



**North American Society for Trenchless Technology (NASTT)
NASTT's 2015 No-Dig Show**



**Denver, Colorado
March 15-19, 2015**

MA-T1-01

**Small Agency, Big Ambition - How a Pennsylvania Township
Authority Chose New Technology to Begin Addressing Their
Infiltration Issues**

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1. ABSTRACT

While it remains important for all sewer agencies to spend their rehabilitation money wisely, it is considerably more vital for small agencies with limited budgets. Hamilton Township Municipal Authority (Chambersburg, PA) has less than 75 miles of sanitary sewer pipe, a very lean budget, and a need to reduce their Inflow and Infiltration (I&I).

At the request of Hamilton Township Municipal Authority (HTMA) Electro Scan, Inc. undertook a single-day project in May 2014 to deploy its ES-620 System to evaluate two different small interceptor pipe runs that had never been able to be assessed due to high flows. In less than six hours, Electro Scan was able to investigate 2,000 feet of pipe that had not been assessed since being installed in the late 1970s. Additionally, the findings from the one-day investigation surprised many, altered the I&I investigation and rehabilitation focus areas, and saved the small agency tens of thousands of dollars. HTMA then began operating their own ES-620 system, and after inspecting a section of pipe using their Electro Scan equipment, which had previously been repaired based on CCTV data alone, they were able to investigate how their approach would have changed if the Electro Scan data had been available to them prior to the repair.

This paper will discuss the methods and procedures used for the Electro Scan testing (in accordance with ASTM F2550-13), and the challenges faced during the evaluation. The paper will also discuss Electro Scan's results and findings of the assessment and how those compared with any other past evaluation data. Cost analyses of testing procedures, investigation, engineering, and rehabilitation will be included to show how, where, and why dollars were saved.

2. CASE STUDY

Problem

As the rain comes down the flows would go up. Most sewer agency directors constantly panic when a large storm approaches, particularly if the system is older. Too often the I&I problems continue until it is too late – events such as sanitary sewer overflows (SSOs), treatment bypasses, environmental damage, and poor public opinion can often culminate in fines and heavy orders from regulatory agencies. One small Pennsylvania agency did not want to wait around until it was too late and began taking steps towards finding and fixing their infiltration issues. But the question remained as to the best approach to start locating the problems.

HTMA had conducted manhole inspections, smoke testing, and utilized CCTV for inspection. During heavy wet weather events the crews would undertake night isolations to identify locations of high infiltration. Each rain event

would yield varying results depending upon the intensity of the rain and water table conditions. Once an issue was located, in-house crews would repair what they could find using acrylic grout, trenchless point repairs, and dig-and-replace techniques. However, despite all this, wet weather flow levels were only reduced slightly.

New Approach

HTMA officials and one of their consulting engineering firms, Barton and Loguidice, contacted Electro Scan after learning about how it was helping other agencies locate and quantify their infiltration that had previously been “undetectable” with the typical sewer inspection technologies. After an initial meeting in March, a date was set to undertake a small two-day project at HTMA in May. An agreement was reached where Electro Scan would provide the equipment, operators, and data at no charge, in exchange for HTMA assembling a group of other interested parties to see the technology in action in the Central Pennsylvania.

Background

HTMA’s sewer system is a collection and conveyance system and is a partner to an Inter-municipal Agreement between the Borough of Chambersburg, Guilford, Greene and Hamilton Townships. It is through this agreement that the sewage collected by HTMA is transported to the Borough of Chambersburg’s wastewater treatment plant (WWTP) for treatment. HTMA’s system is comprised of fourteen (14) pumping stations, three (3) meter stations, approximately 70 miles of sewer line, 1,215 manholes and serves approximately 4,025 customers. HTMA’s present capacity allocation at the Borough’s WWTP is 760,000 gallons per day (gpd).

In 2007 the Borough of Chambersburg was required to enter into a Consent Order with DEP as a result of overflows in the trunk line entering the wastewater treatment plant. As a result of the consent order partnering municipalities were also required to take additional measures to identify and mitigate I&I. In 2009 and 2011, HTMA reached its capacity allocation with average daily flows of 762,750 gpd and 757,547 gpd respectively. In 2009 HTMA established and adopted an I&I Sewer System Management Plan. Since then HTMA has developed a comprehensive and robust metering plan to analyze the reaction of HTMA’s system to various wet weather events and to prioritize areas for I&I investigations. The Authority has been working intensely to find and remediate sources of I&I and has made progress over the last two years. This is substantiated by the fact the 2013 ADF was 628,118 gpd (a reduction on average of 132,000 gpd).

