Construction Specification Framework for Utility Installations

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Utility accommodation policies nationwide contain requirements for the accommodation, location, installation, relocation, and maintenance of utility facilities on the state right-of-way. The policies normally cover basic requirements, making it necessary to use additional specifications and special provisions to handle situations not covered by the policies. Frequently, because of the lack of standard utility installation construction specifications at transportation agencies, many different versions of special specifications and special provisions exist. Closely related to the need to standardize construction specifications for utility installations is the need to standardize methodologies and procedures for determining the cost of utility relocation. This lack of standardization translates into difficulties such as how to verify the validity of the cost data submitted for reimbursement and how to prepare adequately for audits and other internal and external inquiries. This paper summarizes the work completed to develop a prototype framework of construction specification requirements for utility installations, with a focus on water, sanitary sewer, and communication specifications. The specification framework includes five groups of specifications: earth work, pipes and boxes, appurtenances, other, and general (including specifications such as mobilization and traffic control, which highway construction contracts typically include but are also relevant to the utility relocation process). The framework uses tables that summarize the main characteristics of proposed new and modified standard specifications and includes a listing of pay items, subsidiary items, and corresponding measurement units. The framework also includes specification requirements.

A federal mandate requires states to submit a statement to the FHWA on the authority of utilities to occupy the state highway right-of-way (ROW), the power of the state department of transportation (DOT) to regulate such use, and the policies the state DOT uses for accommodating utilities within the ROW of federal-aid highways under its jurisdiction (*1*). Following policies and guides published by AASHTO, states around the country have developed utility accommodation policies that include requirements for the accommodation, location, installation, relocation, and maintenance of utility facilities on the state ROW (*2, 3*). These documents also establish that industry or governmental codes, orders, or laws that require utilities to provide a higher degree of protection than is provided in the policies take precedence.

In practice, because utility accommodation policies tend to cover only basic requirements, it is common to use additional construction specifications and special provisions to handle a wide range of utility installation and relocation situations. These construction specifications and special provisions are integral components of the utility agreement between transportation agencies and utility companies and the highway contract (if this contract includes utility relocation work items). A question that frequently arises is whether those construction specifications and special provisions are appropriate and comply with relevant laws and regulations as well as industry standards and specifications.

As documented here, there is a need to develop standardized construction specifications for utility installations on highway corridors that satisfy not only the technical requirements of the utility owners and operators but also those of the transportation agencies, which are responsible for short- and long-term management of the highway ROW. This need is becoming increasingly acute as the interaction between highway facilities and utility facilities continues to grow. In many cases, the close proximity between highway and utility facilities or between utility facilities located within the highway ROW requires not just close coordination among affected stakeholders (e.g., transportation agency, utility company, highway contractor, and utility contractor) but also the development and enforcement of robust utility construction specifications. If realized in practice, these specifications have the potential to facilitate not just utility construction and inspection but also the bidding process and long-term record keeping.

As an illustration of the need to standardize construction specifications for utility installations on transportation corridors, consider the case in Texas. The Texas utility accommodation rules (UAR) and the Texas Department of Transportation (TxDOT) *Utility Manual* govern the accommodation of utility facilities on the state's highway ROW (*4, 5*). However, because of the lack of standardized utility installation construction specifications at TxDOT, many different versions of utility-related specifications and special provisions exist around the state. Specifications might vary from contract to contract and among utility companies for similar types of work, which makes it difficult to coordinate highway construction and utility relocation work properly and to apply appropriate inspection methods and procedures.

Utility construction specifications have an impact beyond the purely engineering and construction aspects of the utility accommodation and relocation process. Many utility relocations are reimbursable by the state or the federal government. In principle, the basis for utility relocation cost estimates and billings should be a set of construction specifications that outline the scope of each work item in such a way

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as to systematically facilitate the production of comparable, verifiable cost estimates. The ability to accomplish this objective is a fundamental requirement to ensure effective long-term utility relocation cost management practices at transportation agencies.

Unfortunately, partly because of the lack of a standardized construction specification framework for utility installations, utility companies use a variety of ways to submit utility relocation costs for reimbursement. For example, although the TxDOT *Utility Manual* requires utility companies to provide sufficiently detailed information for determining costs (*5*), the manual gives utility companies a large amount of freedom with respect to utility relocation cost estimate and billing procedures and supporting documentation. Variability in the method of preparing utility cost data and the lack of standardization for utility installation construction specifications translates into difficulties when verifying the validity of the cost data submitted for reimbursement, preparing for audits, and responding to other internal and external inquiries.

This paper describes a prototype framework for utility installation construction specifications at transportation agencies (*6–8*). The specification framework is compatible with standard highway construction specifications and unit cost structures that are typical at state DOTs. Although the prototype uses TxDOT specification and unit cost structures and procedures as an example, the approach is sufficiently generic that the model could be applied by other DOTs with relatively minor modifications.

REVIEW OF EXISTING SPECIFICATIONS

Depending on whether a utility relocation item is included in the highway contract, the process for developing and using utility-related construction specifications may vary. At TxDOT, for each utility relocation item in the highway contract, there is a construction specification that describes the scope of work. That specification also includes a list of related bid items and measurement procedures. The utility construction specification usually follows the same quantity per unit cost approach as the rest of the highway contract (although, as documented below, there is wide variability regarding actual utility construction specification scope and content throughout the state). In addition, normal highway design and construction procedures apply, including the production of plans, specifications, and estimates and standard highway bidding and construction protocols. At TxDOT, it is common to include utility relocation items such as water and sanitary sewer in highway contracts. There is also increased interest in including communication and electric utility relocation items, although this practice is not yet common (it may be worth mentioning that, as part of the intelligent transportation system program, TxDOT has a number of communication-related specifications of its own).

If the utility relocation item is not included in the highway contract, different protocols apply. As mentioned earlier, for reimbursable utility relocations, the TxDOT *Utility Manual* requires the submission of sufficiently detailed information to provide a reliable foundation for determining costs (*5*) but gives utility companies considerable freedom regarding documentation structure and content requirements. Although utility companies need to provide construction procedure documentation, there is no guarantee that the structure and content of those documents are compatible with those for similar types of work included in the highway contract. Something similar happens with nonreimbursable utility relocations. This lack of correspondence translates into difficulties such as multiplicity of construction specifications and lack of compatibility in utility relocation cost information, which makes it difficult to build a reliable historical database of utility relocation construction specifications and associated cost data.

