little or no utility coordination. Some projects required utility coordination but mainly to determine service requirements (e.g., location of electrical equipment for the electric bus service, the installation of 40 BRT bus stops along three new routes, and the construction of the Hammer Triangle Station).

Utility Coordination

The agency interacts with all utility stakeholders the same way; that is, using phone calls, meetings, and e-mails. Meetings with utility owners can be in groups or one on one. For complex projects that require special expertise, RTD hires consultants or engineers to aid with utility coordination efforts. Stakeholder interaction does not vary whether or not the project involves federal aid.

For the regional transportation center project, the agency involved utilities starting somewhere in the middle of the detailed design phase. Some utilities, such as electric utilities, were contacted earlier to allow for utility adjustment schedules that are lengthier and more complex. To improve overall coordination, the agency hired a former utility company employee as a consultant to help with utility coordination. The consultant is responsible for most of the agency's utility coordination activities. The consultant has considerable experience and knows which steps are critical at certain phases of the project development process. The consultant is also involved in local government, which helps with the navigation of local government regulations and requirements. The consultant also helped with data collection by pointing the agency to databases that provide information about utility installations.

Utility Data Collection

The agency does not routinely engage in utility data collection. However, for the Phase 1 and Phase 2 environmental clearance documents required for the regional transportation center under development, the agency hired a consultant to provide information about underground utility installations. This effort focused mostly on abandoned utilities that could involve hazardous waste because of the potential for environmental problems.

Utility data collection efforts during project development are minimal. For the most part, the agency or its consultant coordinates directly with utility companies in the area and uses data provided by utility owners. Efforts include calls to the One Call service to receive information about underground lines. If there were a concern about a utility facility on design-build projects, the agency would request the design-build contractor to hire an expert to investigate further.

Utility Conflict Resolution

RTD staff members work directly with utility owners to identify and resolve utility conflicts. The key is to keep everyone on track and focused on the issue. The agency found that the most effective way to resolve utility conflicts is by finding a win-win situation for both parties. The agency pays for most utility relocations. Some privately owned utilities, such as the electric utility, pay for their own utility relocations if the work involves new service. However, if the agency has special requests, such as specific locations for electric service equipment, the agency pays for such requests.

Challenges

The most significant challenge when dealing with utilities is the lack of historical records and abandoned installations that are not recorded anywhere. In the early 20th century, the city of Stockton, California, did not require the recording of utility installations, so there are many unknown utility facilities in the ground.

There are few training opportunities available for staff involved with utility coordination. Because projects that involve utility issues are not common, and because RTD uses consultants to help when a need for utility coordination arises, there is not a pressing need to engage in a lot of training focused on utility issues until RTD is regularly engaged in projects involving utilities.

North Carolina: Charlotte Area Transit System

The Charlotte Area Transit System (CATS) is a department within the city of Charlotte, North Carolina, which operates 70 fixed bus routes, one light rail line on 10 miles of track, 75 active vanpools, and general public demand-response service in the urbanized area (*37*). The service area population is 1.5 million and covers 527 square miles. CATS provides 27 million passenger trips per year. The revenue vehicle fleet includes 20 light rail vehicles, 323 buses, and 84 demand response vehicles. CATS operates and maintains four transit centers and provides service to 50 park-and-ride lots.

CATS's FY 2013 operating budget was $106 million, and the capital budget was $157 million. A half-cent sales tax, passenger revenue, advertising revenue, and interest income comprise operating funding. Capital funding sources include federal and state grants and operating revenue (*38*).

Utility Coordination

For a current project, CATS is extending the Lynx Light Rail Blue Line along the median of State Route 29, which requires the relocation of about 5 miles of water lines and several sewer crossings. If CATS finds any city-owned utilities as part of a project, coordination is straightforward because both parties are part of the city of Charlotte. Because the project started years ago, the design team has involved and met with city-owned utilities, such as water and sewer, on a regular basis.

Other utilities that CATS coordinates with are electric, communication, and natural gas providers, and each relationship is somewhat different. The city spends the most coordination time with the electric utility because most utility conflicts are with electric installations. Starting with project discussions about 6 years ago, during the preliminary engineering phase of the Blue Line extension, the city has regularly met with the provider, with the meetings increasing in frequency to about biweekly over the last 3 to 4 years.

There is a good working relationship between the city and the electric utility in part because the utility is headquartered in Charlotte and because the city has a cost-sharing agreement for relocations with the electric utility. The agreement specifies that, depending on the circumstances, both parties might be responsible for a portion of the total relocation cost. In some cases, the city pays 100% of the relocation costs; for example, when the city asks the provider to move the lines underground. For the current Lynx Blue Line extension project, 80% to 90% of the power poles had to be relocated on both sides of the road on a stretch of about 4 miles. Because the electric utility had adequate records of its installations and the cost-sharing agreement was in place, most relocations were straightforward.

Utility Data Collection

For the Lynx Blue Line extension project, the city hired a consultant to gather utility information and prepare plans showing existing utilities on the ground, including those that were in conflict with the project design. At the beginning of the detailed design phase, the consultant contacted all utilities that were active in the project area and requested a copy of their records. The consultant also led meetings to discuss issues with utility owners. For the construction phase, the city hired a consultant to serve as the construction manager. This consultant hired a subconsultant, who is available to coordinate issues that come up with planned relocations.

About 5 or 6 years ago, during the preliminary engineering phase of the Lynx Blue Line extension project, the city surveyor conducted an inventory of existing utilities, including above and below ground utilities, using records of existing utilities as a starting point. Although this information was useful, its usability has decreased over time because new utilities have been installed on the right-of-way over the last few years and do not appear on the initial utility plans.

For previous projects, the city hired consultants to coordinate with utility owners but found that utilities were more willing to relocate if the request came directly from the city. The city also found that construction contractors were not particularly effective in dealing with utility issues. For the most part, contractors would limit utility coordination to requesting utility locations from One Call services and calling the city and/or utility owner to report damaged lines so they could be repaired. As a result, the city decided to split the responsibility of resolving utility issues between the contractor and the construction manager. Under this arrangement, the city is responsible for major relocations, and the contractor is responsible for minor issues that arise during construction. This also helps to avoid situations in which contractors use utility coordination issues as an excuse for construction delays. In practice, contractors make the city's construction manager aware of major utility conflicts, and the construction manager resolves the issue. The two major contractors in the area also have utility coordinators who participate in major utility relocation projects.

City staff support the construction manager with utility coordination activities. The construction manager typically handles most of the field coordination, coordination with Blue Line extension project contractors, and running biweekly coordination meetings with the privately owned utilities. City staff handles most of the direct correspondence with utility owners, utility plan reviews, and coordination with other permitting authorities. The involvement of city staff has also been helpful in cases in which utility relocation schedules were delayed or utilities were slow to provide requested information.

During construction, city contractors have damaged multiple utility facilities in the field, mostly because One Call data were inaccurate, missing, or wrong. In some cases, city contractors have been at fault for damaging lines that were marked in the field. Some of these conflicts and accidental utility cuts have caused considerable project delay, and all of them have proven to be a public relations issue and inconvenience to the utility customers.

Utility Conflict Resolution

For the Lynx Blue Line extension project, the city is building electric duct banks and is leaving the installation of the electric lines to the electric utility. This strategy is saving the city money because the city can build the duct banks at a lower price than the contractor for the electric utility. The city is also building communication duct banks. Initially, a communication provider submitted a duct bank design that was too simplistic, lacking detail and scale. The city had little confidence that a contractor would be able to build the duct banks without causing additional conflicts with the project. Because of the lack of engineering detail, the North Carolina Department of Transportation (NCDOT) did not give the utility an encroachment agreement to start the installation. The city also noted that the utility received construction bids that were too high. The city redesigned the duct banks, overlaid them on the city's construction plans, and received a bid from the project contractor that was about 75% lower than the bids based on the utility's design.

Once the city showed that the city's contractor could build the duct banks at a cost that was significantly less, the utility agreed to the city's design because both parties saved funds in the process. However, the utility has strictly adhered to the construction standards, so some duct banks have taken longer to build than expected. The city also agreed that the utility could provide construction materials for the duct banks to the city's contractor to control the quality of the materials. In addition to cost savings, this allowed the city to improve the coordination of the above-ground design with the underground utility design. The duct bank shared by multiple utility providers allows the city to coordinate the installation of communication lines from multiple providers in a limited space.

The project included a large number of retaining walls. Almost all retaining walls were delayed because of utility problems during construction. When the contractor found a utility line, the contractor notified the city, which in turn notified the utility owner, who then rerouted or lowered the line. Many utilities that were "found" this way were damaged in the process. For the most part, the impact on project schedules was minor, but in a few cases, such relocations actually delayed the project. Project impacts were reduced to a minimum by developing a phased approach for the construction of retaining walls. The quality of existing utility records varied significantly. Most large utility owners had sufficient records, whereas some of the smaller utilities did not have adequate records and did not participate in early coordination meetings.

Challenges

Buy America provisions have been a huge challenge on the Lynx Light Rail Blue Line project. Both communication and electric utilities had significant difficulty complying with the new regulations when procuring specialized equipment. For example, it took these utility companies a great deal of effort to prepare a list of required materials and their source. Documenting that their procurement was compliant with Buy America provisions was a challenge for all utility companies on the project.

An additional difficulty for the communication provider was that the utility company could not acquire some materials under Buy America provisions. Two communication controller cabinets were not compliant, which made it necessary to request a waiver from FTA. Because of the delays documenting compliance, the utility relocation schedule was delayed. There was also a concern that the communication provider might not receive the waiver, which would have delayed the project even longer because the communication provider was not willing, and possibly not able, to find a compliant source. FTA indicated that the waiver was a one-time exception, so this type of equipment is likely to cause issues and delays on future projects.

For the communication provider, the city had to go through a lengthy legal review to be able to build the duct banks. The city also had to negotiate the cost sharing agreement and then negotiate an amendment to that agreement, which was difficult and time consuming. One of the reasons was that the agreement was more urgent to the city than to the communication provider. In practice, the city was able to develop a good understanding of the actual costs, which decreased the utility's argument that unit costs for materials was proprietary information.

Ohio: Greater Cleveland Regional Transit Authority

The Greater Cleveland Regional Transit Authority (RTA) operates one heavy rail line on 19 miles of track, three light rail lines on 15 miles of track, 69 fixed route bus routes, one BRT line, five trolley routes, and demand-response service in the urbanized area of Cleveland, Ohio (*39*). RTA contracts a portion of its demand-response service to a third party. The service area population is 1.3 million and 457 square miles. RTA's annual ridership is more than 50 million and includes 8.5 million rail passenger trips, 39 million fixed-route bus passenger trips, five million BRT trips, 1.5 million trolley trips per year, and 705,000 demand response trips. The revenue vehicle fleet includes 60 heavy rail cars, 48 light rail cars, 415 buses, 23 BRT buses, 17 trolleys, and 80 demand-response vehicles. RTA provides service to five park-and-ride locations.

RTA's FY 2012 operating budget was $229 million, and the capital budget was $33 million (*39*). Approximately 18% of operating revenues are from passenger fares. Other operating funding sources are advertising and investment income, sales and use tax, and grants. Capital revenues come from federal and state grants, local sources, and investment income.

Utility Coordination

Over the last 10 years, RTA has become more proactive with regard to utility coordination practices. The agency relies considerably on consultants for design activities, particularly for larger projects. The agency has strengthened its scope requirements for deliverables, including utilities. As a result, the agency has seen an improvement in the quality of utility research data deliverables earlier in the project.

The agency uses the traditional 30%, 60%, 90%, and 100% project development process. Utilities are contacted during the 30% design stage. At this point, the agency may not know the exact location of every utility installation, but feedback from the industry provides information about most known utility installations. RTA also has the policy that if a consultant does not provide a set of preestablished deliverables by the end of a phase, the consultant is not allowed to proceed with the next phase. The consultant is also not paid until the consultant submits all the deliverables for that particular phase.

To assist in this process, the agency produces a checklist of deliverables by phase that is specific to each individual project. As a result, the checklist of deliverables of a complex project such as a new rail station is different from the checklist of deliverables for a park-and-ride lot. The checklist of deliverables is included in the scope of services. RTA uses the checklist as a reference to measure the consultant's adherence to scope of services. As an illustration, Figure 3 provides a list of utility-related requirements included in the request for proposals for architect-engineer services in connection with the East 116th Station Design project.

