

Utility Relocation Management System:

Reducing Construction Delays and Costs



NASCIO 2024 State IT Recognition Awards

State: Commonwealth of Pennsylvania

Agency: Department of Transportation

Application: Utility Relocation Management System (URMS)

Category: Business Innovations

Project Dates: August 2017 – March 2023

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Office of Administration, Infrastructure and Economic Development Delivery Center

Executive Summary

The relocation of utility lines and facilities is an integral part of many highway and bridge construction projects and often represents the greatest risk to the project scope, schedule, and cost.

Driving down the road, notice the number of utility poles and lines along or near the shoulder—but also consider the vast number of electricity, communications, water, and gas lines running underground and on bridges. When these utility facilities lie in the path of a construction project, they often need to be moved to accommodate construction activities and vehicles. If these relocations are not completed on time, they cause delays that cascade and impact the highway project and its contractor, other utilities' relocations, and ultimately the businesses and residents who rely on the roadway and utility services daily.

In March 2023, PennDOT's IT development team, working with the Utility Relocation business unit of PennDOT's Bureau of Project Delivery, successfully completed and delivered the final installment of the Utility Relocation Management System (URMS). This project reimaged the utility relocation management process in support of PennDOT's highway and bridge projects. The new application manages and coordinates utility relocation efforts from scope, design, and contract development, and all the way through construction and financial closeout.

URMS has transformed how PennDOT interacts with utility companies and their consultants. PennDOT has already realized cost savings of over \$33 million through early identification of utility conflicts. Additionally, PennDOT has saved over \$4 million due to increased administration efficiencies and process automation afforded by the software. Most importantly, the URMS application has minimized the risk of lengthy and costly construction delays caused by utility relocations. In fact, there were zero compensable utility delays for the 2022-2024 construction seasons. This is not only a huge financial benefit to PennDOT and our utility partners, but also a benefit to the Pennsylvania communities who travel our roads and utilize the utility services.

Idea

The Problem

Nearly every PennDOT highway and bridge construction project – approximately 90 percent – requires temporary or permanent relocation of utility facilities. Large projects may require relocation administrators and designers to orchestrate the relocation of hundreds of poles, lines, and underground facilities with multiple utility organizations. Coordinating these moves with the construction schedule and the activities of other utility companies is complex and time consuming. One miscalculation in a utility's relocation schedule or one missed conflict has the potential to cascade into costly delays with other utilities and the overall construction schedule. The delays can increase contractor costs, material costs, equipment leases, and staff time to manage the schedule extensions. They also cause frustration for local communities and governments.

Faced with mounting construction costs due to delays, PennDOT recognized the need to better manage utility relocations and minimize their impact on highway and bridge projects. PennDOT held a Utility Relocation Summit to evaluate the history of utility delays and recommend mid-term and long-term solutions to address the rising costs and construction delays. The outcome of the summit is summarized in The Vision section below.

Why it Matters

Utility relocations pose one of the greatest risks to highway and bridge construction projects. Like many other states, Pennsylvania did not have the data or systems to track the delays or costs incurred due to utility relocations. To further obscure the scope of the problem, the cost of construction delays varies widely based on project location, size, and complexity and it is hard to isolate what portion of the delays are attributable to utilities. The Texas A&M Transportation Institute conducted a study of preconstruction utility delays in 2016 and estimated that a delay of just one month in the utility design phase of a single medium to large size construction project could incur additional costs of between \$420,000 to \$1.3 million. The cost of delays in the construction phase would have an exponentially greater cost impact on PennDOT and the construction contractors.

The Vision

In July 2015, PennDOT management assembled a cross-disciplinary business team to identify ways to improve utility relocation activities in both the design and construction phases of work. The team identified that the long-term solution required IT system improvements to capture and increase visibility of utility relocation data and milestones to provide better coordination and management of utility relocation activities.

