University of Kentucky College of Engineering

Kentucky Transportation Center

Research Report
KTC -14-15/SPR-460-13-1F

Methods to Expedite and Streamline Utility Relocations for Road Projects

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Methods to Expedite and Streamline Utility Relocations for Road Projects

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Executive Summary

This report describes best practices and tools to streamline and expedite utility relocations when they are required as part of road construction projects. As part of this effort, a research team from the Kentucky Transportation Center (KTC) conducted extensive qualitative research that involved mapping current practices at the Kentucky Transportation Cabinet (KYTC) and reviewing utility manuals from KYTC and other state transportation agencies. The KTC research team also conducted in-depth interviews with KYTC engineers and staff as well as representatives from utility companies (UCs). Based on the data from these investigations, KTC developed a number of recommendations to improve interactions between KYTC and UCs. A number of the proposed improvements relate to training and coordination. For instance, fostering better coordination between KYTC and UCs early in the design process can prevent unexpected delays from hampering the construction process, cut down on the impacts to utilities, and allow for the exploration of alternative design options to identify those that will minimize expense while optimizing efficiencies and shortening project duration. Preconstruction meetings facilitate improved communication between KYTC and UCs, and set the stage for holding follow-up meetings throughout the construction process. All of these suggestions will forge better communication and therefore lead to stronger coordination between the Cabinet and UCs. The research team organized the suggested practices according to use and benefit while also itemizing some of the drawbacks associated with using those respective practices. The guidance provided in this report will provide KYTC utility staff with the knowledge of best practices, while also informing them on the circumstances under which each should be implemented. To accompany the summary of best practices, KTC researchers developed a method of risk assessment to determine the level of difficulty a project may expect when utility relocations are necessary. This model, which uses multiple linear regression, has robust predictive utility (R^2 = 0.84), and will offer KYTC staff insights into what best practices are most compatible with the level of risk faced. This study presents several valuable tools along with organized best practices and guidance for STAs' utility coordinators. When used pragmatically, these methods will assist in STAs and UCs in identifying problematic projects early in their life to resolve any issues.

Background & Scope of Work

Introduction

Utilities located within and near road right-of-ways present challenges to state transportation agencies (STA's) in terms of coordinating the reconfiguration of those facilities to accommodate highway system improvements. Construction and maintenance operations that improve transportation infrastructure in turn affect, and require, relocation or protection of utility infrastructure that share space with transportation facilities. Utility work associated with highway projects presents many challenges to the Kentucky Transportation Cabinet (KYTC). In most cases, KYTC cannot directly manage utility relocations because the utility owner and/or operator directly supervise the process. Utility owners and operators maintain direct oversight because a wide range of complexities can emerge during the relocation; dealing with these complexities can pose challenges for even the most experienced utility planner. While utility relocations are controlled by permit, contractual, and legislative regulations, there are tools and procedures available that, when strategically employed, can assist the relocation process. This project identified the best practices KYTC can adopt to streamline and implement utility relocations.

Problem Statement

All sectors of the construction industry have become increasingly litigious. Under the duress of possible legal action, organizations involved in these industries now meticulously document, track, and contract all of their activities. Coupled with shortages in skilled labor and increased labor costs, the relocation of utilities along infrastructure corridors is one process that has been significantly impacted by the growing demand to preserve meticulous documentation. In addition, some utility relocations have become more complex and require sophisticated operations, such as moving fiber optic or high-pressure lines to new areas. Recent upticks in KYTC project lettings have also produced negative consequences. Whereas in previous years KYTC would see peaks and lulls in project delivery, lettings have recently plateaued and stayed relatively consistent; although this is a positive, it has some detrimental outcomes, such as utility companies being unprepared to address the stream of relocation requests. All these issues lead to the fundamental problem statement for this research effort – how can utility relocations be streamlined and expedited?

This project identified and developed best practices and processes to improve the efficiency of utility relocations. In doing so, KTC sought to pinpoint strategies that will mitigate the negative impact of utility relocations that occur during KYTC projects. Potential ways to improve the process include:

1) Early design involvement
2) Fiscal incentives/disincentives for expedient relocation
3) Incorporation of utility corridors
4) Increased utilization of Subsurface Utility Engineering to promote utility avoidance
5) The use of utility relocation management software
6) Offering utility relocation design and construction services via statewide contracts
7) Establishing term utility agreements
8) Clearing right-of-way prior to utility relocations
9) Providing a loan program to help finance utility relocations
10) Forming utility coordination councils
11) Exploring the four C's (communication, cooperation, collaboration, coordination)

12) Adopting trenchless technologies to expedite utility relocations
13) Use of advanced sensing technologies to improve the accuracy of locating existing utility lines
14) Development of utility conflict matrices
15) Use of Civil Information Models for improved visualization of utility conflicts in 3D CAD models

While exploring these strategies and practices, KYTC also established a workforce to investigate ways to improve utility relocations. This workforce offered the Cabinet a variety of solutions. For example, early involvement – by KYTC – in design or simply beginning the utility relocation process earlier helps streamline and accelerate utility relocations.

During the design process, KYTC aims to inform project teams of potential utility conflicts, but often, minimal data are available at this stage. While efforts are made to avoid utility relocations, they often become a necessity. The time and labor spent identifying possible conflicts can significantly impact KYTC and should be analyzed to determine areas in which the process can be improved. Once ordered, utility relocations occur in an orderly and fiscally responsible manner. Utility relocations can be completed through the road contract execution but are most often executed directly by the utility owner/operator. With another agency performing the relocation work, the schedule of the relocation is beyond KYTC's control. Because KYTC recognizes the rights of the owner/operators, they must engage in strategies that will support the more collaborative and expedient relocation of utilities. Foremost, KYTC needs better methods to estimate the time and risks associated with relocations.

Study Objectives

The purpose of this study was to propose process changes or present best practices for streamlining and expediting utility relocations for KYTC projects. The principal objectives of this project are to:

1) Describe and map the current Cabinet processes for identifying, planning, and executing needed utility relocations in support of KYTC highway projects
2) Identify successful utility relocation management practices and processes used by other state transportation agencies and construction owners
3) Design modifications to the current Cabinet processes for identifying, planning, and executing utility relocations to enhance their efficiency
4) Prepare implementation guidance throughout to assist the Cabinet in adopting the new process and any associated technologies.

Research Tasks

The following series of tasks will help to accomplish the proposed research. Listed below are the tasks pursued during this project, in chronological order. These tasks align with study objectives above.

Task 1: Review of current Cabinet Processes for Planning and Executing Utility Relocations

The first task of the research involves collecting information and reviewing current processes from KYTC that pertain to utility relocation. This task aligns with the first two objectives of the study. A task force (internal to KYTC) on utility relocation concurrently revised the utility relocation process during the course of this project, which slightly complicated this task. Beneficially, a researcher of this study participated on that workforce, meaning this activity to align with KYTC's effort. In addition to participating in and collecting information from this taskforce, this task entails the following reviews:

- Review of the current Cabinet processes for identifying, planning, and executing utility relocations
- Review of utility relocation related Cabinet processes that involve the development of projects
- Review of legal and contractual regulations involved in the process of utility relocation.

Task 2: Review Utility Relocation Practices of Other Agencies

The research team reviewed other agencies to identify best practices or procedures that, if adopted by KYTC, would potentially improve the process of relocating utilities. This effort identified agencies with successful utility relocation management practices (state transportation agencies and others) and then scrutinized their practices. Attending a KYTC event hosting a consortium of state transportation agency utility coordinators also benefitted this task.

Task 3: Interview Stakeholders and Identify Successful Practices

Following these reviews, the project team interviewed and surveyed Cabinet employees, consultants, and utility owner/operators to acquire information and practices concerning a spectrum of utility relocation types. Analyzing these interviews and surveys generated stakeholder feedback on current practices and uncovered best practices for future adoption. Additionally, these lines of communication provided opinions and varying viewpoints about several of these practices. When viewpoints conflicted, the research team investigated further and discussed areas in which perceived best practices are not always ideal.

Interim Report

The interim report compiled the results of task one through three along with identified areas of concern. The KYTC study advisory committee reviewed the report and findings during an interim project presentation that achieved study objectives one and two.

Task 4: Develop New and Recommend Revisions to Current Cabinet Processes for Improved Utility Relocations

Best practices and processes were gathered and used to develop new protocols for improving utility relocation practices at KYTC. Organizing the previous findings into methods that would be acceptable and implementable for the Cabinet began during this task. Our main effort focused on how the collected information was organized; we sought to assemble it in such a way that it offered usable guidance. The flowcharts that are contained in the following report illustrate those recommended for KYTC; we also include illustrations of workflows used by KYTC before its task force commenced work. A technical memo presented this information in a way that could guide implementation. This memo was provided to the study advisory committee, and addresses Objective 3.

Task 5: Develop and identify resources to support implementation of the research findings

The final task involved the development of a tool to support the implementation of the best practices and procedures identified during the study. The purpose of this tool is to assist users in understanding the complexity and risk involved in utility relocation. In turn, it provides guidance to identify strategies that are appropriate to resolve particular situations. This risk assignment tool, along with the tools and resources already developed, served as the product of this research and addressed Objective 4.

Task 6: Prepare final report

The final step of this research was to prepare this report and present project materials and key findings. The remainder of this report summarizes the project findings and presents all the developed tools and guidance for expediting and streamlining utility relocation efforts at KYTC.

Policy and Literature Review

To accomplish the study's tasks, researchers conducted a comprehensive search of all published information – including print- and web-based sources – on institutional processes that contribute to utility-related delays at different levels and stages of planning, design, and construction. The research team began with a detailed review of KYTC processes currently used to plan and execute utility relocations. Researchers then gathered data on successful utility relocation management practices used by other agencies. Lastly, the research team used interviews with stakeholders at KYTC and utility companies (UC's) to validate these practices. The literature review provided the necessary background and ensured that researchers were well acquainted with the most innovative techniques, as well as prospective opportunities, for expediting and streamlining utility relocations.

The literature review looked at materials obtained from all areas of government, including AASHTO; FHWA, CFR, KRS, KAR, STA's or KYTC manuals; project reports; conference proceedings; periodicals; brochures; and resources such as UCs' annual reports and the International Right of Way Association (IRWA). Information was collected from the following sources:

- Federal regulations from FHWA, CFR
- Presentations at AASHTO utility and ROW meetings
- Kentucky utility relocation policies based on KRS, KAR
- STA (KYTC) manuals, guides, handbooks
- Transportation Research Board (TRB) databases
- Research programs from NCHRP
- Research engaged and resources developed by state transportation agencies and other partnering agencies
- Utility accommodation policies and coordination guidance from STA's
- STA conferences, white papers, and presentations on utility relocation issues
- Technical plans/reports from STA engineers/utility companies
- Industry journals/periodicals

The review of these sources concentrated on utility conflicts and problems that STA's and UC's deemed as institutional barriers impeding utility relocation. Factors influencing delays will be summarized in the next phase. Researchers also focused on the conflict resolution methods to alleviate disputes that arise between STA's and UC's. Avoiding conflict mitigates utility delays. In addition, potential improvement opportunities were another area researchers focused on. These included: early design involvement, fiscal incentives/disincentives for expedient relocation, incorporation of utility corridors, increased utilization of Subsurface Utility Engineering to promote utility avoidance, utility relocation management software, offering utility relocation design and construction services via statewide contracts, term utility agreements, clearing right-of-way prior to utility relocations, providing a loan program to help finance utility relocations, utility coordination councils, exploring the four C's (communication, cooperation, collaboration, coordination), trenchless technologies to expedite utility relocations, use of advanced sensing technologies to improve the accuracy of locating existing utility lines, utility conflict matrices, and the use of Civil Information Models for improved visualization of utility conflicts in 3D CAD models.

The research team reviewed 30 STA/KYTC utility manuals, which address the following issues (See Tables 1, 2, and 3):

- Utility relocation reimbursement policies
- Procedures for utilities to obtain ROW
- STA coordination processes
- Utility obligations when relocation is necessary

To grasp the nuances of the utility relocation policies, researchers selected 11 representative STA's to compare what differences and similarities emerge on issues such as reimbursement, ROW acquisition, and the coordination process respectively. The ten STA's include:

- Arizona DOT
- California DOT (Caltrans)
- Colorado DOT
- Florida DOT
- Indiana DOT
- Kentucky KYTC
- Michigan DOT
- New York State DOT
- Pennsylvania DOT
- Texas DOT
- Virginia DOT

Legal Regulations Governing Issues in the Utility Relocation Process

The literature review indicated that the most problematic areas related to utility relocations typically involve reimbursing utility companies for relocations, the acquisition of right-of-way, or communication and coordination with utilities. The following review discusses each problem in turn.

Reimbursement

Reimbursement is a significant issue among state accommodation policies. Most states provide general guidance for reimbursement and stipulate the procedures used to compensate Utility Companies (UCs) under varying conditions of relocation and according to the type of UC involved. Some states only provide basic unit cost reimbursement for all utility relocations. Most states treat reimbursement as a legal issue rather than a coordination issue; however, a few states use reimbursement to incentivize relocation.

Federal laws

According to § 645.103 (a), utility regulations contained in 23 CFR 645A apply to the payment of costs incurred under all FHWA/utility agreements. §645.117 (cost development and reimbursement) contains details about the federal policy on reimbursement for utility relocation programs.

The FHWA's reimbursement to the STA is managed by state law or provisions from federal regulations. When the state law or regulation differs from the federal regulations, the STA can make a final decision on which standards are the most reasonable and practical if utility relocation is needed. Some important federal guidelines for reimbursement are listed below:

- §645.117 FHWA: "When the utility is a self-insurer, there may be reimbursement at experience rates properly developed from actual costs. The rates cannot exceed the rates of a regular insurance company for the class of employment covered", and "Costs not eligible for Federal reimbursement include, but are not limited to, the costs associated with advertising, sales promotion, interest on borrowings, the issuance of stock, bad debts, uncollectible accounts receivable, contributions, donations, entertainment, fines, penalties, lobbying, and research programs."
- 23 CFR 645.107(a) (2): "For utility relocation expenses to be eligible for federal participation, the state transportation agency must certify to FHWA that payment is made pursuant to a state law authorizing such payment."
- 49 CFR 24.306: "State law and federal regulation require the Utility and State to reach prior agreement on the nature of the utility relocation work to be accomplished, the eligibility of the work for reimbursement, the responsibilities for financing and accomplishing the work, and the method of accumulating costs and making payment."

State Laws

Federal law requires that STA's have an approved program and procedures for utility relocation and accommodation to be eligible for federal funding reimbursement. In Kentucky, when a federally approved program is absent, the local public agencies must follow the KYTC utility relocation/reimbursement procedures.

Kentucky Revised Statutes (KRS) 177.035 and 179.265 contain the most salient laws on reimbursement, while the KYTC Utilities and Rails Manual includes regulatory guidance. In the Utility Manual, KYTC outlines the circumstances under which compensation is allowable. KYTC is legally able to compensate utility companies under these circumstances (sourced from KYTC Utilities and Rails Manual):

- "According to KRS 177.035, the KYTC may compensate certain utility companies for relocating their facilities as needed to complete a road project. This includes relocations of facilities owned by publicly held companies and, in certain instances, privately held utility facilities. A publicly held utility may be a municipally owned utility, water district, water association, sewer district, or local school district.
- KRS 179.265 authorizes the KYTC to compensate a utility company if a road project requires the relocation of a privately held utility facility located on private easements.
- For compensation of qualifying relocations, the damaged utility company must enter into an agreement with the KYTC. Relocations may be performed as a part of the road construction contract or prior to the road project. If the relocation work is completed before the road project, it may be done with utility company personnel, a continuing contract approved by the KYTC, or the utility company may elect to bid and award its own contract for the relocation."

KYTC shall not reimburse a utility company for relocation work involving the following circumstances (sourced from KYTC Utilities and Rails Manual):

- Non-reimbursable facilities pursuant to KRS 416.140 or KRS 179.265
- Work completed prior to funding authorization
- Betterments or improvements to utility facilities
- Expenditures improperly documented
- Work undefined in the approved relocation plans and estimate
- Work not required by the designated road project
- Utility work or costly changes to an approved design for the benefit or convenience of the utility company or its contractor
- New facilities

The following documents are needed for utility reimbursement:

- Utility Agreement
  a) Conflict Letter
  b) Reimbursement Information Form
  c) Federal funding approval
  d) Reimbursement Package
  e) Authorization Letter(s)
- Reimbursement Certification
  f) Accompanying property rights documents from Utility

Right-of-Way

Right-of-way (ROW) acquisition is a complex, time-consuming and socially-sensitive process that is an integral component of the overall planning and implementation of transportation projects. The purpose of the ROW acquisition process is to obtain the title to the required ROW. Generally, the acquisition of ROW takes place before the construction phases of road projects, so the ROW division faces continuous pressure to obtain land and deliver properties as soon as possible. In other words, the acquisitions of ROW are usually in the critical path of the utility relocation process and have a significant impact on the whole schedule, cost and efficiency of labor. The ROW acquisition process begins with preparatory tasks, including the collection of preliminary ROW and required utility data, the development of project plans, and the review of deeds. After this, the ROW authorization is released and local offices are allowed to secure the required properties. Once the desired property has been valued, the agency presents an initial offer to the property owner, which begins negotiations. Normally, agency ROW officials are most concerned with the valuation of the parcel and the negotiation with property owners during the ROW acquisition process. Below is a brief description about these two processes: valuation & negotiation.

Valuation involves appraising a parcel to guarantee that the owner is compensated fairly by an agency's offer; this process begins in the district office after it receives the official ROW letter of release from the ROW division. Developing an appraisal constitutes the main work of the valuation process. The objective of the appraisal process is for valuation of the land needed for construction of a highway project but land needs for associated utility relocations must also be included. After providing an initial appraisal, the next step is to deal with the payment issues arising between the owners and agencies. This process must delicately balance the process of obtaining the property needed to complete a project while also making justifiable payments for the property. If the owner accepts the compensation, acquisition and owner relocation take place. Otherwise, the phase shifts to condemnation proceedings.

Federal laws

The federal laws that speak to ROW acquisition are Public Law 91-646 and The Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (also called The Uniform Act). The Uniform Act protects property owners whose property and/or improvements are acquired, or who are displaced because of ROW acquisition by federal or federally assisted state projects (FHWA, 2006). Title III of The Uniform Act, the "Uniform Real Property Acquisition Policy," describes the regulations governing the acquisition of real property for federal and/or federally assisted road projects. Title III obligates agencies to attempt to obtain real property via negotiations, and to alleviate or eliminate conflicts among the stakeholders.

Part 24 of the Code of Federal Regulations (CFR), the Uniform Act, directly addresses ROW acquisition on federal and federally assisted projects. According to the Real Estate Guide for LPAs (TxDOT, 2004), the CFR is "a codification of the general and permanent rules published in the Federal Register by the Executive department and agencies of the Federal Government."

After the preliminary paperwork for ROW acquisition has been completed, the appraisal phase occurs. The Uniform Act requires that federal agencies determine the level of payment to compensate owners. The Uniform Act also requires that property be appraised before the negotiations to acquire it begin, and that the amount decided prior to negotiations should inform what qualifies as just compensation.

Further, the Uniform Act encourages agencies to attempt to obtain property by negotiation rather than by invoking their condemnation authority. Qualified and trained staff should be selected from agencies to conduct the negotiations pursuant to procedures stipulated by the Act. The detailed requirements for ROW negotiation mandated by The Uniform Act are quoted below:

"Prior to the beginning of negotiation, present a written offer of the approved estimate believed to be just compensation for the real property; Contact the property owner in order to explain the acquisition process, basis for establishing just compensation, etc.; Give the owner a chance to consider whether to accept or reject the offer of just compensation; Have the appraisal updated if new appraisal information is needed or a significant delay occurs; and Negotiate without any coercive actions in order to reach an agreement (42 USC 4601, 1970)."

State Laws

In January 2007, KYTC published the "Right of Way Guidance Manual" which fully describes the process for ROW acquisition. According to this manual, the ROW acquisition process includes five phases:

- **Project development** (also known as planning). Planning is the first step and mainly involves environmental valuation, establishing design standards, and encouraging public involvement. Under the supervision of the Division of Highway Design, right-of-way plans are prepared in accordance with current right-of-way design standards and criteria (Right of Way Guidance Manual, ROW-305).
- **Appraisals.** Appraisal standards are the same throughout the state. A staff or fee appraiser is to appraise all property to be acquired with the exception of those properties acquired using the format of waiver valuation. Owners are to receive an offer that reflects the current fair market value of the taking at the date of take, without the influence of any outside factors. To ensure KYTC meets these objectives, a review appraiser is to examine all appraisals and recommend just compensation prior to initiation of negotiations. (Right of Way Guidance Manual, ROW-601).
- **Negotiations.** Negotiations for rights of way are to be conducted by a staff or contract buyer as soon as possible after the approval of just compensation. The staff or contract buyer should be thoroughly familiar with the acquisition, fully prepared for the negotiation by having studied the plans and approved appraisal, and knowledgeable of current policies and procedures. (Right of Way Guidance Manual, ROW-801).
- **Property Management.** This step mainly involves the clearing of ROW. The activities in this phase can be time-consuming and may lead to significant schedule delays. The Division of Right of Way and Utilities shall manage all acquired rights of way and, to the extent practical, remove all improvements from the right-of-way limits prior to releasing the parcels to the roadway contractor (Right of Way Guidance Manual, ROW-1202).
- **Relocation.** According to the Real Estate Acquisition Guide (FHWA, 2006), the relocation process is divided into four parts. The first is relocation planning, which deals with analyzing the location, size, and timetable of the displaced residents. Second, in accordance with The Uniform Act, agencies must provide relocated residents with a general information notice, inform them of their eligibility for relocation, and give them a 90-day notice. The third part of the relocation

process involves providing residents with an advisory service that communicates pertinent information, and offers counseling and advice. Finally, payments must be made to the affected residents.

Communication & Coordination

Poor communication and coordination between the parties involved in utility relocation is a frequent problem. STA's and UC's acknowledge that insufficient communication, scheduling, and coordination in planning, ROW acquisition, and construction phases can negatively impact utility relocation projects. These difficulties, in turn, lead to scheduling delays and hassle the traveling public. In 1998, an FHWA survey determined that the most significant problem related to utility relocation was lack of cooperation, coordination, and communication among stakeholders. A report prepared by the U.S. General Accounting Office concluded that States with good cooperation, coordination, and communication between STA's and UC's had fewer utility-related problems.