TxDOT divides highway construction specifications into two types: standard specifications and special. Standard specifications are included in the "standard specification book" (*9*). Special specifications address activities not covered by the standard specifications and may be project specific, district specific, or statewide. Depending on the circumstances and potential for statewide applicability, a special specification may become a standard specification in the next release of the "standard specification book." To address specific project needs, TxDOT uses special provisions to amend standard and special specifications. In general, special provisions govern over plans, which govern over standard and special specifications, but for cases such as hazardous material responsibilities and traffic control plans, special provisions govern over standard and special specifications, which govern over plans.

TxDOT has standard specifications for drainage structures as well as lighting and signal installations but not for water, sewer, or communication installations. Special specifications cover water, sanitary sewer, and communication installations and special provisions amend either standard or special specifications. In addition, special provisions may be attached to utility permits in connection with requests from utility companies to occupy the state ROW, but, in general, these transactions are not part of the highway construction process.

The researchers reviewed a large sample of utility-related special specifications and special provisions. The review included bid items and unit bid prices associated with the specifications. Most water and sanitary sewer special specifications selected covered utility relocation items included in the highway contract. In contrast, most communication special specifications corresponded to TxDOT-owned communication infrastructure—for example, fiber optic cable and communication cabinets, ground boxes, and duct banks. Very few special specifications in existence at TxDOT correspond to telecommunication provider-owned installations that require relocation during the highway project development process. The review also included lighting and signal standard and special specifications that were relevant to the development of communication specifications.

Standard construction specifications at TxDOT typically include articles or sections such as description, materials, equipment (if appropriate), construction or work methods, measurement, and payment (*9*). Standard specification numbers use three-digit numbers. The standard structure for special specifications is the same as for standard specifications, except special specifications use four-digit numbers.

Some utility-related special specifications followed the standard specification style. However, many other specifications had significant style variations, such as adding a table of contents; having more than the standard number of articles; including an attachment with special provisions or detailed construction specifications from a local jurisdiction; and dividing the specification into two or more sections, each one containing a variation of the standard specification style article structure. In general, earlier specifications followed the standard specification style more closely than recent specifications. This trend coincides with changes in policy that gave utility companies more flexibility in submitting utility relocation documentation.

An analysis of common trends and differences among special specifications with respect to content led to several observations that suggest areas for improvement. Some specifications included legal and administrative requirements such as contractor qualifications, definitions of ownership, and warranty requirements—which are normally addressed by a separate group of standard specifications. This was typically the case for special specifications that included partial or complete copies of construction specifications from local jurisdictions. Some of those "general provisions" were quite generic, which could make monitoring and inspection difficult.

Some special specifications included amendments to standard specifications, instead of relying on special provisions to amend those standard specifications. The amendments included voiding, replacing, and supplementing text. In other cases, the construction method specified activities according to the standard specifications, but the specification included nonstandard specification payment items. Likewise, many special specifications borrowed heavily from previous versions. That was usually the case for specifications developed for projects in the same district, although in several cases districts developed specifications using text borrowed from other districts. In other cases, there were substantial modifications to the special specifications, even within the same district. However, the process of updating the specifications sometimes resulted in inconsistencies and poor sentence construction.

There was considerable variability in item payment, particularly in the case of excavation, backfill, casing, salvaging and removing structures, pavement cut and restore, and fittings. Most specifications listed excavation and backfill as subsidiary items to pipe installation. However, some specifications provided direct payment for extra excavation and select backfill. Likewise, most specifications listed fittings as subsidiary items to pipe installation. However, some specifications provided payment (by the ton) for fittings sized 24 in. and smaller. In the case of backfill, specifications usually considered regular backfill a subsidiary item but treated cement stabilized backfill and flowable backfill separate payable items.

Districts labeled specifications in different ways. Bid item names and measurement units also varied widely, which could complicate record keeping and cost comparisons across projects. Table 1 illustrates this situation by showing the bid items for water pipe associated with two sample water main special specifications. In the first case, the disaggregation of water pipe by pipe material and diameter resulted in 32 different water pipe bid items. In the second case, the disaggregation was only by pipe material, which resulted in seven different bid items.

TABLE 1 Water Pipe Bid Items in Two Sample Special Specifications

Specification title: water mains	Specification title: water mains and sanitary sewers
Specification book: 1993	Specification book: 1993
Specification date: May 2003	Specification date: March 2004
Number of pages: 73	Number of pages: 208
Number of bid items: 140	Number of bid items: 84
Water pipe bid items (32):	Water pipe bid items (7)
Water main pipe (DI) (16 in.)	3 in.–water line
Water main pipe (DI) (20 in.)	6 in.–water line
Water main pipe (DI) (24 in.)	8 in.–water line
Water main pipe (DI) (30 in.)	12 in.–water line
Water main pipe (DI) (36 in.)	16 in.–water line
Water main pipe (FRP) (12 in.)	18 in.–water line
Water main pipe (FRP) (16 in.)	24 in.–water line
Water main pipe (FRP) (20 in.)	
Water main pipe (FRP) (24 in.)	
Water main pipe (FRP) (6 in.)	
Water main pipe (FRP) (8 in.)	
Water main pipe (PVC) (12 in.) (C-900)	
Water main pipe (PVC) (6 in.) (C-900)	
Water main pipe (PVC) (12 in.)	
Water main pipe (PVC) (2 in.)	
Water main pipe (PVC) (24 in.)	
Water main pipe (PVC) (4 in.)	
Water main pipe (PVC) (6 in.)	
Water main pipe (PVC) (8 in.)	
Water main pipe (STL) (12 in.)	
Water main pipe (STL) (36 in.)	
Water main pipe (STL) (24 in.)	
Water main pipe (STL) (30 in.)	
Water main pipe (DI) (12 in.)	
Water main pipe (DI, STL) (8 in.)	
Water main pipe (PVC) (16 in.)	
Water main pipe (PVC) (8 in.)	
Water main pipe (PVC) (SCHD 40) (2½ in.)	
Water main pipe (PVC) (SCHD 40) (2 in.)	
Water main pipe (PVC) (SCHD 40) (4 in.)	
Water main pipe (STL) (6 in.)	
Water main pipe (STL) (8 in.)	

