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16. Abstract Each year, the Texas Department of Transportation (TxDOT) issues thousands of approvals that enable new utility installations to occupy the state right of way (ROW). The current utility installation review process relies on the physical delivery of an application package to a TxDOT district office that includes a notice of proposed installation and supporting documentation depicting the location and characteristics of the proposed installation. The review process typically includes several offices at the district and, as needed, communication exchanges with installation owner applicants for additional clarifications and/or documentation. In its current structure, the utility installation review process is paper and labor intensive. It is also not appropriate for supporting the long-term goal of helping to maintain a reliable inventory of utility installations on the state ROW. This report describes the development and implementation of a web-based system that automates the submission, review, approval, construction, and archival of utility installation requests at TxDOT. The system, called the Utility Installation Review (UIR) system, enables users to submit and process installation requests online, including supporting documentation such as design and construction drawings. The system also includes an online geographic information system (GIS)-based interface that enables users to locate and query proposed installation requests using an interactive map. The system includes tabular and GIS-based reporting options. This report also summarizes the results of an extensive testing phase at four TxDOT districts: San Antonio, Pharr, Bryan, and Fort Worth, which included the participation of a large number of utility companies and operators.			
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**UTILITY INSTALLATION REVIEW SYSTEM
IMPLEMENTATION REPORT**

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DISCLAIMER

The contents of this document reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official view or policies of the Federal Highway Administration (FHWA) or the Texas Department of Transportation (TxDOT). This document does not constitute a standard, specification, or regulation, nor is it intended for construction, bidding, or permit purposes. The engineer in charge of the project was Cesar Quiroga, P.E. (Texas Registration #84274).

The United States Government and the State of Texas do not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of this report.

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LIST OF ACRONYMS, ABBREVIATIONS, AND TERMS

AASHTO	American Association of State Highway and Transportation Officials
ArcIMS	Arc Internet Map Server
ArcSDE	Arc Spatial Data Engine
ASP	Active Server Page
CAD	Computer-Aided Design
CDO	Collaboration Data Object
DFO	Distance From Origin
ESRI	Environmental Systems Research Institute
FHWA	Federal Highway Administration
FSO	File System Object
GIS	Geographic Information System
HTML	Hypertext Mark-Up Language
IIS	Internet Information Services
MNT	Maintenance Division
NAD	North American Datum
NOPI	Notice of Proposed Installation
ODBC	Open Database Connection
PDF	Portable Document Format
ROW	Right of Way
SCOT	Standard Committee on Training
SMTP	Simple Mail Transfer Protocol
SP	Service Pack

LIST OF ACRONYMS, ABBREVIATIONS, AND TERMS (Continued)

SQL	Structured Query Language
SS	State Spur
TNRIS	Texas Natural Resources Information System
TQD	Training, Quality, and Development
TRM	Texas Reference Marker
TSD	Technology Services Division
TxDOT	Texas Department of Transportation
UAR	Utility Accommodation Rules
UIR	Utility Installation Review
XML	Extensible Mark-Up Language

CHAPTER 1. INTRODUCTION

Each year, the Texas Department of Transportation (TxDOT) issues thousands of approvals that enable new utility installations to occupy the state right of way (ROW). The current utility installation review process relies on the physical delivery of an application package to a TxDOT district office that includes a notice of proposed installation and supporting documentation depicting the location and characteristics of the proposed installation. The review process typically includes several offices at the district and, as needed, communication exchanges with installation owner applicants for additional clarifications and/or documentation. In its current structure, the utility installation review process is paper and labor intensive. It is also not appropriate for supporting the long-term goal of helping to maintain a reliable inventory of utility installations on the state ROW.

Research Project 0-2110 developed a prototype geographic information system (GIS)-based platform for the inventory of utilities on the state ROW (*1*). As part of the project, the researchers developed a prototype GIS-based utility inventory model and a prototype Internet-based data entry procedure to capture notice of proposed installation (NOPI) data. TxDOT's decision to implement the Internet-based prototype has resulted in a web-based system, called the Utility Installation Review (UIR) system, which automates the submission, review, approval, construction, and post-construction phases of utility installation requests at TxDOT. UIR includes user interfaces for installation owners and TxDOT officials. The installation owner interface enables users to:

- prepare and submit installation requests online,
- track and respond to requests from TxDOT in connection with utility installation requests,
- select and view historical installation request data (limited to requests submitted by the installation owner), and
- manage installation owner user accounts (depending on privilege level).

The TxDOT interface enables TxDOT users to:

- review and forward installation requests to relevant stakeholders (other TxDOT users and installation owner request applicants),
- approve or reject pending installation requests,
- document the construction inspection process,
- select and view historical installation request data from all installation owners, and
- manage installation owner and TxDOT accounts.

This report describes the development and implementation of the UIR system. It also summarizes the results of an extensive testing phase at four TxDOT districts: San Antonio, Pharr, Bryan, and Fort Worth, which included the participation of a large number of utility companies and operators. This report also includes recommendations for implementation and training. Additional information about the system is available in the system documentation and training materials (*2, 3*).

CHAPTER 2. UTILITY INSTALLATION REVIEW (UIR) SYSTEM DEVELOPMENT

BACKGROUND

The Utility Accommodation Rules (UAR) and the TxDOT *Utility Manual* govern the accommodation of utility facilities on the state highway ROW (4, 5). The rules and guidelines are the result of a federal mandate that requires states to submit a statement to the Federal Highway Administration (FHWA) documenting the following information:

- authority of utilities to use and occupy the state highway ROW,
- power of the state department of transportation (DOT) to regulate such use, and
- policies the state DOT uses for accommodating utilities within the ROW of federal aid highways under its jurisdiction (6).

The rules, which can be traced to utility accommodation policies and guides the American Association of State Highway and Transportation Officials (AASHTO) developed, prescribe minimums relative to the accommodation, location, installation, adjustment, and maintenance of utility facilities within the state ROW (7, 8). However, the rules also establish that where industry standards or governmental codes, orders, or laws require utilities to provide a higher degree of protection than provided in the UAR, such regulations and laws take precedence (4). At TxDOT, a number of documents provide additional information regarding specific requirements that might affect utility installations on the ROW, including standard and special construction specifications, special provisions, and survey standards (9, 10).

UTILITY INSTALLATION REQUEST (UTILITY PERMITTING) WORKFLOW

The researchers conducted numerous meetings with district officials (district office, area office, and maintenance section levels) as well as utility company representatives in order to understand the utility installation review process at TxDOT in detail. During the course of those conversations, it became clear that this process was very complex and could involve many different individuals and activities. Discussions with officials from several districts revealed many similarities as well as substantial differences in actual implementation of the process.

As Figure 1 shows, the installation of utility facilities on the state ROW is a five-phase process. A summary of the process follows, with a focus on how UIR implements each phase.

Submitting. The installation owner user submits a utility installation request online (also called notice of proposed installation). As part of the process, the user provides detailed information about the proposed installation; uploads and generates portable document format (PDF) versions of plans, schematics, and other supporting documents; and locates the proposed installation on an interactive map. After submitting the request, UIR sends an email to designated TxDOT district officials to alert them about the new submission.

Reviewing. TxDOT district officials review the feasibility of the proposed installation. Depending on the case, the review might involve routing the proposal to area offices, maintenance sections, and other offices, as well as interaction with the installation owner user to gather additional and/or revised documentation. The outcome of this process is a recommendation to approve or reject the proposal. Every time a user routes the request to another user, UIR sends an automated reminder email to the recipient.

Approval/Pre-construction. A designated TxDOT official approves the proposed installation and routes the approval form along with any relevant special provisions to the installation owner user. At least two business days prior to starting construction, the installation owner user uses UIR to notify TxDOT that construction is about to commence. UIR sends an email to the designated TxDOT inspector who then coordinates with the installation owner user details such as construction schedule and traffic control plans.

Construction. The installation owner proceeds with the construction of the utility installation. TxDOT officials conduct field inspections to verify compliance with the proposed documentation and relevant specifications and regulations. This process ends when the TxDOT inspector notifies the utility permit office that construction has ended, indicating whether there were changes between approved and actual alignments.

Post-construction. After the TxDOT field inspector notifies the district utility permit office that construction has ended, this office requests the installation owner to submit an as-built certification online. After the submission and review of the as-built certification, the utility permit office archives the completed request.

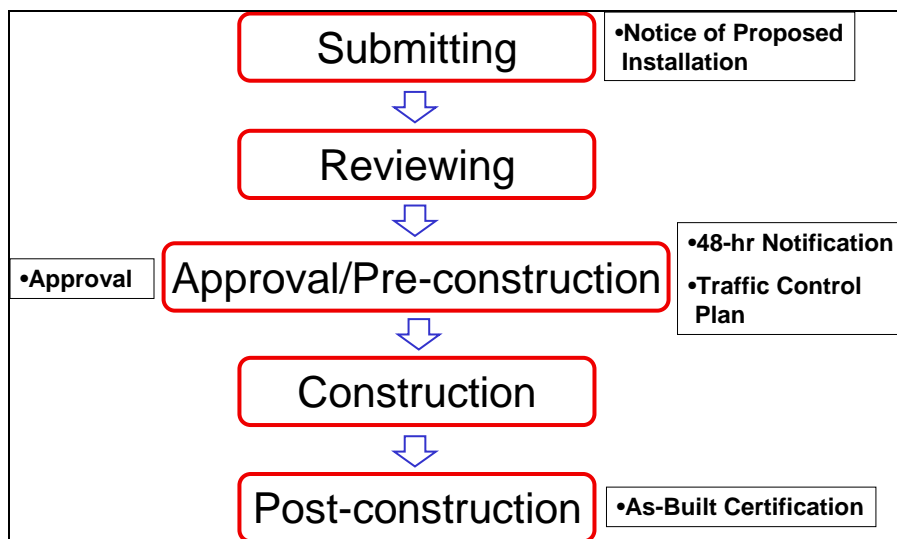


Figure 1. Utility Installation Request Workflow.

Each installation request is different and can involve many different steps, requirements, and review by a large number of stakeholders. [Figure 2](#) and [Figure 3](#) show a detailed view of the installation request workflow.

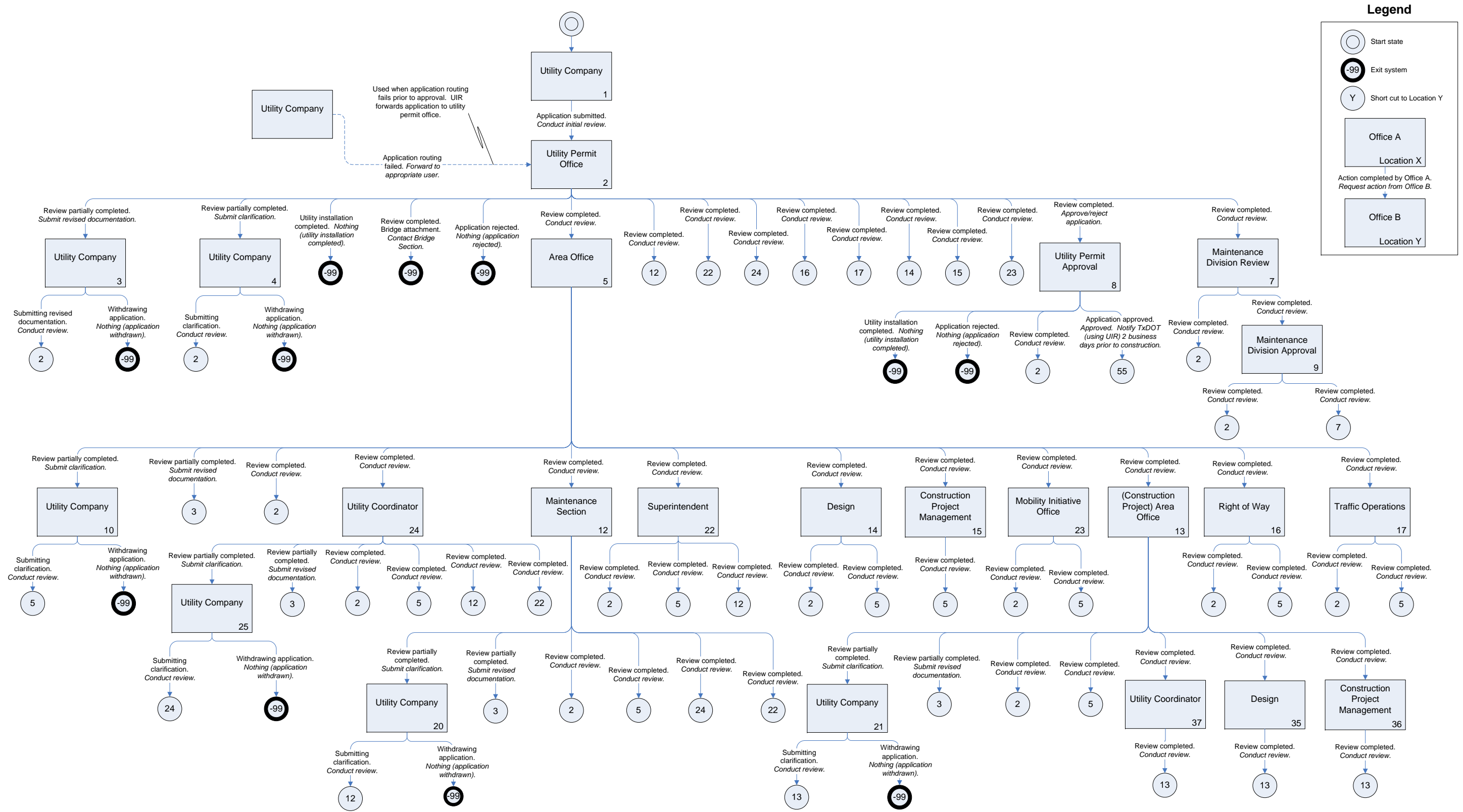


Figure 2. Utility Permit Workflow Diagram (Submitting and Reviewing Phases).

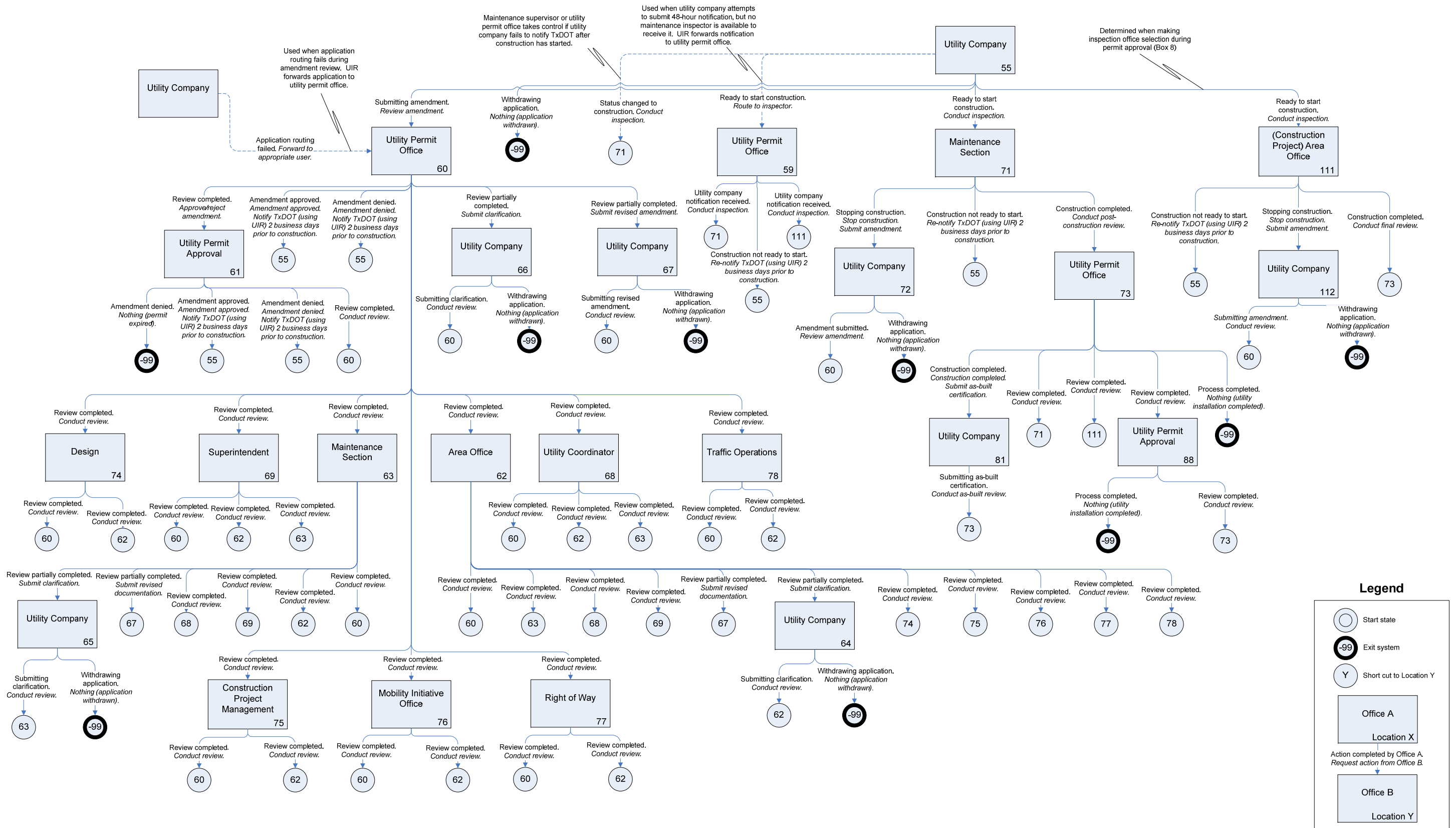


Figure 3. Utility Permit Workflow Diagram (Approval/Pre-Construction, Construction, and Post-Construction Phases).

DATABASE MODEL

The foundation of the UIR system is a relational database that handles data and transactions associated with the utility installation review process. The corresponding data model is in Computer Associates® ERwin Data Modeler® format, following TxDOT's data architecture standards (11). The data model includes a number of subject areas, including the following:

- **Permit.** The Permit subject area includes entities that describe the installation submission and review process. The most important entities are Permit, Permit Event, Permit Event Detail, Permit Event Attachment, Permit Event Location, Permit Workflow Activity, Permit Checklist Answer, and Permit Provision.
- **TxDOT User Management.** The TxDOT User Management subject area includes entities that describe TxDOT users, accounts, and profiles. The most important entities are TxDOT User, TxDOT User Profile, TxDOT Office, and TxDOT Unit.
- **Installation Owner User Management.** The Installation Owner User Management subject area includes entities that describe installation owner users, accounts, and profiles. The most important entities are Utility Company User, Utility Company User Profile, and Utility Company Office.
- **UIR System Setting.** The UIR System Setting subject area includes entities that are necessary for the system to work properly. Examples include Permit Checklist, Provision, TxDOT Unit Type, TxDOT Office Type, Permit Status, Last Permit Event, Permit Type, Status, Utility Class, Attachment Type, Attachment Limit, Place Type, and System Setting.
- **Location.** The Location subject area includes entities that are necessary for the UIR interactive mapping component. The most important entities are Route, Control Section, TxDOT County, and Maintenance Section. It may be worth noting that the mapping component also uses a number of entities for map visualization purposes, including local streets, city limits, railroads, parks, and landmarks.

Additional information about each subject area and all entities and attributes is available in the system documentation (2).