General Responsibilities

- Identification, including ownership, and verification of all underground and above ground utilities at the project site during the Conceptual Design Phase and registration of the project with OUPS.
- Submittal of plans as required for approval to agencies involved with storm water runoff and soil preservation.
- At the design development phase, submit to the utility owners plans of the project for their verification and concurrence with the location of their utilities existing and proposed.
- Develop approved means to protect these utilities during construction.

Phase I – 10% Sketch Study and Conceptual (30%) Design

- Site and track survey and mapping are to be performed under the supervision of an Ohio registered surveyor.
- Arrange for a subsurface utility firm to locate all underground utilities, both horizontally and vertically, as required for design. The confirmation of these locations through test pits or other means shall be the responsibility of the contractor during construction.
- Identification and notification of the owners of underground and above ground utilities on the site and their protection services, if any, and the location of these utilities.
- 30% conceptual drawings and sketches of the designs shall include site plans and indicate all anticipated utility relocations and installations; track, signals, and catenary work; and landscaping.

Phase II – Preliminary (60%) Design Development

- Develop a preliminary engineering to refine the design prior to the development of construction documents. The development shall be to the 60% complete level.
- Submit site plans showing topography, track, signal, catenary, roads, utilities, storm drainage system, planted areas, buildings and other structures and pavements.

Phase III – (Note: No description or requirements specified)

Phase IV – 100% Construction Documents and Construction Bid Documents

- Prepare construction drawings and specifications for project bidding and construction. The drawings shall include site and civil plans including existing survey base map; demolition plans; grading; paving; utilities; erosion control; retaining wall modifications; track work; landscaping; and other details.
- Legal requirements regarding underground and overhead utilities:
    - Verify the location of underground and overhead utilities in the proposed project area and incorporate that information in a manner which fulfills the GCRTA's obligations as a public owner under the provisions of Ohio Revised Code 153.64.
    - Obtain utility information from municipal and other owners of underground utilities or from OUPS or comparable service for those utilities that are members of such a service.
    - Verify location of all utilities within construction limits by topographic survey and subsurface utility investigation and show on construction plans.

FIGURE 3 Utility-related requirements for architect-engineer services for the East 116th Station design [Greater Cleveland Regional Transit Authority (*40*)].

The agency deals with a wide range of utility owners. The city of Cleveland operates its own utilities, mainly water and power. There is also a host of public utilities, including a regional sewer system. The cable provider is a franchise utility. There are also private vendors, including a private electric utility, a private gas utility, and private fiber-optic communication providers. During the communication boom, the city of Cleveland issued a large number of permits, resulting in a wide proliferation of duct banks, which can be challenge when the agency undertakes capital projects.

There is not a significant difference in coordination practices between municipality-owned utilities and franchised utilities. In general, as a project approaches roughly 60% design, all stakeholders begin to pay more attention to project details, including utilities and utility conflicts. The agency itself frequently reviews plans from other agencies, and the level of review is more thorough as the project approaches the end of design. One of the challenges with preliminary plan sets is that there may not be enough data to determine whether relocations are required. At that point, potential conflicts may be identified and an investigation outlined. In this case, the agency includes a utility location service as part of the scope of services for the design work. The data from this data collection effort might not available until the middle of design.

RTA is not part of the municipal government. The agency also does not have the same statutory authority as the Ohio Department of Transportation. As such, the agency ends up paying for most utility relocations. Cable is the only franchise agreement within the city of Cleveland that includes RTA. In addition, the city operates its own electric utility and usually relocates its own installations. The agency has a standard utility agreement form that it uses for all relocations, along with attachments that describe the specific relocation work, impact, and the cost agreement. The standard form was originally developed for a large project years ago. Anecdotally, the agency's impression is that coordination and relocations tend to take a bit longer when the utilities affected have to pay for the relocations themselves.

RTA's preference is for the utility to do the relocation and for the agency to reimburse the utility. This structure facilitates the process (particularly in the case of gas, power, and cable utilities) and is efficient because the utility can best control the quality. In some cases, the agency builds part of the infrastructure, such as a duct bank, and the utility handles the rest. In other situations, such as for water, the agency handles the relocation as part of the construction project. One of the reasons is that contractors or their subcontractors also do construction work for the utilities and know their specifications and procedures.

If the relocation is in the contract, RTA uses bid items, but then allows the utility company to inspect the work. The frequency of inspections tends to vary from utility to utility. For example, for city-owned utilities, city inspectors are regularly notified but sometimes are not present at the jobsite. For franchised utilities, there is usually an inspector in the field. If the utility handles the relocation, the utility agreement with the utility includes a cost estimate, but then the agency reimburses the utility on actual costs. In practice, the cost estimate in the utility agreement might include an "order of magnitude" estimate, which might be refined as the design progresses to reach a level consistent with an engineer's estimate. The cost estimate also includes a contingency.

Most utility relocations are less than \$100,000. In some rare cases, the relocation can be higher and receive more scrutiny, including the requirement to receive approval from the board of trustees. In practice, high-dollar relocations also include additional reviews by several departments before the request for approval goes to the board. FTA project management oversight is also part of this review because utilities and third party agreements are a standard agenda item in meetings with FTA officials.

RTA's approach to utility relocations is based on risk assessment and management principles, which the agency implemented after FTA conducted a series of outreach efforts nationwide in the early to mid-2000s as a strategy for reducing the impact of serious issues affecting the development and delivery of major transit projects. One of those issues was substantial cost overruns related to utility relocations. The agency's perception is that implementation of risk management principles has resulted in tighter schedules and project costs that more closely resemble cost estimates developed during the design phase. Disposition of comments at the end of each phase before allowing the consultant to proceed with the next phase is part of the set of strategies for addressing and mitigating risks during project development.

At RTA, there is not an official title for a utility coordinator. Within Engineering and Project Development, 16 officials are active in several roles, including project managers, project engineers, and resident engineers. Background and expertise includes civil engineering, mechanical engineering, electrical engineering, and architecture. Most of these officials interact with utilities and fulfill utility coordination activities.

RTA participates in the Ohio Utilities Protection Service (OUPS). RTA also attends many of the monthly meetings of a utility council in Northeast Ohio. RTA designates two to three officials to attend these meetings. Through OUPS, RTA provides training to staff members every other year, usually in the form of a refresher seminar that focuses on the need to adopt damage prevention strategies to prevent disasters. RTA also provides internal training on electric power safety for any official who needs to be on the rail right-of-way. Through the training department, RTA also conducts power substation training. Although this training is not necessarily related to utility relocations, it does increase the level of awareness about and operational knowledge of utility installations.

Utility Data Collection

The agency uses One Call tickets primarily for damage prevention before construction. On occasion, the agency has used One Call when it has encountered substantial difficulties in obtaining utility location data during design. The agency also uses utility location services as part of the design phase. In practice, utility location services have contacts and relationships with utility companies, and they are able to obtain additional information about existing utility installations.

Depending on the type of project and the approach for managing risk for a specific project, RTA includes SUE in the scope of services for design contracts. On some contracts, the agency has also executed a change order to the design contract to conduct additional investigations (e.g., in tight corners where there is a need for a vacuum excavation to expose the utility facility and determine its actual X, Y, and Z coordinates).

RTA includes utility plans (showing both existing and proposed utility locations) in construction plans. In cases in which another agency handles the utility relocation, the agency might not necessarily show those utility installations on the construction plans. However, there is usually a note to alert the contractor about the need to coordinate with those other stakeholders.

At RTA, the architect-engineer, who is part of the design team, is responsible for the production of as-builts. Contractors redline construction plans to reflect actual conditions on the ground, and the architect-engineer transcribes that information into the final as-builts. As-builts include utility relocations. As-builts also show utility installations that were not relocated.

Utility Conflict Resolution

At RTA, 30% design is usually the time when utility conflicts are first identified. The agency does not formally use a utility conflict matrix. Instead, the agency uses a spreadsheet to track comments. Some of the comments address utility conflicts. In general, the design contractor must address each comment before moving to the next phase of design.

The general strategy to manage utility conflicts is to try to stay away from utility objects or features that are hard to move. Examples include fiber-optic installations and duct banks. Gravity sewers (sanitary and stormwater) can also be challenging. The easiest features to relocate are usually water and gas lines. In the case of old utilities, sometimes the most effective decision is simply to replace the facility. RTA reimburses utilities for the cost to replace the installation but not for betterments.

Challenges

Most projects receive federal funding, either directly from FTA or through other mechanisms that involve other agencies in the state. A current issue for the agency is the recent changes in Buy America provisions, which have been problematic for some utilities. A welcome relief was a recent clarification that Buy America provisions do not apply if the cost of the relocation is less than $100,000. In a recent example, the agency was working with a gas company on a $55,000 utility relocation. The company was doing the relocation with its own forces and had already purchased materials from a foreign steel producer. The company was not willing to sign off on Buy America provisions in the utility agreement. After the clarification was issued, the utility company promptly signed the agreement with the agency and started the relocation work in the field.

Buy America provisions are also problematic in connection with a wide range of power- and signal-related components that are needed for train operations because often the providers are headquartered abroad. The result is additional lead time that needs to be incorporated into the schedule and, in some cases, additional costs.

Oregon: TriMet, Portland, Oregon

TRI MET

The Tri-County Metropolitan Transportation District of Oregon (TriMet) operates 79 fixed-route bus routes, four light rail lines on 52 miles of track, one commuter rail line on 15 miles of track, and demand-response services in the urbanized area of Portland, Oregon (*41*). TriMet directly operates bus and light rail services and contracts demand-response, hybrid rail, and taxi services to a third party contractor. TriMet also operates and maintains the Portland Streetcar system, which runs two lines on a 14.7-mile network (*42*). Unlike the light rail, the Portland Streetcar is owned by the city of Portland and managed by the Portland Office of Transportation (*43*).

TriMet serves a population of 1.5 million and an area of 570 square miles (*44*). TriMet provides 100 million passenger trips per year. Sixty million passenger trips are bus, 39 million are light rail, 440,000 are commuter rail, and 1 million are demand-response trips. TriMet's revenue vehicle fleet includes 603 buses, 127 light rail vehicles, three diesel multiple units and two rail diesel cars (commuter rail), and 268 demand-response vehicles. Passenger amenities the TriMet operates include 6,742 bus stops, 87 light rail stations, and five commuter rail stations (*41*).

TriMet's FY 2014 operating budget was $489 million, and the capital budget was $103 million. Employer payroll tax and self-employment tax (12%), passenger revenues (25%), and federal formula grants (15%) contribute to TriMet's operating funds. Other operating funding sources include state and local grants. Capital program funding sources include state, local government, and private contributions; federal grants; and bond proceeds (*45*).

Utility Coordination

TriMet has two utility engineers who work full time on the coordination of utility issues and design alternatives. In addition to an understanding of and experience with light rail system requirements, TriMet utility engineers are expected to be knowledgeable about the design criteria and operating restrictions of all the utilities that typically exist within the alignment of light rail tracks. TriMet utility engineers are involved from the early stages of preliminary design to the completion of construction. This continuity is a significant benefit because many fewer issues arise on projects, particularly those with many different groups involved and those handed off from one group to the next.

Utility coordination typically starts once the locally preferred alignment alternative has been identified. TriMet utility engineers contact their jurisdictional partner, most often the city of Portland, to request a list of all affected utilities within project limits. The city has a formal notification process that can be used at this point. The notification from the city includes some basic project information and a project description, along with a request to coordinate with TriMet. The partnership with the city is essential because, unlike the city, the transit agency has little or no legal authority to make utilities move out of the right-of-way. TriMet works as a steward between the utility companies and the city of Portland to obtain all necessary construction permits and provide oversight for all relocation efforts.

TriMet's relationship with the city becomes critical once TriMet and a utility owner have agreed on a relocation design and the utility owner applies to the city for a permit to install the new facility. Normally, the city review of a design can take a significant amount of time and might involve several departments, including water, sewer, and transportation. However, in the case of TriMet, the city's review is expedited because the city knows that TriMet has reviewed and approved the utility's design and from past experience trusts TriMet's engineering expertise.