A similar situation happened with communication specifications, where there were references to a wide range of bid item names. For example, in the case of multiconduit structures (or duct banks) there were references to bid item names such as CONDT MULTDCT, MULT-DUCT COND SYS, MULTI-DUCT COND, MULTI-DUCT COND SYS, MULTIDUCT COND SYS, MULT-DUCT COND.SYS., MULTI-DUCT CONDUIT, MULTIDUCT CONDUIT, MULTIDUCT CONDUIT SYS, and MULTI-DUCT CONDUIT SYSTEM. Most of these bid items were also disaggregated by material, conduit size, and construction method, which could cause problems when attempting to compare costs for a specific item across projects, further demonstrating the need for standardized bid item naming conventions.

Some special specifications included definitions of items. Providing uniform definitions offers several advantages. First, it helps readers to understand the specification, which is critical to facilitate consistency in the bidding process as well as for measurement and payment. Second, it provides clarity in the use of terminology, which is critical given the wide range of naming conventions, particularly in the telecommunication industry. For example, in the product and specification literature, cable vaults typically refer to underground chambers that allow for installation of cables and other devices and for making connections and tests. Boxes such as handholes, pull boxes, and ground boxes serve a similar purpose. However, whereas cable vaults tend to be relatively large structures (large enough for a person to enter) and boxes tend to be small structures that a person cannot enter, it is somewhat common to refer to boxes as "vaults."

A related case is the overlap between vaults and manholes. It is common to find references to rectangular underground structures as manholes as well as cases in which similar structures are called vaults. It is also common to find references to cable vaults as manholes containing cables or as underground chambers that allow entry through manhole openings. The latter reference highlights another potential confusion with the term "manhole" because, strictly speaking, a manhole is an opening large enough to enable access to an underground structure. However, it is common to refer to the complete underground structure, including any access barrel(s), as a manhole.

Although providing item definitions is advantageous, the potential downside to providing definitions in specifications is the risk of multiple item definition versions among various specifications. In general, it would be preferable to develop a separate reference document with a glossary of standardized bid item definitions.

There were also cases in which the specification was vague in the description, construction procedure, or measurement of an item. An example of this situation is the application of temporary relocation items, where there was no clarity as to the scope of work and, just as importantly, no clarity as to whether parts of the temporary relocation would extend past the utility agreement termination date. Temporary relocations are a frequent source of contention with utility companies because of the difficulty of inspecting and measuring those items. In general, considering temporary relocation items as subsidiary to permanent installation items is not appropriate because the magnitude and cost of the temporary relocation items could distort the unit cost of the permanent installation items. In some cases, it may be effective to pay for temporary relocations per linear foot of temporary relocation. This strategy is not always feasible, particularly in complex localized construction situations, but it is preferable to the simpler alternative of paying for the temporary relocation in a lump sum. Disaggregating temporary relocations into smaller construction units is a possibility, but whether that would be beneficial in the long term (i.e., whether the added bid item disaggregation could result in monetary savings) is not clear. To facilitate inspection, measurement, and payment, it may be advisable to consider temporary relocations as plans' quantity measurement items—and explicitly state it in the specification—in which the quantity to pay is the quantity shown on the proposal.

Additional examples of vagueness included cases in which the specification assumed relatively large items to be subsidiary (e.g., a communication building), potentially skewing the unit cost of the associated pay item; cases in which there was confusing language regarding the measurement and payment of cable assemblies and splicing; cases in which there was no clarity about what party would be responsible for furnishing certain materials; and cases in which the specification provided incomplete references to other specifications.

PROTOTYPE UTILITY-RELATED SPECIFICATION FRAMEWORK

Many approaches might be possible for standardizing water, sanitary sewer, and communication specifications. To ensure consistency with current business processes, the researchers adopted a framework similar to TxDOT's current framework for drainage and lighting and signal installations. As a reference, Figure 1 shows the existing framework for drainage-related standard specifications and Figure 2 shows the existing framework for lighting and signal standard specifications. Figures 3, 4, and 5 show the proposed framework for water, sewer, and communication installations, respectively. In general, each specification has one or more bid items as well as one or more subsidiary items associated with it.

The prototype specification framework divides utility-related work items into five groups: earth work, pipes and boxes, appurtenances, other, and general (left column in Figures 1–5). The general category includes standard specifications such as mobilization and traffic control, which highway construction contracts typically include but are also relevant to the utility relocation process. In general, the basic assumption is that highway contractors are responsible for the items in the general group of specifications, which means it would not be necessary to include any activities related to those items in other work items. For example, Item 100, "Preparing Right of Way," involves clearing the ROW of all obstructions in preparation for the construction (*9*). Similarly, Item 502, "Barricades, Signs, and Traffic Handling," involves providing traffic-control devices and maintaining adequate traffic control during construction. Because the highway contract already pays for these activities, it would constitute duplicate payment if, for example, the water pipe bid item also included the same activities.

In practice, to prevent interference with highway contractor activities, it is frequently desirable and most efficient to relocate utilities before letting the highway contract. As a result, a number of activities that would normally be part of the highway contract (at least to the degree that those activities affect the utility relocation) become the responsibility of utility companies or their contractors, thus affecting utility relocation work items and costs. In general, if the utility agreement needs to include activities such as traffic control, mobilization, and ROW clearing, it is more efficient in the long term to account for those activities separately (i.e., by using separate bid items), instead of including those activities as subsidiary to other work items. Reasons to adopt this practice include the following:

- The integrity of the utility relocation unit cost data would be retained, particularly when the impact of items such as mobilization and traffic control on total utility relocation cost is significant, thus facilitating the comparison of unit cost data across projects. As the impact on total utility relocation cost decreases, keeping those items separate becomes less critical. However, as a matter of general policy, it should be possible to require utility companies always to submit the corresponding cost data using separate bid items.
- Current standard specifications (e.g., 100, 500, 502, 508) could be used with few or no modifications, making it possible to request utility companies to use those standard specifications and prepare the corresponding unit costs. If modifications to the standard specifications are necessary, special provisions could be used to modify specific sections or articles, following a practice that is already standard in regular highway construction projects.
- Although the impact on highway contract quantities and unit costs would be relatively minor, maintaining a separate tally of activities that are now part of the utility relocation process (but that would be part of the highway contract under normal circumstances) would facilitate overall project management and monitoring.