Federal guidance on coordination specifies that all invested parties should make an effort to improve their coordination and seize opportunities to bolster communication between the parties involved in utility relocation. There is, however, no compulsory law on coordination or the communication process and/or requirements. Most states assign a coordinator to deal with the issues that emerge during the utility relocation process, and clearly delegate responsibilities amongst stakeholders. Normally, the coordination process is broken into two phases: preliminary coordination, which takes place before project implementation, and coordination, which occurs during construction.

Preliminary coordination: When utility relocation is needed, STA-based engineers begin the relocation design effort. To involve the utility companies as early as possible, design plans are distributed to them so they can pinpoint conflicts with the onsite utilities. Plans are circulated when the design phase is approximately 30 percent complete, in most cases. STA engineers will begin contacting utilities at this time; but the time needed to work through this process, as well as its format, may vary substantially. Generally, the responsible agency sends a preliminary coordination letter to all potentially affected utility parties after the environmental documentation has been completed, or earlier if it is possible to do so. Once the design phases has been 60 percent completed, the STA typically provides the UCs with the preliminary drawings and request the UCs to make design changes that will accommodate required relocations. In many cases, the STA engineers and UC representatives never meet with each other, with most of the communication taking place via mail or email. But some STAs prefer to speak with UCs face-to-face at design milestone meetings. The objective of preliminary coordination is to solve a transportation need in a way that minimizes potential conflicts.

Coordination in construction phase: On large projects or projects with complex impacts on utilities, STA engineers offer UCs an anticipated construction schedule. Once this has been circulated on projects with significant utility issues a preconstruction meeting will take place. If utilities are involved, the UC representatives are also invited to participate in progress meetings. Under such scenarios, coordination is frequently needed – usually daily communication is required. In other situations, a consultant will be employed by the STA to coordinate UCs activities during the construction phase. Coordination seeks to alleviate the following complications: UC compliance with relocation schedules, schedule changes due to the contractor, and validity of resolutions to previously unknown conflicts.

States Regulation and Policies on Utility Relocation Issues

Given that state policies have a significant impact on utility relocation, the research team determined to examine and then synthesize different policies used by various states. This information is summarized in Table 1, which focuses on reimbursement policies, Table 2, which relates to ROW policies, and Table 3, which highlights coordination policies.

Table 1 State Utility Relocation Reimbursement Policies

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

(* Δ denotes updated data from the SHRP2 S2-R1-RW report)

Table 2 State Utility ROW Policies

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

(* Δ denotes updated data from the SHRP2 S2-R1-RW report)

Table 3 STA Coordination Processes

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

Review of Other Agencies Practices and Procedures

After reviewing federal and state regulations and mapping out KYTC's process for coordinating utility relocations, the research team identified practices that the Cabinet could adopt to streamline is process. This section summarizes the best practices currently employed by other STAs. It then discusses which of these practices cause the most significant delays during utility relocation.

Best Practices for Utility Relocation from Other Agencies

The research team drew from several sources to compile a list of best practices. The practices listed in Table 4 are those used for successful utility relocation. Table 5 synthesizes the best practices for ROW acquisition. Lastly, Table 6 catalogs guidelines and practices recommended by AASHTO to improve utility relocations.

Table 4 Successful Practices for Utility Relocation

No.	Successful Utility Relocation Practices	Sources	KYTC Adopted
1	Train project managers and other design team personnel on utility issues. Training may be more comprehensive for project manager.	PennDOT, GDOT	
2	Train consultants and utility owner personnel in utility coordination processes and issues. Turnover in the work force may place inexperienced personnel in utility decision-making positions without the proper knowledge.	PennDOT	
3	Consider paying utility relocation design costs regardless of prior rights to maintain coordination between available space and project timing.	VDOT	
4	Consider task-order contracts with expert consultants versed in utility and highway design as an additional resource for design alternative suggestions.	VDOT	
5	Develop an early utility cost estimate based on worst-case assumptions and continually revise it as design progresses.	VDOT, SHRP 2 R-15	
6	Use technology tools such as Google Earth, roadway video logging, and GIS systems to get early visualization of utilities in the planning stages of projects.	PennDOT	●
7	Place a utility expert on the project design team as early as possible and keep them involved and informed as design develops.	GDOT, PennDOT, VDOT	●
8	Develop a standardized format for identifying and resolving utility conflicts and continually revise it as design progresses.	GDOT	
9	Develop a mechanism to capture any changes to the existing utility facilities performed by utility owners or contractors on the project as design develops. Update the utility mapping on the design plans as the utility data changes.	SHRP 2 R-01	●
10	Develop or utilize a GIS system to store, manage, and recall utility information gathered during plan development and during utility relocations and new installations during construction.	SHRP 2 R-01	
11	Install or require utilities to install radio frequency identification markers on nonmetallic utilities during utility relocations or new installations.	SHRP 2 R-01	
12	Develop a catalogue or database of historical utility relocation costs to generate the best possible cost estimate. Update this database on a regular basis, but do not exceed annually.	AASHTO Scan, VDOT	
13	Develop visualization aids for utility pole and structure relocation costs.	AASHTO Scan	
14	Develop catalogues and visualization techniques to assist designers in alternate design possibilities.	AASHTO Scan	
15	Develop a rigorous pre-qualification for SUE consultants that address their technical qualifications.	SHRP 2 R-01,	●

		PennDOT, GDOT, VDOT	
16	Develop a screening tool to assist and formalize the process of selecting the appropriate Utility Quality Levels for utility mapping. This might be an iterated process that is re-evaluated as additional detail is added to the design plans.	PennDOT	
17	Build on cost–benefit studies already performed to evaluate the cost-effectiveness of SUE.	SHRP 2 R-01, SHRP 2 R-15, PennDOT	
18	On projects where it is known in advance that utilities are a significant time or cost factor, get QLB (Quality Level-B) mapping as early as possible, preferably at time of topo development. Consider the underground utilities as an underground topo feature.	VDOT	
19	Have frequent joint meetings with utility owners as design progresses to get their input on relocation issues and to make certain they coordinate their relocation designs with the available space.	AASHTO Best Practices Guide, SHRP 2 R-15	●
20	Provide training in highway plan reading to utility owners.	VDOT, GDOT	
21	Ensure that no guidance documents conflict with each other and that they use the same standard terminology as it relates to utilities.	PennDOT	
22	Use or consider establishing utility corridors for utilities crossing major highways or located longitudinally along highway ROWs.	AASHTO Scan	
23	Acquire sufficient ROW for utility purposes.	VDOT	●
24	Advance relocation of utility work before highway construction begins.	TNDOT, NCDOT, SHRP 2 R-15	●
25	Each project is supposed to be handled by a utility coordinator from start to finish. Operational planning meetings will discuss any issues that may be related to the construction.	WIDOT	
26	DOTs share annual bills and monthly schedules with UCs, so that UCs can plan and budget accordingly.	DEDOT	
27	DOTs provide incentive to UCs for early utility relocation and permit the opportunity to reimburse a utility for the cost of relocating its facility early.	TNDOT	
28	Utility impact matrix is used to list all utility conflicts and a SUE consultant is needed to provide the corresponding recommendations.	SHRP 2 R-15	
29	Work site utility coordination supervisor is needed to coordinate utilities during the construction phase on every project that uses SUE.	SHRP 2 R-15	

(*●denotes the practices that KYTC has adopted)

Table 5 Successful Guidelines and Practices for ROW acquisition

No.	Guidelines	Successful Practices for ROW acquisition	Sources	KYTC Adopted
1	Regularly train, monitor, evaluate the expertise of right-of-way staff, fee appraisers, and review appraisers.	Offer opportunities for right-of-way staff, fee appraisers, and review appraisers to attend training courses in order to ensure their up-to-date understanding of laws and procedures relating to right-of-way valuations.	(FHWA, 2002; AASHTO, 2003; NCHRP, 2000	
2		Recommend that right-of-way staff, fee appraisers, and review appraisers take refresher courses periodically or develop an ongoing in-house employee development program.	Adkins and Buffington, 1967	
3		Monitor the time required to deliver appraisal reports.	TxDOT Project 0-5379 report	
4		Assign projects according to the appraiser's experience.	TxDOT Project 0-5379 report	
5		Evaluate appraisers periodically on their performance.	TxDOT Project 0-5379 report	
6		When outsourcing, remember that TxDOT is public service driven rather than profit driven; public satisfaction and good rapport with property owners are of paramount importance to TxDOT.	TxDOT Project 0-5379 report	
7		Offer opportunities for district office staff members to meet to exchange ideas and share preferred methods for the valuation process.	TxDOT Project 0-5379 report	
8		No appraiser or review appraiser shall have any interest, direct or indirect, in the real property being appraised for the Department that would in any way conflict with the preparation or review of the appraisal	AkDOT, 2001	
9	Involve and contact the property owner personally early in the acquisition process.	Encourage right-of-way staff and fee appraisers to meet property owners in person.	TxDOT Project 0-5379 report	
10		Invite the property owner (or the owner's designated representative) to accompany the appraiser during the inspection of the property.	AkDOT, 2001; TxDOT, 2006A; ILDOT, 2004	
11		Explain the offer to purchase the property to the property owner including the appraisal basis for the offer and the agency's real property acquisition policies and procedures	TxDOT, 2005	
12		Advise the property owner of the appropriate personnel to contact on specific technical or engineering information.	TxDOT, 2000	
13		Review records concerning a parcel before approaching the landowner. These records include tax records, zoning, flood maps, topographic maps, and previous deeds to the property.	TxDOT Project 0-5379 report	
14		Require appraisers to provide proof that the property owner was afforded the opportunity to accompany him or her on the inspection, and also to provide proof that an inspection was done.	TxDOT Project 0-5379 report	
15	Streamline the valuation process to maximize	Prioritize parcels according to complexity/appraisal difficulty, and conduct appraisals for those that are most complex first.	TxDOT Project 0-5379 report	

16	production time, cost, and efficiency benefits**.**	Provide the appraisers with pre-appraisal information.	TxDOT Project 0-5379 report	
17		Obtain and store electronic copies of appraisal reports.	TxDOT Project 0-5379 report	
18		Reduce the time lapse between the appraisal valuation date and the initiation of negotiations.	Minnesota DOT, 2003	
19		Utilize most appropriate technology to expedite appraisal production.	FHWA, 2002; AASHTO, 2003	
20	Simplify value determinations, reporting protocols, and review procedures.	Streamline appraisal review procedures.	FHWA, 2002; AASHTO, 2003	
21		When property values increase or decrease because of proposed public improvement, such changed values must be disregarded when estimating the 'before' value but not when estimating the 'after' value of the property.	FHWA, 2002; AASHTO, 2003	
22		To reduce appraisal time and costs, encourage the use of the Value Finding Appraisal Format rather than a Real Estate Appraisal Report, when appropriate.	FHWA, 2005; TxDOT, 2006	
23		Use the Memorandum of Value Determination to expedite the valuation process and minimize the appraisal cost.	TxDOT, 2006	
24		Emphasize compromising on issues related to just compensation. Such techniques are recognized for effectively resolving acquisitions in a timely and cost effective manner.	FHWA, 2002	
25	Inform property owners of what will take place at each step about the entire acquisition process	Furnish the property owner with information on the overall anticipated timing of the acquisition process, the general type of facility to be constructed, and the appraisal procedures that will follow. The more information provided to the property owners, the fewer questions and delays may occur	AASHTO, 2003; TxDOT, 2000	
26		Share and discuss the preliminary right-of-way map for the project with all property owners	TxDOT, 2000	
27		Inform the property owners of the method for selecting qualified appraisers and estimating values.	TxDOT, 2000	
28		Identify real property and personal property prior to proceeding with the appraisal. Solve any uncertainties over whether an item is personal property or realty before the appraisal report is completed and just compensation is determined.	TxDOT Project 0-5379 report	
29	Frequently and regularly, contact property owners in person to promote confidence in the agency and to reduce delays and negotiation costs.	Encourage agents to perform in-depth interviews with property owners discussing issues such as the influence of the project, property usage by the owner, etc.	TxDOT Project 0-5379 report	
30		Conduct an "open house" event at public meetings and hearings.	AASHTO, 2003; NCHRP, 2000	
31	Conduct simplified and efficient negotiation processes, including the title acquisition process,	Require negotiators to meet owners prior to the initiation of the negotiation process.	TxDOT Project 0-5379 report	
32		Use a streamlined process to provide immediate payment to property owners for low-value property rights.	AASHTO, 2003; FHWA,	

	in order to minimize schedule delays of the negotiation process.		2002; FHWA, 2006	
33		Use a closing manual that provides relevant contacts, phone numbers, and directions to the courthouse to minimize time spent at courthouse.	TxDOT Project 0-5379 report	
34		Use sketch maps, if a final map is pending, to accompany the offer on administrative settlements of just compensation	TxDOT Project 0-5379 report	
35		Encourage appraisers to process all approval, grant, and disclosure forms at the same time the tenant/owner signs the disclosure form.	TxDOT Project 0-5379 report	
36		Emphasize the effectiveness of compromising on disputed values of the property to be acquired in order to avoid or reduce time spent on litigation.	TxDOT Project 0-5379 report	
37		Use incentive programs for early completion of the negotiation process (e.g., incentive payments for early completion and penalties for late completion).	TxDOT Project 0-5379 report	
38		Establish the negotiating party (or agent) prior to the completion of the appraisal process (i.e., during project development, or during the appraisal preparation).	TxDOT Project 0-5379 report	
39	Encourage negotiators to execute negotiations in a manner that builds good rapport with property owners and increases the owner's confidence in the agency.	Require negotiators to present and discuss the offer in person.	AASHTO, 2003; ILDOT, 2004; FHWA, 2006	
40		Emphasize the importance of getting to know the property owner at the outset of the negotiation process. Encourage agents to have an introductory conversation before beginning the negotiations	TxDOT Project 0-5379 report	
41		Require agents to regularly share copies of final appraisal reports with property owners.	TxDOT Project 0-5379 report	
42		Furnish each property owner with a folder that includes comprehensive information related to the project.	TxDOT Project 0-5379 report	
43	To the greatest extent possible, minimize the possibility of proceeding to condemnation.	Use alternative dispute resolution techniques to settle acquisition disputes at the beginning of preliminary eminent domain processes.	TxDOT Project 0-5379 report	
44		Give the property owner's file to a condemnation specialist or a legal expert before entering the condemnation proceedings in order to assess risks and to determine whether to enter into litigation.	TxDOT Project 0-5379 report	
45		Encourage negotiators to assist property owners in preparing and negotiating a counteroffer, with no assistance in reaching a specific amount.	TxDOT Project 0-5379 report	
46	Emphasize the significance of providing property owners not only with legally required information but also with any pertinent information that may enhance	Ensure that all information required by law is provided to the property owner when delivering the written offer to initiate the negotiation process.	TxDOT Project 0-5379 report	
47		Provide notice to property owners of the intent to acquire the property, the function of the acquisition, the agency's need for the property, the possible impact of the improvement on the property, the capability of the agency to accomplish the transaction, the right to donate the property to the agency, and the owner's legal protections	CalTrans, 2001; ILDOT, 2004; TxDOT, 2004	

	public trust.			

Table 6 AASHTO' guidelines and Best Practices for handing utilities

No.	Guidelines	Best Practices	KYTC Adopted
1	Use current available technology to the greatest extent possible	Use Subsurface Utility Engineering (SUE) for projects where underground utilities are present and high quality levels of information are needed for design purpose.	
2		Require utility company certification of record drawings and encourage development of a CADD database system and electronic transfer system.	
3	Encourage frequent coordination and communication with local government agencies to reduce delivery time, reduce cost, and improve quality in the utilities process.	Work with local governmental jurisdictions to establish pavement cutting criteria and backfill requirements.	
4	Encourage frequent coordination and communication with utilities companies to reduce delivery time, reduce costs, and improve quality in the utilities process.	Provide utility companies with long-range highway construction schedules.	
5		Host meetings with utility companies to discuss future highway projects.	
6		Recognize the importance of long-range highway/utility coordination.	
7		Organize periodic (monthly, quarterly, annual) meetings with utility owners within municipality, county, or geographic or highway planning region.	
8		Solicit similar information on utility owner's capital construction programs, particularly where a utility has planned expansion or reconstruction may encroach on or coincide with a planned highway project.	
9		Consider using the long range planning meeting as a convenient forum to discuss other highway/utility issues, such as accommodation policies, reimbursement, etc.	
10		Provide utility companies with a notice of proposed highway improvements and preliminary plans as early in the development of highway projects as possible.	
11		Involve utility companies in the design phase of highway projects where major relocations are anticipated.	
12		Conduct on-site utility meetings or utility plan-in-hands with utility companies to determine utility conflicts and resolution.	
13		Participate in local one-call notification programs to the maximum extent practicable per state law.	
14		Invite utility companies to pre-construction meetings and encourage or require utility companies, contractors, and project staff to hold regular meetings, as deemed appropriate, during the construction phase of a project.	
15	Improve Contract, internal project development and training process to expedite utility relocation.	Use standardized utility agreements.	
16		Initiate separate contracts for advance roadway work on selected projects prior to utility relocation.	
17		Set forth responsibilities for appropriate action to reduce delays to contractors.	
18		Provide utility special provision language in the construction contract.	
19		Avoid late plan changes.	
20		Have highway contractors relocate utility and municipal facilities, when possible.	
21		Acquire sufficient right-of-way for utilities purpose.	
22		Provide training to Department of Transportation utility staff and utility companies' staff.	

Reasons Most Commonly Identified by STA's for Utility Delays

The research team compiled a list of issues that commonly affect utility relocation. Table 7 lists these issues and provides a count of how many states have experienced them.

Table 7 Reasons Identified by States for Delays in Relocating Utilities

Reason for Delays	Number of States
Utility lacked resources (financial and personnel)	34
Short time frame for states to plan and design project	33
Utilities gave low priority to relocations	28
Increased workload on utility relocation crews, because highway/bridge construction has increased.	28
Delays in starting utility relocation work: some utilities would not start until construction contract was advertised or let.	28
Phasing of construction and utility relocation work out of sequence.	26
Inaccurate locating and marking of existing utility facilities.	23
Delays in obtaining rights of way for utility.	23
Shortages of labor and equipment for contractor.	19
Project design changes required changes to utility relocation.	19
Utilities were slow in responding to contractor's requests to locate and mark underground utilities.	16
Inadequate coordination or sequencing among utilities using common poles/ducts.	13
Source: States responses to GAO (general accounting office)'S questionnaire.	

(*Source: Development of Improved Strategies for Avoiding Utility Related Delays during FDOT Highway Construction Delays*)

According to SHRP Report S2-R15, engineering challenges faced by STAs can result in utility relocation delays. Some of the most significant challenges include:

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

The same report also presents factors influencing delays over the past decade:

- DOT construction letting volumes have rose, more than doubling over the past decade in some states. At the same time, the number of annual utility adjustments has increased. In some states, the number of reimbursable adjustments per year has tripled.
- In response to accelerated construction, STAs have expressed increased interest in compressing relocation schedules.
- Overhead utility lines are becoming a thing of the past except in rural areas, and underground space in corridors is growing more congested; the urban underground increasingly resembles a spider web of utility lines – phones, electricity, gas, cable television, fiber optics, traffic signals, street lighting circuits, drainage and flood control facilities, water mains, and wastewater pipes.

The deregulation of utility services has added to the problem because multiple service providers compete to locate their networks underground.

- Recent consolidation in the utility industry hampers efforts to address concerns at the state level given that utilities are now managed regionally and nationally.
- Utility asset relocation during construction has become increasingly complex.
- Utility relocation problems that emerge during project construction cause contractors major issues. Many relocation problems result from a breakdown in communications and a lack of timely coordination among the invested parties, especially early in the project development process, although this problem lasts through construction.

After reviewing best practices and issues affecting the utility relocation process, the research team analyzed this information and prepared an interview instrument (included in the appendix) that could be used to interview stakeholders involved in KYTC utility relocation efforts.

Interviews of Stakeholders at KYTC and Utility Companies

Identifying successful practices that could be used to streamline and expedite utility relocations on KYTC projects was a key objective of this project. To achieve this goal, the following tasks were undertaken, in order.

1. Identify agencies with successful utility relocation management practices (STAs and others).
2. Review practices of agencies with successful utility relocation management practices (STAs and others).
3. Interview and/or survey stakeholders to collect data on a spectrum of utility relocation types from KYTC employees and utility owner/operators.
4. Recommend utility relocation practices for implementation on road construction projects.

To get a handle on the nuances of the conflicts, barriers, and practices that influence the progress utility relocation, in-depth interviews with KYTC engineers and utility companies were conducted, respectively. A questionnaire of best practices was developed based on the research team's literature review, the professional insights of research team members, and feedback received on this questionnaire from KYTC and utility companies. The interviews yielded findings, which are laid out in the following sections.

Data Collection

KYTC Utility Engineers

Obtaining feedback from utility engineers at KYTC is very important because of their deep familiarity with the processes and issues surrounding utility relocation. KYTC uses a Right-of-Way Supervisor and a Utility Supervisor to address the needs of KYTC projects in each of their 12 districts. Additional support and supervisory staff for these programs reside in the KYTC Central Office. Researchers scheduled interviews with staff in the Central Office for this project, and will conduct further interviews with district personnel in future phases. During these interviews, the research team explained the purpose of the project to respondents and sought their views on the conflicts, barriers, and processes most often responsible for relocation delays as well as any other practices that could expedite utility relocation.

At the outset of each interview, the research team provided respondents with a list of best practices that were derived from its literature review (the appendix contains all interview questions). Each of the interviewees was then asked to assess the frequency, rationality, and availability of each practice. After this, they were asked to identify the major source of delays in utility relocation KYTC, utility companies, or both confronted. The interviews revealed information on the following topics:

- Frequency and severity of conflicts that influence utility relocation
- Strategies on avoiding or minimizing delays during planning, design, and construction
- A spectrum of opinions regarding utility relocation. By hearing from KYTC and utility companies, the research team was able to contrast opinions on best practices across stakeholder groups and therefore validate the effectiveness of different relocation practices.
- Successful utility relocation practices identified by other STAs. This information can potentially be used to shape agreements between KYTC and utility companies on relocation projects.

The researchers interviewed two utility engineers from KYTC to discuss utility relocation issues, conflicts, barriers and best practices. Each interview lasted approximately two hours.