SYSTEM ARCHITECTURE

As Figure 4 shows, UIR has two groups of components: client-side components and server-side components. On the client side, a web browser serves as a front-end interface that allows users on client computers to submit installation notice applications, select and view installation notice application data, review pending applications, and view and query utility maps. The client side also includes an email client application to notify utility company users and/or TxDOT officials about the progress of the review process.

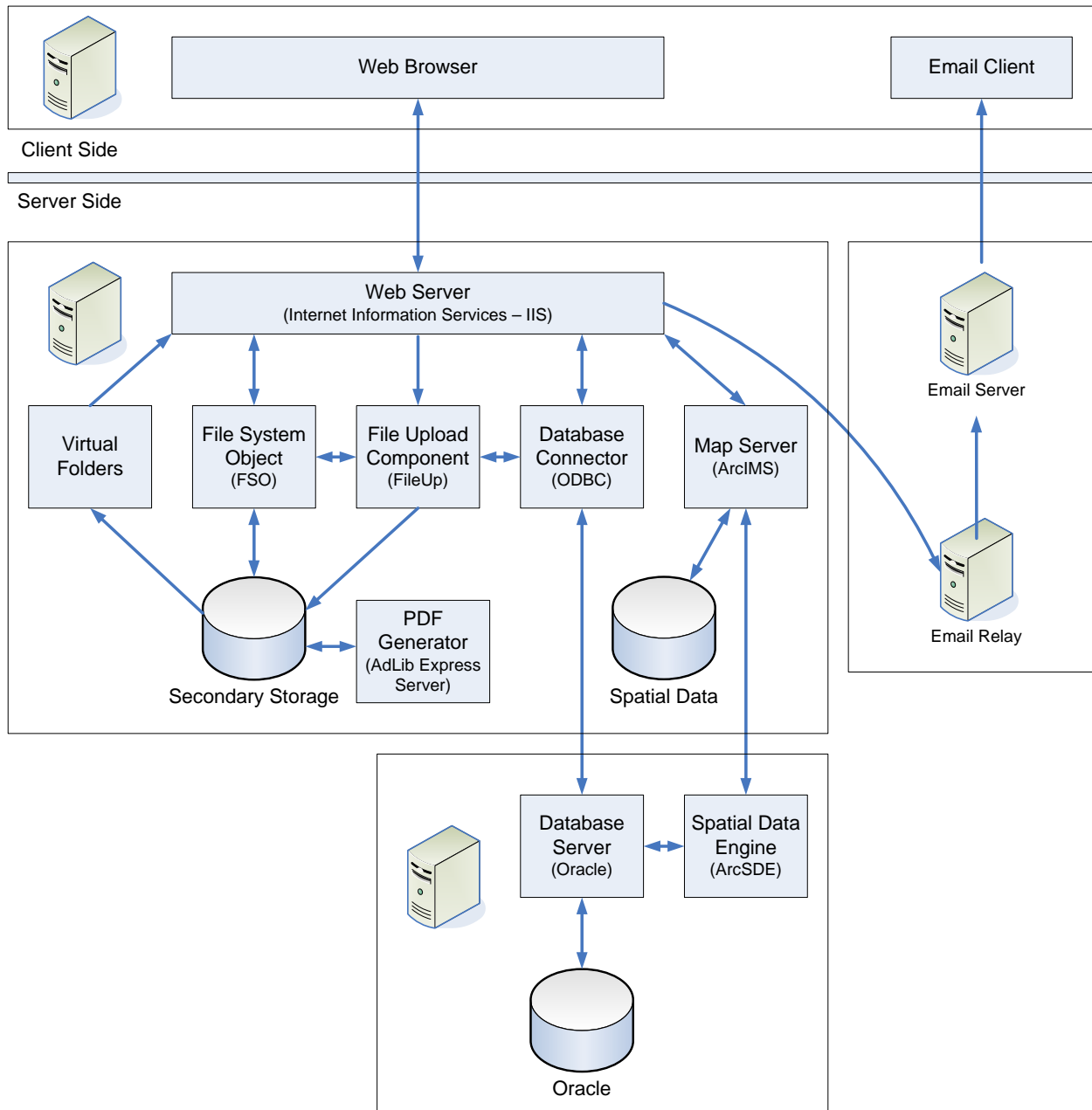


Figure 4. UIR System Architecture.

Minimum client requirements include:

- desktop or laptop computer running Windows® XP with Service Pack 2 (SP2),
- Microsoft® Internet Explorer® 6.0 with SP2,
- PDF reader such as Adobe® Acrobat Reader® 6.0,
- email account, and
- UIR active account.

Both utility company users and TxDOT users can act as clients, but their interfaces are different and require different access levels.

On the server side, UIR includes a number of components, including the following:

- **Web server.** Microsoft Internet Information Services® (IIS) running on Windows Server 2003®.
- **Map server.** Arc Internet Map Server (ArcIMS®).
- **Java component.** Java Runtime Environment® 1.4.2_06. Needed for ArcIMS.
- **Map server connector.** New Atlanta ServletExec® SE 5.0 application program interface (API).
- **Spatial data engine.** ArcIMS can be configured to access spatial data in formats such as Environmental Systems Research Institute (ESRI®) shape file format, personal geodatabases (.mdb file format), or geodatabases (using ESRI's Arc Spatial Data Engine [ArcSDE®]). TTI has experimented with all of these formats successfully.
- **File upload component.** Softartisans® FileUp® Professional. Presumably, other file uploading components could also work with UIR, but TTI has not tested them.
- **PDF generator.** Adlib Express Server® with Compressor Add-On. This is a standalone server application that monitors the contents of a specific input folder at regular time intervals. In the TTI implementation, the application checks the contents of a designated input folder every five seconds. If Adlib Express Server detects a new file in that folder (typically if a utility company or TxDOT user has uploaded a file to the server), Adlib Express Server generates a PDF file and stores that file in a designated output folder.
- **Microsoft Office®** (Word®, Excel®, PowerPoint®, and Visio®). Adlib Express Server supports a number of native applications installed on the server, including Microsoft Office. In the current TTI implementation, UIR recognizes Word, Excel, PowerPoint, and Visio files, allowing Adlib Express Server to generate PDF versions of Word .doc files, Excel .xls files, PowerPoint .ppt files, and Visio .vsd files.
- **PDF file extension support.** Cimmetry AutoVue 3D Advanced. This software enables Adlib Express Server to generate PDF versions of additional file types, in particular MicroStation® .dgn and AutoCAD® .dwg.
- **Other objects and components.** File system object (FSO) and open database connection (ODBC).
- **Database server.** The UIR implementation at TTI uses Oracle 10g.

- **Email server.** The UIR implementation at TTI uses a simple mail transfer protocol (SMTP) that provides way-out only email capabilities; i.e., UIR can send out emails but not receive emails.

As [Figure 4](#) shows, the UIR implementation at TTI uses three server side environments: a database server (that includes Oracle and ArcSDE), an email server (external server in College Station), and a web server (that includes all the other components in addition to the UIR code). The web server also stores all files uploaded to the system as well as data files UIR generates during the utility permitting process. In the long term, the UIR implementation at TxDOT will likely involve separate mapping and data storage servers.

It may be worth noting that the UIR implementation at TTI is actually composed of two sets of server environments: a development server environment (that supports development and demonstration versions of the system) and a production server environment. In the development server environment, UIR uses two servers (an Oracle server and a web server). In the production server environment, UIR uses a table space in the agency's Oracle database server and a dedicated web server. Unfortunately, TTI's system administrators did not allow the researchers to install ArcSDE on the production TTI Oracle server. As a result, it was necessary to rely on shape files to serve all spatial data on the production web server.

The researchers installed ArcSDE on the development Oracle server and tested UIR on that environment. While UIR worked as intended, the researchers decided after a while to use shape files on the development server environment. The reason is that shape files use truncated field names (because of the limitation of the .dbf file extension). As explained below, UIR uses several GIS layers to extract data to populate location-related fields in the UIR database. To facilitate the migration of code from the development server environment to the production server environment, the researchers found it to be considerably more efficient to use only one type of spatial data source (shape files) instead of dual sources that would require two versions of the code (ArcSDE on the development Oracle server and shape files on the production web server).

The researchers realize TxDOT uses an ArcSDE environment, which supports full table field names. During the current transition phase, while TxDOT tests UIR, it would be ideal for TxDOT to use the shape files provided in the external hard drive and, then, after verifying that UIR works satisfactorily, the researchers will provide a slightly modified version of the system that relies on ArcSDE. This transition is anticipated to be straightforward because UIR only uses the truncated field names to pass values to other fields in the database that support full field names.

SYSTEM DEVELOPMENT

System Architecture

Implementation of the system design involved developing interactions among several computers: one or more client computers, a web server, an Oracle server, and an email server. The interaction begins with a client computer, which, as mentioned previously, has minimal technical

requirements, mainly in the form of an Internet browser and email software that supports the SMTP protocol (e.g., Microsoft Outlook, Novell GroupWise). This client computer interacts with a web server that serves the online application to the client computer over the Internet using IIS. The web server also stores all files uploaded by the client user in a designated folder that Adlib Express Server uses to generate PDF versions of those files. When the system generates a database request, the system sends the request to the Oracle server, which, in turn, completes the request and returns with a response. The final computer involved is the email server, which sends application-driven emails to client users in response to requests made by the system through the web server.

Database

The researchers exported the ERwin database design in script format and then ran the script in Oracle to generate the database. After generating the database, the researchers populated the database with a “seed” data set that included records in several critical tables such as PERMIT_WORKFLOW, PERMIT_EVENT_TYPES, and PERMIT_STATUS. These tables directly reflect the workflow gathered in the system design phase and control the flow of the online application. As mentioned previously, the design is dynamic so that if the online application flow needs changes, only the database entries will require modifications.

Source Code

The system is actually the integration of two subsystems: a data management subsystem and a web mapping subsystem. This modular architecture facilitated the development process.

Data Management Subsystem

The data management subsystem includes web pages and procedures that enable users on client computers to log into the system, enter data, upload files, review pending applications, and print forms. The subsystem generates web pages dynamically using active server pages (ASP) and then serves those pages to client computers. In addition, server-side scripts perform a variety of tasks such as connecting to the database, transforming and parsing data, and uploading files. ASP files also contain client-side scripts that make calls to client components, e.g., to check the client browser configuration.

The Oracle database stores all data entered by users, except files such as computer-aided design (CAD) drawings and other attachments, which are stored on the web server’s hard drive. To interact with the Oracle database, the application uses structured query language (SQL) queries through an ODBC object. To upload files from client computers, the application uses SAFileUp, which is a server-side component that enables file uploading through client browser interfaces. After uploading files to the server, the system makes those files available to view and download. At the same time, the Adlib Express server generates a PDF version of the uploaded files, which the system also makes available to view and download. As individual applications undergo processing, the data management subsystem automatically sends emails to designated officials or

back to utility company users. ASP uses objects in the collaboration data object (CDO) library to pass SMTP requests to the email server.

Web Mapping Subsystem

The web mapping subsystem includes web pages and procedures that enable users on client computers to view maps, query features, and select and view installation notice application locations. As [Figure 4](#) shows, the system handles map requests through an ArcIMS map server, which includes an application server, a spatial server, and a map service. Every time the client sends a request, e.g., to zoom in, zoom out, or pan, the map service produces and delivers a snapshot of the map in image format back to the client through the spatial server. The application server directs incoming spatial requests to the appropriate spatial server.

To ensure integration with the data management subsystem, the researchers developed new ASP and ArcXML (ESRI's version of the extensible mark-up language [XML]) code, JavaScript functions, and hypertext mark-up language (HTML) pages, and customized native ArcIMS JavaScript functions and HTML pages to accommodate those new pages:

- **ASP and ArcXML Code.** Using an ODBC link, ASP code queries data from the database and packages the data for transfer to the JavaScript functions. ArcXML code passes requests to the spatial server, which, after processing by the map service, returns with responses packaged as ArcXML messages back to the client. For example, ArcXML generates requests to load “acetate” layers to display points along routes where installation owner users click to define proposed utility installation locations. In this case, the spatial server response is a map image of installation notice locations on the requested “acetate” layer. In general, to support map viewing and relational database querying capabilities, it was necessary to modify some default ArcIMS files.
- **JavaScript Functions.** JavaScript functions create, manage, and delete the “acetate” layers that dynamically display utility installation locations selected by the user. JavaScript functions generate ArcXML tags for the spatial server request based on the data retrieved by the ASP pages. JavaScript functions perform calculations such as conversion of screen coordinates to world coordinates. They also manage HTML page event handlers such as those used for clicking on the map, and generate and alter HTML pages viewed by clients.
- **HTML Code.** HTML code provides interaction with client computers through a series of frames, each of which has a specific function. HTML pages are the front end of the application and the only means of interaction between users and the JavaScript functions. The HTML component is the final product of the other two pieces of code, combining the map images created by the ArcXML and ASP code with the background and interactive work of the JavaScript functions.

To facilitate the utility installation request submission and review process, the researchers configured the ArcIMS web mapping subsystem to support the display and query of several map layers. There are three types of map layers in UIR:

- **Acetate layer.** As mentioned previously, UIR uses the acetate layer to display utility installation request locations dynamically.
- **Display-only layers.** UIR uses these layers to provide background and context to the map to facilitate map navigation and usage. Other than for display purposes, UIR does not use those layers.
- **Display-and-query layers.** UIR uses these layers for display *and* query purposes. For example, when an installation owner user clicks on the map to select the location of a new proposed installation request, UIR uses the corresponding coordinate values to query the route, control section, segment, district, and county layers to populate the corresponding location-related fields in the database.

As an illustration, [Figure 5](#) shows the mapping component in Step 4 on the installation owner side immediately after the user selects the Location tool (upper left control) and clicks a point along State Spur (SS) 117 to identify the location that should be associated with the installation request. Notice that the system displays a red star and the corresponding installation request tracking number at the selected location, queries several data layers, and shows the corresponding values on the table at the bottom of the map. In the example in [Figure 5](#), UIR has extracted the following information from the map layers:

Geographic District:	San Antonio
Maintenance District:	San Antonio (normally the same as the geographic district, except in some district boundary situations)
County:	Bexar
Route:	SS0117
Control Section:	052108
Area Office:	Bexar Metro
Maintenance Section:	Bexar Metro

The user can change the location of the proposed installation request as needed. Once the user is satisfied with the installation request location, the user clicks the Save and Continue button on the lower right corner of the screen to populate the corresponding location-related fields in the database. UIR uses these fields to populate several forms, including the notice of proposed installation (NOPI) and approval forms, which constitute official installation request submission documents.

The data layers that are available to the user vary by zoom level. [Table 1](#) shows the relative position of each layer as well as the maximum and minimum display scale ranges. [Table 2](#) summarizes fill, outline, and label display properties such as color, line weight, and font size. [Table 3](#) provides additional information, including data layer source and how UIR uses each data layer.

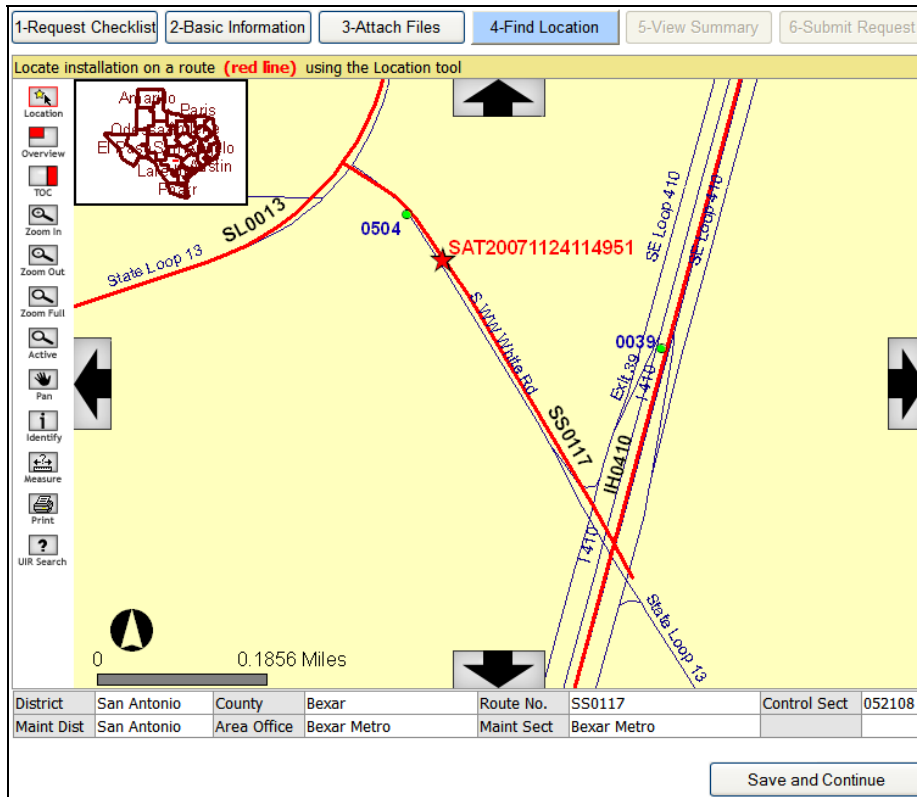


Figure 5. UIR Mapping Component in Step 4.

Table 1. ArcIMS Data Layer Display Range Properties.

Layer Name/Group	Position	Display Scale Range (1:X)		Comment
		Maximum	Minimum	
Acetate	<div style="text-align: center;"> Top ↑ ↓ Bottom </div>	100,000,000	0	
Reference Markers		120,000	0	Active layer by default
Routes		450,000	0	
Control Sections		1,900,000	0	
Segments		450,000	0	Not displayed by default
Streets – Stratmap1		40,000	4,000	
Streets – Stratmap2		4,000	0	
Districts		100,000,000	600,000	
Counties		50,000,000	0	
Railroad		40,000	4,000	
Other		1,000,000	4,000	
River		1,000,000	4,000	
Lake		1,000,000	4,000	
Parks		1,000,000	4,000	
Cities	4,000,000	4,000		
Aerial Photography	Bottom	4,000	0	

Note: All layers are in State Plane Coordinates (North American Datum [NAD] 1983, South Central) to support the display of aerial photography as background.

Table 2. ArcIMS Data Layer Fill, Line, and Label Properties.

Layer Name/Group	Fill Color	Outline		Label			Label Scale Range (1:X)	
		Weight	Color	Field	Font Size	Color	Maximum	Minimum
Acetate		Several	Several		Several	Several		
Reference Markers		8	0/255/0	TRM Number	11	15/0/176	80,000	0
Routes		3	255/0/0	Route Name	15 bold	0/0/0	450,000	1
Control Sections		1	23/135/0	No labels				
Segments		1	115/0/0	No labels				
Streets – Stratmap1		1	9/0/133	Street Name	10	9/0/133	25,000	4,000
Streets – Stratmap2		1	255/255/0	Street Name	10	255/255/0	4,000	1
Districts	No color	3	115/0/0	District Name	13 bold	115/0/0	100,000,000	600,000
Counties	No color	1	110/110/110	County	11	0/0/0	3,000,000	200,000
Railroad		4	0/0/0	No labels				
Other	255/175/175	1	0/0/0	Name	11 italics	0/0/0	85,000	4,000
River		1	10/147/252	No labels				
Lake		0.4	64/101/235	No labels				
Parks	56/168/0	1	0/0/0	Name	11	0/0/0	85,000	4,000
Cities	255/255/190	1	0/0/0	Name	8	0/92/230	500,000	20,000
Aerial Photography		n/a	n/a	n/a				

Note: All layers are in State Plane Coordinates (NAD 1983, South Central) to support the display of aerial photography as background.