SPECIFICATION REQUIREMENTS

For each specification labeled "New" or "Modified Existing" in Figures 3, 4, and 5, the researchers developed corresponding specification requirements that conformed to the following structure:

- Summary table. Each summary table described the main characteristics of the proposed new or modified specification, including a list of bid items, corresponding measurement units, and subsidiary items. As an illustration, Table 2 shows the summary table for open-trench conduit structures. Summary tables for other specifications in Figures 3, 4, and 5 are available elsewhere (*6*–*8*).
- Specification requirements. Following the summary table was a compilation of requirements that were consistent with the current TxDOT specification style (*10*). The purpose of the specification requirements was not to write the specifications (which was outside the scope of the research) but to provide a foundation upon which a specification writer could prepare the specification. To assist in this process, the specification requirements included numerous references

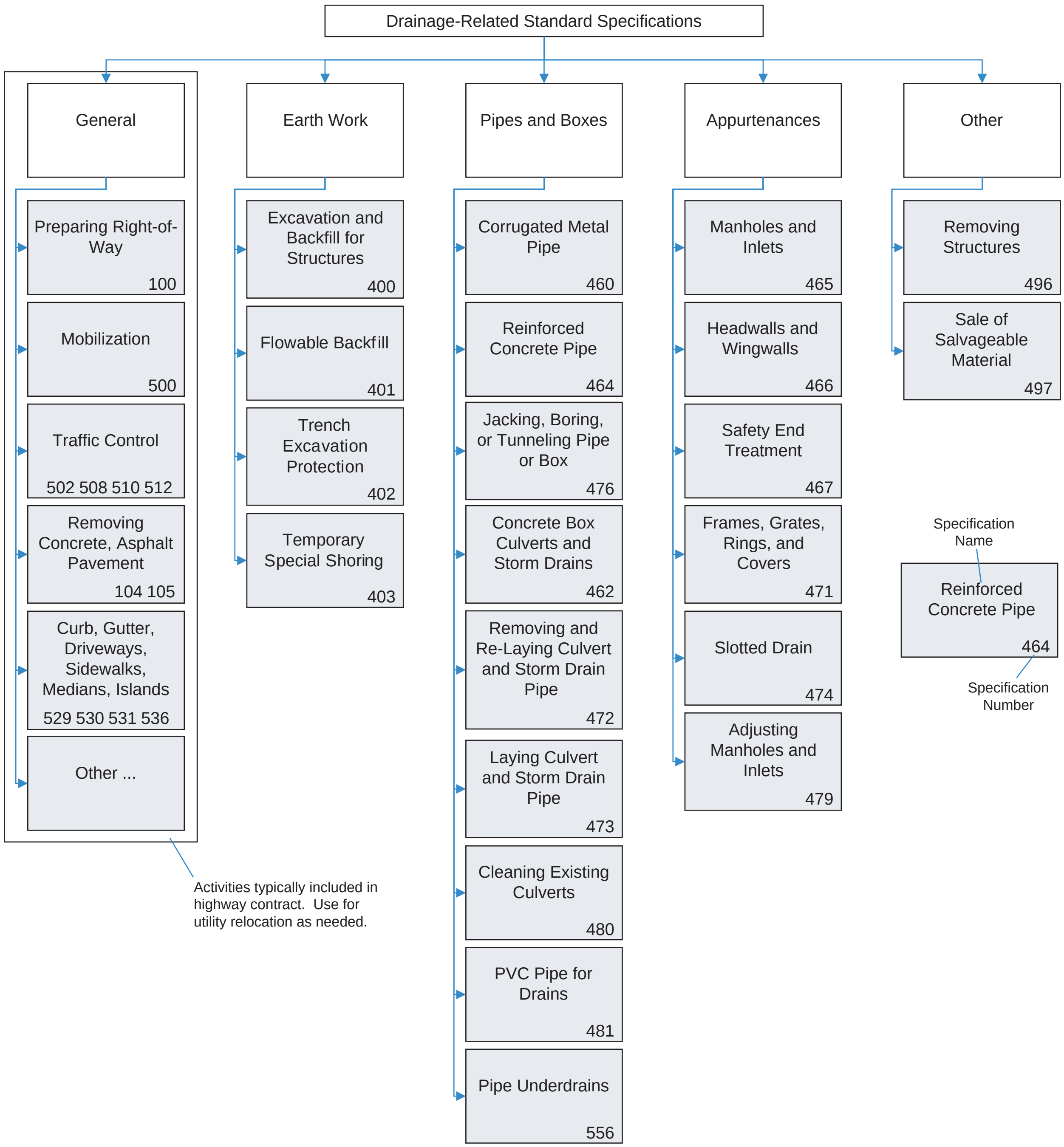

FIGURE 1 Existing drainage-related standard specifications. PVC = polyvinyl chloride. Adapted from TxDOT (*9*).

to industry standards, specifications, and guidelines, including those developed by the following organizations:

– American National Standards Institute (ANSI) (*11*),
– ASTM International (*12*),
– American Water Works Association (AWWA) (*13*),
– National Electrical Manufacturers Association (NEMA) (*14*),
– National Fire Protection Association (*15*),
– Underwriters Laboratory, Inc. (*16*), and
– United States Department of Agriculture's Rural Utilities Service (RUS) (*17*).

As needed, the requirements also included references to TxDOT standard specifications and manuals (*9, 18*), state regulations (*4, 19*), and specifications from local and regional agencies such as the North Central Texas Council of Governments (*20*) and the city of Houston (*21*).

The specification requirements covered typical topics in construction specifications at TxDOT, such as description, materials, construction methods, measurement, and payment (*9*). For each topic, the specification requirements included a list of appropriate industry standards and additional requirements a specification writer would