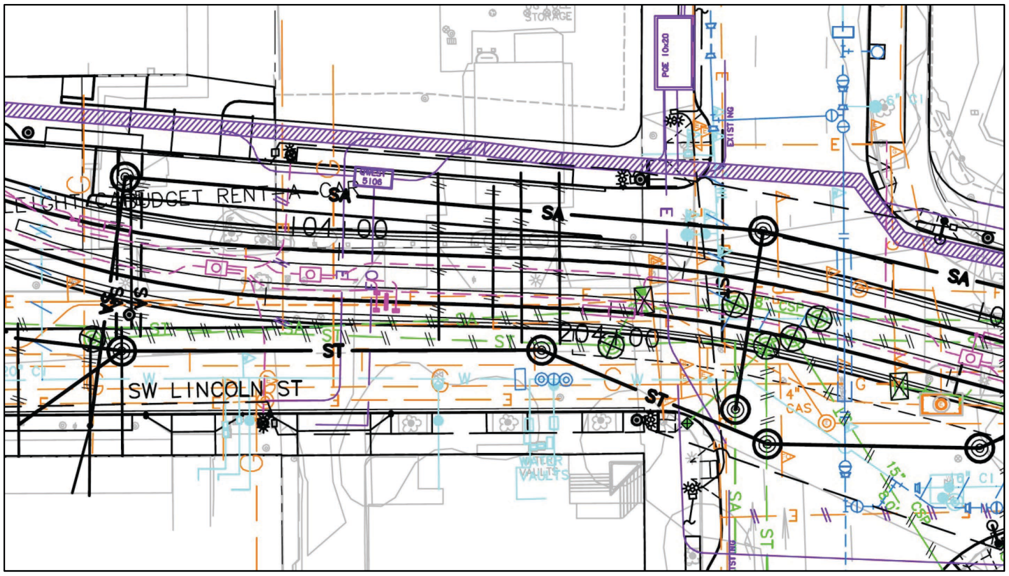
TriMet has developed an effective relationship with utility companies. Part of this relationship is TriMet's willingness to avoid expensive relocations when possible, considering alternative design approaches, and helping utility owners with relocation design and construction when needed and feasible. For utilities on private property or by easement right, TriMet and the affected utility establish the scope and estimated cost of the relocation. Regardless of which party bears the financial burden, TriMet considers that notifying stakeholders early and preparing a utility relocation plan is critical to completing utility relocations before light rail project construction. The city's franchise rules specify the financial responsibility for design changes once a utility has relocated. If a utility pays for a relocation according to the plan that TriMet agreed to but is in conflict during construction for whatever reason, TriMet bears the financial burden of the second relocation.

As the project design progresses and becomes more defined, subsequent notices are sent, adding additional information about the light rail construction project (typically design and schedule updates), at which time utility relocation schedules are refined and consequences for a utility's failure to act are addressed. During detailed design, TriMet staff has weekly meetings with all utilities involved in a project. There are meetings that involve representatives from all utilities, the city, and other involved agencies, as well as one-on-one meetings with individual utility owners to focus on specific issues. Publicly owned sewer and water facilities have stand-alone coordination meetings but are also represented at privately owned utility coordination meetings. To assist in the coordination effort, TriMet provides a complete picture of all identified existing subsurface utilities and all future surface improvements, and shares this information with all stakeholders (Figure 4).

A challenge for utility companies frequently is the number and size of design files that TriMet shares with stakeholders. This makes it difficult for utility company staff to review the files and mark up utility conflicts. In addition, files usually are shared at 30% design, which means that the design is likely to change in the future and must then be reviewed a second time. TriMet has found that most utility owners simply give up on the task before even starting. A strategy that has worked for TriMet is to work with utility owners individually and to go over the design plans together with the utility owner.

Once utility relocation begins in the field, TriMet works closely with the affected utility companies to relocate facilities in a manner that does not create additional conflicts with other utilities or surface features.

TriMet staff has found that most utility issues are straightforward to deal with, but a small percentage of utility issues (perhaps about 5%) require considerably more effort, as well as innovative or creative solutions. For example, a recent project involved a communication provider that agreed to relocate all its utilities except one line that carried sensitive government data. The fact that the line carried sensitive data became known only after several meetings, and the provider's position was to oppose or delay the relocation of this line for as long as possible. By reviewing the design and verifying the depth of the line, the TriMet staff was able to develop an engineering solution that allowed the line to remain in place.



Courtesy of TriMet. The plan view shows a section of a light rail project in downtown Portland, Oregon, depicting the rail alignment and existing and proposed underground installations. Some of the facilities shown are as follows:

Existing installations:

Green (SA label):	Existing sanitary sewer. A dashed line indicates the sewer will be abandoned or removed.
Green (ST label):	Existing storm sewer. A dashed line indicates the sewer will be abandoned or removed.
Cyan:	Existing water main or lateral.
Orange:	Other existing utility differentiated by letter: E = electric, G = gas, FO = fiber optic.
Light grey:	Other existing facilities.

Proposed installations:

Magenta:	TriMet duct banks and vaults, generally under the track slab or in the guideway.
Black (bold, SA label):	Proposed sanitary sewer.
Black (bold, ST label):	Proposed storm sewer.
Blue:	Proposed water main or lateral.
Purple (hash):	Joint utility trench for electric and communication utilities.

FIGURE 4 TriMet light rail project in downtown Portland, Oregon: Design plan with future surface improvements and utility installations.

Utility Data Collection

Oregon law requires utility owners to locate their lines during early stages of a highway project, so a designer can request utility locations even during preliminary engineering. Location information is usually accurate within 3 ft, which is sufficient for preliminary engineering but not necessarily for detailed design. In some cases, TriMet collects test hole data, but only on high-risk utilities that might be allowed to remain in place. For example, if crossings are sufficiently deep, they can remain in place. In this case, TriMet asks the utility owner to verify the depth of their installations, usually with help from TriMet. Most utilities have a vacuum truck perform the verification, and few of them ever hire a SUE consultant. Often TriMet coordinates with the utility and sends a surveyor under contract with TriMet to the field to measure the depth of the crossing once the utility has exposed its line.

Utility Conflict Resolution

Once utility data become available, TriMet adds the data to a file called Existing Utilities using the same coordinate system as the project design file (Figure 4). TriMet staff continues to update the file as more data become available. This map file is used during engineering meetings to discuss potential utility conflicts and ways to resolve them, risks to schedules and costs, and implications of alternatives. It also helps the designers to highlight areas where a more detailed investigation is necessary, such as in the form of test holes. In many cases, there is no need for a more detailed investigation. For example, the city water bureau has standards that prohibit water lines within 10 ft of the track, so if the existing line is less than this distance from the planned track, the design team knows that the line will have to be relocated.

As information from private utilities becomes available, the design team adds that information to the map file. Many utilities need considerable help because they are unfamiliar with CAD or do not produce drawings according to TriMet's standards. Essentially, TriMet staff convert all information to the same design standard so that at any time during the project there is a file available with information about existing utility installations, and one file with information about proposed locations for utility relocations.

For a recent project in downtown Portland, the Transit Mall, TriMet came up with some unique solutions to utility conflicts. The Transit Mall is essentially a pair of one-way streets with lanes restricted for transit vehicles only. The Transit Mall started with bus vehicles only but added light rail in 2009. Because most utilities in downtown Portland were buried with a minimum depth of cover of 3 ft, TriMet reduced the overall depth of the track slab and duct bank package from 3 ft, 8 in. to 2 ft, 1 in. This was accomplished by using a RI 59 girder rail system that has a low height and burying track conduit directly in the track slab, instead of using a duct bank. The direct bury conduits were set in a sand bedding under the track slab (Figure 5).

Incorporating a shallower track section avoided a majority of the utility installations in downtown Portland. However, the shallower design required some concession from TriMet resulting from the placement of TriMet conduits (without concrete encasement) in a more vulnerable position directly under the light rail tracks. TriMet frequently needs to work on its system, performing routine maintenance or constructing line extensions, which may require demolition and removal of rail and concrete track slab. In those events, the concrete-reinforced duct bank for the track conduits provides an extra level of protection for the track system. To mitigate this risk, TriMet implemented a track access permit program: the program requires that prior to the start of construction activities, any contractor working on or near the light rail system must have completed the track access training program and apply for a work permit by submitting a work plan and job hazard analysis that identifies potential risks.

An existing sewer line also posed significant challenges on the Portland Transit Mall Project. The light rail track runs directly over the existing sewer main for much of the alignment on 5th and 6th Avenues in downtown Portland. Requirements at the city of Portland's Bureau of Environmental Services for horizontal and vertical separation between sewer and light rail were not met, and TriMet was concerned about maintenance of the sewer and manhole access, which was vertically in line with the sewer and therefore in line with the track. However, all coordinating parties agreed that the light rail project would become highly unpopular with citizens and downtown businesses if the city or TriMet required a prolonged relocation of the 15-ft deep sewer using an open trench in downtown Portland, in addition to other utilities installing numerous duct banks.

During utility coordination meetings, the design team came up with a creative solution. Maintenance concerns were addressed by rehabilitating the sewer pipe using a cured-in-place pipe liner and trenchless technology, and the construction of large, offset manholes at every major intersection (Figure 6). Cured-in-place pipe increased the life of the existing sewer main, and the offset manholes provided necessary access for cleaning and maintenance. As a result, the sewer pipe remained under the track but the access point to the sewer is now to the side of the track. TriMet estimated that this design change saved at least a year of utility work and millions of dollars in relocation costs, while minimizing the impact to the general public and core downtown business district and developing goodwill with utility owners, who were pleased that facilities could remain in place.

For the current Portland-to-Milwaukie LRT project, the agency was unable to use the girder rail system because of Buy America requirements; TriMet used a standard T-rail system along with duct banks, instead of direct bury. Along the light rail corridor, designers requested vertical duct banks for track electrification. The depth of this track system would have affected many utilities crossing the right-of-way. A

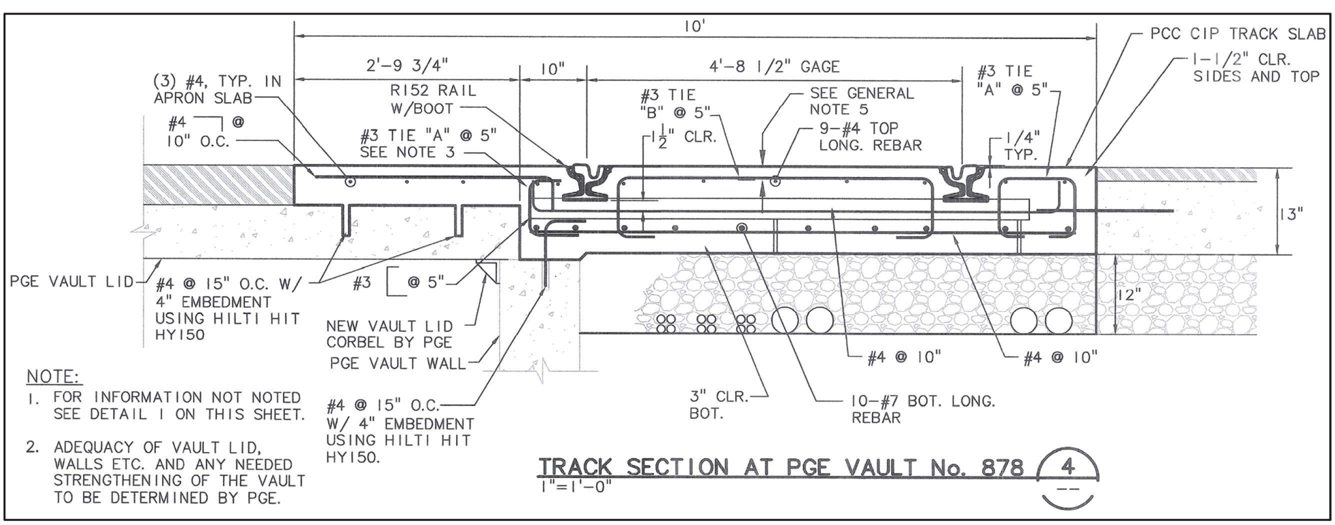


FIGURE 5 Typical section of embedded track used for Portland Transit Mall light rail, near PGE vault (*Courtesy*: TriMet).