Table 3. ArcIMS Data Layer Type, Source, and UIR Use.

Layer Name/Group	Description
Acetate	Type: ArcIMS acetate layer Source: Included in ArcIMS. Comment: n/a
Reference Markers	Type: Point Source: TxDOT (TSD). The researchers generated this feature class by converting a reference marker layer received in 2006, which contained linear segments representing sections of roadway between adjacent highway reference markers. In 2007, the researchers received a highway reference marker dataset from the Transportation Planning and Programming (TPP) Division. However, this dataset did not comply with the TxDOT data architecture standard (11). In addition, as part of a different project, the researchers noted some inconsistencies in the location of highway reference markers on the map (12). For this reason, the researchers decided not to use this dataset. Comment: Display-only layer.
Routes	Type: Polyline M Source: TxDOT (TSD). The researchers received this dataset in 2004, which corresponds to year 2002 conditions. The researchers also received an updated version of the dataset in early 2006, which included additional attributes. Unfortunately, TxDOT officials confirmed there were quality problems with this version. As a result, the researchers continued to use the 2002 dataset version. In 2007, the researchers received an updated version of the centerline dataset from TPP. However, this dataset did not comply with the TxDOT data architecture standard (11). For this reason, the researchers decided not to use this dataset. Comment: Display-and-query layer.

Table 3. ArcIMS Data Layer Type, Source, and UIR Use (Continued).

Layer Name/Group	Description
Control Sections	<p>Type: Polyline M Source: TxDOT (TSD). The researchers received this data layer in 2004, which corresponds to year 2002 conditions. The researchers also received an updated version of the control section layer in 2006, which displays control sections as controls and sections separated by dashes with no leading zeros (e.g., 351-4). The problem with this nomenclature was that districts routinely used the traditional six-digit style (e.g., 035104), and there were questions on what approach to use for database query purposes. In addition, there were questions related to the quality of the corresponding route layer. For consistency with the decision to use the 2002 version of the route layer, and after consultations with TxDOT officials, it was decided to use the 2002 version of the control section layer. As in the case of the route layer, in 2007 the researchers received an updated version of the control section dataset from TPP. However, this dataset did not comply with the TxDOT data architecture standard (11). Comment: Display-and-query layer.</p>
Segments	<p>Type: Polyline Source: TxDOT (TSD and TPP). The researchers generated this feature by using a route event in ArcGIS (on the Routes feature class) using data from the TxDOT RHiNo file. TxDOT does not have official GIS layers for maintenance sections and area offices. The TxDOT roadway inventory RHiNo file contains a very large number of attributes, including the maintenance section code and maintenance district for every segment on the state highway network. Creating a GIS layer for the entire RHiNo file using a route event in ArcGIS (on the Routes feature class) was straightforward. Unfortunately, because of the large number of attributes (138) and the large number of records (some 90,000) in the RHiNo file, query performance in ArcIMS after adding that layer to the map service decreased significantly. As a result, it was necessary to create a subset of the RHiNo file that only included the maintenance section codes and route names (along with some other attributes that might eventually be necessary, such as beginning and ending Texas Reference Marker (TRM) displacement, beginning and ending milepost, segment length, and control section). With the reduced dataset, the researchers used a route event on Routes to generate the Segments data layer. Comment: Display-and-query layer.</p>
Streets – Stratmap1	<p>Type: Polyline Source: Texas Natural Resources Information System (TNRIS) (13). In 2007, the researchers received a copy of TNRIS’ Strategic Mapping Program (StratMap) transportation theme (version 2.0), which TNRIS released in September 2006. The dataset covers urban and rural streets for the entire state, and includes local streets, county roads, and state roads. For the UIR implementation, the researchers generated a subset that only included a small number of attributes (mainly street name) to avoid query performance issues when using the full StratMap transportation dataset. Because the dataset includes all kinds of roads and ArcIMS displays both linear segments <i>and</i> street names, the dataset has become extremely useful to installation owner and TxDOT users as a tool to navigate the UIR map in urban and rural areas. Overall, based on a sample of observations at different locations, the positional accuracy of the StratMap version 2.0 dataset appears to be better than other datasets the researchers have reviewed. It may be worth noting the current UIR implementation at TTI uses a shape file that covers streets for five active UIR districts (Bryan, Houston, Fort Worth, Pharr, and San Antonio). The researchers also obtained from TNRIS an ArcSDE export file that includes streets for the entire state. Comment: Display-only layer (displayed in dark blue without aerial photography background).</p>
Streets – Stratmap2	<p>Type: Polyline Source: TNRIS. The researchers received this data layer in 2007. Comment: Display-only layer (displayed in yellow with aerial photography background). This layer uses the same data source as Streets – Stratmap1.</p>

Table 3. ArcIMS Data Layer Type, Source, and UIR Use (Continued).

Layer Name/Group	Description
Districts	<p>Type: Polygon Source: TxDOT (TSD). The researchers received this data layer in 2006. In 2007, the researchers received an updated version of the district dataset from TPP. However, this dataset did not comply with the TxDOT data architecture standard (11). In addition, this dataset only included district names, not district codes, which would make table querying and joining difficult. Comment: Display-and-query layer.</p>
Counties	<p>Type: Polygon Source: TxDOT (TSD). The researchers received this data layer in 2006. In 2007, the researchers received an updated version of the county dataset from TPP. However, this dataset did not comply with the TxDOT data architecture standard (11). In addition, this dataset contained county codes that did not match the 2006 version received previously. Comment: Display-and-query layer.</p>
Railroad	<p>Type: Polyline Source: TNRIS. The researchers downloaded this data layer in 2007. Comment: Display-only layer.</p>
Other	<p>Type: Polygon Source: TNRIS. The researchers downloaded this data layer in 2006. Comment: Display-only layer. It contains various feature classes such as cultural features and military installations.</p>
River	<p>Type: Polyline Source: TNRIS. The researchers downloaded this data layer in 2007. Comment: Display-only layer.</p>
Lake	<p>Type: Polygon Source: TNRIS. The researchers downloaded this data layer in 2007. Comment: Display-only layer.</p>
Parks	<p>Type: Polygon Source: TNRIS. The researchers downloaded this data layer in 2006. Comment: Display-only layer.</p>
Cities	<p>Type: Polygon Source: TNRIS. The researchers downloaded this data layer in 2006. Comment: Display-only layer.</p>
Aerial Photography	<p>Type: 6-inch resolution MrSID format tiles Source: Bexar County Appraisal District. The researchers received this data layer in 2007. In San Antonio, this dataset has become a useful tool to help identify features on the ground (which may be very difficult if not impossible with coarser imagery, e.g., 1 meter resolution). In the long term, as high-resolution aerial photography from other areas around the state becomes available, it is reasonable to assume that aerial photography will be a layer that is routinely used in UIR. Comment: Display-only layer (only covers Bexar County).</p>

UIR extracts data from map layers to populate location-related fields in the database, more specifically, in a table called PERMIT EVENT LOCATION (physical name: PRMT_EVNT_LOCN) (Figure 6). Table 4 summarizes the general process to populate the location-related fields.

(a) Logical model

PERMIT EVENT LOCATION
PERMIT ID (FK) PERMIT EVENT NUMBER (FK)
PERMIT EVENT LOCATION NORTHING MEASUREMENT PERMIT EVENT LOCATION EASTING MEASUREMENT ROUTE NAME CONTROL SECTION NUMBER TXDOT COUNTY ID MAINTENANCE SECTION ID DISTRICT ID MAINTENANCE DISTRICT ID

(b) Physical model

PRMT_EVNT_LOCN
PRMT_ID: VARCHAR2(30) PRMT_EVNT_NBR: NUMBER(3,0)
PEL_NORTHING_MS: NUMBER PEL_EASTING_MS: NUMBER RTE_NM: VARCHAR2(10) CTRL_SECT_NBR: VARCHAR2(8) TXDOT_CNTY_ID: NUMBER MAINT_SECT_ID: NUMBER DIST_ID: VARCHAR2(5) MAINT_DIST_ID: VARCHAR2(5)

Figure 6. UIR Location-Related Fields.**Table 4. General Process to Populate Location-Related Fields.**

Field Physical Name	Data Source	Value Passed	Display on User Interface
PEL_NORTHING	User clicks on map	Permit location northing	Point on map
PEL_EASTING	User clicks on map	Permit location easting	Point on map
RTE_NM	Field RTE_NM in the Routes layer.	Route name	Route name
CTRL_SECT_NBR	Field CTRL_SECT_ in the Control Section layer (notice field name is truncated in the shape file)	Control section number	Control section number
TXDOT_CNTY_ID	TXDOT_NBR in the Counties data layer	County number	County name
MAINT_SECT_ID	Field MNT_SEC ¹ in the Segments data layer	Maintenance section code	Maintenance section name, based on entry in table TXDOT_OFFC
DIST_ID	Field DIST_NBR in the Districts data layer	District ID	District name, based on entry in table TXDOT_UNIT
MAINT_DIST_ID	Field MAINT_DIS in the Segments data layer (notice field name is truncated in the shape file)	Maintenance section district ID	District name, based on entry in table TXDOT_UNIT

¹ Field name in RHiNo file received from TxDOT's TPP.

Although not stored in the database, the map in Step 4 (Figure 5) shows the area office. UIR determines the area office by using the maintenance section number to look up the area office name in table TXDOT_OFFC.

INSTALLATION OWNER USER INTERFACE

Account Types and User Interface Menu Options

The installation owner user interface supports the needs and responsibilities of installation owner users during the installation notice review process, including submitting new requests,

processing pending requests, managing user profile data, and proceeding with the field installation according to the documentation submitted and TxDOT instructions.

Installation owner users must have a UIR user profile in order to access the system. The user profile contains contact data, company data, a user ID, a password, as well as a unique ID that allows the system to retrieve all requests the user has submitted. UIR inserts profile data automatically into all required forms to improve consistency and to reduce the work needed to complete the form.

Each user account has a privilege level that determines the level of access an active user has. The privilege level can be one of the following: Administrator, User, Consultant, and Guest.

Table 5 summarizes the various levels of access for each privilege level.

Table 5. Installation Owner User Types.

Function	Administrator	User	Consultant	Guest
Prepare installation request	X	X	X	
Submit installation request	X	X		
View installation request	X	X	X	X
Prepare response to TxDOT	X	X	X	
Submit response to TxDOT	X	X		
Withdraw request	X	X		
Receive approval	X	X		
Receive copy of approval email	X	X	X	X
Submit 48-hour notification prior to construction	X	X		
Prepare amendment request	X	X	X	
Submit amendment request	X	X		
Submit as-built certification	X	X		
Generate reports	X	X	X	X
View special provisions	X	X	X	X
View permit checklist	X	X	X	X
View TxDOT contact list	X	X	X	X
View installation owner contact list	X	X	X	X
Create initial office account	X			
Manage office accounts	X			

Table 6 shows the menu options available to installation owner users. In general, the menu options available to individual users depend on the user account privilege level.

Table 6. Installation Owner User Interface Menu Options.

Menu	Menu Option	Description
Installation Requests	New Request	Enables the user to submit a new installation request.
	My Requests	Displays the user's active requests (same as Home).
	My Office Requests	Shows a list of active requests from all the users associated with the user's office.
	My Installation Owner Requests	Shows a list of active requests from all the offices registered at the same TxDOT district office.
	Closed Requests	Shows closed requests, grouped into three categories: My Closed Requests, Office Requests, and Installation Owner Requests.
Accounts	My Account	Displays user profile information.
	TxDOT Contacts	Shows a list of TxDOT officials who may be involved in the installation review process.
	Installation Owner Contacts	Shows a list of installation owners, offices, and registered UIR users.
	Manage Accounts	Enables an administrator to manage user accounts.
	UIR User Responsibilities	Includes a summary of basic UIR user acknowledgments and responsibilities.
Reports	Reports	Enables the user to generate reports using a general-purpose query engine.
	Map	Displays an interactive of the state and includes installation request display and query capabilities.
Other Resources	Special Provisions	Displays special provisions that TxDOT attaches to installation request approval forms.
	Request Checklist	Displays questions that installation owner users must answer when they submit installation requests.
	Feedback	Enables users to provide comments and suggestions on how to improve UIR.
	UIR Help	Opens a new browser window that shows the interactive UIR online help system.
	TxDOT Manuals	Opens a new browser window that lists TxDOT manuals that are available online
	Utility Accommodation Rules	Opens a new browser window that lists the Utility Accommodation Rules in Texas.
	TxDOT Standard Specifications	Opens a new browser window that enables users to search standard construction specifications at TxDOT.
	Texas Manual on Uniform Traffic Control Devices	Opens a new browser window that points to the online version of the Texas Manual on Uniform Traffic Control Devices.
	TxDOT Traffic Engineering Standard Plan Sheets	Opens a new browser window that points to standard traffic control plan sheets at TxDOT.
	Utility Listings	Opens a new browser window that lists utility regulatory agencies in Texas along with listings of registered utility owners and operators.
	ROW Maps	Opens a new browser window that points to the ROW Maps application at TxDOT.
	Survey Control Points	Opens a new browser window that points to the Survey Control Point application at TxDOT.

Submitting Installation Requests

The submission of installation requests online is one of the most important UIR functions for installation owner users. Submitting installation requests involves completing a short sequence of data input screens (shown in [Figure 7](#) through [Figure 13](#)) that allow editing and review before

submitting the request to TxDOT. A brief description of each step follows. For additional information, see the UIR user manual (2).

Request Checklist

This step involves providing answers and comments in response to a series of questions designed to improve the quality of the documentation submission.

1-Request Checklist	2-Basic Information	3-Attach Files	4-Find Location	5-View Summary	6-Submit Request
Answer questions and add comments as needed					
Yes <input checked="" type="radio"/>	No <input type="radio"/>	N/A <input type="radio"/>	Is the location and identification (highway number) of the TxDOT highway clearly indicated on the plans?		
Comment: Plans show the highway number.					
Yes <input checked="" type="radio"/>	No <input type="radio"/>	N/A <input type="radio"/>	Are the utility plans legible, drawn to scale, and accurately dimensioned?		
Comment:					
Yes <input checked="" type="radio"/>	No <input type="radio"/>	N/A <input type="radio"/>	Is the location of the proposed utility line clearly shown on the plans?		
Comment:					
Yes <input checked="" type="radio"/>	No <input type="radio"/>	N/A <input type="radio"/>	Are other existing utility lines in the vicinity shown on the plans?		
Comment: Both underground and aboveground existing lines are shown.					
Yes <input checked="" type="radio"/>	No <input type="radio"/>	N/A <input type="radio"/>	Are the right of way line and edge of highway pavement clearly shown on plans?		
Comment: The plans clearly show the state property line and the existing edge of pavement.					
Yes <input type="radio"/>	No <input type="radio"/>	N/A <input checked="" type="radio"/>	For lines to be installed parallel to the highway, is the distance from the right of way line and from the edge of highway pavement clearly shown?		
Comment: The proposed installation is a crossing.					
Yes <input type="radio"/>	No <input type="radio"/>	N/A <input checked="" type="radio"/>	For installations parallel to the highway, does the installation alignment change? Alignment changes need to be justified and reasonable.		
Comment: The proposed installation is a crossing.					
Yes <input type="radio"/>	No <input type="radio"/>	N/A <input checked="" type="radio"/>	Are appropriate temporary erosion control devices (e.g., rock berms, silt fences) shown where the line will be across/along a creek, drainage way, steep slope, within the Edwards Aquifer Recharge Zone, or in other critical areas?		
Comment:					
Yes <input type="radio"/>	No <input type="radio"/>	N/A <input checked="" type="radio"/>	For aerial installations, do the plans clearly show and differentiate between existing poles and new poles?		
Comment:					
Yes <input checked="" type="radio"/>	No <input type="radio"/>	N/A <input type="radio"/>	For highway crossings, is the location of the crossing clearly shown on the plans? The crossing should be as close to 90 degrees as practical.		
Comment:					
Yes <input checked="" type="radio"/>	No <input type="radio"/>	N/A <input type="radio"/>	For lines crossing the highway, crossing intersecting streets/county roads, or passing through the protected root area of desirable trees, is it clearly shown that the line will be installed by boring? In addition, casing should be shown under highways and paved city street/county road intersections.		
Comment:					
Yes <input type="radio"/>	No <input type="radio"/>	N/A <input checked="" type="radio"/>	agv afds asd as TEST		
Comment:					
Reset			Save and Continue		

Figure 7. Installation Owner User Interface. Step 1-Request Checklist.

Basic Information

This step involves providing basic information about the proposed installation.

1-Request Checklist	2-Basic Information	3-Attach Files	4-Find Location	5-View Summary	6-Submit Request
Provide basic information					
Installation Request No.	SAT20071124114951				
Applicant Name	Cesar Quiroga				
Installation Owner Name	UIR Utility Testing Company				
Installation Office Name	San Antonio Office 1				
TxDOT District	San Antonio District				
Installation Owner Job No. <small>[Optional]</small>	UTC 2007-01 Only letters, numbers and hyphen are allowed				
Request Type	Regular Installation Request Click here for definitions				
Proposed Construction Schedule <small>[Tentative]</small>	Beginning: December 3 2007 Finishing : December 7 2007				
Installation Purpose	Public Utility Installation Click here for definitions				
Installation Class	Telephone				
Installation Location	<input type="radio"/> Aerial <input checked="" type="radio"/> Buried <input type="radio"/> Aerial and Buried				
Description	This text box contains a detailed description of the proposed installation. Its purpose is to assist the reviewers in understanding the project scope, limits, overall construction approach and/or procedures, and other technical characteristics. This section should also include distances to the closest state highway reference markers, e.g., "installation starts 357 ft NW of reference marker 0456 and ends 227 ft SW of reference marker 0458." Any text in this section appears on the first page of the installation request document.				
Special Comments <small>[Optional]</small>	This text box is used to provide additional relevant information, e.g., if this request is part of a large project that involves several requests (in this case, the user would list all installation request numbers: SAT20071120083012, SAT20071120100512, and so on).				
<input type="button" value="Save and Continue"/>					

Figure 8. Installation Owner User Interface. Step 2-Basic Information.

Attach Files

This step involves uploading supporting documentation to the server and converting the uploaded documents to PDF format.

1-Request Checklist 2-Basic Information **3-Attach Files** 4-Find Location 5-View Summary 6-Submit Request

Select and attach files

Find File:

[\[Click here to see valid file types you can upload\]](#)

View and verify attachments and PDF files

Attachment	Size	PDF	Delete
Sample Microstation file1.dgn	73.5KB		<input type="checkbox"/>
Sample Microsoft Word file1.doc	91KB		<input type="checkbox"/>
Sample image file.jpg	902.19KB		<input type="checkbox"/>
Sample PDF file1.pdf	150.49KB		<input type="checkbox"/>
Sample AutoCAD file1.dwg	112.84KB		<input type="checkbox"/>

Open, review, and print each PDF file to make sure it is readable and prints correctly. Keep in mind the system automatically converts CAD files (e.g., Microstation, AutoCAD) to 11x17 PDF files. If the PDF file is not readable, delete the attachment, correct the drawing, and try again.