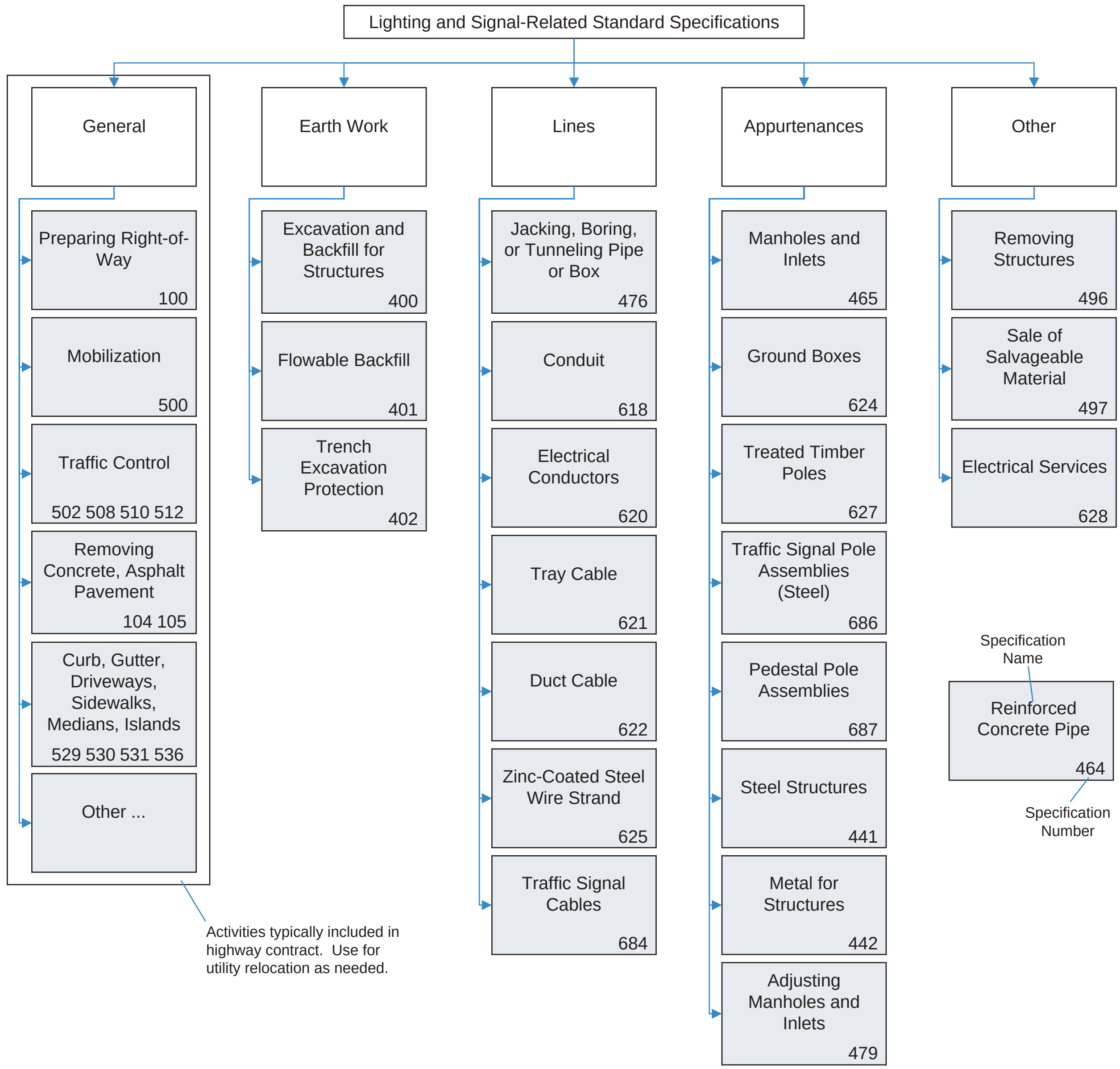

FIGURE 2 Existing lighting and signal-related standard specifications. Adapted from TxDOT (*9*).

need to consider when developing the specification. Many of the additional requirements were in response to issues transportation officials highlighted as critical for managing the state ROW effectively, such as compliance with the UAR as well as ground control and positional accuracy.

For example, a frequent complaint by transportation officials is that utility companies and their contractors do not follow basic UAR requirements such as minimum depths of cover, encasement requirements, and minimum spacing between adjacent utility facilities (*4*). The utility industry is responsible for knowing the UAR. However, the researchers found that the level of UAR knowledge among utility company designers and technicians (i.e., at the level where UAR proficiency is most critical) was scant at best. To address this issue, in addition to recommending the implementation of dissemination and outreach programs, the specification requirements provide ample references to the UAR.

Ground control and positional accuracy issues are another point of contention between transportation officials and utility companies. The UAR requires all utility installation design plans and as-built plans to include vertical elevations and horizontal alignments based on the department's survey datum (*4*). To improve compliance, the specification requirements include horizontal and vertical positional accuracy requirements in line with existing survey standards in Texas (*18*), the requirement to measure and record as-built alignments at specific intervals, and the requirement to submit as-built plans in accordance with the UAR. For trenchless construction or renewal, the specification requirements include the need to furnish a plan that includes the proposed line profile (in the case of horizontal directional drilling) and horizontal and vertical control method and expected accuracies.

As mentioned before, providing item definitions offers several advantages, including helping readers to understand the specification