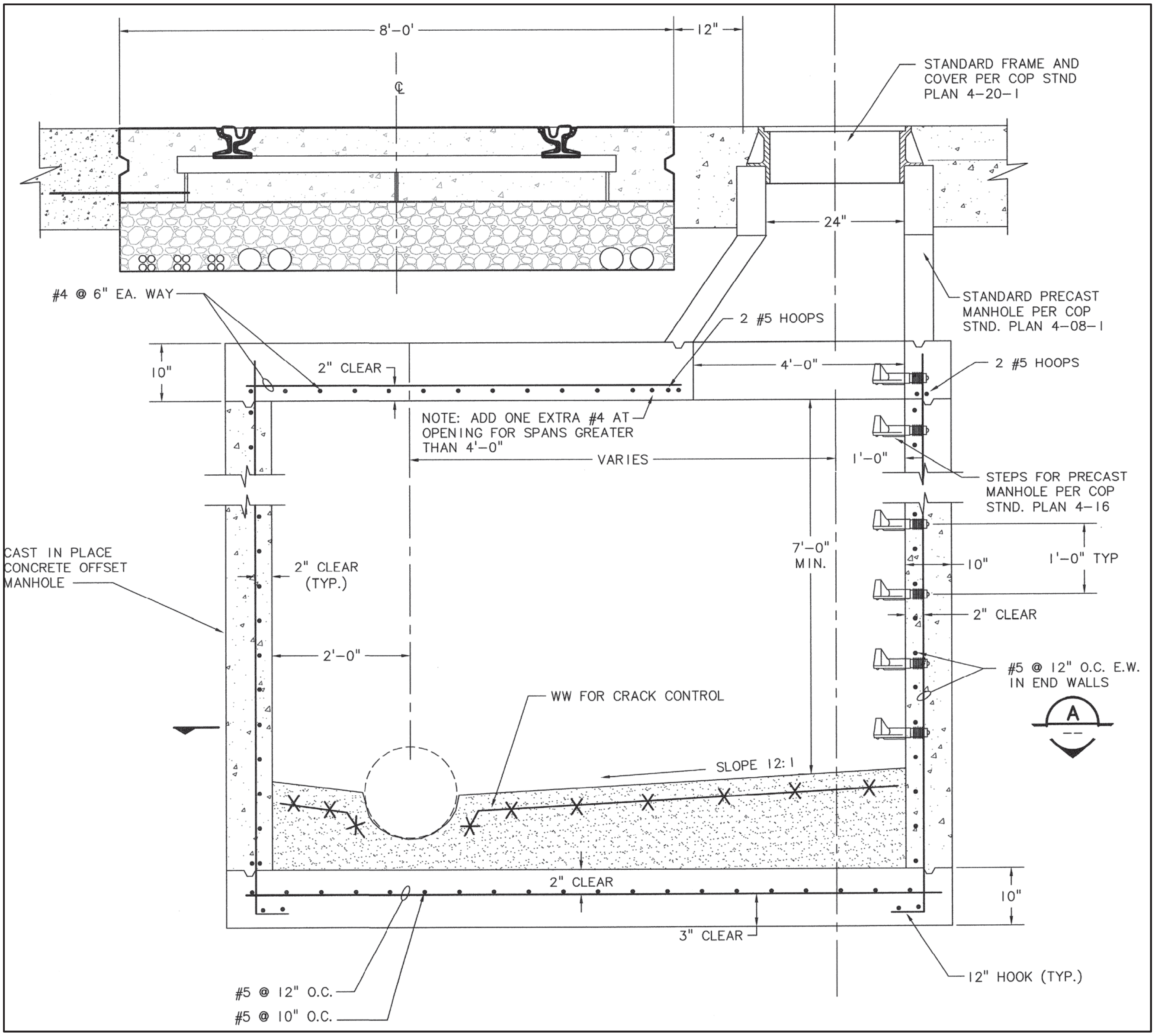


FIGURE 6 Offset manhole for Portland Transit Mall project (*Courtesy*: TriMet).

review of the design resulted in a recommendation for a flat horizontal layout of the duct banks, instead of a vertical stacking. Figure 7 shows a typical track section for the Milwaukie LRT project with a section depth of 3 ft, 8 in.

TriMet asked all utilities within 4 ft of the finished grade to lower their lines to a depth of at least 6 ft to the top of their conduit. TriMet was able to avoid several utility relocations, but a majority of crossings had to be lowered or relocated, which could have been avoided with the girder rail system. In the case of fiber-optic lines, several crossing relocations had an impact on fiber-optic lines for miles because such lines cannot simply be lowered at the crossing but have to be relocated until the next splicing point, which can be far away from the crossing.

Challenges

Utilities often use relocation projects to improve or expand their existing facilities. That is not necessarily an issue unless the utility is not up front about the betterment of their facilities. The challenge is to determine what portion of a utility relocation project should be considered betterment and thus not be part of existing cost-sharing agreements. It is also a challenge to communicate to utility owners that some types of betterment are not allowable, even if the utility pays for the whole relocation. For example, one company was planning to use the relocation opportunity to build a new substation that would have taken years to complete and delayed the project significantly.

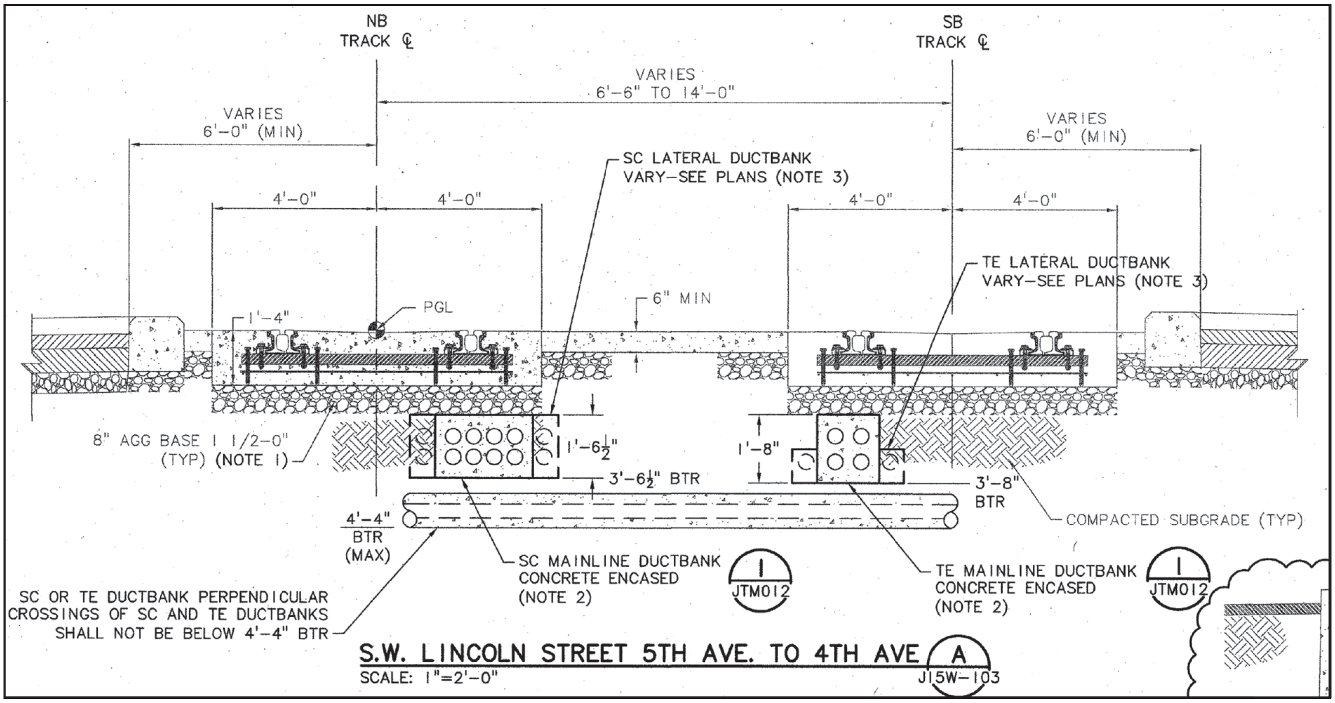


FIGURE 7 Typical section of Portland–Milwaukie light rail project (*Courtesy*: TriMet).

Sometimes it is difficult to relay to designers that utility relocations take a significant amount of time. Even with good utility relocation processes and business relationships in place, it can take a year or more to clear all utilities on a project. Therefore, the challenge is to determine when a project should start with utility relocations. From the utility owners' point of view, it would be preferable to wait until design is 100% complete so that the utility owners can be certain that their facilities are out of the way and that the relocations were indeed necessary. In practice, this is not feasible because it could mean that a project would be delayed for a year or more. On the other hand, there has to be at least some level of confidence in the design before it is feasible to move the utilities. According to TriMet designers, most projects are sufficiently designed at about 70% to 80% design to start with utility relocations. If there is a good working relationship and a level of trust between the utility coordination team and the design team, relocations could start earlier, possibly using 60% or even 50% design plans, if the design team can confirm that the track alignment is locked.

Another challenge is that utilities are often reluctant to make costly relocations if a project has not yet received full funding. The risk to the utility owner is that a relocation might have been unnecessary if the funding and thus the project are canceled. TriMet manages the utility owner's risk by using intergovernmental agreements if it is a publicly owned utility, and memoranda of understanding if it is a privately owned utility. These documents tie the agency and the utility company to a decision, so if the project is canceled for whatever reason, the agency will reimburse the company for the cost of the relocation.

Buy America regulations were a minor issue in the past until the ruling was made that they also apply to reimbursable utility relocations. Publicly owned utilities that were included in the construction have been compliant with Buy America for a long time, although Buy America has had an impact on procurement and cost. The main challenge lies with privately owned utility companies that, in order to comply with the regulations, must open their books and accept audit of their procurement, which utility owners consider private and competitive information. It is also difficult and time consuming to track certain types of utility equipment. For example, although it is easy to source ductile iron pipe from a U.S. manufacturer, a large transformer can consist of numerous components that might come from all over the world. In the past, FTA has granted waivers in some areas. However, FTA has indicated that these waivers will not be granted in the future, so the impact of Buy America is likely to increase for future projects. In many cases, the time spent by the agency and the utility owner in managing and complying with Buy America appear to have no relation to the regulation's potential benefit.

A related issue is that coordination efforts that in the past were conducted in a cooperative spirit suddenly have become more confrontational and more challenging. The utility company must accept audit of the procurement, so utility coordination meetings that previously were focused on engineering solutions are attended by lawyers with a different focus. As a result, these meetings can become more difficult to conduct, convoluted, and overall lengthier, and it might take many more meetings to accomplish what previously could be accomplished in one meeting. In one example, a duct bank had to be lowered by 2 ft in one location, which was a simple task estimated to cost a few thousand dollars and few days of work. Although the case was straightforward and might have been resolved with one meeting, TriMet ended up having numerous meetings over the course of many months discussing specifics related to Buy America regulations.

Pennsylvania: Port Authority of Allegheny County

The Port Authority of Allegheny County operates bus, light rail on 26 miles of track, inclined plane, and demand response services in Allegheny County, Pennsylvania, and minor portions of Beaver and Westmoreland Counties. The agency contracts all demand response services to a third party contractor. The agency serves a population of 1.4 million and an area of 775 square miles. The agency provides 59 million passenger trips per year. A nonprofit society operates the Duquesne Incline. The revenue vehicle fleet includes 701 buses, 83 light rail vehicles, four incline cars, and 411 demand-response vehicles. Passenger amenities include 6,977 transit stops, 280 shelters and stations, and 53 park-and-ride lots (*46*).

The FY 2014 operating budget was $366 million, and the capital budget was $126 million. Approximately 26% of operating revenues are from passenger fares. The remaining 76% of operating revenues are from federal, state, and local operating assistance, and advertising revenue. Capital funding sources include federal formula and discretionary funding, state bond dollars, and local county match (*46*).

Utility Coordination

The agency assigns a utility coordinator to major capital projects. In the past, utility coordinators were employees of the agency, but today there are fewer employees, so utility coordination is mostly outsourced to consultants. Having an experienced person with good contacts to the utility community is key to successful utility coordination.

The agency does not have any standard guidelines for utilities but usually provides utility owners a draft agreement and an overview of standards for occupying or crossing the right-of-way.

Utility Data Collection

Data collection typically starts around 30% of detailed design, involving One Call information, as-builts, and negotiations for utility agreements. Engineering is primarily a task for consultants, so it is mostly up to them to request detailed utility information, such as test holes in areas where needed.

Utility Conflict Resolution

For the most part, utilities need to move out of the way. Occasionally, some utilities can remain in place, usually if they are expensive to relocate, in good condition, and the design team finds a way to move around them, which often is not possible or feasible.

Most utilities that the agency interacts with occupy the right-of-way under franchise agreements with the city. Although these agreements require utilities to relocate as needed, the agency has cost-sharing agreements with most utility companies, typically 50/50. Cost sharing is a win-win for the agency and utility company. Although the agency agrees to pay for half of the relocation cost, the agency has found that there are fewer issues, fewer delays, and utility companies are more willing to work with the agency. These cost-sharing agreements are negotiated separately with each utility owner and cover only in-kind replacements without betterment.

