

The background of the slide is a close-up photograph of water flowing through a metal grate. The water is turbulent and splashing, creating white foam and bubbles. The metal grate consists of several parallel, dark brown, cylindrical bars. A solid blue horizontal bar is positioned below the main text.

Steps You Can Take to Identify, Limit and Prevent **Inflow and Infiltration**



Building a Better World
for All of Us®

INTRODUCTION

Steps You Can Take to Identify, Limit and Prevent Inflow and Infiltration

Inflow and infiltration (I&I) is a risk to all wastewater systems. In fact, stormwater (inflow) and groundwater (infiltration) account for nearly 50% of flow at treatment plants with aging infrastructure. Due to rising water treatment and maintenance costs, reactively addressing I&I is costly to your community and utility ratepayers. Where should you begin? What can you do to identify, limit and even prevent I&I?

Throughout this eBook, we share answers to the questions above, I&I trends, cost implications and proven methods you can rely on to overcome your challenges. We also explore answers to your residents' most common questions regarding I&I and ways you can partner with them to create buy-in.

Short Elliott Hendrickson Inc. (SEH®) is a multidisciplined, professional services firm made up of 800+ engineers, architects, planners and scientists who provide complex solutions to clients throughout the U.S. With offices across the Midwest, Colorado and Wyoming, SEH focuses on improving mobility, improving infrastructure, engineering clean water and creating better places. Our commitment and core purpose revolves around Building a Better World for All of Us®.

Insights

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About the Experts



SPENCER COSSALTER

Spencer is a project design leader who oversees SEH's sanitary and storm sewer infrastructure inspection and evaluation services team. He also leads many of SEH's flow monitoring and other I&I investigations. As a project manager with 10+ years of inspection experience, he has coordinated inspection quality control, fieldwork scheduling and permitting, as well as NASSCO PACP, MACP and LACP inspection coding on many infrastructure projects.



LINDSEY ROBERTS MCKENZIE, PE*

Lindsey is a senior water resources engineer and project manager with 15+ years of experience helping cities overcome I&I challenges. She's experienced in hydraulic and hydrologic analyses; watershed modeling; floodplain management and flood risk reduction; and the design of large-scale stormwater management projects. Lindsey is the society treasurer on the Society of Women Engineers' Board of Directors and co-founder of SEH's Women in STEM employee resource group.

**Registered Professional Engineer in MN, NE, ND, SD*



PAUL KUBESH

Paul is a water resources technician, hydrologist and SEH's senior lead I&I technician. Paul has 20+ years of experience helping cities save money by identifying and resolving I&I challenges. His primary responsibilities include conducting flow metering for I&I projects, leading smoke testing and dye testing projects, and undertaking sewer system evaluation surveys.

For additional insight into ways you can identify, limit and prevent I&I, contact our experts:

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LOOKING FORWARD

How Much is Too Much? I&I Cost Implications, Steps and Trends

In sewer lines and wastewater systems with aging infrastructure, stormwater and groundwater entering the system account for nearly 50% of flow. If unaccounted for, the cost of this disruption can be significant. Yet, by identifying issues early and understanding your options, you can overcome and even prevent these challenges.

Because even minimal amounts of I&I can lead to substantial costs, especially in a time when funding and budgets are limited, where should you draw your line in the sand?

Here, we reveal what causes I&I, cost implications, how much is too much and where you should begin. The conclusion of this section also features five actionable and proactive steps you can take.

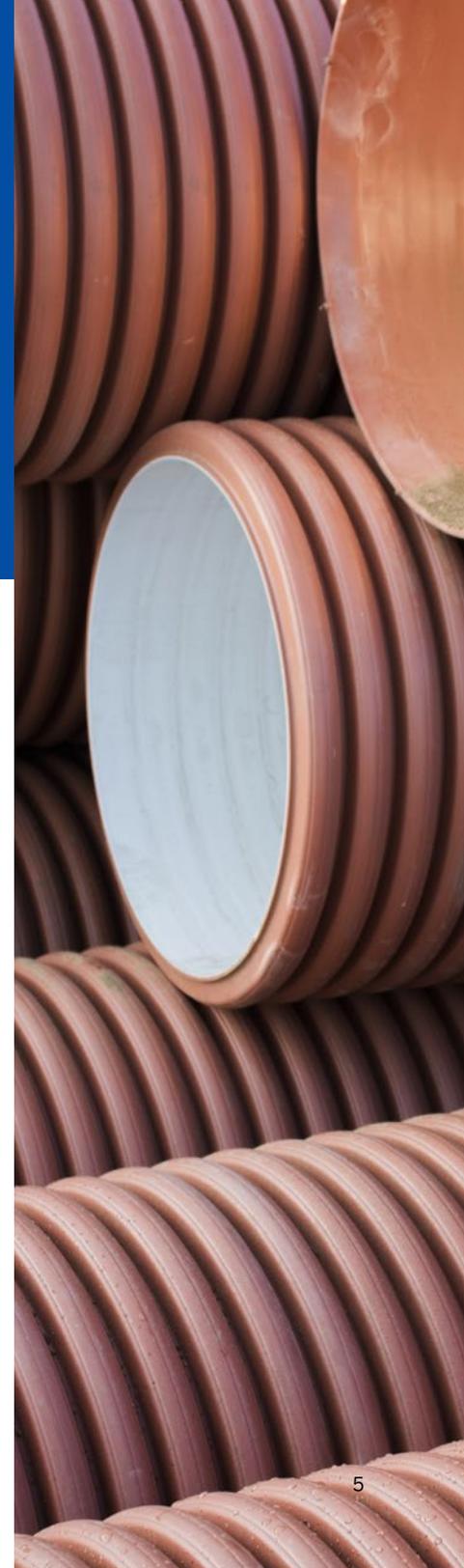


Although I&I is inevitable, knowing what's considered normal and excessive is key to ensuring your treatment systems operate effectively.

LINDSEY ROBERTS MCKENZIE
SENIOR WATER RESOURCES ENGINEER

Here's what you'll learn:

- 01 What is I&I?
- 02 Why do communities need to monitor?
- 03 Treating I&I – What are the costs?
- 04 Inflow – How much is too much?
- 05 Infiltration – How much is too much?
- 06 5 I&I actionable steps



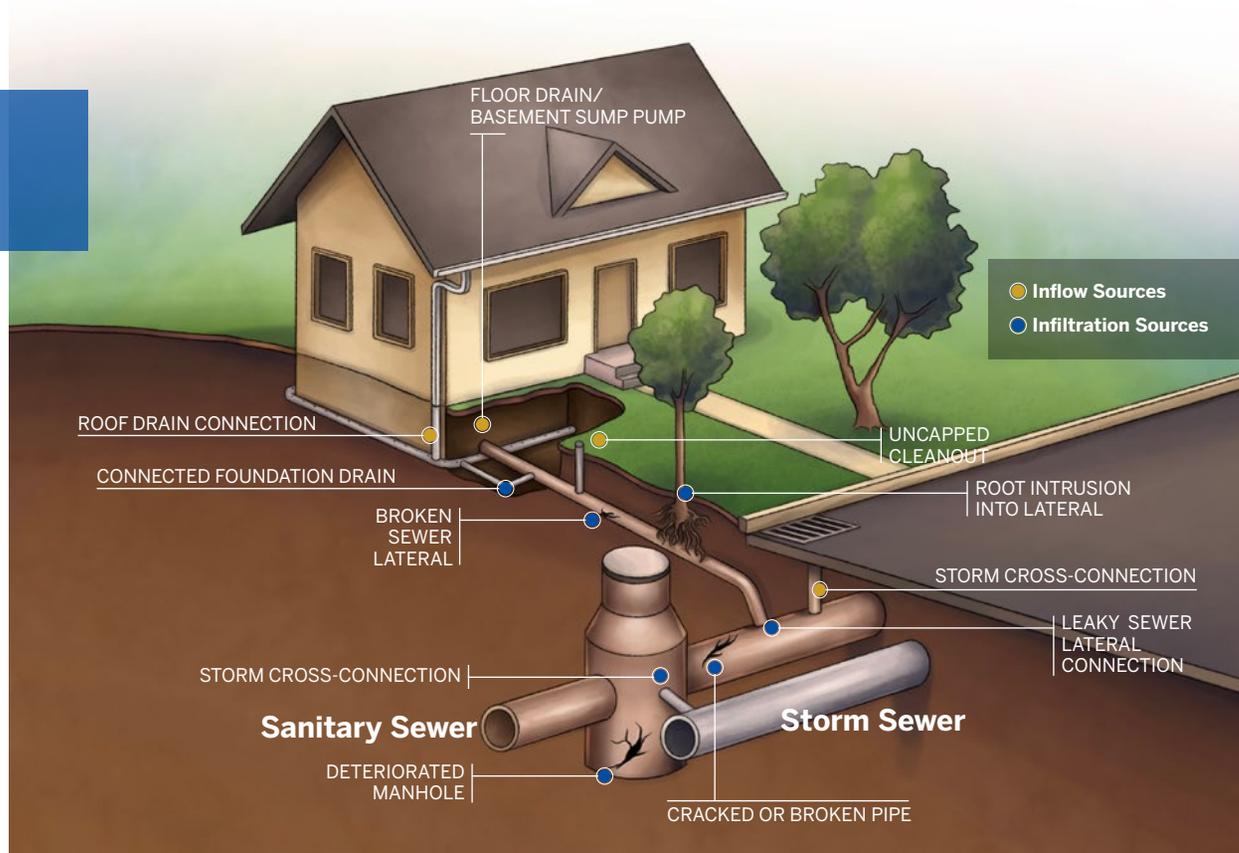
What is I&I?

I&I describes what happens when stormwater (inflow) and groundwater (infiltration) enter a wastewater system. This water, which ideally should drain into the ground or be routed to storm drains, can easily overload wastewater systems – causing sewage overflows to creeks, backups in basements and impaired operations, among other challenges.

Inflow

Inflow is stormwater that enters the sewer collection system through direct connections such as roof leaders, yard drains, catch basins, defective manhole covers and frame seals, sump pumps or through indirect connections with storm sewers. It can also be caused when foundation drains are improperly connected to a sewer line.

Inflow occurs as a result of heavy storm events such as rainfall, snowfall and/or snow melt, each of which contribute to excessive sewer flows – resulting in hydraulic backups and pooling of water. Inflow is generally measured during wet weather.



Infiltration

Infiltration is groundwater that enters sewer pipes (e.g., interceptors, collectors, manholes or side sewers) through cracks, leaky pipe joints, connection failures and deteriorated manhole covers. Infiltration amounts vary by season and in response to groundwater levels. Storm events can trigger a rise in groundwater levels and increase infiltration flows.

Because they are designed as direct connections, sump pumps and foundation drains are considered inflow sources. Yet, they act very similar to infiltration due to their nature of draining the groundwater surrounding a structure. The highest infiltration flows often result from significant storm events or extended precipitation. It's generally measured in wet weather seasons during seasonally high groundwater conditions.



Why do communities need to monitor?

You can extend the life of your water infrastructure by proactively identifying and eliminating I&I.

I&I can result in adverse environmental impacts, regulatory compliance issues, higher treatment costs, basement backups and excess wear on your collection system. Additional water from I&I sources reduces the useful life and capacity of sewer systems and treatment facilities – specifically, their ability to effectively transport and treat domestic and industrial wastewater.

Conversely, you can extend the life of your water infrastructure by proactively identifying and eliminating I&I.



Historically, small amounts of I&I are expected and tolerated. However, I&I may be considered excessive when it is the cause of overflows or bypasses, or the cost to transport and treat exceeds the cost to eliminate it.