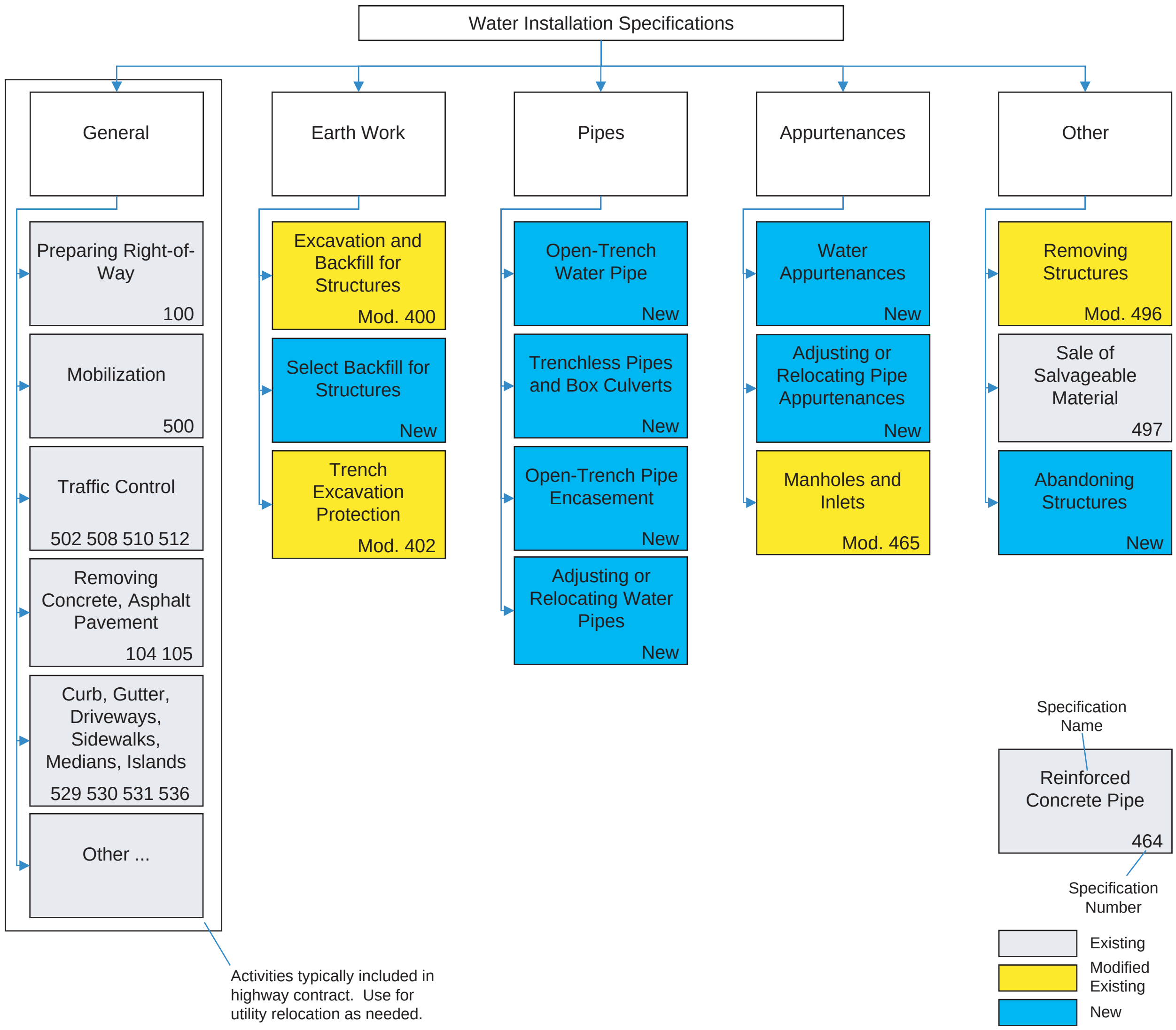

FIGURE 3 Prototype water installation specification framework.

and providing clarity in the use of terminology, which is critical given the wide range of naming conventions used by the utility industry, particularly in the case of communication infrastructure. To facilitate the understanding of the specification framework and the corresponding specification requirements, Table 3 provides brief definitions for commonly used communication-related items; more complete definitions are available elsewhere (*8*). The purpose of Table 3 is to provide examples of terms that could be used as the foundation for common terminology in support of the specification framework, not to serve as a final, authoritative source of definitions (although the table does intend to group terms following the specification and construction item structure described here).

CONCLUSIONS

To facilitate accurate cost comparisons, not just between estimates but also among different projects, it is critical to develop and implement construction specifications that provide both a clear differentiation between bid items and subsidiary items as well as adequate information about materials, construction procedures, and performance requirements. Developing clear and consistent specifications also has the effect of reducing uncertainty and risk in the bidding process, which, in the long term, should result in monetary savings for all parties involved.

This paper describes a prototype framework of construction specifications for utility installations, with a focus on water, sewer, and communication utilities. The framework includes specification requirements emphasizing overall consistency and is compatible with a companion unit cost structure framework for utility relocations (*6*). Although the prototype uses TxDOT construction specification structures and procedures, the model is sufficiently general that it could be applied by other DOTs with relatively minor modifications.

In developing the specification framework, the researchers reviewed a large sample of utility-related special specifications and provisions. The review included bid items and unit bid prices associated with these specifications. The review found numerous variations with respect to the official TxDOT specification style and identified trends, differences, and issues with respect to specification content. The review noted inconsistencies in the application of bid item naming

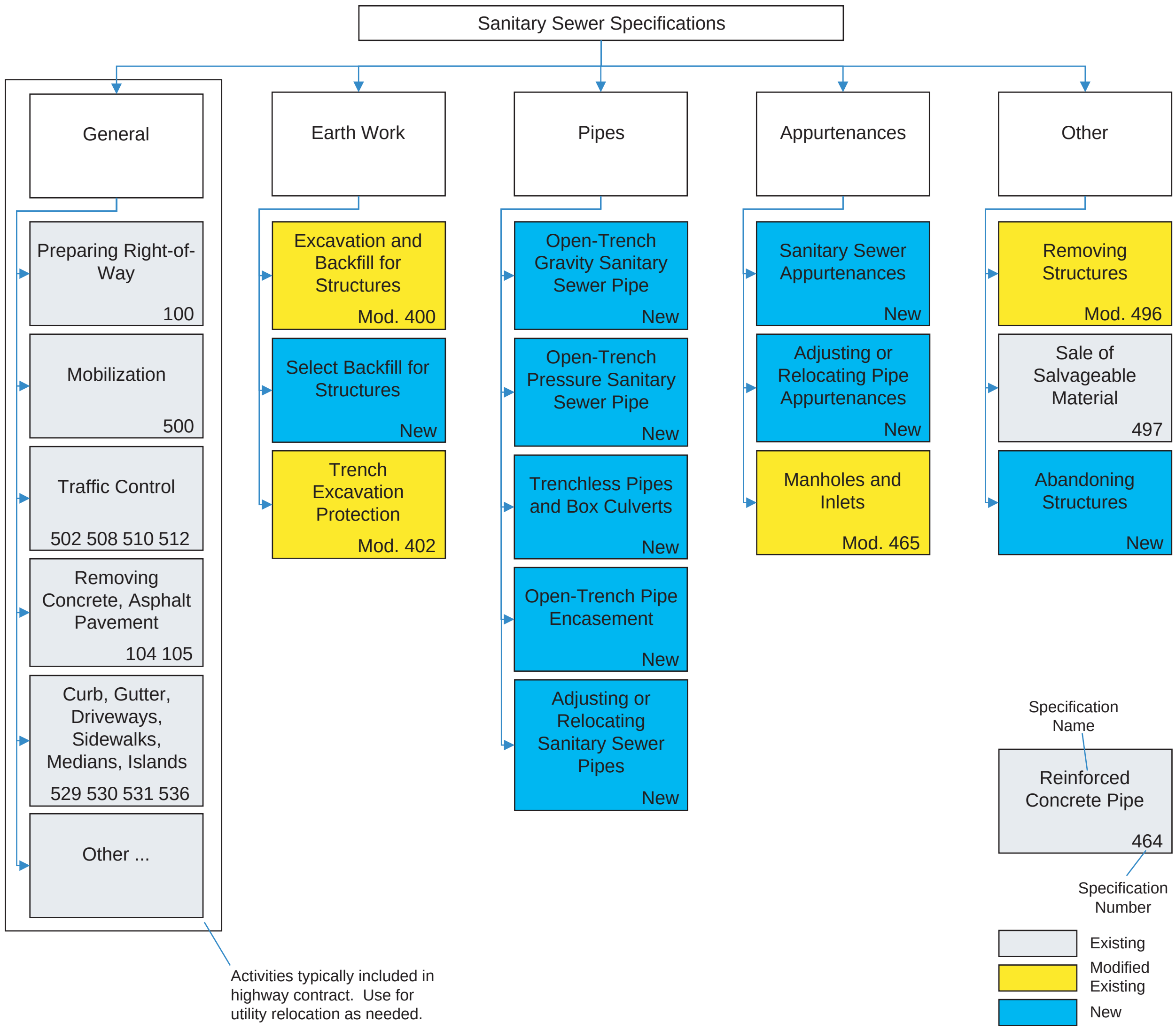

FIGURE 4 Prototype sanitary sewer specification framework.