In one example of cost sharing, the agency designs and builds duct banks for communication providers. Upon completion, the utility installs its own lines in the duct bank. Utility structures, such as manholes and duct banks, can be included in the construction contract or bid out separately. In the agency's experience, rolling items into the construction contract tends to produce lower bids than does separately bidding out the utility work.

City facilities such as sewers are relocated at 100% cost to the agency. The city does not charge for the use of the right-of-way, so when the agency has to relocate facilities, it also does not charge the city for the relocation cost.

Challenges

Throughout the last few projects, the Port Authority has had few issues with utility owners during construction. According to the Port Authority, the key to avoiding utility issues during the construction phase is to get utility agreements in place before construction begins. However, it is important to consider that utility agreements can take a long time to obtain. For example, some utilities cannot relocate immediately but must wait until certain times of the year to take facilities out of service, so these relocations must be prioritized and scheduled a long time in advance.

The biggest challenge to obtaining utility agreements on time usually is getting the utility owner's cost participations into the utility owner's capital program. For utility owners to participate, they often must schedule the expense years in advance of the relocation.

Training to stay up to date on utility coordination procedures has been a challenge. However, the agency owns utility facilities and participates in One Call. As a result, the staff involved in the One Call program stays up to date by participating in mandatory training that is offered through the One Call program, including an annual workshop.

Utah: Utah Transit Authority

The Utah Transit Authority (UTA) operates a fleet of more than 600 buses and demand-response vehicles (including BRT), 400 vanpools, 146 light rail vehicles, 63 commuter rail cars, 18 locomotives, and streetcar service in a service area that stretches over six counties, from Payson to Brigham City, Utah (*47, 48*). UTA contracts a portion of its demand-response service to a third party. UTA's serves a population of 2.2 million and an area of 751 square miles. UTA transports 43 million passengers per year. Approximately 713,000 trips are demand response, 21 million trips are bus, 18 million trips are light rail, and 1.8 million trips are commuter rail.

The FY 2012 operating budget was $219 million, and the capital budget was $308 million (*47*). Sources of operating funds include fare revenue (22%), state funds (53%), federal funds (23%), and other funds (3%). Sources of capital funds include state funds (26%), federal assistance (30%), and other funds (44%).

Utility Coordination

The typical process involves the utility coordinator at UTA engaging the project manager as soon as a project starts. Before engaging designers, the utility coordinator schedules a field visit with utility owners to determine if any major utility installations could have a significant impact on the project. This exercise enables the agency to conduct a risk assessment and identify potential up-front risk mitigation strategies.

After the designer is on board, meetings with utilities have taken place, and surface features have been surveyed, the agency prepares a utility conflict matrix. UTA uses this information during the design phase to determine if it is possible to design around major conflict areas. Depending on the situation, UTA often prefers to complete the utility relocation in-house as a strategy to reduce risk and control the outcome. To make this process work, UTA requests lists of preferred contractors from all the utility companies in the area. With this information, UTA identifies a reduced list of contractors that are on everybody's lists and then enters into master on-call contracts with each of those contractors. Because these selected contractors are already on the utilities' lists of preferred contractors, it is straightforward for them to work with UTA directly. In parallel, UTA executes agreements with the utilities involved to confirm the scope and outline responsibilities by each party. UTA typically pays 100% of all utility relocation work, regardless of project funding source. The only exception is rail corridors, for which a utility occupies the right-of-way by license. In this case, UTA asks the utility to pay for the utility relocation cost.

Coordination practices during the design phase are similar regardless of utility company. UTA treats all utility companies the same way. Coordination practices during construction tend to vary. For installations such as water and stormwater, UTA contractors usually handle the relocation and construction work, and the city typically sends an inspector to the jobsite. For communication, gas, and electric installations (which are usually privately owned), a number of union agreements and regulations preclude UTA from completing certain activities. For these installations, the utility companies are much more involved in the relocation work.

UTA first starts coordinating with utilities during the preliminary engineering phase. In practice, as soon as the project is laid out at the beginning of the design phase, UTA begins systematically coordinating with utility owners.

The agency uses design-bid-build, design-build, and CM/GC project delivery methods. For design-build and CM/GC projects, hand-off to the designer team usually takes place after the environmental clearance.

Utility Data Collection

When a project is laid out, the utility coordinator schedules field visits with individual utility companies. During a field visit, the utility coordinator and the utility company representative walk the project, review existing records, take notes and pictures, and review the project layout. This activity is particularly critical in the case of certain utilities that have old or obsolete records. Utility representatives frequently point out buried features on the ground that existing records have not identified. This is one of the reasons the agency uses One Call primarily for damage prevention before construction but not as a useful tool for identifying existing installations during project development. For UTA, walking the project with utility company representatives frequently is more valuable and useful as a risk management tool.

UTA heavily relies on test holes to confirm the location of utilities. The agency also uses EM pipe and cable locators, mainly through the design contract. For test holes, the design consultant usually has a budget item for test holes, and the agency tells the consultant where to locate the test holes. Right before the contractor comes on board, the consultant usually conducts another (denser) series of test holes. As the test holes are backfilled, UTA places a vertical 2-in. plastic pipe right next to the utility (Figure 8). The plastic pipes stick out of the

FIGURE 8 Test hole markers (*Courtesy*: UTA).

ground and are capped so they can be identified easily. Removing the cap enables officials to confirm the depth of the utility.

Although UTA uses test holes, it normally does not certify the resulting data as QLA. The agency also does not collect QLB data. One of the reasons is the practice of conducting test holes before construction and the realization that contractors frequently collect utility data on their own.

As a strategy to reduce risk to the agency, UTA shows both existing and proposed utility locations on bidding documents. However, at the conclusion of the construction contract, the contractor only provides as-builts showing where the track is. In the future, UTA would like to change this practice so that contractors provide as-builts that also contain information about existing and relocated utility installations.

UTA does not keep or maintain utility records after completing the relocation work. If the utility requests it, UTA does a field survey and provides the results to the utility.

Utility Conflict Resolution

A challenge with using UCMs is that they can easily grow to the point where they become unmanageable. For example, for a recent project, the list included 900 conflicts, and extracting information from the spreadsheet became extremely inefficient. Another challenge is that consultants usually limit the identification of resolution priorities as 1, 2, or 3 without providing additional information, forcing the agency to review the matrix in detail anyway.

The protocol for managing utility conflicts during construction is that the contractor contacts the UTA utility coordinator. The utility coordinator then contacts all affected utilities to develop a conflict resolution strategy.

The agency has begun to use 3D modeling, although in a limited capacity. For the Draper light rail line project, the design builder used 3D modeling to identify the location of conflicts with water, sanitary sewer, and stormwater systems. After developing the model, it was straightforward to move fiber-optic and gas lines to resolve the conflicts. This project was completed in 2013. The contractor absorbed the cost to prepare the 3D model.

Challenges

Buy America provisions have been problematic for the agency and some of the utilities with which the agency needs to interact. For example, the gas utility has difficulty finding parts made in the United States. In other situations, utility companies are complaining about having to pay more for U.S.-made components. UTA is adopting a wait-and-see approach.

The agency has only one utility coordinator who has a wealth of experience thanks in part to his many years spent doing design work for a utility company before joining UTA. The agency does not have formal training programs in the area of utilities. In addition, there is no program in place to disseminate information about federal policies, reports, manuals, and relevant documents.

Washington State: Sound Transit, Seattle

SOUNDTRANSIT
RIDE THE WAVE

The Central Puget Sound Regional Transit Authority (Sound Transit) operates seven commuter bus lines, two light rail lines, one commuter rail line, and streetcar rail in the urbanized areas of King, Pierce, and Snohomish Counties in Washington (*47*). Sound Transit contracts a portion of the commuter bus and all of the commuter rail services to third party contractors. Sound Transit serves a population of

3 million and an area of 1,086 square miles. Annual ridership is 31 million passenger trips. In FY 2012, the Sound Transit revenue vehicle fleet included 225 commuter buses, 26 light rail vehicles, 56 commuter rail vehicles, and two streetcar rail vehicles.

The FY 2014 operating budget was $322 million (including the departmental budget), and the capital budget was $742 million. In FY 2012, fare revenues accounted for 23% of the operating funds. Remaining operating funding sources include local (70%) and other (7%) funds (*47*).

Utility Coordination

Most projects at Sound Transit are delivered as design-bid-build projects. However, the agency recently began to use alternative delivery methods, such as CM/GC and design-build, for a few projects.

For most projects, the agency starts coordinating with utilities during the planning and preliminary engineering phases. At this stage, Sound Transit asks utilities to provide information about major utility installations along the project corridor as well as major plans that might have an impact on the project.

During the final design phase, coordination with utilities is the responsibility of the design team. Walking the project with utilities in the field is not common, although it can happen when there are major or critical utility relocations. In most cases, the design team interacts with utilities on paper because utilities are quite familiar with their own systems and know what to expect out of the coordination process. Although each project is different, Sound Transit's target is to identify the need for all major utility relocations by 30% and most minor utility relocations by 60%. By 90%, the need for all known utility relocations would be confirmed.

Sound Transit applies risk assessment and risk management principles for project development. The agency prepares risk matrices for the entire project during preliminary engineering and uses that information to develop the scope of work for the final design consultant.

Sound Transit normally conducts utility relocations as part of the construction contract. In some cases, the agency uses separate contracts for advance relocations ahead of the main construction contract, such as when the utility relocation might have a significant impact on the construction schedule or there are strong seasonal reasons. For example, if there is a need to relocate an electric transmission line, the best time of the year to do this is in late summer. In this case, a separate relocation agreement may be necessary to accommodate this requirement and avoid potential project delays. It also depends on the specific utility company. In some cases, utility companies prefer to do their own relocation or, at least, parts of it. For example, Sound Transit might take care of the conduit and other civil infrastructure, but the utility takes care of the wiring. Some cities have undergrounding ordinances, which provide the general framework for what kind of infrastructure needs to be put in place.

Historically, Sound Transit has had master agreements with some utility companies, particularly franchised utilities that operate regionally, outlining the percentage of the relocation cost for which each agency would be responsible. For example, for one of the major utilities in the area, the 10-year agreement included a 55/45 split. This agreement recently expired and is being renegotiated.

Utility coordination practices tend to vary depending on the type and size of utility company. For example, at some small water or sewer districts, everything has to go through the board of directors for approval. By comparison, at a large power company, it may be just a matter of identifying the proper manager with whom to interact. In some cases, Sound Transit has found coordination to be more efficient and businesslike with private-sector utilities than with public-sector utilities.

To facilitate coordination, Sound Transit asks each utility company to designate a central point of contact who is responsible for coordinating with Sound Transit and for gathering all reviews and feedback within their own organizations. On large projects, the agency is testing the use of utility action plans, which describe all major activities that are needed in connection with each utility, including data collection, preliminary work, development of composite utility maps, and milestones. Also included is a depiction of the utility design process and a work schedule (Figure 9). Concurrence letters typically are used to document decisions with local jurisdictions as the design progresses. Formal agreements are used to establish legally binding commitments and reimbursement procedures.

A large number of officials at the agency are involved in utility issues, including project managers, utility engineers, right-of-way engineers, legal counsel, and others within the project team. Inspections usually are handled by a construction management consultant. If utility issues arise during construction, the utility engineers become involved to coordinate with the affected utility company.