Additionally, the team agreed that a new IT solution presented opportunities to modernize and improve how PennDOT does business with its utility partners in the future. Specifically to:

- Provide a single point of access for utilities with an intuitive, customer-focused user interface (UI),
- Simplify and automate utility relocation processes,
- Automate and standardize utility relocation documents and communications across all districts,
- Facilitate knowledge sharing across PennDOT, utility, and consultant teams involved in a construction project.

The Solution

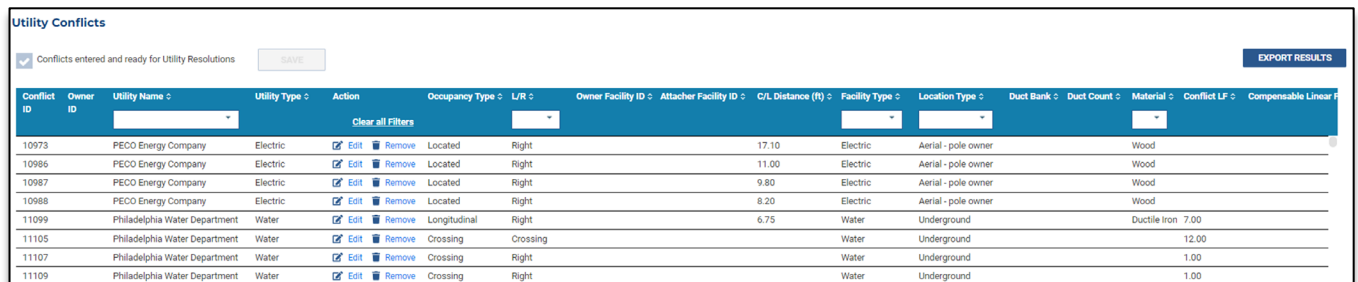
The URMS implementation reinvented PennDOT’s utility relocation planning and management processes with a solution that enables and drives accurate and timely collection of utility relocation project data. This facilitates better tracking of a relocation project from inception through design and construction. URMS functionality highlights include:

- **Collaborative Environment for Utility Relocation Stakeholders:** URMS provides increased visibility and access to all information and documentation related to a utility relocation project. It allows PennDOT project managers and designers to share information and work collaboratively with utility stakeholders to develop project-specific contractual plans of action. This helps ensure that PennDOT’s schedules are met and utility customers receive the services they require with minimal impact throughout construction.
- **Improved Utility Conflict Management:** The Utility Conflict Matrix (UCM) is at the heart of the URMS application. It is the central location to identify utility facilities that are likely to infringe on the construction project. A utility conflict can be as basic as identifying a manhole that needs to be raised flush to the pavement, or as complicated as moving an electric line that delivers power to a third of the City of Philadelphia. The UCM details the scope of the utility relocation effort and drives the application functions and relocation processes to ensure all utility conflicts are resolved in a way that is timely, cost effective, and minimizes impact to construction schedules.

“Two critical factors that contribute to utility inefficiencies in the delivery of transportation projects are (a) the lack of adequate information about the location and attributes of utility facilities that might be affected by the project, and (b) the lack of an effective process to manage conflicts between those facilities and project phases and features.”

Strategic Highway Research Program (SHRP2)

The UCM is based on a model developed by the Federal Highway Administration’s Strategic Highway Research Program (SHRP2). PennDOT expanded the model to increase usability and to support URMS’ automated functions.



Conflict ID	Owner ID	Utility Name	Utility Type	Action	Occupancy Type	L/R	Owner Facility ID	Attacher Facility ID	C/L Distance (ft)	Facility Type	Location Type	Duct Bank	Duct Count	Material	Conflict LF	Compensable Linear
10973		PECO Energy Company	Electric	Edit Remove	Located	Right			17.10	Electric	Aerial - pole owner			Wood		
10986		PECO Energy Company	Electric	Edit Remove	Located	Right			11.00	Electric	Aerial - pole owner			Wood		
10987		PECO Energy Company	Electric	Edit Remove	Located	Right			9.80	Electric	Aerial - pole owner			Wood		
10988		PECO Energy Company	Electric	Edit Remove	Located	Right			8.20	Electric	Aerial - pole owner			Wood		
11099		Philadelphia Water Department	Water	Edit Remove	Longitudinal	Right			6.75	Water	Underground			Ductile Iron	7.00	
11105		Philadelphia Water Department	Water	Edit Remove	Crossing	Crossing				Water	Underground				12.00	
11107		Philadelphia Water Department	Water	Edit Remove	Crossing	Right				Water	Underground				1.00	
11109		Philadelphia Water Department	Water	Edit Remove	Crossing	Right				Water	Underground				1.00	

Figure 1. Utility Conflict Matrix allows users to scroll through summary details for each conflict on the project. Users can click on a conflict to view or edit the conflict details.

Some unique features of the URMS UCM include:

- **Enhanced Location Details and Mapping:** The UCM leverages PennDOT GIS and Esri mapping services to automatically calculate longitude/latitude and segment/offset details based on project stationing. Users can view a project or conflict location on a map with custom layers to display relevant information such as nearby railways and protected waterways.
- **Source Data for Permits, Real Property Interest, and Right of Way:** The UCM records the nature and extent of each public and private utility conflict, as well as the ownership, responsible party, permitting requirements, and occupancy rights. This key data allows the system to automate the subprocesses to generate highway occupancy permits, real property interest requests, and right-of-way acquisitions.
- **Underground Utility Asset Identification:** As project conflicts are identified and resolved, URMS builds a registry of utility assets that were previously undocumented or not easily retrieved. This improves worker safety and minimizes unplanned utility relocations during construction. The location of underground utility assets is preserved and available for future projects.
- **Standard Workflow Process:** The business and IT development teams reviewed the diverse processes of PennDOT’s 11 districts, policy documents, and regulations to build a standard, automated workflow for utility relocation projects. With the new workflow process, utilities are engaged early in the project to ensure they have sufficient time for planning and design work.
- **Scheduling, Project Management, and Resource Management Tools:** URMS provides numerous tools that enable PennDOT’s utility relocation staff and utility organizations’ personnel to quickly identify past-due and pending project activities and milestones that have the potential to delay the transition to the construction phase of the project. This information is critical for keeping all utility relocation stakeholders informed and allows them to initiate corrective action to get on track before design delays impact project construction.

Final Design Plans Sent	09/21/2023	09/21/2023	11/09/2023	m	10/11/2023
Conflicts Resolved	03/07/2024	03/07/2024	03/28/2024	m	
Conflict Resolutions Approved (4/9)	03/21/2024	03/21/2024	05/09/2024	m	04/23/2024

Task Name	Due Date	Assigned User	Utility - UtilityType	Completed Date	Days Remaining
Resolve Conflict Accelerated	🔴 03/28/2024		Indiana County Municipal Services Authority-Water		- 33
Resolve Conflicts	🔴 03/28/2024		Comcast Cable Communications Management, LLC-Cable Television		- 33
Resolve Conflicts	🔴 03/28/2024		Verizon North LLC-Telecomm		- 33
Resolve Conflicts	🔴 03/28/2024	Cody Trabert	Pennsylvania Electric Company-Electric		- 33
Resolve Conflicts	03/28/2024		Indiana County Municipal Services Authority-Water	04/01/2024	
PM Review of Resolutions & Work Units	04/10/2024	Ronald Ferlin	Peoples Gas Company LLC-Natural Gas	04/03/2024	
Review Resolutions & Work Units	04/10/2024	Melissa Booker	Peoples Gas Company LLC-Natural Gas	04/03/2024	
PM Review of Resolutions & Work Units	04/12/2024	Ronald Ferlin	Indiana County Municipal Services Authority-Water	04/01/2024	
Review Resolutions & Work Units	04/12/2024	Melissa Booker	Indiana County Municipal Services Authority-Water	04/01/2024	
PM Review of Resolutions & Work Units	04/18/2024	Ronald Ferlin	Peoples Gas Company LLC-Natural Gas	04/16/2024	

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D419 Complete (0/1)	04/04/2024	04/04/2024	06/28/2024	m
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Figure 2 The Project Milestones page is one of many project management tools in URMS. It displays all tasks related to a milestone and whether they are on time, behind schedule or completed.

- **Automated Communications, Document Generation, and Document Sharing:** Prior to URMS, district utility administrators had to manually create large numbers of documents to share with utility companies. The formats and detail level of these documents were inconsistent across districts and forced redundant entry of project and facility details in each document. URMS leveraged several PennDOT shared services to automate and streamline the process of producing, storing, and sending these documents, eliminating countless hours of administrative work. Now district and central office staff can focus more time on the actual coordination and management of utility relocations. A few automated documents that have had the most impact:

- **Electronic Utility Agreement Development:** One of the major achievements of the URMS project is the ability of the application to aggregate project information related to the utility’s conflicts, resolutions, funding, and estimated costs to calculate utility reimbursement totals and generate the utility relocation agreement in a new, standard format approved by the Office of Chief Counsel and State Attorney General. The reimbursement totals automatically reflect cost sharing arrangements, real property interests, and incorporation of work, as needed, based on information captured in the URMS subprocesses. The automatic generation of utility agreements eliminates the need to manually calculate costs and create an agreement for each utility. The URMS automated agreement process improves accuracy, streamlines the legal reviews, and achieves utility commitment to the project work sooner.
- **Electronic Permitting:** Before a utility can relocate their facilities, they must have the right-of-way to access and move the facility. URMS automatically recognizes when the right-of-way is required based on multiple data points in the UCM and then automatically prepares and sends a utility highway occupancy permit. This automation eliminates delays and inaccuracies in the permitting process.
- **Utility Clearance:** The Utility Clearance is a contractual document that provides the highway contractor with the step-by-step relocation activities and work durations specified by each utility in the UCM. Prior to URMS, utility clearances were inconsistent, varying greatly in format, writing style, and level of detail. Now, PennDOT’s contractors can rely on consistently detailed and organized information delivered in the same manner across all projects throughout the state.
- **Utility Construction Performance Reporting:** URMS interfaces with PennDOT’s Engineering and Construction Management System (ECMS) to receive Construction Project Site Activity (PSA) updates that indicate when there is a construction delay or work stoppage due to a utility not being onsite or not completing contracted “prior work.” URMS then automatically sends notifications to utilities and PennDOT utility relocation teams to alert them of the issue so they can remediate. Prior to URMS, visibility into the utility relocation activity on a construction site was limited and relied on PennDOT district staff site visits.

Project Site Activity Log										
Utility - Type	D419 Work Bucket	Utility Work Unit	Work Type	# Days on Site	Est Work Duration (days)	Actual Work Duration	Work Start Date	Work End Date	Work Completed	
PPL Electric Utilities Corporation - Electric	Aerial relocations	WO 58565248	Coordinated	14	28	375	04/20/2023			

Resolution Type	Activity	From Location	To Location	Activity Date	Status	Work Delayed?	Work Stoppage?	Work Completed?	Prior Work Not Complete?	New Location?	Comments
Conductor Transfer	Transfer / Install Conductors	SR/Local Road:0772/W High Street Begin Seg/Offset: 0280/0071 Station: 0702+44	SR/Local Road:0772/W High Street Begin Seg/Offset: 0280/0071 Station: 0702+44	06/20/2023	Approved		Y				IB Abel on site to continue with transfe...
Conductor Transfer	Transfer SL Conductor	SR/Local Road:0772/W High Street Begin Seg/Offset: 0280/0071 Station: 0702+44	SR/Local Road:0772/W High Street Begin Seg/Offset: 0280/0071 Station: 0702+44	06/20/2023	Approved		Y				IB Abel on site to continue with transfe...

Figure 3 Project Site Activities log provides updates from the construction site to identify whether there are work delays or stoppages.

Implementation

Roadmap

PennDOT’s IT team built the URMS application using an agile development process. The application was rolled out in three major releases (2020-2021) and multiple minor releases to address bugs and enhance functionality based on user feedback (2022-2023). This approach allowed the team to build the application and associated processes incrementally and for the business to train and build their experience with the new application in stages with each release.

Design Collaboration

The IT and business stakeholders understood that engaging all internal and external utility relocation stakeholders was critical to the success of the project. This included representatives from multiple PennDOT business areas, utility companies, and the consulting companies working on behalf of PennDOT and the utilities. The insights and feedback from these participants ensured that the needs of all parties were represented in the solution.

To ensure continual engagement throughout the project, the IT development team conducted frequent demonstrations as well as iterative user acceptance and feedback phases. Business users and utility business partners had hands-on experience with the developing application. This approach was crucial to the development process and a large factor in the success of the project.

Training Reimagined

The original URMS training program planned to provide classroom training to 2,600 users in facilities across Pennsylvania from April 2020 through 2023. Due to the COVID-19 pandemic, the URMS team had to rethink its approach to training and instead created a series of 53 videos. The two- to five-minute videos cover all major application functions and are available “just in time” for users in the URMS Training Resource Library within the application.

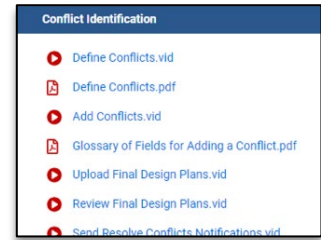


Figure 4. URMS Training Resource Library organizes training materials by topic.

The Technology

In addition to implementing a wide range of utility relocation features and process improvements, the URMS application also incorporates modern technologies and development approaches that add to the business value.

- **Responsive UI/UX frameworks** support varying screen sizes and devices to allow use of tablets in the field.
- **Single Sign On** allows users who have registered for URMS to access a range of PennDOT applications (including URMS) with a single sign on.
- **Web services** allow users to access real-time data from other PennDOT applications and incorporate it into URMS application pages. This eliminates the need for users to open and work across multiple applications when scoping a project or processing invoices and payments, for example.
- **Data-driven configurations** allow the business to easily and quickly modify application rules, page permissions, and content such as email body text and agreement paragraphs without the need for a maintenance release.
- **Exportable lists** allow users to export filtered and sorted lists of data from URMS to MS Excel where they can further manipulate application data for analysis and ad hoc reports.

Impact

URMS is the industry leader in utility relocation management software. No other custom or off-the-shelf product integrates the conflict matrix to automate and drive the utility relocation process as extensively as URMS. The application is saving PennDOT millions of dollars each year in process improvements and automation, allowing PennDOT and utilities to focus their time and effort on the coordination and management of utility relocations rather than the administration of the program.

“PennDOT’s URMS provides a central collaboration point to facilitate the sharing of project information and identifying points of conflict between highway and utility facilities. Since utility relocation is typically on the critical path for project delivery, the improved efficiency in the design phase and the elimination of conflicts during construction helps save time and dollars.”

RICHARD KERCHER, PE; Director, Project Management & Engineering
Federal Highway Administration PA Division Office

The following sections highlight some of the key impacts and cost savings to PennDOT and its utility partners.

Increased Utility Engagement

Prior to URMS, only a handful of utility companies used PennDOT’s relocation software and then only to upload documents. Today, over 500 utility companies are registered in URMS and 2,250 of their employees and contractors are using the application. The increased utility engagement is a game-changer for PennDOT’s utility relocation program. Having utilities actively using URMS and collaborating with PennDOT utility administrators, project managers, and designers ensures projects are designed to meet all stakeholder needs and that construction proceeds as planned.