conventions that could make future analysis of historical unit cost data more difficult. There were also cases in which the specification was vague in the description, construction procedure, or measurement of an item. Examples included confusing application of temporary adjustment provisions and pay items; cases in which the specification assumed relatively large items to be subsidiary, potentially skewing the unit cost associated with the associated pay item; cases in which there was confusing language on the measurement and payment of cable assemblies and splicing; cases in which there was no clarity about what party would be responsible for furnishing certain materials; and cases in which the specification provided incomplete references to other specifications.

The prototype specification framework developed in this research covered typical cases of water, sewer, and communication installations under the assumption that the framework will eventually lead to the development of standard specifications for water, sewer, and communication infrastructure, while addressing the issues and shortcomings of present practice identified above. The framework is generic and therefore is not limited to public or private utilities that occupy the state ROW (*4*), which means transportation agencies could also use it advantageously for the design, construction, and cost management of their own communication infrastructure. This additional use is possible because the companion unit cost methodology that was developed in conjunction with the specification framework separates construction costs from reimbursement procedures and emphasizes that, to facilitate cost comparisons across projects, bid items and corresponding unit costs should follow the same structure regardless of infrastructure ownership (*6*).

The specification requirements proposed included references to standards and specifications from a number of organizations such as ANSI, ASTM International, AWWA, NEMA, and RUS. The framework assumed that specifications resulting from the specification requirements developed in this research will reference specific relevant standards instead of reprinting text from the original standards documents, thus enabling specifications to stay up to date with industry standards without requiring major revisions to the specifications. However, to facilitate the specification writer's work when developing the specifications, the specification requirements also included references to a variety of construction specifications and guidelines from the utility industry and regulatory agencies.

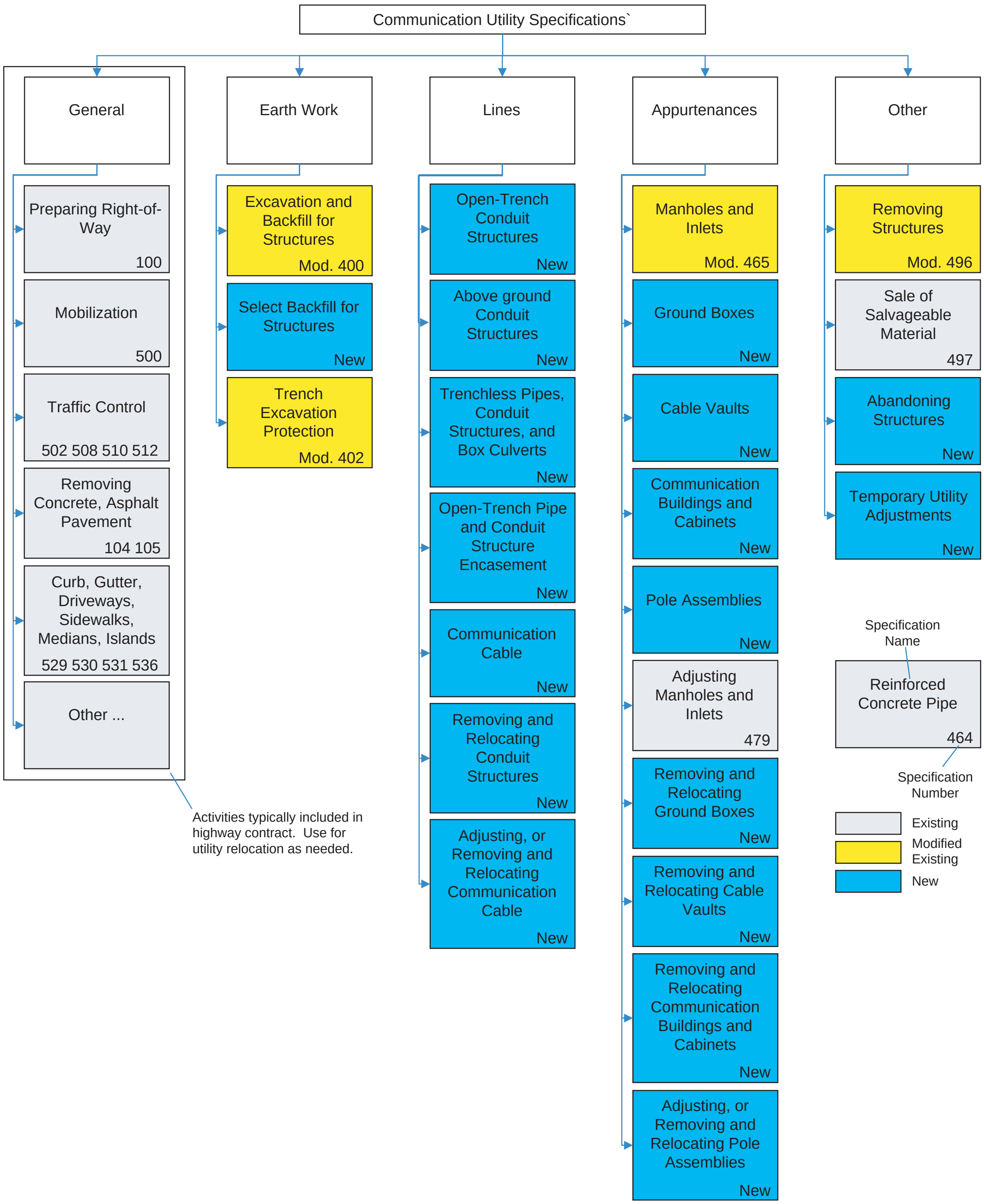

FIGURE 5 Prototype communication utility specification framework.