Staff training includes both external training and on-the-job training. External training includes topics such as stormwater and drainage topics because of the large number of utilities that tie into regional drainage systems. Information about other topics, such as coordination and federal and state regulations, typically is available online, so additional training on these topics is not considered necessary. For external entities, there is limited access to agency information such as manuals and guidelines (for example, the *Design Criteria Manual* and Utility Agreement Agency Policies). These

ID		Task Mode	Task Name	Duration	Start	Finish	Predecesso	Resource Names
1			**Basemap**	**284 days**	Thu 12/27/12	Tue 1/28/14		
2			Field Survey	274 days	Thu 12/27/12	Tue 1/14/14		
3			Perform Records Research	60 days	Thu 12/27/12	Wed 3/20/13		
4			Field Verify (Locates)	60 days	Thu 7/11/13	Wed 10/2/13	3,13	
5			*Field Review Complete*	*0 days*	*Tue 1/14/14*	*Tue 1/14/14*	*4,2*	
6			*Record of Survey Completed and Filed*	*0 days*	*Tue 1/28/14*	*Tue 1/28/14*	*5FS+10 da*	
7								
8			**Preliminary Utility Work**	**140 days**	**Thu 12/27/12**	**Wed 7/10/13**		
9			Size and Identify Service	20 days	Thu 3/21/13	Wed 4/17/13	3	
10			Develop Site Plans	40 days	Thu 12/27/12	Wed 2/20/13		
11			Storm water Tech Memo(Compliance)	20 days	Thu 2/21/13	Wed 3/20/13	10	
12			Obtain Franchise Agreements	20 days	Thu 4/18/13	Wed 5/15/13	9	
13			Identify Conflicts and Risk Assessment	40 days	Thu 5/16/13	Wed 7/10/13	12	
14								
15			Composite Utility Plans	217 days	Wed 7/10/13	Fri 5/9/14		
16			Notify Utility Owners	0 days	Wed 7/10/13	Wed 7/10/13	13	
17			Meet with Owners	20 days	Thu 7/11/13	Wed 8/7/13	16	
18			Establish scope(Betterments,Upgrades,etc)	20 days	Thu 8/8/13	Wed 9/4/13	17	
19			Schedule & Sequence	20 days	Thu 9/5/13	Wed 10/2/13	18	
20			Identify RoW needs	0 days	Wed 10/2/13	Wed 10/2/13	19	
21			Develop Utility Plans	117 days	Thu 10/3/13	Fri 3/14/14	20	
22			*Utility Plans Complete*	0 days	Fri 5/9/14	Fri 5/9/14	37	
23								
24			**Agreements**	**215 days**	**Thu 7/11/13**	**Wed 5/7/14**		
25			Establish Agreement Boilerplate	20 days	Thu 7/11/13	Wed 8/7/13	16	
26			Negotiations	75 days	Thu 9/5/13	Wed 12/18/13	18	
27			Draft Agreement	40 days	Thu 12/19/13	Wed 2/12/14	26	
28			Review	40 days	Thu 2/13/14	Wed 4/9/14	27	
29			Route for Signatures	20 days	Thu 4/10/14	Wed 5/7/14	28	
30			Agreements Signed	0 days	Wed 5/7/14	Wed 5/7/14	29	
31								
32			**60% Design**	**225 days**	**Mon 9/2/13**	**Fri 7/11/14**		
33			General Plan Development	180 days	Mon 9/2/13	Fri 5/9/14		
34			RoW plans	40 days	Thu 10/3/13	Wed 11/27/13	20	
35			*RoW Plans Complete*	*0 days*	*Wed 11/27/13*	*Wed 11/27/13*	*34*	
36			Overlay Utility Plans	40 days	Mon 3/17/14	Fri 5/9/14	21	
37			Refine Schedule and Sequence	40 days	Mon 3/17/14	Fri 5/9/14	21	
38			QC/QA Review	45 days	Mon 5/12/14	Fri 7/11/14	33,34,36	
39			Submittal	0 days	Fri 7/11/14	Fri 7/11/14	38	

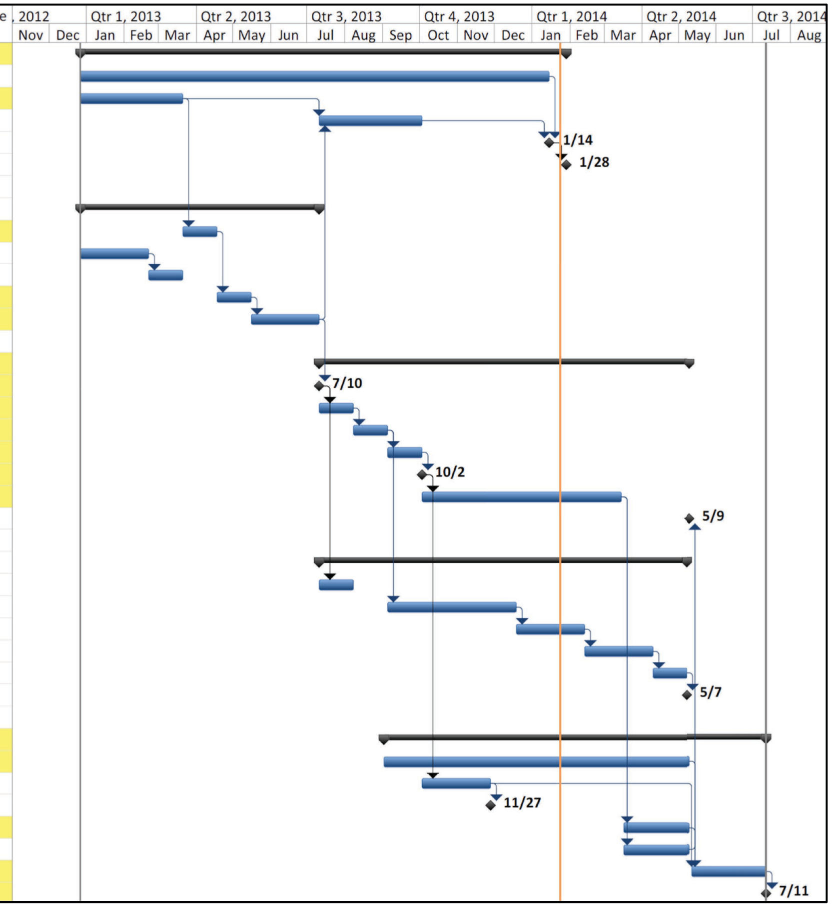


FIGURE 9 Sample schedule to address utility issues (*Courtesy*: Sound Transit).

documents are considered “controlled” documents, although they are available through a public disclosure request.

Utility Data Collection

Sound Transit uses One Call for damage prevention. The agency has a contractor that does utility location services for developers within the area.

The risk assessment in the preliminary engineering phase helps Sound Transit determine the utility investigations that are needed during the design phase. Depending on the situation, project managers use the ASCE 38-02 standard. The scope of services for design consultants specifies more precisely the kind and level of utility investigations for a specific project. For example, for a recent aerial guideway project, the design manager wanted to make sure that all utilities were mapped at a sufficient level of detail within an additional 10-ft radius around the proposed column foundations.

As the agency develops projects, it has learned a few lessons concerning the identification and depiction of utility installations. For example, their initial segment of light rail, which involved street running track, ran 4 miles along a busy arterial in the city of Seattle. For this project, early decisions resulted in a less-detailed utility investigation than what was actually necessary. As a result, the quality and coverage of the utility mapping were poor. During construction, it was discovered that a few parallel utility lines were actually located a few feet from where the plans indicated, forcing the agency to conduct several unplanned relocations. On that project, the number of test holes was also limited. Moving forward, the agency’s goal is to have the proper number of test holes as a strategy for managing risk. The location and number of test holes is a function of the specific need. For example, for elevated guideways, the agency specifies test holes at the column locations.

Sound Transit (through the final design consultant) creates and maintains records of existing and relocated utilities during the design and construction phases. Utilities are shown on the plans used for bidding purposes.

Utility Conflict Resolution

As mentioned, Sound Transit prepares a risk matrix for the entire project during preliminary engineering and uses that information to develop the scope of work for the final design consultant. The agency also uses matrices to manage utility conflicts. Every contract is different, but the amount of information managed is similar in most cases (Table 7). The matrix template spreadsheet could vary from project to project at the discretion of the official in charge.

Challenges

Compliance with recent Buy America provisions requiring Sound Transit to pass along these requirements to utility companies during utility relocations has been an issue for the agency and the utility companies. Buy America provisions had always been included in the construction contract, but extending this requirement to utility relocations has forced the agency to conduct much more thorough reviews at the individual component and subcomponent levels, sometimes involving attorneys, to determine whether the provisions apply.

Some of the utilities that know they will be doing a large amount of utility relocations with Sound Transit have modified their internal procedures to identify individual components that will be used for Sound Transit work orders, store these components separately at their warehouses, prepare the corresponding documentation to certify compliance, and verify that these components are actually installed on the job.

Locally funded projects are not subject to Buy America provisions. However, there are cases where there is no clarity whether the agency will request federal funding. To be on the safe side, Sound Transit usually includes Buy America provisions on such contracts.

TABLE 7
SAMPLE UTILITY CONFLICT LIST AT SOUND TRANSIT

Utility Owner	Franchise or Easement	Authority Allowing Utility	Utility Conflict Resolution Strategy
Seattle City Light	Franchise	City of Seattle	Brooklyn Station: SCL re-route cables in order to abandon existing SCL DB during N120, and then pull cables back in new DB in N140. New services to station & future TOD. Remove existing street light conduit along the east sidewalk of Brooklyn Ave NE in N120 and re-install new street light conduits/DBs in N140. Protect existing DB and vault in the alley. Roosevelt Station: Relocate aerial 26-KV distribution lines from west to east side along 12th - prior to N120. Re-install 26-KV back to north side of NE 65th & west side of 12th Ave NE - during or post N150. New DB to feed condo/apartment in NE 67th and remove existing aerial lines along the south side of NE 66th & 67th. New services to station. North Portal: Relocate overhead 26KV from west to east side of 1st Ave NE. Northgate Station: Overhead transmission and distribution lines due to guide way and stations. New services to stations.
SDOT	N/A	N/A	Traffic signal, interconnect, street lights relocation.
Puget Sound Energy	Franchise	City of Seattle SMC 15.32.120 to cause utilities to relocate at their own expense for a public transportation project	Brooklyn Station: PSE to install 2" tie along 12th Ave NE, from NE 43rd to 45th; PSE to cut-and-cap existing 2" along Brooklyn Ave NE & NE 43rd St before N120; Reinstallation of 2" gas along Brooklyn Ave NE in N140. Roosevelt Station: PSE to install 4" tie along Roosevelt Ave NE, from NE 43rd to 45th; PSE to cut-and-cap existing 2" along NE 67th & 66th St before N120; PSE will not re-installation 2" gas across station excavation. North Portal: TBD. Northgate Station: TBD.
Seattle Public Utilities	Easement	City of Seattle	Relocate existing sanitary pipes and new services for TPSS and station excavation. Brooklyn Station: Relocate existing 10" CS to just outside station exaction along west side of Brooklyn Ave NE in N120. Roosevelt Station: Raise existing 8" sewer in N120, to be above station roof, along NE 66th one block east to Brooklyn Ave NE. Could be longer to 14th Ave NE. North Portal: TBD. Northgate Station: TBD.
360 Networks LTS	N/A	City of Seattle SMC 15.32.120 to cause utilities to relocate at their own expense for a public transportation project.	Protect existing comm/FO conduits & vaults in Brooklyn Station. 360 Network also has sold/leased DB/vaults to other parties- DOIT (COS), Level 3, XO Comm.

Source: Sound Transit. Adapted from sample North Link utility matrix.
Note: N/A = not applicable.

CHAPTER FIVE

CONCLUSIONS

Transit projects frequently affect other modes of transportation and various kinds of utility facilities above and below ground along the project corridors. A literature review was conducted to characterize utility coordination and management of utility issues during transit project development and delivery. The literature review included references that discuss utility practices at transit agencies and, for completeness, references that discuss relevant highway-related reports, guidelines, and research. In 2011, U.S. transit agencies spent $17 billion on capital expenditures: $10 billion on facilities (i.e., guideway, stations, administration buildings, and maintenance facilities) and $7 billion on rolling stock and other expenditures. The highest percentage of capital expenditures was on heavy rail (32%), followed by bus and trolleybus (28%), light rail and streetcar (19%), and commuter rail (15%). At the national level, funding for capital expenditures included federal (43%), local (19%), directly generated (25%), and state (13%) sources. For individual transit agencies, the distribution of federal, state, local, and directly generated funds can vary substantially from these national trends.

Most utility relocations at transit agencies probably are associated with rail and streetcar projects and, to a much lesser extent, bus projects. FTA requires detailed monthly reports from grantees. However, it is not clear to what extent this information is compiled or archived in databases that can be easily accessed to gather information about utility relocation costs and trends. In addition, it is not clear whether FTA would keep statistics on local projects or utility relocations that use local funds. Statistics showing capital expenditures that are spent on utility relocations are not easily available. Having access to these statistics would facilitate a number of applications, including project planning and scoping, project cost monitoring, and risk management. In some isolated instances, references in the literature provide information about capital cost percentages or contingency levels that might be associated with utility relocations. For example, for a 1996 study that included an evaluation of capital costs for eight light rail projects, analysts considered 8% to 10% of the project capital cost to be associated with utilities, betterments, and mitigation measures. However, it is not clear whether these percentages were based on a review of actual project cost data or engineering judgment.