Figure 9. Installation Owner User Interface. Step 3-Attach Files.

Find Location

This step involves using an interactive map to place the location of the proposed installation on the map and display the corresponding route, control section, area office, and maintenance section data.

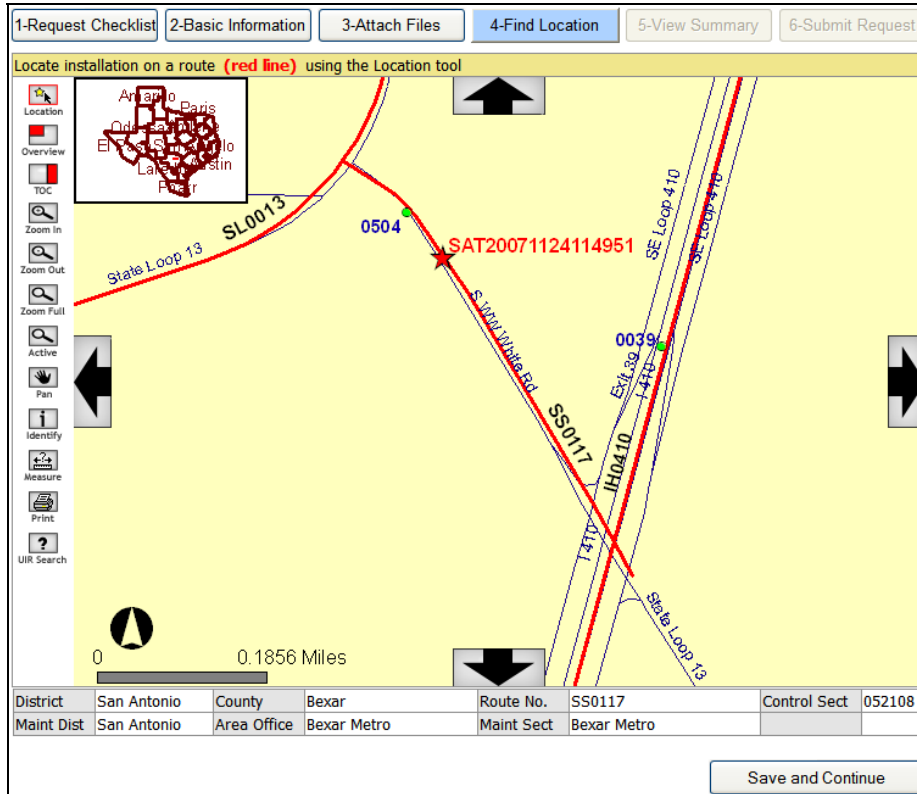


Figure 10. Installation Owner User Interface. Step 4-Find Location.

View Summary

This step involves reviewing the documentation provided in the previous steps.






1-Request Checklist	2-Basic Information	3-Attach Files	4-Find Location	5-View Summary	6-Submit Request
---------------------	---------------------	----------------	-----------------	----------------	------------------

Review installation request information

Basic Information

Installation Request No.	SAT20071124114951
District Application No.	
Installation Owner Job No.	UTC 2007-01
Applicant Name	Cesar Quiroga
Contact Information	c-quiroga@tamu.edu - 210-731-9938
Installation Owner Name	UIR Utility Testing Company
Office Name	San Antonio Office 1
Proposed Construction Schedule	Begin on: 12-03-2007 Finish on: 12-07-2007
Request Type	Regular Installation Request
Installation Purpose	Public Utility Installation
Installation Class	Telephone
Installation Location	Buried
Description	This text box contains a detailed description of the proposed installation. Its purpose is to assist the reviewers in understanding the project scope, limits, overall construction approach and/or procedures, and other technical characteristics. This section should also include distances to the closest state highway reference markers, e.g., "installation starts 357 ft NW of reference marker 0456 and ends 227 ft SW of reference marker 0458." Any text in this section appears on the first page of the installation request document.
Special Comments	This text box is used to provide additional relevant information, e.g., if this request is part of a large project that involves several requests (in this case, the user would list all installation request numbers: SAT20071120083012, SAT20071120100512, and so on).
Notice Printout	View Notice (HTML)
Request Checklist	Show Request Checklist Answers

Attachments

Attachment	Size (KB)	Attachment (pdf)
Sample Microstation file1.dgn	74	
Sample Microsoft Word file1.doc	91	
Sample image file.jpg	902	
Sample PDF file1.pdf	150	
Sample AutoCAD file1.dwg	113	

Location

Geographic Location District	San Antonio
Maintenance District	San Antonio
Maintenance Section	Bexar Metro
Control Section	052108
Route	SS0117
County	Bexar
Map	View Map

Continue

Figure 11. Installation Owner User Interface. Step 5-View Summary.

Submit Request

This step involves generating the installation request document in PDF format and officially submitting the request to TxDOT.

The screenshot shows the '6-Submit Request' step of the installation request process. It includes a navigation bar with steps 1-6, a section for selecting email recipients, a table of recipient actions, and a 'Submit Application' button.

Select users that should receive emails from UIR

For email recipients with UIR accounts, select existing user:

For email recipients without UIR accounts, select email address:

or type new email address:

Select type of email user(s) should receive

Email Recipient	Delete	Submissions to TxDOT	TxDOT Requests before Approval	TxDOT Approvals	48-hour Construction Notifications	TxDOT Requests during Construction	TxDOT Requests after Construction	Closed Requests
ajones@earthlink.net	✗	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
jsmith@yahoo.com	✗	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Select one of the following options

Edit Request: Click 1, 2, 3, or 4 above

Submit Application: I agree (You must check "I agree" to submit application)

Figure 12. Installation Owner User Interface. Step 6-Submit Request.

After submitting the request to TxDOT, the installation owner user interface displays the request as Submitted, and users can click the installation request number to open and view all the data and documentation, including the notice of proposed installation PDF file, associated with the new submission.

Requests Currently at Installation Owner (0) [Hide/Show]						
Requests Currently at TxDOT (1) [Hide/Show]						
Installation Owner Job No.	Installation Request No.	Dist App No.	Maintenance Section	Highway	Status	Last Event
UTC 2007-01	SAT20071124114951		Bexar Metro	SS0117	Submitted	11-24-2007

Figure 13. Installation Owner User Interface. Submitted Request.

Reviewing Phase

After submitting the installation request, TxDOT officials proceed with the review of the proposed installation. The review may include routing the proposed installation request to appropriate TxDOT offices and, if needed, back to the user who submitted the application for clarification or additional/revised documentation. A request for clarification from TxDOT is a request for a simple comment to help clarify or confirm information that was not evident in the

documentation originally submitted. A request for revised documentation enables the applicant to access the six-step interface to add, delete, and/or edit data (including files) associated with the original submission. If TxDOT sends a request back to the applicant, UIR generates an email to alert that user.

Approval/Pre-Construction

During the approval phase, a designated TxDOT official approves the proposed installation and routes the approval form along with any relevant special provisions to the installation owner user for further processing. UIR also sends an email to the applicant, the designated inspector, as well as any email recipient that the applicant added in Step 6. For convenience, the email includes direct links to the notice of proposed installation and approval forms.

At least 2 business days prior to starting construction, the installation owner user (or another duly authorized installation owner user) must notify TxDOT—using UIR—that construction is about to commence. During the notification process, UIR sends an email to the designated TxDOT inspector who then coordinates with the installation owner user details such as the actual construction schedule and traffic control plans.

Construction

After the TxDOT inspector receives the 2-business day notification (via UIR), the status of the installation request in UIR becomes “Construction.” By default, during the construction phase, the TxDOT inspector has control of the installation request in UIR. In general, the TxDOT inspector has the following UIR interface options:

- Ask the installation owner user to resubmit the 2-business day notification to TxDOT at a later date. This option may be necessary if, for example, TxDOT is conducting maintenance work on the ROW that might prevent the installation owner from starting its own construction activities. If the inspector chooses this option, UIR will transfer control of the installation request to the applicant.
- Stop construction, and ask the installation owner user to submit an amendment request. This option might be necessary if, in the opinion of the inspector, the conditions on the ground are such that an amendment to the previously approved proposal is warranted. Examples of potential conditions include the determination of the need for significant changes in horizontal alignment, vertical alignment, and/or construction schedule. If the inspector chooses this option, UIR will transfer control of the installation request to the applicant.
- Notify the utility permit office that construction has ended. The TxDOT inspector chooses this option if, in the opinion of the inspector, construction has finished completely (i.e., there are no pending construction items or temporary utility adjustments, and the finished installation meets all relevant specifications, rules, and regulations, including the Utility Accommodation Rules). If the inspector chooses this option, UIR

changes the status of the installation request to “Post-construction” and transfers control of the installation request to the TxDOT district utility permit office for further processing.

Post-Construction

After the TxDOT field inspector notifies the district utility permit office that construction has ended, this office requests the installation owner to submit an as-built certification online.

After the submission and review of the as-built certification, the utility permit office archives the completed request. Archiving the completed request involves routing the request to the closed permit box and changing the status of the request to “Completed.”

TXDOT USER INTERFACE

Account Types and User Interface Menu Options

The TxDOT user interface supports the needs and responsibilities of TxDOT officials during the review process. The system facilitates this process through automated emails that alert specified officials when an application has reached a status for which those officials are responsible. The specified official then logs into the system, clicks on the appropriate processing link in the navigation bar, and processes the application.

TxDOT users must have a UIR user profile in order to access the system. The user profile contains contact data, TxDOT unit and office data, a user ID, a password, as well as a unique ID that allows the system to retrieve all requests the user has processed. UIR inserts profile data automatically into all required online forms to improve consistency and to reduce the work needed to complete the form.

Each TxDOT user account has a privilege level and a role that determines the level of access that user has. The privilege level can be one of the following: User, Administrator, and Guest:

- *User*. A user with a user privilege level can fulfill basic UIR functions according to the specific office type.
- *Administrator*. A user with an administrator privilege level can fulfill additional UIR functions according to the specific office type. At the district level, it is normally sufficient to assign an administrator privilege to users in the following office types: utility permit office, utility permit approval, and security administrator.
- *Guest*. A user with a guest privilege level has read-only access to UIR, regardless of office type.

[Table 7](#) summarizes the functions for users with a *user* privilege level.

Table 7. UIR Functions for TxDOT Users with a *User* Privilege Level.

Function/Role	Office Type								
	Information Systems Division Security Administrator	Other Division or District Security Administrator	District Utility Permit Office	District Utility Permit Approval	District Area Office or Maintenance Section	District Utility Coordinator or Superintendent	Other District Offices	Maintenance Division Review or Approval	Right of Way Division Oversight
View request	X	X	X	X	X	X	X	X	X
Review request			X		X	X	X	X	
Approve request				X					
Receive 2 business day notification					X				
Stop construction					X				
Notify construction completion					X				
Take control of approved request					X				
Review amendment			X	X	X	X	X	X	
Approve/reject amendment				X					
Request/review as-built certification			X						
Send to closed permit box			X						
Generate reports	X	X	X	X	X	X	X	X	X
Manage special provisions			X	X					
Manage permit checklist			X	X					

Table 8 summarizes additional functions for TxDOT users with an *administrator* privilege level.

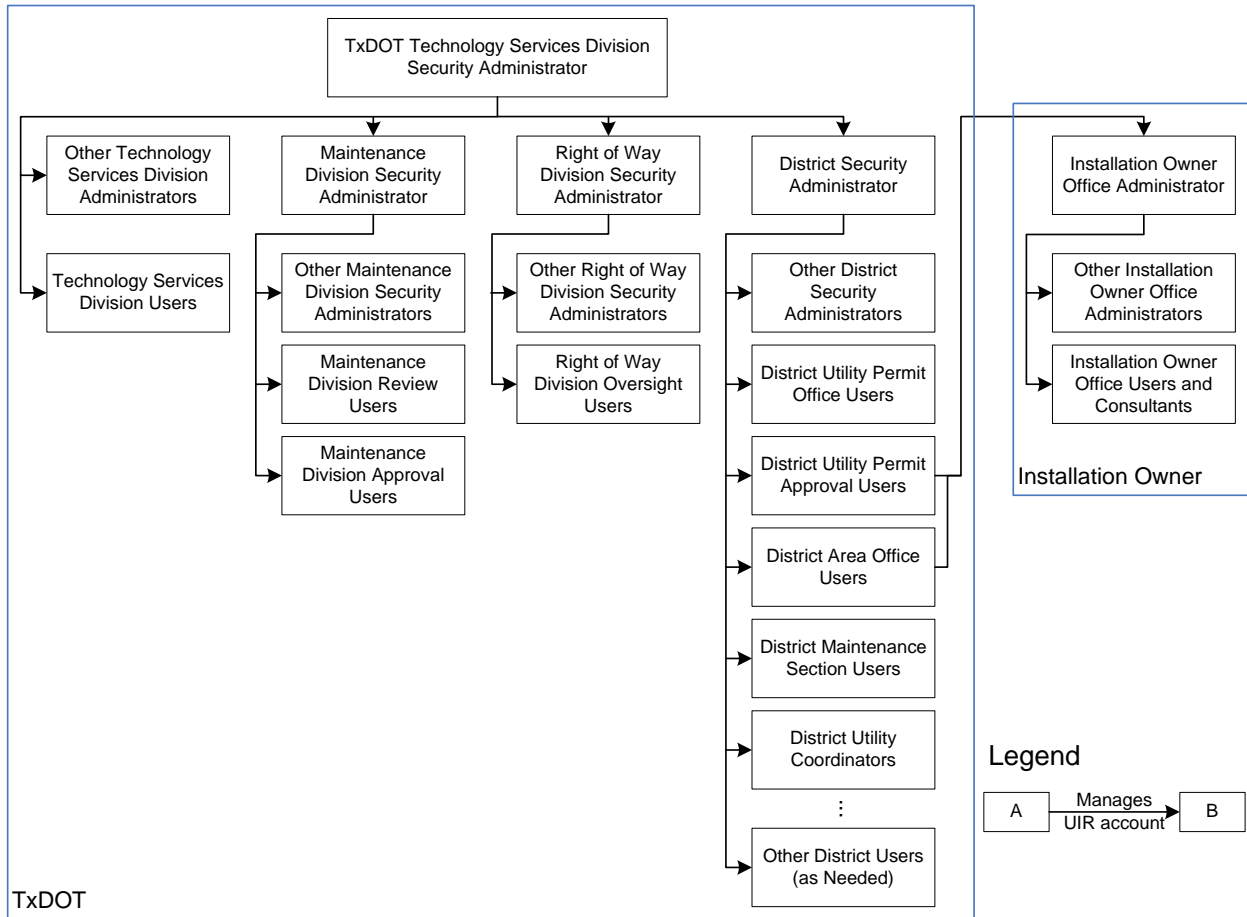
Table 8. UIR Functions for TxDOT Users with an *Administrator* Privilege Level.

Function/Role	Office Type								
	Information Systems Division Security Administrator	Other Division or District Security Administrator	District Utility Permit Office	District Utility Permit Approval	District Area Office or Maintenance Section	District Utility Coordinator or Superintendent	Other District Offices	Maintenance Division Review or Approval	Right of Way Division Oversight
Manage incomplete request			X	X					
Purge request			X	X					
Rollback request			X	X					
Take control of approved request			X	X					
Manage installation owner account			X	X					
Manage TxDOT unit security administrator account	X								
Manage TxDOT unit district account		X							

Security administrators manage UIR TxDOT accounts. There are two types of security administrators:

- *TSD security administrators.* A TSD security administrator activates TxDOT units (e.g., districts) and creates and manages security administrator accounts for each TxDOT unit.
- *Other TxDOT unit security administrators.* A security administrator at a TxDOT unit other than TSD (e.g., ROW Division, Maintenance Division, districts) creates offices within each unit and creates and manages TxDOT users within each office.

As a reference, [Figure 14](#) shows the overall user management structure within UIR.



Notes:

- "User" is a generic term that denotes a UIR account holder. Depending on the privilege level, a "user" could be an administrator, user, consultant (on the installation owner side), or guest.
- District utility permit office or approval users with an administration privilege can manage installation owner accounts.

Figure 14. UIR User Management Structure.

Table 9 shows the menu options available to TxDOT users. The menu options available to individual TxDOT users depend on the specific role that users play on the installation review process and on user account privilege level.

Table 9. TxDOT User Interface Menu Options.

Menu	Menu Option	Description
Installation Requests	My Requests	Displays the user's active requests (same as Home).
	My Office Requests	Shows a list of active requests associated with all TxDOT users in the same office.
	My District Requests	Shows a list of active requests submitted to the same TxDOT district office, grouped by maintenance section.
	Approved Requests	Shows a list of active requests that have an approval status, grouped by maintenance section.
	Closed Requests	Shows closed requests, grouped by maintenance section.
Accounts	My Account	Displays user profile information.
	TxDOT Contacts	Shows a list of TxDOT officials who may be involved in the installation review process.
	Installation Owner Contacts	Shows a list of installation owners, offices, and registered UIR users.
	Manage Installation Owner Accounts	Enables a district user with administrative privileges to manage installation owner user accounts.
	Manage <Unit> Accounts	Enables a TxDOT unit (e.g., a district or a division) security administrator to manage TxDOT user accounts within that unit.
	Manage <Unit> Offices	Enables a TxDOT unit (e.g., a district or a division) security administrator to manage TxDOT offices within that unit.
	Manage TxDOT Units	Enables a TSD security administrator to manage TxDOT units (e.g., a district or a division) and create and manage security administrator accounts for each unit.
Reports	Reports	Enables the user to generate reports using a general-purpose query engine.
	Map	Displays an interactive map of the state and includes installation request display and query capabilities.
Database Tools	Incomplete Requests	Shows a list of incomplete new requests and incomplete new responses to TxDOT.
	Purge Request	Enables the TxDOT user to purge installation requests from the UIR database.
	Rollback Request	Enables the TxDOT user to rollback the last transaction associated with an installation request.
Other Resources	Special Provisions	Displays special provisions that TxDOT attaches to installation request approval forms.
	Request Checklist	Displays questions that installation owner users must answer when they submit installation requests.
	Feedback	Enables users to provide comments and suggestions on how to improve UIR.
	UIR Help	Opens a new browser window that shows the interactive UIR online help system.
	TxDOT Manuals	Opens a new browser window that lists TxDOT manuals that are available online.
	Utility Accommodation Rules	Opens a new browser window that lists the Utility Accommodation Rules in Texas.
	TxDOT Standard Specifications	Opens a new browser window that enables users to search standard construction specifications at TxDOT.
	Texas Manual on Uniform Traffic Control Devices	Opens a new browser window that points to the online version of the Texas Manual on Uniform Traffic Control Devices.
	TxDOT Traffic Engineering Standard Plan Sheets	Opens a new browser window that points to standard traffic control plan sheets at TxDOT.
	Utility Listings	Opens a new browser window that lists utility regulatory agencies in Texas along with listings of registered utility owners and operators.
	ROW Maps	Opens a new browser window that points to the ROW Maps application at TxDOT.
Survey Control Points	Opens a new browser window that points to the Survey Control Point application at TxDOT.	

Reviewing Installation Requests

Other than providing occasional technical support to company users who may have difficulty with the UIR user interface, TxDOT's role in the installation review process begins after utility company users have submitted installation requests online. While the user interface for TxDOT users involved in the installation review process varies somewhat depending on user role and privilege level (primarily with respect to menu options), the actual online review form (i.e., the form that users see when they open an installation request) is the same. The only difference is the drop down menu options available to individual users when routing an installation request to other users. Note: The approval form (only accessible to users in the utility permit approval office type) includes additional options that pertain to the approval activity.

