

Fixing Our Pipes

Coordinating Natural Gas Main Replacement between Local Governments & Gas Companies

A study carried out by the Metropolitan Area Planning Council and Home Energy Efficiency Team



Funded by a 2015 Technical Assistance Grant from the Federal Department of Transportation's Pipeline
& Hazardous Materials Safety Administration

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Organization Overview

The Metropolitan Area Planning Council (MAPC) is a regional planning agency serving the people who live and work in the 101 cities and towns of greater Boston, with a mission to promote smart growth and stakeholder collaboration within our region. MAPC works to support sound municipal management, sustainable land use, protection of natural resources, efficient and affordable transportation, a diverse housing stock, public safety, economic development, an informed public, and equity and opportunity among people of all backgrounds. MAPC's Clean Energy Department specifically focuses on helping cities and towns reduce greenhouse gas emissions.

The Home Energy Efficiency Team (HEET) is a nonprofit with the mission to reduce energy bills and energy use through efficiency. Since 2013, HEET has been at the forefront of the natural gas leaks issue, working with Boston University Professor Nathan Phillips and with Robert Ackley of Gas Safety Inc. to map and analyze the natural gas leaks from aging underground pipes in Cambridge and Somerville, Massachusetts. HEET has also used utility-reported data to map gas leaks in over 230 municipalities across Massachusetts. HEET has been educating and collaborating with a variety of cities, state agencies, and nongovernmental groups on the issue.

Acknowledgements

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Participating municipalities to thank:

Acton	Framingham	Natick
Arlington	Gloucester	Newton
Ashland	Hingham	North Reading
Avon	Hopkinton	Norwell
Ayer	Hudson	Peabody
Bedford	Lexington	Quincy
Bellingham	Lincoln	Randolph
Boston	Littleton	Reading
Braintree	Malden	Salem
Bridgewater	Marblehead	Swampscott
Brookline	Marlborough	Tewksbury
Cambridge	Medfield	Walpole
Carlisle	Melrose	Wellesley
Chelsea	Milford	Winchester
Cohasset	Millis	Winthrop
Concord	Milton	Woburn

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Executive Summary

Massachusetts' 2014 An Act relative to natural gas leaks set the state on an accelerated course to replace its thousands of miles of leaking and leak-prone pipe within 20 to 25 years. Accomplishing the replacement, while coordinating to minimize damage to municipal streets, inconvenience of construction, and overall cost to ratepayers, will stretch the abilities of gas companies and local municipalities alike. Even then, the State faces more than a decade with substantial amounts of leak-prone pipe.

In 2015 MAPC, partnering with HEET, secured a Technical Assistance Grant from the U.S. Department of Transportation's Pipeline & Hazardous Materials Safety Administration to identify mechanisms to help gas companies and cities and towns replace pipe more efficiently and possibly accelerate the 20 to 25 year timetable. The grant funded a study of municipality and gas company coordination as well as independent gas leak surveys.

Nearly half of municipalities interviewed in the study expressed low satisfaction with the existing gas company communication and/or coordination; however, the study identified many improvements for both gas companies and municipalities to make. Based on the interviews, the study developed best practice recommendations for coordination, the vast majority of which are already in use by at least one city, town or gas company but that need to be implemented more consistently throughout the state. Additionally, most of the best practices are low- or no- cost and can be implemented in the short term.

Ultimately, the best practices are intended to help municipalities and gas companies identify more shared opportunities to synchronize work. Synchronizing means that the gas company could perform its pipe replacement before the municipality repaves, and when applicable, before the municipality replaces its water or sewer mains. Doing so can avoid the need for the gas company to cut into a newly paved street, which would incur unnecessary costs for paving, damage municipal roads, and likely reduce the useful life of the road.

To achieve synchronization, more municipalities should develop three to five year infrastructure plans across paving, water and sewer and share those with the gas company. For their part, gas companies already have their own plans, but should share multiple years with municipalities. Also, gas companies should improve their communication process with municipalities, to ensure more consistency and quality across their regions. With plans and communication structures in place, gas companies and municipalities should schedule an annual pre-construction season meeting to compare plans, identify opportunities to synchronize projects, and set communication and coordination expectations for the construction season. To improve the ability to compare multi-year plans, municipalities should leverage widely-used GIS technology for mapping, analysis and data management. Finally, synchronization can generate avoided costs for the gas company, and both the gas company and municipality should share those savings in order to fund additional pipe replacement and paving.

The independent gas leak surveys found that the gas companies and municipalities who are already implementing multiple best practices appear to be successfully reducing the number of leaks per mile on new pavement, but there is ample room to improve.

Additionally, the gas leak surveys suggest a practical way to target “super-emitting” leaks - those that emit a disproportionate amount of gas, and whose pipes should be addressed first for the largest and most cost-effective reduction in leaked gas. Specifically, the data indicates that measuring the surface area extent of each leak could be a low-cost and effective way to identify the leaks emitting the largest volume of gas.

The gas leaks surveys also support the need to replace leak-prone pipe rather than chase leak repairs, based on the growth rate seen between the last report from the gas companies and this survey. The gas leaks surveys also support the efficacy of new, plastic pipe installations, finding that they were virtually leak free.

The team concludes that improved coordination can help reduce frustration, construction delays, and lost opportunities for leak-prone pipe replacement while creating synergies, significant cost savings, and better roads.

The team encourages municipalities and gas companies to review the best practices and identify which they currently meet, and which they do not. For municipalities, the team suggests that each municipality catalog their current practices, review them on an annual basis, and identify best practices to add. To assist municipalities, the study includes a checklist of best practices and a calendar of implementation dates.

Additionally, the team recommends that gas companies and municipalities take this opportunity to reassess each element of their coordination process and meet with the other party to comprehensively discuss issues, needs, and how both parties plan to improve. With years of shared experiences, many of them challenging, municipal and gas company relationships may understandably be stressed or frayed. Take this chance to reset the relationship, clarify needs, and set expectations for how to move forward.

I. Introduction

Massachusetts, and the greater Boston region in particular, has some of the oldest natural gas main infrastructure in the nation. Over 30% of this infrastructure consists of leak-prone pipe, the average age of which is over 60 years old, which collectively support tens of thousands of leaks throughout the system. In Massachusetts, gas companies pass the cost of any lost gas on to the ratepayers, and the emissions from the leaks are known to impact personal safety, climate change and vegetation. In 2014, prompted in part by recent research suggesting the amount of lost gas could be much higher than previously estimated, the State of Massachusetts took action, passing An Act relative to natural gas leaks (Ch.149 of the Acts of 2014). The Act required natural gas companies to report annually on the total number of active leaks and the repaired leaks, as well as instituted a program to fund the accelerated replacement of leak-prone pipe.

Gas companies filed plans in response with 20 to 25 year replacement schedules, beginning in 2015.¹ In the first five years, each gas company has a ramp up period, in which it will add more mileage each year through roughly 2020. At that time, the total mileage replaced each year will be about 60% greater than in 2014. While the ramp up is occurring, municipalities will continue to annually repave streets and work to upgrade their own below-ground infrastructure, including sewer and water mains. It takes active synchronization for the gas company to successfully align its schedule with the municipalities' and thereby avoid having to cut through a recently paved street or miss an opportunity for leak-repair and pipe replacement. Each municipality may have different structures and processes for the gas company to work with, adding complexity to the task of synchronizing work.

Even if existing coordination between the gas company and municipalities is working well, the 60% increase in annual mileage poses a challenge for both parties. Additionally, the increase makes the prospect of accelerating the 20 to 25 year timeframe for replacement of leak-prone pipe daunting.

In this context, the Metropolitan Area Planning Council (MAPC) and Home Energy Efficiency Team (HEET) decided to study the state of and potential for improvement to coordination between municipalities and gas companies in the greater Boston region. MAPC secured a 2015 Technical Assistance Grant from the U.S. Department of Transportation's (DOT) Pipeline & Hazardous Materials Safety Administration (PHMSA) to fund the study. In addition to developing best practices for coordination, the grant also funded independent gas leak surveys. Through analysis and dissemination of the results, the team endeavors to:

- Facilitate and expedite the efficient replacement of aging, leak-prone pipeline infrastructure by providing data to support best practices for municipal coordination with utilities to repair leaks; and
- Augment the understanding of the extent of leaks to educate communities and partners more comprehensively on risk mitigation.

¹ Department of Public Utilities Report to Legislature on Prevalence of Gas Leaks report
http://web1.env.state.ma.us/DPU/FileRoomAPI/api/Attachments/Get/?path=15-GLR-01%2fReport_to_Legislature_92415.pdf

Through the study, MAPC and HEET identified existing inconsistency in the coordination practices between gas companies, and sometimes between geographic divisions within a gas company, as well as between municipalities. Additionally, substantial frustration exists among municipalities with existing coordination efforts. Dispersed throughout the study's participants, there were examples of successful strategies for the many steps of the coordination process. From these, the team developed best practices recommendations, most of which are low- or no- cost and can be implemented in the short term. The best practices are separated into four primary categories:

Set Foundation: Successful coordination must be built upon a strong foundation of communication, plan development and information management. Gas companies should improve their staffing and communication strategies both internally and externally. Municipalities should more consistently develop asset management plans; leverage existing data management technologies, such as Geographic Information Systems (GIS); and manage paving contractor schedules.

Share & Strategize: Both gas companies and municipalities should improve on which infrastructure plans are shared, the duration of shared plans, and when those plans are shared. Annually, both parties should meet to discuss schedule alignments and agree on a strategy to maintain communication throughout a complex construction season.

Capture Savings: Setting the foundation for coordination and successfully aligning schedules can generate cost savings, particularly in terms of final paving (i.e. permanent patch) costs for the gas company. Those savings can and should be shared between both parties. For the municipality, savings can incentivize, reward, and help support coordination. For the gas company, savings can free funds to perform additional main replacements.

Find Efficiencies: There are a range of improvements that can minimize frustration and increase efficiency for synchronized and unsynchronized projects alike. These include improved permitting application and payment systems, mark-outs for municipal and gas company infrastructure, and improved information sharing on inspections of pavement patches.

Much of the other infrastructure in New England, from sewer mains to bridges, is aging just like Massachusetts' gas mains. Many of the practices learned through this research can be applied broadly to create integrated infrastructure repair for more than just gas main replacement to reduce disruption and waste of resources, as well as state, municipal and utility costs.

To respect the sensitivity of the municipal-utility relationship, the paper generally omits personally identifying information from critical quotes or stories.

The Need for Coordination

The gas companies own and maintain the gas mains, and in order to access them for leak repair and pipe replacement, they must cut through municipally-owned and maintained streets. Multiple owners necessitates coordination, but so too does the relatively short construction season in New England (typically lasting from April 15 to November 15 when the ground is thawed). Both municipalities and gas companies have only a portion of the year to perform their paving and gas main work, respectively. To accomplish it all requires effective planning to make the most out of a limited window of time.

There are reasons specific to paving that make coordination important, too. Paving is an expensive endeavor for municipalities. To protect their investment, once a municipality paves or repaves a street, most impose up to a five-year moratorium on any street-opening activity, with the exception of repairs for emergencies. As a result, if a gas company misses the opportunity to access a street before paving, it may have to wait years before it can replace leak-prone pipe or address Grade 3 leaks.

Even after a moratorium expires, roads will last longer when the surface is not disturbed. When gas companies excavate roadways for repair, maintenance or adding new customer service lines, they follow procedures from the Department of Public Utilities (DPU) that govern how to backfill excavations, how to restore the pavement, how to inspect the pavement repair (i.e. patch) over time, and how to remediate failed patches.² No matter how well done, these patches create new opportunities for water, ice and other substances to penetrate and damage the pavement over time (See **Figure 1**). As a consequence, pavement meant to last decades may degrade well before then. Since a single mile of street costs on average \$675,000 to repave in Massachusetts (the fourth most expensive state in the country in terms of repaving), this damage can be incredibly costly.³ The damage can also increase municipal frustration, as it is seen as counterproductive to their work to provide the highest quality roads and other infrastructure for their city or town.

Meanwhile, gas companies reported in 2015 that the average cost to replace a mile of leak-prone gas main was just over \$1 million⁴, and between 8% and 15% of that cost may be attributed to final paving patches.

If a gas company can access their infrastructure ahead of a scheduled municipal paving project, then it can install only a temporary patch and avoid the costs of final paving (i.e. a permanent patch) and potential repair. At the same time, the municipality avoids future cuts into its roads, helping to extend the pavement life. These opportunities arise when the municipality plans to repave a road curb-to-curb, which can happen due to the natural life cycle of roads or the municipality's need to replace its water and/or sewer infrastructure. These opportunities can also arise if other utilities, such as electric or cable, need to perform work in the same area as the gas company.

² Docket 98-22: Standards To Be Employed by Public Utility Operators When Restoring any of the Streets, Lanes and Highways in Municipalities, August 26, 1999, by the Massachusetts Department of Telecommunications and Energy (DTE). DTE is now known as the Department of Public Utilities (DPU).

³ The Reason Foundation 2014 report showed the *average* cost of a mile of state controlled road in Massachusetts is \$675,000. <https://reason.org/files/21st-annual-highway-report.pdf>

⁴ Average of reported cost per mile for National Grid, Columbia Gas and Eversource reported in 2015 GSEP Plans as DPU 14-132, 14-134 and 14-135, respectively.



Figure 1. Pavement patch over a stretch of replaced gas main (darker pavement running length of street) and replaced service (darker pavement extending into sidewalk). At least two new seams for water, ice, and dirt to penetrate have been created running almost the entire length of the road.

By effectively identifying such opportunities then synchronizing schedules to have the gas company - and possibly other utilities - address their infrastructure problems before a municipality - or the State - repaves a road, gas leaks can be effectively minimized and scarce rate-payer and tax-payer funds put to efficient use. If the State hopes to accelerate the 20 to 25 year timeframe for replacing all leak-prone pipe, this coordination is even more necessary.

Gas Leaks in Massachusetts

LEAK-PRONE PIPE, LEAK CREATION & REMEDIATION

In Massachusetts, 51% of homes are heated and 64% of electricity is generated by natural gas.⁵ The gas is conveyed through gas pipes called mains, typically running under public streets. These mains have service lines running off of them to individual homes and businesses. The mains in Massachusetts may be made of plastic, steel (cathodically and non-cathodically protected⁶), wrought-iron or cast-iron. Natural gas leaks are most commonly found in cast-iron, wrought-iron or non-cathodically protected steel pipes, known collectively as “leak-prone pipe.”

⁵ <http://www.eia.gov/state/print.cfm?sid=MA>

⁶ Cathodic protection runs a small electrical current through the steel pipe to prevent corrosion.

Leaks often occur at the joints between pipe segments, when old fitting materials wears out. This is particularly common in cast-iron pipes, because the connection between two pipe segments historically was sealed with the use of an organic, plant-based material. Over time, this material dries out and degrades, a process accelerated because modern gas is less humid, letting gas escape. Leaks can also occur along the body of the pipe due to rust and corrosion. The annual freeze-thaw cycle contributes heavily to the creation of new leaks by causing separation at the joints or cracks along the pipe body. The gas companies routinely monitor their gas distribution network for leaks, especially in the winter.⁷

Leak remediation can involve replacing the entire main or just patching and repairing individual leaks and leaving the main intact. In the long term, repairing leaks is viewed as a stop-gap measure; new leaks will continue to form over time as the leak-prone pipe material degrades and the pressure inside the pipe forces its way out. To reduce and ultimately minimize gas leaks, the gas companies need to replace all leak-prone pipe. Currently, the best replacement is plastic pipe that can flex and bend, rather than break, and is not susceptible to rust or corrosion.



Figure 2. Plastic Gas Main Ready for Installation

WHAT RESIDENTS CAN DO

If you smell gas or suspect a leak, immediately notify your local gas company. Each has a gas emergency phone number easily available on their website.

Once notified, the gas company will send out a team to investigate the potential leak within one hour.

- If it is considered hazardous (Grade 1), they will take immediate action to remove the hazard.
- If it is potentially hazardous (Grade 2), they will monitor it and remediate it within a year.
- If it is not currently hazardous and is expected to remain non-hazardous, they will monitor it annually, but there is not fixed timetable for repair.

You can help get leaks repaired and leak-prone pipe replaced faster, by ensuring your town or city has effective procedures in place to coordinate with the gas company. See the Best Practices Recommendations section of this study for more information.

⁷ See each gas company's response to the first set of information requests to DPU 15-GLR-01, Report to the Legislature on the Prevalence of Natural Gas Leaks

Distribution of Leak-Prone Pipe across Gas Companies

Figure 3. Total Miles of Gas Mains by Gas Company

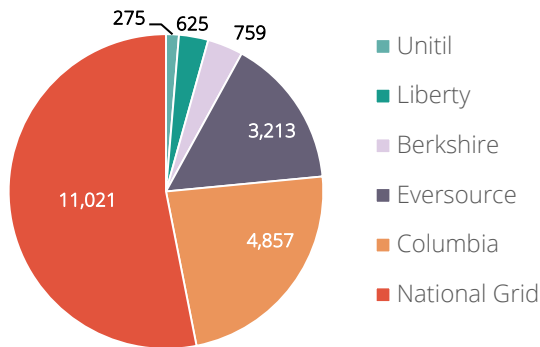
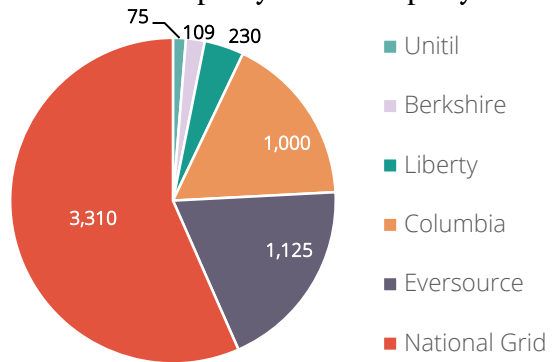
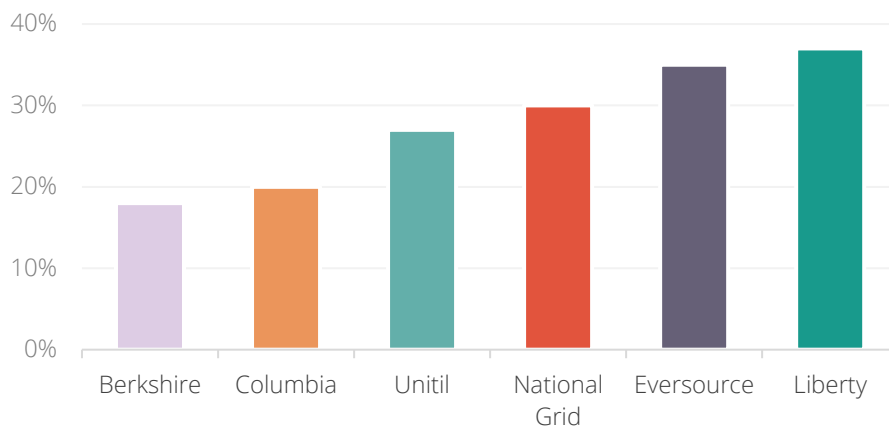


Figure 4. Total Miles of Leak-Prone Pipe by Gas Company



There are currently six major investor-owned gas companies operating across Massachusetts with a total system length of 20,750 miles of pipe.⁸ As of the end of 2014, 5,849 miles or 28% of that pipe was considered leak-prone, with a total of 20,773 active leaks as reported by the gas companies. As shown in **Figure 3** and **Figure 4**, roughly half of the leak-prone pipe is in National Grid territory, which also has over half the total miles of gas mains. **Figure 5** shows that the percentage of leak prone pipe ranges between 18% and 36% across gas companies.

Figure 5. Percent Leak-Prone out of Total Gas Mains by Gas Company



RECENT LEGISLATION

The 2014 legislation, An Act relative to natural gas leaks, represented a major step forward for Massachusetts to curb emissions from gas leaks. The legislation:

⁸ Berkshire Gas, Columbia Gas (AKA Bay State Gas), Eversource (AKA NStar), Liberty Utilities, National Grid (made up of Boston Gas and Colonial Gas) and Unitil. Blackstone Gas did not report enough data for the team to include in these numbers. Data from the 2015 Department of Public Utilities' Report on the Prevalence of Natural Gas Leaks in the Natural Gas System, DPU 15-GLR-01

- Required a uniform system to classify natural gas leaks
- Established the first source of publicly available data on gas leaks by requiring gas companies to report annually the location, Grade, date of classification and status (repaired or active) of every known leak on their distribution system.
- Required the DPU to establish a program to fund the accelerated replacement of leak-prone pipe. Each gas company may file an annual Gas System Enhancement Plan (GSEP) outlining how it will accelerate leak-prone pipe replacement and identify the segments that it will replace the following year and the ensuing four years.

The legislation provided initial guidance on how to classify gas leaks, shown in **Table 1**. Each classification is based on a leaks’ potential for explosion and risk to persons and property. In 2016, the DPU opened an investigation to establish additional guidelines to ensure uniform leak classification.

Table 1. Leak Classification		
Grade	Definition	Action
Grade 1	Leak poses an existing or probable hazard	Hazard must be addressed immediately
Grade 2	Leak is non-hazardous at time of detection but is a probable future hazard	Hazard must be addressed within 12 months and re-evaluated at least every 6 months.
Grade 3	Non-hazardous at time of detection and likely to remain non-hazardous	Must be re-evaluated every 12 months or during the next leak survey, whichever comes first

The GSEP plans will replace all leak-prone pipe within 20 to 25 years, depending on gas company. Prior the legislation’s passage, gas companies statewide replaced nearly 200 miles of leak-prone mains annually. This figure will increase to over 300 miles annually over the next few years. National Grid for instance will be ramping up from over 120 miles per year to over 175 miles per year. This ramp up poses a challenge for the gas company resources and crews, as well as municipalities. Of the municipalities included in this project, on average over 3% of municipally-owned road miles will be affected between 2016 and 2020 as part of the GSEPs.

Compared to the first year of publicly reported data in 2014, by the end of 2015 1% of leak-prone pipes had been replaced and leaks have been reduced by 19% as reported by the gas companies in their Annual Service Quality Reports and in the GSEP reports.

In August 2016, the state passed An Act to promote energy diversity (Ch. 188 of the Acts of 2016), which requires the DPU and the Department of Environmental Protection to develop a method to evaluate the environmental impact of leaks, and to develop a plan for repairing leaks that are determined to be causing significant environmental damage. As of this study’s completion, no regulations have been drafted.

THE PROBLEMS WITH GAS LEAKS

In 2015 the DPU Report on the Prevalence of Natural Gas Leaks in the Natural Gas System estimated/reported that 1.68 billion cubic feet of lost and unaccounted (LAUF) gas. This represents 0.4% of all the gas delivered in the calendar year. Only a portion of LAUF is due to leakage - damage, theft, purging and meter inaccuracy play a role. Of the leaked gas, only some of it escape the ground to the atmosphere in the form of methane emissions.

In addition to the risk of explosion, gas leaks:

- Suffocate trees and other plants by forcing oxygen of the soil, suffocating the roots. Leak surveyors often look for dead or dying trees or other vegetation as a sign of a potential leak.
- Increases ground-level ozone. Ozone is associated with asthma and other respiratory diseases.
- Contributes to global climate change. Natural gas is primarily made of methane, one of the most powerful heat-trapping greenhouse gases. Methane traps 100 times as much heat as carbon dioxide over a five year period. That amount of LAUF could represent up to 40,470 metric ton of methane emissions. If it all escaped to the atmosphere, it would amount to roughly 1.3% of the entire State of Massachusetts greenhouse gas emissions in calendar year 2011.
- Create a financial burden for ratepayers, because the cost of the lost gas is included in the price we pay per therm. A 2015 calculated the total cost of lost gas to be \$90 million per year in the Greater Boston area.

Municipality & Gas Company Infrastructure

Gas mains are only one layer of infrastructure running underneath a municipal street, which typically includes drinking water, storm water and sewer mains, along with electric and data cabling. All of this infrastructure is covered by the street paving.

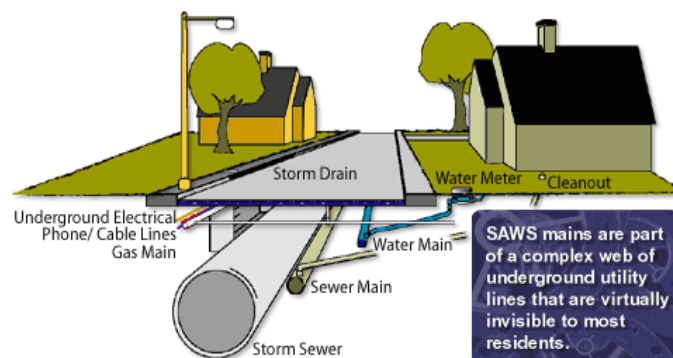


Figure 6. Example of Infrastructure Layers Under a Street⁹

⁹ San Antonio Water System at <http://www.saws.org/infrastructure/Overview/>

INFRASTRUCTURE RESPONSIBILITIES

The municipality has responsibility for road paving, water mains, and in some cases, sewer lines. All of these typically fall under the jurisdiction of Department of Public Works (DPW), which often includes the Highway, Water and Sewer departments; however, in some cases the Water and Sewer departments are separated from DPW. The city or town engineer is often the primary contact with the gas company for coordination.

The gas companies have responsibility for leak detection and repair, replacement of leak-prone pipe, and installation of new mains and services. Each of these three responsibilities tend to be housed in different departments of the gas company. Additionally, there are departments for engineering, which may cover activities across the three departments.

For gas leak repair and main replacement, most gas company communications with the municipality go through the DPW department. The gas company also communicates with Fire and Police Chiefs to notify them of Grade 1 (i.e. emergency) leaks.

DETERMINING INFRASTRUCTURE PLANS

Municipal Plans

Municipal paving plans are relatively malleable. For paving, the DPW determines paving priorities based on condition of the road, as well as considering the need for other infrastructure projects, like water or sewer repairs or gas main work. Road conditions can be assessed periodically using visual or quantitative approaches.

Paving plans often cover multiple years and can be informal lists of streets with priority rankings, or more formal plans with streets segmented by year of paving. After the end of the construction season, typically in mid-November but the season can be extended if weather cooperates, the municipality refines its priorities for paving the next year. The priorities are based on any existing plan, outstanding paving from that season, assumed budget and assumed cost of paving.

Paving costs are determined through a municipal procurement process in late winter or early spring. Most paving projects are funded through Chapter 90 by the Massachusetts Department of Transportation (MassDOT).¹⁰ These funding awards are not announced or available until the new fiscal year (July 1), which occurs well after the construction season has already begun. As a result, paving projects done in the first few months of the construction season tend to be done with leftover Chapter 90 money or, in some cases, the municipality's capital fund. Local politics, as well as input by the gas company or other utilities ahead of the construction season can also impact the paving plan. In addition to the long list of desired paving projects and limited funding sources, potential delays from contractors during the season mean that not all planned paving projects will necessarily get completed during that year.

¹⁰<http://www.massdot.state.ma.us/highway/DoingBusinessWithUs/LocalAidPrograms/Chapter90Program.aspx>

Municipalities may also have management plans for upgrading their drinking water, storm water, and sewer distribution systems.

Gas Company Plans

For the gas companies, leak detection occurs year round.¹¹ By law, any Grade 1 (i.e. emergency leak) must be addressed immediately. Repairs to non-emergency leaks and the replacement of gas main will occur during the construction season whenever possible. For gas main replacement, the gas companies follow federal guidelines to assess the priority of each segment of main, based on condition, safety risk factors, and more. The gas company schedules the highest priority mains for replacement first. It can adjust the schedule to synchronize with known municipal paving plans; however, due to safety concerns, the gas companies reported they will not delay higher risk mains simply to accommodate paving on lower risk mains.

The gas companies tend to have a five year planning horizon for gas main repair, and they must file an annual GSEP outlining their strategy and budget for the next three years.

EXECUTING GAS COMPANY AND MUNICIPAL INFRASTRUCTURE PROJECTS

Approvals

Prior to excavation for gas leak repair and main replacement, the gas company must secure an excavation and/or street opening permit from the municipality. In the case of Grade 1 (i.e. emergency) gas leaks, due to the urgency of the problem, the gas company often applies for a street opening permit after it has addressed the leak. By law, the gas company - and any excavator - must notify Dig Safe before excavation¹². Dig Safe is a non-profit that notifies all utilities in the area, and each has 72 hours to mark-out on the pavement the location of its infrastructure. Municipal permit applications typically require a Dig Safe number to ensure the notification has been made.

Municipalities are only allowed to charge the gas company for the administrative cost of processing the permit.¹³ The administrative cost includes receiving the permit application, receiving and depositing the gas company's check, logging the permit and issuing it. Issuing the permit may involve administrative time to assess whether it conflicts with other planned projects or is a candidate for schedule synchronization. The administrative cost may include effort spent ensuring that the gas company plan does not interfere with existing municipal infrastructure and is not on a road with a moratorium. Inspection of re-paved areas (i.e. patches), per DPU order D.T.E. 98-22, is the responsibility of the gas company.

Once a permit has been secured, the gas company may also need to secure a police detail to guide traffic and protect construction crews during leak repair and main replacement.

¹¹ Responses of gas companies to the First Set of Information requests in DPU 15-GLR-01: Report to the Legislature on the Prevalence of Natural Gas Leaks

¹² http://www.digsafe.com/laws_rules.php

¹³ [Boston Gas Company v. City of Newton](#), 425 Mass. 697 (1997) and [Boston Edison Company v. Town of Bedford](#), 444 Mass. 775 (2005)

Leak Repair & Main Replacement

For a gas company to repair a leak, it must drill test holes within the leak extent to attempt to pinpoint the source or sources of the leak. It may also do research into existing records that provide insight into the location and substance of the leak. It will excavate pipe to find the leak, at which point repair efforts can begin. The process to find, excavate and repair a single leak can take 4 to 6 hours. Replacing an entire section of gas main may take weeks or a month, depending on the length of the segment.

Paving & Patching

The opening made by a gas company, called a trench, is generally rectangular and has a width narrower than a single lane on a street. After completing work, the restoration of the trench and pavement must be accomplished according to standards from the Department of Public Utilities (DPU) order D.T.E. 98-22. **Figure 7** shows the typical layers that comprise a street and that must be replaced:

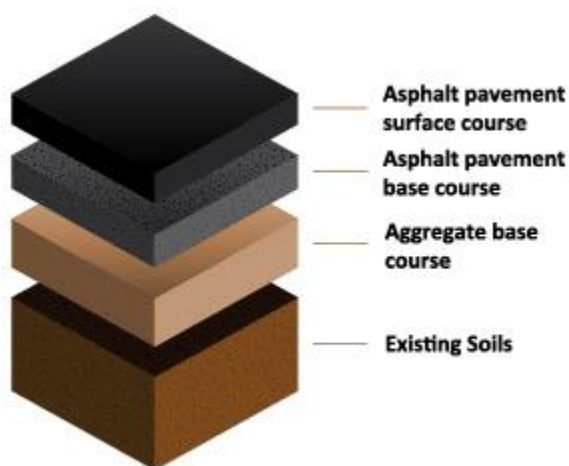


Figure 7. Typical Layers of a Street.¹⁴

The gas mains lie under the aggregate base course, in the existing soil. When restoring the trench, in some circumstances, the gas company may install a temporary pavement patch, which using lower grade pavement. A temporary patch must be replaced with a permanent patch with 2-5 days depending on the season. If the existing pavement is new (defined as less than five years old), then the municipality has freedom to define the patching technique; this could range from complete curb-to-curb repaving or simply following the same patching procedures as required for old pavement.

The gas company must inspect permanent patches to ensure they continues to meet statewide standards at least twice: between 30 and 60 days and after one year.¹⁵ If it does not meet the standards, then the gas company will grind away the surface coat of pavement on and around the

¹⁴ Source: My Asphalt Paving Project <http://www.myasphaltpavingproject.com/design/pavement-design/>

¹⁵ Docket 98-22: Standards To Be Employed by Public Utility Operators When Restoring any of the Streets, Lanes and Highways in Municipalities, August 26, 1999, by Massachusetts Department of Telecommunications and Energy (DTE)

trench and repair with additional pavement that blends, as well as possible, into the surrounding pavement.

CASE STUDY: CITY OF MELROSE, SERVED BY NATIONAL GRID GAS

Melrose is a city of 28,000 with a median income 20% above the state average, with a large portion of its gas mains made up of cast-iron and other leak-prone materials. As a result, the percent of miles of its street having gas main replaced per year is almost double the average of the other 25 municipalities interviewed for the project, (according to the annual Gas System Enhancement Plans). To coordinate such a high level of work and minimize the impact on the City, Melrose has developed a successful coordination program that relies on frequent communication and leveraging data shared by the gas company.

Prior to the construction season, the City ensures that its staff learns all the names and contact numbers of the gas company's key representatives: managers of leak repairs, new services and all contract work. During the construction season, the Town Engineer typically calls the gas company at least twice a week to confirm he knows what is happening, see if there are any updates, can identify any changes in the work that is planned, and communicate any changes from the City.

As part of its infrastructure planning process, Melrose has arranged with National Grid to have access to a map of which City streets have gas infrastructure, and the map is available in Geographic Information Systems (GIS) format. Although the map does not show the type of pipe material, it is still helpful for City planning purposes. For example, when the City has a planned water main project and the map shows that gas main exists, the City notifies National Grid and strongly requests that the company replace any leak-prone pipe before the project starts. This benefits National Grid, because if any leak-prone pipe is encroached on by the project, the gas company is required to remove it¹⁶. Rather than having to react last-minute when the City encroaches, National Grid can plan ahead and replace the pipe as efficiently as possible. It also benefits the City, because it avoids potential interruptions and delays to their projects.

City also notifies the gas company when it plans to repave a street. Ahead of repaving, the City looks at the GIS map showing existence of gas mains and requests that National Grid replace any mains or services they consider leak-prone. The City also looks at available data on gas leak history for areas where it may put special emphasis on the gas company fixing leaks or replacing pipe prior to paving. This notification process helps minimize the need for the gas company to later cut into newly paved streets.

Finally, when Melrose plans to do its own infrastructure work, the City requests detailed drawings on the location of gas main infrastructure so that it can develop its plans to reduce conflicts with gas mains, services, and other elements of the distribution system.

National Grid and the City work together to reduce cuts into new streets another way: the gas company sends a notice to the residents before paving explaining that if they want new gas service, they should request it now before the street is repaved. The City makes sure that the new-services

¹⁶ Per 200 CMR 113.00 all cast-iron pipe that gets encroached upon by another excavation inches needs to be replaced since without the support of the soil, these old pipes are more likely to leak or fail.

manager's phone number is on the notice so new potential customers can call the manager directly.

The City has built up this successful practice by generating new ideas to improve collaboration, then proposing it to the gas company to find out how to make it work. This is summed up through the advice of the City's Town Engineer, "Don't be shy. All they can do is say no."

2. Methods

The team chose to focus municipal recruitment to achieve a similar mix of median-income levels, community types, and gas companies as are found within the entire 101 municipalities of the MAPC region. For gas companies, the team included National Grid, Eversource and Columbia Gas of Massachusetts, omitting Wakefield Gas & Electric and Blackstone Gas as each covered only one eligible municipality in the region or less than 1% of the total municipalities.

Municipal recruitment occurred from late December 2015 through May 2016. The team recruited 26 municipalities and each participated in an interview about their roadwork planning and coordination practices and other experiences with their gas company.¹⁷ The team then selected 15 municipalities in which to conduct a gas leak survey of 10 to 15 miles of roadway with natural gas infrastructure, again proportionally representing the characteristics of the MAPC region. In late September 2016, MAPC held workshops to present preliminary findings, collect feedback and hear additional perspectives. **Figure 8** illustrates all of the participants in the study and workshops. Full details on recruitment are available in **Exhibit 1**.

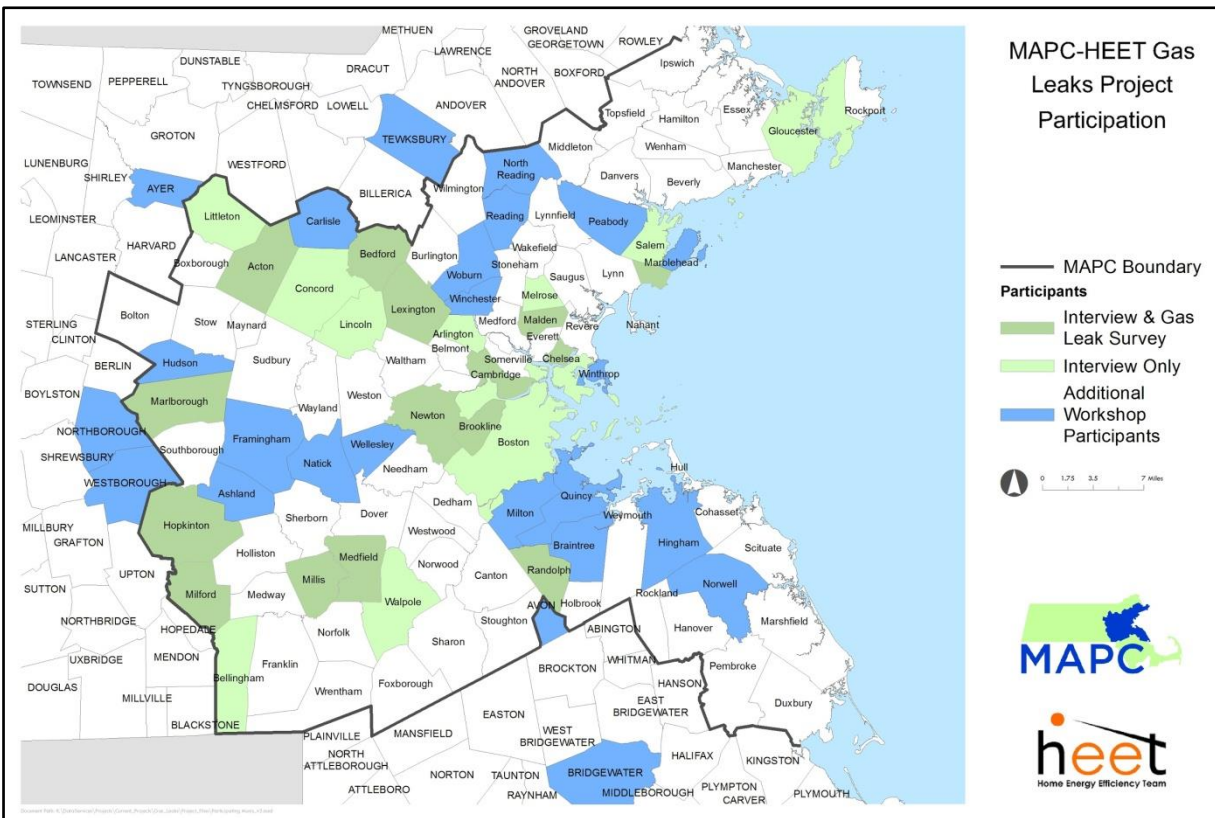


Figure 8. MAPC-HEET Project Participation

¹⁷ The Town of Cohasset also provided an interview, but due to timing it could not be included in these findings.

MUNICIPAL & GAS COMPANY INTERVIEWS

Either MAPC or HEET led each municipal interview, which typically took place with the director of the Department of Public Works (DPW) and/or the city or town engineer. Occasionally representatives from the Police and Fire Departments or an Energy Manager joined as well. The interviews used a standard set of questions to guide the conversations, covering the municipality's practices for road work planning, roadwork execution, coordination with the gas company, experiences and overall satisfaction with the gas company (See **Exhibit 2** for list of questions). Interviews lasted roughly one hour, and the team took written notes. The team later tabulated the data for analysis.

MAPC led the gas company interviews, conducted in June 2016, after the municipal interviews had concluded. Follow-up discussions in person and over email were had with each gas company.

The team notes that more municipal staff were interviewed than gas company staff, and these municipal interviews took place earlier in the process. The team had an opportunity to raise many of the municipal issues with the gas companies, but not vice versa. This does influence the team's data collection. Certainly many additional questions and follow up research could be beneficial.

GAS LEAK SURVEYS

In each municipality, 10 to 15 miles of road with gas infrastructure were surveyed for gas leaks. Road segments were selected in order to cover a mix of leak-prone and plastic pipe, as well as roadways with various ages of pavement. The gas leak surveys began in late April 2016, after the ground had sufficiently thawed, in order to allow methane to escape to the surface where it can be detected. The gas leak surveys continued through mid-June 2016.

Gas Provider	Median Miles Per Municipality	Miles Surveyed	Municipalities
Columbia Gas	8.88	26.49	3
Eversource	12.85	50.82	4
National Grid	11.5	95.25	8
Total		172.56	15

Median mileage for Columbia Gas is less than 10 miles. MAPC surveyed about 10 miles in each town. Data shared by Columbia Gas later indicated some sections of surveyed road did not have gas infrastructure.

For each municipality, the study's contractor drove the selected road segments while running a Picarro high-precision natural-gas analyzer to capture levels of methane (parts per million) in the air and the corresponding Geographic Positioning System (GPS) coordinates.¹⁸ The resulting data was analyzed to identify potential leak locations, based on locations that had an elevated methane level compared to background levels. The contractor then returned to each of those elevated methane areas to perform an on-the-ground investigation to determine whether the source of the methane was attributable to a

¹⁸ Contractor Robert Ackley of Gas Safety USA performed the gas leak surveys. Mr. Ackley was Operator Qualified by the Northeast Gas Association at the time of the surveys and has an extensive background surveying for gas leaks in Massachusetts (See **Technical Appendix** for details)

gas leak or not. This investigation used a Combustible Gas Indicator (CGI) to take readings of the percent of methane in the air *below ground* (i.e. subsurface). If methane was found in the air below ground, the contractor considered it a leak. The contractor took multiple subsurface readings in order to determine the extent of soil impacted by the leak. The contractor assigned each leak a Grade (1, 2 or 3), using the reported classification criteria of the appropriate gas company. **Figure 9** shows an example of the leak report drafted by the contractor, showing leak extent.

It is important to note that neither this study nor the gas companies can know whether the methane readings in the air below ground are caused by one individual leak or many, until the pipe is excavated and examined. The study counted as a single leak any contiguous area of methane readings in air below ground, including readings on opposite sides of the street, as shown in **Figure 9**.

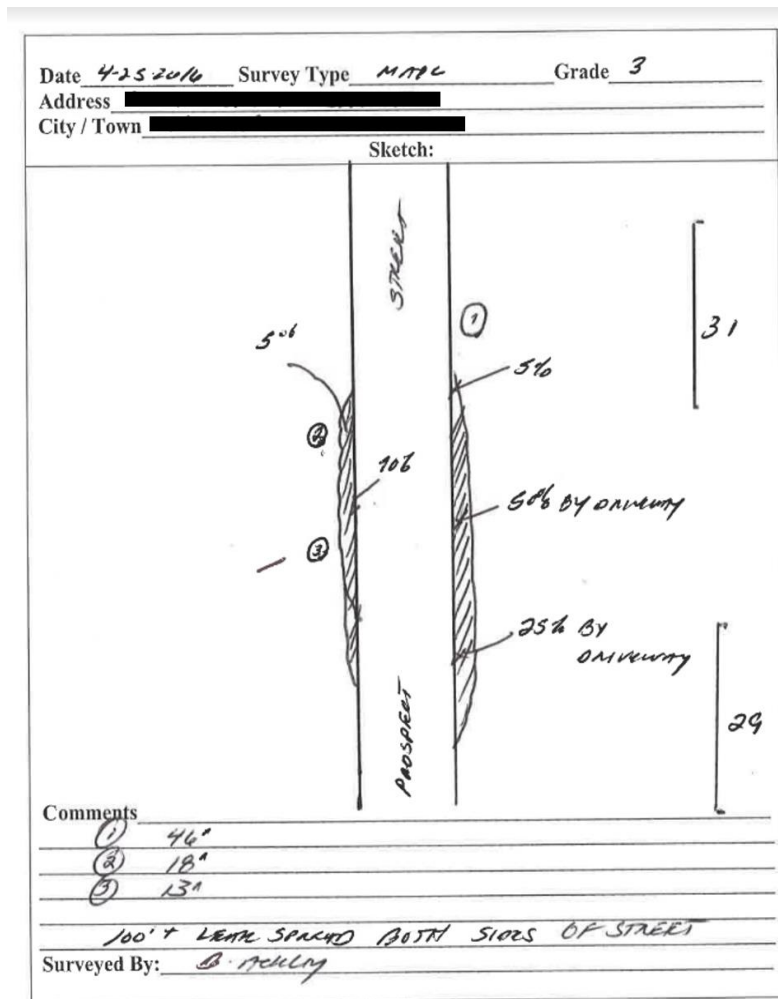


Figure 9. Sample Leak Report Leak report showing extent of the leak (shaded region), multiple measurements of the percent of methane in air below ground, and location of trees near the leak (circled numbers) and their diameter-at-breast-height.

The leak detection and classification procedures used in this study were developed using published gas company procedures and, as a result, are largely the same as those used by gas company.¹⁹ Both processes rely on a mobile survey that captures the presence of methane in the air, and when elevated readings are discovered, there is an on-the-ground investigation to identify if there is methane below ground (i.e. subsurface). Subsurface methane is considered a leak. The primary difference between the study's process and that of the gas companies is that the study used a Picarro analyzer for the mobile survey, whereas the gas companies typically use a Flame Ionization Unit (FIU). The Picarro measures the level of surface methane in parts per million (ppm) and logs each reading along with its GPS coordinates in a data file. In contrast, the FIU also samples the air but is an analog device that does not log data and must be monitored while the vehicle is moving. See the **Technical Appendix** for further details on leak detection.

¹⁹ As described in each gas company's response to the first set of information requests to DPU 15-GLR-01, Report to the Legislature on the Prevalence of Natural Gas Leaks

CASE STUDY: CITY OF CAMBRIDGE, SERVED BY EVERSOURCE GAS

Cambridge has a population of over 100,000 with the median household income slightly over the state average, and a large commercial tax base. The City is currently performing a city-wide sewer separation project while also dealing with the impact of adding significant new development. At the same time, the gas utility, Eversource, is working to replace its aging and leak-prone gas mains.

In an attempt to efficiently deal with the increasing amount of construction and to avoid one or more utilities needing to excavate a recently paved street, the DPW instituted a mandatory Monday morning meeting during the construction season for all utilities, the major universities and large developers. Any organization that does not send a senior representative to attend the meeting does not get a Cambridge building permit that week.

At the meetings, presentations are made about each group's upcoming developments and work, followed by breakout groups working on specific projects. The meetings provide an opportunity to share plans and discuss potential to sequence projects that need to occur in the same area. Sequencing helps maximize the chance that curb-to-curb paving will not need to be cut into an excavated at a later date.

Cambridge is able to use the meetings to coordinate schedules during the upcoming construction season, as well as in future years. That's because the City has a Five Year Street & Sidewalk Reconstruction Plan.^[1] While five years might seem too long to plan given the many changes that could occur, the City is careful to note that, "DPW will review the Plan on an annual basis. The uncertainties are significant and thus the annual revisions may also need to be significant."

The City also produces a map of the streets which are under a street-cut moratorium, so that utilities clearly understand which segments are off-limits, except for emergencies.

The Monday meetings started off in the DPW conference room but as the amount of development in Cambridge and the buy-in to the meetings increased, the meetings were moved to the community room in the main library where they were open to the public.

"Just sending [lists or maps] to one another wouldn't allow for the discussions that are needed," said Owen O'Riorden, Cambridge DPW Commissioner.

When surveyed for as leaks through this project, no gas leaks were discovered under newly paved roads. This indicates the success the City is having synchronizing its paving projects with the gas company, so that it allows time for the gas company to fix leaks and replace leak-prone pipe, before paving occurs.

^[1]<https://www.cambridgema.gov/theworks/ourservices/engineering/aboutengineering/fiveyearplandescription>

3. Multi-Community Gas Leak Surveys

The following sections discuss the results of the gas leak surveys carried out for the purpose of this study on municipal and utility coordination. The surveys examined the frequency of leaks across a socioeconomically and geographically diverse range of municipalities in Massachusetts. Although there has been public research into the frequency of gas leaks in a variety of large cities such as Boston, Washington DC and others, there has been no research study that has looked at gas leak frequency and impacts across this wide a range of income levels and population densities.²⁰ The report highlights the primary findings of the surveys and the connections that can be made to the coordination best practices identified later in this report. For more detail on methodology and in depth results from the gas leak surveys carried out, see the **Technical Appendix**.

Understanding Gas Leak Dynamics

GAS LEAKS SURVEYED

The survey results provide insight into whether or not an identified leak is below ground (i.e. not above ground from a different source or located at a meter). The surveys identified 513 gas leaks with less than 1% of the leaks (5) occurring above ground. These five were near a home or business' external gas meter. The remaining 508 leaks were determined to be emanating from below ground. The study findings cannot address whether the leaks occur on the main itself, the service, or the joint between the two. However, the finding that most leaks occur below ground confirms the necessity of directing leak reduction efforts towards leak-prone pipe removal.

The distribution of leak Grades within the survey results roughly corresponds to the distribution reported by the gas companies throughout their territories, with Grade 3 leaks being the most commonly occurring leak classification (see **Table 3**). The discrepancy between the survey and the gas companies' reported distributions for Grade 1 leaks is likely the result of the requirement for the gas companies to immediately address all Grade 1 leaks upon classification. When compared to the Grade distribution for all unrepaired leaks (as of December 31, 2015), it is clear that the gas companies make significant progress throughout the year addressing all gas leaks that pose an immediate danger (i.e. Grade 1).

Table 3. Distribution of Leaks

	Grade		
	1	2	3
Survey (n=513)	5%	18%	76%
Gas companies: reported leaks in 2015* (n=29,185)	26%	20%	54%
Gas companies: reported unrepaired leaks remaining at end of 2015* (n=15,785)	>0%	4%	96%

*All leaks reported by National Grid, Columbia Gas, and Eversource as of December 31, 2015

²⁰ Environmental Defense Fund has surveyed 10 municipalities as of this writing, but most of these are larger municipalities such as Los Angeles or Syracuse NY.

GROWTH OF LEAKS OVER TIME

The study afforded the opportunity to assess the growth rate of gas leaks over time. The most recent gas company data was reported as of December 31, 2015, in each gas company's Annual Service Quality Report for 2015. The study's surveys occurred between April 15 and June 15, 2016. In the intervening time between January and June, the winter freeze thaw cycle as well as general pipe and joint degradation is expected to lead to new many new leaks. At the same time, the gas company is expected to be repairing leaks.

As of December 31, 2015 there were 291 leaks in the survey area and by the middle of June, the study had found 513 leaks in the survey area. The study used spatial analysis to compare the December leak locations to the June leak locations. December leaks that had no matching leak in June may have been missed by the study or may have been fixed by the gas company; the study found 152 instances of this. June leaks that had no matching December leak may have been missed by the gas company or may have been created during that time; the study found 358 instances of this.

With a potential reduction of 152 leaks and a potential increase in 358 new leaks, the data suggest a net increase of 206 leaks over the 291 existing in December, or a 70.8% increase.

These findings highlight the fact that gas leaks in Massachusetts are dynamic and increase dramatically throughout a single season. They must be battled with constant efforts at remediation, which gas companies do throughout the entire year. Simply repairing gas leaks appears to address safety concerns well, but does not stem the flow of new leaks. As a result, the findings underpin the need to replace leak prone pipe if the State desires to reduce gas leaks long term.

For a discussion of how this data fits into the context of other published gas company data, as well as more detail on methodology, see the **Technical Appendix**.

LEAKS ON PLASTIC PIPE

Of the 172 miles of gas main surveyed, roughly 16% consisted of plastic pipe, which is used to replace leak-prone pipe. The rate of leaks per mile on plastic pipe was dramatically lower than non-plastic pipe, as shown in **Table 4**.

Table 4. Leaks per Mile on Non-Plastic and Plastic Pipe			
Pipe Type	Miles	Leaks	Leaks per Mile
Non-Plastic Pipe	144.24	470	3.26
Plastic Pipe	27.42	9	0.33
Total	171.66	479	2.79

Two scenarios prevented attributing some leaks to either type of pipe. 21 leaks occurred at the intersection of plastic and non-plastic pipe. Another 8 leaks occurred on street segments with both plastic and non-plastic pipe running parallel (0.89 miles total).

The findings confirm the usefulness of replacing leak-prone pipe with plastic pipe in order to reduce gas leaks long term.

ASSESSING GAS LEAK IMPACT

Super-Emitting Leaks

The study estimated the surface area of soil that contained gas, called the leak extent. Of the 508 subsurface gas leaks identified, only about 8% accounted for about half of the total leak extent area (47%), see **Table 5**. On-going research at Boston University indicates that the volume of gas emitted per leak in the Boston area is skewed, with 7% of leaks emitting roughly 50% of the gas.²¹ These leaks are often referred to as “super-emitting” leaks or “super-emitters”. This similarity between Boston University study and this study suggests a potential correlation between leak extent and volume of lost gas.

Leak Size	Quantity	Extent Area (sq ft)
Oversized (>1,000 sq ft)	40	92,100
All	508	196,987

While the median leak extent is 100 square feet, these over-sized leaks are all greater than 1,000 square feet, and have a median of 2,000 square feet. This means that the extent of the over-sized leaks are at least an order of magnitude (i.e. 10 times) larger than the extent of the median leak.

The study also took a closer look at the characteristics of the over-sized leaks. Of those, roughly two-thirds (62.5%) are classified as Grade 3. Those Grade 3 leaks comprise over two-thirds (68.8%) of the total extent area of the 40 over-sized leaks (See **Table 6**) and roughly one-third (32.2%) of the total extent area for all 508 leaks.

Grade	Quantity	Extent of Oversize Leaks (sq ft)
1	5	10,000
2	10	18,700
3	25	63,400
Total	40	92,100

The small number of Grade 3 leaks (25) responsible for a large portion of the leak extent area illustrates how targeting those over-sized leaks for gas main replacement or leak repair could provide significant reduction in volume of leaked gas. Up to this point the gas companies have prioritized repair of Grade 1 and 2 leaks. However, the energy legislation enacted in July 2016 requires DPU and the Department of Environmental Protection to establish criteria to identify the environmental impact of Grade 3 gas leaks and to set deadlines for their repair. In order to quickly and cost-effectively address the super-emitting leaks, the gas companies must have a method to relatively quickly assess the potential volume of a gas leak. Past gas leak studies that have focused on the environmental impact of gas leaks have relied on measuring the exact volume of leakage, which can be a cumbersome task and is not feasible to perform at scale across each gas company.

²¹ Margaret F. Hendrick et al. Fugitive methane emissions from leak-prone natural gas distribution infrastructure in urban environments, *Environmental Pollution* (2016). DOI: 10.1016/j.envpol.2016.01.094

The leak extent analysis carried out on the gas leak survey data is the first to study the size of the leak extents, instead of volume, within diverse range of cities and towns in Massachusetts. The methods used in this study could aid the gas companies because area estimates can be made relatively quickly, and could be based on existing gas company data for pipe size and pressure, to obtain a rough estimate for total leakage.

Gas Leaks & Tree Exposure

The leak extent analysis was also used to further understand the breadth of impact that gas leaks may have on trees located in close or nearby proximity to a gas leak. The study found that 130 trees were exposed (i.e. within a leak extent) across 102 separate leaks, representing 20% of all leak (See **Table 7**). A tree was classified as “exposed” if the tree’s drip line, the area defined by the outermost circumference of a tree canopy where water drips from the branches and onto the ground, intersected with the leak extent.

	Leak Extents
With a Tree	102
No Tree	406
Total	508

The majority (80.4%) of trees were located in non-super emitting leak extents.

It is encouraging that a minority of the leak extents contain trees. Nevertheless, it is not necessarily rare, which suggests that municipalities should be careful to check for the existence of leaking gas before planting new trees, especially if replacing a dead tree, which could have been killed by gas. This supports the need for information sharing, about the location of known gas leaks and leak-prone pipe, so that municipalities know when they may be planting in relatively higher-risk areas for a gas leak. Additionally, it supports the need for improved coordination between the gas company and municipality, so that the gas company could potentially survey for leaks ahead of necessary plantings.

Evidence of Successful Municipal-Utility Coordination

NEW PAVEMENT COMPARISON

The survey covered street segments with new pavement, defined as any pavement placed in the last three years (2015, 2014 and 2013), as well as older pavement. 15% of the 172 miles of surveyed road had new pavement.

Paving provides a great opportunity for the gas company to survey for and access leaks. If done before paving, the gas company can make repairs or even replace leak-prone pipe and avoid or sharply minimize the need to cut into the street in the future. As a result, the team hypothesized that strong coordination practices between gas companies and municipalities would result in lower leaks per mile on new pavement compared to old pavement. As shown in **Table 8** the study found that new pavement had roughly 57% fewer leaks per mile.

Pavement Age	Miles	Leaks	Leaks per Mile
Old Pavement	146.24	460	3.15
New Pavement	26.32	36	1.37
Total	172.56	496	2.87

The lower rates of leaks per mile on new pavement, indicate that recent collaboration efforts by gas companies and municipalities to address leaks and leak-prone pipe before paving is having some success in reducing missed opportunities. While it is possible that some leaks on newly paved roads were remediated after paving, the five year moratorium imposed by most municipalities, combined with the more stringent and expensive requirements on repaving during the moratorium, make it much less likely that leaks are addressed after paving unless an emergency condition appears.

As shown in **Figure 10**, six of the 15 municipalities had no leaks per mile of new pavement, and each gas company is represented by at least one of those municipalities. **Figure 10** also shows that the variability in leaks per mile on new pavement is largest for National Grid, lower for Eversource, and lowest for Columbia Gas.

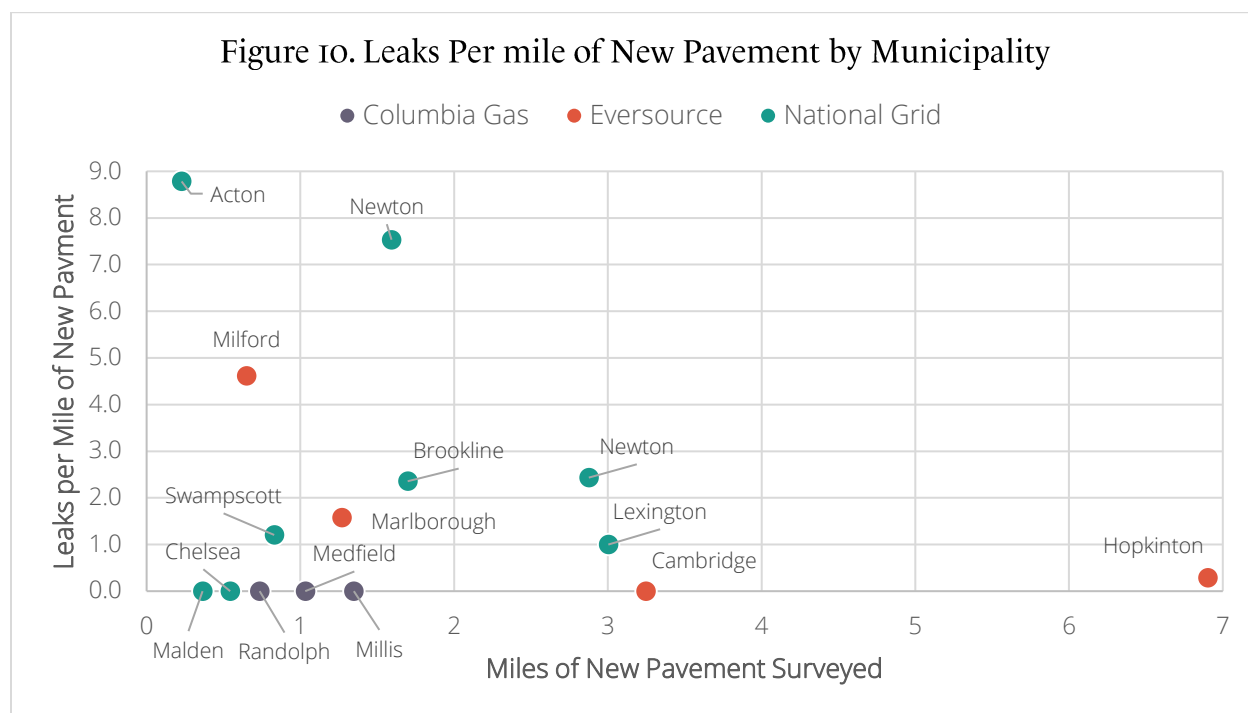


Table 9 shows that Columbia Gas has the lowest rate of leaks per mile of the three gas companies. All three companies are reduced leaks per mile on new pipe about 1.5 leaks per mile compared to old pipe.

As discussed in the best practices section, there are a multitude of distinct elements on both the part of municipality and gas company that can influence the successfulness of coordination. These include communication structure, data organization, information updates and more. The study found that the combination of practices that each municipality and its gas company implemented varied to some

degree, as it did across gas companies. As a result, no single practice can fully explain the low leak rates in each town, but some practices are more common amongst the municipalities than others.

Table 9. Leaks per Mile by Gas Company

Gas Company	Leaks per Mile			% of Leaks at Intersection of Old & New Pavement
	New Pavement	Old Pavement	Difference	
Columbia Gas	0	1.88	1.88	N/A
Eversource	0.58	2.19	1.61	4%
National Grid	2.6	3.94	1.33	2%
Total	1.37	3.15	1.78	0

In Cambridge, Chelsea and Randolph, municipalities with comparatively high amounts of gas main replacement, and no leaks per mile on new pavement, each reported holding regular meetings with gas company, including pre-construction season and during the construction season. Each sends their paving plan for at least the upcoming season to the gas company over the winter, and each also tracks information on which streets have a paving moratorium. Cambridge also has online permitting. See the **Case Study** on Cambridge for more detail on their coordination process using regular weekly meetings.

In terms of the gas companies, Columbia Gas’ success across the three communities surveyed may be attributed to a few factors such as:

- Requesting municipal paving plans for return in February, giving the municipality time to plan
- Offering a per-construction season one-on-one meeting with each municipality to discuss each party’s plans, make adjustments and introduce key staff members
- A single point of contact for the municipality that appears to have a manageable workload allowing for reasonable response times
- As discussed in *Current Practices & Issues Raised*, its municipalities have a lower rate of complaints about coordination

Especially when one considers that the presence of leaks may mean leak-prone pipes are still buried under these new streets, and that these pipes are likely to need to be replaced within a decade, the lost opportunities here might be significant. Further investigation into how and to what extent collaboration reduces lost opportunities is needed. However, the preliminary results from this study suggest strongly that collaboration could be significantly reducing lost opportunities for leak repair, gas main replacement, and cost savings for both gas companies and municipalities.

CASE STUDY: COLUMBIA GAS OF MASSACHUSETTS

Columbia Gas, a NiSource company, is one of the three largest gas companies in Massachusetts, with 61 towns in its territory and over 300,000 gas customers. Its municipalities range from urban centers such as Springfield, Brockton and Lawrence to smaller suburbs such as Franklin and Ludlow. The company has implemented model coordination structures that emphasize regular, effective communication with municipalities and consistent delivery of its standards across its territories. It has also begun implementing a program to help incentivize and reward municipal coordination on infrastructure projects.

As of 2015, the Columbia Gas had already transferred its infrastructure maps to GIS, and it still had over 800 miles of leak-prone pipes ^[1] In order to comply with the new law on gas leaks, the company began to speed up its infrastructure replacements. However, it quickly became apparent that the increased construction stressed the resources of the local municipalities, so Columbia Gas sought municipal input to improve the process. The major request from the municipal staff was to have one point of contact at Columbia Gas to reduce the difficulty of figuring out who to call or how to navigate the system. In response, the company created the position, “External Affairs Specialist,” with each specialist serving an assigned territory as the primary contact on infrastructure replacement projects for customers, communities and DPW directors, facilitating coordination to resolve issues and concerns.

To prepare for the construction season, Columbia Gas holds municipal-specific meetings in the beginning of each calendar year. The meetings are used to establish mutually agreeable project start dates, identify specific municipal requests, effectively sequence gas main replacement with paving and/or water/sewer improvement projects, clarify street restoration expectations and strengthen relationships between the DPW and Columbia Gas staff. The External Affairs Specialists facilitate the meeting and key subject matter experts attend: engineering, construction, operations, systems operations and restoration. Columbia Gas developed a *DPW Meeting Playbook* to establish a standard meeting presentation, deliver consistent information, and ensure continuity of information-sharing with municipal DPW partners during times when Columbia Gas staff may transition in or out.

This high quality communication and coordination has led to opportunities to achieve cost savings. In Lawrence, the City planned to upgrade a water main, which would have required a gas main to be re-routed. Columbia Gas identified that installing a new water main, rather than upgrading the old one, would avoid the need to move the gas main and cost substantially less. Columbia Gas and the City agreed to changes in the restoration standards (i.e. paving) for trenches, which provided the same quality of pavement but avoid duplicative costs for Columbia Gas. Columbia Gas shared part of its savings with the City so that it could pay for the cost of installing the new water main. The City got funding for a new water main, avoided long term construction for gas main replacement, and Columbia Gas avoided the significant cost of moving a gas main.

Columbia Gas is now planning to build on this pilot by offering municipalities the opportunity to share in financial savings the gas company achieves when the municipality agrees to certain paving restoration requirements. The changes allow for:

- Temporary patches to last until the municipality repaves the road or until the preferred trench settlement period has elapsed
- Permanent patches to use the grind-and-inlay method, rather than full-depth cutback

The new program approach is designed to improve project collaboration and coordination with municipal projects, and is intended to maintain or improve quality of paving, returning value to customers and taxpayers through reduced cost of both paving and gas main facilities replacement. This model provides a powerful incentive to municipalities to coordinate and a great reward for doing so. It also provides Columbia Gas with savings that could be used toward additional replacements of leak-prone pipe.

Sheila Doiron, Columbia Gas' Director of Communications and Community Relations, notes that the company's approach to coordination is "to maximize the opportunity to achieve both the municipality's and the Company's objectives -- with the least impact to the cities and towns -- to enhance satisfaction while balancing cost savings and flexibility".

[1] Direct Testimony of David E. Mueller, Columbia Gas of Massachusetts, D.P.U. 15-GSEP-05

4. Current Practices & Issues Raised

Executing municipal-gas company coordination presents many challenges, particularly information management and sharing. Through interviews with municipalities and gas companies, the team explored the sources of these challenges, collected stories of innovative solutions, identified areas that may benefit from further research, and compiled recommendations for best practices for municipalities and gas companies.

The following sections report on the diversity of practices found across municipalities and gas companies, as well as issues about barriers and problems raised by each party. The team notes that this study was developed in the context of the natural gas companies undergoing a major increase in the amount of leak-prone pipe that they replace annually, coupled with on-going leak repairs. Many of the issues identified in the study are a product of this acceleration, and the team realizes that the gas companies are actively working to make changes to address them. As a result, the structures in place during our interviews should not be perceived as static, and the team notes where innovative experiments and pilots from the gas companies are already driving improvements.

Satisfaction with Coordination

The interviewed municipal staff expressed a wide range of responses from satisfaction to frustration with their local gas company's collaboration on gas leak repair and replacement. In aggregate, nearly half of respondents expressed low satisfaction with the gas company communication (46%) and over half of respondents had complaints about gas company coordination (58%).

Figure II. Prevalence of Municipal Communication Issues by Gas Company

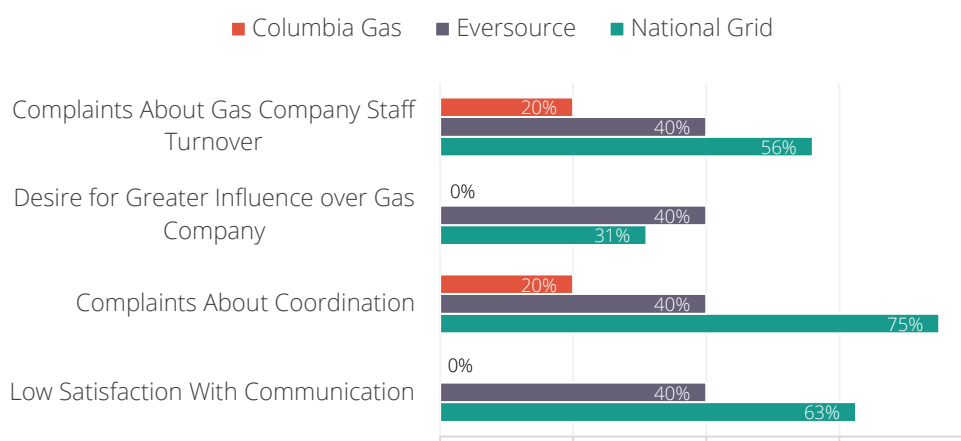


Figure 11 shows the percentage of municipalities within each gas company's territory that expressed a particular concern or complaint.

When the team examined statistics on complaints and satisfaction by gas company, a potential trend appeared with Columbia Gas tending to perform better on communication and coordination (See Figure

11). See the **Case Study** on Columbia Gas to learn more about their municipal coordination and communication processes.

Additionally, in terms of their satisfaction level, five municipalities --Boston, Cambridge, Malden, Melrose and Worcester-- stood out. These municipalities have a higher than average percentage of their streets being dug up each year for gas main replacement.²² With excess work comes complexity and potential for miscommunication and frustration, yet these municipalities expressed high levels of satisfaction with the overall result of the work.

The following sections assess what factors may contribute to the trends, and use those conclusions to shape best practice recommendations.

General Communications

COMMUNICATING WITH THE APPROPRIATE CONTACTS

As shown in **Table 10**, each gas company reported having a community liaison (i.e. point-person) available to municipalities who could field all questions across all three sectors.²³ Each municipality is also assigned a manager or managers of gas leak repair and gas main replacement. Both Eversource and National Grid indicated that their organizational structures were actively evolving to better serve their municipalities due to the new goals laid out in the GSEPs. For example, Eversource recently added its Construction Manager position.

Table 10. Key Representatives for Gas Company

	National Grid		Eversource	Columbia Gas
Community Liaison	Community Manager (both gas and electric)		Community Relations Representative	External Affairs Representative
Gas Leak Repair	Local Area Manager	Area Maintenance Manager	Area Maintenance Manager	Operations Manager
Gas Main Replacement		Construction Manager	Construction Manager	Construction Manager

Both National Grid and Columbia Gas reported that in addition to these key representatives, municipal staff frequently work with contacts directly within the engineering division, on construction crews, staff that deliver permit applications, and more.

²² According to data from the five year Gas System Enhancement Plans (GSEP) filed with the DPU.

²³ The title of the liaison are 'External Affairs Representative' for Columbia Gas, 'Community Relations Representative' for Eversource and 'Community Manager' for National Grid

The use of these alternate contacts may be explained in part by the fact that nearly half (46%) of municipalities indicated that they had difficulty knowing which person to contact for any specific issue, because gas company representatives are switched out regularly. When broken out according to gas company, the results showed differences between the companies, with Columbia Gas having the fewest complaints of staff turnover, as shown previously in **Figure 11**.

The gas companies reported that working through these alternate channels makes it harder for them to ensure that all of the proper parties within their company are notified. As a result, it challenges coordination, and it can lead to increased frustration because the municipality feels it has conveyed information that the gas company has ignored.

As soon as [gas company representatives] learn the town policies or needs, they are gone.

- Public Works Director

I have to label business cards with the exact date because the people change so fast.

- Public Works Director

COORDINATION BETWEEN DIVISIONS AT THE GAS COMPANY

Many municipalities worried about internal communication at the gas company, which may stem partly from municipal communication with the wrong gas company contacts, but it may also represent simple failure to share information across departments.

Some municipalities reported that they would get multiple requests from different contacts at the gas company for the same type of information, such as their paving plans, indicating that the internal information-sharing strategies in the gas company were not perfect. While sending information several times to the same company can be annoying and time consuming, construction mistakes resulting from a lack of information-sharing can be remarkably expensive. For example in 2015, there was a large MassDOT paving project along Mass Ave in Arlington. To ensure all stakeholders were informed of the repaving plans, MassDOT mandated that representatives from all the local utilities as well as the pertinent municipal staff sit down to several meeting about the project. MassDOT finished the project and had a ribbon cutting. Three months later, the local gas company announced it needed to cut up approximately 1,000 feet of the street that MassDOT had just installed.

Municipalities also complained about the gas company advertising to recruit new customers on streets that had only just been repaved, even in cases where the municipality had provided the gas company of documentation of the roads under a street-cut moratorium. This appears to reflect lack of coordination between the gas main replacement group and the new services group. The municipality's five-year

We pave a road and within two weeks they are putting in a new service.

- Town Engineer

People at the gas company are easy to work with, but the info doesn't get through. They are looking at multiple towns and the info gets lost.

- Public Works Director

moratorium policy ostensibly prevents the installation of new main and services in these cases; however, resident frustration and outcry can force the municipality to grant exceptions.

STAFF WORKLOAD

Multiple municipalities reported that gas company staff were too busy to respond to inquiries or oversee all the on-going work.

One common observation was that construction managers were too overloaded to adequately oversee and inspect their crews and the resulting pavement patches. According to one municipality, its gas company construction manager was assigned 25 municipalities and thus had difficulty managing all the construction projects at the same time. Two other municipalities indicated that they did not feel their gas company actively inspected pavement patches, so that they had to do inspections themselves and then contact the gas company to remediate. The lack of remediation of patches caused one of the municipalities to regularly withhold permits in the spring until the patches are fixed. The municipalities in these cases either assume the burden inspection and follow up, or risk having poor pavement quality. Such anecdotes reflect the fact that many representatives may have difficulty responding to municipal staff in a timely way due to geographic and workload scope.

Both National Grid and Eversource indicated that there may be over-burdened staff, likely due to the massive increase in recent repair and replacement work. Eversource has recently created its Construction Manager position, and currently only has two Construction Managers compared to their four Maintenance Managers.

Sometimes it takes weeks to get an answer back from them. It seems like they have too few people trying to manage construction coordination.

- Town Engineer

Data Management & Sharing

TYPES OF DATA TO COLLECT & SHARE

Gas Main Replacement Plans

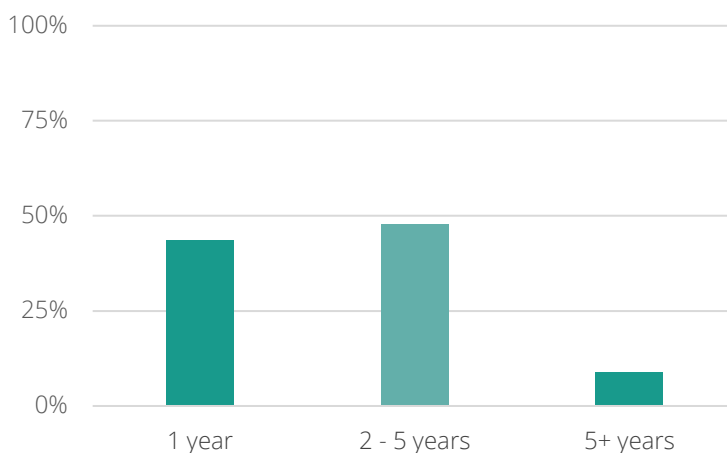
As part of their GSEP, each gas company submits a five year main replacement plan. All three interviewed gas companies stated that they include specific street addresses for the first year. In the second years and third years, the plans tend to list streets with rough lengths of main to replace, but no addresses. Beyond that, the plans only identify lengths of main to replace per municipality.

Despite the existence of these five year plans, many municipalities reported not being aware of a five year plan from the gas company or having seen any data from the gas company showing plans that show more than the next construction season. Specifically, of the 11 municipalities that reported how many years of plans they received from the gas company, only one received multi-year plans.

Municipal Paving & Other Infrastructure Plans

All municipalities reported sending a paving plan covering at least the next construction season to the gas company each year.²⁴ The plans sent varied in their formality, length and availability to the public. As shown in **Figure 12**, over half the plans sent covered more than one year.

Figure 12. Length of Municipal Paving Plans Sent to Gas Company



The City of Cambridge offers an example of a five year planning process for road and sidewalk work. An excerpt from their plan is shown in **Figure 13**, which maps road construction by planned fiscal year.

²⁴ Three municipalities did not answer the question of if they sent paving plans to the local gas company.

It is worth noting that many of the municipalities with multi-year plans did not make their plans public beyond the first year of data. This was done to avoid making implied promises to residents and businesses, thereby maintaining flexibility to adjust plans. At the same time, 10% of the municipalities reported sending only one year of data to the gas company, even though they had additional years of plans. In some cases, this was done to ensure the gas company “focuses” on their upcoming year’s priorities. In other cases, municipalities reported the gas company only asked for one year of plans.

Gas companies stressed the importance of having access to having access to three- to five- year plans for municipal paving and other infrastructure projects, such as water and sewer. The study did not collect data about water and sewer plans; however, interviews with gas companies indicated that these plans are not as frequently available or shared as are paving plans.

Both municipalities and gas companies are aware that long term plans are subject to change due to a host of factors. Nevertheless, gas companies stressed the importance of receiving as much information as possible about the municipalities’ plans and priorities for its infrastructure. By comparing municipal plans to gas company plans, the two parties can find opportunities to synchronize work. Identifying these opportunities for synchronization, and potential cost savings, a year or two in advance can provide leverage to the municipal department to secure funding for the work. Additionally, both parties will have greater flexibility to align schedules if planning is done more than just one construction season ahead of time.

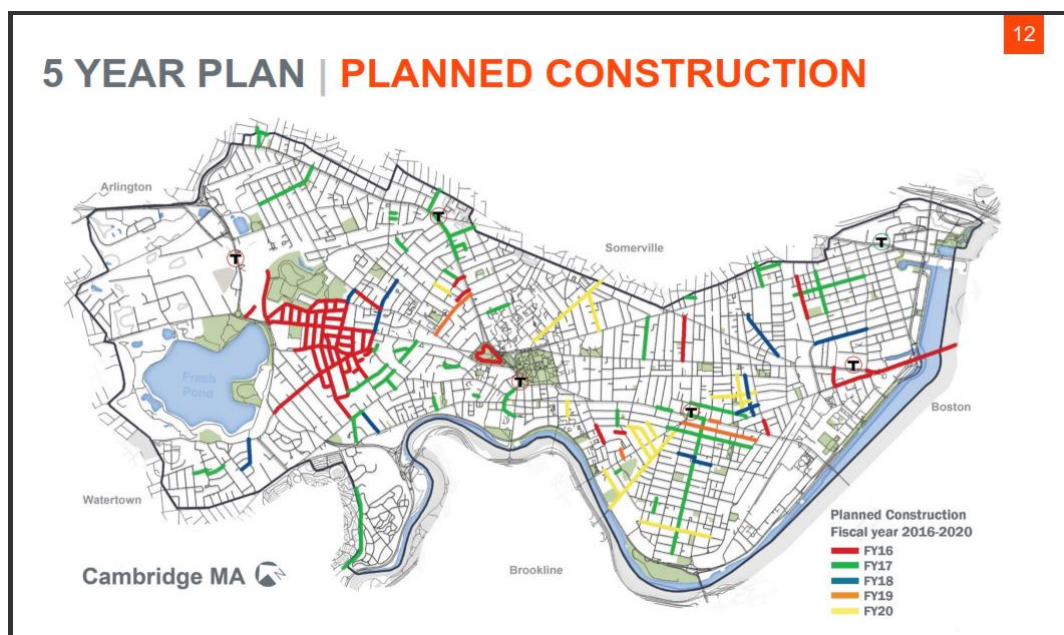


Figure 13. City of Cambridge, “Five Year Sidewalk and Street Reconstruction Plan 5.1.2016”

To map the plans, municipalities can enter their plans into Geographic Information Systems (GIS) software. Currently, only two municipalities (7%) reported entering paving plan information into a GIS system. Of those that do not, four municipalities (17%) indicated they plan to, or are in the process of, inputting their paving plans into GIS.

Outside of paving, the vast majority of municipalities (92%) indicated that they use GIS to track the location of sewer and water systems along with upcoming plans. Some included the location of storm drains, fire hydrants, and streetlights.

Municipal Completed Paving

16 municipalities (62%) reported tracking completed paving in a centralized location. Of those, 10 (63%) input the data into GIS, such as the City of Newton, shown in **Figure 14**. Using GIS, the City can quickly identify all road segments that fall under its five year street-opening moratorium and easily convey the information to the gas company and other utilities with a map. Two municipalities tracked completion information only in individual project folders.

The gas companies all noted that without information on completed roads, they cannot know which roads are under the five year moratorium, and it makes coordination much more difficult.

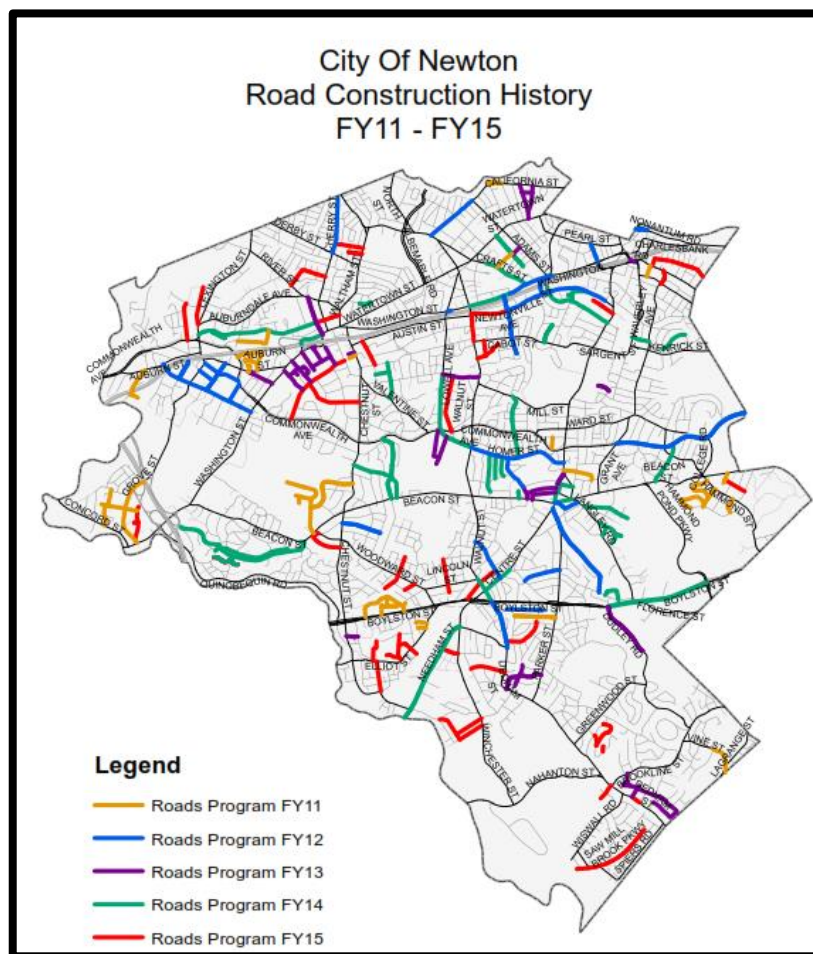


Figure 14. City of Newton Road Construction History

New Residential & Commercial Developments

New developments often require a new main to service the area or expansion of an existing main. It is critical that gas companies and municipalities communicate as soon as possible to discuss whether work will be needed, and how that could fit into the municipality's infrastructure and paving plans. One

municipality in the study highlighted an example of potential problems with new developments. The Town said that it had provided notification to the gas company of a large new developments. Despite plans for the development had been known for several years, the Town indicated that the gas company provided relatively little notice that it had to expand its mains running to the new development. According to the Town, the lack of advance planning or information sharing with the Town on the behalf of the gas company resulted in unnecessary damage to local streets.

Locations and Type of Gas Main

Municipalities in the study reported that, prior to the existence of Dig Safe, they commonly had paper maps of as-built gas pipeline schematics. Many of them still have these maps, although the information is outdated. Over half (54%) of municipalities interviewed specifically asked for better maps of the gas infrastructure under their streets. In addition to whether a gas main exists on the street, municipalities said it would be valuable for the municipality to know the pipe material (e.g. cast iron or plastic). Municipalities understood that having this map would not be a substitute for calling Dig Safe; rather it could allow them to improve their planning efforts. In this survey, only the City of Melrose indicated that they had a recently updated map of gas infrastructure.

Gas companies expressed concern about sharing some gas infrastructure data for an entire municipality. Gas companies indicated that detailed information about the location of their infrastructure within a specific street segment, such as GPS latitude and longitude, depth, and width of pipe for both location of services and mains, could present security and safety concerns if made available for the entire municipality.²⁵ Also, such detailed data could quickly become obsolete based on year-round work. However, gas companies indicated willingness to share that information for specific segments of road for a planned or potential municipal project. Sharing that upon request would ensure the municipality gets the information it needs to plan a project and that the information is as up-to-date as possible. The gas companies did note that in their drawing may not always have accurate data, because records for the oldest pipes may no longer exist and surrounding conditions may have changed.

Additionally, the gas companies did express some willingness to share basic information for the entire municipality, such as whether or not a street has gas main on it and what material that main is made of. This means information about location of the pipe in the street, services, any control points, etc. would not be included. Through this project, Columbia Gas shared with the study maps of streets with gas main that does indicate the material.

²⁵ See Critical Energy Information Infrastructure <https://www.ferc.gov/legal/ceii-foia/ceii.asp>

City of Melrose, working with National Grid, provides a good example of how to use the detailed drawings and more general municipal map (note: the City's municipal map does not show pipe material).

They are endangering their own infrastructure by not telling you where the structure is.

- Town Engineer

I'd love to have an as-built.

- Public Works Director

First, the City has a map of streets with gas mains from National Grid, and when it plans to repave or do infrastructure work on a street with gas, it notifies the gas company to make sure it has a chance to replace any leak-prone pipe ahead of time. This is especially important because if the municipality's excavation encroaches on leak-prone pipe, the gas company is required by law to remove it.²⁶ The City's notification gives the gas company time to plan to remove that pipe or repair leaks as efficiently as possible. The City also requests detailed drawings of the gas infrastructure when it is engineering its projects. The information helps the City avoid in-field delays and costly change-orders that could arise if there are conflicts between the location of the City's planned infrastructure and existing gas infrastructure.

FORMAT OF DATA SHARING

The vast majority of municipalities shared planned paving plans with the gas company using a spreadsheet or list, and the reported receiving a spreadsheet or list from the gas company with its replacement plans. The municipalities that do have their paving plans in GIS did not share the layers, noting that the gas company did not ask for them.

The City of Boston stands out for sharing information via a database that the gas company, other utilities, and the City can access. The database, the City of Boston Utility Coordinating Software (COBUCS), was developed by the City. To ensure use of the system by the gas company and other utilities, the City requires that applications for street opening permits contain a reference number from the COBUCS system. When inputting data into the system, COBUCS will notify the user if the street is under a moratorium, in which case a permit is denied, or if there are opportunities to coordinate work with other utilities.

²⁶ Per 200 CMR 113.00 all cast-iron pipe that gets encroached upon by another excavation inches needs to be replaced since without the support of the soil, these old pipes are more likely to leak or fail.

each municipality in the beginning of the calendar year. Columbia Gas has even developed a *DPW Meeting Playbook* to establish a standard meeting presentation, deliver consistent information, and ensure continuity of information-sharing with municipal DPW partners during times when Columbia Gas staff may transition in or out. The meeting introduces municipal staff to all key representative of the gas company, serves for both parties to compare plans and discuss opportunities to synchronize schedules, and set expectations for communication during the construction season.

The gas companies reported that not all municipalities in their territories provide their paving plans or completed paving information, but the numbers have been increasing. For example, National Grid reported that the response from municipalities to their request for paving plans has improved, from as low as 15% a few years ago, to 85% presently. Nevertheless, the high levels of municipal frustration indicate that simply sharing the plans may not be sufficient.

Figure 16. When Municipalities Send Paving Plans to Gas Company

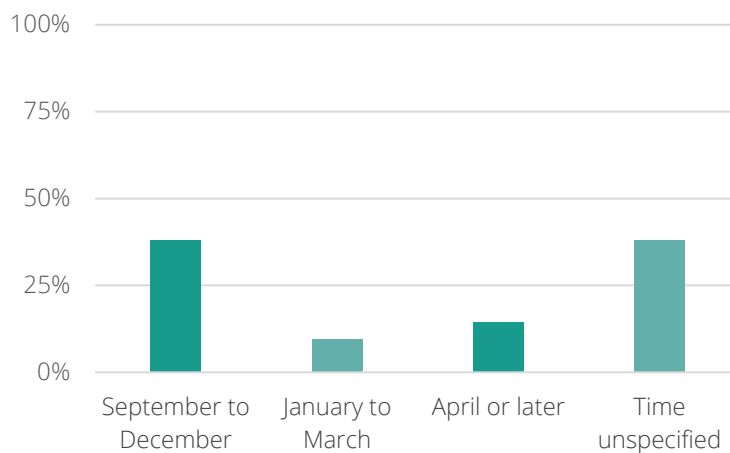


Figure 16 shows a break out of when municipalities reported sending paving plans to their gas company. Reflecting the preponderance of National Grid municipalities in the survey and National Grid’s end of December deadline, about a third of the municipalities reported sending plans before the end of the calendar year. However, another third of the municipalities indicated they did not send the data at any specific time. When municipalities do not send data at a specified time of the year, planning is made unpredictable for the gas company, and when the information is provided too late it does not allow time

We tell them [gas companies] in the fall or winter what streets we will be working on, but they don't tell us what they will be doing.

- Municipal Director of Public Works

If [the gas company] said what they need over a few years, we could have arranged it so they could do it during summer. Instead they come in at the end of the season and it's always an emergency.

for sufficient flexibility before the construction season.

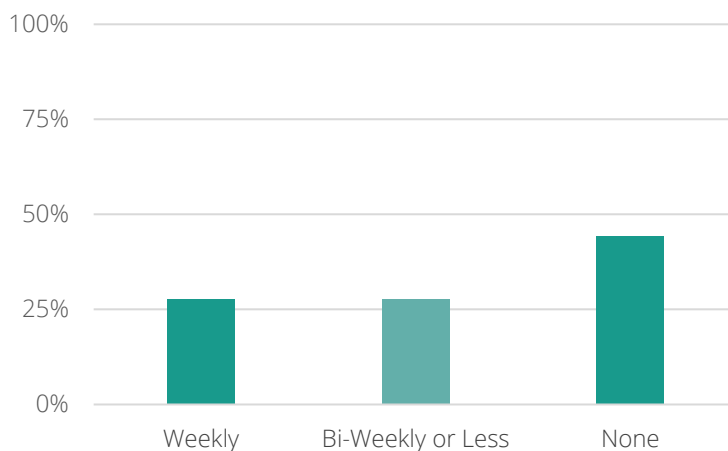
The National Grid engineering department is reaching out in winter now; this is much better than before. They ask what they can jointly do with us to sequence the work so the roads and quality of life along the roads doesn't diminish.

- Michael Hale, Gloucester Director of Public Works

Construction Season Communication

The gas companies reported that one of the biggest challenges to effective coordination is a lack of updates from municipalities about changes to their schedules during the construction season. The primary driver of schedule changes appears to be paving contractors. Gas companies reported that most municipal paving contracts give the contractor leeway to adjust their schedule without specific limits for notification periods. As a result, gas companies report often receiving short notice of a change and they are not always able to meet the new timeline. Other times no notice is given at all and the opportunity to fix leaks is missed.

Figure 17. Construction Season Meetings with Gas Company



One way to keep both parties updated is to have regular meetings during the construction season. As seen in **Figure 17**, about half of municipalities reported having regular meetings with their gas company during the construction season, and one quarter reported having those meetings on a weekly basis.

The frequency of construction season meetings needed for each municipality depends on the amount of work occurring and the number of different entities involved. On the busy end, the City of Cambridge

offers a testament to the effectiveness of weekly meetings. In the City's case, weekly, mandatory meetings help manage a large amount of work across multiple project types, including major water and sewer and gas main projects, as well as other utilities. If a utility does not attend the weekly meeting it cannot get a permit for its work.

The gas companies noted that even with weekly meetings, changes occur between meetings, and those updates are important for them to learn about as quickly as possible. This is especially important when the gas company is planning to fix leaks the same week as paving is happening.

Street Opening Permits

PERMITS AS A LEVER

80% of municipalities reported that they consider withholding or revoking permits in order to secure changes or improvements from the gas company. The right of municipalities to withhold or revoke permits can be a blunt tool, in that it stops all new gas company work until the original problem is resolved.

PERMIT APPLICATION & PAYMENT PROCESS

The majority of municipalities in the study have off-line permit applications and most were paper-based. The applications may be available online for download, but they must be filled in by hand and then emailed, faxed, or hand delivered. Some municipalities did have a fillable PDF available, which allows the gas company to type in information.

Hand delivery of applications requires substantial administrative time from the gas companies. Some municipalities reported that requiring hand delivery ensured they got to talk to someone from the gas company. However, gas companies reported that the person submitting or picking up the application is usually not the appropriate contact for those discussions. The gas companies would prefer that communication occur through regularly scheduled meetings, so they can ensure the necessary staff and data are available.

A handful of municipalities, such as Arlington, Boston, Cambridge, and Concord, have online permitting located on the municipality's website. The online form has fields for the applicant's name and contact info, as well as the status of the insurance and bonding, then asks for specifics of the excavation including work dates, addresses and depths, as well as license numbers. The result is sent to the municipal engineering department, giving the staff the standard number of days to decide if they will approve it, while eliminating the travel time needed for the gas company to fill out and hand in the form. It also eliminates the need to track paper copies and store cumbersome paper files.

Eversource cited the city of Cambridge's electronic permitting system as a major improvement over other city and town systems that require hand written permits and paper checks. Columbia Gas also reported that more electronic permitting would be beneficial. Finally, Columbia Gas suggested that administrative time could be reduced if it did not have to apply for each permit within a municipality separately, including monthly or annual billing. This practice is already in place in Lexington, which currently invoices National Grid twice a year. Moving to online payment or even batched invoicing, like

Lexington, could reduce municipal administrative burdens dramatically, by eliminating the burden of tracking paper checks, photocopying checks for records, and then manually depositing the checks.

PERMIT APPROVAL PROCESS

National Grid reported that many municipalities do not process or approve permits until April 1 or the start of construction season, April 15. Doing so delays the start of projects and shortens an already brief construction season. On top of that, at least one municipality reported withholding all permits in the beginning of the season until the gas company had made repairs to outstanding pavement patches. The team did not have the chance to ask municipalities about their cause for the permit scheduling. It may be that poor coordination in the past has made municipalities hesitant to approve permits early. If that is the case, it would suggest the importance of the pre-construction season coordination meetings. These would improve communication and coordination, and give gas companies a chance to make requests, such as early permit applications, and address outstanding municipal issues.

Additionally, some municipalities reported that they commonly refuse to issue permits for Grade 3 leaks, because they did not want their streets damaged for these non-emergency leaks. However, repairing a Grade 3 leak can have significant benefits to the municipality and rate payers in general. The Grade 3 classification does not mean the leak is small, but only that the leak is not within a contained space or near the building of a foundation. A Grade 3 leak can be quite large, damaging nearby trees, increasing ground-level ozone (a human health hazard) and releasing damaging greenhouse gas.

Paving & Patching

RESTORATION STANDARDS

Despite the standards for pavement older than five years stipulated in D.T.E. 98-22, the gas companies reported that municipalities often requires variations. Variations exist for how far to cut back into surrounding pavement, depth of pavement courses, and whether patches must get repaired regardless of settling. For example, in response to municipal complaints, Eversource reported that its policy is to return to almost all patches after a year and grind-and-inlay the pavement.

A few municipalities have also been successful in requiring a non-standard fill called flowable fill. Flowable fill acts somewhat like concrete and is intended to minimize settling better than standard fill. Eversource, Columbia Gas and National Grid all indicated that they oppose flowable because it changes how leaked gas migrates out of the ground, which could make it harder to find the source of a leak in the future. The flowable fill may also have a corrosive effect on steel. Gas companies indicated that they often acquiesce to municipal paving requests out of a desire to repair frayed relationships that have occurred to due past poor coordination.

Two recent innovations address some of the municipal concerns behind the aforementioned variability. First, in Marlborough and Cambridge, Eversource has been experimenting with requiring contractors to use a soil compaction meter (a.k.a. “soil supervisor”), a device which monitors soil compaction of the trench and gives the contractor approval when soil is properly compacted. Eversource prefers this approach because it can minimize compaction issues without the use of flowable fill.

PATCH INSPECTION & TRACKING

A related problem with patching arises with contested ownership. It can be difficult to track which entity made each patch and hence whether or not the gas company is responsible for repairing a failed patch. All three utilities are currently piloting in some municipalities putting plastic caps in their patches to track ownership. This strategy seems to make major improvements in ownership clarity where it is implemented. See **Figure 18** for an example of the plastic caps used to identify patches.



Figure 18. A Plastic tracking tag used by Eversource (formerly NSTAR)

Additionally, National Grid reported that it and other gas companies are required to track the frequency and results of paving patch inspections.²⁷ However, municipalities did not report being aware of this information, and often reported feeling like they had to be the ones inspecting the patches and identifying failed patches. If the gas company shared their reports on some frequency with the municipality, it could provide assurance that inspections are happening. Alternatively, it could highlight the need for improved or increased inspections by the gas company.

Cost Savings

Two programs, one run by Columbia Gas and another by the City of Worcester, provide an example of how synchronizing municipal and gas company projects, along with other changes, can reduce restoration costs for the gas company. Further, these programs allow the gas companies to share the cost savings with the municipality, which helps incentivize, reward and enable coordination. Columbia Gas recently piloted a program in the City of Lawrence, and plans to expand the program to more of its municipalities. In Worcester, with Eversource, the City has run its program for over a decade. In both

²⁷ See DTE 98-22 Section 11.2 "Utilities shall track the success and failures of their programs to include the restorations and the inspections of such restorations. Utilities shall specify the number of failed restorations compared to the total number of restorations made during the preceding calendar year, the number of failures reported by a party other than a utility inspector and the age of the failed restoration"

cases, the programs are making cost saving changes to the restoration standards DTE 98-22, which is allowed by the regulations.

COLUMBIA GAS

The **Case Study** on Columbia Gas in this report describes its pilot program in the City of Lawrence. In that case the company found a way to help the City meet its needs to both upgrade water mains and have high quality pavement over gas main trenches, while reducing total cost. Based on its experience in the City of Lawrence, Columbia Gas has developed a standardized plan to generate and share cost savings from restoration, called the Paving and Restoration Initiative. Under the Initiative, Columbia Gas will share with the municipality half of the avoid costs of final paving (i.e. the permanent patch) under the following conditions:

- **For projects that are not synchronized with municipal repaving** (i.e. no curb-to-curb paving by municipality after gas main replacement)
 - Allow Columbia Gas to install a temporary patch that will be replaced with a permanent patch only after the full duration of the settling period. This is in contrast to the DTE 98-22 requirement to replace temporary patches after only 2-5 days.
 - This agreement avoids the potential for Columbia Gas to have to pay to replace or repair a permanent patch due to settling.
 - When installing the permanent patch, allow Columbia Gas to use the grind-and-inlay method to restore trenches, rather than, as required by DTE 98-22, performing full depth cut-backs.
 - Grind-and-inlay is less costly method of integrating the permanent pavement patch into the existing pavement, compared to full depth cut-back.
- **For projects that are synchronized with municipal repaving** (i.e. municipality will do curb-to-curb repaving after gas main replacement)
 - Allow Columbia Gas to only install a temporary patch that will last until the municipality repaves.
 - In this case, Columbia Gas avoids all final paving costs.

In Lawrence's case, the City signed a bilateral agreement (e.g. a Memorandum of Understanding) with the gas company to document the coordination practices each intended to follow and the resulting calculation of savings and transfer of funds.

CITY OF WORCESTER

The **Case Study** on the City of Worcester documents its program, called the Cooperative Patching Program, and results in depth. The City's program is remarkable in that it achieves synchronization of project not just with the gas company and municipality, but also with other utilities. Further, the program actually helps the City pave more roads than it otherwise would.

Through regular meetings and exchanges of infrastructure plans, the City and utilities identify areas with infrastructure updates needed by multiple utilities. If that area is also in need of repaving - but often not scheduled for repaving - then the utilities' projects are eligible for the Cooperative Patching Program. Under the program, if each utility can commit to finish its work during the same construction season, then the City allows them to both install a temporary patch, pay the City for the cost of the

permanent patch, and let the City handle managing final paving. The City then repaves the street curb-to-curb that year or the following. This approach is technically cost-neutral for the utilities compared to the DTE 98-22, because each utility still pays for the final patch. However, Eversource reports that it saves their Construction Managers valuable time - instead of overseeing paving projects, those Managers can oversee additional gas main replacements. From the municipal standpoint, the City has to incur cost to repave the entire width of the street, but the cost is much lower than it would be if the utilities were not chipping in.

Both Worcester and Lawrence's programs are notable in that they are achieving coordinated municipal and gas company projects and capturing financial savings without the use of expensive coordinating software. Rather, they are simply having regular meetings, developing plans, and sharing those plans, which allows them to identify shared opportunities and capitalize on them.

Columbia Gas' program is more likely to allow the gas company to accelerate the amount of leak-prone pipe it replaces each year. The full cost of restoration is included in its annual GSEP budget and the avoided costs of restoration can be clearly calculated, freeing up budget in same construction season. In the City of Worcester's example, cost savings for Eversource are harder to quantify and much smaller, originating not from avoided restoration costs directly but rather from reduced administrative oversight of restoration.

Other Practices and Issues Raised

MARK-OUTS

In Massachusetts, at least 72 hours before any construction work in or around a public byway, the organization wishing to complete the work must notify Dig Safe. Dig Safe takes responsibility to notify all entities that may have underground infrastructure near the upcoming project. Once notified, each entity then marks out the location of its infrastructure, using either internal staff or independent contractors. Each type of infrastructure uses a different color for the mark out, with gas in yellow (See **Figure 19**).



Figure 19. Gas Mark Out after Notifying Dig Safe

Unfortunately, over 30% of the municipalities interviewed complained about the accuracy or safety of this system. Mistakes in the mark-outs can result in significant slowdowns, increased cost and even potential explosions. In one case, a municipality reported that Dig Safe gas markings were in the wrong

color in one spot, then spray painted over, with other marks in the right color off a few feet over, forcing the staff to make assumptions about which marks to believe. In another case, a town found several fake Dig Safe markings on their streets. In a third, a street was never marked out even after giving Dig Safe an extension, leaving the crew to dig by hand to search for the service.

The interviews with municipal staff made it clear that there exists some confusion about responsibilities for mark-outs. Many municipal staff suggested that Dig Safe was the one doing the mark-outs. Dig Safe does not make any mark-outs; it only notifies the entities that own the infrastructure and then those entities can make their own mark-outs. While this could simply be a semantics issue, it suggests there is confusion about responsibilities, which may undermine the process to convey feedback about errors and ensure that information gets updated.

Another issue identified by municipalities is that abandoned gas mains are not marked out by the gas utility as part of the Dig Safe process. When gas mains are no longer used, they are frequently not removed, but just left where they are under the street. Although these mains technically do not present a safety hazard, if a municipality or its contractor discovers one, it must assume that the pipe is active until confirmed otherwise by the gas company. Municipalities reported that this can delay a project easily by at least half a day. The delay adds unnecessary cost to the project for the street crew's time and diminishes the amount of work feasible in an already short construction season.

On the other hand municipalities are not bound by Dig Safe to mark their facilities. This creates the same confusion and work delays for utilities due to the uncertainty of water and sewer locations.

We get to abandoned pipe and don't know if the gas is live and have to stop to call the gas company. We lose half a day of work.

- Public Works Director

The system doesn't seem safe.

- Public Works Director

Dig Safe has a credibility issue. I would be shocked if you could find a fire chief who says they know what they're doing. Don't market yourself as safe and then not do it right.

- Municipal Fire Chief

GATE BOXES

Gate boxes are openings in the street that extend down to the gas main below, allowing access to a valve to turn off the flow of gas. The gate box is simply an access point, it is not connected to the main or valve. Before a road is repaved, the gate boxes must be raised to the new level of the street so they

remain accessible when needed during an emergency or doing gas-company work. If not raised, the gate boxes will be paved over and the gas company must come later, locate them and raise them.

The gas companies reported is not unheard of for a municipality to proceed with paving without notifying or waiting for the gas company to raise the boxes. This also adds expense, as the company will have to make repairs to pavement when it raises the boxes. Columbia Gas noted that it can be difficult for a municipality to stay abreast of the changes that a paving contractor may make in its schedule.

If the municipality chooses to delay paving instead, it is possible to have to wait for up to a month, delaying the street from being finished and traffic returning to normal. This delay can mean a road is left unfinished through the whole winter until the next construction season. In this case the municipality would be saddled with the additional cost of lowering manhole covers back down to the level of the unpaved street so the snow plows do not hit them during the winter.

Municipalities said that, because of gas company contracts with unions, only union members are allowed to move these gates. Clearly, advanced notification must improve to help gas companies access the gate boxes in time. At the same time, the gas companies may need to investigate ways to improve staffing to better respond to these short notices.

GAS LEAKS

Gas leaks are reported publicly to the DPU by gas companies in their Annual Service Quality Reports, submitted in early March. Municipalities expressed frustration that data about the leaks in their City or Town had not been sent to them. Some towns did not even know that it existed.

Why do I have to hear from HEET about gas leaks? I should hear it from the gas company.

- Municipal Fire Chief

MUNICIPAL TREE PLANTING

Dead or dying vegetation may be a sign of a gas leak. The gas forces oxygen and moisture out of the soil, damaging plants as small as grass to adult trees. A full grown public shade tree can cost thousands of dollars for a municipality to have removed and then have a new tree replanted. If the gas leak has not been remediated, there is no reason to believe that a new tree will survive any better. Before planting a tree, the municipal arborist or tree contractor can use a combustible gas indicator to check that the soil is not saturated with gas.²⁸ Based on the municipal interviews, less than 10% of cities and town check for gas before planting trees.

²⁸ Bascom Turner - Combustible gas indicator, Gas Sentry, model 201, @ \$3,000.
<http://www.bascomturner.com/gas-sentry.php>

CASE STUDY: CITY OF WORCESTER, SERVED BY EVERSOURCE GAS

Worcester is a city of 182,000 with an average income below the state median. The city contains 600 miles of water mains, much of which dates back to before 1800, and it has more gas leaks per mile of street than almost any other municipality in the state. Like the City of Cambridge, Worcester highlights the benefits of regular, in-person meetings to share information. The City also capitalizes on the resulting coordination to help fund street repaving projects.

Since the 1990s the City has hosted mandatory monthly meetings where all the local utilities -- gas, water, sewer and electrical -- attend to cross-notify each other of all future plans for underground infrastructure repair and replacement. In 2001, Debra Davis of the Worcester DPW added to this collaboration the Cooperative Patching Program.

If two or more utilities have infrastructure upgrade needs for the same area, and that affected road needs repaving, then the City can select that road for the Cooperative Patching Program. If selected, the two or more utilities perform their work during the same construction season (April - November). When they complete their work, they install a temporary patch over the trench as normal. Afterward, instead of installing a wider, permanent patch over the trench after the fill had settled, each utility simply pays the City what the work would have cost (as calculated by the City based on its records of the previous year's average cost per square foot for that work).

In this way, the City receives money from at least two utilities to subsidize repaving the aging street just after the underground utilities have been updated.

The program encourages integrated infrastructure repair, thus reducing disruption to nearby residents. The City's repaving money is literally stretched further and the City gets to manage the paving projects to ensure they are completed to their satisfaction. The streets last longer with fewer patched trenches since the underground infrastructure has just been repaired. The utilities perform the same amount of work for the same cost, while not having to send work crews out to patch the same street twice, freeing up its managers and crews to get more work performed elsewhere.

Tom Sheehan, Eversource's Paving Manager, said, "It saves us time. So we can do other work... We'd love for other towns to do it."

In the last 15 years, the Cooperative Patching Program has helped repave over 23 miles of Worcester's roads. The utilities have paid 57% of the total cost of repaving those roads so the City has had to pay less than \$4 million for all 23 miles, a dramatic cost savings for the city.

5. Best Practice Recommendations

Based on the issues identified and the existing practices of both municipalities and gas companies, the team developed recommendations for best practices and organized them into four categories:

1. Set Foundation
2. Share & Strategize
3. Generate & Capture Savings
4. Find Efficiencies

The team encourages municipalities and gas companies to review the best practices and identify which they currently meet, and which they do not. For municipalities, the team suggests that each municipality catalog their current practices, review it on an annual basis, and identify best practices to add. To assist municipalities, there are two resources provided as **Exhibits 3 & 4**:

1. **Checklist of Best Practices** - Use to assess current status
2. **Calendar of Best Practices** - Use to guide implementation of best practices throughout the year

Additionally, the team recommends that gas companies and municipalities take the opportunity to reassess each element of their coordination process and meet with the other party to comprehensively discuss issues, needs, and how both parties plan to improve. With years of shared experiences, many of them challenging, municipal and gas company relationships may understandably be stressed or frayed. Take this chance to reset the relationship, clarify needs, and set expectations for how to move forward.

Finally, the team stresses the need for gas companies to improve consistency of their procedures across managers and territories. Best practices should be delivered throughout the territory and should persist even as staff change over. The diversity of experiences between municipalities interacting with the same gas company revealed that current procedures can be quite variable.

Set Foundation

To effectively coordinate, both gas companies and municipalities must have the appropriate structures in place to build upon and utilize for coordination. Gas company staffing and communication issues are a source of municipal frustration and impediment to coordination. Municipalities need to improve their internal coordination to ensure that departments like Water and Sewer, which might be separate from Public Works, are effectively included in the coordination process with the gas company. Additionally, more municipalities need to develop three to five year infrastructure plans so the gas companies can align their own multi-year plans. Finally, municipalities could position themselves to more effectively use their own data, as well as the shared data from the gas company by leveraging existing technologies.

Staffing & Communication		
Who	Best Practice	Background
Gas Company & Municipality	Hold pre-construction season meeting.	<p>The municipality and gas company should meet to have a one-on-one meeting in person ahead of the construction season. The meeting will serve to:</p> <ul style="list-style-type: none"> ▪ Introduce all participants in the coordination process for gas company and municipality ▪ Compare infrastructure plans and identify opportunities for aligning schedules ▪ Establish communication procedures for the construction season ▪ Establish clarity on restoration, paving and inspection procedures <p>Columbia Gas developed a DPW Meeting Playbook to ensure consistency of meetings across its territory.</p> <p>*Hold in late February latest - This provides sufficient time for parties to update plans and allow times before construction season to accommodate changes in schedule.</p> <p>See Share & Strategize and Generate & Capture Savings for pre-construction season meeting details.</p>

Staffing & Communication		
Who	Best Practice	Background
Gas Company	Provide online contact list of key representatives	<p>Key representatives should include: Community liaison (i.e. point-person) and managers for gas main planning (i.e. engineering), gas main construction, gas main maintenance (i.e. leak repair), and new services.</p> <p>Municipalities frequently reported having old or obsolete contact information, often due to high rates of staff turnover at the gas company. An online list would eliminate the hassle and confusion municipalities currently report when trying to find the correct contact, and it would increase the likelihood that the right person at the gas company receives updates from the municipality.</p>

	<p>Provide mechanism for municipal feedback to supervisors of key representatives</p>	<p>Provide contact information or an email submission form along with the online contact list.</p> <p>When key representatives are overburdened or not performing, municipalities should have an easy way to notify the appropriate supervisor. This can provide valuable feedback to the gas company and an opportunity to direct the municipality to the correct point of contact, rather than having them scramble to find alternates.</p>
	<p>Regularly assess workload and efficacy of key representatives</p>	<p>Adjust staffing or workload if needed. The assessment might also involve municipal surveys on some regular basis.</p> <p>Municipalities reported delays in responses from gas company staff, and based on reports, some of this may be attributed to excessively large territories and workloads for key representatives. As coordination efforts increase, gas companies should evaluate if current staffing levels can support the necessary work.</p>
	<p>Incentivize key representatives to stay in position for more than one year.</p>	<p>Municipalities cited high rates of staff turnover in key representative positions as a source of frustration and complication for their coordination efforts. Turnover makes it challenging to accumulate knowledge relevant to the municipality and build trust.</p> <p>Using strategies like bonuses, awards or internal recognition may be useful ways to encourage representatives to stay for at least two construction seasons.</p>
	<p>Implement a standard transition process for key representatives.</p>	<p>Some turnover is inevitable. When that does occur, a company-wide policy for managing the transition, including whether or not an in-person, phone, or email introduction is made, when, and what information is covered in that meeting will help ensure continuity and minimize chances for municipal frustration and missed communication.</p>

Staffing & Communication		
Who	Best Practice	Background
Municipality	Establish policy to coordinate paving, water, and sewer infrastructure planning efforts internally.	<p>Gas companies reported that one or more of the departments with infrastructure responsibilities outside of paving, such as water and sewer, often do not participate in the coordination and planning process.</p> <p>For successful coordination that most reduces cost and disruption, all these departments - whether housed under a single Public Works department or not - must work together to participate in planning and coordination efforts with gas company.</p> <p>It may be necessary for one department to take the lead on interacting with the gas company and organizing the municipal departments.</p>
	Hold annual internal meeting to schedule infrastructure plan updates.	<p>The meeting should set responsibilities, a timeline and deliverables for each department with infrastructure responsibilities to update its infrastructure plan and list of completed projects, so that the municipality can deliver to the gas company. Municipality should know gas company's deadline for receiving the plans, prior to holding this meeting.</p> <p>*Hold in early December after construction season has finished</p>
	Obtain contact information for gas company key representatives.	<p>This information should be requested if not already provided through through a website by the gas company. Should include:</p> <ul style="list-style-type: none"> • Community liaison (i.e. point-person) • Managers for gas main planning (i.e. engineering), gas main construction, gas main maintenance (i.e. leak repair), and new services <p>Municipalities often utilize relationships with gas company staff in various departments. However, this can result in information getting siloed in just one department or sent to the wrong person. The gas company's key representatives will know how to move information around to the other parties in the gas company that may need it. Driving communication through them will help maximize the chance that all relevant parties get information and updates.</p>

	<p>Include requirement in paving contracts for 3-week minimum notice of schedule changes.</p>	<p>The paving contract should require a minimum of three weeks notice for schedule changes. This can allow the gas company time to adjust its crews to do leak surveys, leak repair and raise gate boxes. Requirement can direct paving contractor to notify the gas company directly.</p> <p>Language recommended by Columbia Gas is "...contractor is required to provide at least three weeks notice of the street paving schedule to all utilities."</p> <p>Municipalities and gas companies reported that paving contractors routinely change schedules with little advanced notice. When schedules are moved earlier, gas companies cannot always adjust to survey and repair gas leaks, replace their leak-prone mains, or raise gate boxes. This results in excess cost and missed opportunities to address leaks. However, few municipalities have contract language that specifically limits such schedule changes. As more municipalities implement this type of language, it will become the standard, rather than the exception for paving contractors. Columbia Gas has reported initial success with some of their municipalities using such contract language.</p>
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Infrastructure Plans		
Who	Best Practice	Background
Municipality	<p>Maintain three year plans for paving, water and sewer infrastructure upgrades.</p>	<p>Maintain three to five year plans for municipal infrastructure and paving that identify replacement and other excavation needs.</p> <p>Gas companies recognize that these municipal plans cannot be static and will be impacted by availability of Chapter 90 funds, emergency infrastructure problems and local politics. Nevertheless, gas companies stressed that having information from the municipality about its priorities for infrastructure projects is critical to maximize their ability to shift projects to align with municipal schedules.</p> <p>Plan data for years two and beyond does not necessarily have to be as comprehensive and detailed as the first</p>

		<p>year. For example, it could contain entire streets, rather than address-to-address segments and/or a short-list of wish-list items, rather than comprehensive plan. The gas companies noted that their second and third year of main replacement plans is not as detailed as the first year either.</p> <p>*Update by end of January to mid-February each year</p>
	Update annually list of completed paving, water and sewer projects.	<p>Gas companies report that completed information is vital in order to know which streets are under street-cut moratorium or which might still have opportunities for collaboration. Having this data will also help the municipality update infrastructure plans.</p> <p>*Track this information during the construction season or compile it immediately after</p>
	Maintain street-cut moratorium list	<p>List should show the year the street was paved and preferably be mapped using GIS.</p> <p>Roughly a two thirds of municipalities surveyed were already maintaining such a list.</p>

Data Management		
Who	Best Practice	Background
Gas Company	Coordinate requests for municipal data and sharing updates between departments.	<p>Coordination includes determining internal department needs for municipal plans and information and then assign responsibilities for data requests.</p> <p>Municipalities reported instances of providing information to the gas company, but it appeared information was not appropriately shared with other groups. This led to duplicative data requests and information not being acted upon.</p>
Municipality	Acquire access to Geographic Information Systems (GIS).	<p>Software (i.e. desktop) and online-based options exist for GIS.</p> <p>GIS can act as a database to track municipal plans and completed projects, based on the street segments on which they occur. GIS also visualizes the plan in map form. This makes it easy to review location data for mistakes (such as</p>

		<p>repaving Main Street vs Main Terrace). And maps are useful for engaging the public and communicating plans.</p> <p>Additionally, GIS allows for efficient comparison of the municipality's multi-year plans, as well as the gas company or other utilities. Through mapping and built-in analysis tool, GIS can identify areas of overlap between plans, even if they occur in different years. At a minimum, printing a paper map can make discussions with utilities more fruitful than trying to compare lists on a spreadsheet.</p> <p>GIS is commonly used by most municipalities in the study (92%). Unlike a standalone database, GIS has applications beyond roadwork coordination, making it a valuable acquisition for a municipality if it is not already in use.</p>
	<p>Keep paving, water, and sewer infrastructure plans in GIS and produce map.</p>	
	<p>Keep street-cut moratorium list in GIS and produce map.</p>	
	<p>Explore need for a database system, like COBUCS</p>	<p>Database software allows access to users in addition to the municipality, such as the gas company and other utilities. User's input planned projects according to address segments, and the database can automatically identify shared opportunities or conflicts. The database can also include rules that ensure format and quality of data. However, a database was only used by the City of Boston in this study.</p> <p>The rarity of a database likely reflects the fact that 1) it is most beneficial in the municipalities with lots of projects and lots of parties to coordinate and 2) there is a substantial cost to developing or purchase a database service.</p> <p>Municipalities could evaluate a database as a longer term solution if it fits their needs and funding can be made available.</p>

Share & Strategize

With communication systems, infrastructure plans and appropriate technology in place, the next step of coordination relies on sharing data between the gas company and municipality, identifying projects on which to coordinate scheduling, and establishing a process to keep both parties moving in sync over the course of the construction season.

For gas companies, the shared data should include all years of gas main replacement plans, as well as information on the existence of gas mains throughout a municipality. Municipalities should be open to the idea that the specificity and scope of gas main location data will vary depending on the municipality's needs, as described below. For municipalities, data sharing should include all years of its own infrastructure plans. Where possible and valuable, sharing plans in GIS should be offered by both gas companies and municipalities.

Both parties need to use the pre-construction season meeting to compare shared plans and identify opportunities to adjusting schedules so that gas companies can replace their infrastructure and fix leaks while minimizing patches and damage to municipal roads.

Share Data		
Who	Best Practice	Background
Gas Company	Request all years of all municipal infrastructure plans.	Gas companies annually ask for paving plans from municipalities, but municipalities reported they are not usually asked for water and sewer plans. Also, some municipalities reported sharing only one year of plans because gas company did not ask for multiple years.
	Set reasonable deadline for receipt of municipal infrastructure plans.	Suggest late-January to mid-February. Deadline must balance the municipalities' need for sufficient time to update plans after the construction season ends in mid- to late- November with the gas companies' need to receive plans with enough time to adjust their own.
	Share all years of gas main replacement plans.	Despite gas companies having gas main replacement plans for years 2 and 3, many municipalities reported only having access to one year of gas company plans at a time. Providing access to additional years will allow municipalities to incorporate it into their planning process.

	<p>Share map of municipal streets with existence of gas main and pipe material.</p>	<p>The map should not include the level of detail necessary to locate the pipe in the street, pipe size, pressure or existence of other gas-system equipment. It is possible that such information could constitute Critical Energy Infrastructure Information (CEII) if shared for the entire municipality's system²⁹.</p> <p>In contrast, providing information on just the existence of pipe under a street and its material for the entire municipality's system should not constitute CEII. Further, that data would suffice to be valuable for coordination, because municipalities can use it to identify 1) which of their projects that might encroach upon leak-prone pipe, forcing the gas company to replace it; and 2) which road segments are leak-prone and thus likely to be good sites of future coordination.</p> <p>Roughly half of municipalities interviewed requested such a map. See Case Study on City of Melrose to see how they are using this type of information.</p>
	<p>For municipal engineering projects, share gas main location information.</p>	<p>This information should include the level of detail necessary to locate the pipe in the street, pipe size, and existence of other gas-system equipment. Because it is only shared for small segments of the entire system at a time, this should not constitute Critical Energy Infrastructure Information (CEII).</p> <p>Municipalities need this detailed information to identify potential conflicts with gas infrastructure during the design phase for their infrastructure projects, in order to avoid expensive delays in the field and/or revisions to design. Dig Safe mark-outs happen only 72 hours at most before excavation, too late to inform this process.</p>
	<p>Share gas leak data.</p>	<p>The data is made publicly available each year on the Department of Public Utilities' website when the gas companies submit Annual Service Quality Reports, but many municipalities are unaware that it is available and the format is often difficult to manipulate. Providing this data would increase transparency and help municipalities identify the leakiest areas.</p>

²⁹ <https://www.ferc.gov/legal/ceii-foia/ceii.asp>

	<p>Offer GIS files for both main replacement plans and map of streets with gas mains.</p>	<p>The majority of municipalities have GIS capabilities. Combining their own plans with the gas companies plans in GIS will allow them to more easily identify overlap and potential areas to synchronize projects.</p> <p>The data shared should only show the street segments, not detail about where in the street the gas main lies, to avoid constituting Critical Energy Information Infrastructure (CEII).</p>
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Share Data		
Who	Best Practice	Background
Municipality	Share list of streets under a Street Cut moratorium.	<p>List should show year paved and be updated annually.</p> <p>*Share in December or as soon as possible after the end of construction season.</p>
	Share all years of all infrastructure plans.	<p>This includes plans for paving, water and sewer projects. Gas companies recognize that these plans are often tentative, as funding, winter damage, emergencies and politics can change priorities.</p> <p>Some municipalities only shared one year of plans in order to “force” the gas company to focus on coordinating year one projects. While well intentioned, this severely limits the amount of advance notice the gas company receives and therefore limits its ability to adjust its plans in response.</p>
	Share any other “wish-list” information.	If the municipality has other long-term infrastructure project goals, share this information may help the planning process for the gas company.
	Share information on planned new developments as soon as possible.	New residential and commercial developments may require new gas mains and/or updates to existing gas mains servicing the area. The municipality should ensure that the gas company is aware as early as possible and municipality should request an affirmative decision on whether work on mains will be needed.

	Request gas main replacement plan.	Ensure that the municipality receives an updated copy each year of the gas company's gas main replacement plans, which should cover at least three years.
	Request map showing existence of gas main on streets and pipe material.	<p>Use this information to proactively identify 1) which of municipal projects might encroach upon leak-prone pipe, forcing the gas company to replace it; and 2) on which road segments will need pipe replaced eventually.</p> <p>This level of detail - simply showing whether the street has pipe and its material, but not where in the street pipe exits or other aspects of the system - should not constitute Critical Energy Infrastructure Information (CEII)³⁰ but should be sufficient to benefit the coordination and planning process.</p>
	For municipal engineering projects, request gas main location information.	<p>This information should have the level of detail necessary to locate the pipe in the street and determine its dimensions. This enhanced level of detail should not constitute CEII because it will only be shared for small segments of the system at a time.</p> <p>Use this information to proactively improve engineering designs and minimize the need for future change orders or in-field delays. However, remember that gas company data may not be entirely accurate, as the depth and location of pipes may have changed over time due to natural and man-made activities. Further, this information does not substitute for getting mark-outs from Dig Safe.</p>
	For gas company engineering projects, share water and sewer main location information.	Provide the same level of detail as the gas company provides to facilitate their engineering and design process. This can benefit the municipality by reducing in-field change orders that might prolong the gas company's work and therefore disruption to traffic.
	Request gas leaks data.	Data is publicly available each year in each gas companies Annual Service Quality Report and could be shared directly by the gas company as part of the overall data sharing to help the municipality better understand its infrastructure. *Data available in early March.

³⁰ <https://www.ferc.gov/legal/ceii-foia/ceii.asp>

	Request and offer to share GIS files for infrastructure and plans.	<p>Requested GIS files can include gas main replacement plans and the existence of gas mains and material type. Files can be easily opened in the same map as the municipality's plans to facilitate comparison.</p> <p>Offer to share street-cut moratorium list and infrastructure plans as GIS files.</p>
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Compare & Synchronize Plans		
Who	Best Practice	Background
Gas Company & Municipality	Compare infrastructure plans for years 1-3.	<p>Occurs during pre-construction season meeting</p> <p>Both parties should bring infrastructure plans and a street-cut moratorium list to the meeting, and preferably have maps showing street segments coded by year. If possible, the parties could load GIS data onto the same map and look at it live on the screen together to identify overlaps and adjust plans.</p> <p>If possible, look at opportunities and plans for beyond year 3.</p>
	Agree on infrastructure schedule changes for years 1-3 that would benefit both parties.	<p>Planned work may overlap on the same street segment in the same or different years. For those in the same year, the projects schedules should be adjusted, if needed, to allow the gas company to perform its replacement before paving.</p> <p>For projects planned for different years, the parties can decide if one schedule can be adjusted so that the gas main replacement can occur before paving.</p> <p>As previously mentioned, schedule changes for municipal work beyond year one may be affected by unforeseen circumstances. However, making a commitment to synchronize work can help maximize the chance that the municipal plans come to fruition, for example, by providing additional rationale for allocating or retaining funding to that specific project.</p>

	Define projects that need sequencing for the upcoming construction season.	The gas company and municipality should be clear which segments of street the gas company needs to have access to before paving or other municipal work takes place. The municipality can then commit to prioritizing efforts to keep its schedule for those segments on track and update the gas company as soon as possible if changes are needed.
Municipality	Develop program for other utilities to participate in plan sharing and project synchronization efforts.	<p>Like the Cities of Worcester and Cambridge, including additional utilities in regular meetings to discuss and compare infrastructure plans can generate additional opportunities for synchronization.</p> <p>Both Cities have been able to find these shared opportunities through regular-in person meetings where utilities and municipalities bring plans and discuss opportunities to adjust schedules.</p>

Generate & Capture Savings

Trench restoration regulations from the State, DTE 98-22³¹, can create unnecessary paving costs when gas companies try to meet both the regulations and municipal preferences. By comparing these preferences and formally agreeing to changes, municipalities can generate savings for the gas company and still meet municipal goals for high quality, durable pavement. The savings are largest on the road segments which the gas company and municipality have agreed to synchronize projects.

Where savings are generated due to active coordination and synchronization efforts, both parties should be able to capture part of the financial savings. If accomplished, these savings can not only incentivize improved coordination, but can fund accelerated gas main replacement and additional municipal paving projects.

If funds will be exchanged, the municipality will need to sign some form of agreement with the gas company (e.g. bi-lateral agreement). The agreement can memorialize the coordination practices expected of each party, make official the restoration practices allowed, and specify how savings will be calculated and shared. Decisions on restoration standards and sharing saving should happen over the off-season and at the pre-construction season meeting.

³¹ Docket 98-22: Standards To Be Employed by Public Utility Operators When Restoring any of the Streets, Lanes and Highways in Municipalities, August 26, 1999, by Massachusetts Department of Telecommunications and Energy (DTE)

Generate Savings		
Who	Best Practice	Background
Municipality & Gas Company	Discuss trench restoration requirements of DTE 98-22 compared with municipal preferences.	<p>Occurs during pre-construction season meeting</p> <p>A permanent pavement patch uses a higher grade of pavement than a temporary patch and the permanent patch covers more surface area because it must be “cut back” wider into existing pavement. As a result, the permanent patch costs substantially more than a temporary patch.</p> <p>DTE-98 22 requires temporary patches be replaced after 2-5 days with a permanent patch, depending on season. One implication of this is that, in cases where the municipality is synchronizing a paving project with the gas company, the gas company would have to install a permanent patch only to have it removed shortly thereafter during municipal repaving.</p> <p>Due to trench settling, some municipalities prefer that final patching occurs after a settlement period of 30 or 60 days, or even an entire winter season. In cases where the municipality will not repave, the 2-5 day requirement for permanent patches means that the gas company will have to install an initial permanent patch, then return to replace or repair it later on.</p> <p>Finally, some municipalities prefer that final patches use the “grind-and-inlay” method, rather than the “cut-back”. This impacts less surface area and has a lower cost as a result.</p>
	Agree to changes to trench restoration that are cost saving or cost neutral.	<p>Gas companies and municipalities can make changes to the restoration standards, DTE 98-22, as long as both parties mutually agree to the changes and they are cost-saving or cost-neutral compared to the regulations.</p> <p>Some examples of cost-saving changes are:</p> <ol style="list-style-type: none"> 1) Allow temporary patches to persist until municipal paving occurs 2) Allow temporary patches to persist through the preferred settlement period 3) Allow permanent patches to use the grind-and-inlay method rather than full depth cut-back

	<p>Schedule an early-construction season check-in.</p>	<p>To ensure that as many synchronized projects as possible will get executed over the course of the construction season, the gas companies and municipality should schedule a check-in meeting roughly one month into the construction season. Both parties should evaluate whether coordination and communication commitments made during the pre-construction season meeting are being upheld and working effectively. Where there are deficiencies, this provides a mechanism to correct them early on.</p> <p>*Schedule for mid-May</p>
	<p>Determine frequency of other meetings during construction season.</p>	<p>The gas company and municipality should have some regular communication during the construction season. The frequency, method (e.g. in person meeting or phone call), and staff in attendance should be determined based on the amount and complexity of gas main replacement work. In person meetings may be particularly effective if other utilities are invited so that all parties can be updated.</p> <p>Having a regularly scheduled meeting can ensure municipalities have an opportunity to raise issue and get answers. This may be able to avoid or minimize the practice of pulling or withholding permits. Municipalities reported withholding permits because of non-responsiveness from the gas company. While an effective tool, it slows down gas main replacement work during a relatively short construction season.</p>
<p>Municipality</p>	<p>Consider not requiring curb-to-curb repaving during the street-cut moratorium.</p>	<p>In instances where the municipality has not regularly provided the gas company with a list or map of its street-cut moratorium, municipalities should consider allowing the gas company to install a permanent patch over the trench, rather than repave curb-to-curb. If the gas company did not have access to information about which streets to avoid, it is unfair to penalize them for not avoiding them.</p> <p>A sub-set of municipalities interviewed by the project did already allow permanent patches, with the additional use of an infrared sealing, for trenches during the street-cut moratorium.</p> <p>Curb-to-curb repaving is much more expensive than</p>

		trench restoration, which utilizes limited resources for paving that could otherwise be used to replace more leak-prone gas mains.
	Link permits to gas company attendance at any construction season meetings.	<p>To ensure gas company attendance at the meetings during the construction season, make permit applications conditional upon their attendance. For example, in the case that the municipality decides to have a monthly meeting, if the gas company does not attend the meeting at the beginning of June, its permits for the rest of June would be withheld until it meets with the municipality.</p> <p>This will help increase the incentive for the gas company to attend the check-in meetings, and hopefully reduce the instances of withholding permits.</p>

Capture Savings		
Who	Best Practice	Background
Municipality & Gas Company	Sign bilateral agreement to share savings from synchronized projects.	<p>The bilateral agreement should document any cost-neutral and cost-saving changes to DTE 98-22, how the gas company savings will be calculated, and how the savings will be shared by the gas company with the municipality.</p> <p>Additionally, the bilateral agreement should document the commitments made during the pre-construction season meeting that will facilitate coordination and project synchronization. This includes what type of plans and data will be shared, when parties will meet, how communication updates will be shared, etc.</p>
Gas Company	Agree to share half of cost savings with municipality.	<p>For synchronized gas main replacement projects that generate cost savings due to coordination with municipal paving projects, agree that gas company will share half of savings with municipality.</p> <p>Doing so will be cost-saving from the standpoint of the DTE 98-22 regulations, because the gas company avoids some or all of the cost of final paving. If half of those savings are provided to the municipality, the gas company will still spend less than budgeted that season on the gas main replacement project.</p>

		<p>Also, sharing the savings provides a strong incentive to municipalities to pursue and maintain coordination efforts.</p>
	<p>Apply cost savings to additional leak-prone pipe replacement.</p>	<p>If cost savings are applied towards replacement of additional leak-prone pipe, it can help the gas company stay on pace or potentially accelerate its timeline for leak-prone pipe replacement, while remaining on-budget.</p>
Municipality	<p>Institute mechanism to use shared savings for municipal infrastructure projects.</p>	<p>The goal of this best practice is to ensure that money saved through coordination returns to the departments responsible for the coordination, like Public Works, Water and/or Sewer. Those departments can use the savings potentially to help fund its coordination efforts, such as paying for staff time to update infrastructure plans and input into GIS or to pave additional roads.</p> <p>By default, payments to the municipality will go into the general fund, eligible for allocation anywhere in the municipal budget. It is possible to create a special revenue fund so that payments are allocated to a specific department. A special revenue fund requires approval from the legislature. MAPC can help explore this if desired. In the interim, municipalities may want to seek informal agreement within the municipal government that the payments will be prioritized to be added to the appropriate department's budget.</p>
	<p>Start a cooperative program to leverage shared savings to incentivize more infrastructure repair across utilities.</p>	<p>The City of Worcester's Cooperative Patching Program provides an excellent example.</p> <p>A similar program should use information sharing and meetings to identify areas where more than one utility needs to perform infrastructure upgrades, and the roadway is in need of repaving. If the utilities coordinate their work in the same construction season, then the program could allow them both to only install temporary patches and share half of the savings of avoided final paving with the municipality. The municipality can then use that funding to subsidize curb-to-curb repaving.</p> <p>The result is a win-win that leverages the shared savings to get more infrastructure replaced and streets paved at a lower cost for both parties than would otherwise occur.</p>

Find Efficiencies

Across all gas main replacement and municipal paving projects, not just those that will be synchronized, there are ways to improve efficiencies to build trust, save time and money, and improve safety:

- If new customers can be better managed, it may avoid cuts into roads under moratorium or recently repaved, reducing frustration and avoiding paving costs;
- The municipal permit system can be upgraded dramatically to reduce gas company and municipality administrative time, through measures such as email submissions and batch invoicing or through online permitting and payment;
- Improvements to the mark-out process exist for both the gas company and municipality to reduce incidence of damaged infrastructure and work delays; and
- Targeted changes to the trench repair and tree planting approaches can result in better roads and tree survival while minimizing cost.

New Customers		
Who	Best Practice	Background
Gas Company	Do not direct-mail advertise to customers on roads under a street-cut moratorium.	<p>Where possible, gas companies should avoid actively recruiting new customers when their road is under a street cut-moratorium. Doing so can place the resident or business in conflict with the municipality, which has to refuse their request for installation of a new service. If the municipality acquiesces, then it results in a patch in an otherwise newly paved road.</p> <p>General marketing through web, online, radio, etc. cannot be expected to be targeted based on address, but the gas companies should be able to easily exclude addresses from direct-mail campaigns. Of course, this is contingent upon municipalities providing those addresses in their street-cut moratorium lists.</p>
	Identify ways to recruit new customers on roads before a street-cut moratorium starts.	<p>The gas company should focus efforts on recruit new customers before a street get paved and is under a street-cut moratorium. This will be challenging, depending on how much lead time the municipality can provide the gas company on its plans for paving.</p> <p>Within this context, providing an additional financial incentives on gas equipment to customers who can convert before the moratorium begins may help.</p>

Municipality	Include address information in street-cut moratorium list.	Gas companies will need this data to adjust mailings to avoid residents on roads with street-cut moratoriums. Using GIS can facilitate this process because addresses can be automatically stored along with the street segments.
	Notify residents of opportunity to convert on roads that may be paved.	<p>Notifying residents of paving and infrastructure plans can be a useful service to set expectations and keep the community informed. The plans should be accompanied with a notice about the impending street-cut moratorium, to encourage conversions to gas before paving. At the same time, the plans should make clear that the plan shows priorities and it is subject to change.</p> <p>Making a map public on the municipality's website will likely be much less time intensive than trying to notify only the residents on specific street segments.</p>

Trench / Street Opening Permits		
Who	Best Practice	Background
Municipality	Process permits at least two weeks before the start of construction season.	Allow gas company to start work on the first day of the construction season, so that they can take full advantage of the short construction season to replace leak-prone pipe.
	Implement batch payments or electronic payment for permits.	<p>Processing paper checks is a time and resource intensive for municipalities, as well as the gas company. A few municipalities have chosen to invoice the gas company once or twice a year for all permit applications. This has reduced administrative time dramatically without the need for any new payment or technology systems.</p> <p>Longer term, implementing electronic payments would also streamline the payment process. It may require funding to acquire and support the software to manage the payments.</p>
	Implement email or online permit application process.	The majority of permit applications are currently done on paper and must be hand-delivered or mailed in. Simply turning the application into a PDF document that can be filled in electronically then emailed to the municipality can

	<p>substantially reduce the administrative burden for the gas company. If using PDF, create a fillable form, so that a user can type in their responses. Otherwise, the user must print it out, handwrite answers in, scan and email it back, which is not nearly as convenient.</p> <p>A few municipalities are currently using online permitting. This can generate efficiencies for the municipality too. Submission rules can ensure all necessary data is entered, drop-down lists can allow only valid road names and addresses, and the data will all be stored in a centralized location which facilitates searching and reporting. Additionally, the review and approval process can happen within the system, rather than requiring tracking separate files or pieces of paper.</p> <p>Some municipalities have online permitting in other departments, such as building permits, but not in Public Works. Those municipalities should look to expand their permits to street opening.</p>
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Mark-Outs for Underground Infrastructure		
Who	Best Practice	Background
Gas Company	Mark out abandoned gas mains.	<p>Municipalities frequently reported issues with abandoned gas mains during excavations. These are generally not marked out during Dig Safe. It poses a challenge and a safety risk. Municipalities will likely hand-excavate around the first main they find, and use the backhoe for the rest of the excavation. Not infrequently, that first main is actually an abandoned main. As a result, the municipality is then much more likely to hit and puncture the live active main later on.</p> <p>Where gas company records show abandoned main, it should be included in the Dig Safe mark-out. Moving forward, gas companies should track the location of abandoned main so that they can mark it out in the future.</p>

Municipality	Clarify with gas company if and when it will mark out abandoned mains.	The municipality should seek to have the gas company mark out abandoned mains when its records indicate their presence. Through discussion with the gas company, confirm whether this is possible and be clear how the presence of abandoned main will be communicated.
	Report errors with mark-outs using Dig Safe form.	Gas company records are not always accurate. Some of the pipe is over 60 years old, and records may have been lost, abandoned pipe not tracked, or soil conditions have changed the depth and location of the main. If and when municipalities discover errors with mark-outs, it should use the Dig Safe report form so that the gas company can be notified of issues with its data or identify the source of mark-out errors.
	Call Dig Safe before excavating for municipal projects.	Gas companies reported that some municipalities rarely call Dig Safe before they perform their own excavations. This can result in hits to infrastructure and dangerous punctures. Municipalities should make a commitment to call Dig Safe before any excavation.

Trenches & Paving		
Who	Best Practice	Background
Gas Company	Explore ways to ensure sufficient resources exist to raise gate boxes.	Ideally, with improved notice by paving contractors of schedule changes, there will be fewer instances where union labor is unavailable. But in the interim or when notification is short, consider options to improve response rate. This could include having the option to let qualified outside contractors raise the gate boxes or hiring additional union contractors. In either event, the goal is to avoid the cost and disruption of having to excavate and raise them after paving.
	Explore use of a soil compaction meter to improve quality of trench compaction	Eversource has piloted a soil compaction meter on some trenches with the Cities of Marlborough and Cambridge. The use of the tool could be expanded if it demonstrates improved compaction and less settling over time.
	Share data with municipality on frequency and result of paving patch inspections.	Municipalities felt that gas companies were not adequately inspecting their paving patches for settlement and pavement quality. Meanwhile, gas companies

		<p>reported actively tracking their inspections and results. This disconnect indicates information is not being shared.</p> <p>Simply sharing the inspection data with municipalities would increase transparency and help prove that the gas company is in fact performing inspections and repairs. Alternatively, it may highlight that not enough inspections are happening, in which case actions need to be taken to remedy the situation.</p>
	Use plastic ownership tags for patches.	For both leak repairs and gas main replacements, put plastic ownership tags in the patch. This will avoid future confusion about the responsibility for inspection and repair of failed patches.
Municipality	Request data on frequency and result of paving patch inspections.	<p>Gas companies reported actively tracking their inspections and results, despite most municipalities reporting the perception that inspections hardly happen at all.</p> <p>Municipalities should request the records of paving inspections on some regular basis during the construction season. If patches are not being inspected, or inspections are passing patches that really should fail, the municipality can have a more informed discussion with the gas company about how to improve.</p>
	Request gas company use plastic ownership tags for patches.	For both leak repairs and gas main replacements, request that the gas company put plastic ownership tags in the patch. This will avoid future confusion about the responsibility for inspection and repair of failed patches.
	Do not request use of “flowable fill”.	<p>Gas companies report that their primary opposition to “flowable fill” is that it can change the way that leaked gas migrates out of a leak. This can make it more difficult for them to locate leaks in the future.</p> <p>To achieve better compaction and less settling, talk with the gas company about using a soil compaction meter during the restoration process. Eversource has piloted these in the Cities of Marlborough and Cambridge.</p>

Street Tree Plantings		
Who	Best Practice	Background
Municipality	Require that an arborist or tree contractor check soil in tree pits for the presence of natural gas.	<p>Natural gas in soil forces out oxygen, vital for the roots. When planting new street trees or replacing dead trees, it is important to check for the presence of gas in the air below ground. If gas exists, it may damage or kill the new tree.</p> <p>Municipalities could purchase a Combustible Gas Indicator used to check for gas when planning street tree plantings.</p> <p>Municipalities could also look at the annual gas leak data and the map of pipe material - hopefully shared by the gas company - to identify if the area near the tree is likely to have gas leaks.</p>
	Prohibit planting if natural gas is found below the soil.	<p>If gas is found, make sure to report the gas leak to the gas company immediately.</p> <p>Do not plant a tree until the leak is fixed or cleared by the gas company. If greenery is needed, consider placing a planter on the site for flowers and shrubs in the interim.</p>

CASE STUDY: CITY OF BOSTON, SERVED BY NATIONAL GRID GAS

The City of Boston has 22 different organizations doing major infrastructure repair and replacement and a backlog of \$180 million worth of street repair. Working with this many organizations and this large a backlog of work makes long-term planning exceptionally difficult. The approximately 18 million square feet of new development being added in Boston within the next decade, complicates planning even more. To deal with these challenges, the City of Boston developed COBUCS, the City of Boston Utility Coordination System.

When any entity, including a gas company, wants to secure a permit to do work in a public way in the City, they must input the project into COBUCS with the exact address or street segments, as well as the dates and other details. For National Grid, the City's primary gas company, gas main replacements, as well as repair of Grade 2 gas leaks and their repair dates are inputted into the system.

COBUCS checks that planned project against the list of streets under a street-cut moratorium as well as planned projects by the City. The system then either approves the work or provides a notification if there is a conflict. Where there are conflicts, the City and company work together to identify whether and how to proceed. COBUCS also cross-notifies all the pertinent organizations that are doing work in the same area to help increase integrated infrastructure repair. The Boston DPW also requires regular meetings with all the utilities and major developers. Through COBUCS and the meetings, the organizations have been able to sequence the work to increase integrated infrastructure repair.

Preliminary data shows that sequencing the work through COBUCs seems to help reduce the amount of "lost opportunities." A Boston University 2016 doctoral thesis by Margaret Hendrick found that 35% of recently paved Boston streets still had the leak-prone pipes under them in comparison to 86% of Brookline streets, a nearby town that - like the vast majority of municipalities in the State - does not have a similar automatic review and notification system.³²

The Boston DPW has found COBUCS enormously useful and wants to upgrade it to add in large events and make it more of a visual map. They will also start to produce a three-year paving plan so they can work more proactively with the utilities to meet that plan.

National Grid has found COBUCS very helpful, too. "If every municipality had COBUCS, it would be great" says Susan Fleck of National Grid's VP of Gas Pipeline Safety & Compliance, "It drives automatic coordination."

National Grid noted that a system like COBUCS is only effective if all of the entities requiring permits actually use it. While there are some off-the-shelf software products available, they often need tailoring and can be expensive for municipalities to support. As a result, National Grid suggested that this could be an opportunity for the State to develop and support a COBUCS like system that all municipalities would have access to.

³² Hendrick, Margaret, Boston University doctoral thesis, 2016, not yet published.

6. Conclusion

In the two years since An Act relative to natural gas leaks became law in Massachusetts, gas companies have begun to ramp up their existing efforts to replace leak-prone pipe throughout the State. Doing so often requires cutting into recently paved streets, which diverts rate payer resources to repaving trenches, diminishes roadway life, and causes municipal frustration. Further, with the current timeframe for eliminating the leak-prone pipe, gas will continue to escape for decades. In this context, it is imperative to find ways to accelerate replacement and minimize costs.

As evidenced through this project's interviews, both gas companies and municipalities identified numerous shortcomings in each other's coordination efforts. At the same time, each also recognizes that it has its own improvements to make. This project found numerous examples of successful coordination strategies used by individual municipalities and gas companies, but they are not widely implemented across the state. Based on these examples, the project developed its best practice recommendations. The best practices apply to both gas companies and municipalities, and encouragingly, most are low-cost measures that could be implemented in the short-term. The gas leak surveys undertaken by this project highlight the impact of utilizing some of these coordination best practices to avoid "missed opportunities" for leak repair and pipe-replacement.

The surveys also highlight a potentially practical method to find and target super-emitting leaks. This method could be investigated further as a way to identify those leaks that cause significant environmental impact, as required by An Act to promote energy diversity.

MAPC and HEET encourage both municipalities and gas companies to consider this report an opportunity to reassess their coordination practices and initiate a fresh start at coordinating with each other. As identified by the report, critical elements include regular communication, tracking and sharing the appropriate data, and identifying shared opportunities on which to capitalize. Throughout the process, opportunities abound for streamlining and improving efficiencies which can improve coordination further. MAPC and HEET hope that this report has successfully highlighted many of the biggest barriers to coordination and look forward to supporting municipalities and gas companies in their efforts to overcome them.

Based on data shared by Columbia Gas and the City of Worcester, the cost savings achieved by synchronizing gas main replacement with municipal paving, thereby avoiding final paving (i.e. permanent patch) costs, may be between 8% and 15% of the total cost of replacing a mile of leak-prone pipe. At an average cost of \$1,020,000 per mile of leak-prone pipe, the savings could amount to between \$83,000 and \$153,000 thousand per mile.³³

If all of the 5,512 miles of leak-prone pipe that must be replaced across National Grid, Columbia Gas and Eversource were synchronized with municipal paving, the total savings could amount to \$452,000,000 to \$843,000,000. Clearly, only a portion of the projects will be able to be synchronized. Ideally, both municipalities and gas companies should work together, using the best practices developed by this

³³ Based on costs reported in 2015 GSEP Plans.

project as well as continued innovation, to maximize the number of projects that can be synchronized and the resulting value that can be captured.

Exhibit I: Municipal Recruitment

MAPC and HEET endeavored to achieve municipal participation in the gas leaks that reflects a mix of median-income levels, community types, and natural gas distribution utilities from within the MAPC region.³⁴

Table 1. Natural Gas Distribution Utility

Natural Gas Distribution Utility	# Municipalities in MAPC Region	% of Total	Municipalities Interviewed	% of Total	Municipalities Given Leak Survey	% of Total in Project
National Grid	57	56%	15	58%	8	53%
Eversource	18	18%	5	19%	4	27%
Both National Grid and Eversource	4	4%	1	4%	0	0%
Both Eversource and Columbia Gas	1	1%	0	0%		0%
Columbia Gas	20	20%	5	19%	3	20%
Total	100[^]	100%	26	100%	15	100%

[^]Not including Wakefield which has its own gas distribution utility

Table 2. Municipal Median Household Income

Quartile	MAPC Region Median Income Range	Municipalities Interviewed	% of Total	Municipalities Given Leak Survey	% of Total in Project
Below Q1	<\$75,298	9	35%	5	33%
Q1 to Median	\$75,298 to <\$95,465	6	23%	2	13%
Median to Q3	\$95,465 to <\$116,875	4	15%	3	20%
Above Q3	>\$116,875	7	27%	5	33%
Total		26	100%	15	100%

Table 3. Community Type

Quartile	Municipalities Interviewed	% of Total	Municipalities Given Leak Survey	% of Total
Developing Suburbs	5	19%	2	13%
Inner Core	8	31%	5	33%
Maturing Suburbs	8	31%	6	40%

³⁴ Information on community types can be found at http://www.mapc.org/sites/default/files/Massachusetts_Community_Types_-_July_2008.pdf

Regional Urban Centers	5	19%	2	13%
Total	26	100%	15	100%

Table 4. Participating Municipalities

Town	Utility	Income	Income Bracket	Community Type	Participation
Acton	National Grid	\$120,865	Q4	Maturing Suburbs	Interview & Survey
Arlington	National Grid	\$92,338	Q2	Inner Core	Interview Only
Bedford	National Grid	\$114,676	Q3	Maturing Suburbs	Interview & Survey
Bellingham	Columbia Gas	\$87,417	Q2	Developing Suburbs	Interview Only
Boston	Eversource/Ngrid	\$54,485	Q1	Inner Core	Interview Only
Brookline	National Grid	\$93,640	Q2	Inner Core	Interview & Survey
Cambridge	Eversource	\$75,909	Q2	Inner Core	Interview & Survey
Chelsea	National Grid	\$48,725	Q1	Inner Core	Interview & Survey
Concord	National Grid	\$132,385	Q4	Maturing Suburbs	Interview Only
Gloucester	National Grid	\$60,229	Q1	Regional Urban Centers	Interview Only
Hopkinton	Eversource	\$128,267	Q4	Developing Suburbs	Interview & Survey
Lexington	National Grid	\$137,456	Q4	Maturing Suburbs	Interview & Survey
Lincoln	National Grid	\$127,763	Q4	Maturing Suburbs	Interview Only
Littleton	National Grid	\$111,652	Q3	Developing Suburbs	Interview Only
Malden	National Grid	\$55,523	Q1	Inner Core	Interview & Survey
Marlborough	Eversource	\$71,424	Q1	Regional Urban Centers	Interview & Survey
Medfield	Columbia Gas	\$143,641	Q4	Maturing Suburbs	Interview & Survey
Melrose	National Grid	\$86,409	Q2	Inner Core	Interview Only
Milford	Eversource	\$68,007	Q1	Regional Urban Centers	Interview & Survey
Millis	Columbia Gas	\$96,773	Q3	Developing Suburbs	Interview & Survey
Newton	National Grid	\$118,639	Q4	Inner Core	Interview & Survey
Randolph	Columbia Gas	\$63,259	Q1	Maturing Suburbs	Interview & Survey
Salem	National Grid	\$59,044	Q1	Regional Urban Centers	Interview Only
Swampscott	National Grid	\$96,494	Q3	Maturing Suburbs	Interview & Survey
Walpole	Columbia Gas	\$90,332	Q2	Developing Suburbs	Interview Only
Worcester	Eversource	\$45,001	Q1	Regional Urban Centers	Interview Only

Exhibit 2: Interview Questions

Street/Sidewalk Reconstruction Planning

- What % of streets are repaved per year?
- Does the City/Town have a formal, multi-year street and/or sidewalk reconstruction plan (repaving a street or street segment, rather than fixing potholes) that identifies streets and/or sidewalks to be reconstructed?
 - If Yes
 - When did the City/Town begin using a plan?
 - How many years does the plan cover?
 - Are funds appropriated for the entire plan period? (E.g. the estimated funding for all work is appropriated for a 3-year plan once it's approved).
 - Is there an annual review / update of the plan?
 - Are there metrics to track progress (i.e. % of streets per year)? What are they?
 - Is the plan published publically? Where? Can we have a copy?
- If No
 - Has the City/Town considered developing a multi-year plan?
 - Are there any specific challenges or barriers that have prevented you?

For Both Formal Plans and Otherwise

- How are reconstruction needs identified?
 - Formal survey of roads and sidewalks (how frequently)? Resident reports? DPW worker reports?
- How are reconstruction needs prioritized and selected?
 - Sewer separation needs; Buffer zones of sensitive areas, like park, library, school, youth center, elderly housing, senior center, public transit stop
 - Major thoroughfares that receive heavy traffic; Commission for Persons with Disabilities priority areas; Areas with lack of bicycle facilities
 - Gas leak prevalence
 - Other?
- How are reconstruction efforts tracked? (i.e. how do you track those that need reconstruction, those selected, and where reconstruction finished)
 - Geographic Information Systems (GIS), spreadsheet or other software

Street Reconstruction Activities & Trees

- What does reconstruction entail?
 - Repaving and re-striping; bicycle lanes; curb cuts reconstructed; Medians evaluated for accessible pedestrian crossing; Planting street trees
- Does the City/Town check for gas leaks when planting new trees?
 - If a gas leak is suspected or identified, does planting proceed? If so, are any measures taken to protect tree from damage by gas?

City/Town communication with Gas Utility

- Does the City/Town send its reconstruction or other roadwork plans to the gas distribution utility? If so, at what time of the year or how frequently?
- Do you meet regularly w/ the utility? How often?
- Who is at the meeting? What is their name, job title and responsibilities? Anyone else you communicate with (name, title and responsibilities)?

Utility communication w/ city

- Do you receive construction plans from the gas distribution utility?
- If so, at what time of year do you receive it?
- Does it cover one year or more?
- Are specific addresses mentioned and dates?
- Other information on it?
- Is there other info you'd want on it?
- What other forms of communication and collaboration do you have with the gas distribution utility? What frequency do these occur on?

Impact

- Does your communication or collaboration with the gas distribution utility influence either your own road construction plans or their construction plans? Please describe.
- Are there any policies (carrots or sticks) to encourage utilities to coordinate repair work with your road reconstruction schedule? Provide detail and length of time in use.
 - Moratorium on repairs after reconstruction. How long has it been enforced?
 - Special Permitting requirements
 - Fees or penalties
 - Other?
 - Do you wish there were others? What would they be?
- Do you feel that the City/Town is generally successful in coordinating gas utility repairs with road reconstruction? Why or why not? If you want more coordination, what would it be (on the city or utility side)?
- What is the permitting process for a gas distribution utility to do repair work? How long does it take? Do they complain about it? What are their suggestions?
- Do you help/hinder the utility in any other way with their work: traffic control? Work day restrictions? Police details? Restoration?
- Would you want to partner with the utility to provide a pipeline of job seekers? Perhaps by connecting them with a vocational school or work training program?

Pipeline Map

- Do you have a map of the gas distribution pipes in the municipality?
- If yes, when is it from, and do you receive this on any regular basis? Can we get a copy of it?

Exhibit 3: Checklist of Best Practices for Municipalities

Checklist of Best Practices for Municipalities Coordination with Gas Company

I. Set Foundation

Staffing & Communication

Hold pre-construction season meeting with gas company.

Purpose:

- Introduce **all** participants in the coordination process for gas company and municipality
- Compare infrastructure plans and identify opportunities for aligning schedules
- Establish communication procedures for the construction season
- Establish clarity on restoration, paving and inspection procedures

Establish policy to coordinate paving, water, and sewer infrastructure planning efforts internally.

Hold annual internal meeting to schedule infrastructure plan updates across highway, water and sewer.

Obtain contact information for gas company key representatives, including

- Community liaison (i.e. point-person)
- Managers for gas main planning (i.e. engineering), gas main construction, gas main maintenance (i.e. leak repair), and new services

Note: these may be available on a website provided by the gas company.

Include requirement in paving contracts for minimum of three week notice of schedule changes

Paving contractor should send updates directly to gas company.

Infrastructure Plans

Maintain three year plans for paving, water and sewer infrastructure upgrades.

Extend to five years if possible. Gas companies expect that plans beyond year one will be priorities and subject to change. Gas companies have a five year planning cycle for gas main replacement.

Update annually list of completed paving, water and sewer projects.

Maintain street-cut moratorium list, showing streets by year paved.

Data Management

Acquire access to Geographic Information Systems (GIS), through software- or cloud-based programs.

Some options in use by MAPC municipalities are: [ArcGIS](#), [UtilityCloud](#), [PeopleGIS](#), and [MapGeo](#)

Keep paving, water, and sewer infrastructure plans in GIS and produce map.

Keep street-cut moratorium list in GIS and produce map.

Explore need for a data-base system, like COBUCS.

One option tested by at least one MAPC municipality is: [Envista](#)

2. Share & Strategize

Share Data

Share list of streets under a Street Cut moratorium.

Share all years of all infrastructure plans, including paving, water and sewer.

Share any other “wish-list” information related to infrastructure plans or needs.

Share information on planned new developments as soon as possible.

Request gas main replacement plan.

Request map showing existence of gas main on streets and pipe material.

For **municipal** engineering projects, request gas main location information.

For **gas company** engineering projects, share water and sewer main location information.

Share Data (Continued)

Request gas leaks data.

Request and offer to share GIS files for infrastructure and plans.

Compare & Synchronize Plans

At pre-construction season meeting:

-

1. Compare gas company and municipal infrastructure plans for years 1-3.

Use maps and GIS if available to facilitate comparison.

2. Agree on infrastructure schedule changes for years 1-3 that would benefit both parties.

3. Define projects that need sequencing of schedules for the upcoming construction season.

Develop program for other utilities to participate in plan sharing and project synchronization efforts.

Like Cities of Worcester and Cambridge, this may take the form of a regular meeting or series of meetings with all utilities present.

3. Generate & Capture Savings

Generate Savings

At pre-construction season meeting:

-

1. Discuss trench restoration requirements of [DTE 98-22](#) compared with municipal preferences.

2. Agree to changes to trench restoration that are cost saving or cost neutral.

Some examples of cost-saving changes are:

- Allow temporary patches to persist until municipal paving occurs
- Allow temporary patches to persist through the preferred settlement period
- Allow permanent patches to use the grind-and-inlay method rather than full depth cut-back

(At pre-construction season meeting: continued)

-

3. Schedule an early-construction season check-in, such as mid-May.

Evaluate efficacy of coordination efforts one-month into the season and identify improvements or corrections needed.

4. Determine frequency and method of other meetings during construction season.

Method and frequency should be commensurate with complexity and type of work.

Link permits to gas company attendance at any construction season meetings.

Consider **not** requiring curb-to-curb repaving during the street-cut moratorium.

Approach suggested especially if municipality has not historically provided street-cut moratorium information to gas company.

Capture Savings

Sign bilateral agreement to share savings from synchronized projects.

Institute mechanism to use shared savings for municipal infrastructure projects.

Could be a Special Revenue Fund, approved by the legislature, or a verbal agreement in the municipal government to prioritize returning funds to the Public Works or department responsible for coordination.

Start a cooperative program to leverage shared savings to incentivize more infrastructure repair across multiple utilities.

Like the City of Worcester, implement a program to identify opportunities for more than one utility to do infrastructure upgrades. Use the shared savings to reduce the cost of repaving that section of street curb-to-curb. This could build upon the regular meeting or series of meetings with all utilities to share plans and find shared opportunities.

4. Find Efficiencies

New Customers

Include address information in street-cut moratorium list.

Facilitates gas company removing address from direct mail campaign lists

Ahead of paving, notify residents of opportunity to convert on roads that may be paved.

Making a map of road paving priorities could be a low- effort and low-cost method to notify residents. Be clear that priorities are subject to change to preseve municipal flexibility.

Trench / Street Opening Permits

Process permits at least two weeks before the start of construction season.

For applications, implement: -

1. Email submission of electronically fillable PDFs (near-term solution)

2. Online permitting (long-term solution)

Programs in use by MAPC municipalities include: [PeopleGIS](#), [Tyler Technologies](#), and [ViewPoint Cloud](#)

For payment, implement: -

1. Batch payments for invoices, such as invoicing twice per year for all permits submitted

2. Online permit payment

Mark-Outs for Underground Infrastructure

Clarify with gas company if and when it will mark out abandoned mains.

Report errors with mark-outs using Dig Safe form.

Form at: http://www.digsafe.com/violation_reports.php

Call Dig Safe before excavating for municipal projects.

Trenches & Paving

Request data on frequency and result of gas company paving patch inspections.

Request gas company use plastic ownership tags for patches.

Do not request use of "flowable fill".

Consider requesting use of a soil compaction meter to achieve better compaction results.

Tree Planting

Require that an arborist or tree contractor check soil in tree pits for the presence of natural gas.

Use a combustible gas indicator (CGI) to take sub-surface readings. CGI used in MAPC-HEET study is [Bascom Turner Gas Ranger](#).

Prohibit planting if natural gas is found below the soil.

Report any gas found to gas company immediately. Consider using an above ground planter until leak is fixed or pipe is replaced.

Exhibit 4: Calendar of Best Practices for Municipalities

Calendar of Best Practices for Municipalities Coordination with Gas Company

Note: See Best Practice Checklist for Municipalities for the full list of recommendations for municipal best practices. The following calendar only address those recommendations which are annually recurring.

Year-Round

Send updates on planned new residential or commercial developments to gas company key representative as soon as possible.

If needed for engineering **municipal** infrastructure projects, request from gas company information on location, depth, and size of gas mains along applicable street segments.

December

Update list of completed projects from past construction season for municipal infrastructure:

- Paving, including street-Cut Moratorium list containing year paved
- Water main
- Sewer main

Send Street-Cut Moratorium list to key representative at gas company

Determine gas company's deadline for:

- Receiving municipal infrastructure plan updates and to whom the updates should be sent
- Sending gas main replacement plans to municipality

If needed, request from gas company an updated map and/or GIS file of streets in municipality with gas mains and type of pipe.

January

Review coordination effectiveness, recommended best practices, identify gaps, and select one or more best practices to implement

Assign municipal responsibilities and set timeline for completing 3-5 year municipal infrastructure plan updates, including:

- Paving
- Water main
- Sewer main

Include time to put plans into GIS. Consider including longer term infrastructure priority information if possible.

***Deadline should be mid-February or date provided by gas company, whichever is earlier**

January (Continued)

Schedule the pre-construction season meeting with gas company.

***Municipality and gas company will need to have their infrastructure plans at the meeting**

***Should be held no later than end of February**

Determine how and when to notify residents and businesses if their road has an impending moratorium due to planned paving, so that they may request gas service if desired

Confirm municipal paving procurement will have contract language requiring a minimum three-week notice for schedule changes.

Changes can be sent directly from paving contractor to gas company.

February

Continue implementing any best practices

Send infrastructure plan updates by mid month, if not already done, to key representative at gas company

- Paving plan
- Water main plan
- Sewer main plan

Offer to send gas company GIS files of plans.

Confirm receipt of gas company's **multi-year** gas main replacement plan, if not already received.

Request GIS file if planning to use for analysis.

Hold pre-construction season meeting, by end of month, if not already done.

At meeting:

- Introduce **all** participants in the coordination process for gas company and municipality
- Compare infrastructure plans and identify opportunities for aligning schedules
- Establish communication procedures for the construction season
- Establish clarity on restoration, paving and inspection procedures
- Determine whether bilateral agreement to capture savings will be signed or updated.

Schedule May check-in for coordination.

March

Continue implementing any best practices.

Start processing street opening permits at least 2 weeks before the start of construction season.

April - November: Construction Season

Continue implementing any best practices.

Hold check-in meetings as agreed to during pre-construction season meeting.

Track completed paving, sewer and water main projects as they are completed.

Use Dig Safe reporting form when errors are found in mark-outs.

Test tree pits for natural gas prior to planting.

May

Hold check-in with gas company to assess progress on coordination efforts.

Assess whether paving contractor is providing municipality with required advanced notification for schedule changes.

July

Once Chapter 90 funds are announced, if the funding changes municipal paving plans, notify gas company key representative.

November

Discuss with gas company possibility of working past end of construction season into winter and what the requirements will be.