Some of FTA's guidelines include information related to utilities. For example, the *Project and Construction Management Guidelines* assist with the development of transit capital projects in areas related to project scope, function, schedule, cost, and quality. Regardless of project delivery method, the guidelines highlight the importance of identifying utility conflicts during the preliminary design phase. The guidelines also emphasize the importance of executing master agreements with utility owners in this phase to outline each party's responsibilities during design and construction. However, compared with the amount of documentation related to preliminary design, the guidelines are relatively brief with respect to utility-related design and construction recommendations and requirements. FTA also published a series of lessons learned based on feedback received from FTA Project Management Oversight Program contractors, transit agencies, and FTA regional managers. However, utility issues were mentioned only incidentally in some of the lessons learned.

Although the available literature on utility-related research and applications for transit projects is sparse, the body of knowledge for highway applications is much wider. This synthesis included a partial review of relevant references, including the following:

- 1974 guidelines for the accommodation of utility facilities within the right-of-way of urban streets and highways;
- 1984 *NCHRP Synthesis 115* documenting the results of a review of practices to reduce conflicts between highway projects and utility installations;
- 1993 *Highway/Utility Guide* to state DOTs, local jurisdictions, and utility owners on highway and utility issues;
- 2004 recommended strategies and most effective practices to optimize right-of-way and utility processes;
- 2000 scanning study of several European countries on innovative practices for right-of-way and utility processes;
- 2008 scanning study in Australia and Canada on innovative practices for right-of-way and utility processes; and
- 2012 Second Strategic Highway Research Program (SHRP 2) R15B project, which dealt with the use of utility conflict matrix (UCM) approaches to identify and manage utility conflicts.

A survey of transit agencies was conducted to better understand utility coordination practices. A two-tier approach was followed in which a preselection survey was distributed to transit agencies nationwide, and based on the results of this preselection survey, a targeted round of phone interviews was conducted with selected transit agencies. In total, ten transit agencies were selected based on the results of the preselection survey and invited to participate in phone interviews, yielding case examples. Of this total, eight agencies responded (80% response rate), and phone interviews were scheduled with each one of them.

Lessons learned from the preselection survey and case examples include the following:

- Utility conflicts result in significant impacts to transit projects, particularly during design and construction. Participants provided information on the relative level of impact of 24 utility-related issues that are common during project development and delivery. Two issues stood out as having a significant impact: identifying utility conflicts during design and identifying utility conflicts during construction. As participants highlighted, these issues have ramifications throughout the process, such as difficulty in preparing and maintaining utility cost estimates and coordinating with other stakeholders effectively.
- Transit agencies strive to involve utility owners early in the project development process. Several agencies noted that they contact utility owners in the early stages of project development, primarily during the preliminary design phase. This is consistent with FTA recommendations. Among transit agencies, there is some confusion in terminology as to what constitutes preliminary design (e.g., some officials indicated that a project at 30% design was in the preliminary design phase). Nonetheless, it was clear that agencies attempt to start utility coordination activities as early as possible, which is critical to giving a utility owner sufficient time to include utility cost estimates in the utility owner's capital program so that there will be approved funding if a utility relocation is necessary. Although utility coordination starts early, and data collection timing can be critical, agencies frequently do not start utility data collection activities in the field until later in the process, when the project is in the detailed design phase.
- Successful utility coordination requires experience, partnerships, diligence, and accurate and complete utility data. Agencies highlighted key requirements for successful utility coordination practices, including the following:
  - Having staff members who are experienced on all aspects of utility coordination, utility data collection, and utility conflict management, and who are focused and diligent.
  - Having project team members who have experience identifying win-win scenarios in which both utility owner and project owner benefit.
  - Having continuity in the utility coordination process from planning to construction by minimizing the number of responsibility hand-offs throughout the process. Projects in which utility coordination is assigned to the same individual or group throughout the process tend to have fewer issues, such as gaps in communication with utility owners and designers. Outsourcing utility coordination works in many cases, but lack of continuity can be a problem if the coordination contract is not properly managed.
  - Having a composite utility map or drawing that shows utility locations on top of design files that can be shared among stakeholders. Sharing available utility data on design sheets can be an effective tool for utility coordination. Including utility locations (existing and proposed) on letting documents is also critical in assisting bidders in the preparation of cost-effective proposals that reduce the level of risk for both contractor and transit agency.
  - Developing relationships with utility companies on the basis of transparency and knowledge of each other's business processes and constraints. Effective coordination is based on valued relationships that take a long time to develop. These relationships are essential to keeping the project on schedule, particularly in situations that require flexibility from all stakeholders, such as when it would be strategic to have a utility owner relocate its facilities, even though the project has not been fully funded. Flexibility from stakeholders is also critical for accelerating project delivery, such as when right-of-way is acquired in parallel with design, and it becomes a challenge how to minimize utility impacts on all stakeholders. Early coordination among stakeholders is also critical, such as when it is necessary to acquire additional right-of-way to accommodate relocated utilities, because of all the potential implications for the project schedule and budget, including changing project limits, modifying environmental analysis constraints, and required funding.
- The amount of utility coordination effort varies substantially depending on the type of utility owner. For franchised utilities, transit agencies typically do not have the same power as cities to ask utilities to relocate at their expense. If possible, agencies try to work through the cities to accomplish the relocation objective. In these cases, agencies frequently have to pay for the utility relocations. For municipality-owned utilities, it is usually a matter of negotiating the terms of the specific agreement with the municipalities. Sometimes utility owners are interested in betterments, which makes it necessary to discuss those requests on a case-by-case basis. Betterments are not eligible for federal funding, so agencies pay for betterments only if they come to an agreement with an individual utility company.
- Existing records research, survey of visible utility appurtenances, utility location services, and test holes are standard utility data collection techniques. Transit agencies routinely use traditional utility data collection techniques that have been around for decades. Transit agencies also rely on the One Call process to gather information about the location of utility facilities. However, feedback from respondents indicates that One Call is used primarily for damage prevention before construction, although some agencies reported the use of One Call design tickets.

The overall use of One Call for transit projects depends largely on how state law regulates its use (for example, whether it allows the use of design tickets).

- Transit agencies rarely collect quality level B (QLB) or quality level A (QLA) utility data in accordance with ASCE 38-02. Using utility location services to obtain information about underground utilities is common at transit agencies. However, these services normally do not follow the ASCE 38-02 standard for the collection and depiction of underground utility facilities, which is designed to increase the quality of utility data deliverables and reduce uncertainty and risk for the project owner. Transit agencies are not sufficiently familiar with ASCE 38-02 and rarely collect QLB or QLA data. Agencies that are familiar with this process frequently do not use it or limit its use to specific locations because of the cost involved. From some of the references in the literature review, it appears that one of the reasons transit agencies encounter problems such as delays and unplanned utility relocations is inadequate utility data quality, both in terms of positional accuracy and characterization of the existing utility infrastructure. Although agencies use test holes routinely, in some cases it appears that test holes are the main tool used to detect and characterize underground utilities, instead of being used as an integrated tool that complements the use of geophysical methods, as recommended in the ASCE 38-02 standard.
- Using three-dimensional (3D) technologies for project development and delivery is still uncommon. Some agencies are beginning to use 3D technologies during project development, primarily for public outreach during the environmental review phase. The use of 3D technologies for design applications is extremely rare. In one reported instance, an agency used 3D modeling to identify utility conflicts. Use of 3D technology is driven primarily by consultants who are familiar with the technology, not by project owners.
- Utility conflict matrices are useful for managing utility conflicts, but their use is inconsistent. Transit agencies reported on the use of utility conflict matrices, but their use varied dramatically among respondents. One of the agencies does not use them and instead relies on design drawings that include overlays of utility installations. Other agencies use utility conflict matrices widely, tracking hundreds of conflicts on a project using mostly spreadsheets. Most agencies that use utility conflict matrices consider this tool to be an effective tracking mechanism. They are particularly useful if they include a risk assessment component for the utility conflicts being tracked.
- Some utility conflicts require unique engineering solutions. Some transit agencies provided examples of how they approached the resolution of particularly challenging utility conflict situations. Although design standards provide a general framework, sometimes unique situations require unique engineering solutions. In some cases, the engineering solution includes accepting an exception to a policy or standard, which means accepting a certain amount of risk. It was unclear from the information provided whether agencies systematically conduct a formal risk assessment in these situations. In any case, implementing win-win engineering solutions for both transit agency and utility owner requires significant design and construction experience and a willingness by both parties to work collaboratively.
- Transit agencies apply risk assessment and risk management principles, but there is little information on specific risk assessment techniques for handling utility issues. Feedback from participants indicates that using risk assessment techniques is a standard practice at transit agencies. Agencies follow a variety of approaches to assess risk in connection with utility issues. Benefits of implementing risk management principles that agencies cited include tighter schedules and project costs that more closely resemble cost estimates developed during the design phase. FTA emphasizes evaluating "requirements risks" (i.e., risks from early planning to alternatives analysis). In addition, there is little information on specific techniques or examples about how to apply risk assessment techniques to manage utility issues. Developing and disseminating this information would be an important addition to the set of tools available to transit agencies. There is a wide range in cost-sharing agreements for utility relocations. Transit agencies frequently develop projects on corridors that cities, counties, and other jurisdictions own or operate. Utility owners have a wide range of property rights and agreements that enable the placement of utility installations on those corridors. In this environment, transit agencies have implemented a few strategies for facilitating utility coordination and utility relocations. Examples include executing master agreements with utility owners outlining each party's responsibilities and cost-sharing provisions, executing more detailed agreements for individual projects or work orders (which might include the master agreement by reference), and identifying which facilities or components to relocate in advance and by whom. Cost sharing is quite common. Depending on the situation, the split between transit agency and utility company could be 50/50 or 70/30, but it could also be that the agency pays 100% of the utility relocation costs. In some cases, the transit agency is not legally responsible for the entire utility relocation cost but agrees to pay in order to avoid project delays. Having to pay for a substantial percentage of the cost to relocate utility installations is one of the reasons a common strategy to resolve a utility conflict is to avoid the conflict and relocate a utility facility only if absolutely necessary. This means agencies tend to prioritize which types of utilities to relocate, such as, by avoiding infrastructure such as fiber-optic lines or duct banks as much as possible. Trying to avoid having to relocate gravity sewers is also common. Water and

gas lines are relatively easy to handle and frequently are the first relocations on which agencies decide.

- Compliance with Buy America provisions is a significant issue affecting transit agencies and utility companies. After Moving Ahead for Progress in the 21st Century Act (MAP-21) was enacted, FHWA and FTA began to inform state and local transportation agencies that Buy America requirements applied to utility relocation agreements. Historically, Buy America requirements applied to construction contracts but not to utility relocation agreements because the resulting payments to utilities were the equivalent of compensation payments to affected property owners. Some utility relocation costs are easy to deal with (e.g., miles of steel pipe), whereas other costs (e.g., steel used for complex communication cabinets) are much more difficult. A common problem is the expectation to meet Buy America provisions, even in cases where the utility owner pays for the utility relocation work. Another problem commonly cited by utilities in relation to the change in policy is that the purchasing environment at a typical utility is highly dynamic. Especially for complex component-based assemblies, utilities rely on a wide range of suppliers, and the supply chain in the international market fluctuates depending on factors such as price variations for individual components. Identifying which components are manufactured in the United States at any given point in time can be challenging.
- There is a need for guidance documents at transit agencies to help utility stakeholders during the project development and delivery process. There is a general lack of documentation at transit agencies outlining utility accommodation and relocation practices or manuals providing guidance to utility companies, consultants, and contractors. In some cases, the reason is infrequent involvement of utilities in capital projects or capital projects that have started requiring utility relocations only in recent years. In other cases, there is frequent interaction with utility owners, but there are not enough resources (or the need has not become acute) to develop useful guidelines. In some instances, manuals are considered controlled documents, are not available on the agency's website, or are available only through public information requests.

Based on the information gathered for this synthesis, the following research topics are suggested.