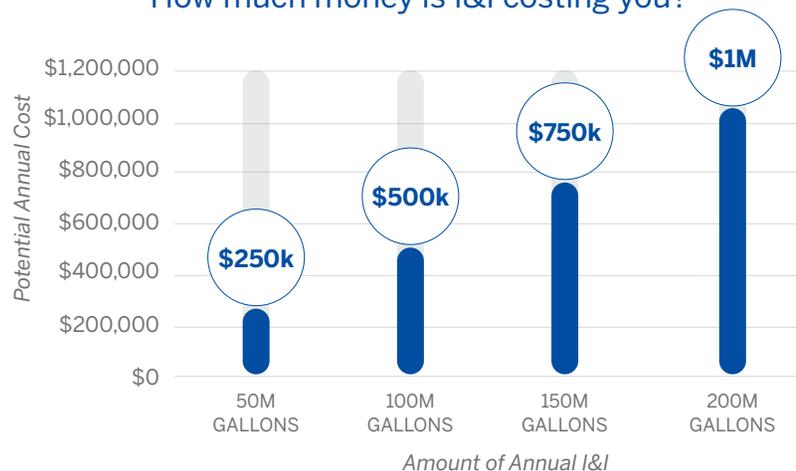
GUIDE FOR ESTIMATING INFILTRATION AND INFLOW
ENVIRONMENTAL PROTECTION AGENCY

Treating I&I – What are the costs?

The Environmental Protection Agency (EPA) reports that wastewater collection and treatment expenses range from \$2-5 per thousand gallons of water. Subsequently, an annual I&I volume of 150 million gallons of water could cost a community \$300,000-750,000 per year to transport and treat annual flow to treatment plants.

However, residential and economic development opportunities are integral to community growth, quality of life and capturing additional tax revenue. Limiting either of these sacrifices opportunity and may create long-term financial challenges.

How much money is I&I costing you?



Treating I&I at the facility can lead to inefficient treatment, higher costs and illicit discharges into rivers/lakes due to capacity issues. Proactively identify I&I – making sure your infrastructure can accommodate residential and economic expansion – then take action.

LINDSEY ROBERTS MCKENZIE, SENIOR WATER RESOURCES ENGINEER

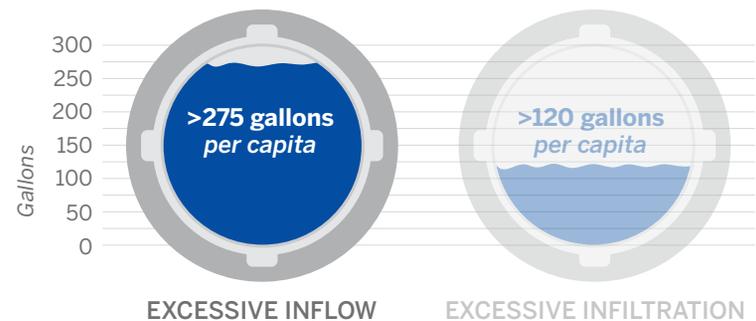
Communities must often decide between investing their available dollars to reduce I&I or limiting new residential or economic development; new developments can strain collection and treatment systems that are already at capacity, leading to further repairs.

If your treatment facility is at or near capacity and an upgrade is likely necessary, it's important to first measure the cost of reducing I&I to free up capacity at your existing treatment facility against the cost of building additional capacity. Building new is sometimes the best option but, often, adjustments or renovations can mitigate issues if caught early enough.

Inflow – How much is too much?

Inflow is considered excessive (too much) if your plant experiences hydraulic overflows during storm events.

Inflow can be measured in multiple ways but often varies by state and community. The EPA's benchmark is 275 gallons per capita per day; a number established based on the average wet weather flow in more than 45 different sewer systems across the U.S.



The EPA's benchmark also takes into consideration the "feasibility and cost-effectiveness" of eliminating sources of inflow. Regardless of the numbers, **inflow is considered excessive (too much) if your plant experiences hydraulic overflows during storm events.**

The Massachusetts Department of Environmental Protection's definition of excessive inflow affirms the EPA's guidance. Its definition revolves around the financial impact of the situation and includes "all public and private inflow sources, unless existing conditions render such removal technically infeasible or cost-prohibitive." Ultimately, this means that all inflow is excessive unless it's too expensive to remove.

Infiltration – How much is too much?

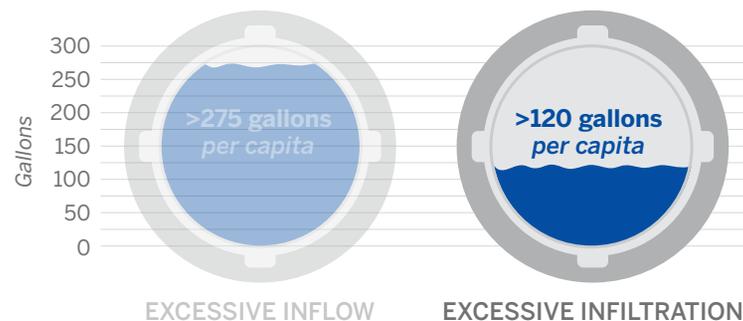
Excessive infiltration includes any infiltration sources that can cost-effectively be removed from the sewer system.

“

Including I&I efforts in your annual budget allows you to incrementally plan for and tackle improvements, saving valuable dollars.

SPENCER COSSALTER, WATER RESOURCES PROJECT DESIGN LEADER

The EPA's Project Certification Standards consider infiltration excessive if the average dry weather flow is more than 120 gallons per capita per day. This quantity includes domestic wastewater flow, infiltration and very small industrial and commercial flows.



This metric provides a good rule of thumb. However, it's important to take it 1-2 steps further; the number of gallons to reach an excessive level doesn't incorporate factors like the intensity of rain or snow events, or varying groundwater levels. Many U.S. states use additional measures to establish reasonable rates of infiltration.

For example, some community wastewater systems measure I&I by gallons per day per inch of diameter per mile of pipe (GPD/IDM). According to the EPA: "Infiltration rates for whole collection systems (including service connections) that are lower than 1,500 GPD/IDM are not usually excessive."

As with inflow, the Massachusetts Department of Environmental Protection addresses the issue more broadly. Its definition of **excessive infiltration** includes any infiltration sources that "can cost-effectively be removed from the sewer system, based on a comparison of the cost of removal to the cost of transporting and treating the flows."



5 I&I actionable steps



ACTIONABLE STEP 1

Understand the impact of I&I

Sewers and treatment facilities are designed based on precise estimates of expected average and maximum flows. Excess stormwater and groundwater entering the sewer system through I&I strips your system of its valuable capacity, burdens your operation and maintenance efforts, and reduces the life expectancy of your treatment facility. Surcharges, backups and overflows require emergency response and can significantly impact your planning and budgeting.

The American Water Works Association (AWWA) believes that restoring and expanding U.S. water systems to overcome capacity issues as well as aging, at-risk and failing components will cost \$1 trillion over the next 25 years. With more than 90% of spending on water infrastructure coming from the local level, the urgency to be strategic and proactive with your project decisions cannot be overstated.

Gaining insight into the impact of I&I better prepares you to not only address current challenges but gain buy-in as well as plan for and mitigate futures challenges.



The EPA may waive compliance requirements, even fines, if you have a structured strategy to reduce I&I, further reaffirming the importance of creating a plan and being proactive with regard to I&I.

PAUL KUBESH, SENIOR LEAD I&I TECHNICIAN



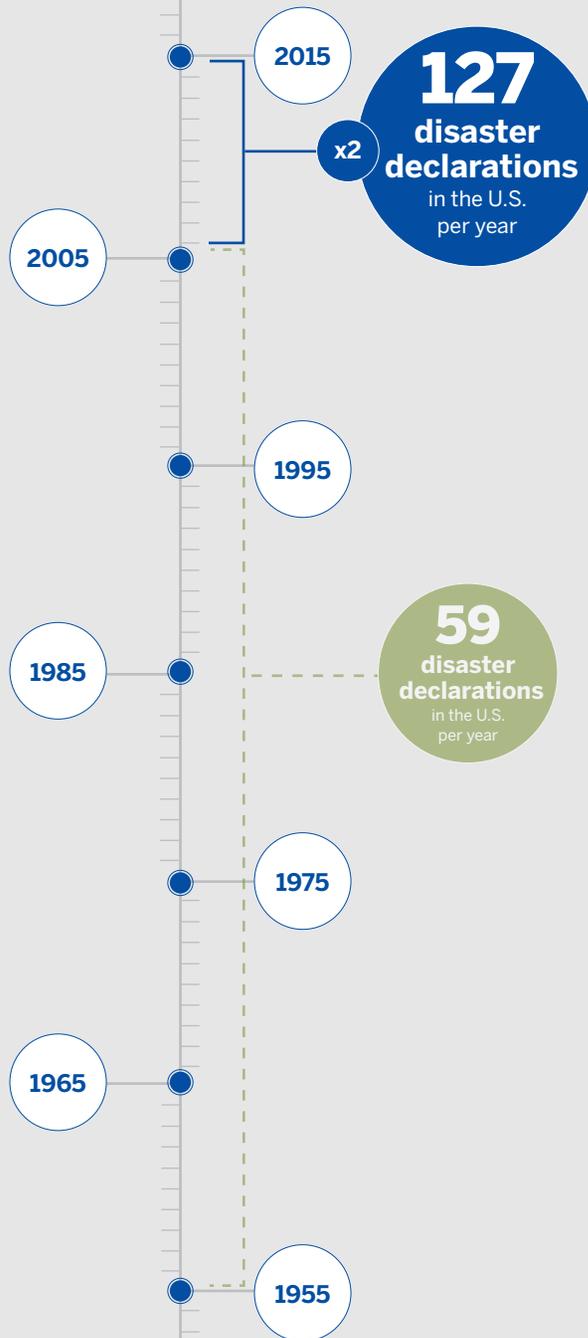
ACTIONABLE STEP 2

Stay up to date on regulations

While the benchmarks and references from neighboring states are helpful and can serve as an introductory guide, your standards likely depend on your location. The most effective way to ensure compliance and reduce costs, even fines or government intervention, is to stay up to date on local and federal regulations.

The EPA's Clean Water Act establishes the basic structure for regulating discharges into U.S. waterways and setting standards for the wastewater industry. The cost of non-compliance under the Clean Water Act can be greater than the cost of creating a comprehensive inspection program.

Many federal and local government organizations offer compliance and inspection resources – for example, the Metropolitan Council Environmental Services (MCES) in Minnesota offers its free online *Inflow and Infiltration Tool Box*, while the EPA has created a free online *Guide for Estimating Infiltration and Inflow*.



ACTIONABLE STEP 3

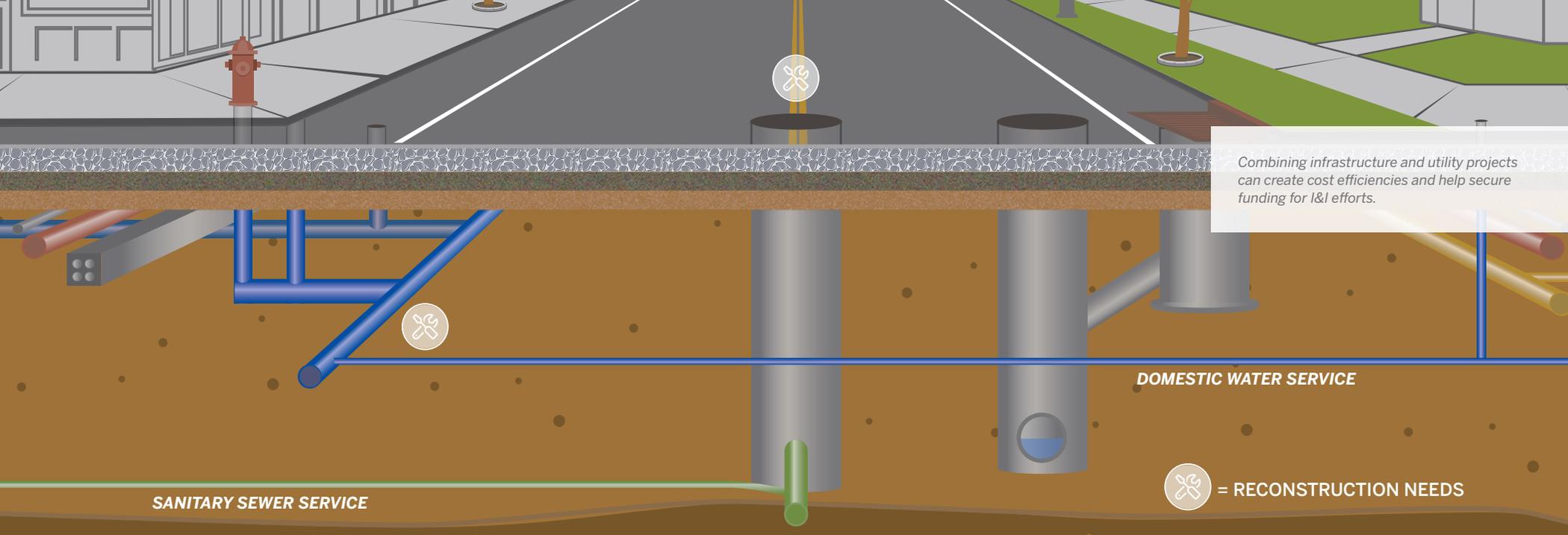
Consider the climate and plan ahead

Though evaluations may reveal that your system falls within the non-excessive range, strategic municipalities are always on the lookout for sources of I&I and ways to reduce it.

One reason for more proactive approaches in 2021 and moving forward – in addition to limited budgets – is the fact that there have been, on average, 59 disaster declarations in the U.S. per year over the last 60 years. Between 2006-2015 alone, this number more than doubled to 127 annual declarations.

Natural disasters like heavy rain events and flooding have become more frequent, and therefore costly. You can remain proactive by identifying current and potential future risks as well as vulnerabilities associated with natural disasters and I&I. Planning empowers you to develop long-term strategies for protecting your people, property and infrastructure from unpredictable weather events.

In the section ahead, *6 Ways to Identify I&I – Including 3 Warning Signs*, we explore specific methods you can use to proactively and accurately identify I&I.



Combining infrastructure and utility projects can create cost efficiencies and help secure funding for I&I efforts.

DOMESTIC WATER SERVICE

SANITARY SEWER SERVICE

= RECONSTRUCTION NEEDS

ACTIONABLE STEP 4
Understand I&I funding options, limitations

Recognizing that I&I efforts preserve and protect the environment, there have been an increase in climate change and sustainability grants in recent years that target I&I projects. However, it's often still a challenge to secure funding for needs that are strictly I&I related. One way to overcome this is by combining infrastructure and utility projects.

Does a street in need of reconstruction also have utilities underneath it nearing their life expectancy? Could you maintain the surface until a utility replacement is needed and shift the money to an area in need of both? Is there a nearby water main in need of replacement? Could you extend the scope of the street reconstruction an additional block to coincide with the water main and handle both simultaneously? Perhaps adding a few blocks to the project would make a city street more attractive to private investment for connected business locations.

Combining the two can provide cost benefits on both fronts and help as you seek funding for I&I needs. The case study in the next section explores how the City of Eagan, Minnesota, aligned multiple projects to help secure I&I funding.

ACTIONABLE STEP 5
Know your ordinances

I&I is often a tall task because of "ownership" (i.e., who pays: the city or its residents). Communities can only fix what they own, but they are still impacted by I&I that comes from the parts they don't technically own.

Some parts of a community's sewer system fall within the city right-of-way and is thus owned by the city. Other parts are owned by property owners and homeowners – such as sump pump connections or leaky, private service laterals. For example, the City of St. Paul, Minnesota, mandates that property owners are responsible for their entire sewer lateral until it connects to the City's mainline, even though it may lie beneath the public right-of-way. This is how many cities handle ownership and responsibility.

Ultimately, it's important to understand how your ordinances read (who owns what) to delineate and take ownership over various pipes and I&I challenges. A precise understanding of your ordinances can eliminate confusion on all sides, and serve as the kick-start to public education and even partnership.

LOOKING FORWARD

6 Ways to Identify I&I – Including 3 Warning Signs

When groundwater and stormwater enter city collection systems, treatment plants become less efficient and strained. This additional water can create unplanned expenses. The key is uncovering whether an issue is present or imminent, then determining the most efficient way forward. Here are six ways to proactively identify I&I, including warning signs that it may be lurking.

There are several proven methods to identify and tackle I&I.

Each of the tactics ahead are effective, but the appropriate approach for your efforts depends on the challenges at hand, the state of your infrastructure, the amount of flow and your budget. Partnering with trusted, experienced consultants is the best way to identify which approach is right for you.



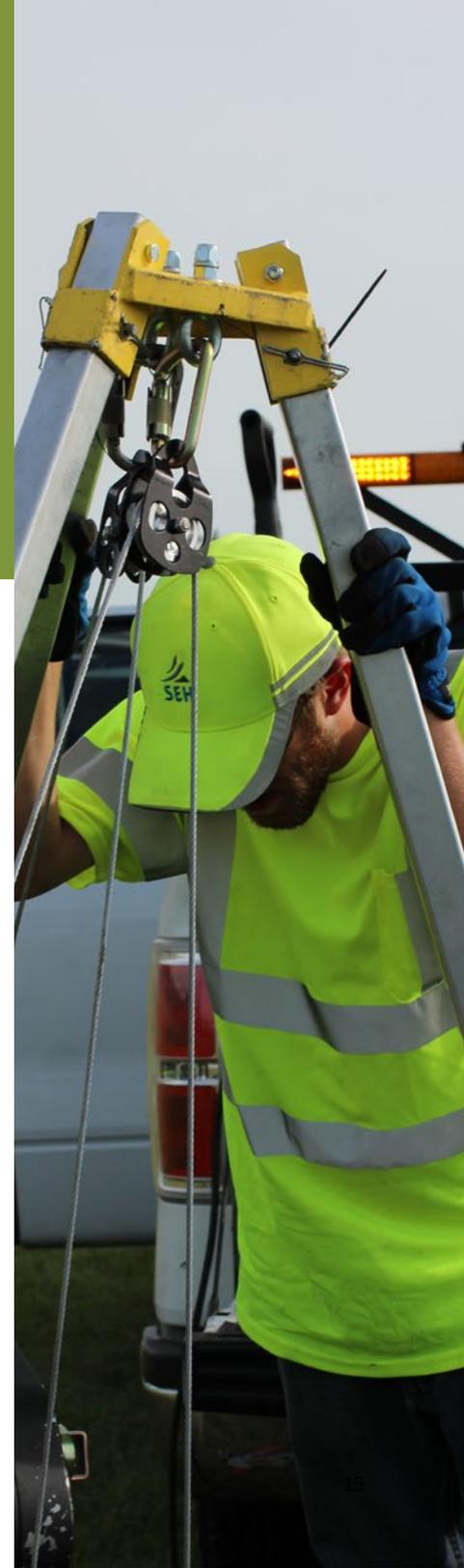
Here's what you'll learn:

01 3 I&I warning signs

02 6 ways to identify I&I

03 Case study
CITY OF EAGAN OVERCOMES EXCESSIVE I&I THROUGH FLOW MONITORING

04 I&I Quick Reference Guide and Flowchart





3 I&I warning signs

Clear water that enters your wastewater or sewer system gets treated. This treatment can eat away at limited budgets while also taking up limited capacity within a collection system.

Water from I&I is referred to as “clear water” which distinguishes it from sanitary sewage water. Clear water that enters your wastewater or sewer system gets treated. This treatment can eat away at limited budgets while also taking up limited capacity within a collection system.

This creates a pressing challenge for communities whose collection systems are already at capacity. You can be proactive, gain a deeper understanding of your infrastructure and avoid unnecessary costs by answering: Do we have potential or underlying I&I risk?



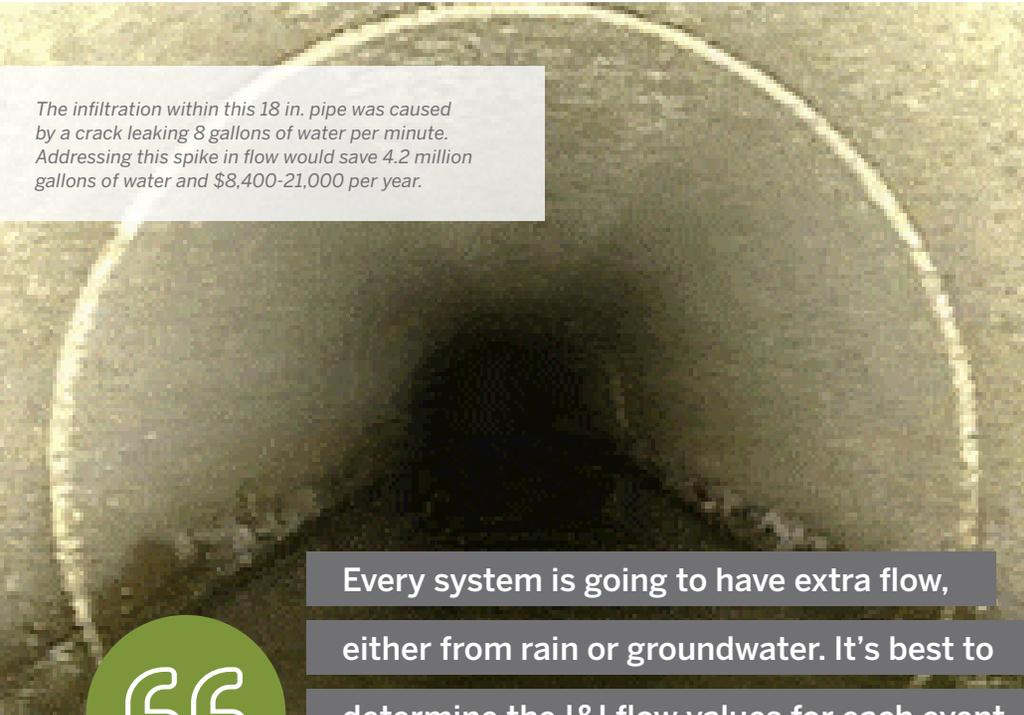
There may be underlying I&I issues if you experience the following:

Your lift station pumps run continuously; they start and stop

You may have an underlying I&I issue if your lift station pumps run for a long and continuous time after a rain event, or if your pumps start and stop frequently after a significant rain event. Each likely means stormwater has entered your sanitary sewer system, is on its way to be treated and is perhaps taxing its capacity.

Your pipes are backed up

Backed up pipes are often a clear indicator of an impending I&I issue. There is likely an issue at hand if, during a rain event, manholes are spilling wastewater on to local roadways or green space, rain water isn't draining into sewer systems and/or various residential or business basements begin to flood. These issues need to be identified and addressed quickly.



The infiltration within this 18 in. pipe was caused by a crack leaking 8 gallons of water per minute. Addressing this spike in flow would save 4.2 million gallons of water and \$8,400-21,000 per year.

“

Every system is going to have extra flow, either from rain or groundwater. It's best to determine the I&I flow values for each event, then uncover which areas of your system have the worst issues.

PAUL KUBESH, SENIOR LEAD I&I TECHNICIAN



You see significant spikes in flow

As you measure and evaluate the effectiveness of your wastewater treatment plant during precipitation or high groundwater conditions, readings that return spikes in flow likely indicate an I&I issue. While small amounts of I&I are to be expected, significant spikes rarely happen unless there is a deeper issue at hand. The images above illustrate a “spike” in flow that would have created more than 4 million gallons of I&I over the course of a year if left untreated.

6 ways to identify I&I

Warning signs are helpful but only offer surface level indicators of potential problems. Once you're certain I&I issues are present, or if you have projects in place to identify and address particular challenges, there are multiple methods you can rely on. The following highlights six proven methods for capturing important I&I information and creating the ability to act.



FLOW MONITORING



MANHOLE INSPECTIONS



SMOKE TESTING



DYE TESTING



CCTV OR ELECTROSCAN



PRIVATE PROPERTY INSPECTION



1. Sanitary sewer flow monitoring

The first step in identifying I&I is to uncover where problems are occurring, then isolate the most vulnerable areas or the areas experiencing the highest amounts of I&I. Flow monitoring is one of the most effective ways to do this.