Automation Cost Savings

The URMS application automated and streamlined many of the utility relocation processes. These improvements allowed PennDOT to realize immediate cost savings by reducing the time it takes to produce, send, and upload permits, clearances, agreements, etc. Figure 6 (below) details a conservatively estimated \$3.8 million in cost savings since the launch of URMS.

Metric	Count	PennDOT Est Hrs Saved	PennDOT Est \$ Saved
Engineering Authorizations issued	7711	3856	\$481,938
Real Property Interest Requests	657	986	\$123,188
Cost Share Agreements	283	425	\$53,063
Notice to Proceed (NTP) documents	1288	644	\$80,500
Highway Occupancy Permits (HOP)	511	511	\$63,875
Utility Cost Estimates	505	631	\$78,906
Pre-Agreement Authorizations	116	116	\$14,500
Utility Reimbursement Agreements	383	1341	\$167,563
D-419 Utility Clearances	1021	10210	\$1,276,250
Special Provision Utility Clearances	1140	1140	\$142,500
Project Site Activity Reports (PSA)	1582	1978	\$247,188
User Document Uploads	71809	8976	\$1,122,016
Totals		30812	\$3,851,484.38

Figure 5 Automation Cost Savings from Nov 2020 through May 1, 2024

Growing Registry of Utility Asset Details

As utility relocation projects are entered in URMS, PennDOT is building a registry of utility assets that were previously undocumented or not easily retrieved. Since URMS' launch in 2020, the system has captured the attributes and location details of over 25,000 utility assets in the UCM. The value of this is hard to overstate. Many underground utility facilities predate automated systems and are notoriously unmapped – or if mapped, have unreliable location details which can prove to be problematic and even dangerous during construction.

All utility asset details in URMS are available and searchable for future projects. The data is also available to share with other PennDOT initiatives such as Digital Delivery/paperless plans and 3-D mapping of utility assets.

Conflict Costs Avoided

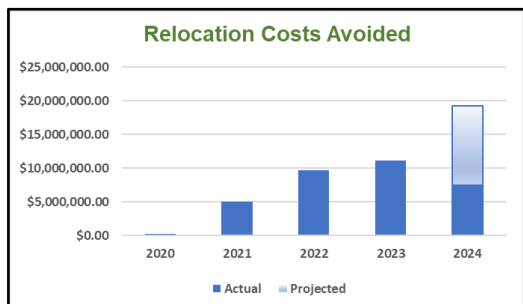


Figure 6. Relocation Costs Avoided by year. 2024 is projected based on the first 4 months of the year.

A major benefit of URMS's standardized workflow and conflict-driven processes is that conflicts are identified much earlier in the project workflow—beginning when the project is in the scoping phase. Prior to URMS, project designers often fully designed the project, only to consider utilities later, after the design was in place, making it difficult to mitigate or avoid utility conflicts.

Since URMS' rollout, 2,110 conflicts have been either completely avoided or accommodated (by short outage or other protection) without a relocation. Avoiding these relocations saved PennDOT over \$33 million to date, with another \$12 million projected by year end. The increased rate of savings will likely level off over time, but it is safe to expect that avoided conflicts will save PennDOT \$20 to 25 million annually.

Reduced Costs of Utility Construction Delays

It is challenging to isolate and calculate the costs of utility delays because there are many compounding factors such as weather and availability of materials. The single best measure of the cost of a utility construction delay is the penalty paid to the construction contractor as compensation for the delay. These figures are not public because they're handled in closed settlements with the contractor. But PennDOT's Bureau of Project Delivery reports that there were **zero** compensable construction delays from 2022-2024. This is a major achievement and the primary business driver for PennDOT's investment in the URMS application!

What's Next?

The URMS application will continue to evolve with enhancements based on feedback and experience. The most recent enhancement included a completely redesigned utility clearance document based on the experiences and feedback from PennDOT's construction contractors.