In general, the review process includes the following activities:

- *General monitoring.* At any point during the review process, TxDOT users can access installation requests. In general, the access is read-only unless the user has received control of an installation request from a previous user. The interface provides two general screens to support this function: Basic Information ([Figure 15](#)) and Event History ([Figure 16](#)).
- *Installation request review and processing.* Users who have received a request at any point during the review process (typically those users have received an automated email from UIR asking them to conduct a review) can access, process, and route installation requests. The interface provides three general screens to support this function: Basic Information ([Figure 15](#)), Event History ([Figure 16](#)), and Conduct Action ([Figure 17](#)). Note: the Conduct Action screen is disabled for users who do not have control over an installation request at that point in time.

The number of routing events during the installation review process depends on the characteristics and requirements associated with a specific installation request. As an illustration, [Figure 18](#) shows the event history for a sample installation request that has seven events so far in the database.

SAT20071124114951 [Basic Information](#) [Event History](#) [Conduct Action](#) [Go back](#)

Basic Information

Installation Request No.	SAT20071124114951
District Application No.	
Installation Owner Job No.	UTC 2007-01
Applicant Name	Cesar Quiroga
Contact Information	c-quiroga@tamu.edu - 210-731-9938
Installation Owner Name	UIR Utility Testing Company
Office Name	San Antonio Office 1
Proposed Construction Schedule	Begin on: 12-03-2007 Finish on: 12-07-2007
Request Type	Regular Installation Request
Installation Purpose	Public Utility Installation
Installation Class	Telephone
Installation Location	Buried
Description	This text box contains a detailed description of the proposed installation. Its purpose is to assist the reviewers in understanding the project scope, limits, overall construction approach and/or procedures, and other technical characteristics. This section should also include distances to the closest state highway reference markers, e.g., "installation starts 357 ft NW of reference marker 0456 and ends 227 ft SW of reference marker 0458." Any text in this section appears on the first page of the installation request document.
Special Comments	This text box is used to provide additional relevant information, e.g., if this request is part of a large project that involves several requests (in this case, the user would list all installation request numbers: SAT20071120083012, SAT20071120100512, and so on).
Notice Printout	View Notice (PDF) View Notice (HTML)
Request Checklist	Show Request Checklist Answers

Attachments


Attachment	Size (KB)	Attachment (pdf)
Sample Microstation file1.dgn	74	

Figure 15. Sample Installation Request Review *Basic Information* Screen.

SAT20071124114951 [Basic Information](#) [Event History](#) [Conduct Action](#) [Go back](#)

Statistics [\[Show/Hide\]](#)

Status	Days	Status	Days	Status	Days
Submitted	0.8	Pre construction-at Installation Owner		Post construction-at Installation Owner	
Under review-at TxDOT		Pre construction-at Installation Owner (notify by phone)		Post construction-at TxDOT	
Under review-at TxDOT Total	0.8	Pre construction-Total		Post construction-Total	
Under review-at Installation Owner		Amendment-at Installation Owner		Closed	
Under review-Total	0.8	Amendment-at TxDOT			
Days to approve/reject		Construction			
		Construction stopped-at Installation Owner			
		Construction-Total			

Event History [\[Collapse/Expand\]](#)

Status	Events	By	Office Name	Date
Submitted	1. Application submitted	Cesar Quiroga	UIR Utility Testing Company, San Antonio Office 1	11-24-2007

Figure 16. Sample Installation Request Review *Event History* Screen.

SAT20071124114951		Basic Information	Event History	Conduct Action	Go back
Enter or Confirm District Application Number					
Installation Request No.	SAT20071124114951				
District Application No.	TE-07-53				
Review Installation Request Type					
Request Type	Regular Installation Request		Click here for definitions		
Installation Purpose	Public Utility Installation		Click here for definitions		
Select or Confirm Inspection Office and Inspector (mandatory during request approval)					
Maintenance Section	Bexar Metro (according to geographic location)				
Inspection Office Selected	--- Select an Inspection Office ---				
Inspector Selected	--- Inspector Name ---				
Select Office/Person to Forward Request					
Route To	Installation Owner Office		San Antonio Office 1		
Send To	Cesar Quiroga				
Action Needed	Submit revised documentation				
Review Comments [Optional]	This text box contains comments for the recipient. In this example, the request is being sent back to the applicant (hint: include as much information as possible to document why the request is being sent back).				
Select or Confirm Applicable Special Provisions					
Special Provisions	<input type="checkbox"/> Inspector Map <input type="checkbox"/> San Antonio District Special Provisions				
Select and Attach Files					
Find File:	<input type="text"/>				Browse...
[Click here to see valid file types you can upload]					
<input type="button" value="Upload File"/>					
<input type="button" value="Submit Review"/>					


Figure 17. Sample Installation Request Review *Conduct Action* Screen.

(a) Event History Expanded

SAT20071124114951 Basic Information **Event History** Conduct Action Go back

Statistics [Show/Hide]

Event History [Collapse/Expand]

Event 7	Review completed / Conduct review
When	11/25/2007 10:40:51 AM
By	TTI SATAO1 (TxDOT, Bexar Metro Area Office) - satao1
Send to	TTI SATUPO1 (TxDOT, Utility Permit Office) - satupo1
Comment	No objections from the field office. I would like the inspection to be coordinated with the Bexar Metro Maintenance Section (see above). Also, use the special provisions below.
Event 6	Review completed / Conduct review
When	11/25/2007 10:36:17 AM
By	TTI SATMS1 (TxDOT, Bexar Metro Maintenance Section) - satms1
Send to	TTI SATAO1 (TxDOT, Bexar Metro Area Office) - satao1
Comment	No objections. See attached picture, which shows the project area in more detail.
Attachment 1	Picture 028.jpg 
Event 5	Review completed / Conduct review
When	11/25/2007 10:30:43 AM
By	TTI SATAO1 (TxDOT, Bexar Metro Area Office) - satao1
Send to	TTI SATMS1 (TxDOT, Bexar Metro Maintenance Section) - satms1
Comment	Example of transaction where the area engineer routes the request to a maintenance supervisor to conduct a field evaluation of the feasibility of the proposed installation.
Event 4	Review completed / Conduct review
When	11/25/2007 10:28:11 AM
By	TTI SATUPO1 (TxDOT, Utility Permit Office) - satupo1
Send to	TTI SATAO1 (TxDOT, Bexar Metro Area Office) - satao1
Comment	Example of transaction where the utility permit office user routes the request to an area engineer.

(b) Event History Collapsed

SAT20071124114951 Basic Information **Event History** Conduct Action Go back

Statistics [Show/Hide]

Event History [Collapse/Expand]

Status	Events	By	Office Name	Date
Under review	7. Review completed	TTI SATAO1	TxDOT, Bexar Metro Area Office	11-25-2007
Under review	6. Review completed	TTI SATMS1	TxDOT, Bexar Metro Maintenance Section	11-25-2007
Under review	5. Review completed	TTI SATAO1	TxDOT, Bexar Metro Area Office	11-25-2007
Under review	4. Review completed	TTI SATUPO1	TxDOT, Utility Permit Office	11-25-2007
Under review	3. Submitting revised documentation	Cesar Quiroga	UIR Utility Testing Company, San Antonio Office 1	11-25-2007
Under review	2. Review partially completed	TTI SATUPO1	TxDOT, Utility Permit Office	11-25-2007
Submitted	1. Application submitted	Cesar Quiroga	UIR Utility Testing Company, San Antonio Office 1	11-24-2007

Figure 18. Sample Installation Request with Seven Events in the Database.

Approval/Pre-Construction

During the approval phase, a designated TxDOT official (utility permit approval office type) approves the proposed installation and routes the approval form along with any relevant special provisions to the installation owner user for further processing. UIR also sends an email to the applicant, the designated inspector, as well as any email recipient that the applicant added in Step 6 while submitting the installation request. The approval user interface also enables the TxDOT user to reject installation requests, e.g., if the proposed installation does not comply with the Utility Accommodation Rules or if a different protocol would be necessary (e.g., in the case of bridge attachments). From a procedural standpoint, the only difference between approvals and rejections is that rejections are routed to the closed permit box (the system will automatically send an email to the applicant), whereas approvals are routed to the applicant.

At least 2 business days prior to starting construction, the installation owner user must notify TxDOT—using UIR—that construction is about to commence. During the notification process, UIR sends an email to the designated TxDOT inspector who then coordinates with the installation owner user details such as the actual construction schedule and traffic control plans.

Construction

After the TxDOT inspector receives the 2-business day notification (via UIR), the status of the installation request in UIR becomes “Construction.” By default, during the construction phase, the TxDOT inspector has control of the installation request in UIR. In general, the TxDOT inspector has the following UIR interface options:

- Ask the installation owner user to re-submit the 2-business day notification to TxDOT at a later date. This option may be necessary if, for example, TxDOT is conducting maintenance work on the ROW that might prevent the installation owner from starting its own construction activities. If the inspector chooses this option, UIR will transfer control of the installation request to the applicant.
- Stop construction and ask the installation owner user to submit an amendment request. This option might be necessary if, in the opinion of the inspector, the conditions on the ground are such that an amendment to the previously approved proposal is warranted. Examples of potential conditions include the determination of the need for significant changes in horizontal alignment, vertical alignment, and/or construction schedule. If the inspector chooses this option, UIR will transfer control of the installation request to the applicant.
- Notify the utility permit office that construction has ended. The TxDOT inspector chooses this option if, in the opinion of the inspector, construction has finished completely (i.e., there are no pending construction items or temporary utility adjustments, and the finished installation meets all relevant specifications, rules, and regulations, including the Utility Accommodation Rules). If the inspector chooses this option, UIR changes the status of the installation request to “Post-construction” and transfers control of the installation request to the TxDOT district utility permit office for further processing.

Post-Construction

After the TxDOT field inspector notifies the district utility permit office that construction has ended, this office requests the installation owner user to submit an as-built certification online.

After the submission and review of the as-built certification, the utility permit office archives the completed request. Archiving the completed request involves routing the request to the closed permit box and changing the status of the request to “Completed.”

REPORTS

Tabular Reports

The current version of UIR supports three types of reports ([Figure 19](#)):

- *Installation Request Listing*. This report provides a list of requests and basic related attribute data.
- *Performance Measures*. This report provides a summary of installation request performance data (essentially, number of days that an installation request spends between major milestones).
- *Totals*. This report provides a summary of the number of installation requests according to criteria such as installation owner, applicant name, route, and control section.

Map

The map enables users to display the location of installation requests on an interactive map ([Figure 20](#)). The map also enables users to query individual locations to display all the attribute data, event history, and documents associated with the corresponding installation request ([Figure 21](#)).

Reports

Select TxDOT District

District: San Antonio District

Select Installation Request

Installation Request No.: --- All Installation Requests ---

Applicant Name: --- All Applicant Names ---

Installation Owner: UIR Utility Testing Company | --- All Offices ---

Installation Class: --- All Installation Classes ---

Route: --- All Route Numbers ---

Control Section: --- All Control Sections ---

Area Office: --- All Area Offices ---

Maintenance Section: --- All Maintenance Sections ---

County: --- All Counties ---

Request Status: Closed Requests | --- All Closed Requests ---

Currently At: --- All Office Types --- | --- Office Type ---

NOPI Submitted Date: From: November 20 2007 To: November 25 2007

Select Report Type

- Installation Request Listing
- Performance Measures
- Totals

Reset

Check fields to display in the report

Installation Request No.	<input checked="" type="checkbox"/>
District Application No.	<input type="checkbox"/>
Installation Owner Job No.	<input type="checkbox"/>
Applicant Name	<input type="checkbox"/>
Installation Owner	<input checked="" type="checkbox"/>
Office Name	<input type="checkbox"/>
Route	<input checked="" type="checkbox"/>
Control Section	<input type="checkbox"/>
County	<input checked="" type="checkbox"/>
Status	<input checked="" type="checkbox"/>
Currently At	<input checked="" type="checkbox"/>
Area Office	<input type="checkbox"/>
Maintenance Section	<input checked="" type="checkbox"/>
NOPI Submitted Date	<input checked="" type="checkbox"/>
NOPI Approved Date	<input checked="" type="checkbox"/>
Amendment Requested Date	<input type="checkbox"/>
Amendment Approved Date	<input type="checkbox"/>
Installation Class	<input type="checkbox"/>

Generate Report

Figure 19. Reporting Tool Query Interface.

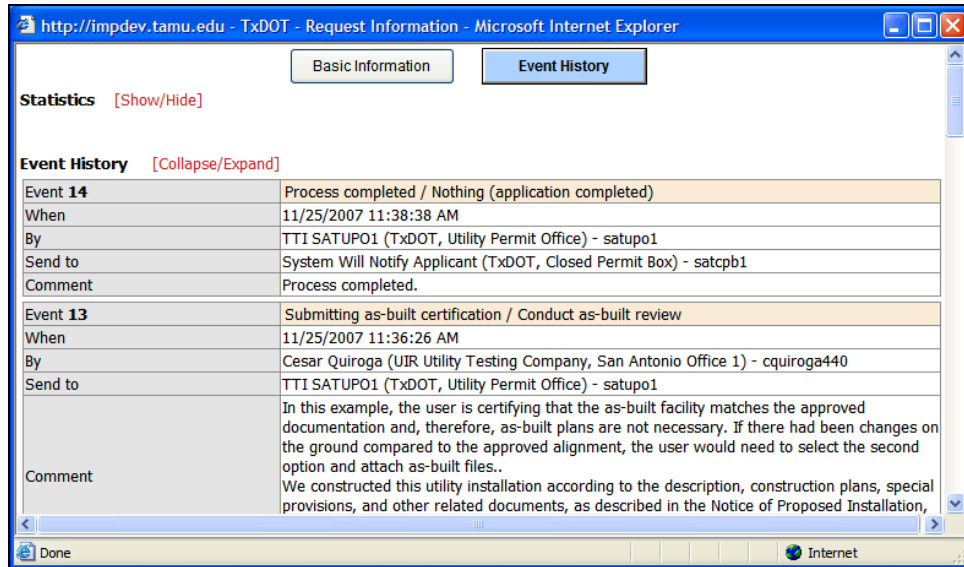
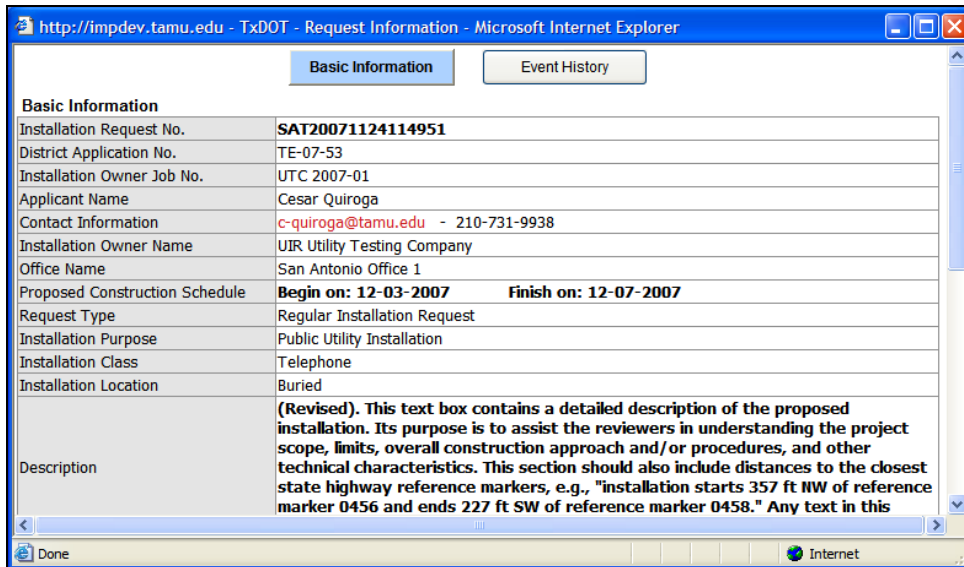


Figure 21. Basic Information and Event History Associated with Sample Installation Request in Figure 20.

CHAPTER 3. TESTING AND TRAINING ACTIVITIES AND RESULTS

TESTING AND TRAINING PROCEDURES

For testing purposes, the researchers set up three websites:

- **Development site (<http://impdev.tamu.edu/uirdev>).** The researchers used this website for developing, testing, and debugging the system.
- **Demonstration site (<http://impdev.tamu.edu/uirdemo>).** The researchers used this website for demonstration and training purposes and for testing the system before migration to the production site.
- **Production site (<http://uir.tamu.edu>).** TxDOT and installation owners used this website for creating and processing installation requests during the testing phase. The researchers also used this website for training purposes.

As mentioned previously, the development and demonstration sites were on a different server environment than the production site.

UIR testing activities involved five TxDOT districts: Bryan, Fort Worth, Houston, Pharr, and San Antonio. In addition, the researchers gave presentations and live demonstrations of the system at all 25 districts (in the case of San Angelo, a district representative attended the live demonstration in Odessa).

Testing of the UIR system at each of the five districts involved the following activities:

- **Introduce the system to users.** This phase included scheduling an initial presentation and demonstration of the UIR system to potential users, understanding the district's utility permitting process, gathering information needed for populating "seed" tables in the database, and preparing the website to accommodate installation requests and associated transactions from that district.
- **Conduct a round of training sessions.** This phase included conducting several half-day training sessions for TxDOT and installation owner officials (Table 10). Typically, the training sessions took place at the district's main computer training facility and included an initial live demonstration of the system, opportunity for individual users to create their own accounts, and opportunity for individual users to learn how to use the UIR interface. In most cases, the training sessions focused on specific types of users (e.g., installation owner users or TxDOT area engineers and maintenance supervisors/inspectors), which enabled the researchers to tailor training sessions to address the needs of individual user types. As requested by the district, the researchers conducted additional training sessions to address specific issues and/or to provide training to new TxDOT and installation owner users. Interaction with the users during the training sessions also enabled the identification of areas where the system and/or system documentation (user manual and training materials) could be modified or enhanced.

- **Provide technical support to TxDOT and installation owner users.** As requested by individual users (both TxDOT and installation owners), the researchers provided technical support to address specific technical issues. Examples of situations where the researchers provided technical support included cases where users had difficulty with the interface because they were not sufficiently familiarized with it, cases where users had difficulty uploading files to the system, cases where the users had difficulty navigating the interactive map, and cases where there were bugs in the system which had to be addressed. On several occasions, interaction with UIR users resulted in improvements to the system and/or identification of potential future enhancements.

Table 10. Dates When Half-Day Training Sessions Took Place.

Bryan (05/02/2007)¹	Fort Worth (07/02/2007)¹	Houston (08/23/2007)¹	Pharr (06/23/2006)¹	San Antonio² (09/13/2005)¹
04/18/2007 ³	06/26/2007	08/09/2007	05/30/2006	09/01/2005
04/19/2007	06/27/2007	08/10/2007	06/15/2006	09/14/2005
10/18/2007	06/28/2007	08/23/2007	09/27/2006	09/20/2005
10/19/2007	07/03/2007	08/24/2007	04/16/2007	09/21/2005
	08/16/2007		05/14/2007	09/30/2005
	09/19/2007			10/10/2005
	10/12/2007			12/06/2005
	10/30/2007			04/04/2006
				06/01/2006
				06/14/2006
				06/20/2006
				07/05/2006
				07/27/2006
				10/02/2006
				02/15/2007
				03/13/2007
				08/03/2007

¹ Date when the first online installation request was submitted to the district.