Utility Companies

Interviews with utility company representatives provided insights into what issues they prioritized with respect to utility relocations. Before interviewing these representatives, the research team asked KYTC personnel for feedback on its questions; the purpose of soliciting feedback was to ensure the interviews would generate information useful for all parties. KYTC also provided researchers with a list of contacts at Kentucky-based utility companies. After screening these suggestions, the research team chose three utility companies for initial interviews. Companies were selected that, historically, have been the most impacted by KYTC projects. Researchers focused on the following types of utility companies:

- Electric
- Oil &Gas
- Telecommunications

The research team plans to conduct additional interviews during later phases of this project. It plans to select companies based on several factors, including scale (of the company's operations), location (i.e. what KYTC district it is located in), and industry.

Analysis and Evaluation

Based on the initial interviews, research team members developed an understanding of the procedures, policies, barriers, and conflicts related to utility relocation. Following the interviews, the research team created and distributed a questionnaire to further illuminate challenges involved in relocation projects. The questionnaire contained five questions; one of these questions had 54 subparts covering various best practice applications. Surveys went out to stakeholders at KYTC as well as UC personnel. Analyzing the survey responses yielded six critical issues related to utility relocation that merited intensified scrutiny. Once analysis was complete, the research team met with individuals and groups to further investigate hurdles impeding utility relocation. These structured interview sessions revealed where there is room to improve relocation; each critical issue is discussed below.

Critical Issue I: Training

To understand respondents' familiarity on the utility relocation process, they were asked questions about the frequency and quality of training programs provided by UCs/KYTC. Respondents could answer by saying: 1) Never; 2) Rarely; 3) Sometimes; 4) Often; 5) N/A. Table 8 summarizes the responses, and lists the number of times each answer was given.

Table 8 Frequency of Training Program on Utility Relocation

Question		Never	Rarely	Sometimes	Often	N/A
1	Train project managers and other design team personnel on utility issues.		2	2	1	
2	Train consultants and utility owner personnel in utility coordination processes and issues		1	3		1
20	Provide training in highway plan reading to utility owners.	3		2		

Most interviewees agreed that providing training to designers, managers and consultants is a helpful practice because many engineers and/or administrators are not sufficiently knowledgeable of the utility relocation process, especially on issues of technical matters. Utility networks are very complex and high turnover rates at KYTC and UCs have led to inexperienced engineers assuming responsibility for design work. Table 8 suggests that KYTC sometimes provides training on subjects related to utility relocation, but most respondents felt it should be offered more regularly.

The consensus among utility industry stakeholders was that if the administrators and designers were knowledgeable about the utility relocation process, and understood the complexity of utility systems, it would encourage project stakeholders to avoid unnecessary or problematic utility relocation schemes. As such, bolstering the level of training at KYTC would communicate the complexity of utility relocation to designers. In turn, designers could adopt design strategies that are mindful of utilities and attempt to minimize relocations. Innovative design will potentially save time and prevent cost overruns.

The most interesting point reviewers brought up related to offering UC employees training in how to read plans. KYTC interviewees felt training was not needed and that it would be used because UCs deal with plans every day. However, UC respondents resoundingly felt this would be an excellent practice. ***With an increasingly young and inexperienced workforce, many lack plan reading experience, especially highway plan reading experience. This skill is a much sought after commodity. Providing more training to UC staff will ultimately improve communication between them and KYTC.***

Implementation Requirements and Potential Obstacles

Developing a training program, and finding the necessary personnel to lead it, will entail a significant effort; KYTC's limited staff availability could pose difficulties. Additionally, this is a venture that would need to be prioritized, as designers need knowledge on the complexities of utility relocation; likewise, they require reliable training in plan reading. It is possible to adapt current training to meet these needs, but it would be more appropriate to create a standalone program to accomplish both goals. This effort could potentially serve as the foundation of a certification process, which if it gained widespread traction, could benefit the entire industry.

Critical Issue Ⅱ: Coordination and Communication

Coordination and communication are both central factors that impact whether utility relocation occurs in a timely manner. Coordination among KYTC, utility companies, and contractors is necessary for utility relocation planning and the identification of potential barriers or long lead efforts that might prevent or slow a utility relocation. Sometimes, utility poles and trenches serve multiple utilities, such as cable, telephone, and electric. When multiple utilities share space (e.g. on poles), installing the utilities on the new poles or in trenches must follow a prescribed order – electric must be installed on new poles prior to any other utility. When these circumstances arise, utility companies are supposed to coordinate with one other to keep utility relocation on schedule. If this coordination does not occur in a timely manner, the typical outcome is prolonged delays.

Numerous best practices related to coordination and communication were listed on the questionnaire. For each item, respondents were asked to rate how often coordination takes place among KYTC, UCs, and other project stakeholders. Table 9 displays the results of this survey. The number in the individual grid cells indicates the number of interviewees selecting a particular answer.

Table 9 Frequency of Coordination/Communication among Utility Companies, KYTC, and Contractors

Question		Never	Rarely	Sometimes	Often	N/A
19	Have frequent joint meetings with utility owners as design progresses to get their input on relocation issues and to make certain they coordinate their relocation designs with the available space.			3	1	1
34	Host meetings with utility companies to discuss future highway projects.		1	2	2	1
35	Recognize the importance of long-range highway/utility coordination.		1		2	2
36	Organize periodic (monthly, quarterly, annual) meetings with utility owners within municipality, county, or geographic or highway planning region.			1	2	2
38	Consider using the long range planning meeting as a convenient forum to discuss other highway/utility issues, such as accommodation policies, reimbursement, etc.	1	1	1	1	1
39	Provide utility companies with a notice of proposed highway improvements and preliminary plans as early in the development of highway projects as possible.		1	2	1	1
41	Conduct on-site utility meetings or utility plan-in-hands with utility companies to determine utility conflicts and resolution.		2	1	1	1
43	Invite utility companies to pre-construction meetings and encourage or require utility companies, contractors, and project staff to hold regular meetings, as deemed appropriate, during the construction phase of a project.			2	2	1

KYTC personnel observed that the Cabinet holds quarterly meetings with UCs to discuss ongoing and future work plans within individual districts. They argued that KYTC has promoted communication among UCs, KYTC, and contractors. However, UCs contended that KYTC should increase the frequency of these meetings. Some answered 'N/A' to these questions, because they noted observed inconsistencies in interactions with UCs across the state. Although communication was routinely more open and uniform in urban areas, it was sparser in rural districts. A concern for the UCs was that they do not have the same district boundaries as KYTC and knowing about projects, rural or urban, is needed to optimize planning for relocation. Utility companies also noted that the complexity of some individual projects is enough to warrant meetings focused just on them. In these instances, KYTC may organize monthly, weekly, and even daily meetings to discuss the major issues related to utility relocation. Respondents noted that KYTC has made some changes that appeared to improve communication between it and UCs. The preference expressed by UC stakeholders is for communication to take place on a monthly basis, to update ongoing project status and the letting schedule for the upcoming several months.

The research team also investigated different forms of communication and the methods preferred by the different stakeholders. This research indicated that different forms of communication are widely used; with the type of communication preferred varying according to project stage, (some forms of communication discussed include face-to-face meetings, e-mails, letters, and phone calls). The most popular form of communication is in-person conversations, with other forms being supplementary.

Implementation Requirements and Potential Obstacles

Most utility stakeholders agree that communication during design and construction phases is necessary to identify potential conflicts and analyze potential solutions. Sometimes, preconstruction and progress meetings are also required; these are especially beneficial for complex projects. Regular meetings with UCs can improve the relationships between utilities and KYTC, which translates into conflicts being resolved in a timely fashion.

The takeaway messages on communication and coordination are: 1) actively seek out opportunities to facilitate them and ensure that all communication occurs frequently enough to satisfy all stakeholders, and 2) make sure the necessary stakeholders are present at meetings. Meetings should only be held if the parties present would be able reach a consensus on the subject at hand – and achieve a resolution. Whether a party's attendance is mandatory, suggested, or optional should be communicated to them in a clear, unambiguous manner. In some cases, it may be necessary to decide if such a meeting should be held if the attendance of the required parties remains uncertain. Meeting organization, including the categories of attendees described above, should be carefully handled; in-person meetings require resources and effort but these are never wasted.

Critical Issue Ⅲ: Right of Way (ROW)

Right-of-way (ROW) acquisition significantly impacts utility relocation, dictating when it is able to begin. Consequently, projects that experience delays due to right-of-way acquisition may also lead to utility relocation delays. The researchers investigated practices from other state transportation agencies that have been used to mitigate conflicts when right-of-way acquisition is delayed. **Table 10** summarizes the results for questions pertaining to ROW. Numbers in the table indicate how many interviewees selected the corresponding rating classification.

Table 10 Frequency of Best Practice on Right of Way

Question		Never	Rarely	Sometimes	Often	N/A
22	Use or consider establishing utility corridors for utilities crossing major highways or located longitudinally along highway ROWs.		2	1	2	
23	Acquire sufficient ROW for utility purposes.		1	3		1
54	Define utility corridors during project design.	1	1	1	1	1

Answers to these questions varied widely. From a UC's standpoint, it is hard to anticipate when during a project a permit for utility relocation can be obtained, especially when ROW issues are involved. Most UCs advocate applying for ROW access during the early project phases. In addition, because the process of securing the ROW can be involuted, an increasing number of utility corridors are being used to accommodate not just current projects, but future utilities projects as well. Defining utility corridors is a relatively new issue that KYTC lacks experience in; a number of the interviewees commented on KYTC's lack of engagement with defining utility corridors. The varied responses related to utility corridors is believed to be a result of KYTC's recent adoption of this strategy. UCs, want to see more utility corridors defined during the project design phase. Nevertheless, due to the regulatory constraints that KYTC operates under, it is difficult to implement this.

Implementation Requirements and Potential Obstacles

Some STAs have developed ROW and utility management systems that are coordinated. This lets them manage the utility relocation process more efficiently. Despite the appeal of using coordinated systems, doing so comes at a significant financial expense and requires substantial human resources, especially during the construction phase. System specifications vary across states; however, the objective of these systems is to provide utility information for the duration of the project. This streamlines the process of utility relocation. Some of the obstacles to building coordinated ROW and utility management systems include inadequate budgets, the need to train employees and, time for implementation. KYTC is in the development stages of this type of system, currently, but the potential benefits are great.

Critical Issue Ⅳ: Subsurface Utility Engineering (SUE)

Subsurface Utility Engineering (SUE) is an engineering process used to accurately identify the quality of subsurface utility information needed construct highway plans, execute ROW acquisitions, and manage different aspects of projects [1]. An increasing number of states are conducting research to promote the implementation of SUE. For states where SUE is not standard, or where there are no SUE programs, this type of engineering can be deployed on an *ad hoc* basis under exceptional circumstances [2]. SUE highlights underground utility locations at varying levels of detail by relying on records, surface features, surface geophysical methods, and excavation. The levels are labeled A through D, according to the level of effort associated with their management; management prioritizes mitigate risks associated with incomplete or inaccurate knowledge. The researchers identified some best practices related to SUE and provided them to interviewees to obtain their feedback on each practice. Table 11 characterizes the frequency at which SUE practices are used by KYTC or utility companies. The number each grid cell indicates is how many interviewees selected the corresponding rating categories.

Table 11 Frequency of Best Practice on Subsurface Utility Engineering

Question		Never	Rarely	Sometimes	Often	N/A
15	Develop a rigorous pre-qualification for SUE consultants that address their technical qualifications.	1		1	1	2
16	Develop a screening tool to assist and formalize the process of selecting the appropriate Utility Quality Levels for utility mapping. This might be an iterated process that is re-evaluated as additional detail is added to the design plans.	1		1	1	2
17	Build on cost–benefit studies already performed to evaluate the cost-effectiveness of SUE.	1		2		2
18	On projects where it is known in advance that utilities are a significant time or cost factor, get QLB (Quality Level-B) mapping as early as possible, preferably at time of topo development. Consider the underground utilities as an underground topo feature.	1	1	2		1

SUE can be used to locate existing underground utilities and identify potential conflicts. As described in Table 11, there is a range of best practices. UCs view SUE as a cognate of surveying, and most respondents indicated that prequalification for SUE consultants is not necessary. Many STAs find SUE services to be very expensive, yet there is still a misconception about the varying levels of SUE and cost. For question 17, there was confusion about 'cost-benefit' versus 'cost-effectiveness', but the consensus was that SUE is treated as a commodity rather than a professional service [2]. In states where the SUE rating tool has been adopted, designers have noted the importance of being judicious with its use, and how critical it is to determine the quality level of SUE necessary at different locations in a project.

Implementation Requirements and Potential Obstacles

High-level SUE services are expensive, and to construct a SUE management system requires additional funds. Employees must also undergo training before they can use SUE. Thus, it is necessary to develop guidelines that inform employees of when and where to use SUE as well as the level it is appropriate to use it. Even though some engineers consider SUE a best practice, they still may not have the knowledge to judge when and where it is acceptable to use it. The following obstacles prevent widespread adoption:

- STAs will require budget increases to deploy it effectively
- Determining its level of effectiveness is challenging
- Instituting a training program is essential to verify it is used correctly
- Developing guidelines for optimized use can be a lengthy process

Critical Issue V: Financing and Reimbursement

This subsection identifies financing and reimbursement practices that KYTC employs or would like to adopt during the utility relocation process. The financing and reimbursement issues under consideration here include financing utility design, utility companies seeking reimbursement, and financing relocation. Table 12 summarizes financing and reimbursement best practices derived from the questionnaire. Respondents were queried about whether KYTC has adopted these practices to accelerate the utility relocation process. For those financial issues they indicated having the most interest in, the researchers ask respondents for more information.

Table 12 Frequency of Best Practice on Financing and Reimbursement Issues

Question		Never	Rarely	Sometimes	Often	N/A
3	Consider paying utility relocation design costs regardless of prior rights to maintain coordination between available space and project timing.	2	1	1		1
5	Develop an early utility cost estimate based on worst-case assumptions and continually revise it as design progresses.	1			4	
12	Develop a catalogue or database of historical utility relocation costs to generate the best possible cost estimate. Update this database on a regular basis, but do not exceed annually.	2		1		2
26	DOTs share annual bills and monthly schedules with UCs, so that UCs can plan and budget accordingly.		1	2		2
27	DOTs provide incentive to UCs for early utility relocation and permit the opportunity to reimburse a utility for the cost of relocating its facility early.	2	3			
50	Pay non-reimbursable utilities for relocation design.	3				2

Due to regulations, KYTC has a number of reimbursement policies; these vary depending on whether it is dealing with private utilities or public utilities. KYTC rarely pays for utility design of private utilities, while it sometimes funds the design of public utilities. One area personnel at KYTC have contemplated doing more is in design, specifically assisting public utilities with design to incentivize expedited relocation. UCs and KYTC have independent systems for estimating the cost of utility relocation. For KYTC, cost estimates are specific to the district level – there is not a formal statewide system for calculating utility relocation costs. UCs typically have an individual company database that guides cost estimates of utility relocations. UCs and STAs routinely confront difficulties stemming from fluctuating budgets, project scheduling, and the immense variability of road projects. All of these issues can make utility relocation an unreliable and unpredictable process. As UCs and STAs strive to develop comprehensive databases to inform cost estimates and cost management, it is imperative that utility relocation work grow more predictable.

Question 26 asked respondents about sharing monthly schedules with UCs. KYTC typically provides UCs with an 18-month schedule that lists upcoming projects. However, UCs consider this schedule too short, and it prevents them from developing budget plans; it also obscures KYTC's long-term plans. It may be useful for UCs to have access to KYTC staff for consultation as they prepare their budgets. This would let them more accurately estimate the probability of specific projects receiving the go-ahead over the long-term.

Question 27 queried respondents about incentivizing UCs to promote earlier relocation. This offers one strategy to expedite utility relocation. Most utility representatives would like to see KYTC reimburse their companies, yet there was some uncertainty over whether doing so will speed up relocation. Some of the UC representatives noted they considered this similar to providing bonuses to relocate their facility early and they did not believe it would impact the timeline much. They viewed the incentive as a small amount of money compared to the amount of spending involved in utility relocation. They viewed this as a sub-optimal practice because it would double fees to the public given that taxpayers are also ratepayers. It is understandable that utilities are reluctant to invest effort, time, and human and financial capital in planning or executing relocations that turn out to be unnecessary when the STAs decide against advancing a project. Some STAs allow reimbursing a utility for the cost of relocating its facility early, such as Tennessee DOT [3]. Interviewees from KYTC indicated that KYTC is willing to reimburse private utility companies when they either had prior rights within the area of the roadway, or when they relocate prior to construction and are obligated to perform a second location for the same project.

Interviews revealed that sometimes the UCs distrust STAs on the topic of project priorities because the fortunes of particular projects oscillate based on shifting political influence. When there is an absence of trust between UCs and STAs, the result is more delays because the UCs wait until latter portions of projects to initiate relocations – so they are sure relocation will be necessary.

Implementation Requirements and Potential Obstacles

For UCs to receive compensation early in the relocation project, legislation and regulations will need to be established. Legislation should contain guidance on relocation dynamics, including timing requirements, permit acquisition requirements, limitations on reimbursement claims, and which contractors are to perform the utility relocation work.

The following circumstances may prevent reimbursement for early relocation incentives:

- Lack of legislations enabling early reimbursement
- Inadequate budgets to reimburse early relocation
- Utility companies may lack the resources to execute their work before construction begins
- Lack of agreements between utility companies and STAs.

Critical Issue Ⅵ: Technical Tools

This section summarizes the technical tools UCs and KYTC currently use, and attempts to identify what technical tools have proven to quicken utility relocation. The research team sought feedback on tools that can be used to aide this process:

- Geographic information systems (GIS)
- Marker technology and field markings
- Computer-aided design and drafting (CADD)
- Utility impact matrices

Table 13 lists questions in the survey applicable to technical issues/methodologies.

Table 13 Frequency of Technical Tools used in Utility Relocation Projects

Question		Never	Rarely	Sometimes	Often	N/A
6	Use technology tools such as Google Earth, roadway video logging, and GIS systems to get early visualization of utilities in the planning stages of projects.	1		2		2
9	Develop a mechanism to capture any changes to the existing utility facilities performed by utility owners or contractors on the project as design develops. Update the utility mapping on the design plans as the utility data changes.	4		1		
10	Develop or utilize a GIS system to store, manage, and recall utility information gathered during plan development and during utility relocations and new installations during construction.	3				2
11	Install or require utilities to install radio frequency identification markers on nonmetallic utilities during utility relocations or new installations.	2	1			2
14	Develop catalogues and visualization techniques to assist designers in alternate design possibilities.	2	1	1		1
28	Utility impact matrix is used to list all utility conflicts and a SUE consultant is needed to provide the corresponding recommendations.	3		1		1
31	Require utility company certification of record drawings and encourage development of a CADD database system and electronic transfer system.	3	1			1

Interviews revealed that KYTC and UCs seldom use GIS as a tool to store, manage, and recall spatialized utility information. One utility supervisor from KYTC observed that GIS can only be applied to work that occurs on the surface (i.e. not belowground), and is therefore not useful to underground utility projects. While GIS constitutes a best practice, the extensive data requirements, time needed to build a system, inadequate funding, and lack of resources often prevent agencies from taking advantage of it. UCs endorsed the use of GIS, however, company representatives noted it would take a huge effort and budget to construct the necessary datasets and geodatabases. Instead, UCs often adopt simple mapping systems. However, both the KYTC and the UCs indicated that, given the pace of growth in the utility sector, it would be greatly beneficial to employ GIS more frequently to serve the utility works.

UCs and KYTC each noted the possible benefits of using marker tools for relocation projects focused on underground utilities (e.g. water and gas). Currently, these are used rarely or never. Stakeholders were worried about the vulnerability of radio frequency markers, particularly the amount of information they may store, which can potentially be accessed by outside parties. There is a fear that vandalism or even terrorism could threaten high-value utility lines.

Most UCs acknowledged that computer-aided design and drafting (CADD) files and plans are efficient. However, there is not uniformity in software used across the industry, which can lead to compatibility issues. Consequently, much of the design and planning work is still done on paper, and then scanned into computers. One interviewee from a UC noted that, currently, the most popular way to store drawings is in PDF format, which profoundly limits the modifications that can be made electronically. Respondents also mentioned that some people in the industry even prefer making final modifications or adjustments on paper drawings to avoid CADD technologies.

A utility impact matrix is a management tool used to identify potential utility conflicts. Matrices offer a way to organize information such that conflicts are made transparent; by analyzing where conflicts are at, a solution to each one can be worked out during the utility relocation process. A utility impact matrix is developed by listing every utility conflict, and asking for SUE consultants or other relocation engineers to find resolutions. Utility impact matrices have a track record of improving the coordination utility relocations. For example, Georgia DOT has implemented these matrices widely, and now use it on every project involving utilities [4]. As demonstrated by Table 13, KYTC has not applied such utility impact matrices, yet. However, utility supervisors interviewed commented that KYTC is developing a utility impact matrix for designers to make design decisions that will circumvent potential utility conflicts.

Implementation Requirements and Potential Obstacles

The following section discusses the implementation of the previously described technologies.

- GIS and CADD
    - KYTC and UCs need sufficient budgets to implement a completely functional electronic document system that would enable file sharing of STA's as-built drawings. In addition, they also need enough funding to purchase software licenses, and provide training to employees on the use of GIS, CADD, and related software. Barriers to implementing these technologies include: difficulty transferring files in compatible electronic formats; challenges handling large volumes of data; funding; some engineers being reluctant to work on computers; the hesitance of some companies to share proprietary information, as this could involve sacrificing their competitive advantage.
- Markers and field markings
    - The main problems associated with the use of marker and field markings in utility relocation include inaccurate and incomplete field markings, risk of using multiple locators, reluctance to include location and security sensitive data, and process inefficiencies.
- Utility impact matrix
    - The principal drawback of developing a utility impact matrix is the additional time required and the funding needed to hire a SUE consultant to identify all potential utility conflict and recommend a fully useful resolution. While matrices can save time and money, they are not simple tools to use. Their effectiveness also diminishes on complex relocation efforts.

Major Delays in Utility Relocations

Table 14 summarizes the major delays that UC and KYTC utility supervisors view as most responsible for delaying utility relocation (Question 4 can be found in the Appendix).

Table 14Primary Reasons and Responsible Party for Major Delays

	Major Delays	Responsible Party	Cited by KYTC or utilities	Number of interviewees agreed on
1	Inadequate financial budget and personnel resources.	Both	Both	5
2	Utility companies would not be notified early when plan changes are made by KYTC.	KYTC	Utilities	2
3	Project design changes required changes to utility relocation.	KYTC Both	Both Utilities	4 3
4	Poor control on big projects, especially coordination, is time consuming.	Both	Utilities	1
4	Long process of ROW acquisition.	KYTC	Utilities	4
5	Relocations that could have been avoided during the design phase.	KYTC	Both	3
6	Involving utilities late in the design phase.	KYTC	Utilities	3
7	Contract controversy.	Both	Utilities	2
8	Material acquisition and equipment procurement.	Utilities	Utilities	3
9	Damages to existing facilities delay other relocation.	Utilities	Utilities	1
10	Lack of communication between KYTC and Utilities.	Both	Both	2
11	Limitations on utility design consultant capacity.	KYTC	Utilities	1
12	Short time frame for state transportations to plan and design the projects.	KYTC	KYTC	1
13	Utility companies giving low priority to utility relocation.	Utilities	KYTC	1
14	Rework required/change orders.	Both	Utilities	1
15	Severe weather events.	N/A	N/A	1
16	Some services are not clearly clarified in the contract. Or sometimes some information is missed and leads to utilities are misallocated.	Both	Utilities	1

Analysis of Interview Results

Interviews were used to develop a clear understanding of the current practices used by STAs and UCs, and also to develop insights into best practices that would accelerate the utility relocation process. The researchers conducted face-to-face interviews with utility supervisors from KYTC and utility engineers from UCs. After analyzing the interviews, the research team arrived at the following conclusion:

- Because KYTC rarely provides training to administrators/designers on utility relocation issues, many administrators/designers are not sufficiently knowledgeable about them. Training STA designers – and the owners of UCs – could establish a comprehensive, and shared, knowledge of utility relocation.
- Utility coordination meetings held during the design phase would help identify where potential conflicts exist. Improving interactions early in the utility relocation process boosts collaboration on the analysis of optional design plans and open lines of communication between KYTC and

utility companies. Currently, when meetings take place, they are usually organized more often than not by KYTC.

- Holding meetings during the preconstruction phase, as well as during subsequent construction phases, lets KYTC and UCs negotiate resolutions to problems that arise during utility relocation. KYTC and UCs should prioritize ongoing collaboration to ward off potential conflicts.
- Currently, credibility and trust are lacking between KYTC and UCs.
- Communication and coordination among KYTC, UCs, and contractors is currently lacking, especially on large projects. KYTC needs to rethink its handling of significant relocation projects.
- UCs expect KYTC to share with them long-term budget plans and long-term schedules (not only 18-month schedule).
- UCs expect KYTC to be responsible for a utility management and ROW information system, KYTC is currently investigating the feasibility and effectiveness of such a system.
- Some UCs (such as those focused on water or gas) would like to see more utility corridors defined during project design phase.
- SUE has not been widely adopted by both utilities and KYTC, even though other states have found it a helpful tool to locate existing underground utilities and identify potential conflicts.
- KYTC needs to further refine policies related to issues of reimbursement. Incentivizing early utility relocation can potentially streamline projects.
- Neither KYTC nor UCs have realized the benefits of cataloguing or historical utility relocation costs. This information is critical to generate accurate cost estimates.
- GIS and CADD techniques are seldom used by KYTC and utilities because of the exhaustive work needed to map the expansive backlog of historical utilities data. Additional resources will be needed to develop a process for acquiring as-built plans and entering them into these systems.
- KYTC has not developed a utility impact matrix to facilitate utility relocation.

Utility Relocation Task Force

Shortly after this project began, KYTC commissioned a Utility Relocation Task Force. This task force was comprised of KYTC personnel with its sole purpose being to review utility relocation processes and procedures. The task force's objective was to define and implement practices that will streamline utility relocation efforts when they take place in conjunction with transportation projects. KTC researchers were able to participate in the Utility Relocation Task Force. This was beneficial, but it also complicated the research effort. Studying a process that is dynamic and undergoing revision presents challenges that are absent when looking at practices which have been locked into place.

The task force held a series of meetings with the aim of developing a toolbox of methods to improve and expedite utility relocations. This section will study the products of the task force and analyze other STAs to identify strategies that could further benefit KYTC. This section will also outline guidance on the use of utility relocation tools and describe a utility impact risk analysis metric that will enable KYTC to effectively pursue the relocation of utilities while adhering to all regulatory and contractual terms.

While a complete synthesis of the task force's activities is beyond the scope of this report, its findings are briefly discussed here. Two key findings of the task were that 1) it is imperative for KYTC and UC staff to coordinate early in the design phase, and 2) that KYTC and UC staff must maintain communication throughout the course of a project. There were many ideas and questions posed by the task force, with some of the notable points being captured below:

- STAs and UCs involve the same stakeholders (taxpayers are rate payers)
- The possibility of KYTC designing and/or constructing utility relocations should be investigated
- Shared utility spaces (poles, chases, duct banks, etc.) provide opportunities but also challenges in coordinating the locations of certain utilities
- Consolidating contract agreements, (master agreements) may catalyze project streamlining.

Because KYTC sought immediate improvements, the first step it took was shifting UC involvement and utility relocation to an earlier point in the road design process. This effort to coordinate with the activities of the Right-of-Way Task Force, which met concurrently, led to some exciting opportunities for accelerating project timelines with only minimal added coordination efforts.

KYTC Right of Way, Utility Involvement, and Project Development Processes and Revisions

The first task of the research project involved mapping and reviewing KYTC's processes for utility planning and relocation. Upon review of the procedures involved, a flowchart was developed mapping the process, which was interpreted from the written procedures. Figure 1 depicts this flowchart. Participating in KYTC's Utility Relocation Task Force facilitated the research team's understanding of utility relocation; this process was then overlaid atop the highway design process, with a temporal component added. Figure 2 recreates the process chart originally prepared during the task force by the Executive Director of the Office of Project Development at KYTC. This process is outlined for a typical one-mile, federally funded project having an environmental document classification of categorical exclusion type three, and including 30 right-of-way parcels along with six to eight utility relocations. Given those characteristics, a timeline of the processes involved in design, right-of-way acquisition, and utility relocation was developed, as seen in Figure 2. Figure 3 is the result of the discussions held by the Utility Relocation Task Force (and in coordination with the Right-of-Way Task Force, which KYTC commissioned concurrently). These task forces were able to show the project development process could be shortened by approximately a year with better coordination and communication.

Figure 1 Interpretation of KYTC Utility Planning and Relocation Process

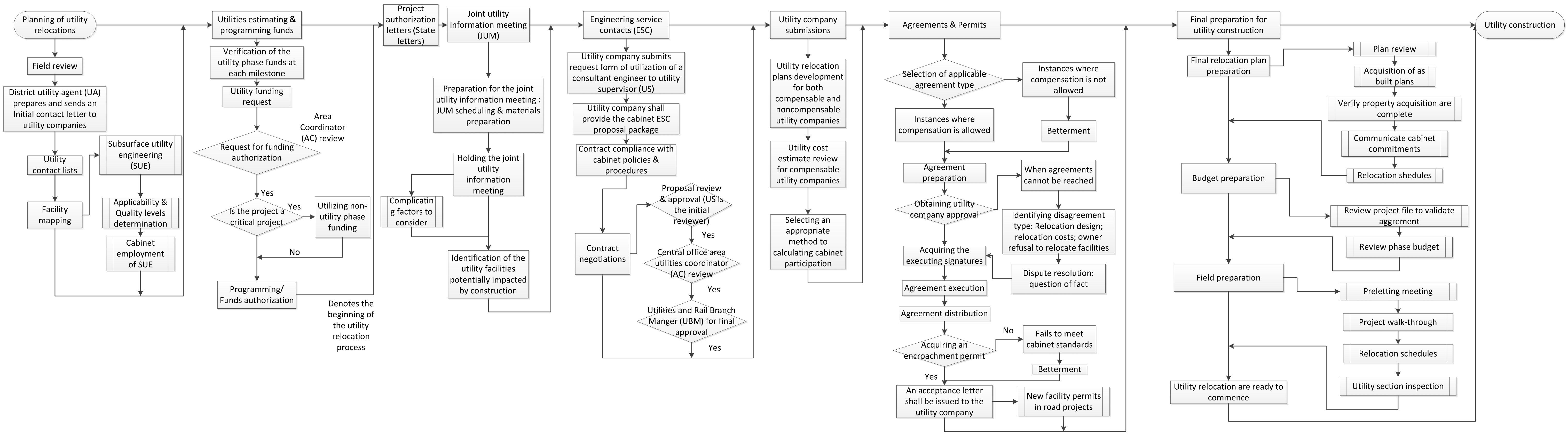


Figure 2 Adaption of the Original KYTC Project Development Process (Source: Executive Director of the Office of Project Development)

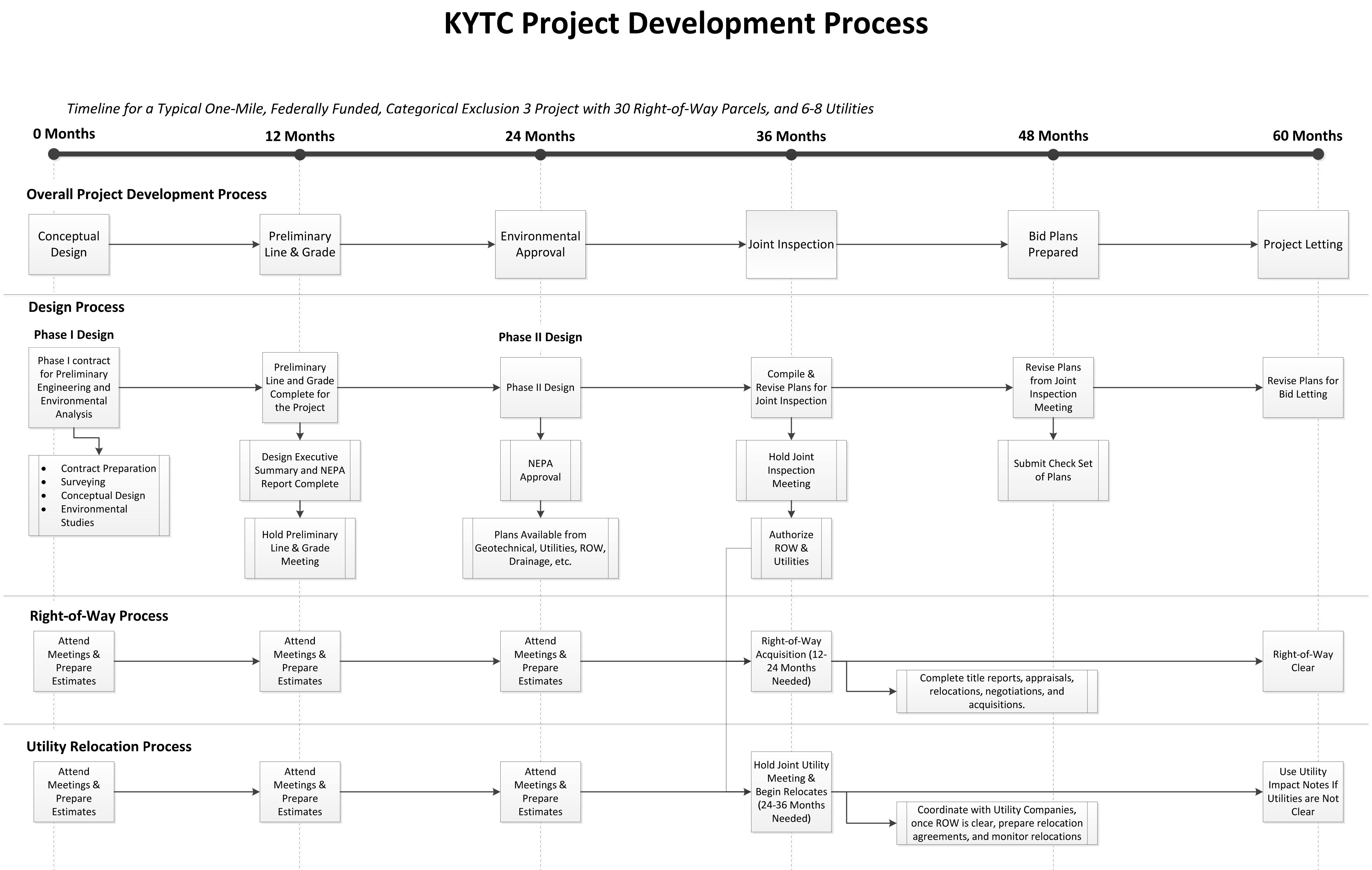
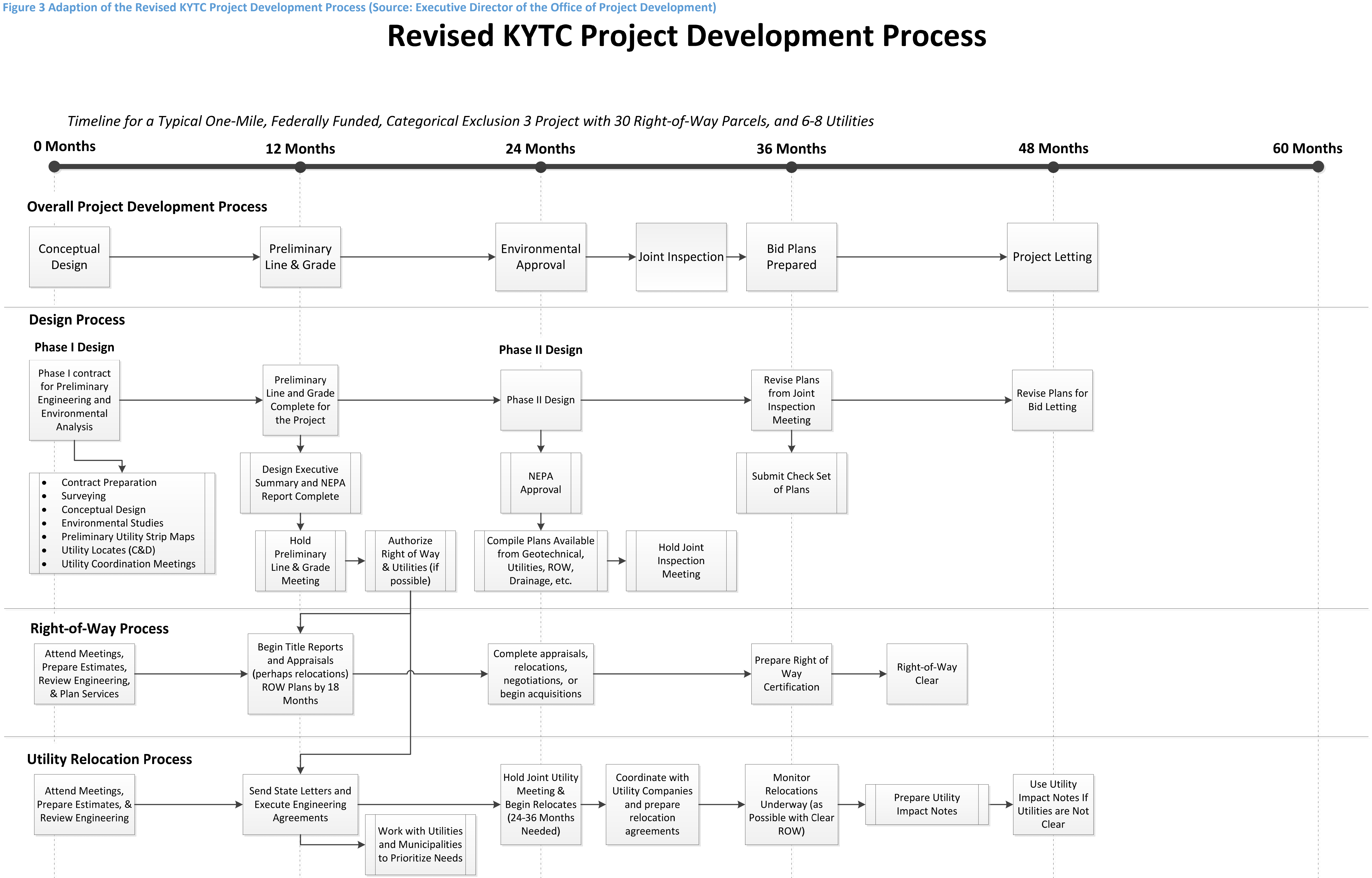


Figure 3 Adaption of the Revised KYTC Project Development Process (Source: Executive Director of the Office of Project Development)



Outcomes of the KYTC Task Forces

The revised processes implemented because of the Right-of-Way and Utility Relocation Task Forces is recent; as such, the eventual impacts they will have on accelerating these processes remains uncertain. Nevertheless, they have influenced this research. Participating on both task forces let the research staff become much more knowledgeable of the processes involved in utility coordination and relocation as well as the regulatory guidelines that shape them. Many possibilities, technologies, and techniques were mentioned as part of the task force meetings. For the most part, these mirrored possibilities researchers found during their literature review. However, some of these recommendations were eliminated after taking part in the task forces because it became clear that the complexities and legalities of utility relocation and coordination in Kentucky would render them inappropriate. The KYTC task forces opened new directions that will let the Cabinet move forward with adopting new strategies to hasten project development and utility relocation. The task forces' work also revealed possible pit falls that are involved in making reforms. No clear solutions will unquestionably speed up these procedures. Streamlining this process will be predicated on the strategic use of technologies, employing efficient communication techniques, and learning to sensibly organize and coordinate multiple efforts. With this knowledge established the project team sought to a clear understanding of the regulations controlling these procedures. The next sections review these regulations.

Best Practices: Application of Recommendations

Based on the literature review, interviews, and surveys, the following sections lay out all potential best practices. The first section discusses procedural and programmatic changes, which would be applied to all aspects of programs involving utility relocation. The later sections provide an overview of tools that can be applied to projects on an *ad hoc* basis to correct specific problems.

Procedural/Organizational Recommendations or Ensuing Changes

Earlier and Enhanced Utility Coordination and Involvement

Description

KYTC's previous model for project development involved few interactions with UCs until design had advanced to the point that funding could be authorized for utility relocations. This authorization occurs after the Cabinet verifies that all aspects of a project comply with the National Environmental Policy Act (NEPA) regulations. By this point, many decisions related to the design and main alignments have been made; introducing changes that affect right-of-way acquisition or design orders can be quite costly and potentially lead to delays at this juncture. This severely limits the influence of the UCs, which are typically left out of the decision-making process up to this point. As **Figure 2** indicates, the input by UCs is usually received during the middle of a project (around year three of a five-year design). Getting UCs involved earlier in the process may require additional coordination and communication, yet there are vast benefits and savings that can be realized in doing so. **Figure 3** illustrates an example of where UCs will be enfolded into the revised KYTC project development process.

Potential Benefits

In addition to potential timesavings, involving UCs earlier during projects allows design professionals to cater their designs so that impacts to utilities will be minimized. Designers of transportation facilities often have limited knowledge of what impacts their designs have on project duration and costs as well as on the local utility infrastructure. Making them aware of these impacts, and involving UCs early during the design phase, lets stakeholder make informed decisions about project siting. Making changes to the design process entails providing stakeholders with more information about the utilities that will impact the project (e.g. the types of utilities present, their location relative to the project location)

KYTC Assessment

Based on interviews, it is clear that KYTC stakeholders are confident that bringing UCs onboard earlier in the process will streamline and quicken utility relocations. Nearly one-third of KYTC employees surveyed noted doing this has the greatest potential to enhance project quality and execution.

Utility Assessment

The UCs contacted also felt being involved earlier on in projects would improve workflows. Several UC stakeholders noted that if UCs are doing their due diligence they should investigate proposed project sites to determine if their presence is warranted. Another helpful step would be attending project development meetings to offer feedback on project planning. One-third of the UC respondents felt that better collaboration between UCs and KYTC would make the most impact on utility relocations.

Emphasize Strategic Avoidance in Project Design

Description

Emphasizing strategic avoidance in project design is a two-staged process; it is also critical that UCs be involved early on if this is to happen. Under this scenario, project designers would use a more context-sensitive design approach, one that is mindful of current utility placement. Adopting this strategy would let stakeholders modify designs to avoid or minimize effects on existing utilities. Designs, however, must not adopt changes that would sacrifice safety or project functionality. Arriving at appropriate designs is only possible when subject matter experts and UC representatives participate in the process. The second stage of this concept hinges on UCs providing input. Given their expertise, UCs can highlight specialized or critical utility infrastructure that would be exceedingly costly to relocate. During this stage, UC stakeholders should be responsible for calling attention to features that require long-lead items for relocations.

Potential Benefit

Being mindful of utilities during the design process may carry additional upfront costs. However, the benefits realized over the project's lifecycle will far outweigh these initial expenses. Avoiding utilities altogether can yield significant financial gains when dealing with long-lead items or those that demand specialized relocation efforts.

KYTC Assessment

KYTC responded favorably to emphasizing strategic avoidance in project design. Some interviewees felt that the location of utilities should not impact design choices. These respondents commented that the designers needed to prioritize, above all else, road functionality and safety. However, all respondents agreed that due diligence is warranted.

Utility Assessment

UCs overwhelmingly support the practice of projects avoiding utility facilities when possible.

Strategic and Routine Communication between Utility Companies and KYTC

Description

It is critical that KYTC and UCs remain in frequent communication with one another so that each party is aware of the other's needs. "Strategic" in this context refers to the need for sustained communication for projects impacting urban locations; conversely, when projects occur in rural locations, discussions between KYTC and regional UCs can be more sporadic (based on project needs). Here, communication denotes interactions between KYTC and UCs on planned short- and long-term projects as well as any talks that take place in response to specific issues. Communication should be routine and conducted on a district-by-district basis. Potentially, the communication process could be modified to separate out discussions about long-term planning from those related to short-term issues.

Potential Benefit

KYTC and UCs mutually benefit when both are informed of the others activities. The information shared during these exchanges can inform UCs about where short- and long-term impacts to their facilities may occur. KYTC will receive word on the completion data of relocations. UCs will also be able to use long-range planning to determine where system updates may be most feasible. For instance, a UC may delay upgrading a system if it is likely to be impacted by a transportation project in the near term. Additionally, KYTC may reallocate resources on specific projects that project managers know utility relocations will be delayed on beyond the original completion date.

KYTC Assessment

KYTC staff felt better communication would generate positive outcomes. However, only 22 percent of KYTC utility personnel who responded mentioned that the current level of communication between UCs and the Cabinet was inadequate. Yet, 75 percent of KYTC design employees who responded felt the communication level was inadequate. A targeted effort at improving communication may produce the most benefits as the level of interaction between KYTC and UCs varied from district-to-district.

Utility Assessment

UC representatives also observed that communication between UCs and KYTC varied by district. They noted that boosting strategic communications in the short- and long-term would be very beneficial to their planning and coordination. 50 percent of respondents believed current levels of communication were sufficient.

Develop and Offer Training Related to the Use of Subsurface Utility Exploration (SUE), Utility Specific Plan Reading, and the Coordination of Project Design, Utilities, and Right-of-Way

Description

Interviewees and stakeholders observed there were multiple areas in which new training concepts could be implemented to improve project outcomes. The three principal areas were: 1) the use of SUE; 2) conducting training or workshops focused on reading utility plans; and 3) training to coordinate project design, utility relocation, and right-of-way acquisition.

Potential Benefit

Although many people misrepresent SUE as pinpointing the location of utilities, it is a method used to determine the level of spatial/locational information required given the constraints of project design; it can also be used to evaluate the amount of spatial/locational information needed to conduct a specific stage of a project design. SUE encompasses the strategic application of methods designed to ensure that utility funds are spent in a fiscally responsible manner.

Respondents offered multiple suggestions to improve stakeholders' ability to read utility plans. First, an improved understanding of utility plan symbols and layout can help project designers to better visualize the location of utilities that may be affected under different implementation scenarios. Representatives from UC companies emphasized that utility designers did not understand highway plans. Expanding the level of training available to KYTC and UC staff can eliminate potentially costly errors – for example, like those that can arise when utility designers do not incorporate adequate clearance because they do not interpret highway plan sets correctly.

Lastly, UC and KYTC personnel stressed the importance that all project stakeholders have a solid grasp of project design, utility relocation, and right-of-way acquisition. When there is mutual understanding among all project stakeholders with regard to their respective tasks, the likelihood of attaining satisfactory project outcomes increases.

KYTC Assessment

Some KYTC staff believed the onus for developing training programs would ultimately fall to the Cabinet; as such, the design of training protocols should be carefully considered and implemented using a phased approach. Although everyone endorsed the move to enhance stakeholders' ability to read plans, there was some skepticism over whether dedicated training programs were necessary.

Utility Assessment

UCs supported plan-reading training. Representatives were particularly enthusiastic about training utility designers to read and interpret highway plans. They felt this training would confer the most benefits if KYTC conducts it.

Coordinated Statewide Electronic Management System for Utilities and Relocations

Description

Several best practices guides and STA guidance manuals highlighted the critical role of data tracking and availability. KYTC is currently developing a system to improve its capabilities in this area. Creating a more robust GIS interface is also a possibility KYTC is contemplating.

Potential Benefit

Data warehousing systems can track utility relocations, store updates from UCs, enable the submission and exchange of e-documentation, and provide a solid foundation on which to base communication. If KYTC has a centralized database with historical information it can, for example, empower staff to make more accurate cost estimates on relocation projects.

KYTC Assessment

Most KYTC stakeholders expressed positive feelings about installing a data warehousing system, but there was uneasiness over the technological changes required, the level of additional effort needed to input and update information, and the accessibility of information.

Utility Assessment

UCs lacked a strong opinion about this concept and felt it was something that ultimately benefited the Cabinet. One interviewee, however, did voice concern over the security of information.

Use of Master Agreements

Description

Master agreements streamline the establishment of agreements between KYTC and UCs. This is helpful, as it would prevent parties from having to get involved on a project-by-project basis.

Potential Benefit

The advantage of using master agreements lies in reducing the amount of time needed to execute design and relocation agreements.

KYTC Assessment

KYTC personnel supported this strategy, especially since time savings could be realized without overlapping effort in establishing agreements.

Utility Assessment

UCs had mixed feelings on master agreements. Some supported their use, while others commented that it was unlikely that company lawyers would permit a binding agreement.

Risk Analysis & Guidance Development

Theory & Approach

This section describes efforts to develop a number of strategies that would align best practices with the needs of individual projects. Two strategies were attempted to define a level of utility risk for a project based on design characteristics. The first approach considered risk according to how many project issues and/or change orders were utility-related. The research team used the Post-Construction Review Database for this approach. The second strategy used project information and dates entered into the database for utility funding authorization, utility clearance, and the number of utilities involved and their respective level of impact. This data was analyzed from the much larger Pre-Construction Database and required paring down information to a manageable subset.

Post-construction Data Method

The first data source examined was the Post-Construction Review records, which were collected by KYTC's Quality Assurance Branch. This data set contained information from reviews of 293 KYTC projects. Reviews are captured once a project has been finished; their objective is to identify any lessons learned during the project lifecycle that could be applied in other contexts. Lessons learned may pertain to change orders, disputes, or minor project issues. Review teams speak with designers, administration staff, the project contractor, and other stakeholders to obtain a cross section of opinions. After the review team completes its work, lessons are coded and entered into the database. For each project, the database includes information on: project identification numbers, route type and number, county, district, project mile points and length, project type, letting date, date of the review, change orders and associated causes and costs, designer and contractor involved, and other information. Each lesson learned is assigned to a category and subcategory within the database. For this project, the main category of concern was utility issues. There were 35 projects in the Post-Construction Review Database that experienced utility-related problems. Despite this being a small subset, the research team carried out statistical analyses to detect any trends.

The researchers calculated the risk of utility relocation by using the number of utility issues as a proxy. A higher number of utility issues that the research team assumed predicted higher risk or effort involved in that particular relocation. The objective of this analysis was to develop a predictive model that could be used to estimate the number of utility issues that are expected to occur during a project. Research team members assumed there were three different levels of risk: low, medium, and high. If the predicted number of utility issues was from 0 to 5, it was assigned a low risk level. For a predicted number of utility issues between 5 and 10, a medium level of risk was designated. If the predicted number of utility issues exceeded 10, the level of risk assigned was high.

The following method was used to generate predictive models:

1. The Post-Construction Review database was searched, and the results filtered, to identify only those projects that experienced utility issues and the number of those issues was totaled and entered in a separate field.
2. Project details, length, route, project type, etc., were combined with the current data from a second data source, the Preconstruction database, to assist in equation development.
3. The research team attempted to develop equations that would estimate the number of utility issues based on various project characteristics.

In this step of data analysis, the team members calculated the R- squared value to assess how the attempts performed in estimating the number of utility issues and other characteristics. These attempts showed very little success stemming from small sample sizes, data correlation, and bias, among other issues. The study advisory group felt this data would provide clues to the potential of utility concerns. For this reason, the figures below are provided to present the results of the analyses that provided little in way of a method forward.

Figure 4 Utility Issues versus Number of Change Orders

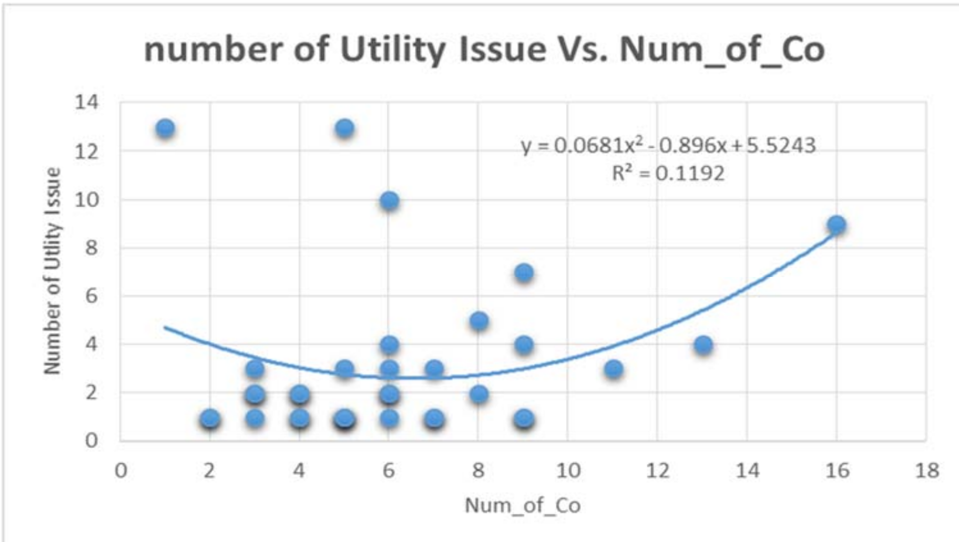


Figure 5 Utility Issues versus Utility Phase Authorization Amount

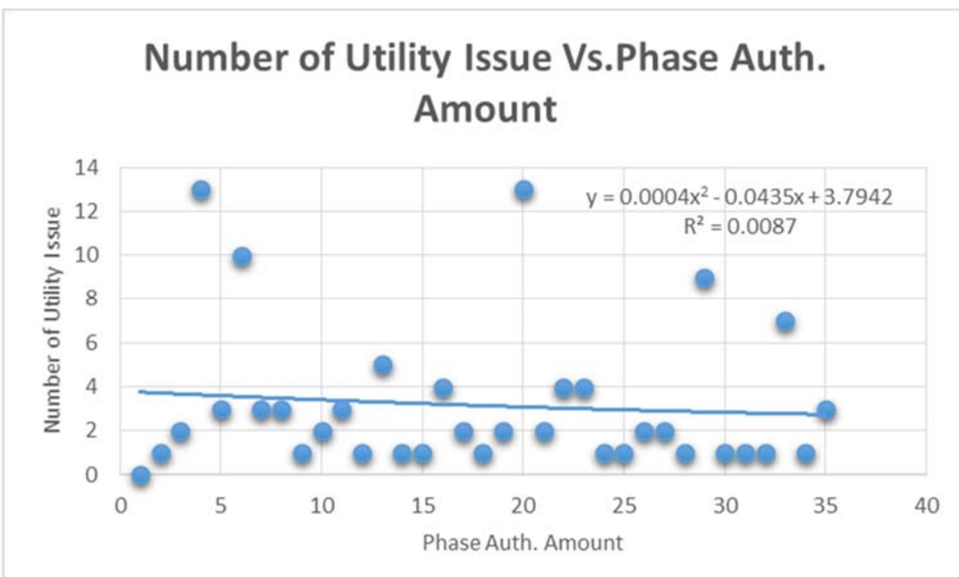


Figure 6 Utility Issues versus Number of Utility Negotiations Initiated

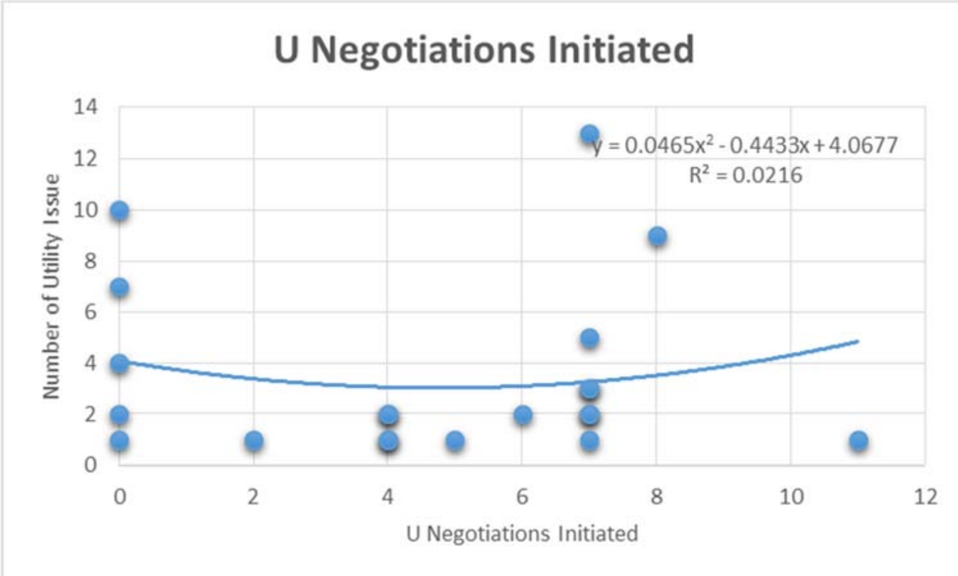


Figure 7 Utility Issues versus Project Construction Cost

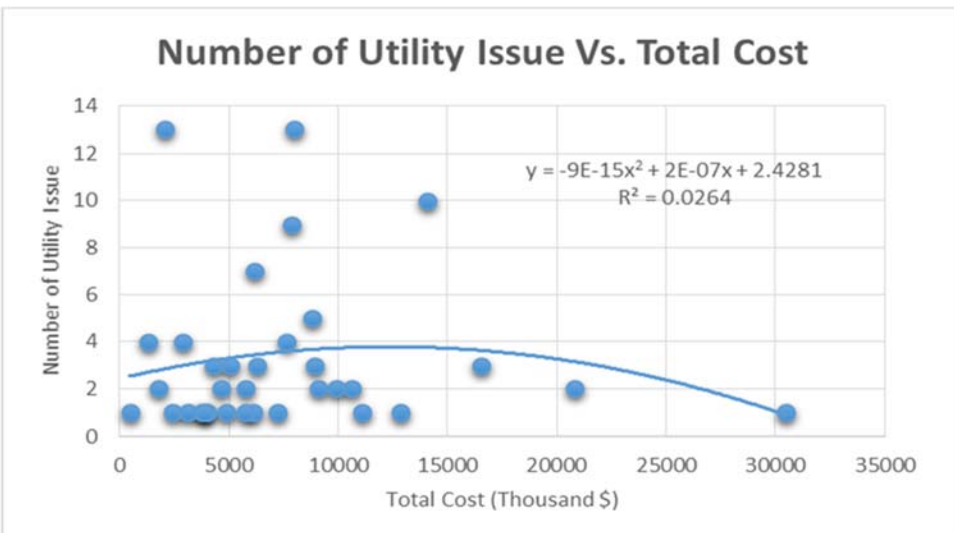


Figure 8 Utility Issues versus Number of ROW Parcels

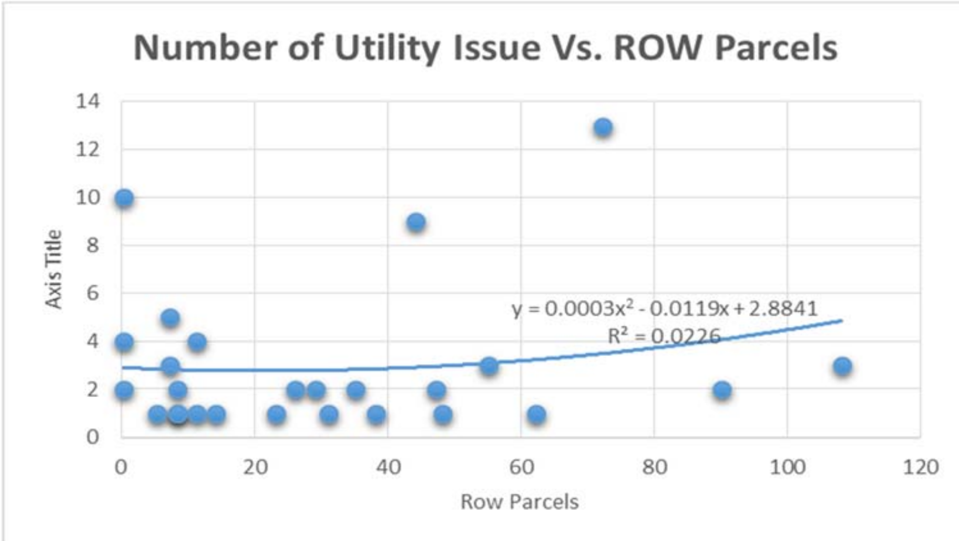
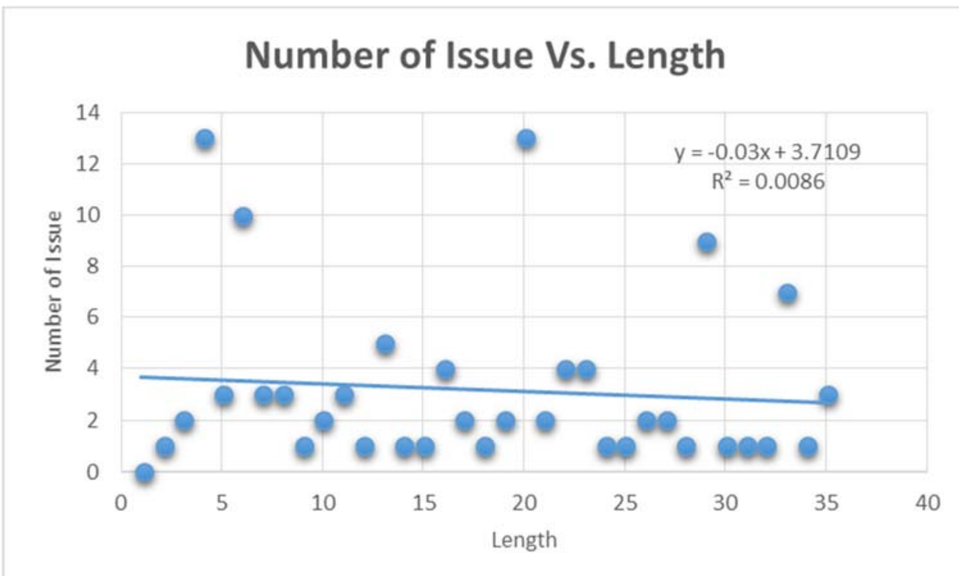


Figure 9 Utility Issues versus Project Length



Preconstruction Data Method

The second set of data analyzed was collected from the preconstruction database containing information related to 13,856 KYTC projects. The information related to each project included district, project item number, type of work, length, number of Lanes, route type and number, beginning and ending mile points, phase funding and authorization date, construction cost estimates, the number of right-of-way parcels, a utility clearance date (though few existed since this was newly implemented), the number of utility negotiations initiated and completed and by what date, as well as the same information for utility agreements and relocations, and much more. This was obviously the more robust data set with the only issue being how to define risk from the many possible variables.

There were several attempts to analyze the data along single comparisons such as only looking at projects with utility clearance dates, but this approach drastically limited the population of data for analysis. The selected method for modeling risk hinged on the comparison of three variables: 1) time required for utility activities; 2) number of utilities impacted by a project; and 3) the dollar value assigned to utility activities. After filtering the database, this more expansive view returned 1,966 records. First, risk assignments were made by normalizing comparisons of different projects. Projects fell into three risk categories – low, medium, and high. Projects that qualified as low risk, involve utility relocations that do not demand extensive effort and have a short duration. Medium risks involve a modest cost, do not involve longer durations, but should be managed with careful oversight. On high-risk projects, costs and durations are extremely high, such that strong mitigation efforts would be necessary for smoothing out the process. After defining the levels of risk, researchers reviewed each of the three areas of comparison described above to refine the level of risk previously assigned.

The first area of risk assignment was made according to the time associated with utility related activities. One can infer that the risk involved in a utility relocation will be higher on projects that have suffered longer durations related to these efforts. Because utility relocation time related data fields were not fully populated (for example, not every project had a utility phase authorization date, which would denote the beginning of utility work or a utility clearance date denoting relocation completion), researchers made multiple comparisons to estimate the duration of utility relocation. Durations were estimated using the following parameters, with the list below offering a priority ranking:

1. Utility Clearance Date versus Phase Authorization Date
2. Utility Relocations Completed Date versus Phase Authorization Date
3. Utility Agreements Completed Date versus Phase Authorization Date
4. Utility Negotiations Completed Date versus Phase Authorization Date

Using these comparisons 743 records were assigned risk levels. These definitions of risk levels are found in Table 15.

Table 15 Risk Assignment per Relocation Duration

Risk Level	Description for Utility Duration
Low (1)	Less than 365 days (1 year)
Medium (2)	Between 365 and 1095 days (3 years)
High (3)	Greater than 1095 days

The next method for assigning risk was the number of utilities involved in a given project. The idea here was that having to move a larger number of utilities would increase the amount of time spent of utility relocation for a project. Though the researchers felt this measure was more abstract than the previous one, it was still valid and had a value on 1,503 of the records available. The maximum value recorded for the number of utilities negotiated, utilities relocated, or utilities with agreements determined the associated risk within this metric. Table 16 illustrates the allocation of risk associated with this method.

Table 16 Risk Assignment per Number of Utilities

Risk Level	Number of Utilities Involved
Low (1)	Less than 3
Medium (2)	Between 3 and 6
High (3)	Greater than 6

The final metric used to allocate risk was the amount authorized for projects' utility phase. The idea here was that higher utility phase costs equated to more complicated and prolonged relocations. Using this metric brought 1,878 points into the dataset. Researchers assigned risk values based on descriptive statistics – which are summarized in Table 17. The utility phase values are highly skewed, indicating a large spread. Risk assignments were challenging to issue, but the research team settled on using twice the median as the divisor. This appeared to divide the data into thirds according to the third quartile. Table 18 summarizes the risk assignments according to the phase value comparison.

Table 17 Utility Phase Statistics

Descriptive Statistic	Utility Phase Value
Average	$541,305
Standard Deviation	$962,140
Minimum	$0
Maximum	$9,717,856
First Quartile	$50,000
Median	$150,000
Third Quartile	$586,500

Table 18 Risk Assignment per Utility Phase Estimate

Risk Level	Utility Phase Authorized Amount
Low (1)	Less than $300,000
Medium (2)	Between $300,000 and $600,000
High (3)	Greater than $600,000

After classifying all of the projects, the research team used a simple algorithmic average to determine the final risk score for a project. A final review of the scores indicated that the risk scores aligned across multiple projects, which vindicated the averaging the approach. Taking averages dampened the effect of outliers, improving the robustness of the results. After making comparisons using the average risk scores, the research team developed a model for risk assignment using multiple linear regression. Table 19 lists the number of projects falling into each risk category.

Table 19 Breakdown by Risk Level Assignment

Risk Level	Number of Projects Per Risk Level (1,966 Total)
Low (1)	836 (42.5%)
Medium (2)	745 (37.9%)
High (3)	385 (19.6%)

A complete description of the statistical methodology can be found in the Appendix. First, the research team performed exploratory data analysis to ensure the data met the assumptions of multiple linear regression. Although the data contained a number of outliers, it did not require transformations to meet the assumption of normality. The first model developed included as many variables as possible; this yielded a regression equation with an R-squared value of 0.915, which indicated that ≈ 92 percent of the variation was explained by the regression. The first model used six variables; of these, three were categorical (n = 27 categories). Despite its good predictive value, this model was exceedingly complex to use because of the large number of variables. Using a stepwise procedure to slim down the regression, a final model was developed that included district, project type, utility phase amount, and the number of utilities involved as the independent variables. The resultant equation has an R-squared value of 0.84 and is:

$$\begin{aligned} Risk = {} & 1.14 - 0.02 * District - 0.00 * Type\ Bridge\ Replacement\ (1\ or\ 0) + 0.45 \\ & * Type\ Design\ Engineering(1\ or\ 0) - 0.09 * \ Type\ I - Change\ Reconst(1\ or\ 0) \\ & + 0.13 * Type\ Major\ Widening\ (1\ or\ 0) + 0.68 * Type\ Minor\ Widening\ (1\ or\ 0) \\ & - 0.11 * Type\ New\ Interchange(1\ or\ 0) + 0.58 * Type\ Reconstruction\ (1\ or\ 0) \\ & + 0.07 * Type\ Safety(1\ or\ 0) + 0.36\ Type\ Safety - Hazard\ Elim(1\ or\ 0) + 0.00 \\ & * Type\ Spot\ Improvements(1\ or\ 0) + 0.02 * Phase\ Autorization\ (in\ \$100{,}000) \\ & + 0.13 * Number\ of\ Utilities\ Involved \end{aligned}$$

This equation lets stakeholders estimate the level of risk associated with a project. Knowing the level of risk can let stakeholders identify the tools and best practices for dealing with risk. The following section describes tools the user can adopt to improvise solutions based on the estimated utility risk of a specific project. The regression equation should not be viewed as offering deterministic predictions; rather, it should serve as a starting point to provisionally estimate risk and strategize about the most appropriate way to mitigate that risk. The user must keep in mind that the risk estimates are not entirely objective and that professional judgment should always be used in conjunction with these methods.

Utility Relocation Risk Assessment & Relocation Toolkit

Table 20 offers guidance on best practices for accelerating utility relocations. The table summarizes the strengths and weaknesses of each approach; it also identifies opportunities and contains information on the potential drawbacks of implementing each one. This tool should offer guidance; no situation will perfectly align with those described, and circumstances may arise when a tool falls outside of the defined risk type; professional judgment should always be used. Additionally, some tools do not align well with particular risk types and should be used on an as-needed basis.

Table 20 Utility Best Practice Toolkit Guidance

Tool	Appropriate Risk Level	Strengths	Weaknesses	Opportunities	Threats
Early Utility Involvement in Design	1,2,3	• Early incorporation of utility knowledge in design process • Early identification of potential utility issues • Better coordinated	• Level of effort increases for utility staff early in project	• Time savings from better coordination • Money savings form avoiding potential issues	• More involvement could slow early design
Training project managers and other design personnel on utility issues	1,2,3	• Sufficient knowledge with regards to utility relocation • Better and early identification of potential utility issue	• Level of effort increases for manager and design personnel	• Time and cost saving from better design • Time and cost saving from better management • Better coordination from more knowledge	• Spending more cost and time for training
Training consultant and utility owner personnel	1,2,3	• Sufficient knowledge with regards to utility relocation	• Level of effort increases for consultant and utility owner personnel	• Less reworks • More coordinated	• Spending more cost and time for training
Early utility cost estimation based on worst assumption	2,3	• Better budgeting	• Time & effort in development	• Early understanding of cost & potential scope	• Pricing unheeded budget
Using technology tools such as Google Earth, GIS in the planning stage	2,3	• More effective tools for planning	• Lack of enough experts • Personnel training	• Time saving • Cost saving • More effective management	• Spending more time and cost for training
Contracting with expert consultants versed in utility design	2,3	• Better consultant • Better design	• Availability • Higher cost	• Less conflict and rework from better design	• More cost from contracting with expert consultant
Developing a database of historical utility relocation costs to generate best cost		• Sufficient historical data with regards to utility relocation cost	• Additional effort	• Faster and more accurate utility relocation cost estimation	• Spending more time and expense to accumulate the historical data

estimate					for the first time
Installing radio frequency identification markers on nonmetallic utilities		• Using easy and heap method to find nonmetallic utility	• This kind of technology is not that common. • The cost of this technology is high	• Time and cost saving to identify nonmetallic utilities	• Need more time to install these markers • Spending additional cost to provide and install these devices • Security concern
Developing GIS system to store, manage, and recall utility information		• Having a strong, sufficient, and modern database.	• Lack of professional personnel.	• Easy to update • All sectors can update database with any changes in utility • Easy access to database for all sections that are involved in utility relocation. • Better management • Time and cost savings	• Needs much time and cost to transfer old data to new system. • Spending time and cost to train personnel.
Establishing utility corridors for utilities crossing major highway	3	• Early identification of utility area	• Requires more consideration and possibly cost early design	• Time saving • Easier utility design & utility R.O.W issues	• Increases R.O.W cost • May not always meet utility needs
Ensuring that all guidance documents do not conflict with each other	2,3	• Better coordination. • Early identification of potential conflict in different guidance	•	• Time saving from better coordination	• Spending much time providing all guidance documents without conflict
Placing a utility expert on project design team	2,3	• Enhancing utility knowledge of design team	• Additional time spent in early design	• Time and cost savings from more professional design	• More effort spent to satisfy utility constraint, than perhaps needed
Developing a standardized format to identify and resolving utility conflict		• Early identification of utility conflicts and their resolution • Better management	• Standardized format can't cover all conflicts	• Time and cost savings from quick identification and resolving utility conflicts	• Issues from using standardized format may cease being a problem when the conflict is outside the

					standard scope
Having frequent joint meetings with utility owners as design process	2,3	• Incorporate utility knowledge design process • Identification of potential utility issues • Better coordinated	• Level of effort increases for utility staff	• Time savings from better coordination • Money and time savings from avoiding potential issues	• More involvement could slow design
Providing training in highway plan reading to utility owners	1,2,3	• Sufficient utility owner knowledge in highway plan reading • Better coordinated	• Level of effort increases for utility staff	• Time savings from better coordination	• Spending more cost and time for training
Advancing relocation of utility work before highway construction begins	3	• Construction can begin without utility conflicts.	• Possible delay in bid telling.	• Less conflict between highway construction and utility relocation work	• Some delay from waiting to finish utility relocation work • Cost escalating could occur
Handling each project just by utility coordinator from start to finish	1,2,3	• Better coordinated • Better management	• Cannot control loss of personnel	• Time saving from better management and coordination. • Money saving from better management	• Staffing turnover could leave gaps without replacement, if others are not familiar with the project.
Acquiring sufficient ROW for utility purpose	2,3	• Sufficient ROW for utility purpose	•	• Time saving for achieving R.O.W for utility purpose • Time saving and less conflict in design step	•
Work site utility coordination supervisor is needed to coordinate utility during the construction phase on every project that uses SUE.	3	• more coordination	• Level of effort increases for Work site utility coordination supervisor • Availability	• More coordination • Less conflict • Less rework	• More cost for hiring expert supervisor
SUE consultant is needed to provide	3	• Better consultant • Better design	• Availability • Higher cost	• Less conflict and rework	• More cost from contracting with

the corresponding recommendation				from better design	expert consultant
DOTs permit the opportunity to reimburse a utility for the cost of relocating its facility early	3	• Early involvement	• Higher cost	• Less negotiation • Less conflict	• Less quality • Maybe more rework

Table 21 describes specific project issues and identifies what tools and practices could offer the greatest benefits.

Table 21 Project Utility Issues Aligned with Best Practices

Project Issue	Helpful Tools	Potential Benefits & Concerns
Overhead Utility Relocations & Associated Delays	Early Involvement & Communication	Engineering and relocation begins as soon as possible and parties are able to plan or apply other tools accordingly
	Investigate temporary relocations	May simply push delays back; may incur additional costs
	Establish a Utility Corridor	Could ease the engineering process if done appropriately; may not satisfy all needs
	Separate or Service Contract for Clearing & Grubbing	Could speed the relocation process; could entail erosion concerns
	Utility Impact Notes	Allows the project to go to letting and work to begin; if the dates noted slip, could result in delay charges to the KYTC
	Incentives for Non-Reimbursable Utilities	Could incentivize utilities to relocate; some companies will not view the incentive as prosperous; use with caution
	KYTC design of Utility Facilities	This could speed engineering; may be difficult finding qualified designers and utility companies may not allow it
Long-Lead or Specialty Items	Early Involvement & Communication	Engineering and relocation begins as soon as possible and parties are able to plan or apply other tools accordingly
	Avoidance	Considering redesign costs is needed to avoid potentially lengthy utility issues

	KYTC order/purchase of items	May speed utility company order/purchase process; may acquire unused items and reimbursement may be cumbersome
Underground Utility Location & Relocation & Associated Delays	Early Involvement & Communication	Engineering and relocation begins as soon as possible and parties are able to plan or apply other tools accordingly
	Investigate temporary relocations	May simply push delays back; may incur additional costs
	Incentives for Non-Reimbursable Utilities	Could incentivize utilities to relocate; some companies will not view the incentive as prosperous; use with caution
	Use of joint trenches	May speed alignment but coordination could be a concern
	Strategic use of SUE	Determine level needed based on guidance
	Use of Marker Balls or other RFID location devices for future reference	Good for continued location; utility companies may not approve
	Technology locations, e.g. ground penetrating radar	Could be costly; best associated as part of SUE determination
Utility Company Easement Issues	KYTC acquisition of easements	Legal concerns
Local/Small Utility Constraints for Relocation	Incorporate utility relocations in contract	Could speed relocations if acceptable by utility owner though inspection and quality control could be a concern
Hazardous Material or High Risk Facilities	Early Involvement & Communication	Engineering and relocation begins as soon as possible and parties are able to plan or apply other tools accordingly
	Avoidance	Consider redesign costs as needed to avoid potentially lengthy utility issues

Project Recommendations, Implementation & Conclusions

Based on interviews and surveys with representatives from KYTC and UCs, this research uncovered a number of strategies to mitigate the negative consequences that often arise due to utility relocations. The principal findings of this project are summarized below:

- Conflicting with the opinions of KYTC staff, UC representatives felt that developing courses in plan reading would streamline the design and execution of construction projects. It produces better communication between all stakeholders and thus enhances project coordination. With new hires making up an increasingly large portion of the construction industry workforce, experience in reading utility/highway plans is a much sought after asset.
- Maintaining strategic and routine communication between KYTC design and utility staff and UCs will provide enormous benefits with relatively little investment. Fostering better communication will assist UCs as they undertake budgeting and planning. Another critical activity is having UCs and KYTC share with one another short- and long-range planning; this point is especially salient for, and applicable to, KYTC, which often does not provide UCs with sufficient lead-time during the planning process.
- Strategically employing SUE stands to benefit KYTC's efforts to handle project designs and utility relocation. Providing training to design and utility staff will give them the background to use SUE – which in turn can mitigate potential conflicts with utilities.
- Interviews with KYTC and UCs suggested that offering reimbursements for non-reimbursable utility relocations, or even bonuses, expedite relocations. UC representatives indicated that the budgeting is rarely a source of delay, and that dedicating additional financial resources will not accelerate utility relocations. More funding does not address the more critical issues – the lack of personnel resources, long lead items, or multiple company coordination. While there may be circumstances under which reimbursements will speed up relocations, this approach should be used strategically and with caution.
- Utility facility design, because it is specialized, is not likely to be incorporated into KYTC consultant contracts; however, there may be instances where this provides net benefits (water, sewer, or other simple facilities). This practice requires strategic implementation.

The tools described in this report offer useful guidance for STAs on construction projects that involve utility relocations. It is critical that UCs with facilities located along transportation corridors be viewed as construction partners. KYTC should make every effort to improve collaboration and communication with them, as this will streamline any utility relocation projects. Determining the level of risk associated with relocations is an integral part of this effort. Understanding risks, applying appropriate tools and best practices can lead to more efficient design and construction practices.

Following from this research are several recommendations:

- Reevaluate the recent changes to the utility relocation processes in two to three years to ensure KYTC personnel use them as planned and determine if incremental changes are appropriate.

- Develop standardized methods of data capture for utility relocations. Review these data in light of the tools and best practices outlined in this report. Refining data analysis will improve the risk determination tool over time and lead to better project outcomes.
- Creating new training courses, such as in reading highway or utility plans, confers significant benefits to stakeholders at UCs and KYTCs. All parties should investigate potential avenues to develop these new training initiatives.

Implementing the tools and best practices described in this report should be a straightforward task, but it could be simplified by using structured spreadsheets that have best practices and tools embedded in them. Along with the suggestions above, implementing user assistance tools can improve the delivery and usability of guidance.

The co-location of utilities within and near road right-of-ways will always present a challenge in terms of restructuring those facilities to accommodate improvements in the highway system. Utility work associated with highway projects presents many challenges to KYTC and even the most experienced utility planners. While the process is controlled by permit, contractual, and legislative regulations, there are numerous tools and procedures available to assist the relocation process. This project attempted to collect best practices, which can potentially assist the KYTC with streamlining and expediting utility relocations. It also provided guidance and strategy for deploying them. The widespread adoption of these tools will enable stakeholders to provide feedback on their use, which will lead to their refinement and transformation so they can play an integral role in expediting and streamlining utility relocations.

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3. Tennessee’s Chapter 86 Provisions: Section 2. Tennessee Code Annotated, Title 53, Chapter 5, Part 8
4. Transportation Infrastructure: Impact of Utility Relocations on Highway and Bridge Projects, GAO/RCED-99-131. 1999
5. Multiple user manuals, guidance documents, and website references as mentioned within document body.

Appendices

Study Interview Questionnaire

The blank questionnaire:

SPR 13-460 Methods to Expedite and Streamline Utility Relocations for Road Projects

Stakeholder Interview/Questionnaire

Question 1: Based on the best practices listed (identified from literature review), with what frequency do you estimate that the KYTC makes use of this practice?

	Best Practices	**Never**	**Rarely**	**Sometimes**	**Often**
1	Train project managers and other design team personnel on utility issues.				
2	Train consultants and utility owner personnel in utility coordination processes and issues				
3	Consider paying utility relocation design costs regardless of prior rights to maintain coordination between available space and project timing.				
4	Consider task-order contracts with expert consultants versed in utility and highway design as an additional resource for design alternative suggestions.				
5	Develop an early utility cost estimate based on worst-case assumptions and continually revise it as design progresses.				
6	Use technology tools such as Google Earth, roadway video logging, and GIS systems to get early visualization of utilities in the planning stages of projects.				
7	Place a utility expert on the project design team as early as possible, keep them involved and informed as the design develops.				
8	Develop a standardized format for identifying and resolving utility conflicts and continually revise it as the design progresses.				
9	Develop a mechanism to capture any changes to the existing utility facilities performed by utility owners or contractors on the project as design develops. Update the utility mapping on the design plans as the utility data changes.				
10	Develop or utilize a GIS system to store, manage, and recall utility information gathered during plan development and during utility relocations and new installations during construction.				
11	Install or require utilities to install radio frequency identification markers on nonmetallic utilities during utility relocations or new installations.				
12	Develop a catalogue or database of historical utility relocation costs to generate the best possible cost estimate. Update this				

	Best Practices	Never	Rarely	Sometimes	Often
	database on a regular basis, but do not exceed annually.				
13	Develop visualization aids for utility pole and structure relocation costs.				
14	Develop catalogues and visualization techniques to assist designers in alternate design possibilities.				
15	Develop a rigorous pre-qualification for SUE consultants that address their technical qualifications.				
16	Develop a screening tool to assist and formalize the process of selecting the appropriate Utility Quality Levels for utility mapping. This might be an iterated process that is re-evaluated as additional detail is added to the design plans.				
17	Build on cost–benefit studies already performed to evaluate the cost-effectiveness of SUE.				
18	On projects where it is known in advance that utilities are a significant time or cost factor, get QLB (Quality Level-B) mapping as early as possible, preferably at time of topo development. Consider the underground utilities as an underground topo feature.				
19	Have frequent joint meetings with utility owners as design progresses to get their input on relocation issues and to make certain they coordinate their relocation designs with the available space.				
20	Provide training in highway plan reading to utility owners.				
21	Ensure that no guidance documents conflict with each other and that they use the same standard terminology as it relates to utilities.				
22	Use or consider establishing utility corridors for utilities crossing major highways or located longitudinally along highway ROWs.				
23	Acquire sufficient ROW for utility purposes.				
24	Advance relocation of utility work before highway construction begins.				
25	Each project is supposed to be handled by a utility coordinator from start to finish. Operational planning meetings will discuss any issues that may be related to the construction.				
26	DOTs share annual bills and monthly schedules with UCs, so that UCs can plan and budget accordingly.				
27	DOTs provide incentive to UCs for early utility relocation and permit the opportunity to reimburse a utility for the cost of relocating its facility early.				
28	Utility impact matrix is used to list all utility conflicts and a				

	Best Practices	Never	Rarely	Sometimes	Often
	SUE consultant is needed to provide the corresponding recommendations.				
29	Work site utility coordination supervisor is needed to coordinate utilities during the construction phase on every project that uses SUE.				
30	Use Subsurface Utility Engineering (SUE) for projects where underground utilities are present and high quality levels of information are needed for design purposes.				
31	Require utility company certification of record drawings and encourage development of a CAAD database system and electronic transfer system.				
32	Work with local governmental jurisdictions to establish pavement cutting criteria and backfill requirements.				
33	Provide utility companies with long-range highway construction schedules.				
34	Host meetings with utility companies to discuss future highway projects.				
35	Recognize the importance of long-range highway/utility coordination.				
36	Organize periodic (monthly, quarterly, annual) meetings with utility owners within municipality, county, or geographic or highway planning region.				
37	Solicit similar information on utility owner's capital construction programs, particularly where a utility has planned expansion or reconstruction may encroach on or coincide with a planned highway project.				
38	Consider using the long range planning meeting as a convenient forum to discuss other highway/utility issues, such as accommodation policies, reimbursement, etc.				
39	Provide utility companies with a notice of proposed highway improvements and preliminary plans as early in the development of highway projects as possible.				
40	Involve utility companies in the design phase of highway projects where major relocations are anticipated.				
41	Conduct on-site utility meetings or utility plan-in-hands with utility companies to determine utility conflicts and resolution.				
42	Participate in local one-call notification programs to the maximum extent practicable per state law.				
43	Invite utility companies to pre-construction meetings and encourage or require utility companies, contractors, and project staff to hold regular meetings, as deemed appropriate, during the construction phase of a project.				

	Best Practices	Never	Rarely	Sometimes	Often
44	Use standardized utility agreements.				
45	Initiate separate contracts for advance roadway work on selected projects prior to utility relocation.				
46	Set forth responsibilities for appropriate action to reduce delays to contractors.				
47	Provide utility special provision language in the construction contract.				
48	Avoid late plan changes.				
49	Have highway contractors relocate utility and municipal facilities, when possible.				
50	Pay non-reimbursable utilities for relocation design.				
51	Use DOT consultants for utility relocation design.				
52	Identify utility avoidance areas during conceptual design.				
53	Identify long lead items related to utility relocations in early design stages.				
54	Define utility corridors during project design.				

Other Best Practices Not Listed:

Question 2: Based on the best practices not currently used by KYTC, what are the top 5 you feel could provide the most benefit if added to normal KYTC procedure?

Question 3: List the major delays you perceive in utility relocations and indicate whether these are caused by KYTC, the utility company, or both?

Major Sources of Delay in Utility Relocations	Responsible Party

Question 4: List the major delays you perceive in utility relocations and indicate whether these are caused by KYTC, the utility company, or both?

Major Sources of Delay in Utility Relocations	Responsible Party

Question 5: Do you have any ideas that could streamline or expedite utility relocation on KYTC projects?

Survey Results Regarding Utility Procedures and Tools

1. Which group best describes yourself? (Demographic Assignment)

26 person attended in Utility Session 1,15 person (58%) are from KYTC-Utilities, 4 person (15%) are from KYTC-Design, 2 person (8%) are from KYTC-Other, 2 Person (8%) are from Consultant-Utilities, 2 person (8%) are from Consultant-Design and 1 person is from a group we called it " Other".

2. How helpful would you perceive training offered for project managers or design personnel concerning utility issue?

44% of all interviewees believe that training offered for project managers or design personnel concerning utility issues would be extremely helpful while 36% believe it would be somewhat helpful. Just 4% of all interviewees believe this training would not be helpful. 16% are not sure it is helpful or not helpful.

From those interviewees that described themselves as KYTC-Utilities 40% believe extremely helpful. 47.67% believe somewhat helpful and nobody of KYTC-Utilities believe training would not be helpful. 13.3% of KYTC-Utilities are not sure about the helpfulness effect of training for project managers or design personnel concerning utility issues.

75% of KYTC-Design believe training would be extremely helpful for project managers and design personnel and 25% of them believe it would be somewhat helpful.

From those interviewees that describe themselves as KYTC-Others, 50% believe this training could be extremely helpful and 50% of them believe it is not helpful.

100% of Consultant-Utilities believe training is extremely helpful.

All consultant-Design are not sure about the helpfulness effect of training.

3. How helpful would you perceive training for utility owners on highway plan reading to be?

60% of all believe that training for utility owners in reading highway plans would be extremely helpful but 100% of consultant utility, 40% of KYTC-Utilities, 75% of KYTC-Design, and 50% of KYTC-Others believe the extremely helpful effect of training for utility owners.no body of Consultant-Design believe that training for utility owners in reading highway plans would be extremely helpful.

4. How often does KYTC host meeting utility company for the purpose of short-term planning?

8% of all interviewees believe KYTC never host meeting with utility companies for purpose of short-term planning. 32% of all believe KYTC host this meeting rarely, and 48% believe KYTC host this kind of meeting sometimes. 12% of all interviewees believe KYTC often host meeting with utility companies for the purpose of short-term planning.

21% of KYTC-Utilities believe KYTC host meeting rarely and 57.14% of them believe somewhat while 21% of KYTC-Utilities interviewees believe KYTC hosts meeting often

25% of KYTC-Design believe KYTC never hosts meeting and 50% believe it hosts rarely, while 25% of them believe KYTC often hosts meeting with utility companies for the purpose of short-term planning.

100% of consultant-Utility believe KYTC host meeting sometimes.

100% of KYTC-Other believe KYTC host meeting rarely.

50% of Consultant-Utility believe KYTC never hosts meeting and 50% of them believe it hosts sometimes.

All other interviewees believe KYTC rarely host meeting for the purpose of short-term planning.

5. How often should KYTC host meeting with utility company regarding upcoming project or issue?

4% of all interviewees believe KYTC should host weekly meeting with utility companies and 50% of all believe KYTC should host monthly meeting, 46% of all interviewees believe it should host meeting quarterly.

From KYTC-Utilities interviewees just 7% believe KYTC should host weekly meeting, and 47% of them believe monthly meeting while 47% of them believe KYTC should host meeting with utility company quarterly.

Half of KYTC-Design believe monthly meeting and other half believe quarterly meeting.