Flow monitoring can help you identify the presence, quantity and type of I&I issues that exist within your sewer system, and provide you with the information needed to support your efforts of fulfilling the requirements defined by the Clean Water Act.

As flow monitoring remains one of the best ways to pinpoint I&I, you may wish to dig deeper into this strategy. Our article and video, *One Method to Identify I&I: Flow Monitoring*, explores this process in depth – including who leads the effort, safety precautions and how data is analyzed to help communities make more informed decisions.

© WATCH AND READ

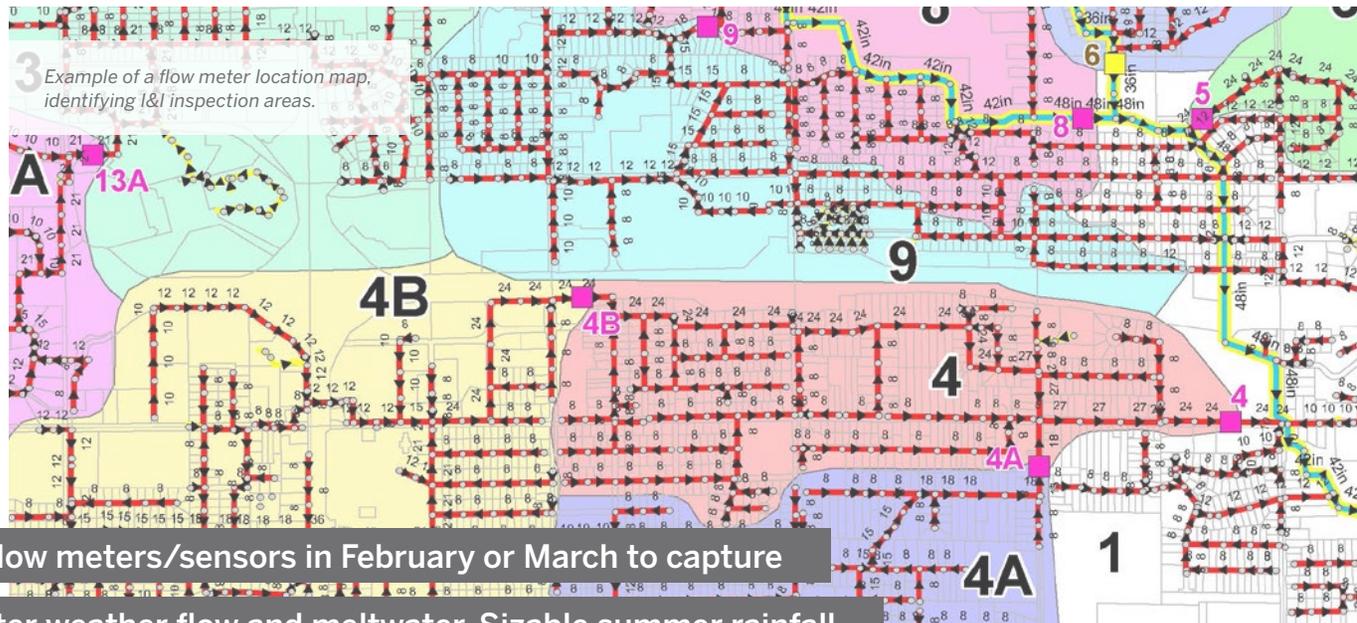


Install flow meters/sensors in February or March to capture dry winter weather flow and meltwater. Sizable summer rainfall events then allow you to capture additional flow data – the more data, the more informed your analysis.

PAUL KUBESH, SENIOR LEAD I&I TECHNICIAN



Flow monitor attached to manhole during I&I inspection.



Example of a flow meter location map, identifying I&I inspection areas.



2. Manhole inspections and 3D technology

Manhole inspections can identify joint leaks and provide the opportunity to evaluate drainage near structures where manholes are located. Designed as an access point into the sewer for maintenance, manholes can provide the same access for clear water intrusion if the proper precautions are not taken. These areas are often located within wetlands or ditches that submerge during rain events.

Aging manholes can contribute significant I&I through leaky covers, deteriorated concrete and missing joint sealant. Three-dimensional manhole scanning technology can inspect manholes and uncover defects.

If manhole inspections reveal an issue, there are several actions you can take to resolve them. In addition to each suggested action, here are the potential cost savings of taking action:

	COST	COST SAVINGS
ACTION 1 1 Replace the manhole covers	Approximately \$200 per cover	Could reduce I&I costs by \$350 per year per manhole if covers are submerged during rain events
ACTION 2 2 Chemical grouting to seal up leaky joints	\$500+	Could reduce I&I costs by as much as \$5,000 per year per manhole
ACTION 3 3 Line the manhole	Approximately \$3,000	Could reduce I&I costs by \$20,000 per year per manhole

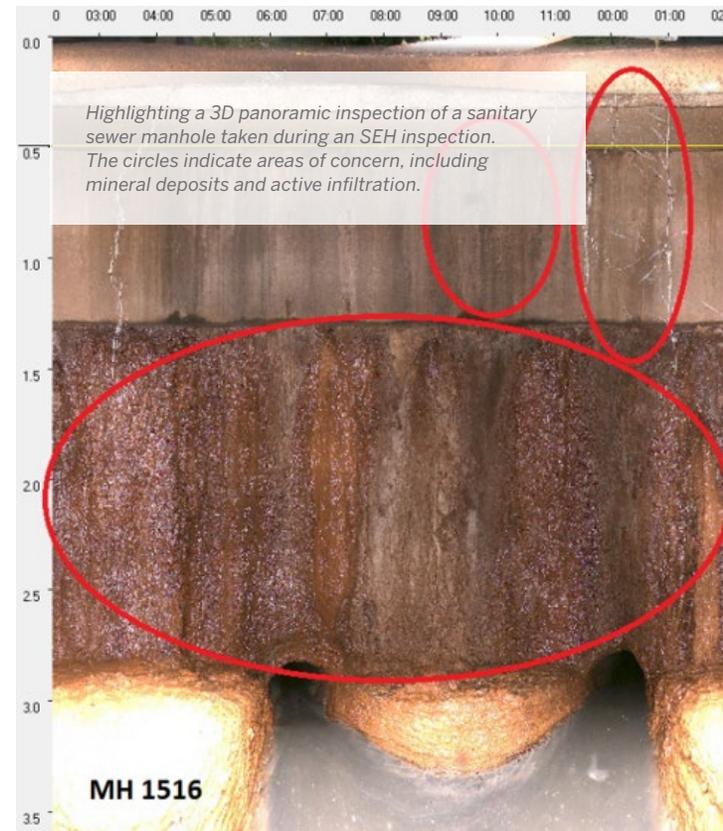


A single joint leak in a pipe or manhole can generate 7,200 gallons of water per day – or an annual cost of \$5,000-13,000 after being treated. Addressing even the smallest leaks in your system can generate significant savings.

SPENCER COSSALTER, WATER RESOURCES PROJECT DESIGN LEADER



MH 1516



Highlighting a 3D panoramic inspection of a sanitary sewer manhole taken during an SEH inspection. The circles indicate areas of concern, including mineral deposits and active infiltration.

MH 1516



3. Smoke testing

Smoke testing is most practical in commercial areas with flat roof buildings, parking lots and other large drainage areas that can be improperly connected to the sanitary sewer. This approach can be completed in residential areas; however, it would mostly be focused on the right-of-way areas rather than the residential properties themselves.

Smoke testing involves setting up a blower then pumping non-toxic, simulated smoke through a community's sanitary sewer line. The smoke is pressurized and follows the path of any leaks within the system – revealing points of entry for I&I.

Sources of I&I can be cracks in the sewer pipes, roof drains, cleanout caps outside of homes, damaged or faulty manholes, or a cross-connection between a storm sewer and sanitary sewer.

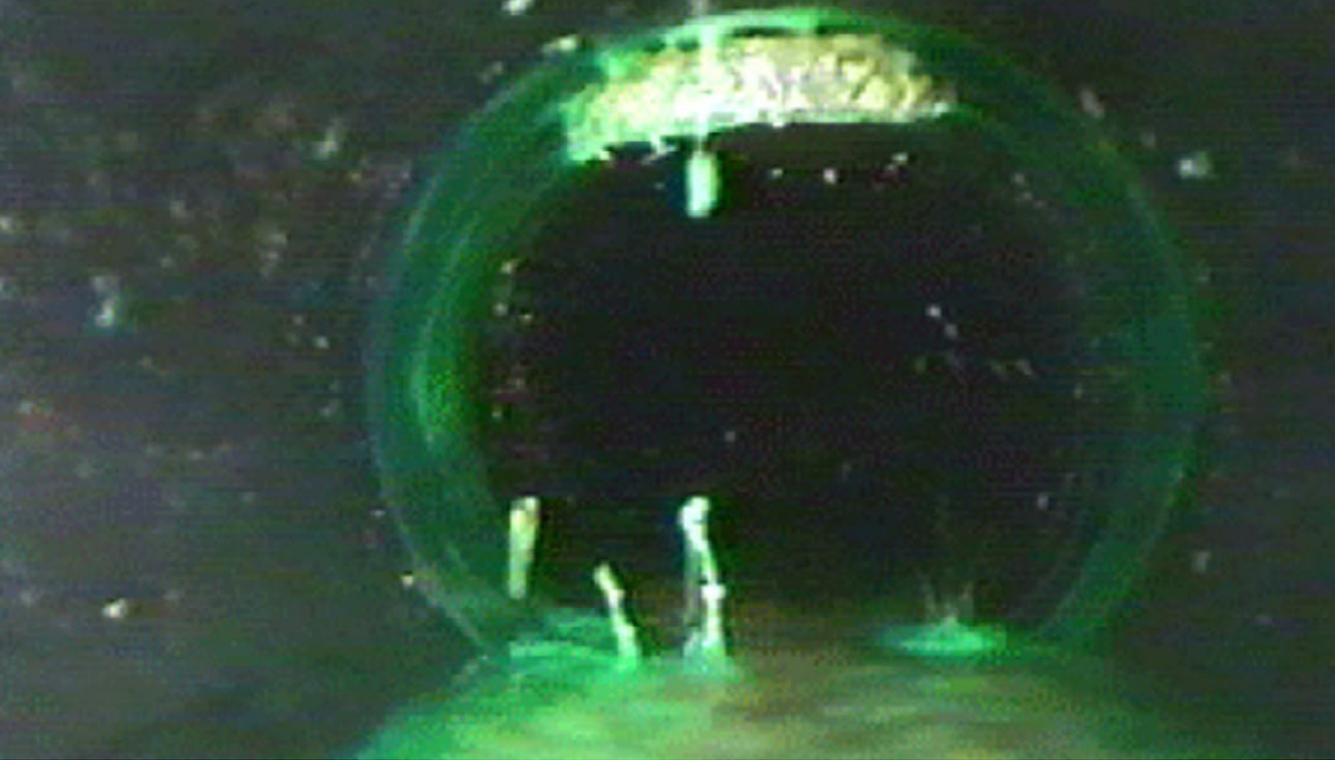
After smoke testing reveals I&I, there are multiple ways you can proceed to reduce or eliminate it. However, depending on where the leaks are found, the fixes may fall on the shoulders of property owners.

The final section of this eBook – *8 Questions Your Residents Will Have About Smoke Testing* – digs deeper into what's involved with smoke testing, shares answers to questions we most often hear from residents and city officials, and also explores ways you can partner with the public to alleviate concerns and create buy-in.



Highlighting smoke escaping from a roof drain (left) and manhole (right) during smoke testing. Both photos reveal high likelihood of I&I.





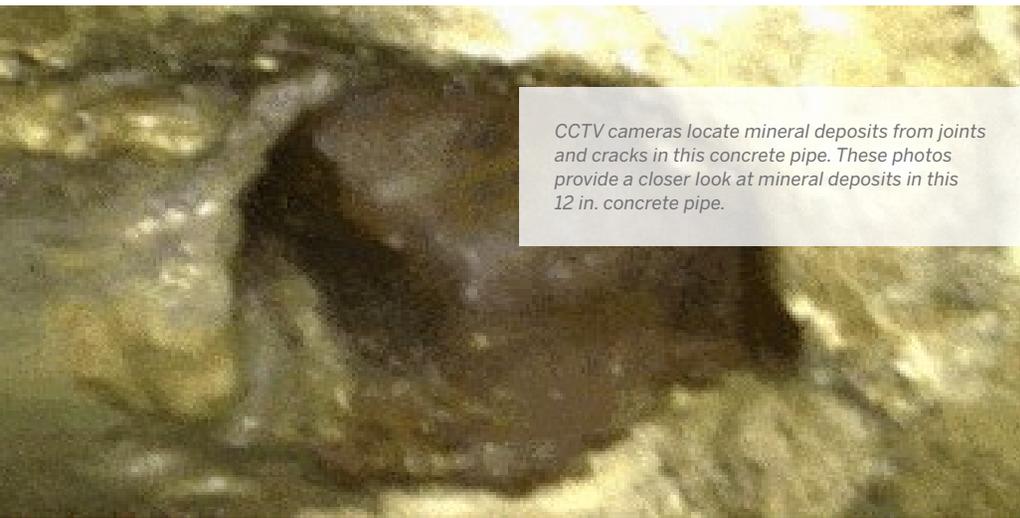
4. Dye testing

Dye testing can be used to identify leaks in your infrastructure and can also be used to confirm smoke testing results. Dye testing involves the use of water mixed with a non-toxic dye. The colored water is then pumped through the groundwater and stormwater systems being evaluated, and appears in the sanitary sewer collection system where leaks occur.

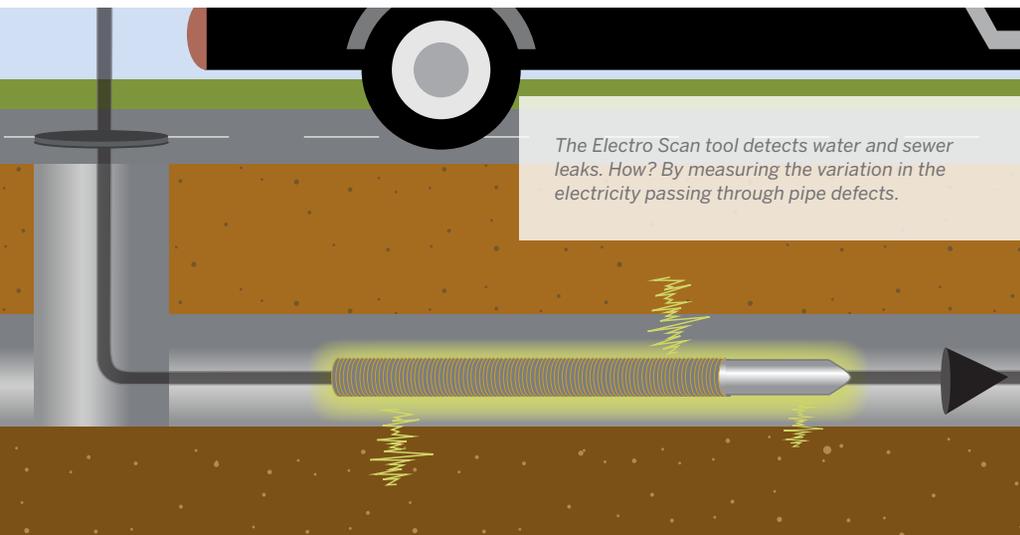
Naturally, there are leaks present if colored water appears. If not, the infrastructure is likely holding up well and in good shape. As noted previously, these methods for identifying I&I often work best when used in conjunction with one another.



The green and pink dyes highlight sources of I&I. The pink dye running through the manhole from the mainline pipe shows the water's progression during testing.



CCTV cameras locate mineral deposits from joints and cracks in this concrete pipe. These photos provide a closer look at mineral deposits in this 12 in. concrete pipe.



The Electro Scan tool detects water and sewer leaks. How? By measuring the variation in the electricity passing through pipe defects.



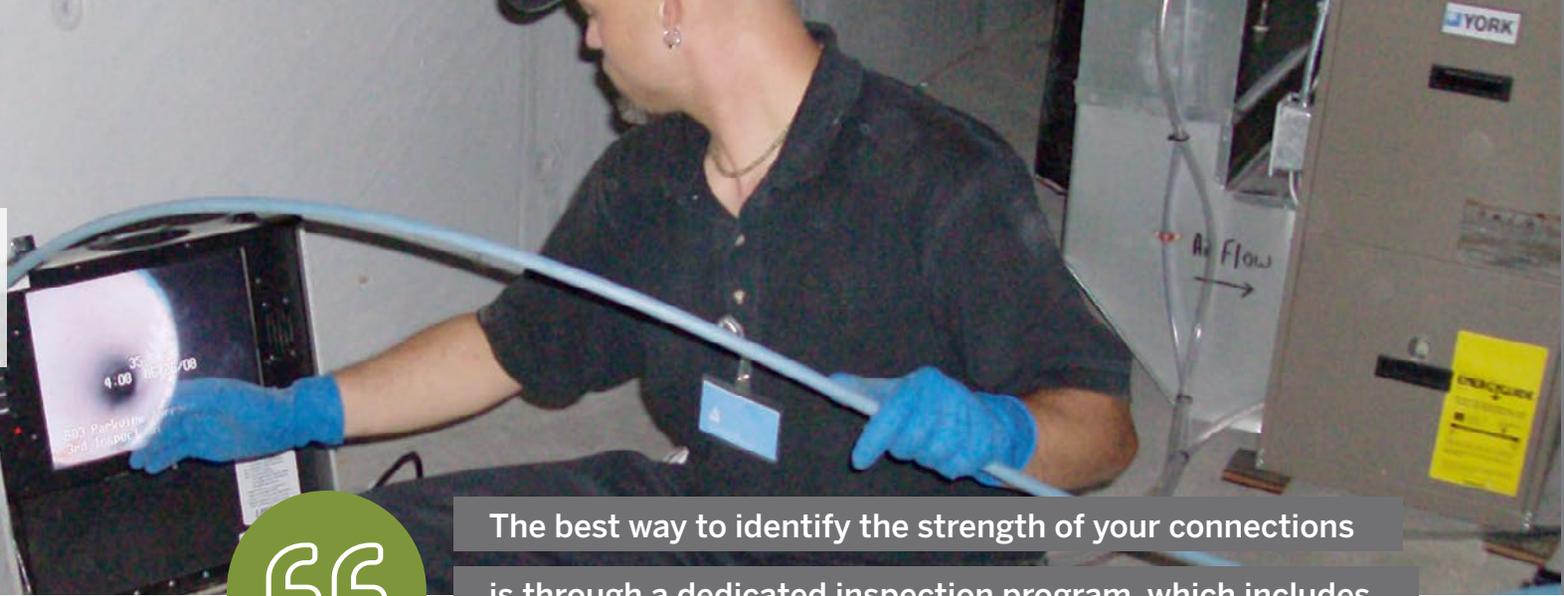
5. Pipe inspection/closed circuit television inspection (CCTV)

The use of CCTV provides communities with direct access to the inside of their pipes. How this type of pipe inspection works: a small camera is non-invasively inserted into and travels down the length of the pipe. The camera sends real-time visuals to the CCTV operator, who then uses the visuals to identify leaks through a monitor viewed at the surface.

CCTV inspections can reveal whether there is need for rehabilitation of leaky pipes. The rehabilitation options are many, including cured-in-place pipe (CIPP) trenchless rehabilitation, chemical grouting to seal up leaks and open cut replacement of pipes. CIPP trenchless rehabilitation provides a solution without disruption (e.g., having to dig up city streets).

In addition to CCTV, the innovative Electro Scan tool, which detects water and sewer leaks, can approximate I&I in pipe segments. The technology, which we often rely on and trust here at SEH, uses low-voltage electrical currents to assess sewer pipes. By sending a low-voltage electrical current through a non-metal pipe (pipes made of brick, cement, concrete, plastic or pipe-lining resins), Electro Scan measures the variation in the electricity passing through any pipe defects.

An SEH technician uses CCTV to identify possible I&I from leaky joints, foundation drains and cracks within a service lateral.



The best way to identify the strength of your connections is through a dedicated inspection program, which includes evaluating and enforcing your local sewer ordinance.

LINDSEY ROBERTS MCKENZIE, SENIOR WATER RESOURCES ENGINEER



6. Private property inspections

Residential sump pumps and foundation drain lines are often one of the biggest contributors of I&I into a collection system when improperly connected to the nearby sanitary sewer laterals. A single sump pump can send more than 7,000 gallons of water to the system during a rainfall event – which is roughly the same amount as the average daily flow from 18 homes!

Properly constructed and maintained sanitary collection systems should result in acceptable levels of I&I each year. These levels vary from community to community and system to system. As systems age, they become more susceptible to surface and groundwater infiltration and increased maintenance challenges when left unaddressed. This can lead to increasing collection and treatment costs over time.

If the results from your private property inspections indicate I&I, the graphic to the right shows three proven solutions, approximate costs that fall to the community or property owner depending on the ordinance, and the potential impact of each action.

		COST	COST SAVINGS
ACTION 1	Sump pump discharge relocations	\$100-1,000 per year per pump	Could reduce I&I costs by up to \$500 per year per pump depending on amount of flow through sump pump
ACTION 2	Foundation drain disconnections and sump pump installations	\$500-5,000 per year per pump	Could reduce I&I costs by up to \$1,000 per year per pump depending on amount of flow
ACTION 3	Service lateral lining and/or replacement	\$1,000-8,000 per year per pump	Could reduce I&I costs by up to \$750 per year per pump depending on amount of flow through the lateral joints and cracks



Case study – City of Eagan overcomes excessive I&I through flow monitoring



Challenge

A significant rainfall event in the City of Eagan, Minnesota (population: ~66,500 residents), resulted in excessive peak flow allocations to the regional collection system and treatment plant owned and operated by the MCES. The culprit of the excess flow: I&I.

The MCES determined the City would need to spend \$1.7 million over five years – \$343,700 per year – to either mitigate their internal I&I or pay that amount to the MCES for the equivalent expansion of the Metropolitan Disposal System through an annual surcharge program. If excessive flows were to continue after a specified date, the annual surcharge would become a permanent demand charge.

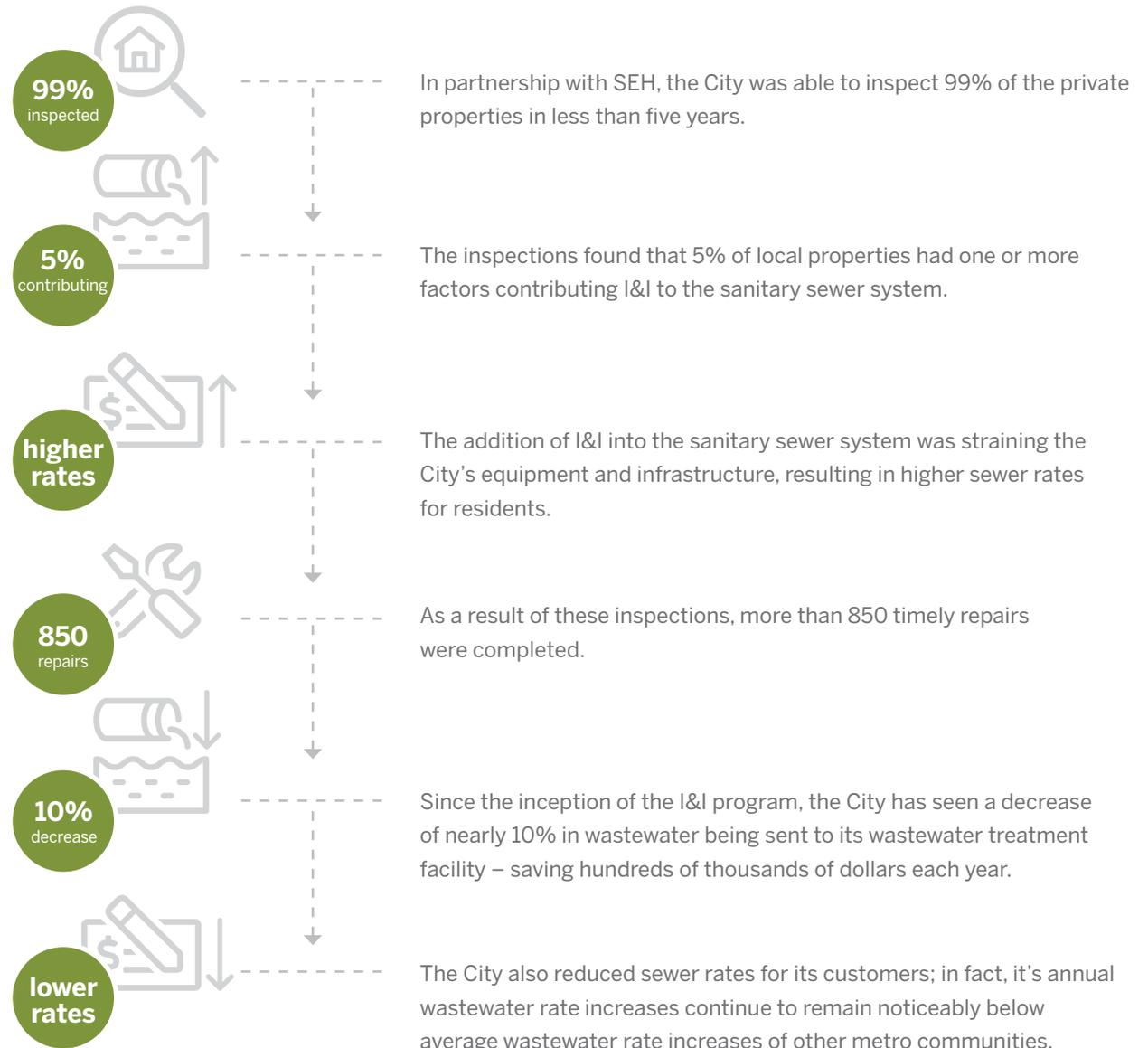
After inspecting and addressing all I&I issues within City sewer pipes and manholes, City staff realized they would also need to address private sewer systems. However, inspecting over 19,000 private connections would be a costly and time-consuming task.



The City also reduced sewer rates for its customers; in fact, it's annual wastewater rate increases continue to remain noticeably below average wastewater rate increases of other metro communities.

Solution

Recognizing the project would likely take 7-10 years handled internally, the City partnered with SEH to create a strategic sump pump and service lateral inspection (flow monitoring program for residential properties within the City – ultimately, to determine and eliminate sources of I&I).





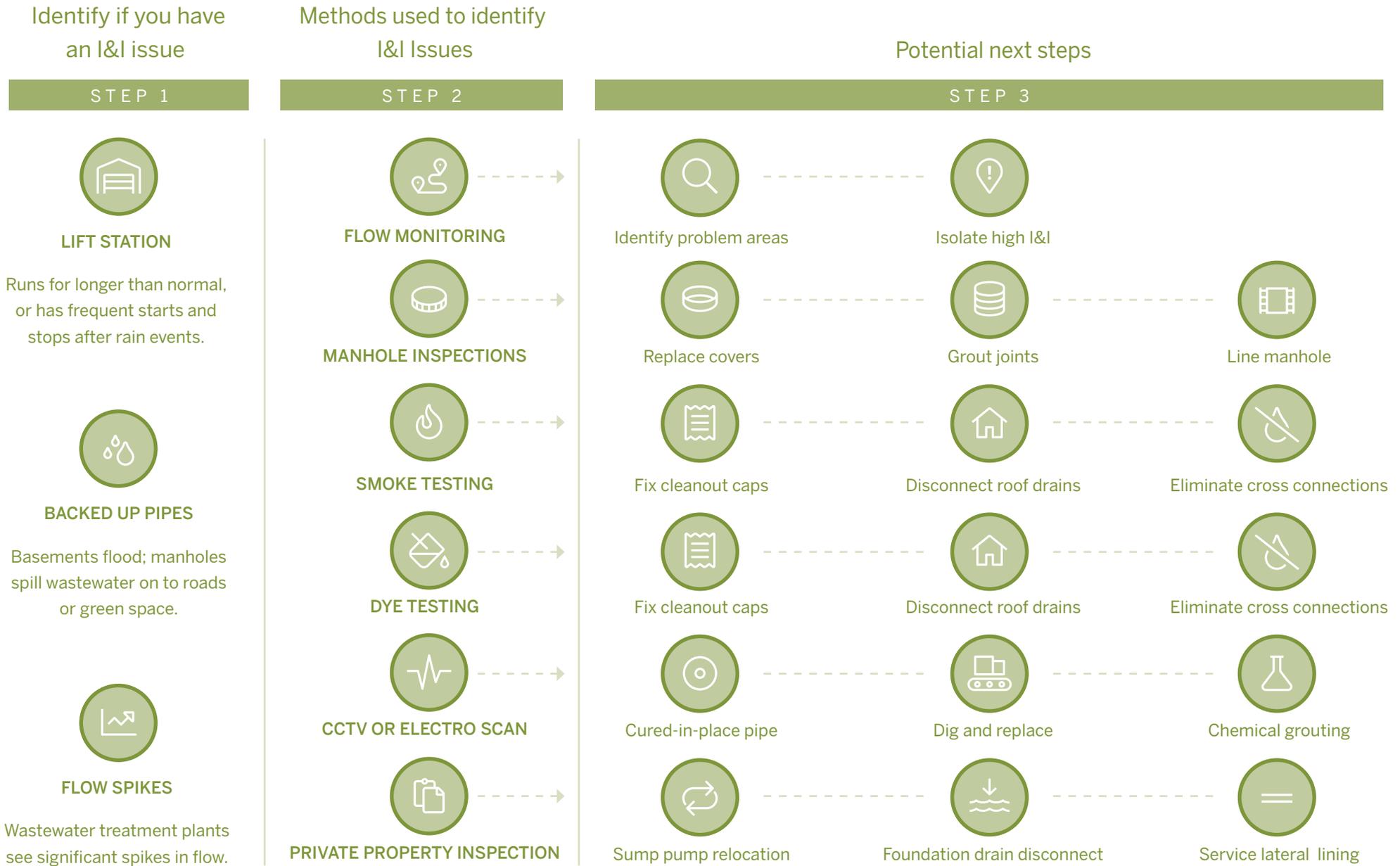
Remaining proactive

The challenge of I&I is not something that can be solved and done away with. It's an ongoing challenge that requires continued inspection and mitigation. For example, having seen the benefits and seeking to remain ahead of potential problems, the City is continually evaluating its publicly owned infrastructure – making repairs and corrections as needed, and monitoring sanitary sewer flows during rain events to better understand where I&I is coming from.

As a part of this continued and proactive effort, utility staff continue to inspect homes for I&I issues – such as sump pumps, beaver boards and other visually recognizable sources of clear water – whenever a water meter inspection or change over occurs.

Uniquely, the citizens of Eagan responded to public outreach/education letters in overwhelming fashion regarding the set up and completion of inspections and corrections – not only helping the City avoid more surcharges but protecting resident properties. Recognizing the win-win situation, both sides worked together.

I&I Quick Reference Guide and Flowchart



COMMUNITY OUTREACH

8 Questions Your Residents Will Have About Smoke Testing

Partnering with the community creates more informed stakeholders, buy-in and public confidence. With smoke testing, community residents, businesses and property owners may have concerns about what the process entails, whether the smoke is toxic and how they can prepare.

The following eight questions are often asked about the I&I smoke testing process.

Here are answers you can use to educate the public and key stakeholders. Prior to these eight questions, you'll also find answers to questions regularly asked by city officials about the smoke testing process.



Here's what you'll learn:

01 5 questions city officials may have about smoke testing

02 8 questions your residents will have about smoke testing



5 questions city officials may have about smoke testing

1. When should cities start planning for smoke testing?

Begin planning in December if not earlier to ensure you're ready to undertake the process during the upcoming spring and summer. A substantial amount of preparation, planning and flexibility are required to implement successful smoke testing projects.

Being proactive is the best way to ensure you have the insight, planning and flexibility needed to lead the process without issue.



SMOKE TESTING PROCESS



SMOKE TESTING PLANNING



JANUARY



FEBRUARY



MARCH



APRIL



MAY



JUNE



JULY



AUGUST



SEPTEMBER



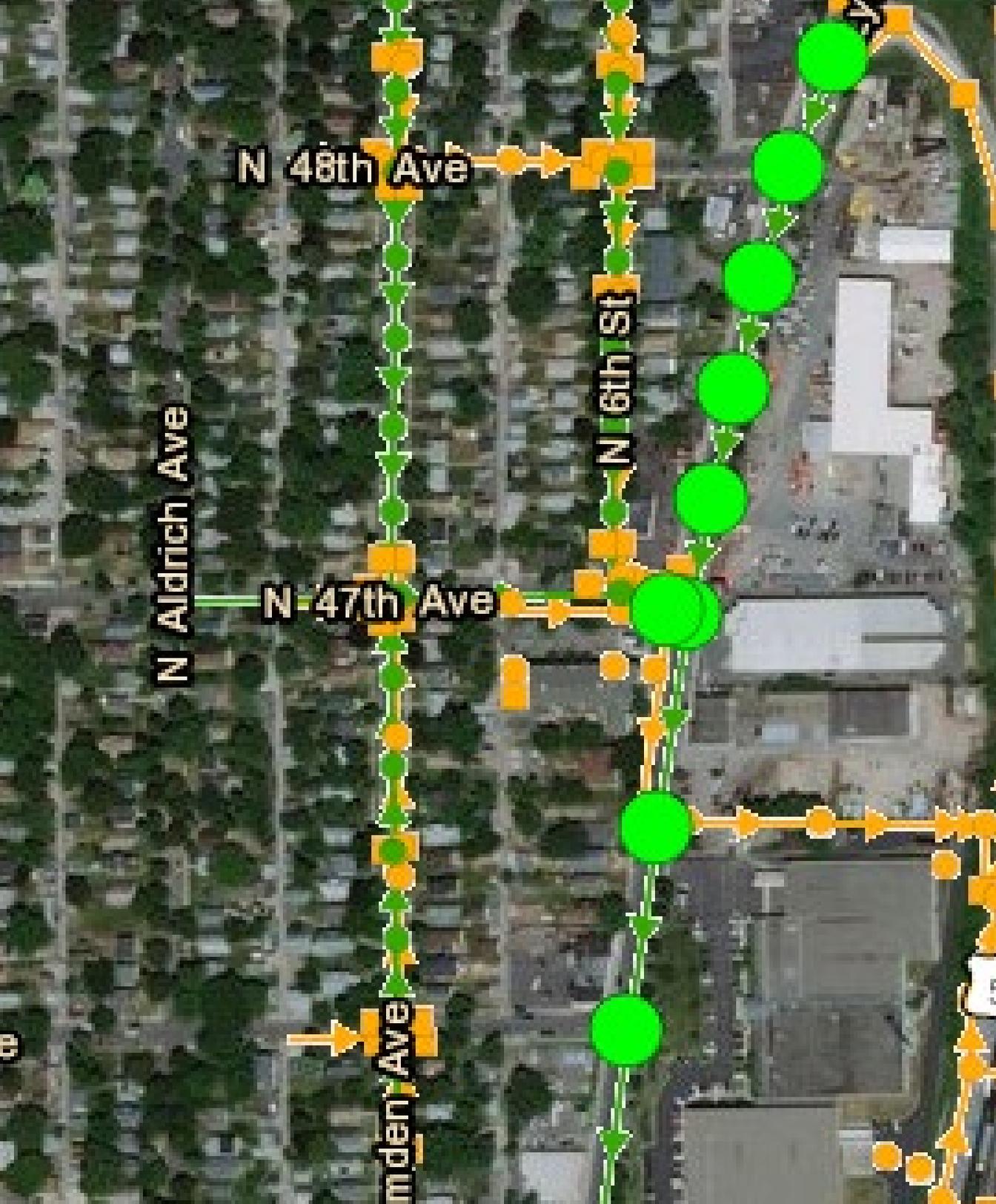
OCTOBER



NOVEMBER



DECEMBER



2. What's the connection between smoke testing and GIS?

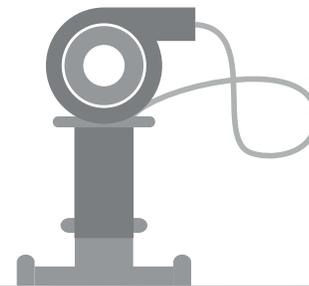
GIS is used during smoke testing to make better use of city resources, as it provides more accurate and accessible data. Using GIS technology to collect complex data in the field allows project teams to lean on existing GIS layers, as highlighted to the left, to help build a map – which then helps to create precise schedules for when and where testing can occur.

GIS also empowers communities to prioritize and coordinate future sewer rehabilitation projects. These projects can take place simultaneously with other road improvement or community development programs.



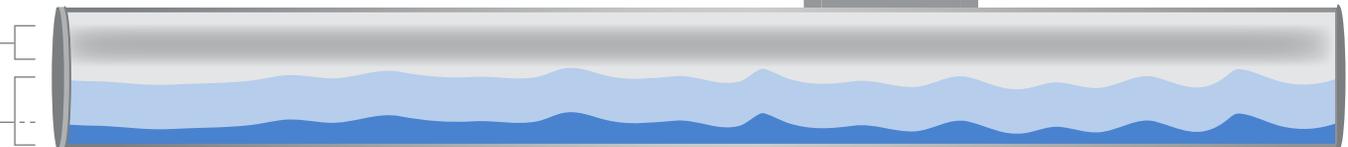
3. Why is smoke testing most often completed in the summer?

Summertime provides optimal conditions to receive the most accurate results. Dry weather conditions lower groundwater conditions, allowing the smoke from smoke testing to travel further and provide easier access out of the system. If your community is located in a drier climate, you have more flexibility in terms of the best times to test.



EASIER TRAVEL ACCESS FOR SMOKE ●

LOWER GROUNDWATER IN SUMMER ●





4. What if English is your residents' second language, or they don't speak English?

It's important to be sensitive and proactive with issues such as residents who speak different languages and have different ways of life. Work closely with your consultant partner(s), city staff and leaders within your communities to create educational resources that meet these unique traits – one example is to consider developing a dedicated English as a Second Language (ESL) website.

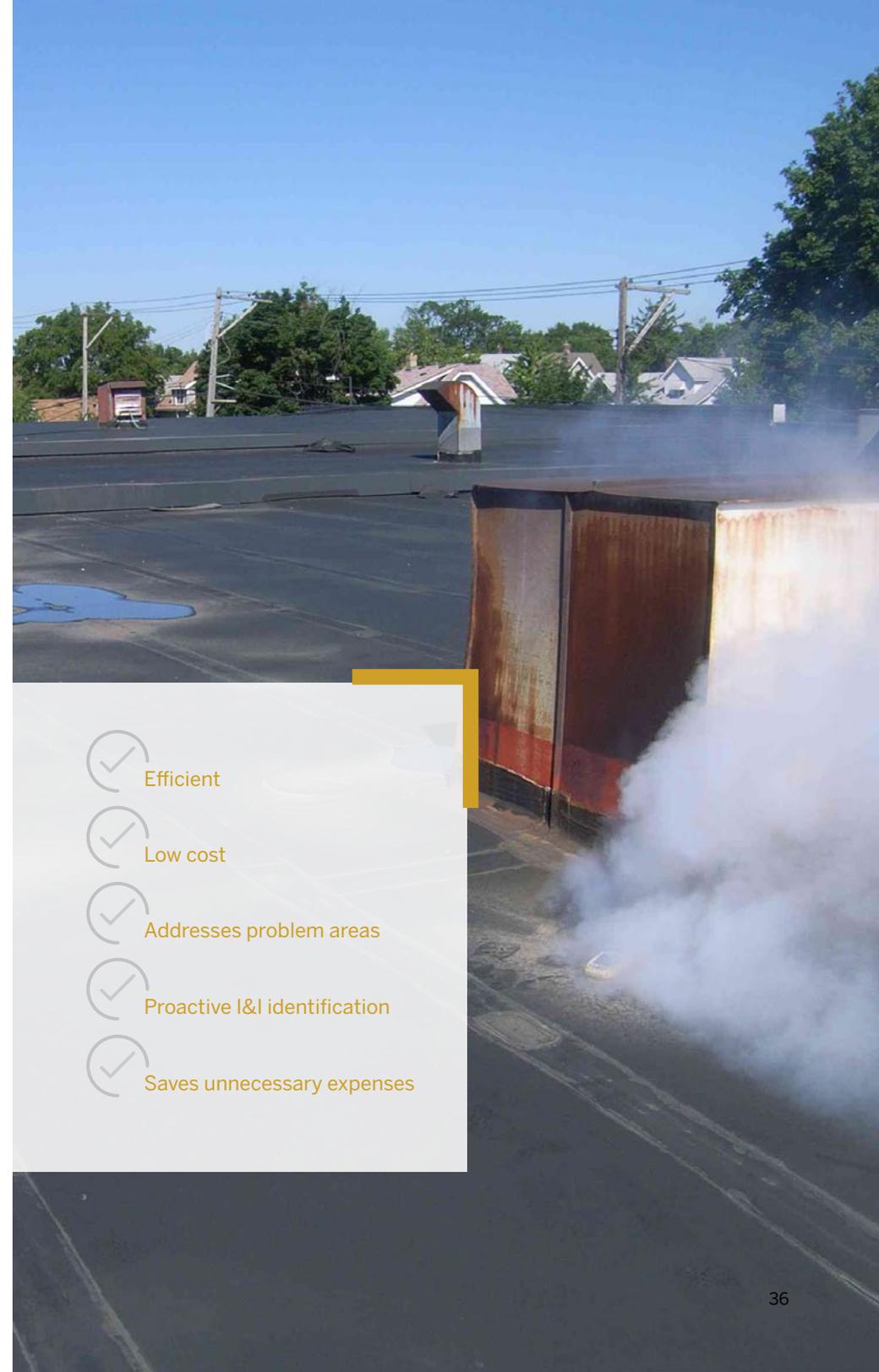
At SEH, we often partner with cities to help them develop such websites, as well as other plans and resources to engage non-English speaking communities. These communities often include Hispanic, Hmong, Russian and Somalian populations. In our experience, we've found it helpful to engage community leaders/elders directly or bring together community leaders and city staff to facilitate discussions – ultimately to find the appropriate messaging, remain sensitive to the unique differences of each culture, educate the community and gain buy-in.

Intentional, sensitive community outreach and equitable engagement play an important role in helping all residents prepare and be clear on what's taking place. Meet these residents where they're most comfortable. Seek understanding. Listen. Regardless of the approach you take, it's important to have a plan in place to engage all audiences.

5. What are the benefits of smoke testing to our community?

I&I reduces pipe capacity and pipe service and can produce future operations and maintenance challenges. Smoke testing is an efficient and low-cost method for avoiding these challenges.

Smoke testing provides you with the information needed to identify and address problem areas before they become deeper, perhaps permanent issues. Proactive methods for identifying I&I can save cities unnecessary repair expenses and ensure the health and safety of community residents.



- ✓ Efficient
- ✓ Low cost
- ✓ Addresses problem areas
- ✓ Proactive I&I identification
- ✓ Saves unnecessary expenses



8 questions your residents will have about smoke testing



CATCH BASINS



AREA DRAINS



HOUSE ROOF
DOWN SPOUTS



SUMP PUMP
DISCHARGE



FOUNDATION DRAINS

SANITARY SYSTEM/STORM SEWER

1. What is the reason for smoke testing?

Smoke testing is undertaken to find leaks before they become larger problems. It's one of the several investigative methods used to locate inflow sources in a community's sanitary sewer collection system.

Typically, direct sources of surface water or groundwater can enter a collection system during rainfall events – including catch basins, area drains, house roof downspouts, sump pump discharge and/or foundation drains directly connected to the sanitary system or storm sewer.

Cities test sewers by putting non-toxic smoke into the sewers to find leaks and faulty connections. This method of field investigation is helpful in detecting direct connection points of groundwater or surface water intrusion into the sewer. The process is cost effective and highly efficient.



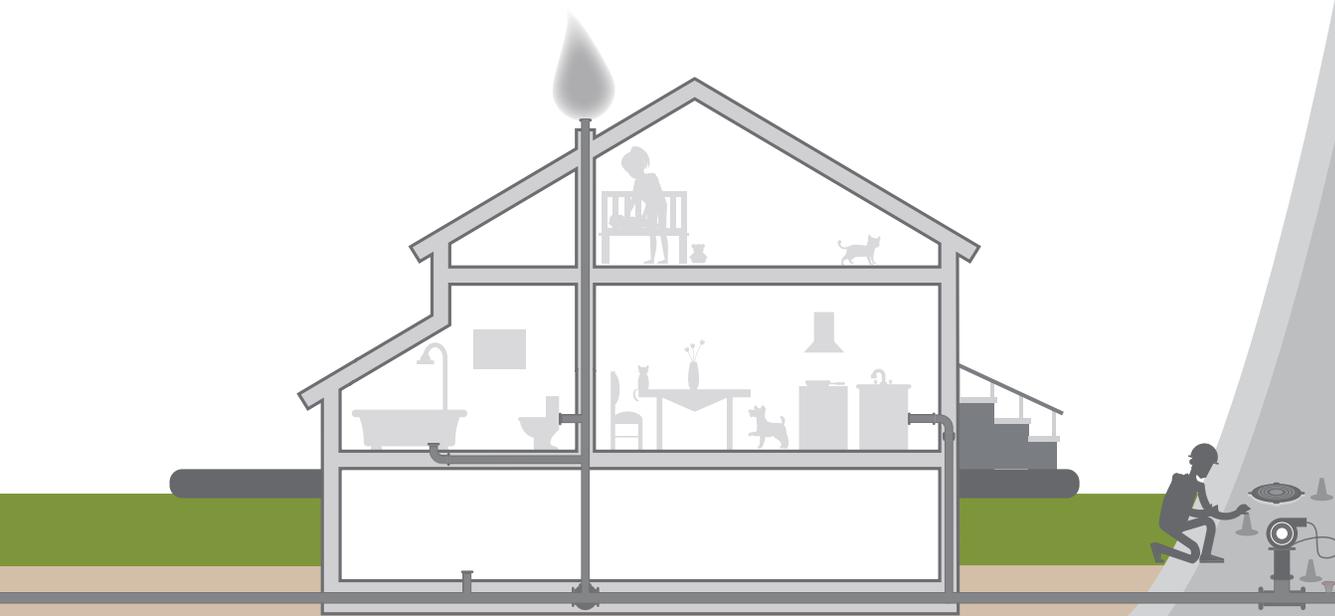
2. What is smoke testing?

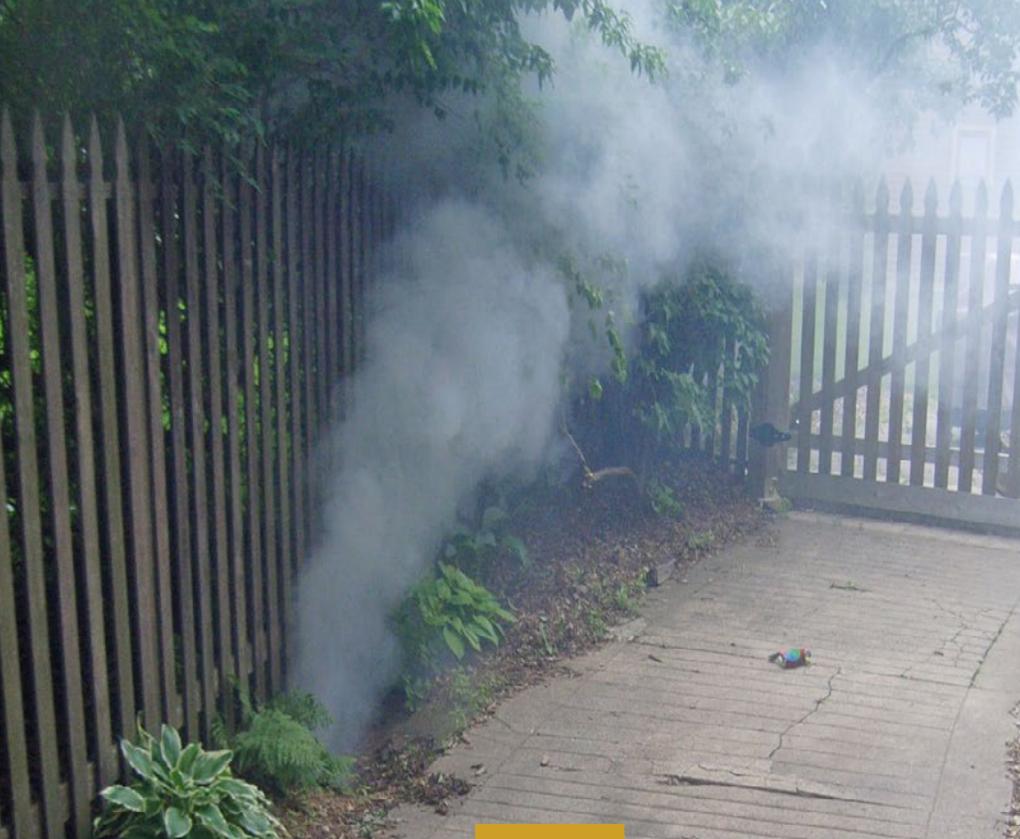
Smoke testing involves pushing a simulated, non-toxic smoke (similar to products used at concerts and theater venues during live performances) through a community's sanitary sewer collecting system, then observing and documenting where the smoke exits. This method for identifying I&I typically involves residential, commercial and industrial areas.

Field technicians set up a blower over a neighborhood manhole, and non-toxic smoke is pumped through the sewer line. The exiting smoke can indicate the location of a broken sewer pipe, manholes, catch basins, or where roof or foundation drains are connected to the sewer system.

Ultimately, smoke testing helps identify where inflow is entering the system. Take a closer, animated look at the smoke testing process in the brief video below.

[© WATCH THE VIDEO](#)





Odorless



Colorless



Will not cause fire



Will not cause explosion



Similar to smoke you see
at events or concerts

3. Is the smoke from this type of test hazardous?

Not in the slightest! The odorless, colorless simulated smoke will not cause a fire or explosion and isn't hazardous or flammable. As noted previously, this "smoke" is akin to what you see at concerts and other live events.

Simulated smoke should disappear quickly. However, it's encouraged to avoid unnecessary exposure to the smoke; extended exposure may cause some skin irritation.



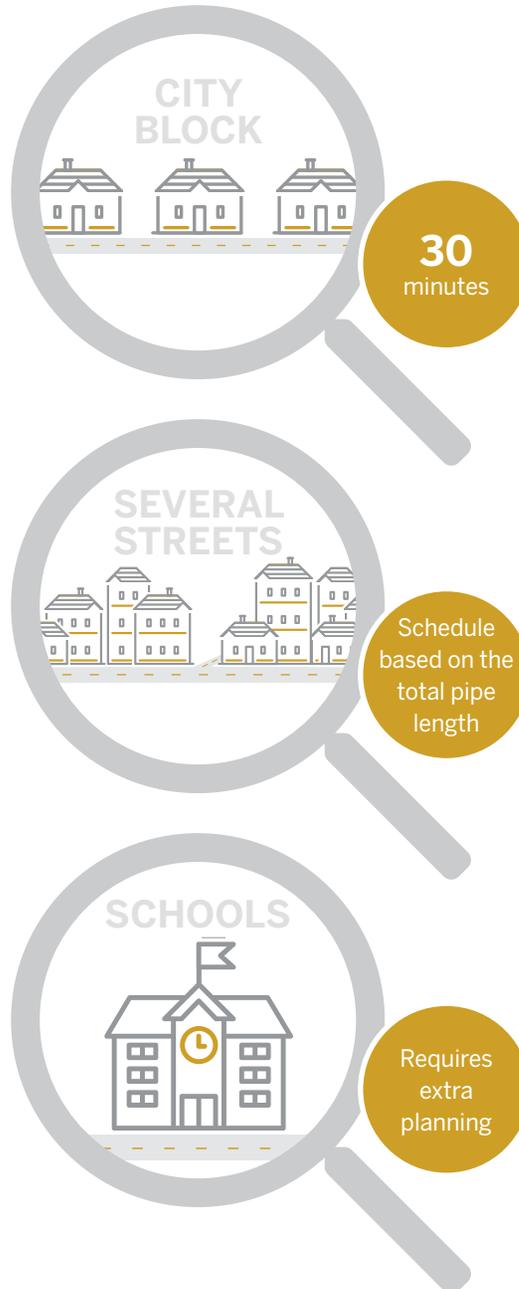
4. How long does the testing process take?

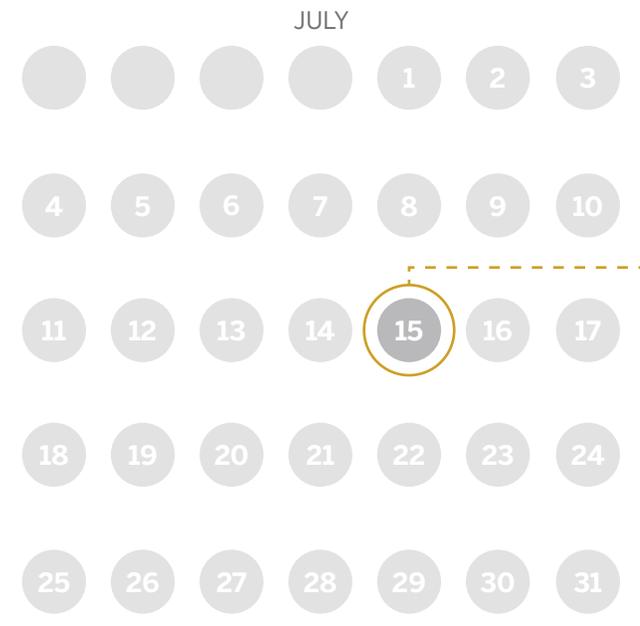
For a single city block, smoke testing lasts approximately 30 minutes. Residents may see the simulated smoke emerging from manhole covers, storm drains, roof vents or building foundations.

For an entire smoke testing project that spans several streets in a neighborhood or an entire community, the engineers and technicians conducting the testing will develop – then communicate to the public – a schedule based on the total pipe length and configurations.

Certain locations, such as schools, require extra planning before the process can take place. At SEH, we seek to schedule smoke testing at schools during summer when class isn't in session. During the summer months, technicians can also isolate areas to test and see how it impacts the public.

It's very important to have a plan in place before a specific area is tested, to communicate with residents, and to isolate the sanitary sewer sections tested to reduce impacts to residents during testing.

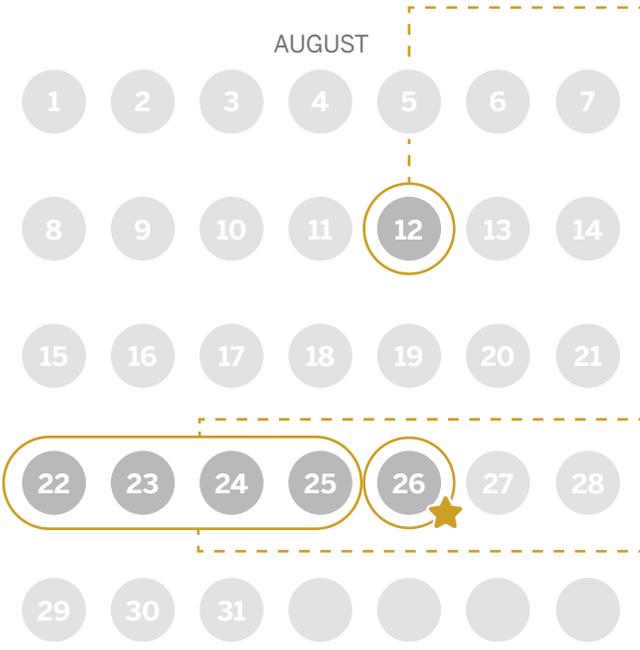




6 WEEKS PRIOR



Receive notice from community leaders



2 WEEKS PRIOR



Attend public or virtual meeting to voice any concerns

DAYS LEADING UP



Pour a gallon of water in open drain traps, basement bathrooms and floor drains

DAYS LEADING UP



Field crews in neighborhoods and flyers in resident mailboxes

5. How can we (residents) prepare for smoke testing?

Community leaders should inform residents of planned smoke testing at least six weeks prior to testing taking place. This proactive notice provides residents with the opportunity to process all information and prepare.

For open drain traps, basement bathrooms and floor drains, we often encourage residents to pour a gallon of water in each (which will create a small pool of water in the fixture trap) to prevent smoke from entering the house. Outside of the smoke testing, property owners should do this regularly to relieve the potential of sewer gas entering homes.

Two weeks before the testing, a public meeting or virtual event should be held to provide residents with the opportunity to ask questions and voice concerns.

Another option is to create a community website, send emails or use local government Facebook pages/community groups to engage residents.

In the days leading up to testing, another way to communicate what's ahead is to have field crews walk the neighborhoods and place flyers in resident mailboxes. These flyers provide information about the tests, tips to prepare and numbers residents can call with any questions. Residents should be informed that they should expect to see these crews around the neighborhood.



6. Will smoke enter my house? What should we do if it does enter my home?

The smoke from smoke testing should not enter homes or buildings. However, do not be alarmed if it does. As noted previously, the smoke is not toxic. Property owners are encouraged to simply open their doors and windows to ventilate the area. Simulated smoke should clear out quickly and will not stain walls or furniture or leave residue. The smoke is safe, but long exposure may cause irritation.

If smoke does enter a home from the inside (basement drains, etc.), residents should be advised to contact a licensed plumber to find out if there is a sewer connection problem. To be proactive in preventing smoke from entering their homes, encourage residents to run water faucets for a few seconds in unused sinks, tubs and drains in order to fill fixture traps and pour water into each floor drain (at least a gallon).





7. Will the city enter my home?

Neither the city nor the crew that performs smoke testing will enter your home during the testing process. However, if smoke is found in your home, you can request they enter to determine where the smoke is entering from.

City officials and project teams can have helpful, educational conversations with residents regarding smoke arising from within homes, but residents will likely need to connect with a licensed plumber to fix faulty issues.



8. Will first responders be on standby in case of emergency?

Smoke testing teams and/or city staff need to inform local fire and police departments of planned testing, so they can be on notice and educate residents if calls related to smoke testing arrive. Smoke testing will not create an emergency situation, but first responders can provide additional education, assurance and guidance.



CONCLUSION

Remain proactive. Listen. Learn.

As you evaluate your I&I needs and develop programs to overcome current or upcoming challenges, begin by gaining a better understanding of your infrastructure and the options available. Our hope is that the methods and tools discussed throughout this eBook will serve as a guide as you get started or continue to hone certain strategies.

At SEH, we're familiar with all methods of identifying, preventing, limiting and resolving I&I. For decades, we've been partnering with clients to help them save critical dollars in these areas. Please be encouraged to contact us with any questions related to I&I, ways you can combine infrastructure and utility projects, or to dig deeper into the concepts explored within the previous pages.

From eBooks to infographics and checklists, we have a library of complimentary downloadable and printable content developed to help you tackle an assortment of project challenges. Another SEH eBook and timely topic, *The State of Water Infrastructure – Trends, Challenges and How to Be Proactive Amidst Constant Change*, provides a nice complement to this eBook!

[VIEW DOWNLOADS](#)

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