The specification framework included four groups of specifications: earth work, lines, appurtenances, and other. The framework included a fifth group (general) to take into account standard specifications such as mobilization and traffic control, which highway construction contracts typically include but, at the same time, are relevant to the utility relocation process. Because the highway contract already includes those items, it would constitute duplicate payment to include the same activities in other work items. However, if needed (because utility relocations typically take place before the highway project goes to letting), it should be possible to request utility companies to include in their cost proposals relevant bid items from the general group of specifications. If modifications to standard specifications are necessary,

TABLE 2 Sample Proposed Specification: Open-Trench Conduit Structures

Specification Title	Open-Trench Conduit Structures
Description	Furnish and install open-trench conduit structures
Previous specifications	Several, including: 2004 Special Specification 6076, "Multi-Duct Conduit System." 2004 Special Specification 6563, "Duct Bank for Surveillance, Communication, and Control (SC&C)" 1993 Special Specification 5732, "Underground Telephone Systems" 2004 Item 618, "Conduit."
Proposed changes	Create new specification for open-trench conduit structures.

Bid item	Measurement Unit
Open-trench conduit structure (PVC) (several combinations of number of conduits and conduit diameter)	Feet
Open-trench conduit structure (PE) (several combinations of number of conduits and conduit diameter)	Feet
Open-trench conduit structure (HDPE) (several combinations of number of conduits and conduit diameter)	Feet
Open-trench conduit structure (Steel) (several combinations of number of conduits and conduit diameter)	Feet
Open-trench conduit structure (Aluminum) (several combinations of number of conduits and conduit diameter)	Feet
Inner duct (several materials) (several diameters)	Feet
Notes to specification writer Measure and pay for each inner duct separately according to the material, diameter, and length of the inner duct. Add other pay items as indicated on the plans or other design documents.	

Subsidiary Item	Referenced Item	Subsidiary to
Structural excavation (pipes)	400, 401	Conduit structure installation
Bedding	400	Conduit structure installation
Spacers		Conduit structure installation
Fittings		Conduit structure installation
Nonmetallic detection system		Conduit structure installation
Backfill	400	Conduit structure installation
Manhole or vault modification		Conduit structure installation
Conduit testing		Conduit structure installation
CIP trench cap (concrete)	XXXX	Open-trench pipe encasement
CIP encasement (concrete)	XXXX	Open-trench pipe encasement
Notes to specification writer Manhole or vault modifications are assumed to be relatively minor. Major modifications would likely require removing the old structure and installing a new one. Add other subsidiary items as indicated on the plans or as required by this specification.		

NOTE: PE = polyethylene; HDPE = high-density polyethylene; CIP = cast-in-place.

special provisions could be used to modify specific sections or articles, following a practice that is already standard in regular highway construction projects. In any case, to prevent unit cost distortions, it would not be advisable to include items from the general group of specifications as subsidiary to other bid items in the cost proposal.

The prototype specification framework satisfies a number of functional requirements, including consistency with TxDOT's standard construction specification and unit cost structure as well as support for federal and state laws and regulations concerning utility accommodation and relocation requirements. Ultimately, it is anticipated that this approach will lead to improved utility accommodation and relocation management practices, which are critical at a time when the interaction between highway facilities and utility facilities continues to increase. If realized in practice, the specification framework can greatly facilitate utility construction and inspection, the bidding process, and long-term record keeping.

TABLE 3 Basic Communication-Related Items and Definitions

Item and Definition
Cabinet. A cabinet is an enclosure, typically aboveground, that houses electrical and communication equipment and enables cable connections and tests. Cabinets normally have electrical power. Types of cabinets typically include communication building, communication cabinet, communication hub, communication hut, controlled environment cabinet, concrete universal enclosure, serving area interface, and loop carrier box.
Cable. A cable is a longitudinal assembly of conductors such as wires, conducting sheaths, or optical fibers, surrounded by insulating layers. Common communication cable types include twisted pair cable, coaxial cable, and optical fiber cable (also known as fiber optic cable).
Cable splice. A cable splice is an interconnection method for joining the ends of two cables in a permanent or semipermanent fashion. Splice enclosures provide protection against the elements by using boxes, tubes, or coatings.
Cable termination. Cable termination is the hardware and process that enables the connection of cables to devices such as equipment, panels, or other cables.
Cable vault. A cable vault (also sometimes called utility vault) is a subsurface chamber, typically flat at the top, *without* access barrel(s), and large enough for a person to enter, for installing cables and other devices, and for making connections and tests. The main difference between vaults and manholes is that manholes have access barrel(s). An environmentally controlled cable vault (also called controlled environment vault) is a vault equipped to control environmental conditions inside the vault, primarily temperature and moisture.
Conduit. A conduit (or duct) is a single pipe or tube that houses cables and/or inner ducts. This paper treats conduits as components of conduit structures.
Conduit structure. A conduit structure is a structural arrangement of one or more conduits bound together using devices such as bands, templates, or spacers. Conduit structures include single-duct conduit systems and multiduct conduit systems (also known as duct banks).
Encasement. Encasement is a structural protection for pipes and conduit structures that uses a rigid enclosure. Typical subtypes include cast-in-place concrete encasement and casing pipe. Casing pipe is a type of structural protection for pipes and conduit structures that uses a prefabricated pipe.
Ground box. A ground box is a relatively small cable enclosure that is usually mounted flush with the ground. Alternative names for ground boxes include handholes, junction boxes, and pull boxes.
Guy wire. A guy wire is a cable that provides stability to tall, narrow structures such as poles. A guy wire assembly typically includes the tensioned cable, cable terminations, a bracket, or other device to connect the guy wire to the structure, and a buried anchor.
Inner duct. An inner duct is a duct placed inside a larger conduit or duct that houses one or more cables.
Mandrel. A mandrel is a device to test for “out-of-round” shape and joint integrity of conduit structures.
Manhole. A manhole is a subsurface chamber *with* access barrel(s), and large enough for a person to enter, for installing cables and other devices, and for making connections and tests.
Ovality. Ovality is a measure of the “roundness” of a pipe or conduit. It is typically expressed as the difference between the maximum and minimum outer diameters divided by the average between the maximum and minimum diameters.
Pedestal. A pedestal is a box that typically protrudes from the ground and contains terminals for wiring connections.
Pole assembly. A pole assembly is an assembly that includes a pole and all additional hardware necessary to support cables and other equipment.
Riser assembly. A riser assembly is a conduit structure that protects a cable transitioning from an underground installation to an aerial installation.

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