- Effective utility investigation protocols for transit projects: Transit agencies rely primarily on utility data collection techniques that have been around for decades. Agencies are not sufficiently familiar with the ASCE 38-02 standard, and it is used infrequently. Research could (1) ascertain the reasons for the infrequent use of ASCE 38-02; (2) develop a risk assessment tool to help agencies determine what kind of utility investigation tools to use under a wide range of circumstances at different points during project development and delivery; and (3) develop a utility investigation manual and training materials.
- Improved methodology to identify and manage utility conflicts: The synthesis found that the use of utility conflict matrices varies among transit agencies. Research could (1) determine the reason and motivation behind the infrequent use of utility conflict matrices at some transit agencies; (2) document the benefit that transit agencies could derive from using utility conflict matrices systematically; (3) adapt the utility conflict matrix approach that was developed as part of project SHRP 2 R15B; and (4) develop and integrate a quantitative risk assessment tool for utility conflicts.
- Templates and model master utility agreements: Although FTA provides general guidelines on how to develop master agreements with utilities, there is a need to assemble a document of most effective practices on how to develop and implement agreements with utility owners. Research could (1) compile a large sample of master utility agreements; (2) review the effectiveness of their use; and (3) develop templates and model master utility agreements that agencies could use in the future for new or existing agreements that are up for renewal.
- Framework and architecture for database of utility coordination and relocation costs in relation to total project costs: Statistics showing capital expenditures that are spent on utility relocations are not easily available. It is also not clear whether current statistics include data on local projects or utility relocations that use local funds. Having access to these statistics would facilitate a number of applications, including project planning and scoping, project cost monitoring, and risk management. Research could (1) determine to what extent FTA compiles and stores information about utility relocation costs; (2) determine whether any existing databases include information about utility relocations that use local funds; (3) develop a framework and data architecture for managing utility relocation costs; (4) develop a methodology to update utility relocation cost estimates at different points during design and construction; and (5) develop training materials for transit agencies, utility owners, and consultants.
- Effective practices for compliance with Buy America provisions: Recent Buy America provisions have been difficult for transit agencies and utility companies to implement. Although the regulatory process will evolve in response to requests or complaints from agencies around the country, agencies and utility companies are introducing substantial changes to their business practices. To assist transit agencies, utility owners, and federal regulators in this process, research could (1) document project-level impacts, program-level impacts, and economic benefits and costs associated with the implementation of Buy America provisions; (2) document case studies outlining effective practices; and (3) outline potential changes, if any, to the existing regulatory framework.

- Guidelines for utility relocation practices in transit projects: Transit agencies, utility owners, and other stakeholders do not have access to documentation that describes utility accommodation and relocation practices and procedures during transit projects. Research could (1) assemble and review current regulations and information that might be available from diverse sources, and (2) develop guidelines to help transit agencies, utility owners, and other stakeholders navigate regulations and requirements for transit projects.
- Utility coordination effective practices for different delivery methods: Utility coordination practices can vary significantly depending on the delivery method selected for a project, such as design-bid-build, design-build, or construction management general contracting. Most documentation available in the literature assumes a design-design-build delivery method. Research could (1) identify case studies, (2) document differences and effectiveness of various utility coordination procedures and practices, and (3) develop utility coordination effective practices and templates to tailor the needs of different project delivery methods, including funding mechanisms and cost controls.
- Feasibility of a strategic transit research program: SHRP 2 was conceived and executed as a targeted, results-oriented research program to address high-profile, strategic highway issues in the areas of safety, renewal, reliability, and capacity. Fundamental to this program was the identification of a strategic road map for each of these areas, which outlined critical research areas and integration points, developed research need statements, identified funding requirements, and produced a multiyear timeline for conducting the research. Research could (1) review past and current transit research efforts, and (2) determine the feasibility of a strategic transit research program that takes lessons learned from SHRP 2 and applies them to the identification and resolution of critical transit issues.

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APPENDIX A

Preselection Survey Instrument

MEMORANDUM

TO: Survey participants

FROM: Donna L. Vlasak, Senior Program Officer
Synthesis Studies

SUBJECT: TCRP Synthesis J-07/Topic SG-13, Successful Practices for Utility Coordination in Transit Projects

The American Public Transit Association (APTA), through its nonprofit educational and research organization, the Transit Development Corporation, Inc. (TDC), is cooperating in a research project to prepare a Synthesis of Current Practice on the topic noted earlier. This is part of the Transit Cooperative Research Program (TCRP), which is managed by the Transportation Research Board (TRB) in cooperation with the Federal Transit Administration (FTA) and the TDC. The Texas A&M Transportation Institute (TTI) is preparing this synthesis report under contract to TRB.

Transit projects frequently involve planning, designing, and building infrastructure that affects other modes of transportation and all kinds of utility facilities (both above and below ground) that exist along those corridors. Very little has been documented on the topic of utility issues or the use of successful practices to facilitate utility coordination in transit projects. To address this knowledge gap, Synthesis J-07, Topic SG-13, Successful Practices for Utility Coordination in Transit Projects, will report on utility coordination practices at transit agencies around the country.

The purpose of this survey is to gather basic information about current utility coordination practices at transit agencies, including successful experiences and best practices, challenges, and information gaps. Based on this information, a few transit agencies will be identified for follow-on telephone interviews. Please complete the survey no later than April 4, 2014. As needed, forward the survey invitation to officials who work on capital improvement programs, design, construction, and, in general, officials who deal with issues such as utility coordination and utility conflict analysis/management during project development and delivery.

Completing the survey, which should take less than 15 minutes, is voluntary. To ensure confidentiality, all records will be kept private and no respondent identifiers will be included in the report (Note: The report will only include aggregated information). If at any point you decide not to participate in the survey, simply close the browser.

Your input is critical to the research. Thank you in advance for participating.

Sincerely,

Cesar Quiroga, Ph.D., P.E.

Senior Research Engineer

Texas A&M Transportation Institute (TTI)

Phone: (210) 321-1229 E-mail: c-quiroga@tamu.edu

SURVEY FORM

First Name: ______________________________

Last Name: ______________________________

Title: ______________________________

Division, Section, or Office: ______________________________

Agency: ______________________________

Mailing address: ______________________________

Phone number: ______________________________

E-mail address: ______________________________

1. In what phase(s) of transit project development and delivery, operations, and/or maintenance are you involved? Check all that apply.

☐ Planning, feasibility studies, and programming

☐ Preliminary/conceptual design

☐ Environmental process

☐ Right-of-way acquisition

☐ Utility coordination and relocation

☐ Design

☐ Letting

☐ Construction

☐ Bus or paratransit operations or maintenance

☐ Light rail or streetcar operations or maintenance

☐ Metro rail operations or maintenance

☐ Commuter rail operations or maintenance

☐ Communications and other intelligent transportation system (ITS) operations or maintenance

☐ Other: ______________________________

2. What is the overall impact of these issues at your agency? Check all that apply.

1 = Least impact

5 = Most impact

Issue	1	2	3	4	5
Not identifying utility conflicts during:					
Planning, feasibility studies, and programming	O	O	O	O	O
Preliminary/conceptual design	O	O	O	O	O
Environmental process	O	O	O	O	O
Design	O	O	O	O	O
Letting and construction	O	O	O	O	O
Inadequate utility relocation cost estimates due to:					
Failure to identify and characterize utility conflicts	O	O	O	O	O
Not updating utility relocation estimates at regular intervals during the project development process	O	O	O	O	O
Inadequate identification of utility cost reimbursement eligibility	O	O	O	O	O
Changes to utility relocation plans due to late project design changes	O	O	O	O	O
Difficulty hiring and retaining staff with adequate utility coordination experience	O	O	O	O	O
Difficulty providing training opportunities in utility issues	O	O	O	O	O
Utility staff turnover	O	O	O	O	O
Difficulty getting utility owners to participate in discussions during:					
Planning, feasibility studies, and programming	O	O	O	O	O
Preliminary/conceptual design	O	O	O	O	O
Environmental process	O	O	O	O	O
Design	O	O	O	O	O
Letting and construction	O	O	O	O	O
Difficulty conducting utility coordination activities with:					

Municipality-owned utilities	○	○	○	○	○
Franchised utilities	○	○	○	○	○
Other utility operators	○	○	○	○	○
Difficulty identifying and resolving utility issues for:					
Design-bid-build projects	○	○	○	○	○
Design-build projects	○	○	○	○	○
Lump sum projects	○	○	○	○	○
Other project delivery methods	○	○	○	○	○
Other:					
If other, please specify (provide examples if possible):					

3. What utility data collection techniques and practices does your agency use in connection with transit projects? Check all that apply. Note: QLB and QLA are quality levels according to the ASCE 38-02 standard.

Utility Data Collection Technique/Practice	Always	Frequently	Rarely	Never
One Call system marks on the ground	○	○	○	○
Electromagnetic (EM) pipe and cable locators	○	○	○	○
Ground penetrating radar (GPR) locators	○	○	○	○
Electromagnetic induction (EMI) arrays	○	○	○	○
GPR arrays	○	○	○	○
Existing records	○	○	○	○
Survey of visible utility appurtenances	○	○	○	○
Test holes	○	○	○	○
Use of geophysical techniques and certified deliverables at QLB	○	○	○	○
Exposing existing underground facilities and certified deliverables at QLA	○	○	○	○

Other	○	○	○	○
If other, please specify:				

4. Traditional project development and delivery relies on 2D information such as plans, profiles, and cross sections. Please provide examples of projects or initiatives that have involved the use of 3D technologies, such as digital terrain models, surface models, 3D models or fully rendered 3D structures in Bentley GEOPAK/InRoads or AutoCAD Civil 3D, LIDAR point clouds, building information modeling (BIM), or 3D animation to support the transit project development and delivery process.

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___

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5. What strategies or innovative approaches has your agency implemented or plan to implement to improve or streamline utility coordination activities?

___

___

___

6. What kind of training and professional development does your agency offer to staff members on utility topics?

___

___

___

7. Do you have sample project data including utilities, which you could share with the research team?

○ Yes

○ No

8. Please provide names and hyperlinks (if possible) of relevant policies, manuals, specifications, and other documents that describe utility accommodation and coordination practices and requirements at your agency.

9. May we contact you to further discuss your agency's utility coordination practices?

○ Yes

○ No

○ No, but you may contact the following:

[Submit Survey Button]

Submission Acknowledgment

Your responses have been submitted. Thank you for your participation! For questions or suggestions please contact Cesar Quiroga at (210) 321-1229 or c-quiroga@tamu.edu.

APPENDIX B

Interview Guide for Case Examples

Based on the results of the preselection survey, the TTI team will identify 10 agencies for detailed follow-on telephone interviews to provide case examples. The protocol for conducting the telephone interviews will be as follows:

- Contact a designated representative at each of the agencies selected.
- Discuss the purpose of the telephone interview.
- Schedule the telephone interview at an agreed upon date and time.
- Provide an advance copy of the interview guide to the agency representative.
- Conduct the telephone interview. The interview will focus on the following topics, in addition to an expanded discussion of the preselection survey responses:
  - Phases of transit project development and delivery:
    - △ How different stakeholders interact with the agency during with the development of a transit project.
    - △ At what point transit agencies engage utilities.
    - △ Differences in coordination practices and impact on project delivery between city-owned utilities, franchised utilities, and other entities.
  - Data collection processes
    - △ Responsible party for acquiring utility data.
    - △ Protocols and procedures.
    - △ Historical record or databases for utility inventories.
    - △ Best practices.
    - △ Challenges.
  - Identification and resolution of utility conflicts
    - △ Differences in practices between types of utilities.
    - △ Differences in defining whether/when utility relocations are required.
    - △ Cost apportionment differences.
    - △ Buy America provisions.
    - △ Right-of-way allocation.
    - △ Impact of missing or inaccurate information about utilities.
    - △ Utility conflict resolution strategies.
  - Utility ownership and operation (public or private) and interagency coordination
    - △ Differences between city-owned utilities, franchised utilities, and other entities.
  - Staff professional capacity
    - △ Differences between agencies that have an ongoing capital program and agencies that do not.
    - △ Availability of training programs.
  - Contractual practices
    - △ Management of utility issues according to the project delivery method.

APPENDIX C

List of Case Examples

Ten transit agencies were selected based on the results of the preselection survey and were invited to participate in phone interviews. Of these, eight agencies responded and detailed phone interviews took place with eight of them, for a return rate of 80%. The eight transit agencies case examples follow:

- California: Sacramento Regional Transit District.
- California: San Joaquin Regional Transit District.
- North Carolina: Charlotte Area Transit System.
- Ohio: Greater Cleveland Regional Transit Authority.
- Oregon: TriMet, Portland, Oregon.
- Pennsylvania: Port Authority of Allegheny County.
- Utah: Utah Transit Authority.
- Washington State: Sound Transit, Seattle.

Abbreviations used without definitions in TRB publications:

A4A	Airlines for America
AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HMCRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
MAP-21	Moving Ahead for Progress in the 21st Century Act (2012)
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation