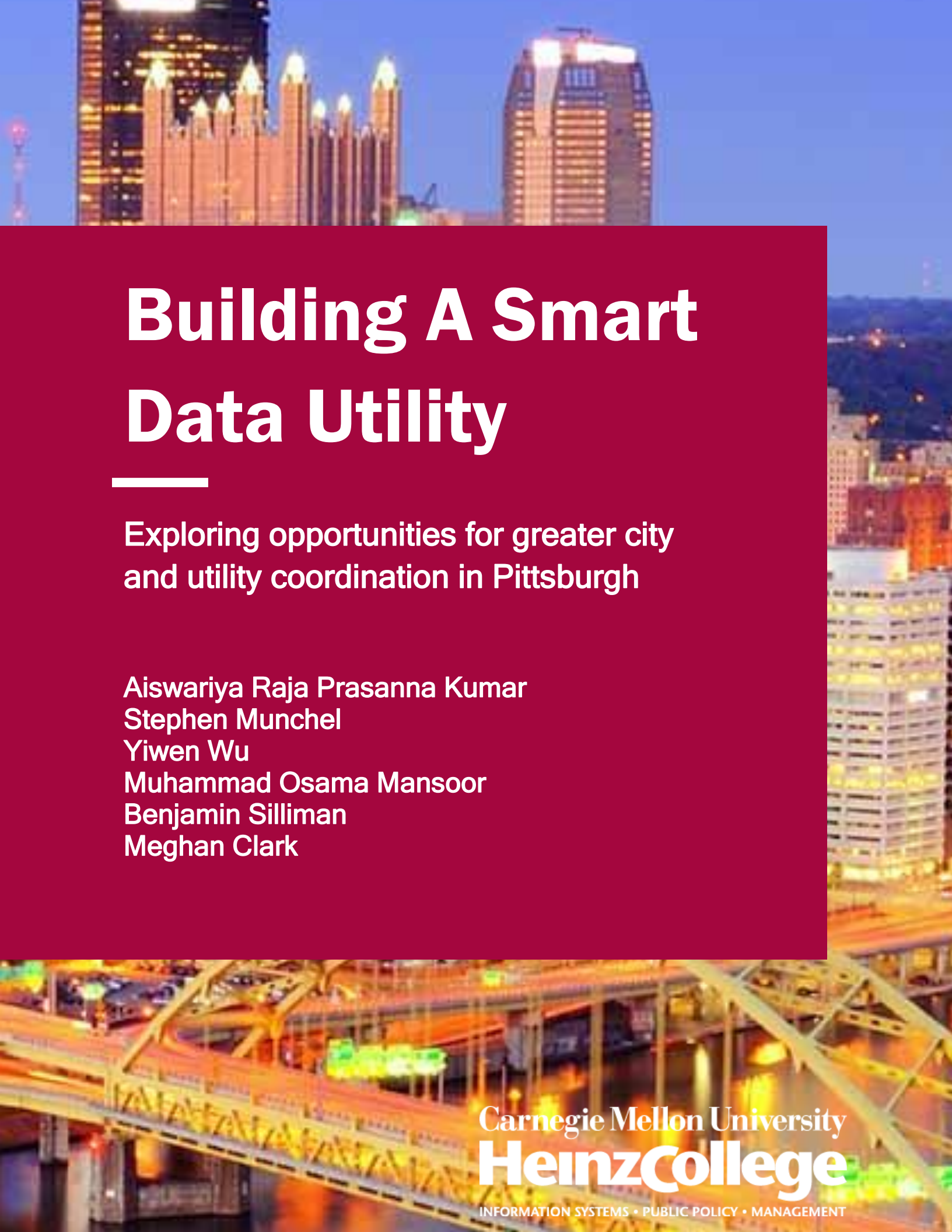

Building A Smart Data Utility

Exploring opportunities for greater city and utility coordination in Pittsburgh

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Executive Summary

The City of Pittsburgh is reinventing itself to become an established leader in smart city technology and intelligent city planning. The city has created partnerships with universities and technology companies to deploy state of the art data collection tools. The city has also become a platform for the newest technologies in transportation, being one of the few cities in the world with autonomous vehicles. However, utility operations have not developed with the rest of Pittsburgh. The city has a rapidly aging infrastructure and will need to engage in large underground construction projects to modernize. This provides Pittsburgh with ample opportunities to develop a robust "Smart Data Utility" to coordinate construction initiatives around the city and reduce costs and disruptions for its residents.

Three major components of the Smart Data Utility were identified to help utilities and the municipal government better coordinate and plan for future investments:

1. *Construction Coordination:* Integrate capital project plans to identify the potential for shared construction projects to reduce the number of street openings and cut the costs of projects for the utilities.
2. *Infrastructure Mapping:* Identify existing underground infrastructure and consolidate the information into a central repository to facilitate planning, permitting, and design.
3. *Smart-Meter Data Sharing:* Share gathered data about energy and water consumption between the city and the utilities to aid in strategic planning and increase operational awareness.

Achieving utility coordination goals will require a robust communication network between critical actors in Pittsburgh. This includes the municipal government, the major utilities, organizations working on coordination initiatives, the public, local universities, and the Pennsylvania Public Utility Commission. It is critical that formal communication channels are established between each of these entities as this will sustain the ongoing process to modernize and integrate utility operations.

Once a solid commitment is made between each entity, pilot projects can be initiated to collect data and show proof of concept for a broader adoption of coordination activities. Pilot projects involving joint construction efforts, shared underground infrastructure maps, and consumption data should be planned. If significant coordination is achieved, it is expected that utility operations will become more efficient, saving time and money. Data sharing will allow for better strategic decision making both at the city government and utility level.

This project was part of an initial outreach between the City of Pittsburgh, Carnegie Mellon University, and the major utilities. It is expected that information and expertise exchange will continue to develop in the city.

Introduction

Urban modernization is rapidly changing how municipal governments function and run the city. New technology has allowed city governments to incorporate new data streams to assist in decision making, with the hopes of improving the lives of the residents. However, municipal approaches to utility management have remained roughly the same despite rapid innovation in other areas. Slow change stems from a history of siloed utility planning, lack of coordination with the city, and tight regulations.

Utilities play an important role in city operations and are relied upon daily by residents. The activities of utilities also impact citizens daily, from detours and delays due to construction efforts. Utilities gather vital energy-use information within the city, which could inform how the city prioritizes investments to improve the quality of life for its citizens. This report aims to gauge the current state of utility operations in the city and identify opportunities for collaboration and modernization.

The smart data utility refers to the ongoing initiatives to improve utility coordination and data sharing between the utilities and the City of Pittsburgh. Rather than being a separate utility service that collects data, it is meant to be the result of a combined effort from multiple stakeholders across the city to integrate data. Improving utility coordination aims to achieve two major results, lower utility bills for consumers in the city and increased operational efficiency for the city and local utilities.

Fit into the OnePGH Initiative

The City of Pittsburgh is currently engaging in a smart city initiative called “OnePGH” which emphasizes resilience, sustainability, engagement, and coordination across many entities in the city to solidify Pittsburgh’s reputation as a smart city leader. Utility coordination is an important aspect of this initiative because it encompasses much of the city’s daily operations. Streamlining construction and design as well as access to data can greatly improve the operational efficiency of the city.

Product Loss and Efficiency

Pittsburgh has aging infrastructure. A large portion of the underground infrastructure will need to be replaced or repaired in the coming years. This unstable infrastructure is causing massive product loss. The most notable loss is from the Pittsburgh Water and Sewer Authority where the Post-Gazette estimates that nearly 40-50% of all consumed water is lost through leaks and other inefficiencies within the infrastructure system. [1] This is also an issue for natural gas pipes where gas leaks can cause product loss as well. Leaks from product loss can drastically increase the price of utility service for customers. Old pipes also create a higher rate of emergency repairs

around the city, which disrupt service and traffic. Huge infrastructure investments will be needed in Pittsburgh, which present the opportunity for high-level planning and coordination.

Operating Landscape

The operating landscape surrounding the utility companies in Pittsburgh is complex. While each stakeholder has their own interests, which can be seen in any city, Pittsburgh is unique in many facets. First, there are different ownership structures for each utility. Peoples Natural Gas and Duquesne Light are both privately held, while the Pittsburgh Water and Sewer Authority is a public utility that is overseen by the Pennsylvania Utility Commission. Second, the history of the City of Pittsburgh has shaped the way each of these utilities interacts with each other, and with external parties such as the city. Important to note is the unique topography of Pittsburgh, which can impact implementation of projects. Lastly, the utility companies are siloed from each other. Very rarely do the utility companies share information with each other. This problem has only worsened due to increased competition.

Duquesne Light Company

Duquesne Light Company (DLC) is a privately held electric utility, servicing 590,000 customers in Western Pennsylvania. DLC operates 690 miles of high voltage transmission lines, 430 substations, and 7,200 miles of distribution circuit lines. DLC primarily services residential customers, with that segment making up 89% of their customer base.

Over the past couple of years, DLC has made significant investments in existing infrastructure and green technology. DLC has stated that it views the long-term role of the utility as a "network operator." The company has made significant investments that align with their view. Additionally, DLC has implemented multiple pilot initiatives to help address emerging utility technology: Transportation Electrification Strategy, Woods Run Microgrid, POLR Solar, and leveraging AMI network for smart city/community applications.

DLC has also implemented a large program to deploy smart meters, thereby improving information gathering and billing technology for its customers. As of early May 2018, DLC has installed 553,400 smart meters in its service area and has plans in place to install smart meters for the entire service area. This large number of smart meters has significantly improved the data collection and analysis capabilities of the organization.

The most relevant investment to the project has been the investment in a new fiber optic network. DLC currently uses a Data Access Point (DAP)/IPv4 network to read advanced metering infrastructure (smart meters). The new technology is a Connected Grid Router (CGR)/IPv6 network that represents a 3G to 4G conversion. This conversion will result in significant bandwidth improvements, giving DLC the opportunity to "rent" bandwidth to other

companies. DLC has targeted the other major utilities as possible partners (customers), as they service the same areas.

Peoples Natural Gas

Peoples Natural Gas is a privately held gas utility, servicing 700,000 customers in Western Pennsylvania, West Virginia, and Kentucky. Currently, Peoples Natural Gas is working on a 20-year project to improve their pipeline infrastructure. This significant long-term investment in existing infrastructure provides an opportunity to market efforts that will help to increase efficiency, lowering project costs.

One major initiative for Peoples Natural Gas includes reducing methane leaks from their pipelines. This initiative has been the result of a partnership with CMU to employ mobile methane detection devices to map methane leaks around the city. Peoples Natural Gas is also beginning a program to install smart meters for their customers to gather higher quality billing and consumption data. This investment is important for the data utility coordination methods.

Pittsburgh Water and Sewer Authority

Pittsburgh Water and Sewer Authority (PWSA) is the major supplier of water and sewage for the Pittsburgh area. They serve roughly 83,000 customers in the Pittsburgh region. The organization is municipally owned. In November 2017 a Pennsylvania state audit found that PWSA was in severe debt. In December 31, 2016 PWSA had $842.5 million in debt. [2] The rapidly increasing debt and quickly worsening condition of the aging pipeline infrastructure has placed PWSA in a difficult financial position. This is a major impediment to many of the utility innovation initiatives in the city because PWSA has limited capacity to make investments. However, PWSA began to invest in smart meters in April 2014, but it has been slower to adopt them than the other utilities in Pittsburgh.

Pennsylvania One Call

Pennsylvania One Call is a non-profit organization that is dedicated to the reduction of pipeline damage from construction accidents. They operate by charging utilities a membership fee. Before digging, it is required to contact PA One Call through their 811 number and confirm the dig site. PA One Call will then contact their member utilities and have them drive out to the dig site and mark out the locations of their pipelines.

PA One Call is the obvious choice for utility coordination efforts because it has been effectively coordinating the location of pipelines and projects for a long time. They have recently developed a new software platform called Coordinate PA that can store construction projects on a geographic database and inform other utilities in the area that a proposed project will overlap. This stands to make construction coordination much easier.

Pennsylvania Public Utility Commission

The Pennsylvania Public Utility Commission (PUC) is the state level regulatory body responsible for regulating utilities. The PUC regulates most of the operational and investment actions of the utilities. This includes regulations for smart meter deployment and data protection. When working with the utilities to encourage innovative practices, the regulations enforced by the PUC are a major factor.

The City of Pittsburgh

The City of Pittsburgh in this context is the municipal government responsible for governing the city boundaries of Pittsburgh. The City of Pittsburgh is responsible for the permitting process for utility infrastructure projects. The city also has many other priorities such as sustainability, economic growth, quality of life standards, and public health. Utility coordination for the city is to gain operational knowledge and improve upon its other policy focuses.

Analytical Approach

To assess the current situation several methods were employed. The task of creating a smart data utility was broken down into three separate initiatives: underground infrastructure mapping, capital project sharing/construction coordination, and smart meter data sharing. Each initiative was identified by stakeholders as a high-potential area. To begin the project, multiple stakeholder interviews and meetings were held. Parties that were consulted include:

- Duquesne Light Company
- Pittsburgh Water and Sewer Authority
- People's Natural Gas
- City of Pittsburgh, Department of Mobility and Infrastructure
- Pennsylvania Public Utility Commission
- Pennsylvania One Call
- Itron
- National Energy Laboratory
- Metro 21
- UI Labs
- Argo
- The City of Boston
- Amsterdam Smart City
- Verizon

Our **value proposition** for this project is as follows:

Stakeholder	Value Created
City of Pittsburgh	• Open and Collaborative Governance: Through consensus and harmonization of interests between the parties involved in this project, assets can be optimized and combined effectively to eliminate redundancies, minimize costs and better serve the residents of Pittsburgh. • Greater Environmental Impact: Effective partnerships between the stakeholders of this project will lead to greater collaboration on street projects. As a result, the city will benefit from reduced carbon footprint leading to a greater environmental impact.
Utility Companies	• Reduced Product Loss: Leveraging the enactment of the Underground Line Protection Act to actively replace and map aging underground infrastructure will allow utilities to benefit from reduction in product losses. In addition, utilities will also achieve an accurate digital blueprint of their underground facility maps. • Reduced Capital Costs: Effective project coordination through a dedicated task force will minimize redundant street projects and renew focus on long-term engineering and design solutions. Overtime, this will lead to reduction in capital costs incurred through recurring emergency situations and redundant infrastructure replacement projects.
Residents	Minimized redundancies through project coordination and active aging infrastructure replacement will allow residents to benefit from: • Minimized utility service interruptions • Lower energy bills • Greater uninterrupted mobility

Utilizing the developed value proposition, stakeholder interests were assessed, and efforts were made to align interests. This included multiple stakeholder meetings and interviews to determine what each utility would require to participate in the coordination process.

Extensive background research was conducted to determine the best practices for utility coordination developed in Chicago, Boston, and Los Angeles. In addition, due to utilities being highly regulated entities, the regulatory climate regarding sharing customer energy-use data and underground infrastructure data was analyzed.

Utilizing street opening permits obtained from the City of Pittsburgh between January 2014 and April 2018, the extent of utility construction coordination potential was determined and will be discussed in depth.

Combining the value proposition, stakeholder interests, best practices of similar cities, relevant regulations, and the potential for coordination, a set of recommendations were developed for each of the three initiatives to consolidate existing city resources, improve utility and city communication, increase data sharing, and streamline utility construction.

General Assumptions

Many assumptions were made in analyzing the potential for utility coordination in the city. These assumptions were needed largely because there was a limit to accessible data that could be used to conduct a more robust analysis. Moving forward, gathering the necessary data would reduce much of the uncertainty and allow for more structure in this analysis. Many organizational practices were also unknown and need to be explored.

It was assumed that the coordination of projects would serve to save utility services money on construction efforts. Even if the projects are on different layers under the street, it is assumed the utilities could at least coordinate restoration. It was also assumed that each separate opening causes delays in the city and increases carbon emissions from idling cars in traffic.

The team operated as though utility companies did not yet have accurate maps of their underground infrastructure. It was also assumed that each utility has access to accurate consumption data from its consumers.

Smart Data Utility Goals

The joint efforts that will constitute the Pittsburgh Smart Data Utility have three goals including:

1) Construction Coordination
2) Underground Infrastructure Mapping
3) Smart Data Coordination

Achieving each goal requires its own recommendations and analysis.

Goal 1: Construction Coordination

The goal of sharing capital improvement plans and the development of utility construction coordination is very intuitive and foreseeable. If one company must open the streets to access their underground infrastructure, another company who also needs to do repairs could complete those repairs while the street is already open—instead of opening the street twice. The concept requires sharing all utilities' short-term, medium-term, and long-term construction work.

Construction coordination mainly belongs to short-term and medium-term coordination work, such as pipeline repair and responses to line breaks. Capital improvement plans will target

longer-term capital projects, such as the replacement of outdated pipelines and the building of new infrastructure, where coordination can begin in the design phase. Due to the energy intensive nature of street openings and the feasibility of coordination, it is important for cities to start coordination of short, medium and long-term projects, and leverage every successful coordination initiative to encourage further coordination.

Relevant Laws/Regulations

The laws governing construction coordination include state laws that require anyone doing underground construction work to report it to the 811 system and local laws that require those doing this type of work to get the proper permits and follow the specific restoration requirements.

Tickets, Permits, and Restoration

The biggest external cost of construction projects is the needed permissions and cost to repair city-owned property. Figure 1 displays the different digging permissions and restoration factors when conducting a construction project. First, the city must grant permission for utility companies, private contractors, and other entities to "remove, relocate, repair, or maintain any surface, overhead or underground facilities" on city owned property which includes "improved and unimproved streets, sidewalks, bridges or culverts, retaining walls, sewers, trees, steps, trails, parks and greenways." [3]

Before anyone digs in Pittsburgh, they must get permission from 811 and the City of Pittsburgh. The 811 service is a phone service that takes a project's construction information and notifies the appropriate utility companies to mark buried lines so that construction can be done safely around them. [4] This step is important because on average every 60 seconds underground infrastructure is punctured in the United States. [5] Depending on the days' notice given to 811, they will give you an emergency ticket, routine ticket, or design ticket.

In Pittsburgh, the permits needed to dig are provided by the City of Pittsburgh's Department of Mobility and Infrastructure (DOMI). Cities have permitting processes for construction because they need to monitor private activities on publicly owned infrastructure. In addition, the permitting processes formally establish the conditions and liabilities associated with private activity damaging public infrastructure. The two required permits are a street opening permit and a street opening bond, and the restoration of the site is dependent on the streets material, the last paving, and moratorium status. In all, the need to notify 811 and have all the utilities mark underground infrastructure, and the need to get the proper permissions from the city and follow their different restoration requirements means all underground digs have fixed costs as well as variable costs.

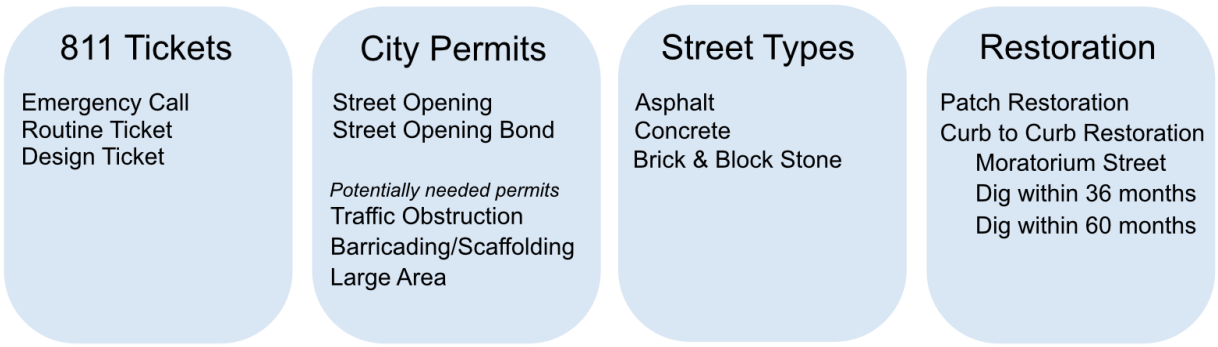


Figure 1: Digging Permission and Restoration Factors: Permitting Components for Underground Infrastructure Projects

Utilizing data obtained from the Department of Mobility and Infrastructure detailing each street opening permit in the city, a method to determine if projects could have been overlapped was employed. The data covered the period from January 2014 to April 2018. [6] A project was considered overlapping with another project only if it met each of the following criteria:

- The permit time intervals overlapped
- The permits were on the same street
- The reported address of the permits were less than 100 feet away

Based on the above criteria, a total of 589 permits met each condition and could have been coordinated with at least one other permit. The total number of permits in this range was 3,072. This means that around 19% of all permits issued in the time frame could have been permitted. This may have reduced the number of street openings by as much as 10% if every project had been coordinated properly. The results of this analysis are displayed in figure 2 below.

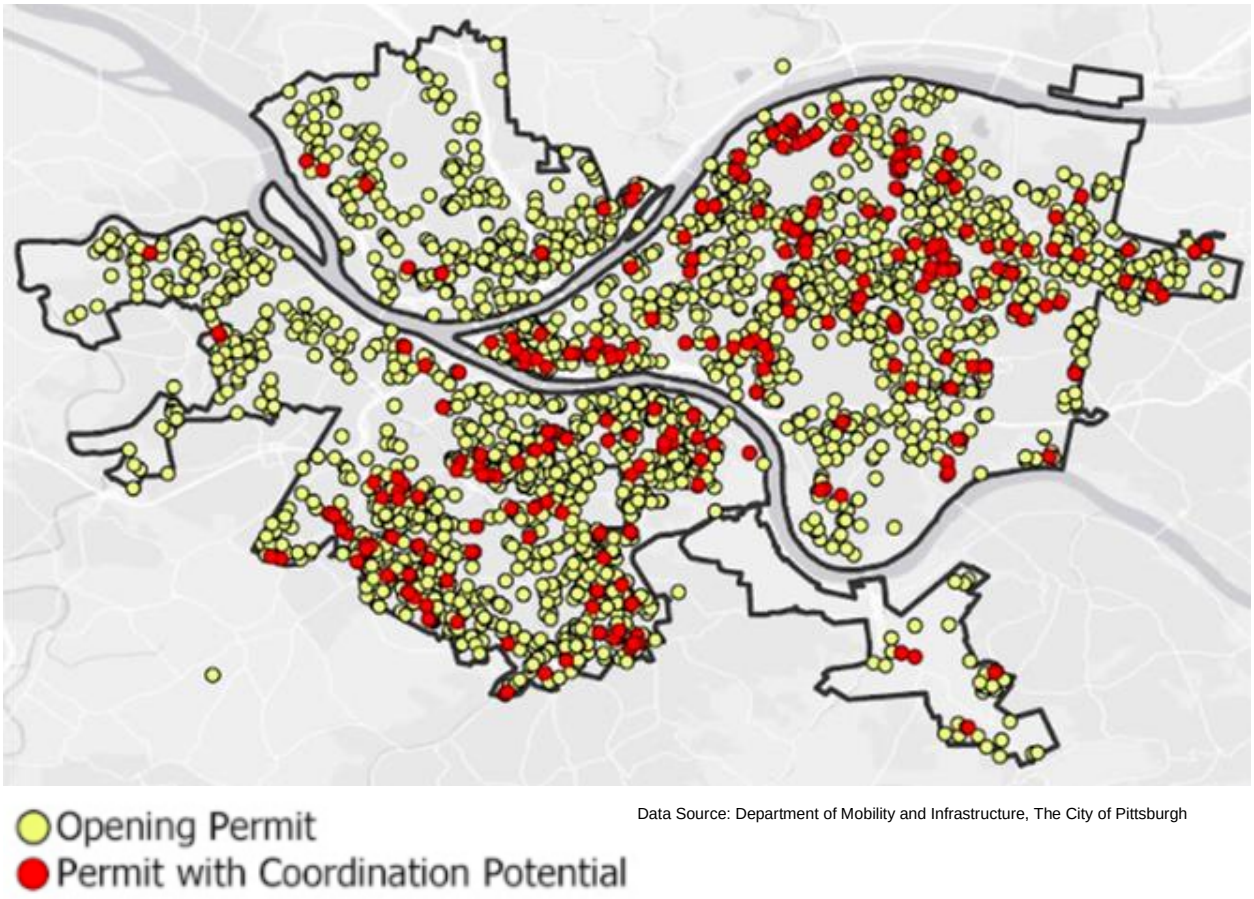


Figure 2: Estimated Permits and Projects with Coordination Potential

Emergency Digging

Emergency work is defined as a sudden or unforeseen occurrence involving a clear and immediate danger to life, property and the environment, including, but not limited to, serious breaks or defects in a facility owner's lines. [3]

Having a construction job defined as emergency work alters the ticket and permitting procedures. Under this circumstance, the utility or private contractor must call PA One Call and give a notification of emergency. [7] At this point, the company can dig even when other underground infrastructure lines are not marked. Within 24 hours, they must seek street opening and other needed permits from DOMI, and only under the emergency condition can “utilities erect barricades or scaffolds, cover or uncover walk ways, erect or relocate utility poles on sidewalks or roadways or temporary bridges or making any curb cuts or lay repair a sidewalk without first obtaining the permit from the DOMI.” Even though there are adjustments to the permitting process, there are no additional cost to companies for having emergency repair work. The comparison of emergency, routine and design permitting processes are illustrated in Exhibit C.

Moratorium Street Digging is Only Allowed for Emergency Digs

When talking about construction coordination, it is necessary to talk about moratorium streets in Pittsburgh. They are a special case for construction because moratorium streets cannot be opened unless the company's written request to excavate a moratorium street is sent to DOMI and the request is approved by DOMI. [3] DOMI only approves requests where there is "an emergency that endangers life or property, interruption of essential utility service, service for building where no other reasonable means of providing service exists, work that is mandated by city, state, and federal legislation." [3]

As seen in Exhibit A and B of the Appendix, the most travelled roads and the most economically productive roads like Forbes and Centre Avenue have the moratorium status. [8] This is a problem for the city and utility companies because if utilities cannot do preventive maintenance on these high traffic streets for three or six years, there is a greater potential for high-impact emergency construction and reduces the incentive for utilities to proactively maintain their underground infrastructure. In addition, under the current law, even if construction coordination was possible, it is unclear whether a second utility can coordinate with the utility approved to dig on a moratorium street without having an emergency themselves.

Lastly, if permission is granted for construction on moratorium streets, the utility company must permanently patch the road according to city specifications, which is often curb-to-curb restoration. However, utility companies can request exceptions and these exceptions must be submitted in writing to DOMI. The ambiguity of this language gives the city a great deal of influence in the restoration of a moratorium street.

With these processes, there is less red tape for emergency work and there is no monetary or otherwise penalty for emergency work. Coordination can only occur if work is planned. In addition, there are no incentives to coordinate designing and planning efforts. If there was an incentive structure in place to encourage coordination, there could be an entity whose assigned responsibility is to help coordinate construction. As a result, there would be cost savings on permitting and ticketing.

Current Efforts

There are multiple organizations in Pittsburgh working to integrate utility operations in their own ways. These organizations include: CONNECT at the University of Pittsburgh, Coordinate PA with the PA One Call system, and the Department of Mobility and Infrastructure with the City of Pittsburgh. Increased coordination between these organizations could improve their ability to work with the utilities and create meaningful progress as there are highly overlapped working areas between them. There are likely more initiatives in the city or similar cities that would be valuable partners.

CONNECT

The Congress of Neighboring Communities (CONNECT) was established in 2009 by the University of Pittsburgh. The central purpose of CONNECT is to empower coordination between the City of Pittsburgh and the surrounding municipalities. CONNECT helps both parties work together to address common public policy challenges that plague the city. It helps bring together leaders from over 40 governments, tackling a broad range of issues such as climate change, infrastructure coordination, energy efficiency, etc.

Currently, CONNECT hosts biannual face-to-face meetings to constantly identify areas of project coordination and collaboration through the mutual sharing of annual or multi-year plans. [9] CONNECT has managed to host two annual Utility Summits that bring together representatives from various municipalities and utility companies. The major takeaway from the meetings were:

- A charge for CONNECT to continue hosting utility coordination meetings and convening various stakeholders from this ecosystem.
- The need to identify and procure a shared data platform between municipalities and utilities to facilitate the electronic tracking and sharing of utility project plans.

Because of these meetings, CONNECT made the following commitments:

- To become the official coordinator of meetings between the City of Pittsburgh, Allegheny County and utility providers in the region.
- To procure a common data platform that will allow the coordinated planning of projects between municipalities and utilities.
- To endorse Coordinate PA as the official shared data platform for infrastructure planning.
- To support PA One Call in the process of introducing the Coordinate PA platform to member municipalities and utilities.

Coordinate PA Platform

Pennsylvania 811 has developed Coordinate PA, a web service application to encourage public works (governmental) and utility coordination in the design and project planning phases. The system is designed to display all non-emergency project locations and timelines to identify opportunities for collaboration, leading to cost savings and minimizing public disruptions and inconveniences.

The whole system directly interacts with 811's ticketing system, Web Ticket Entry (WTE), to empower utilities with more designing and planning capabilities, which is in line with Pennsylvania's Underground Utility Line Protection Law. After the project owner uploads their design tickets in another tab, the project shape will be displayed as a grey box. The WTE process automatically identifies eligible projects for collaboration with a red signal. The project can be divided by time, area, or order of completion. WTE connects and informs all potential members

of the project and permits them to respond to any changes to allow better coordination communication.

Department of Mobility and Infrastructure

The Department of Mobility and Infrastructure organizes utility coordination meetings monthly. This group currently uses a Dropbox folder system to coordinate project plans. Some of the information that utilities share on the systems include:

- 2018 Utility Capital Projects
- Planned Utility Work
- Potential 2018 Paving Projects
- 2017 Utilities Work

One of the major utility coordination challenges that transpired during these meetings is the proximity of utility work in terms of permits issued for the same segment - regular permits and traffic obstruction permits. Projects associated with these meetings are coordinated on Burgh's Eye View - a platform launched by the city's Analysis and Strategy team as a means towards open governance.

Case Study: City of Baltimore

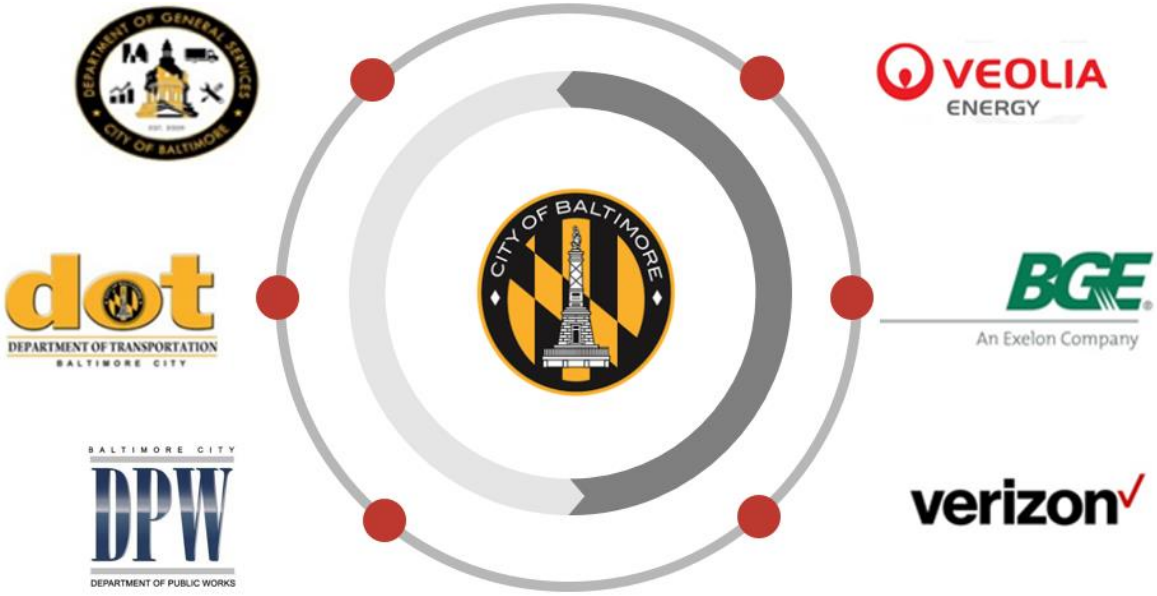


Figure 3: Baltimore Stakeholders

The City of Baltimore and their use of Envista illustrates how to effectively use data management and project tracking graphics to open more opportunities for collaboration.

The City of Baltimore adopted the Envista system in 2009 to have an accessible dynamic infrastructure coordination solution for costly oversights. [10] After working with the Envista system for two years, Baltimore's Department of General Services is now able to proactively review capital projects during their monthly utility coordination meetings to uncover opportunities for collaboration and cost savings. For example, the city could potentially postpone a major road resurfacing project to coordinate with Baltimore Gas & Electric's (BGE) gas line replacement project. In this way "BGE is then able to save the cost of resurfacing the road because Baltimore Department of Transportation can come in immediately behind the gas work to repave the whole road." [11]

Envista works as a third-party software service. There is no programming or special equipment required to use Envista. Project data can be imported from a wide range of formats, including spreadsheets and GIS shapefiles. Envista then automatically maps the data according to its own attributes and business rules to show on the map. Users get alerts from the interactive map, and they can manage everything through an online dashboard that provides critical planning information at-a-glance (See Exhibit D).

The ecosystem initiative started first between the city and BGE in 2009. BGE serves more than 1.2 million businesses and residential electric customers and over 633,860 gas customers. Envista's solution will help enable BGE to keep their maintenance programs ahead of the paving schedules. BGE can perform a leak survey prior to paving and make the necessary repairs. This example of efficient project coordination shows the infrastructure community how to reduce disruption in communities and save tax dollars by coordination. [10]

The City of Baltimore has now become the most comprehensive Envista ecosystem in the U.S. Figure 3 displays all the stakeholders that now use the Envista ecosystem: Baltimore Department of Public Works, Baltimore Department of Transportation, and Baltimore Department of General Services, along with area utilities including Baltimore Gas & Electric, Veolia Energy, and Verizon. [11]

Combined, these entities have uploaded more than 1,500 projects into the Envista database. As a result, the city and its ecosystem partners have avoided hundreds of costly conflicts, while also uncovering many opportunities for acting proactively to improve project efficiencies and realize cost savings. Another way the City of Baltimore has found to extend the value of utility coordination is by looking beyond infrastructure projects to street events, street incidents, and permit management to better benefit communities, which incentivize us to fully explore all the possibilities and scenarios of construction coordination later.

Case Study: City of Amsterdam

To achieve the goal of a smart city strategy, Amsterdam launched their Amsterdam Smart City (ASC) Initiative in 2009; which is a public-private partnership of 11 partners [12] Amsterdam Smart City creates the overview of the ecosystem, connects communities to share expertise, and accelerates and strengthens new projects that make the city futureproof. It has several focused topic areas such as infrastructure & technology, mobility, circular city, and governance & education. Under the infrastructure & technology category, the Open Data Exchange (ODE) project started in 2012, commissioned by the Amsterdam Economic Board. The project aims at strengthening the economy of the Amsterdam metropolitan area by unlocking available (public) data sources to citizens and businesses. By using this data, citizens, businesses, research institutions and other parties are enabled to develop services that previously wouldn't be possible or were too expensive. [13]

The ODE naturally creates a platform and opportunity for utilities to explore the possibilities of sharing more data. The unique scenario in Amsterdam set up a perfect stage for utility coordination:

- Due to the historical reasons, Amsterdam lacks underground mapping documentation;
- The complexity of Amsterdam as a city with centuries of history requires utilities to work together (share cost & diversify risks) to roll out smart grid to eventually take advantage of smart meter data;
- A new strict regulation was issued that the same street can only be opened once within the timeframe of two years;
- The ASC initiative facilitates the data sharing and the use of new technology to transform Amsterdam and the way utility works.

The Amsterdam Smart City initiative took a step back, and Amsterdam persuaded some of the sector's big players to simply share details of their upcoming investment plans. The result was a pilot group comprising operational strategic planners from energy distributor Alliander, waste and water utility Waternet, energy producer Nuon, and the government-owned energy supplier Afval Energie Bedrijf. Each shared the details of the capital plan at the aggregate level (street block) enabling the Amsterdam Economic Board to design a virtual map that showed where future projects would overlap. The shared working plan allowed for collective investment and operation of underground mapping with ground-penetrating radar technology. The highest cost for utilities is to work underground, and the shared capital plan enabled the group to save $20m euro in total (unable to verify). In this way, the group has a solid business case for smart grid investment. [14]

The most important lesson from this pilot project is how to encourage companies to share their data, as data is usually siloed with little transparency.

Goal 2: Underground Infrastructure Mapping

Knowing the location of underground infrastructure seems like a simple concept. However, not all line owners know exactly where their assets are located. Imprecision of location estimates can result in accidental underground line damage and therefore added time in the project design phase. Cities such as Chicago have attempted to solve this problem through advanced platforms that show the exact location of underground infrastructure. The time and cost savings that occurred were substantial, which validates the use of such practices in Pittsburgh.

Relevant Laws/Regulations

Underground Utility Line Protection Act

On October 30, 2017 the Pennsylvania General Assembly enacted Act 50, also known as the Underground Utility Line Protection Act. Act 50 was passed as an amendment to the act of December 10, 1974 (P.L. 852, No. 287), "an act to protect the public health and safety by preventing excavation or demolition work from damaging underground lines used in providing electricity, communication, gas, propane, oil delivery, oil product delivery, sewage, water or other service; imposing duties upon the providers of such service, recorders of deeds, and persons and other entities preparing drawings or performing excavation or demolition work; and prescribing penalties." [7]

The 2017 act more clearly defines the implementation of the original act: "further providing for title and for definitions; providing for lawful start date; further providing for duties of the One Call System, for duties of other parties, for duties of excavators, for duties of designers, for duties of project owners, for audits and for penalties; providing for enforcement, for damage prevention committee and for compliance; and further providing for One Call System authority and for expiration." [7]

The "lawful start date" for the Underground Utility Line Protection Act is April 28, 2018. One of the provisions of the act prohibits the One Call System from requiring facility owners (line operators) to locate any lines or facilities that were installed before the effective date, unless the owner already possesses existing maps. This means that for every replacement or installation of underground infrastructure, the facility owner must submit mapping data to the One Call System. Additionally, the amendment provides standards for communication within the Coordinate PA system.

While this act appears to be the solution to the vague understanding of underground infrastructure location throughout the city, what is uncertain are the incentives. Currently are there incentives to comply (subsidies, credits, discounts)? Penalties for non-compliance? The

most important question surrounding the Underground Utility Line Protection Act is, will line operators comply?

Current Efforts

The Underground Utility Line Protection Act is a good first step towards the goal of accurate underground infrastructure mapping. Pennsylvania 811 has taken the initiative to develop a platform that accurately depicts underground infrastructure. However, facility owners may not know the location of their infrastructure or simply may not comply. The effort of shared mapping capabilities is early in its development, which provides ample opportunity for improvement.

Case Study: City of Chicago

Figure 4: Chicago Stakeholders

In 2016 City Tech Collaborative, a UI Labs collaboration based in the City of Chicago, announced it had developed technology to create an underground infrastructure mapping platform. The platform will "generate, organize, visualize, and store 3D underground infrastructure data, saving cities and utilities millions of dollars in construction and planning processes." [15]

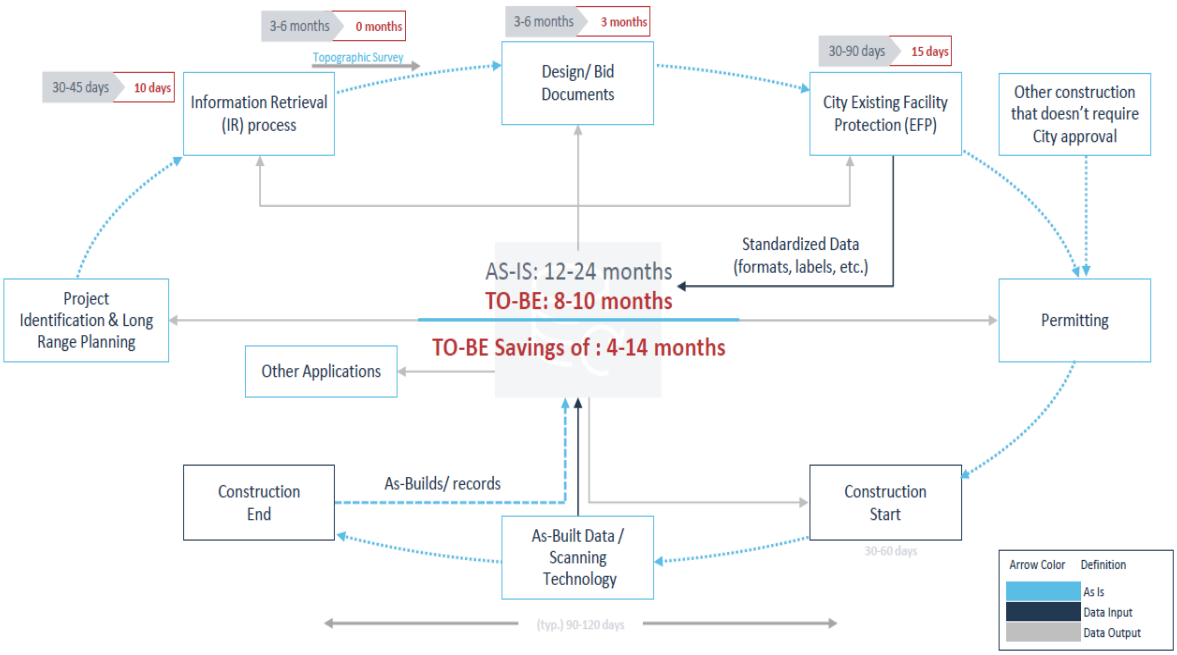
The platform is designed be shared by the City of Chicago and utility companies, who pay to have access to the platform. These parties will be able to view underground assets such as water pipes, fiber optic lines, gas pipes, electrical lines, and legacy infrastructure (subways for instance). City of Chicago CIO Brenna Berman stated, "by improving the accuracy of underground infrastructure information, the platform will prevent inefficient and delayed construction projects, accidents, and interruptions of services to citizens." [15]

According to the American Public Works Association, an underground utility line is hit on average every 60 seconds in the United States due to inaccurate or obsolete data. The platform prototype was first used on construction sites of increasing size, with hopes to roll out the platform to other areas. UI Labs plans to incorporate underground sensors with its platform to make the infrastructure "smarter."

UI Labs brought together multiple stakeholders, as can be seen in Figure 4, to accomplish this goal: Accenture, HBK Engineering, Microsoft, ComEd, Chicago Department of Transportation, Chicago Department of Water Management, ESRI, CityZenith, and the University of Illinois Urbana-Champaign.

The mapping effort in Chicago was crowd-sourced. When there was a construction or utility project, workers used a mobile application to capture data and update the system in real time. The platform is maintained and owned by the City of Chicago, with each party (municipalities, utilities, planning/design firms, engineering contractors, construction workers, and emergency responders) paying a fee.

UI Labs found that the biggest time/money saver was not reducing accidents, but rather the time savings in the design and redesign of infrastructure. Pitching this product to the utility companies was not easy, as UI Labs had a long-term view while utilities were more interested in the short term. Getting everyone to agree was difficult but identifying 4-14 months of time savings in terms of engineering and design made the pitch easier (see Figure 5). From the perspective of the City of Chicago, real-time data visualization creates new business models to collect revenue.



Source: UI Labs

Figure 5: Estimate Utility Project Time Savings

Goal 3: Collecting and Sharing Smart Meter Data

Utilities across the country are gearing up to deploy smart meter technology in their networks for the next generation distribution system. The availability of interval consumption data for all customers promises to not only support more efficient electricity services, but also to unleash significant customer service innovation. Data from the advanced meter infrastructure can allow both utilities and customers to use cloud-based digital services to understand and control their energy use, respond to prices, optimize comfort and cost, or even contribute to reliable operation of the grid. Given the possibilities it creates, a successful smart meter program fits well into the OnePGH strategy. [16]

Relevant Laws/Regulations

Utility data is highly protected and strongly regulated in Pennsylvania. Each individual consumer has the right to his or her data; the utility is viewed as a trusted partner, as the utility requires personal information to complete accurate billing transactions. In Pennsylvania, two major regulations govern the handling and usage of utility data. Pennsylvania Statutes Title 66 Pa.C.S.A. Public Utilities § 2807 lays forth the duties of electric utilities in the state. The statute states that the electric distribution companies, like Duquesne Light Company, shall make electric meter access available to third parties provided they have received consent from the consumer. Third parties are identified as, but not limited to, electric generation suppliers and suppliers of conservation and load management services. This means that there are legal methods to engage in data sharing between third party organizations, if they serve a purpose.

Pennsylvania regulation 052 Pa. Code § 54.8 regulates the privacy of customer information. This regulation prohibits an electric distribution company from releasing information to a third party unless the customer has been notified of the intent and has been provided a convenient method to notify the electric company of the desire to restrict any of the information. Any customer can restrict any of the following information: the customer's telephone number, historical billing data, or data specified either orally or electronically. This restriction of data sharing shall not prohibit any mandatory duties required by the electric company. Regulations for natural gas and water consumption data are not as well defined as electric utility data because the smart meter technology for these products are not as well defined. All utilities in Pennsylvania are covered by Statute 66, but only electric companies are covered by 052 Pa. Code § 54.8.

As Pittsburgh develops a platform to integrate utility data into smart city initiatives and to establish data sharing among utilities, it must work around these established regulations and maintain a respect for consumer privacy. Access to utility data could potentially reveal many details about the customer including when they are on vacation, when they may have turned on energy intensive appliances, such as laundry, and whether they are financially able to pay their electric bills. A small amount of aggregation, to the street level for example, would be a way to

see granular areas of the city without identifying individuals. Some level of aggregation may also reduce the limitations of regulations on data sharing. This is time consuming, and as part of the platform, aggregation must be automatic and performed by the utility companies themselves.

Current Efforts

There are no formal initiatives in place currently to develop data sharing between the city government and any of the three major utility companies, or even between the utilities themselves. Currently, Duquesne Light Company has shared consumption data, without billing information, with the city government only once - when Pittsburgh developed the 2013 Energy Baseline Study.

Case Study: State of Texas

Multiple issues exist as the current obstacles to the vision of sharing smart meter data, such as how to build an advanced data sharing platform, what is the data-sharing process for customers with third-party companies and most importantly how to better analyze the data. To further illustrate this, the Smart Meter Texas (SMT) project can be used as a case study.

Texas was one of the first states to deploy smart meters. Currently, Texas collects 15-minute interval meter data from over 7 million smart meters. Competitive retail electric providers and the independent system operator (ERCOT) consume the data daily to support both retail and wholesale operations. Customers have access to their electric consumption data on a single, shared website that is owned by the utilities, known as Smart Meter Texas. The Public Utility Commission of Texas (PUCT) adopted a third-party data access policy in 2007, and enabling functionality was implemented on the utilities' website in November of 2014. Therefore, SMT 1.0 enables competitive energy services providers (CSPs) to tap into the data stream, with customer's permission, to provide additional data-driven services to customers. [16]

However, due to the slow and cumbersome 10-step data sharing process, the limitations of the existing system have resulted in a low uptake of its services. According to the South-central Partnership for Energy Efficiency as a Resource, there were only 1,735 active data-sharing agreements (many are associated with a state-mandated program for low-income participants) in SMT as of that summer, while over 7 million meters were installed. [17]

The low participation rate forced SMT to upgrade into 2.0 version by streamlining the approval process and upgrading the data-sharing platform. In February 2018, Texas utilities, big energy customers, and representatives of would-be third-party users of the usage data reached a settlement agreement that will unclog these bottlenecks between smart meter data and its users – as expected to be approved by the Public Utility Commission of Texas in April. [17]

SMT 2.0 will dramatically simplify this customers' data-sharing process by not asking customers to create a new account on SMT. Naturally, this is expected to reduce the 10 steps to a three-step process: 1) Customer signs up on the Competitive Service Providers' (CSP) website or app, providing their relevant account information; 2) The CSP, acting on the customer's behalf, sends this information, along with the customer's email address, to SMT 2.0; 3) The customer receives an email from SMT 2.0 asking for confirmation. After one click, customer energy data is shared with the CSP. The most significant benefit of this re-design is that the customer never leaves the CSP's website or app; it's a seamless experience. [18]

The settlement also solves the data transfer problem on the platform by mandating the use of the latest API from the Green Button standard for customer energy data. The application programming interface API data format and API specification used by SMT will be compliant with the Green Button standard as of 2017. [18]

With this upgrade, it is expected that data sharing will jump to 55% leading to better demand optimization and demand response. Aggregators of residential customers like Energy Hub do not need access to smart meter data to sign up customers into bring-your-own-thermostat programs, which allows third-parties to do data analysis through a more straight-forward process. [19]

Recommendations

To achieve each of the three goals laid out, the following recommendations should be considered. As demonstrated by our case studies, they often require multiple parties to coordinate for the best outcomes. While challenging to implement, these recommendations are expected to lead to significant improvements in the ability to share critical information and improve coordination across all aspects of utility operations in Pittsburgh.

Goal 1: Construction Coordination

1. *Data and Recording:* To facilitate construction coordination in Pittsburgh, the city should use permit data every year to identify all missed potential construction coordination projects. The recording of this information will allow the city to monitor how much progress it has made in encouraging construction coordination and through identifying good and bad years for construction coordination, the city can identify the factors that lead to good and bad coordination. Informed by this additional data the city can act intelligently towards creating the conditions for greater construction coordination and fewer street openings.

2. *Permitting:* First, there needs to be an investigation into the incentive structure for the use of design tickets. A potential avenue for this is through the city reducing its permitting fees for coordinated projects and design tickets to serve as an additional financial gain for

utility companies. PA One Call could do something similar, however this would have to be legislated at a higher level and tickets are only cents on the dollar meaning the financial gain would be minimal.

Second, if a project qualifies for a design ticket and made public for coordination by 811, the city must legislate that the project can be done on a moratorium street. This creates an incentive to have planned construction projects and may reduce the amount of emergency digs which is financially better for utilities and operationally better for the city. In all, the impact of the moratorium street policy towards reducing street openings needs to be evaluated.

3. *Greater adoption and use of Coordinate PA:* The use of Coordinate PA can lead to greater efficiencies and communications between line owners. PA One Call, the organization behind PA Coordinate, has recently become entitled to receive the infrastructure plans from each of the utilities in the region under the Utility Underground Line Protection Act. This is enforced with penalties issued by the Pennsylvania Public Utility Commission. This is a natural organization to partner with to improve utility coordination.

4. *Sharing access to Coordinate PA:* Once all companies comply with the Underground Utility Line Protection Act, see if representatives from the city and utilities can have access to project data. The utility company can then contact the entity that has an overlapping project to see if coordination is possible. This would be particularly successful when the city restoration requirement is curb to curb.

5. *Pilot Project:* One of the challenges to encouraging utility companies to strive towards collaboration is the indirect evaluation of construction coordination cost savings. Simply, utility companies and the city do not fully understand the financial and environmental benefits to construction coordination. To address this need, the city needs to put together a team that specifically monitors and records the process of coordination between underground facility owners and the environmental and financial benefits. To target the team's efforts, the city would establish a pilot area where all utilities must coordinate digs in this area. This could be accomplished in a couple of ways.
    - The city could establish an arbitrary geographic area where coordination is encouraged by the city where whenever a permit is requested the city works with the utility to facilitate coordination. This area would be characterized by having different company's underground facility lines close to one another.
    - The city could partner with an academic institution like Carnegie Mellon and have that University make the utilities coordinate during construction.

- The city could also use one of its capital improvement projects like the Bus Rapid Transit System to make utilities coordinate during construction.

This pilot proposal makes the process more localized to get that first round of cost and savings data specifically for Pittsburgh. The data should be made publicly available for the public and the utilities to promote coordination.

Goal 2: Underground Infrastructure Mapping

Pittsburgh is in the early stages of aggregating data on the location of underground lines. The Underground Utility Line Protection Act requires the submission of such data. The problem in Pittsburgh is that line owners have varying levels of data. Some owners already know the location of their lines, while others have almost no knowledge except old paper maps. Looking forward, we consider both the short-term and long-term in our recommendations:

1. *Utilizing technological innovations:* Existing technologies make the concept of an aggregated underground infrastructure map more feasible. Line owners who do not have the data on where their lines are located can look to best practices used across the globe. Examples of innovative ideas can be taken from the City of Chicago, who used a crowd-sourced effort to the City of Amsterdam, who used ground penetrating radar technology to map their infrastructure.

2. *Implementing incentives to map underground lines:* Providing a financial incentive for line owners to map their data could help to speed up the process of gathering data from multiple parties, with varying levels of granularity. For instance, utilities that agree to share, in a timely manner, their underground infrastructure maps with the city should receive a discount in permit fee. In addition, there could be a "fast track" permitting process for these utilities to incentivize other agencies to share maps as well.

3. *Analyze possibility of providing proprietary access to certain line owners:* Incorporating different levels of access in the mapping platform could help to address multiple concerns from both the city and line owners: security and proprietary information being shared with the public.

4. *Analyze possibility of sharing platform with other interested parties:* Sharing the mapping platform with other interested parties, while providing tiered access could lead to new opportunities. The first being a new revenue stream for the mapping platform. The second being new increased coordination with parties who otherwise are not included. Third, new innovations could result from the sharing of line locations. The city of Chicago provided paid access to interested parties such as planning/design firms, contractors, and emergency responders.

5. *Pre-construction meetings in case of complex projects:* It is required by the law that facility owners participate in preconstruction meetings in case of a "Complex project" (as defined by the law). These meetings are essential as they will allow face time for parties involved to discuss any potential cost-cutting solutions w.r.t excavation, labor, material resources employed etc. Furthermore, these meetings could be a useful platform to clarify any final changes in project plans or updates by design engineers that could not be uploaded to the Coordinate PA system. In the digital era, while online mapping seems to be the easy solution, several unforeseen costs and externalities can be avoided through face-to-face meetings. This recommendation is a step in the direction towards avoiding such consequences and externalities.

Goal 3: Smart Metering Technologies

Pittsburgh is ripe for leveraging the potential of data sharing through smart meters. The introduction of IPv6 in the near future will further enhance the extent and potency of data gathered through smart meters installed by DLC. While opening the Pittsburgh energy market to independent providers - with customized their customized fee plans based on household data - might not be feasible in the foreseeable future, there are other areas where this data can be utilized. The team recommends:

1. *Establish Robust Pilot Projects:* The City of Pittsburgh has the opportunity to see the impact of open utility data access with the passage of the Building Benchmarking Ordnance. This requires commercial building owners to use a secure portal to record and keep track of their energy usage. This data is also required to be sent to the City of Pittsburgh for analysis. Leveraging this data to target and keep track of sustainability policies could serve as a proof of concept to begin to analyze residential data.

2. *Establishing Data Coordination Team:* There is a clear need for a team specifically tasked with coordinating the sharing of data between the three utilities; this team should have representatives from each of utility company who will be responsible for routine operations, such as data requests, database management and troubleshooting. Moreover, these representatives would act as an important bridge between the three managements.

3. *Working with the Public Utility Commission:* Strong relationships with the Public Utility Commission can open doors for the City of Pittsburgh to convince utilities to share data. It can also provide the city with important data like the Cold Weather Service survey that can have immediate use to the city.

4. *Develop Automatic Data Aggregation and Collection Capability:* When regulatory hurdles have been cleared, a standard format for data collection (types of data, obscurity of privacy data, and time intervals of data) must be standardized. Each utility should then

automate the process of delivering data on a regular basis to ensure delivery and reduce the man-power involved in preparing the data.

5. *Streamlining the Consumer Experience:* The case study mentioning smart meter data sharing in Texas should be taken as a cautionary tale, i.e., it is very important to optimize consumer's interaction with their consumption data. DLC and PNG should create portals which allow the consumers to access their data and share it directly with third parties, such as energy solutions providers. This would allow the consumers to get financial appraisals on energy conservation initiatives such as insulation.

6. *Initiating Interagency Data Sharing:* While the utilities may not feel the need to have consumption data from any of the other utility companies, PWSA's recent revenue collection woes can, in part, be tackled through gathering data from one of other utilities. We recommend that DLC share household level consumption data with PWSA. This data does not need to be in the exact amounts of electricity consumed; it can be categorized into various predetermined categories based on the amount of consumption. Through this data, PWSA can identify potential bill payers (and their level of water consumption) and match it against its own records to determine if there is adequate collection taking place in terms of revenue received. This can be done at the household level, street level, or any pre-determined catchment area.

Reduce Redundancies

There are many existing projects and organizations around the city working to improve efficiencies in the utility construction landscape. These organizations include CONNECT at the University of Pittsburgh, Coordinate PA with PA One Call, and the new Pittsburgh Department of Mobility and Infrastructure.

Currently, there is poor communication between these organizations, utilities, and municipal government. Focusing on consolidating existing resources around Pittsburgh into a single broader initiative with representatives from each stakeholder would improve both utility coordination and operational efficiency.

Implementation for Pittsburgh

The recommendations detailed above should be implemented in different stages to prioritize the low hanging fruit and get results before moving onto the more regulatory or politically burdensome areas. The implementation stages are detailed below.

Stage 1: Task Force Creation

The first stage should focus on bringing all the stakeholders together and consolidating the existing resources in the city. Members of the task force should include city officials, utility representatives, and members of utility service organizations like Connect and PA One Call. The main goal for this stage is to align stakeholder interests and improve interagency communication. Different organizations, like the City of Pittsburgh, should engage in outreach opportunities at this point to develop relationships with other organizations like the PA PUC. Frequent and open communication channels should be developed between each organization.

Stage 2: Capital Project Planning

The second stage is to identify a central coordinator and software to begin the collection of capital budget plans. This stage should focus on coordinating construction projects and finding cost savings opportunities for the utilities. Long to medium-term projects should be shared at this point with a focus on better planning for the city.

Stage 3: Integrate Existing Data

Once the utilities can coordinate construction projects, focus should be placed on how to best manage the large amount of data being generated by utility operations. Pilot projects with commercial building data and other trial grounds should be started to check for potential impacts of data on policymaking and sustainability goals. Statistical studies could be done to see if there is potential use for utilities getting access to other utilities data. Data owned by the City of Pittsburgh is ideal for this exchange because it is already being collected.

Stage 4: Develop Underground Mapping System

A mechanism for determining where underground infrastructure lines should be determined and implemented. Access to the map should be made available to trusted parties that stand to benefit. The owner of the shared map can be any trusted party with the cybersecurity support necessary to protect sensitive data.

Stage 5: Aggregate Usage Data

As the final step of utility coordination and data sharing, the aggregation of consumption data should be collected by a central data hub upheld by a central organization to improve city decision making capacity. The aggregation level and frequency should be decided by the dedicated task force.

Conclusion

As Pittsburgh continues to modernize and improve the utility infrastructure in the city, opportunities for utility collaboration will continue to present themselves. Focused efforts on construction coordination, underground utility line mapping, and information sharing will vastly improve the operating efficiency of the city; reducing costs to residents, delays, and even carbon emissions. Achieving these three goals will require robust communication networks and coordination through a series of planned pilot projects meant to serve as a proof of concept. Existing efforts to improve operational efficiency should be consolidated. If coordination is achieved, Pittsburgh will take a large step forward in its goal to be a modern, sustainable city.

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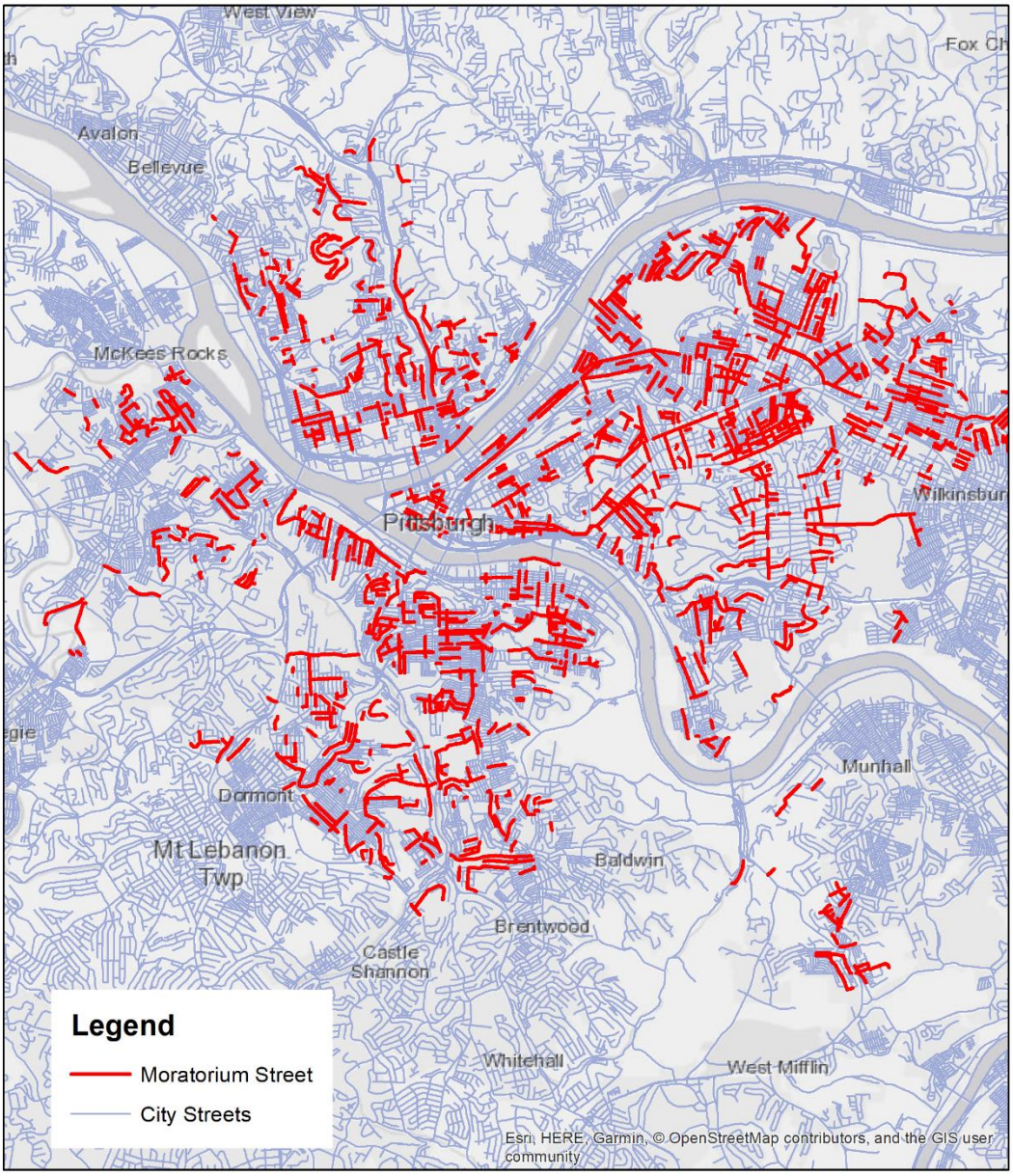
Appendix

Exhibit A.

Moratorium Streets Pittsburgh 2018

Mapped below are all locations characterized as a moratorium street by the City of Pittsburgh. We did not make a distinction between the six year brick and brownstone and the three year concrete or asphalt street policies in this map. Instead, in this map, we followed the concrete and asphalt street policy of three years for all street types.

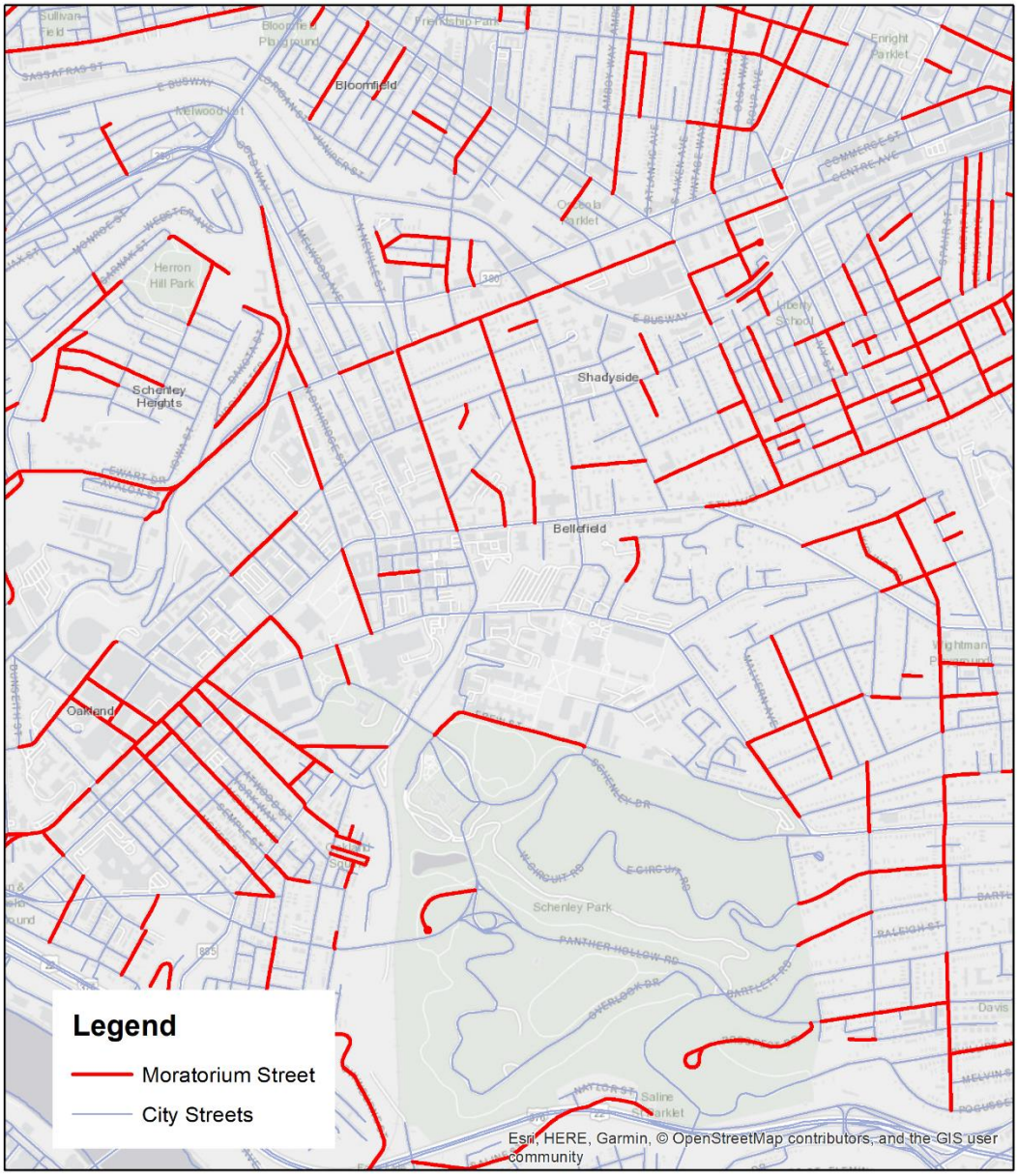


Data Source: Department of Mobility and Infrastructure, The City of Pittsburgh

Exhibit B.

Moratorium Streets Pittsburgh Zoom

Mapped below are all locations characterized as a moratorium street by the City of Pittsburgh. We did not make a distinction between the six year brick and brownstone and the three year concrete or asphalt street policy in this map. Instead, in this map, we followed the concrete and asphalt street policy of three years for all street types.



Data Source: Department of Mobility and Infrastructure, The City of Pittsburgh

811 and City Permitting Process Map: Emergency, Routine, and Design Conditions

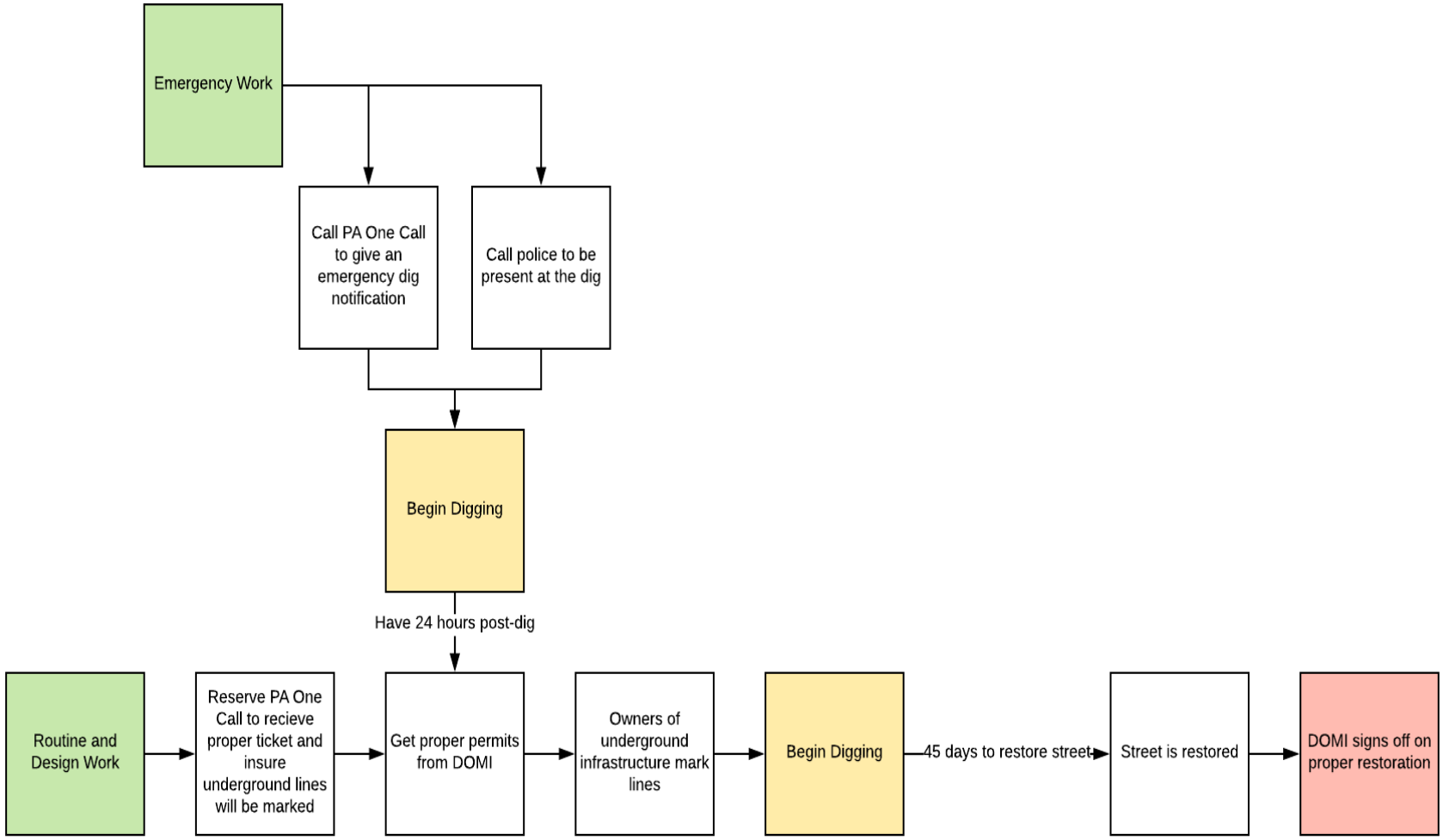
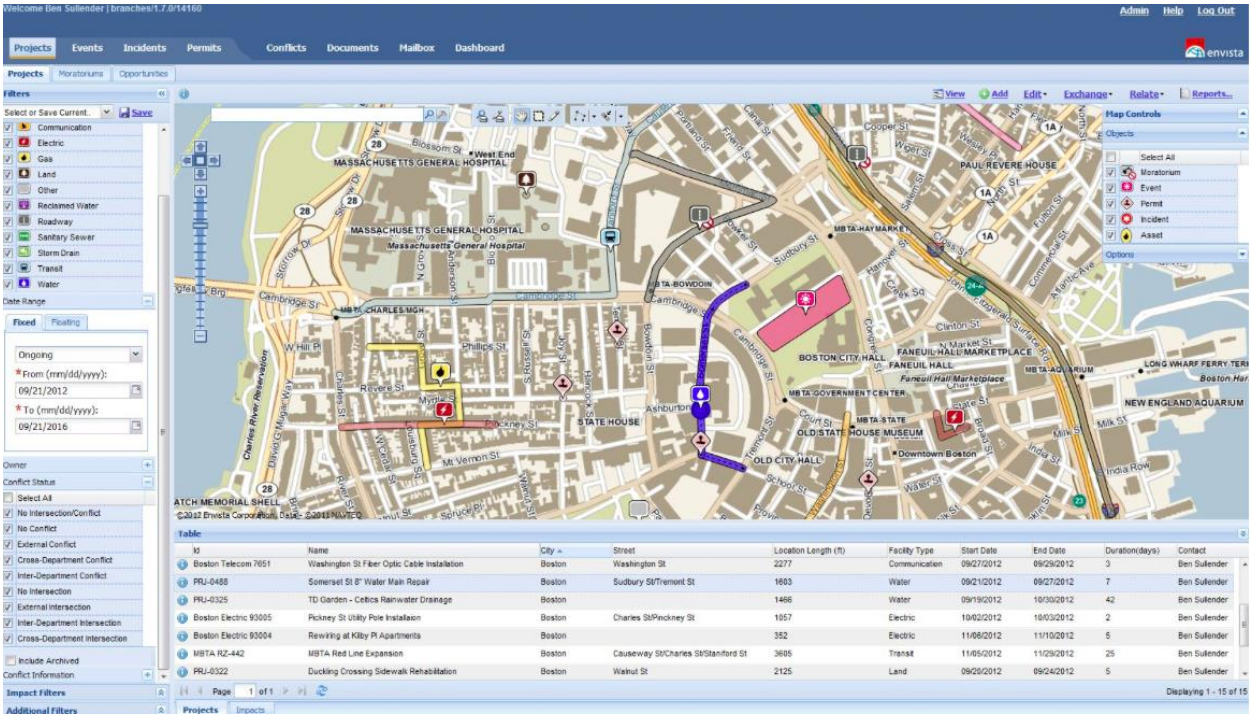


Exhibit C.

Data Source: Department of Mobility and Infrastructure, The City of Pittsburgh

Exhibit D.



Source: Envista [20]