² Several training sessions at the San Antonio District were for small groups.

³ Several dates included two half-day training sessions.

There were some differences in introduction, testing, and training procedures among districts:

- **San Antonio District.** San Antonio was the first district where UIR was introduced and tested. Most of the initial UIR development also took place in San Antonio, which involved a large number of preliminary meetings with various TxDOT and installation owner stakeholders. The first installation request submitted online to the district was on September 13, 2005.

For the initial round of tests, San Antonio District officials decided to use the system to process utility installation requests in one county (Bexar County) and invited four utility companies to participate in the pilot. As part of the test, the participating utility companies used the UIR website to submit installation requests online (i.e., they did not need to submit parallel paper-based applications). In turn, TxDOT officials processed the

submitted requests both electronically and by paper—which involved printing the installation request PDF files and routing the documents to the appropriate TxDOT offices. To ensure continuity with current business processes, district officials continued using their standalone database to create records for proposed installation requests that utility companies had submitted online. After the initial testing phase, district officials expanded the system to other installation owners and eliminated the dual electronic/paper review process. A few months later, the district expanded the system to other counties within the district.

- **Pharr District.** After the initial tests in San Antonio, Pharr District officials expressed interest in participating in the UIR implementation. Having one additional district also offered the opportunity to evaluate differences in permitting practices and to incorporate changes in the code to address those differences. As opposed to San Antonio, Pharr District officials decided from the beginning to implement UIR district wide and for all installation owners. In addition to the training sessions the researchers provided (see [Table 10](#)), district officials provided a number of separate training sessions on their own. The first installation request submitted online to the district was on June 23, 2006.
- **Bryan District.** The Bryan District was one of three additional districts where TxDOT decided to test the UIR system after several months of testing in San Antonio and Pharr. The other two districts were Fort Worth and Houston. The researchers provided training on four different dates ([Table 10](#)), each day including two half-day sessions. The first installation request submitted online to the Bryan District was on May 2, 2007.
- **Fort Worth District.** After deploying UIR at the Bryan District, the researchers began testing in Fort Worth. In the case of Fort Worth, the researchers provided training on eight different dates ([Table 10](#)), most of which involved two half-day sessions. The first installation request submitted online to the district was on July 2, 2007.
- **Houston District.** The Houston District was the last district where TxDOT decided to test UIR as part of the current implementation phase. The researchers provided training on four different dates ([Table 10](#)), each day including two half-day sessions. The database registers August 23, 2007, as the first date an installation request was submitted online to the district. However, this entry (as well as a small sample of similar requests) is not valid. The reason is that Houston District officials decided not to accept installation requests online until the migration of the UIR system from the TTI server environment to the TxDOT server environment.

TESTING RESULTS

At the conclusion of the testing phase, there were more than 6,000 installation requests submitted through the system, many of which had completed the five installation request steps: submitting, reviewing, approval/pre-construction, construction, and post-construction ([Figure 1](#)). This section summarizes the results obtained during the testing phase. Note: All numbers referenced correspond to installation request records in the UIR system as of Thursday, December 27, 2007,

at 4 PM, when <http://uir.tamu.edu> was turned off in preparation for the final migration of the system to the TxDOT server environment (which was completed on Monday, December 31, 2007, at 2 PM).

User Registration in UIR

[Table 11](#) provides information about the number of installation owners, offices, and users registered in UIR. [Table 11](#) also provides information about the number of TxDOT offices represented on the system, along with the number of registered TxDOT users. For completeness, [Table 11](#) provides an indication of the overall usage of the system by registered offices and users.

In general, the results in [Table 11](#) indicate a high level of UIR usage by registered users. Most installation owners and offices registered in the system have requests associated with those owners and offices. The percentage of registered installation owner users who have submitted requests online was lower. However, readers should be aware that there are users, e.g., managers, who oversee the submission of installation requests but do not necessarily submit requests themselves. In addition, there may be registered users who have not had the need to submit installation requests online yet. The percentage of TxDOT offices and registered TxDOT users who have used UIR to process installation requests is also high, although there are variations by district.

Installation Requests in UIR

[Table 12](#) provides information about the number of active and closed installation requests by district, with an indication of the last location of the requests on the system (at TxDOT or at the installation owner). As a reference, [Table 12](#) also shows the date when users submitted the first installation request online at each district.

The distribution of installation requests among installation owners was not uniform. As a reference, [Table 13](#) shows the distribution of requests by installation owner. Within individual installation owners, the distribution of installation requests among registered users was also not uniform. As a reference, [Table 14](#) shows the distribution of installation requests submitted by individual users, along with the corresponding installation owner and TxDOT district associations.

At any given time, the status of an installation request could be one of the following: under review, approved/pre-construction, construction, post-construction, and archived. [Table 15](#) shows the number of installation requests that reached the status listed. For example, in the case of the San Antonio District, of the 3,408 requests that installation owner users submitted through UIR (and therefore reached a review status), 2,967 requests reached an approved/pre-construction status, 2,102 requests reached a construction status, 1,777 requests reached a post-construction status, and 1,777 reached an archived (completed) status. Notice there were 87 requests that the district rejected and 245 requests that installation owner users withdrew.

Table 11. User Registration in UIR.

Item	Registered in UIR	And Have Submitted/ Processed Requests	%
Bryan District:			
Number of installation owners	60	49	82%
Number of installation owner offices	80	56	70%
Number of installation owner users	140 (11 ¹)	73	57% ²
Number of TxDOT offices	18	18	100%
Number of TxDOT users	57	35	61%
Fort Worth District:			
Number of installation owners	66	42	64%
Number of installation owner offices	120	68	57%
Number of installation owner users	396 (9 ¹)	135	35% ²
Number of TxDOT offices	17	12	71%
Number of TxDOT users	41	20	49%
Houston District:			
Number of installation owners	12	0	0%
Number of installation owner offices	27	0	0%
Number of installation owner users	77	0	0%
Number of TxDOT offices	25	0	0%
Number of TxDOT users	100	0	0%
Pharr District:			
Number of installation owners	90	82	91%
Number of installation owner offices	122	106	87%
Number of installation owner users	485 (181 ¹)	252	83% ²
Number of TxDOT offices	19	19	100%
Number of TxDOT users	55	43	78%
San Antonio District:			
Number of installation owners	82	64	78%
Number of installation owner offices	140	97	69%
Number of installation owner users	391 (10 ¹)	256	67% ²
Number of TxDOT offices	32	32	100%
Number of TxDOT users	89	77	87%
Total (excluding Houston):			
Number of installation owners	274	221	81%
Number of installation owner offices	465	327	70%
Number of installation owner users	1,489 (211 ¹)	716	56% ²
Number of TxDOT offices	86	70	81%
Number of TxDOT users	242	182	75%

¹ Registered as consultants (who can help prepare or process but not submit requests to TxDOT).

² With respect to the number of users who are not registered as consultants.

Table 12. Active and Closed Installation Requests by District.

District	Started	Active Requests			Closed Requests			Total
		At TxDOT	At Installation Owner	Subtotal	At TxDOT	At Installation Owner	Subtotal	
Bryan	05/02/07	41	155	196	13	0	13	209
Fort Worth	07/02/07	72	295	367	108	0	108	475
Houston	08/23/07	1 ¹	0	0	2 ¹	0	0	0
Pharr	06/23/06	133	813	946	1,268	0	1,268	2,214
San Antonio	09/13/05	632	667	1,299	2,109	0	2,109	3,408
Total		879	1,930	2,808	3,500	0	3,498	6,306

¹ Invalid installation request record.

Table 13. Distribution of Requests by Installation Owner.

Installation Owner	TxDOT District				Total	%
	Bryan	Fort Worth	Pharr	San Antonio		
AT&T-TEXAS	28	107	283	1,402	1,820	28.86%
CPS Energy				908	908	14.40%
Time Warner Cable			336	505	841	13.34%
AEP Texas Central Company			748	9	757	12.00%
Verizon	12	20	34	68	134	2.12%
Magic Valley Electric Cooperative			127		127	2.01%
North Alamo Water Supply Corp.			125		125	1.98%
Texas Gas Service			87		87	1.38%
Brownsville Public Utilities B			67		67	1.06%
New Braunfels Utilities				58	58	0.92%
Oncor Electric Delivery	11	46			57	0.90%
Guadalupe Valley Telephone Co.				46	46	0.73%
Valley Telephone Cooperative			29	14	43	0.68%
City of Edinburg			39		39	0.62%
City of McAllen			37		37	0.59%
San Antonio Water System				37	37	0.59%
Embarq	5	26		3	34	0.54%
Texas Midstream Gas Services, LLC		34			34	0.54%
Time Warner Cable Dallas		33			33	0.52%
Atmos Energy	14	16		1	31	0.49%
Windstream Communications	17	10			27	0.43%
Bandera Electric Coop., INC.				26	26	0.41%
CenterPoint Energy				26	26	0.41%
Tri-County Electric Cooperative, Inc.		25			25	0.40%
East Central SUD				22	22	0.35%
Karnes Electric Cooperative				22	22	0.35%
City of Mission			21		21	0.33%
City of Pharr			20		20	0.32%
Crosstex North Texas Gathering L.P.		20			20	0.32%
Other	122	138	261	261	782	12.40%
Total	209	475	2,214	3,408	6,306¹	100%

¹ Excludes Houston District.

Table 14. Distribution of Requests by Individual Registered Users.

Individual User Installation Owner Affiliation	TxDOT District	No. of Requests	% of Total Requests
AT&T-TEXAS	San Antonio	350	5.55%
Time Warner Cable	Pharr	331	5.25%
Time Warner Cable	San Antonio	262	4.15%
Time Warner Cable	San Antonio	208	3.30%
AT&T-TEXAS	San Antonio	87	1.38%
AT&T-TEXAS	San Antonio	76	1.20%
North Alamo Water Supply Corp.	Pharr	75	1.19%
AT&T-TEXAS	Pharr	66	1.05%
Texas Gas Service	Pharr	63	1.00%
AT&T-TEXAS	San Antonio	61	0.97%
AT&T-TEXAS	San Antonio	58	0.92%
AT&T-TEXAS	San Antonio	58	0.92%
AEP Texas Central Company	Pharr	56	0.89%
New Braunfels Utilities	San Antonio	55	0.87%
AEP Texas Central Company	Pharr	51	0.81%
AT&T-TEXAS	San Antonio	51	0.81%
AT&T-TEXAS	Pharr	50	0.79%
AT&T-TEXAS	San Antonio	50	0.79%
AEP Texas Central Company	Pharr	50	0.79%
Other		4,254	67.38%
Total		6,306	100%

Table 15. Number of Installation Requests That Have Reached Status Listed.

TxDOT District	Status						
	Under Review	Approved/Pre-construction	Construction	Post-construction	Archived		
					Completed	Rejected	Withdrawn
Bryan	209	168	44	14	7	0	6
Fort Worth	475	411	141	91	79	11	18
Pharr	2,214	2,026	1,514	1,317	1,110	5	153
San Antonio	3,408	2,967	2,102	1,777	1,777	87	245

Assuming a system under equilibrium, over time the number of installation requests that enters the system (through the submission step) should be roughly the same as the number of installation requests that exits the system (through the archival step). As [Table 15](#) shows, the number of requests that reached an archived status at each district was considerably lower than the number of requests submitted, although for districts that had a longer history of UIR implementation (Pharr and San Antonio), the relative difference was not as noticeable as for the Bryan and Fort Worth Districts. It may be interesting to notice that, for all districts, there was a noticeable drop in the number of requests that reached a construction status compared to the number of requests that reached an approved/construction status. A closer examination of the corresponding installation request data revealed that many installation owners received approval of their proposed installation request but did not notify TxDOT 2 business days prior to starting construction. This failure to notify TxDOT in a timely fashion is affecting the effectiveness of the installation request review and inspection process.

Impact on System Resources

Using UIR to submit and process installation requests involved using a number of system resources, including bandwidth, data storage, and other hardware components (both server and client sides). Of particular interest here is the impact of using the system on data storage (on the server side) and overall system response (from a user's perspective). Other impacts such as bandwidth and hardware component usage are more difficult to measure and are probably not meaningful considering that (a) many external factors influence that impact and (b) the final implementation environment at TxDOT will be more robust than the testing environment at TTI (particularly regarding web server physical specifications).

Data Storage Impact

At the conclusion of the testing phase, there were 6,309 installation request records in the Oracle database. This total included 6,309 records in the main permit table and all the records in other related UIR tables. For example, there were 60,432 event or transaction records in the permit event table. Likewise, there were 68,724 records in the permit checklist table. Many of the 6,309 requests were active, which means additional events might still be necessary to complete the entire process for those requests. Overall, the impact of 6,309 installation request records on the Oracle database was minor, as evidenced by the space occupied by the UIR Oracle tablespace (44 megabytes) and the size of the Oracle export file at the conclusion of the testing phase (22 megabytes after compression).

The UIR database included indexes for primary keys and foreign keys. In the long term, additional indexes may be necessary to help optimize database performance. Assuming for simplicity that the ultimate space requirement on the Oracle tablespace for the 6,309 installation requests is 80 megabytes, the equivalent requirement for 15,000–20,000 installation requests per year (which is the current estimate of the total number of installation requests statewide per year according to TxDOT officials) would be 190–250 megabytes.

While the Oracle database included references to every file associated with installation requests, a separate file structure on the web server stored those files. In total, there were 67,411 files stored on the file structure associated with 6,309 requests, occupying 20 gigabytes, for an overall average of 3.2 megabytes per installation request (the median was 1.7 megabytes per installation request). Many of the requests were active, which could result in some additional files. The files stored included attachment files that installation owner users uploaded during the submission of new or revised documentation, the corresponding PDF versions, installation request and approval forms in PDF format, amendment requests, amendment approvals or rejections in PDF format, as well as files that TxDOT officials uploaded (and the corresponding PDF versions) to support the installation request review process.

Based on a statistical analysis of installation requests in the database, 15 percent of installation requests occupied more than 4.5 megabytes in file storage. Using this value for storage requirement estimation purposes, for 15,000–20,000 requests per year throughout the state, the total annual requirement would be 70–90 gigabytes of space. To reduce the risk of exceeding

this amount to less than 5 percent, it would be necessary to increase the storage requirement to 170–225 gigabytes per year.

On average, the database included 9.5 events per installation request. For the first event, i.e., during the initial submission, the average number of files that installation owner users attached was 1.3. The average number of attachments increased to 2.7 after including all the resubmissions that TxDOT requested. The average file attachment was 348 kilobytes in size. Users uploaded files in a variety of formats (Table 16). The most popular file formats were Adobe (.pdf), MicroStation (.dgn), AutoCAD (.dwg), and Microsoft Word (.doc).

Table 16. Attachment File Statistics.

File Type	File Extension	Count	File Size (bytes)		
			Average	Maximum	Minimum
Adobe portable document format	pdf	8,345	339,761	5,219,867	714
Bentley MicroStation drawing	dgn	3,426	323,229	4,838,912	2,345
AutoCAD native drawing	dwg	2,573	362,652	4,301,327	11,553
Microsoft Word	doc	1,353	63,849	3,499,520	5,076
Joint Photographic Experts Group	jpg	694	710,687	4,001,346	9,894
Bitmap	bmp	250	1,821,237	5,170,230	71,342
Microsoft Excel	xls	149	58,519	632,320	15,360
Microsoft PowerPoint	ppt	67	279,797	4,383,232	14,336
AutoCAD Interchange	dxf	55	66,086	717,581	10,395
Graphics interchange format	gif	31	702,815	2,673,852	35,359
Tagged image file format	tif	23	669,092	4,512,055	23,156
Text	txt	12	9,097	15,625	357
Portable network graphics	png	10	44,493	162,435	13,533
Microsoft Visio	vsd	1	47,104	47,104	47,104

System Response

UIR performance levels depend greatly on the configuration of the hardware that supports the system, including the Oracle database server, the web server, the map server, associated connections on the server side, Internet connection speed, and local computer. Any one of these factors can affect system performance. As a reference, Table 17 and Table 18 show typical performance rates for UIR activities the researchers observed with the TTI implementation during typical peak time conditions (e.g., mid morning, when a large number of users were logged in).

The median time interval users spent submitting new installation requests online was 22 minutes. This value uses two time stamps for the calculation (therefore neglecting any preliminary documentation preparation time): the time when the user clicked the Submit button at the end of Step 1 (i.e., the time when the system created a record for the request) and the time when the user finished Step 6. The minimum submitting time was 1 minute, and the maximum submitting time was almost 76 days.

Table 17. UIR Performance Elements (Installation Owner Interface).

Category/Menu Option	Subcategory	User Action	Total User Time	Typical Approximate System Response Time (at http://uir.tamu.edu)	Comment
New Request	1-Request Checklist	Complete checklist	Seconds to minutes	<1 second	
	2-Basic Information	Provide basic information	Seconds to minutes	<1 second	
	3-Attach Files	Upload files and generate PDFs	Seconds to minutes	Upload speed depends on connection speed. PDF generation rate varies by file type and file size: 5–10 seconds/MB for large files (2–3 MB) to 10–20 seconds/file for small files (<1 MB).	Critical
	4-Find Location	Initial map load	<1 second	Depends on connection speed. Typically 3–5 seconds.	Critical
		Map reload	Depends on tool used	Depends on connection speed. Typically <5 seconds.	Critical
	5-View Summary	Review data	Seconds	<1 second	
	6-Submit Request	Complete and submit request	Seconds	Depends on number and size of attached files. Typically 30–35 seconds.	Critical
Download PDF file		<1 second	Download speed depends on connection speed. Depends on number and size of attached files.		
My Requests		Click My Requests	<1 second	~1 second	
		Open installation request	<1 second	~4 seconds	Critical
		Click View Map	<1 second	Depends on connection speed. Typically 3–5 seconds.	Critical
		Conduct action	Seconds to minutes	Depends on action conducted.	
My Office Requests		Click My Office Requests	<1 second	~1 second	
		List requests for a user	<1 second	~1 second	
		Open installation request	<1 second	~4 seconds	Critical
My Installation Owner Requests		Click My Inst. Owner Requests	<1 second	~2 seconds	
		List requests for an office	<1 second	~2 seconds	
		Open installation request	<1 second	~4 seconds	Critical
Closed Requests	My Requests	Click My Requests	<1 second	~1 second	
		Click Requests at TxDOT	<1 second	~1 second. Will grow over time.	
		Open installation request	<1 second	~4 seconds. Will grow over time.	
	Office Requests	Click Office Requests	<1 second	~1 second	
		Click Requests at TxDOT	<1 second	2–3 seconds. Will grow over time.	
		Open installation request	<1 second	~4 seconds	
	Installation Owner Requests	Click Inst. Owner Requests	<1 second	~1 second	
		Click Requests at TxDOT	<1 second	2–4 seconds. Will grow over time.	
Open installation request	<1 second	~4 seconds			
My Account		Click My Account	<1 second	~1 second	
		Click Edit Account	<1 second	~1 second	
		Edit account	Seconds	~1 second	
TxDOT Contacts		Click TxDOT contacts	<1 second	~2 seconds	
Installation Owner Contacts		Click Inst. Owner Contacts	<1 second	~2 seconds	

Table 17. UIR Performance Elements (Installation Owner Interface) (Continued).