Like KYTC interviewees, half of KYTC-Other think monthly meeting and other 50% think quarterly meeting should be hosted by KYTC.

All consultant-Utilities think KYTC should host meeting monthly.

50% of consultant-Design believe monthly meeting and 50% believe KYTC should host meeting with utility companies quarterly.

6. How often does KYTC host meeting with utility companies for the purpose of long-term planning?

12% of all interviewees think KYTC never hosts meeting with utility companies for the purpose of long-term planning.

52% of all interviewees believe KYTC rarely hosts meeting with companies for the purpose of long-term planning while 32% of them think KYTC hosts sometimes and just 4% believe KYTC often hosts meeting with companies for the purpose of long-term planning.

53% of KYTC-Utilities interviewees believe that KYTC rarely hosts meeting and 40% of them think KYTC hosts meeting sometimes with companies for the purpose of long-term planning. 7% off KYTC-Utilities believe KYTC often hosts meeting for long-term planning

67% of KYTC-Design interviewees think KYTC never hosts meeting for long-term planning while 33% of them think it rarely hosts.

From KYTC-Other, 50% believe KYTC never hosts meeting and the other 50% believe it rarely hosts meeting with utility companies for the purpose of long-term planning.

Half of Consultant-Utilities believe KYTC rarely hosts and the other half think KYTC sometimes hosts meeting.

All Consultant-design interviewees believe KYTC rarely hosts meeting with companies for purpose of long-term planning.

7. How would you rate the level of communication between KYTC& Utility Company?

From all interviewees, 12.5% rate the level of communication between KYTC & Utility Company as more than adequate, 45.83% rate it as adequate, 37.5% rate it as inadequate and 4% rate it extremely inadequate.

From all KYTC-Utilities interviewees, 21.43% rate the level of communication between KYTC & Utility Company as more than adequate, 57.14% rate it as adequate, 21.43% rate it as inadequate.

From all KYTC-Design interviewees, 25% rate the level of communication between KYTC & Utility Company as adequate, 75% rate it as inadequate.

All KYTC-Other interviewees rate the level of communication between KYTC & Utility Company as adequate.

From all Consultant-Utilities interviewees, 50% rate the level of communication between KYTC & Utility Company as adequate, and 50% rate it inadequate

From all Consultant-Design interviewees, 50% rate the level of communication between KYTC & Utility Company as adequate, and 50% rate it inadequate

All other interviewees rate the level of communication between KYTC & Utility Company as inadequate.

8. Rank the following (enter the item with the highest impact first) issues according to their impact on timely utility relocation (priority ranking)

30.19% of all interviewees think Right-Of-Way issues have the most impact while 23.19% believe Long Lead Items, 26.2% think Utility Company Workload and 20% believe Poor Communication have the highest impact on timely utility relocation.

33% of all KYTC-Utilities interviewees think Right-Of-Way issues have the most impact while 25% believe Long Lead Items, 25% think Utility Company Workload and 16% believe Poor Communication have the highest impact on timely utility relocation.

26% of all KYTC-Design interviewees think Right-Of-Way issues have the most impact while 24% believe Long Lead Items, 28% think Utility Company Workload and 22% believe Poor Communication have the highest impact on timely utility relocation.

19% of all KYTC-Other interviewees think Right-Of-Way issues have the most impact while 33% believe Long Lead Items, 30% think Utility Company Workload and 19% believe Poor Communication have the highest impact on timely utility relocation.

33% of all Consultant-Utilities interviewees think Right-Of-Way issues have the most impact while 13% believe Long Lead Items, 28% think Utility Company Workload and 26% believe Poor Communication have the highest impact on timely utility relocation.

25% of all Consultant-Design interviewees think Right-Of-Way issues have the most impact while 25% believe Long Lead Items, 25% think Utility Company Workload and 25% believe Poor Communication have the highest impact on timely utility relocation.

33% of other interviewees think Right-Of-Way issues have the most impact while nobody believes Long Lead Items, 30% think Utility Company Workload and 37% believe Poor Communication have the highest impact on timely utility relocation.

9. Rank the following practices as to their ability to expedite utility relocation (enter the most impactful practice first). (Priority Ranking)

23% of all interviewees think Strategic use of SUE is the most impactful practice to expedite utility relocation while 21% believe Utility Corridors, 26.2% think Early utility involvement and 23.55% believe Pay non-reimbursable utilities are the most impactful practices to expedite utility relocation.

24% of all KYTC-Utilities interviewees think Strategic use of SUE is the most impactful practice to expedite utility relocation while 19% believe Utility Corridors, 33% think Early utility involvement and 24% believe Pay non-reimbursable utilities are the most impactful practices to expedite utility relocation

20% of all KYTC-Design interviewees think Strategic use of SUE is the most impactful practice to expedite utility relocation while 27% believe Utility Corridors, 31% think Early utility involvement and 21% believe Pay non-reimbursable utilities are the most impactful practices to expedite utility relocation.

21% of all KYTC-Other interviewees think Strategic use of SUE is the most impactful practice to expedite utility relocation while 29% believe Utility Corridors, 26% think Early utility involvement and 24% believe Pay non-reimbursable utilities are the most impactful practices to expedite utility relocation.

28% of all Consultant-Utilities interviewees think Strategic use of SUE is the most impactful practice to expedite utility relocation while 11% believe Utility Corridors, 33% think Early utility involvement and 28% believe Pay non-reimbursable utilities are the most impactful practices to expedite utility relocation.

22% of all Consultant-Design interviewees think Strategic use of SUE is the most impactful practice to expedite utility relocation while 26% believe Utility Corridors, 29% think Early utility involvement and 22% believe Pay non-reimbursable utilities are the most impactful practices to expedite utility relocation.

10. Rank the following technologies as to their ability to expedite utility relocation (enter the most impactful practice first). (Priority Ranking)

28% of all interviewees think GIS/Utility Management System is the most impactful practice to expedite utility relocation while 21% believe RFID MARKING(Marker Balls), 27% think 3D CADD & Visualization of Utilities and 24% believe Utility Impact Matrix(classifies Severity by project characteristics) are the most impactful practices to expedite utility relocation.

29% of all KYTC-Utilities interviewees think GIS/Utility Management System is the most impactful practice to expedite utility relocation while 21% believe RFID MARKING(Marker Balls), 26% think 3D CADD & Visualization of Utilities and 24% believe Utility Impact Matrix(classifies Severity by project characteristics) are the most impactful practices to expedite utility relocation.

28% of all KYTC-Design interviewees think GIS/Utility Management System is the most impactful practice to expedite utility relocation while 23% believe RFID MARKING(Marker Balls), 26% think 3D CADD & Visualization of Utilities and 23% believe Utility Impact Matrix(classifies Severity by project characteristics) are the most impactful practices to expedite utility relocation.

28% of all KYTC-Other interviewees think GIS/Utility Management System is the most impactful practice to expedite utility relocation while 24% believe RFID MARKING(Marker Balls), 24% think 3D CADD & Visualization of Utilities and 24% believe Utility Impact Matrix(classifies Severity by project characteristics) are the most impactful practices to expedite utility relocation.

19% of all Consultant-Utilities interviewees think GIS/Utility Management System is the most impactful practice to expedite utility relocation while 13% believe RFID MARKING(Marker Balls), 34% think 3D CADD & Visualization of Utilities and 34% believe Utility Impact Matrix(classifies Severity by project characteristics) are the most impactful practices to expedite utility relocation.

29% of all Consultant-Design interviewees think GIS/Utility Management System is the most impactful practice to expedite utility relocation while 24% believe RFID MARKING(Marker Balls),24% think 3D CADD & Visualization of Utilities and 24% believe Utility Impact Matrix(classifies Severity by project characteristics) are the most impactful practices to expedite utility relocation.

11. What level of understanding do you think construction personnel has related to the utility relocation process?

From all interviewees 16% believe construction personnel has strong understanding related to the utility relocation process, 36% think they have neutral understanding, 36% believe they have weak understanding and 12% of them think construction personnel has very weak understanding related to the utility process.

From all KYTC-Utilities interviewees 7% believe construction personnel has strong understanding related to the utility relocation process, 36% think they have neutral understanding, 43% believe they have weak understanding and 14% of them think construction personnel has very weak understanding related to the utility process

From all KYTC-Design interviewees 25% believe construction personnel has strong understanding related to the utility relocation process, 50% think they have neutral understanding, 25% believe they have weak understanding related to the utility process

From all KYTC-Other interviewees 50 believe construction personnel has weak understanding related to the utility relocation process, and 50% of them think construction personnel has very weak understanding related to the utility process

From all Consultant-Utilities interviewees 50% believe construction personnel has neutral understanding related to the utility relocation process and 50% of them think construction personnel has weak understanding related to the utility process

From all KYTC-Design interviewees 50% believe construction personnel has strong understanding related to the utility relocation process, and 50% of them think construction personnel has neutral understanding related to the utility process

All other interviewees (100%) believe construction personnel has strong understanding related to the utility relocation process.

12. What level of understanding do you think design personnel has related to the utility relocation process?

From all interviewees 32% believe design personnel has strong understanding related to the utility relocation process, 24% think they have neutral understanding, 32% believe they have weak understanding and 12% of them think design personnel has very weak understanding related to the utility relocation process.

From all KYTC-Utilities interviewees 27% believe design personnel has strong understanding related to the utility relocation process, 27% think they have neutral understanding, 40% believe they have weak understanding and 7% of them think design personnel has very weak understanding related to the utility relocation process.

From all KYTC-Design interviewees 33% believe design personnel has strong understanding related to the utility relocation process, 33% think they have neutral understanding, and 33% of them think design personnel has weak understanding related to the utility relocation process.

From all KYTC-Other interviewees 50% believe design personnel has strong understanding related to the utility relocation process, and 50% of them think design personnel has very weak understanding related to the utility relocation process.

From all Consultant-Utilities interviewees 50% believe design personnel has strong understanding related to the utility relocation process and 50% of them think design personnel has weak understanding related to the utility relocation process.

From all Consultant-Design interviewees 50% believe design personnel has strong understanding related to the utility relocation process and 50% of them think design personnel has very weak understanding related to the utility relocation process.

All other interviewees believe design personnel have neutral understanding related to the utility relocation process.

13. What level of understanding do you think utility company personnel has related to the KYTC project management process?

From all interviewees 4% believe utility company personnel has very strong understanding related to the KYTC project management process, 16% think they have strong understanding, 16% think they have neutral understanding, 48% believe they have weak understanding and 16% of them think utility company personnel has very weak understanding related to the KYTC project management process.

From all KYTC-Utilities interviewees 14% believe utility company personnel has strong understanding related to the KYTC project management process, 14% think they have neutral understanding, 57% believe they have weak understanding and 14% of them think utility company personnel has very weak understanding related to the KYTC project management process.

From all KYTC-Design interviewees 25% believe utility company personnel has strong understanding related to the KYTC project management process, 50% believe they have weak understanding and 25% of them think utility company personnel has very weak understanding related to the KYTC project management process.

From all KYTC-Other interviewees 50% believe utility company personnel has very strong understanding related to the KYTC project management process, and 50% of them think utility company personnel has very weak understanding related to the KYTC project management process.

From all Consultant-Utilities interviewees 50% believe utility company personnel has strong understanding related to the KYTC project management process, and 50% of them think utility company personnel has neutral understanding related to the KYTC project management process.

From all Consultant-Design interviewees 50% believe utility company personnel has neutral understanding related to the KYTC project management process, and 50% of them think utility company personnel has weak understanding related to the KYTC project management process.

All other interviewees believe utility company personnel has weak understanding related to the KYTC project management process.

Statistical Modeling Outputs

The SAS System

The GLM Procedure

Class Level Information		
Class	**Levels**	**Values**
Type	10	BRIDGE REPLACEMENT(P) DESIGN ENGINEERING(O) I-CHANGE RECONST(O) MAJOR WIDENING(O) MINOR WIDENING(O) NEW INTERCHANGE(O) RECONSTRUCTION(O) SAFETY(P) SAFETY-HAZARD ELIM(P) SPOT IMPROVEMENTS (O)
Route	7	CR CS EB I JC KY US
Fund	10	BRO BRX BRZ NH SB2 SLO SLX SPB SPP STP

Number of Observations Read	1966
Number of Observations Used	52

The SAS System

The GLM Procedure

Dependent Variable: Risk

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	27	14.56356861	0.53939143	9.60	<.0001
Error	24	1.34829036	0.05617877		
Corrected Total	51	15.91185897			

R-Square	Coeff Var	Root MSE	Risk Mean
0.915265	13.61886	0.237021	1.740385

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Dist	1	0.43163014	0.43163014	7.68	0.0106
Type	9	8.58387585	0.95376398	16.98	<.0001
Length	1	0.11126939	0.11126939	1.98	0.1721
Route	5	1.16920222	0.23384044	4.16	0.0073
Phase	1	1.70278406	1.70278406	30.31	<.0001
Fund	8	1.08913014	0.13614127	2.42	0.0447
ROW	1	0.02230266	0.02230266	0.40	0.5346
U	1	1.45337416	1.45337416	25.87	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Dist	1	0.00463371	0.00463371	0.08	0.7764
Type	8	1.93719649	0.24214956	4.31	0.0025
Length	1	0.04362624	0.04362624	0.78	0.3869
Route	4	0.19055251	0.04763813	0.85	0.5088
Phase	1	0.03318491	0.03318491	0.59	0.4496
Fund	8	0.49757330	0.06219666	1.11	0.3929
ROW	1	0.00088915	0.00088915	0.02	0.9009
U	1	1.45337416	1.45337416	25.87	<.0001

Parameter	Estimate		Standard Error	t Value	Pr > |t|
Intercept	1.080544700	B	0.42524377	2.54	0.0179
Dist	-0.004664648		0.01624203	-0.29	0.7764
Type BRIDGE REPLACEMENT(P)	0.444184298	B	0.28657395	1.55	0.1342

Type DESIGN ENGINEERING(O)	0.128895781	B	0.33716534	0.38	0.7056
Type I-CHANGE RECONST(O)	0.079897285	B	0.34002368	0.23	0.8162
Type MAJOR WIDENING(O)	0.142980468	B	0.25590286	0.56	0.5815
Type MINOR WIDENING(O)	1.120521357	B	0.27959192	4.01	0.0005
Type NEW INTERCHANGE(O)	-0.072844257	B	0.29589205	-0.25	0.8076
Type RECONSTRUCTION(O)	0.663141146	B	0.17117516	3.87	0.0007
Type SAFETY(P)	0.063727441	B	0.22844701	0.28	0.7827
Type SAFETY-HAZARD ELIM(P)	0.291093003	B	0.51472183	0.57	0.5770
Type SPOT IMPROVEMENTS(O)	0.000000000	B	.	.	.
Length	0.036506312		0.04142668	0.88	0.3869
Route CR	-0.767764014	B	0.60179937	-1.28	0.2142
Route CS	-0.849314538	B	0.53571886	-1.59	0.1260
Route EB	-0.341459039	B	0.48178625	-0.71	0.4853
Route I	-0.220751707	B	0.42824992	-0.52	0.6109
Route JC	0.000000000	B	.	.	.
Route KY	-0.248586048	B	0.18177673	-1.37	0.1841
Route US	0.000000000	B	.	.	.
Phase	0.000000106		0.00000014	0.77	0.4496
Fund BRO	-0.379455987	B	0.39847023	-0.95	0.3504
Fund BRX	-0.287031475	B	0.37157399	-0.77	0.4474
Fund BRZ	0.173445273	B	0.47037953	0.37	0.7156
Fund NH	0.017087659	B	0.39373281	0.04	0.9657
Fund SB2	0.260515404	B	0.37605530	0.69	0.4951
Fund SLO	0.703945610	B	0.50521932	1.39	0.1763
Fund SLX	-0.009528818	B	0.59633286	-0.02	0.9874
Fund SPB	0.000000000	B	.	.	.
Fund SPP	-0.038964876	B	0.34505696	-0.11	0.9110
Fund STP	0.000000000	B	.	.	.
ROW	0.000749251		0.00595560	0.13	0.9009
U	0.147855190		0.02906926	5.09	<.0001

Note: The X'X matrix has been found to be singular, and a generalized inverse was used to solve the normal equations. Terms whose estimates are followed by the letter 'B' are not uniquely estimable.

The SAS System

The GLM Procedure

Class Level Information		
Class	**Levels**	**Values**
Type	10	BRIDGE REPLACEMENT(P) DESIGN ENGINEERING(O) I-CHANGE RECONST(O) MAJOR WIDENING(O) MINOR WIDENING(O) NEW INTERCHANGE(O) RECONSTRUCTION(O) SAFETY(P) SAFETY-HAZARD ELIM(P) SPOT IMPROVEMENTS (O)
Route	7	CR CS EB I JC KY US
Fund	10	BRO BRX BRZ NH SB2 SLO SLX SPB SPP STP

Number of Observations Read	1966
Number of Observations Used	52

The SAS System

The GLM Procedure

Dependent Variable: Risk

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	26	14.56267946	0.56010306	10.38	<.0001
Error	25	1.34917952	0.05396718		
Corrected Total	51	15.91185897			

R-Square	Coeff Var	Root MSE	Risk Mean
0.915209	13.34811	0.232308	1.740385

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Dist	1	0.43163014	0.43163014	8.00	0.0091
Type	9	8.58387585	0.95376398	17.67	<.0001
Length	1	0.11126939	0.11126939	2.06	0.1634
Route	5	1.16920222	0.23384044	4.33	0.0056
Phase	1	1.70278406	1.70278406	31.55	<.0001
Fund	8	1.08913014	0.13614127	2.52	0.0366
U	1	1.47478766	1.47478766	27.33	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Dist	1	0.00397030	0.00397030	0.07	0.7884
Type	8	1.98496925	0.24812116	4.60	0.0015
Length	1	0.05682925	0.05682925	1.05	0.3146
Route	4	0.19370692	0.04842673	0.90	0.4803
Phase	1	0.08643359	0.08643359	1.60	0.2173
Fund	8	0.50712692	0.06339087	1.17	0.3525
U	1	1.47478766	1.47478766	27.33	<.0001

Parameter	Estimate		Standard Error	t Value	Pr > |t|
Intercept	1.071661253	B	0.41100324	2.61	0.0152
Dist	-0.004209214		0.01551867	-0.27	0.7884
Type BRIDGE REPLACEMENT(P)	0.451506612	B	0.27502252	1.64	0.1132
Type DESIGN ENGINEERING(O)	0.108135178	B	0.28817612	0.38	0.7106
Type I-CHANGE RECONST(O)	0.070513754	B	0.32514675	0.22	0.8301

Type MAJOR WIDENING(O)	0.139668182	B	0.24948423	0.56	0.5806
Type MINOR WIDENING(O)	1.124063154	B	0.27264058	4.12	0.0004
Type NEW INTERCHANGE(O)	-0.071943142	B	0.28992441	-0.25	0.8060
Type RECONSTRUCTION(O)	0.659929343	B	0.16589556	3.98	0.0005
Type SAFETY(P)	0.053524887	B	0.20932194	0.26	0.8003
Type SAFETY-HAZARD ELIM(P)	0.306054571	B	0.49083831	0.62	0.5386
Type SPOT IMPROVEMENTS(O)	0.000000000	B	.	.	.
Length	0.038499236		0.03751725	1.03	0.3146
Route CR	-0.761817861	B	0.58801300	-1.30	0.2070
Route CS	-0.842076384	B	0.52203135	-1.61	0.1193
Route EB	-0.316313482	B	0.42965425	-0.74	0.4685
Route I	-0.210068256	B	0.41140087	-0.51	0.6141
Route JC	0.000000000	B	.	.	.
Route KY	-0.256208655	B	0.16797426	-1.53	0.1397
Route US	0.000000000	B	.	.	.
Phase	0.000000119		0.00000009	1.27	0.2173
Fund BRO	-0.370844319	B	0.38474239	-0.96	0.3443
Fund BRX	-0.277616141	B	0.35672317	-0.78	0.4437
Fund BRZ	0.168483220	B	0.45940425	0.37	0.7169
Fund NH	0.007145192	B	0.37805129	0.02	0.9851
Fund SB2	0.286540034	B	0.30780311	0.93	0.3608
Fund SLO	0.688075080	B	0.47949013	1.44	0.1637
Fund SLX	0.030830799	B	0.49269396	0.06	0.9506
Fund SPB	0.000000000	B	.	.	.
Fund SPP	-0.023066533	B	0.31469983	-0.07	0.9422
Fund STP	0.000000000	B	.	.	.
U	0.147316645		0.02818071	5.23	<.0001

Note: The X'X matrix has been found to be singular, and a generalized inverse was used to solve the normal equations. Terms whose estimates are followed by the letter 'B' are not uniquely estimable.