Category/Menu Option	Subcategory	User Action	Total User Time	Typical Approximate System Response Time (at http://uir.tamu.edu)	Comment
Manage Accounts	Manage Accounts	Click Manage Accounts	<1 second	~1 second	
		View user account	<1 second	<1 second	
	Existing Installation Owner Users	Click Edit user information	<1 second	~1 second	
		Click Edit Account	<1 second	~1 second	
		Edit account	Seconds	~1 second	
	Change Installation Owner Information	Click Change	<1 second	<1 second	
		Change installation owner name	<1 second	~1 second	
	Change Office Information	Click Change	<1 second	<1 second	
Change office name		<1 second	~1 second		
Reports		Click Reports	<1 second	<1 second	
		Define report query	Seconds to minutes	<1 second	
		Click Generate Report	<1 second	Depends on type of report and query parameters. Typically 3–20 seconds.	Critical
Map		Initial map load	<1 second	Depends on connection speed. Typically 3–5 seconds.	
		Map reload	Depends on tool used	Depends on connection speed. Typically <5 seconds.	
		Run UIR search query	Seconds	Depends on type of report and query parameters. Typically 10–20 seconds.	Critical

Table 18. UIR Performance Elements (TxDOT Interface).

Category/Menu Option	Subcategory	User Action	Total User Time	Typical Approximate System Response Time (at http://uir.tamu.edu)	Comment
My Requests		Click My Requests	<1 second	~1 second	
		Open installation request	<1 second	~4 seconds	Critical
		Click View Map	<1 second	Depends on connection speed. Typically 2–5 seconds.	Critical
		Click Event History	<1 second	~1 second	
		Conduct action	Seconds to minutes	Depends on action conducted. Approving requests involves generating PDF files. Typically 15–30 seconds.	
My Office Requests		Click My Office Requests	<1 second	~1 second	
		Open installation request	<1 second	~4 seconds	Critical
		Click Event History	<1 second	~1 second	
		Conduct action	Seconds to minutes	Depends on action conducted.	
My District Requests		Click My District Requests	<1 second	~2 seconds	
		List requests for a maintenance section	<1 second	~2 seconds	
		Open installation request	<1 second	~4 seconds	Critical
		Click Event History	<1 second	~1 second	
Approved Requests		Click Approved Requests	<1 second	~1 second	
		List requests for a maintenance section	<1 second	~2 seconds	
		Open installation request	<1 second	~4 seconds	Critical
		Click Event History	<1 second	~1 second	
Closed Requests		Click Closed Requests	<1 second	~1 second	
		List requests for a maintenance section	<1 second	~2 seconds	
		Open installation request	<1 second	~4 seconds	
		Click Event History	<1 second	~1 second	
My Account		Click My Account	<1 second	~1 second	
		Click Edit Account	<1 second	~1 second	
		Edit account	Seconds	~1 second	
TxDOT Contacts		Click TxDOT contacts	<1 second	~2 seconds	
Installation Owner Contacts		Click Inst. Owner Contacts	<1 second	~2 seconds	
Manage Installation Owner Accounts		Click Manage Inst. Owner Accts	<1 second	~1 second	
		View user office	<1 second	<1 second	
Reports		Click Reports	<1 second	~1 second	
		Define report query	Seconds to minutes	<1 second	
		Click Generate Report	<1 second	Depends on type of report and query parameters. Typically 3–50 seconds.	Critical
Map		Initial map load	<1 second	Depends on connection speed. Typically 3–5 seconds.	Critical
		Map reload	Depends on tool used	Depends on connection speed. Typically <5 seconds.	Critical
		Run UIR search query	Seconds	Depends on type of report and query parameters. Typically 20–40 seconds.	Critical

User Feedback

As mentioned previously, as part of the technical support and training activities, the researchers received frequent feedback about system access, functionality, and documentation improvement areas. Many of those recommendations were incorporated in the system. The interaction with users also enabled the researchers to receive feedback about system acceptability and the identification of future enhancement areas. A summary of user feedback comments in these two specific areas follows.

System Acceptability

- Many users expressed satisfaction with the implementation of an Internet-based utility permitting system at TxDOT. The ability to submit and process installation requests online without having to manually deliver the documentation to TxDOT (in the case of installation owner users), as well as the ability to review, route, and approve route requests electronically (in the case of TxDOT users), are positive characteristics users frequently noted about the system. Users also expressed satisfaction with an interface design that shows the most relevant basic and event information associated with individual requests, along with links to relevant documents, without having to rely on paper copies of those documents. Users also expressed satisfaction with a system that enables those users to access the system anywhere at any time simply by using a web browser.
- After more than 6,000 installation requests submitted online, both installation owner and TxDOT users have widely accepted UIR as the preferred mechanism for submitting and processing utility installation requests at TxDOT. Interaction with TxDOT officials (and a few utility industry representatives) at TxDOT districts where UIR is not online has also indicated that there is a great level of interest in having UIR implemented statewide. UIR has also generated considerable interest at several state departments of transportation nationwide.

It may be worth noting that acceptability by the utility industry was somewhat mixed and slow at the beginning of the project for a number of reasons, including uncertainty regarding electronic documentation management, user account management, and data submission requirements. One of the initial requirements that caused resistance was the requirement to submit geographic coordinates to document the location of proposed utility installation alignments. The original prototype developed during Research Project 0-2110 (*I*) assumed installation owners would be able to submit geographic coordinates to depict the location of their proposed installations. In practice, many installation owners are not at the point yet where they can easily generate geo-referenced design drawings and coordinates on a routine basis. Understandably, there was reluctance to participate in a pilot that would require substantial business process modifications. The decision to support a file upload and PDF conversion process that could accept current design drawing procedures and protocols was a compromise solution that facilitated implementation of an online utility permitting system, but that could also lay the foundation for a new approach to document delivery, handling, and processing. Over time, this new approach should enable improvements in data content, format, and accuracy—provided TxDOT adopts a long-term strategy of continuously working with the utility industry to ensure those improvements actually take place.

- Page standardization was the subject of considerable discussion during the design phase, particularly in relation to the automatic conversion of design drawings to PDF format. With the traditional paper-based approach, installation owners submit drawings in a wide

range of paper sizes such as letter (8.5×11 inches), tabloid (11×17 inches), size D (22×34 inches), and size E (24×34 inches). TxDOT officials noted that installation owners frequently submitted a large number of paper drawings in various sizes that either displayed too much unnecessary information (including many sheets that were not related to the proposed installation on the state ROW) or contained too many blanks. It was therefore critical to adopt document submission standards that most TxDOT offices would be able to support, while, at the same time, contributing to a reduction of unnecessary information and/or blanks in the drawings. After considerable discussion and testing, the decision was to adopt 11×17 inches as the standard paper size for PDF conversions. The system enables users to upload drawings of any page size, but the PDF converter automatically converts CAD files (e.g., MicroStation .dgn files or AutoCAD .dwg files) to 11×17-inch PDF versions. Because installation owner users can view the PDF version the system generates right after uploading any file, the protocol is that those users are ultimately responsible for the content and legibility of the PDF files they generate. It may be worth mentioning that, although the system enables users to upload MicroStation and AutoCAD files, it does not support the upload of separate cell or font libraries (in essence, users need to embed all graphical elements in the uploaded files).

As mentioned previously, document submission standards also include limits on the number and size of files uploaded as part of any transaction (the current limit is five files and five megabytes per file).

- The system facilitates tracking of pending requests in a way that enables both installation owner users and TxDOT users to determine where a request is at all times, how long it has been there, and what information is necessary to proceed with the next step. Some users expressed reservations that the system tracking capabilities could provide managers with a tool to measure performance by individual users. Overall, however, the perception is that the system tracking capabilities will help optimize the utility permitting process by providing a tool to identify potential delay sources objectively and enable the adoption of early corrective measures if needed.
- As mentioned previously, throughout the testing phase the researchers received feedback concerning areas in the system that needed improvement. This type of feedback actually started much earlier in the project because there were meetings throughout the design phase with installation owner and TxDOT representatives that involved preliminary system demonstrations. Some of the major improvement areas incorporated into UIR are the following:
 - **Differentiation between regular installation requests, expedited requests, and emergency repairs.** Expedited requests (also known frequently as notifications), which normally involve relatively minor construction work along already existing utility alignments, do not need to undergo the same level of field review before approval as regular requests. Likewise, emergency repairs require immediate action by an installation owner in the field. To handle these situations, UIR now includes options within the workflow that enable the bypass of field review activities before approval. The interface also includes flags (a green dot for

expedited requests and a red flag for emergency repairs) that users can toggle on and off to help identify those requests. It may be worth noting that TxDOT officials in charge of reviewing the documentation can change the request type to a type that is more consistent with the actual proposed work.

- **Mapping component.** The original mapping component only used layers that TxDOT produced and controlled (more specifically, route, control section, and district boundary layers), in addition to layers the researchers developed based on information available at TxDOT (maintenance section boundaries and highway reference marker locations). Despite labeling, many users felt those layers were insufficient to navigate through the map effectively. Reasons included the lack of landmark identifiers on the map and the lack of a layer with local street name and address/block information. For several installation owner users (although some TxDOT users also experienced this phenomenon), a map that only showed the state highway network was difficult to use. For these reasons, the researchers included layers such as city streets, railroads, rivers, lakes, parks, and city limits (obtained through TNRIS) and ½-foot aerial photography (obtained from the Bexar County Appraisal District through the TxDOT San Antonio District).

It may be worth noting that ½-foot aerial photography enables the identification of numerous features such as pavement markings, edge of pavement, the approximate location of the ROW line, and appurtenances such as poles and cabinets (which would be very difficult if not impossible with coarser imagery, e.g., 1 meter resolution imagery). From this perspective, ½-foot aerial photography is also more useful than other alternatives, e.g., the online TxDOT ROW map application (14). The reason is that the aerial photography is geo-referenced, detailed, and provides contextual information to the rest of the map in ways that the scanned ROW maps (many of which are decades old, non geo-referenced, and frequently only show information inside the ROW lines) cannot provide. The downside of using high-resolution aerial photography is the need to develop and maintain an up-to-date online repository of high-resolution digital imagery, which, at present, does not exist at TxDOT. In the long term, as high-resolution aerial photography from around the state becomes available (either controlled by TxDOT or by subscription), it is reasonable to assume that the use of aerial photography in UIR will increase.

- **User management.** As the number of installation owner users increased during the testing phase, it became evident that the implementation of certain user management tools was necessary to address specific unanticipated situations. Examples of those situations included cases where installation owners created new installation owner accounts, even though there was already a record for that installation owner name in the UIR database, and cases where consultants created separate accounts, even though consultants are not allowed to submit installation requests to TxDOT. To address these situations, the researchers developed interface tools that enable TxDOT district users with administrative privilege to move users from office to office and to delete or deactivate installation owner

offices as needed. The researchers also strengthened the user account review interface to help TxDOT users detect anomalous account requests.

For TxDOT users, at ISD's request, the researchers created a separate category of security administrator users that have the responsibility to manage all TxDOT accounts within their respective unit. During the testing phase, the researchers created system administrator accounts for three divisions (Information Systems, Right of Way, and Maintenance) and for each of the districts where UIR was online (Bryan, Fort Worth, Houston, Pharr, and San Antonio).

- **Amendments.** As the number of installation requests increased during the testing phase, the need for managing amendments to approved requests became evident. Based on district feedback, the researchers developed an amendment request and approval form. In the current version of UIR, the system generates the amendment form in PDF format using data provided by installation owner users.
- **As-built certifications.** The latest version of the Utility Accommodation Rules (4) includes a requirement for installation owners to provide an as-built certification at the conclusion of the construction phase. In the current version of UIR, the as-built certification is simply an extension of the normal installation owner user interface that enables the user to select one of two options: (a) the construction was according to the originally approved documentation, or (b) there were changes in alignment compared to the originally approved documentation (and the user needs to upload as-built drawings).

Future Enhancement Areas

At the conclusion of the testing phase, a few areas deserve consideration for inclusion in UIR in order to improve and/or enhance the long-term usability of the system at TxDOT.

- **High-priority areas.** These areas need to be addressed soon in order to comply with TxDOT policies and procedures and/or because not addressing those areas could potentially affect the usability of the system in the short to midterm.
 - **Installation request and approval form.** The installation request and approval form in UIR is older than the latest TxDOT Form 1082 version. It is critical to update the installation request and approval form in UIR. At the same time, the researchers reviewed Form 1082 and noted a few areas where it would be advisable to modify this form to account for district utility permitting procedures more effectively and to better support changes in business processes brought about by the online UIR implementation. The researchers recommend TxDOT update Form 1082 based on comments provided to the Right of Way and Maintenance divisions and then update the corresponding online version of that form in UIR.

While making the changes to the online version of Form 1082 in UIR, it would be advisable to implement a few procedural changes requested by TxDOT district officials, including the following:

- Introduce a step for users to review and accept the installation request PDF file (in the case of installation owner users) or approval PDF file (in the case of TxDOT users) before completing the transaction. In the case of TxDOT users, one additional benefit resulting from the introduction of the additional step would be the ability to generate approval PDF files for several installation requests simultaneously without having to wait until the system has generated each approval PDF file separately.
- Combine the installation request and approval PDF files into a single file that contains all the relevant data associated with the proposed installation. This change is necessary to address situations districts have observed where utility contractors have hardcopies of the approval PDF files at the job site (but not of the installation request PDF files). By extension, each time there is an amendment, the system would generate a modified version of the combined installation request/approval document that also includes the amendment request (and corresponding approval or rejection).
- **2-business day notification and traffic control plans.** As mentioned previously, installation owners frequently fail to notify TxDOT when they are ready to start construction. Failure to comply with the notification requirement is having a significant impact on TxDOT’s ability to review and approve traffic control plans (traditionally handled by utility inspectors after TxDOT issues the permit approval); inspect the construction; and verify compliance with construction specifications, special provisions, and existing rules and regulations. Although the UIR interface includes warning messages to installation owner users, provides those users with an easy-to-use tool to comply with the 2-business day notification requirement, and sends copies of the approval email to the designated TxDOT inspector, it is clear that these simple measures are not sufficient.

Feedback from district officials indicates that an effective strategy to address this situation would involve delaying access to the approval form until the installation owner submits an appropriate traffic control plan (the details of which would be determined by TxDOT officials during the review and approval phases) to the inspector and the inspector formally reviews and accepts this plan. In UIR, it may be possible to implement this strategy by enabling installation owner users to see a “draft” version of the installation request approval (so they can examine special provisions that might pertain to the approval), requiring the submission of traffic control plans online (as required during the review and approval phases), and waiting for the TxDOT inspector to review this documentation before “unlocking” the approval form.

- **Mapping component.** As mentioned previously, the UIR mapping component uses versions of TxDOT GIS layers in ESRI shape format that are older than current versions at TxDOT. There is a need to update those GIS layers in UIR, in particular the route and control section layers. Readers should also take into consideration that UIR uses GIS layers that are similar to, or that produce information similar to, layers that are currently undergoing implementation at TxDOT, e.g., highway reference marker points and maintenance section boundaries. Further, there are differences between GIS layers currently in existence at ISD and TPP, some of which are relevant to the functionality of the UIR mapping component. In the long term, it will be necessary to develop a strategy and implementation plan to make sure that changes in GIS data structure and/or content at various TxDOT units that might affect UIR are migrated to the UIR mapping component in a timely fashion.

For performance reasons, it would be advisable to integrate the UIR mapping component with the TxDOT ArcSDE environment. The importance of this integration, particularly regarding the display of StratMap street alignment and street name data on user interfaces, will increase as the number of districts using UIR increases. It may be worth noting that the TxDOT ArcSDE environment stores spatial data in latitude and longitude coordinates, whereas the UIR mapping component uses projected state plane coordinates to support the display of aerial photography. During the migration, it will be necessary to evaluate whether ArcIMS can support “on-the-fly” projections of ArcSDE data layers, which would facilitate the transition, or whether it would be necessary to create another map service in latitude and longitude coordinates and edit the records in the permit location table (which store installation request location data in state plane coordinates). A map service in latitude and longitude coordinates might not support the display of aerial photography. However, this is probably not a critical issue, at least in the short to midterm.

- **AutoVue 3D Advanced Issue.** This viewer software enables Adlib Express Server to generate PDF versions of file types such as MicroStation .dgn and AutoCAD .dwg files. An issue with the current version of AutoVue 3D Advanced, as opposed to a previous version called AutoVue SolidModel, is that its three-dimensional (3D) modeling capabilities cannot be turned off and, as a result, the software adds one or more extra pages when it renders AutoCAD .dwg files (even if these files only depict two-dimensional (2D) data). A solution to this issue would be to use AutoVue 2D Professional, although feedback from the AutoVue vendor suggests that an upcoming release of the 3D version would enable turning the 3D modeling capabilities off if needed.
- **UIR data management interface.** The current version of UIR includes a number of features that allow certain users with administrative privileges to perform a number of regular UIR data management functions. Examples include deleting incomplete requests, rolling back transactions, purging requests, moving users from office to office, and deleting user accounts (provided no installation requests

are associated with those users). These functions are accessible mostly to users at the district level. Although the system includes some UIR data management functionality for security administrators at the division level (e.g., ROW Division, Maintenance Division, ISD), some of these users have expressed interest in the development of tools that would enable them to perform some of the same functions as users at the district level, although at a higher level. These tools would provide an integrated data management approach to UIR, which would be beneficial in the long term.

- **Inter-district installation request submissions.** UIR allows installation request submissions from users who are not registered in the same TxDOT district (e.g., a user registered in the Houston District could submit a request to the San Antonio District). However, the current version of UIR only allows users to change the district after they have completed the checklist answers (which are district specific). To address this issue, it would be necessary to modify UIR so that users specify the TxDOT district in Step 1, which would then enable those users to complete the checklist that pertains to the correct district, not their “home” district.
- **Mid-priority areas.** These areas are important and could improve and/or enhance the usability of the system in the short to midterm.
 - **“Special comment” function.** In the current version of UIR, the only way to add content to the event history of an installation request is when a user is in control of an installation request (i.e., when the “Conduct Action” button is enabled). However, there are situations where certain users, e.g., utility permit officials or inspectors, would like to add comments that are not necessarily connected with a specific event. For these situations, it would be advisable to develop a special comment tool to enable those users to add comments at any time (even after a request is in the closed permit box). Users would access this tool by opening an installation request and clicking a “Special Comment” button to the right of the “Conduct Action” button (Figure 15).
 - **Aggregate reporting options for managers.** Feedback from users has highlighted the need for the development of additional reporting tools for managers. Examples of additional reports include reports that retrieve system usage and performance data and aggregate reports that retrieve installation request data at the state level (the current reporting tool in UIR, including the mapping component, only retrieves data at the district level).

Along with the need to develop aggregate reporting options for managers is the need to optimize the current reporting tool. Of all the functions in UIR, the reporting tool is the function that demands the most from the database, which will only increase as the number of installation requests in the database increases. In the current version of UIR, the primary focus was to develop a reporting tool that retrieved records based on a wide number of query parameters. In the future, the

focus will likely shift from simply retrieving records to developing mechanisms to retrieve those records quickly.

- **Highway reference offset data capture.** In the current version of UIR, the only way to capture highway reference offset data (i.e., distances of proposed installation request locations with respect to highway reference marker locations) is by measuring distances between those locations in Step 4 and then manually entering that information in the description field in Step 2. It would be advisable to develop a mechanism to automatically capture highway reference offset data in Step 4 and add the resulting data to the installation request form.
- **Archived installation request management.** In the current version of UIR, installation requests that have completed the entire process, have been rejected by TxDOT, or have been withdrawn by installation owner users, remain in the database, more specifically in the same database tables as active requests. The only difference between active requests and closed requests is the request status. The number of closed requests will continue to grow over time. In contrast, the number of active requests is expected to remain fairly constant (or grow at a relatively low annual rate), once a district reaches equilibrium between the number of requests that enter the system and the number of requests that exit the system.

To optimize database querying and reporting, it would be advisable to develop a procedure to move closed requests to permanent repository tables in the database (which could be in the same Oracle tablespace), while at the same time, enabling access to those requests through the interface for querying, reporting, and other data management purposes. It would also be advisable to develop a procedure to consolidate all files associated with closed requests, e.g., by permanently deleting all files except for the latest version of the installation request approval PDF files and the corresponding attachment files (in both original and PDF versions). Deleting those files would also involve introducing a small change in the code to display a warning message to users whenever those users attempt to access older file versions.

- **Low-priority areas.** These areas are not critical but could contribute to improving and/or enhancing the use of the system in the long term.
 - **Office addresses versus individual user addresses.** In the current version of UIR, a user's street address is in reality the office address. As a result, any of the users in the office can change that address. Feedback from installation owner users indicates there are cases where users that are affiliated with the same UIR office are actually at different physical locations, even sometimes in different cities. For those users, having individual street addresses would be preferable and less confusing than the current structure.

- **Single point versus two points to represent installation request locations.** UIR relies on a single point on the interactive map to identify the location of proposed installation requests. The point provides a general location reference and, as such, does not usually depict the complete extent of the proposed installation. Relying on a single point was a workaround given that installation owners typically upload non geo-referenced drawings. Discussions with TxDOT officials highlighted the need to use at least two points on the map to identify the start and end locations associated with proposed installation, which would enable the determination of start and end distances along state routes.

Associated with this need is the need to implement a procedure to display locations associated with uploaded coordinate data (which was included in the original prototype (*J*) but was removed because installation owners could not support it). Increasingly, installation owners have indicated a willingness to collect field data using global positioning system (GPS) receivers and/or provide geo-referenced data in a GIS format. Uploading geo-referenced data might eventually lead to an automated determination of start and end proposed installation points, potentially rendering the need for manual clicks on the map unnecessary.

- **“Frequently Asked Questions” tool.** Although the UIR user manual (both interactive version and PDF version) and the training materials include many modifications and improvements in response to user feedback, some TxDOT district officials have expressed interest in a tool where they can post comments in response to general or specific questions from users. An enhanced version of this tool could enable the posting of special announcements that would be visible to users at login time.
- **Page optimization.** As the number of users and installation requests increases, the burden on system resources to retrieve and display records quickly will also increase. Over time, it may be necessary to optimize the way certain pages retrieve data from the database to maintain the level of functionality of those pages. It would be advisable to address page optimization issues on a case-by-case basis.
- **Consultant account management.** In the current version of UIR, it is necessary to create consultant accounts within installation owner offices. As a result, if a consultant works for several installation owners, it is necessary to create a separate account, one for each installation owner office. In the long term, it would be advisable to develop a separate consultant user type that would enable consultants to have only one login ID and password. For this option to work, it would be necessary to introduce some modifications to the system, e.g., by requiring the consultant to receive an activation from an installation owner administrator before the consultant can have any access to installation request data, and by only enabling the consultant to display installation request data from one installation owner at a time.

ADDITIONAL IMPLEMENTATION RECOMMENDATIONS

As mentioned previously, UIR is now installed on a TxDOT server environment, which will provide the foundation for the implementation of UIR around the state. As TxDOT moves forward with a statewide implementation, it will be important not just to maintain the current system, but also to adopt a long-term strategy that allows for the continuous improvement of the system to help ensure its long-term viability. Recommendations to achieve this goal include the following:

- follow a systematic approach for the implementation of UIR at other districts around the state with a focus on “training the trainers,”
- maintain UIR software and conduct knowledge transfer based on user feedback and needs, and
- provide technical support to district and installation owner users at districts where UIR is active.

A more detailed description of each recommendation follows.

Follow Systematic Approach for Implementing UIR at Other Districts

Implementing UIR at other TxDOT districts will require careful planning, execution, and follow up. Two critical components of this process are preparing UIR to enable users to use the system and training those users.

Preparing UIR

Enabling a district within UIR involves adding records to certain database tables, primarily those that include TxDOT district office data and permit workflow activity data. The UIR user manual (2) contains a detailed description of the tables that need new records. For completeness, the user manual also includes a complete UIR maintenance schedule, which includes various administrative functions, the level of responsibility (district, division), and the frequency with which those functions should be carried out. Examples include clearing/deleting incomplete installation request records, monitoring user accounts (both TxDOT and installation owners), and monitoring system performance.

Training Users

To optimize the process, the training effort should focus on “training the trainers” at each district where UIR is being implemented. As mentioned previously, the researchers were very involved in providing training to both TxDOT officials and installation owner users during the testing phase. While this exercise was useful and productive, in the long term a different training approach focusing on “training the trainers” (where the trainers are certain district officials who

manage the utility permitting process at the district) is expected to be more cost-effective, under the assumption that those officials can train other users (both TxDOT users and installation owner users).

Training the trainers would typically involve scheduling a round of training sessions to teach specific district officials how to use UIR. The training sessions should emphasize both installation owner and TxDOT interfaces, under the assumption that the TxDOT officials receiving training would be responsible for training and interacting with installation owner officials once UIR is active on their districts. The researchers estimate that for every district, it will be necessary to schedule one on-site visit composed of four half-day training sessions, followed by subsequent web-based and/or video teleconference (VTC)-based training sessions where TxDOT district officials would have access to training personnel who would be available to answer questions and provide guidance as needed. For maximum exposure, it would be advisable to schedule at least one web-based or VTC-based training session per month.

Experience during the testing phase demonstrated that acceptance and effectiveness in the use of UIR increased with the level of participation of critical TxDOT personnel in the initial training. Because of their involvement in the utility permitting process, it will be critical for the following TxDOT district personnel (or their equivalent) to participate in the initial training sessions:

- maintenance director,
- ROW administrator,
- ROW utility agents,
- utility permit office personnel,
- area engineers,
- maintenance supervisor,
- security administrator, and
- central design personnel.

The commitment of the district engineer to implement UIR at the district will also be a critical requirement for the successful implementation of the system. Although security administrators are not involved in the utility permitting process, their participation is important because they will be responsible for managing TxDOT user accounts and for providing technical support to users (mainly in areas related to hardware and software access issues).

Although TxDOT will decide the final implementation schedule for each district, it is reasonable to assume a phased implementation schedule. As part of this process, it will be critical to devise strategies to make the process as efficient as possible, e.g., by inviting district representatives by region for a web-based introduction to the system, followed by the on-site training sessions discussed earlier. Because the five districts where UIR has been introduced and tested are in the eastern half of the state (San Antonio, Pharr, Bryan, Fort Worth, and Houston), the implementation schedule for the remaining 20 districts will likely involve “filling in” the blanks first and then moving progressively toward the west/northwest. Discussions with TxDOT officials have suggested the following district implementation schedule:

- Phase 1 (three months): Wichita Falls, Dallas, Paris, Atlanta, Tyler
- Phase 2 (three months): Brownwood, Waco, Lufkin, Beaumont, Yoakum
- Phase 3 (three months): Laredo, San Angelo, Abilene, Austin, Corpus Christi
- Phase 4 (three months): El Paso, Odessa, Lubbock, Amarillo, Childress

Figure 22 shows the location of the districts associated with each implementation phase.

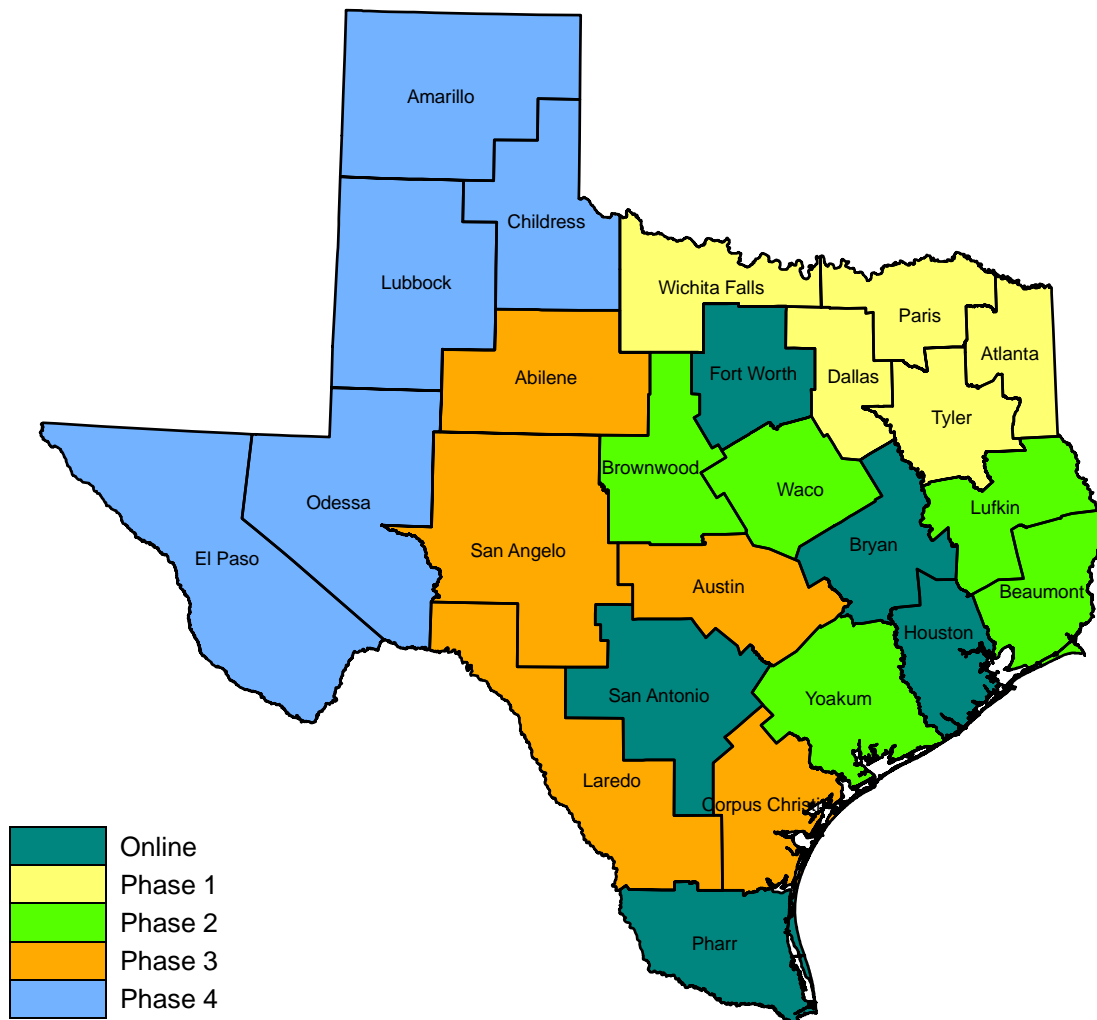


Figure 22. Proposed UIR Implementation Schedule.

The initial training and subsequent web-based and/or VTC-based training sessions would address the training needs during the implementation of the system throughout the state. However, it would also be advisable to maintain a continuous UIR training program to address long-term training needs, e.g., in situations where new officials (or officials who have transferred from

other TxDOT units) are assigned the responsibility to review or process utility installation requests.

To assist in the UIR training effort, the researchers developed a user manual and a set of training materials (2, 3). The user manual exists in two formats: a printable version in PDF format and a fully interactive online help system that is available through the UIR user interface. For convenience, there are two versions of the user manual: one version, which covers the utility permitting process from an installation owner user's perspective and is therefore geared toward installation owner users, and a second version, which covers both installation owner and TxDOT needs (divided for convenience into two parts: Part A – installation owner users and Part B – TxDOT users).

The training materials include presentations in Microsoft PowerPoint format, as well as presenter notes and participant handouts, both in portable document format (PDF) and printout format. There are three types of presentation materials:

- **General introduction presentation (16 slides).** The general introduction presentation is intended for use at special events or conferences, where the main purpose is to promote the use of the system and/or provide the audience with general information as well as some technical details about the UIR system. This presentation should take 15 to 20 minutes. If needed, the presenter could customize the presentation by using slides from the standalone presentation file (see below).
- **Overview presentation (10 slides) followed by online demonstration and training.** The presenter would use the short overview presentation as an introduction for a training session of users who are about to begin using UIR. These users could be TxDOT users or installation owner users. The presentation provides participants with a short background about the development and structure of UIR, followed by a live online demonstration and training component. This format requires access to the Internet and a web browser in order to run the UIR system. The presenter has considerable freedom to present as many UIR components and screens as dictated by the purpose of the training session and/or the audience. Based on previous experience during the testing phase, the expected duration of this training option is as follows: short presentation (10 minutes), online demonstration (1 hour), and interactive training (2 hours).
- **Standalone presentation (276 slides).** The presenter could use this presentation for a training session similar to that recommended for the overview presentation and online demonstration and training in situations where Internet access is either difficult or not possible (although the overview presentation and online demonstration and training is the preferred training option). To address the lack of Internet access, the standalone presentation file includes most of the screenshots necessary to provide detailed information about the system. The standalone presentation includes three groups of slides:

- Group 1 (9 slides). This group of slides is similar to the short overview presentation and is intended to give general background information about the UIR system (approximate duration: 10 minutes).
- Group 2 (135 slides). This group of slides includes screenshots from the installation user interface covering in detail the utility installation permit process from an *installation owner user's perspective* (approximate duration: 1 ½ hours).
- Group 3 (132 slides). This group of slides includes screenshots from the TxDOT user interface covering the permitting process from a *TxDOT user's perspective* (approximate duration: 1 ½ hours).

The training materials can be used both for presential training opportunities (with instructors and students in the same room) as well as for remote and virtual training settings, which could be critical in cases where travel is not possible or if there are travel restrictions.

For both short-term and long-term training activities to be effective, it will be critical to use instructors who are thoroughly knowledgeable of the UIR system (including TxDOT and installation owner interfaces, UIR workflow logic, structure, and problems that users tend to encounter), the TxDOT utility permitting process, and the various rules and regulations that govern the accommodation of utilities on the state ROW. Although not as critical, it would also be advisable for the instructors to be familiar with various UIR system components (e.g., data model and database). The instructors could be ISD, ROW Division, or Maintenance Division employees. However, if internal resources are not available or if it is not possible or feasible to schedule training events to address user needs effectively in a timely fashion, it would be strongly advisable to rely on an external agency to assume that responsibility.

To support the UIR training effort, it would be advisable to involve the TxDOT Human Resources Division's Training, Quality, and Development (TQD) Section. TQD maintains a comprehensive course catalog and manages training programs that address a wide range of needs throughout the department. Depending on the specific case, TQD might decide to rely on TxDOT instructors or hire an external contractor. In general, it is common to rely on external contractors for cases that require highly specialized technical knowledge and expertise, which would be the case of the UIR training effort. In general, adding courses or programs to the TxDOT course catalog involves completing a number of activities, including the following:

- evaluate existing related courses (none, since UIR is a new development for which there is no predecessor);
- develop a justification for the new course or program, which includes identifying objectives, expected outcomes, need, audience, expected duration, agenda, type of course, teaching methodology, description, potential developers, potential instructors, costs, funding sources, and marketing approach; and
- submit Form 1951 (Request for new Training) to TQD and give a presentation to the Standard Committee on Training (SCOT).

The information provided in this section as well as the user manual and training materials (2, 3) can be used to prepare Form 1951 in support of a UIR training program at TQD.

Maintain UIR Software and Conduct Knowledge Transfer

As discussed previously, the list of recommended UIR enhancements was divided into high-priority areas (which need to be addressed soon in order to prevent potential system usability problems in the short to midterm), mid-priority areas (which could improve and/or enhance the usability of the system in the short to midterm), and low-priority areas (which could improve and/or enhance the usability of the system in the long term):

- High-priority areas:
 - Installation request and approval form
 - 2-business day notification and traffic control plans
 - Mapping component
 - AutoVue 3D Advanced issue
 - UIR data management interface
 - Inter-district installation request submissions

- Mid-priority areas:
 - Special comment function
 - Aggregate reporting options for managers
 - Highway reference offset data capture
 - Archived installation request management

- Low-priority areas:
 - Office addresses versus individual user addresses
 - Single point versus two points to represent installation request locations
 - “Frequently Asked Questions” tool
 - Page optimization
 - Consultant account management

To assist in this process, it would be advisable to establish a UIR task force (composed of district and/or division representatives), which would determine the priority and urgency of specific enhancement areas and would guide the future direction and development of the system.

The researchers anticipate the need for providing support in response to two types of system maintenance requests: requests to address problems or “bugs” and requests for new functionality. To address system bugs, the process would involve replicating the problem based on user feedback, modifying and testing the revised code, and coordinating with ISD for delivery, testing, and acceptance of the revised code. To address requests for new functionality (based on the task force’s assessment of priority or urgency), the process would involve assessing

functional and system requirements and providing an estimate of the length of time it would take to implement the changes.

Included in the technical support should be the transfer of knowledge to ISD officials and division and district security administrators regarding the UIR architecture, modules, business process, capabilities, as well as limitations. Using the system documentation (user manual, installation guide, training materials, and reports) (2) to describe and explain UIR concepts and procedures to those officials will facilitate the implementation of the UIR system and ensure its long-term usability at TxDOT.

Provide Technical Support to Users at Districts Where UIR Is Active

UIR is a complex system with many active users, each one having different needs, issues, and requirements. Experience with the current testing phase demonstrated that district and installation owner users experienced problems in certain areas where the online process differed from the traditional paper-based approach, in particular how to deal with user account issues, file uploading issues, use of the interactive mapping component, and client computer compatibility issues. Experience also demonstrated that an expedited response to user requests is critical to ensure user acceptability. To achieve this objective, it would be advisable to implement a two-tier technical support approach (which would be more cost-effective and provide more interaction with users than a centralized help desk in charge of all technical support) as follows:

- **First tier (or first response).** This tier is the responsibility of district officials, including utility permit office personnel and, as needed, the district security administrator. The purpose of the first tier technical support is to assist users in situations that require a good working knowledge of the UIR interfaces (but not necessarily of “back-office” UIR system components such as database tables or the web-based mapping component). Most technical support needs would fall under the first tier category. This type of support will likely include a combination of phone and email response methods.
- **Second tier.** This tier is the responsibility of technicians who have a thorough knowledge of the UIR system, including user interfaces, database components, source code, and business processes. The purpose of the second tier technical support is to assist users in situations where the first tier technical support does not solve the problem. This type of support will likely include a combination of phone, email, and web-based response methods. The technicians responsible for the second tier could be ISD, ROW Division, or Maintenance Division information technology employees. However, if internal resources are not available or if it is not possible or feasible to provide the technical support that users need in a timely fashion, it would be strongly advisable to rely on an external agency to assume that responsibility.

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