The SAS System

The GLM Procedure

Class Level Information		
Class	**Levels**	**Values**
Type	10	BRIDGE REPLACEMENT(P) DESIGN ENGINEERING(O) I-CHANGE RECONST(O) MAJOR WIDENING(O) MINOR WIDENING(O) NEW INTERCHANGE(O) RECONSTRUCTION(O) SAFETY(P) SAFETY-HAZARD ELIM(P) SPOT IMPROVEMENTS (O)
Route	7	CR CS EB I JC KY US
Fund	10	BRO BRX BRZ NH SB2 SLO SLX SPB SPP STP

Number of Observations Read	1966
Number of Observations Used	53

The SAS System

The GLM Procedure

Dependent Variable: Risk

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	25	14.56965228	0.58278609	11.17	<.0001
Error	27	1.40833514	0.05216056		
Corrected Total	52	15.97798742			

R-Square	Coeff Var	Root MSE	Risk Mean
0.911858	13.08595	0.228387	1.745283

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Dist	1	0.35540926	0.35540926	6.81	0.0146
Type	9	8.70771288	0.96752365	18.55	<.0001
Route	5	1.11436032	0.22287206	4.27	0.0054
Phase	1	1.84499231	1.84499231	35.37	<.0001
Fund	8	1.09398741	0.13674843	2.62	0.0289
U	1	1.45319010	1.45319010	27.86	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Dist	1	0.01011472	0.01011472	0.19	0.6632
Type	8	2.09918280	0.26239785	5.03	0.0007
Route	4	0.16141449	0.04035362	0.77	0.5519
Phase	1	0.17844836	0.17844836	3.42	0.0753
Fund	8	0.65797616	0.08224702	1.58	0.1784
U	1	1.45319010	1.45319010	27.86	<.0001

Parameter	Estimate		Standard Error	t Value	Pr > |t|
Intercept	1.038188913	B	0.40105601	2.59	0.0153
Dist	-0.006478277		0.01471139	-0.44	0.6632
Type BRIDGE REPLACEMENT(P)	0.443897974	B	0.26029439	1.71	0.0996
Type DESIGN ENGINEERING(O)	0.260768507	B	0.24396029	1.07	0.2946
Type I-CHANGE RECONST(O)	0.107320863	B	0.31492535	0.34	0.7359
Type MAJOR WIDENING(O)	0.143764568	B	0.19567518	0.73	0.4688
Type MINOR WIDENING(O)	1.146519446	B	0.26383454	4.35	0.0002

Type NEW INTERCHANGE(O)	-0.027342163	B	0.28073837	-0.10	0.9231
Type RECONSTRUCTION(O)	0.677465563	B	0.16046272	4.22	0.0002
Type SAFETY(P)	0.053030261	B	0.20559460	0.26	0.7984
Type SAFETY-HAZARD ELIM(P)	0.391078306	B	0.47424524	0.82	0.4168
Type SPOT IMPROVEMENTS(O)	0.000000000	B	.	.	.
Route CR	-0.716465443	B	0.56547238	-1.27	0.2160
Route CS	-0.812037997	B	0.50138480	-1.62	0.1169
Route EB	-0.326257287	B	0.42085083	-0.78	0.4449
Route I	0.015359680	B	0.34260357	0.04	0.9646
Route JC	0.000000000	B	.	.	.
Route KY	-0.190725550	B	0.15257323	-1.25	0.2220
Route US	0.000000000	B	.	.	.
Phase	0.000000156		0.00000008	1.85	0.0753
Fund BRO	-0.335599930	B	0.35505393	-0.95	0.3529
Fund BRX	-0.266505225	B	0.33397811	-0.80	0.4318
Fund BRZ	0.196770073	B	0.45067138	0.44	0.6659
Fund NH	0.053578315	B	0.35106620	0.15	0.8798
Fund SB2	0.332235039	B	0.29903298	1.11	0.2764
Fund SLO	0.706999630	B	0.46865154	1.51	0.1430
Fund SLX	0.196203594	B	0.43359719	0.45	0.6545
Fund SPB	0.000000000	B	.	.	.
Fund SPP	0.022953123	B	0.29842028	0.08	0.9393
Fund STP	0.000000000	B	.	.	.
U	0.137004386		0.02595640	5.28	<.0001

Note: The X'X matrix has been found to be singular, and a generalized inverse was used to solve the normal equations. Terms whose estimates are followed by the letter 'B' are not uniquely estimable.

The SAS System

The GLM Procedure

Class Level Information		
Class	**Levels**	**Values**
Type	10	BRIDGE REPLACEMENT(P) DESIGN ENGINEERING(O) I-CHANGE RECONST(O) MAJOR WIDENING(O) MINOR WIDENING(O) NEW INTERCHANGE(O) RECONSTRUCTION(O) SAFETY(P) SAFETY-HAZARD ELIM(P) SPOT IMPROVEMENTS (O)
Route	7	CR CS EB I JC KY US
Fund	10	BRO BRX BRZ NH SB2 SLO SLX SPB SPP STP

Number of Observations Read	1966
Number of Observations Used	53

The SAS System

The GLM Procedure

Dependent Variable: Risk

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	17	13.91167612	0.81833389	13.86	<.0001
Error	35	2.06631130	0.05903747		
Corrected Total	52	15.97798742			

R-Square	Coeff Var	Root MSE	Risk Mean
0.870678	13.92188	0.242976	1.745283

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Dist	1	0.35540926	0.35540926	6.02	0.0193
Type	9	8.70771288	0.96752365	16.39	<.0001
Route	5	1.11436032	0.22287206	3.78	0.0077
Phase	1	1.84499231	1.84499231	31.25	<.0001
U	1	1.88920135	1.88920135	32.00	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Dist	1	0.13975700	0.13975700	2.37	0.1329
Type	8	2.36382242	0.29547780	5.00	0.0003
Route	5	0.49477353	0.09895471	1.68	0.1662
Phase	1	0.29126342	0.29126342	4.93	0.0329
U	1	1.88920135	1.88920135	32.00	<.0001

Parameter	Estimate		Standard Error	t Value	Pr > |t|
Intercept	1.327093361	B	0.20819162	6.37	<.0001
Dist	-0.018877924		0.01226963	-1.54	0.1329
Type BRIDGE REPLACEMENT(P)	-0.006489487	B	0.15498904	-0.04	0.9668
Type DESIGN ENGINEERING(O)	0.365851415	B	0.24328981	1.50	0.1416
Type I-CHANGE RECONST(O)	-0.132353131	B	0.31159860	-0.42	0.6736
Type MAJOR WIDENING(O)	0.119675773	B	0.18478240	0.65	0.5214
Type MINOR WIDENING(O)	0.798894353	B	0.22895650	3.49	0.0013
Type NEW INTERCHANGE(O)	-0.148174085	B	0.28608305	-0.52	0.6078
Type RECONSTRUCTION(O)	0.563590526	B	0.15833208	3.56	0.0011

Type SAFETY(P)	-0.063998952	B	0.20485898	-0.31	0.7566
Type SAFETY-HAZARD ELIM(P)	0.166845812	B	0.32775095	0.51	0.6139
Type SPOT IMPROVEMENTS(O)	0.000000000	B	.	.	.
Route CR	-0.286337661	B	0.15042112	-1.90	0.0652
Route CS	-0.448423998	B	0.17838937	-2.51	0.0167
Route EB	-0.283335123	B	0.34391189	-0.82	0.4156
Route I	-0.135787962	B	0.30603468	-0.44	0.6600
Route JC	0.000000000	B	.	.	.
Route KY	-0.184490979	B	0.12368150	-1.49	0.1447
Route US	0.000000000	B	.	.	.
Phase	0.000000156		0.00000007	2.22	0.0329
U	0.132481166		0.02341957	5.66	<.0001

Note: The X'X matrix has been found to be singular, and a generalized inverse was used to solve the normal equations. Terms whose estimates are followed by the letter 'B' are not uniquely estimable.

The SAS System

The GLM Procedure

Class Level Information		
Class	**Levels**	**Values**
Type	10	BRIDGE REPLACEMENT(P) DESIGN ENGINEERING(O) I-CHANGE RECONST(O) MAJOR WIDENING(O) MINOR WIDENING(O) NEW INTERCHANGE(O) RECONSTRUCTION(O) SAFETY(P) SAFETY-HAZARD ELIM(P) SPOT IMPROVEMENTS (O)
Route	7	CR CS EB I JC KY US
Fund	10	BRO BRX BRZ NH SB2 SLO SLX SPB SPP STP

Number of Observations Read	1966
Number of Observations Used	53

The SAS System

The GLM Procedure

Dependent Variable: Risk

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	12	13.41690258	1.11807522	17.46	<.0001
Error	40	2.56108484	0.06402712		
Corrected Total	52	15.97798742			

R-Square	Coeff Var	Root MSE	Risk Mean
0.839712	14.49827	0.253036	1.745283

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Dist	1	0.35540926	0.35540926	5.55	0.0235
Type	9	8.70771288	0.96752365	15.11	<.0001
Phase	1	2.16688641	2.16688641	33.84	<.0001
U	1	2.18689403	2.18689403	34.16	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Dist	1	0.22115022	0.22115022	3.45	0.0705
Type	9	2.36670446	0.26296716	4.11	0.0009
Phase	1	0.59486889	0.59486889	9.29	0.0041
U	1	2.18689403	2.18689403	34.16	<.0001

Parameter	Estimate		Standard Error	t Value	Pr > |t|
Intercept	1.140927859	B	0.18227852	6.26	<.0001
Dist	-0.021741238		0.01169829	-1.86	0.0705
Type BRIDGE REPLACEMENT(P)	-0.002595937	B	0.15261635	-0.02	0.9865
Type DESIGN ENGINEERING(O)	0.451582082	B	0.24073275	1.88	0.0680
Type I-CHANGE RECONST(O)	-0.091388891	B	0.24041898	-0.38	0.7059
Type MAJOR WIDENING(O)	0.134792867	B	0.17153768	0.79	0.4366
Type MINOR WIDENING(O)	0.680695917	B	0.22150735	3.07	0.0038
Type NEW INTERCHANGE(O)	-0.115091825	B	0.29342795	-0.39	0.6970
Type RECONSTRUCTION(O)	0.581991937	B	0.16425443	3.54	0.0010
Type SAFETY(P)	0.074214340	B	0.18863268	0.39	0.6961
Type SAFETY-HAZARD ELIM(P)	0.357163353	B	0.30527308	1.17	0.2489

Type SPOT IMPROVEMENTS(O)	0.000000000	B	.	.	.
Phase	0.000000188		0.00000006	3.05	0.0041
U	0.129748133		0.02220083	5.84	<.0001

Note: The X'X matrix has been found to be singular, and a generalized inverse was used to solve the normal equations. Terms whose estimates are followed by the letter 'B' are not uniquely estimable.

The SAS System

The GLM Procedure

Class Level Information		
Class	**Levels**	**Values**
Type	10	BRIDGE REPLACEMENT(P) DESIGN ENGINEERING(O) I-CHANGE RECONST(O) MAJOR WIDENING(O) MINOR WIDENING(O) NEW INTERCHANGE(O) RECONSTRUCTION(O) SAFETY(P) SAFETY-HAZARD ELIM(P) SPOT IMPROVEMENTS (O)
Route	7	CR CS EB I JC KY US
Fund	10	BRO BRX BRZ NH SB2 SLO SLX SPB SPP STP

Number of Observations Read	1966
Number of Observations Used	53

The SAS System

The GLM Procedure

Dependent Variable: Risk

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	11	13.19575236	1.19961385	17.68	<.0001
Error	41	2.78223506	0.06785939		
Corrected Total	52	15.97798742			

R-Square	Coeff Var	Root MSE	Risk Mean
0.825871	14.92585	0.260498	1.745283

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Type	9	8.52279562	0.94697729	13.95	<.0001
Phase	1	2.70605698	2.70605698	39.88	<.0001
U	1	1.96689975	1.96689975	28.98	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Type	9	2.19336263	0.24370696	3.59	0.0023
Phase	1	1.32779642	1.32779642	19.57	<.0001
U	1	1.96689975	1.96689975	28.98	<.0001

Parameter	Estimate		Standard Error	t Value	Pr > |t|
Intercept	0.9411783194	B	0.15156171	6.21	<.0001
Type BRIDGE REPLACEMENT(P)	0.0953733377	B	0.14744740	0.65	0.5213
Type DESIGN ENGINEERING(O)	0.6010749907	B	0.23358822	2.57	0.0138
Type I-CHANGE RECONST(O)	0.0842184414	B	0.22759256	0.37	0.7133
Type MAJOR WIDENING(O)	0.1702300659	B	0.17550227	0.97	0.3378
Type MINOR WIDENING(O)	0.6889415295	B	0.22799431	3.02	0.0043
Type NEW INTERCHANGE(O)	-.0834146545	B	0.30157167	-0.28	0.7835
Type RECONSTRUCTION(O)	0.5822210406	B	0.16909859	3.44	0.0013
Type SAFETY(P)	0.1780517021	B	0.18548190	0.96	0.3427
Type SAFETY-HAZARD ELIM(P)	0.5283506512	B	0.29962867	1.76	0.0853
Type SPOT IMPROVEMENTS(O)	0.0000000000	B	.	.	.
Phase	0.0000002440		0.00000006	4.42	<.0001
U	0.1175334055		0.02183108	5.38	<.0001

Note: The X'X matrix has been found to be singular, and a generalized inverse was used to solve the normal equations. Terms whose estimates are followed by the letter 'B' are not uniquely estimable.

The SAS System

The GLM Procedure

Class Level Information		
Class	**Levels**	**Values**
Type	10	BRIDGE REPLACEMENT(P) DESIGN ENGINEERING(O) I-CHANGE RECONST(O) MAJOR WIDENING(O) MINOR WIDENING(O) NEW INTERCHANGE(O) RECONSTRUCTION(O) SAFETY(P) SAFETY-HAZARD ELIM(P) SPOT IMPROVEMENTS (O)
Route	7	CR CS EB I JC KY US
Fund	10	BRO BRX BRZ NH SB2 SLO SLX SPB SPP STP

Number of Observations Read	1966
Number of Observations Used	53

The SAS System

The GLM Procedure

Dependent Variable: Risk

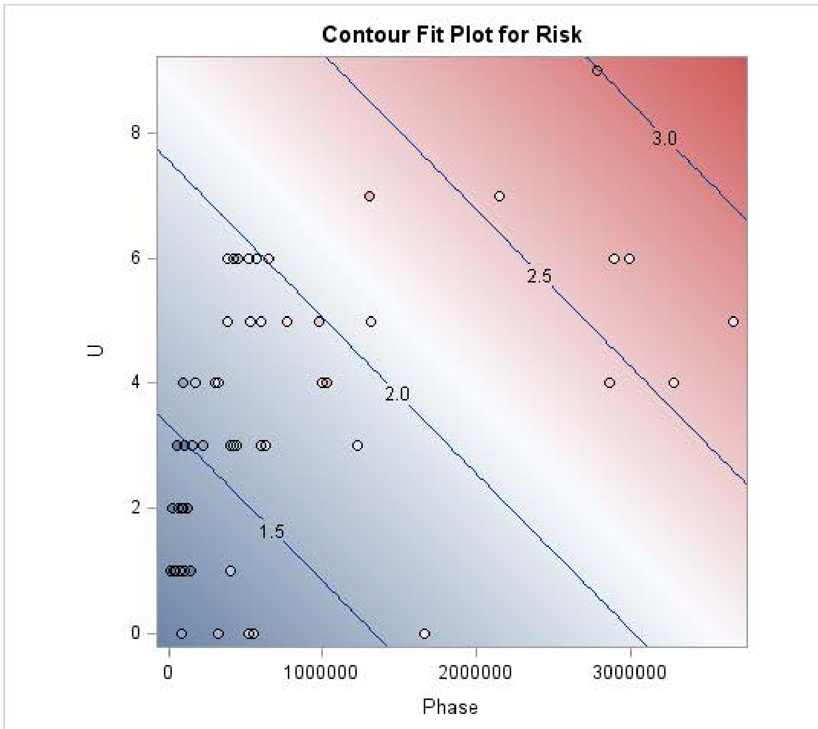
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	11.00238973	5.50119487	55.28	<.0001
Error	50	4.97559769	0.09951195		
Corrected Total	52	15.97798742			

R-Square	Coeff Var	Root MSE	Risk Mean
0.688597	18.07473	0.315455	1.745283

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Phase	1	8.42157587	8.42157587	84.63	<.0001
U	1	2.58081386	2.58081386	25.93	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Phase	1	3.11442265	3.11442265	31.30	<.0001
U	1	2.58081386	2.58081386	25.93	<.0001

Parameter	Estimate	Standard Error	t Value	Pr > |t|
Intercept	1.104423827	0.08310485	13.29	<.0001
Phase	0.000000296	0.00000005	5.59	<.0001
U	0.118130467	0.02319643	5.09	<.0001



Contour Fit Plot for Risk
U
Phase
3.0
2.5
2.0
1.5
0
2
4
6
8
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1000000
2000000
3000000

The SAS System

The GLM Procedure

Class Level Information		
Class	**Levels**	**Values**
Type	10	BRIDGE REPLACEMENT(P) DESIGN ENGINEERING(O) I-CHANGE RECONST(O) MAJOR WIDENING(O) MINOR WIDENING(O) NEW INTERCHANGE(O) RECONSTRUCTION(O) SAFETY(P) SAFETY-HAZARD ELIM(P) SPOT IMPROVEMENTS (O)
Route	7	CR CS EB I JC KY US
Fund	10	BRO BRX BRZ NH SB2 SLO SLX SPB SPP STP

Number of Observations Read	1966
Number of Observations Used	53

The SAS System

The GLM Procedure

Dependent Variable: Risk

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	11.05019812	3.68339937	36.63	<.0001
Error	49	4.92778930	0.10056713		
Corrected Total	52	15.97798742			

R-Square	Coeff Var	Root MSE	Risk Mean
0.691589	18.17030	0.317123	1.745283

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Dist	1	0.35540926	0.35540926	3.53	0.0661
Phase	1	8.07601858	8.07601858	80.30	<.0001
U	1	2.61877027	2.61877027	26.04	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Dist	1	0.04780839	0.04780839	0.48	0.4938
Phase	1	2.61519444	2.61519444	26.00	<.0001
U	1	2.61877027	2.61877027	26.04	<.0001

Parameter	Estimate	Standard Error	t Value	Pr > |t|
Intercept	1.149911878	0.10645293	10.80	<.0001
Dist	-0.008266472	0.01198936	-0.69	0.4938
Phase	0.000000284	0.00000006	5.10	<.0001
U	0.121331666	0.02377680	5.10	<.0001

The SAS System

The GLM Procedure

Class Level Information		
Class	**Levels**	**Values**
Type	10	BRIDGE REPLACEMENT(P) DESIGN ENGINEERING(O) I-CHANGE RECONST(O) MAJOR WIDENING(O) MINOR WIDENING(O) NEW INTERCHANGE(O) RECONSTRUCTION(O) SAFETY(P) SAFETY-HAZARD ELIM(P) SPOT IMPROVEMENTS (O)
Route	7	CR CS EB I JC KY US
Fund	10	BRO BRX BRZ NH SB2 SLO SLX SPB SPP STP

Number of Observations Read	1966
Number of Observations Used	53

The SAS System

The GLM Procedure

Dependent Variable: Risk

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	9	11.54785370	1.28309486	12.45	<.0001
Error	43	4.43013372	0.10302637		
Corrected Total	52	15.97798742			

R-Square	Coeff Var	Root MSE	Risk Mean
0.722735	18.39113	0.320977	1.745283

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Dist	1	0.35540926	0.35540926	3.45	0.0701
Route	6	3.16829690	0.52804948	5.13	0.0005
Phase	1	5.84626924	5.84626924	56.75	<.0001
U	1	2.17787830	2.17787830	21.14	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Dist	1	0.02264849	0.02264849	0.22	0.6415
Route	6	0.49765558	0.08294260	0.81	0.5716
Phase	1	1.74489408	1.74489408	16.94	0.0002
U	1	2.17787830	2.17787830	21.14	<.0001

Parameter	Estimate		Standard Error	t Value	Pr > |t|
Intercept	1.314972918	B	0.13841822	9.50	<.0001
Dist	-0.006631095		0.01414294	-0.47	0.6415
Route CR	-0.320196759	B	0.17592977	-1.82	0.0757
Route CS	-0.262755482	B	0.21259889	-1.24	0.2232
Route EB	-0.417174260	B	0.33964234	-1.23	0.2260
Route I	-0.009583635	B	0.34271412	-0.03	0.9778
Route JC	-0.141344080	B	0.33890269	-0.42	0.6787
Route KY	-0.127825889	B	0.13367025	-0.96	0.3443
Route US	0.000000000	B	.	.	.
Phase	0.000000254		0.00000006	4.12	0.0002
U	0.115684249		0.02516122	4.60	<.0001

Note: The X'X matrix has been found to be singular, and a generalized inverse was used to solve the normal equations. Terms whose estimates are followed by the letter 'B' are not uniquely estimable.

The SAS System

The GLM Procedure

Class Level Information		
Class	Levels	Values
Type	10	BRIDGE REPLACEMENT(P) DESIGN ENGINEERING(O) I-CHANGE RECONST(O) MAJOR WIDENING(O) MINOR WIDENING(O) NEW INTERCHANGE(O) RECONSTRUCTION(O) SAFETY(P) SAFETY-HAZARD ELIM(P) SPOT IMPROVEMENTS (O)
Route	7	CR CS EB I JC KY US
Fund	10	BRO BRX BRZ NH SB2 SLO SLX SPB SPP STP

Number of Observations Read	1966
Number of Observations Used	53

The SAS System

The GLM Procedure

Dependent Variable: Risk

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	17	12.47046947	0.73355703	7.32	<.0001
Error	35	3.50751795	0.10021480		
Corrected Total	52	15.97798742			

R-Square	Coeff Var	Root MSE	Risk Mean
0.780478	18.13845	0.316567	1.745283

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Dist	1	0.35540926	0.35540926	3.55	0.0680
Route	6	3.16829690	0.52804948	5.27	0.0006
Fund	8	5.19794032	0.64974254	6.48	<.0001
Phase	1	2.18681585	2.18681585	21.82	<.0001
U	1	1.56200714	1.56200714	15.59	0.0004

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Dist	1	0.03625271	0.03625271	0.36	0.5514
Route	5	0.19480509	0.03896102	0.39	0.8531
Fund	8	0.92261578	0.11532697	1.15	0.3556
Phase	1	0.65652350	0.65652350	6.55	0.0150
U	1	1.56200714	1.56200714	15.59	0.0004

Parameter	Estimate		Standard Error	t Value	Pr > |t|
Intercept	1.573413127	B	0.27927739	5.63	<.0001
Dist	-0.010893497		0.01811186	-0.60	0.5514
Route CR	-0.037342302	B	0.55704535	-0.07	0.9469
Route CS	-0.168898269	B	0.43445306	-0.39	0.6998
Route EB	-0.419892416	B	0.37859514	-1.11	0.2750
Route I	0.006864994	B	0.39025021	0.02	0.9861
Route JC	-0.196331819	B	0.35352452	-0.56	0.5822
Route KY	-0.067956892	B	0.16143178	-0.42	0.6764
Route US	0.000000000	B	.	.	.

Fund BRO	-0.419166797	B	0.28416896	-1.48	0.1491
Fund BRX	-0.397752693	B	0.29123064	-1.37	0.1807
Fund BRZ	-0.503722115	B	0.45750181	-1.10	0.2784
Fund NH	-0.214021696	B	0.29550208	-0.72	0.4737
Fund SB2	-0.008984226	B	0.25909442	-0.03	0.9725
Fund SLO	-0.285038319	B	0.49770791	-0.57	0.5705
Fund SLX	-0.059554624	B	0.42700656	-0.14	0.8899
Fund SPB	0.000000000	B	.	.	.
Fund SPP	-0.155058589	B	0.26058776	-0.60	0.5556
Fund STP	0.000000000	B	.	.	.
Phase	0.000000200		0.00000008	2.56	0.0150
U	0.111929682		0.02835109	3.95	0.0004

Note: The X'X matrix has been found to be singular, and a generalized inverse was used to solve the normal equations. Terms whose estimates are followed by the letter 'B' are not uniquely estimable.