The Borough’s wastewater treatment plant is currently undergoing an upgrade and expansion to meet the Chesapeake Bay Strategy and to accommodate growth projections for the next 20 years. As a result, the plant capacity will increase from 6.8 mgd to 11.28 mgd with a maximum peak flow of 33.5 mgd. After construction is completed and the plant is fully operational, HTMA’s capacity allocation will increase to 2.0 mgd. In 2010 a new Inter-municipal Agreement was negotiated which included a component to address capacity allocation defaults once the plant upgrade and expansion is completed and operational. There are triggers and mechanisms built in with penalties, special charges, rental requirements, remediation procedures and required provisions to initiate planning any time a participant’s monthly average flow exceeds 90% of the allocated capacity. Despite the fact that HTMA’s capacity allocation would increase to 2.0 mgd, the authority was still faced with the challenge of removing I&I as during significant heavy wet weather events HTMA’s daily flow exceeded 3.0 mgd.

The large majority of the pipe in HTMA’s system is PVC (~70%) and Asbestos Cement (~30%), and between 30 and 40 years old. The first section of pipe that was examined as part of this mini-project was a 14” asbestos cement (AC) interceptor on Commerce Street. (Figure 1)

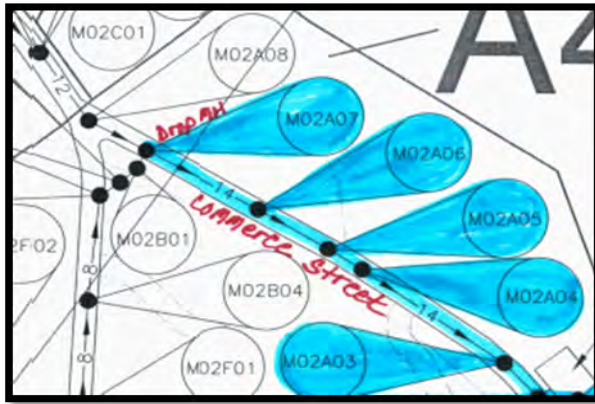


Figure 1. Map showing the pipe segments inspected on Commerce Street

The source of flows going to Commerce Street comes from four (4) pumping stations and gravity flows from four (4) different developments. The average daily flow for this interceptor is approximately 248,000 gpd with an average hourly flow of 14,500 gallons; extreme wet weather events have yielded as much as 1.2 mgd with a peak hourly flow of 83,650 gpd. Based on metering data, the source of the excess flows are mainly from two pumping station basins and the four gravity flows areas. Area velocity meters have been installed at the four locations where gravity flows from the four developments tie into the main trunk line. Wet weather investigations have been targeted for each of the four gravity areas and some repairs have been made. The pipe in this section is asbestos concrete cement which was installed around 1977. Manholes upstream of this section of pipe are experiencing significant hydrogen sulfide deterioration. The area shown on Figure 1 is known for flooding conditions and the road is usually closed to traffic during heavy wet weather events. Due to constant flows, together with the location and size of the pipe, the Authority has been unable to assess this section of pipe via CCTV. Historically, there have not been any repairs made to this section of pipe.

The second section of pipe that was to be examined as part of the mini-project is also an interceptor that runs to a pump station, except this line is 10" PVC. These four (4) sections of pipe run adjacent to a small creek, and are located within the flood plain of the creek. Data from the pump station and creek level observations indicate that flow rates and pump run times increase in tandem with adjacent creek levels. During extreme wet weather conditions the pump station cannot keep up with the incoming flow and is pumping more than 60,000 gallons per hour with metering data recording flows of nearly 1.1 mgd. Again, due to constant flows, the Authority has been unable to assess this section of pipe via CCTV. Historically, there have not been any repairs made to this section of pipe.

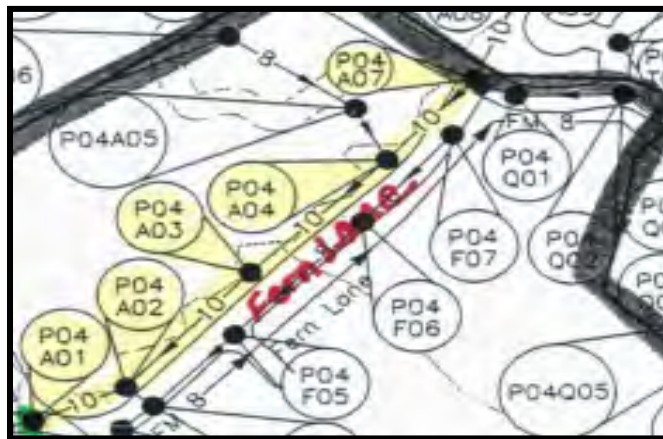


Figure 2. Map showing the pipe segments inspected on Fern Lane

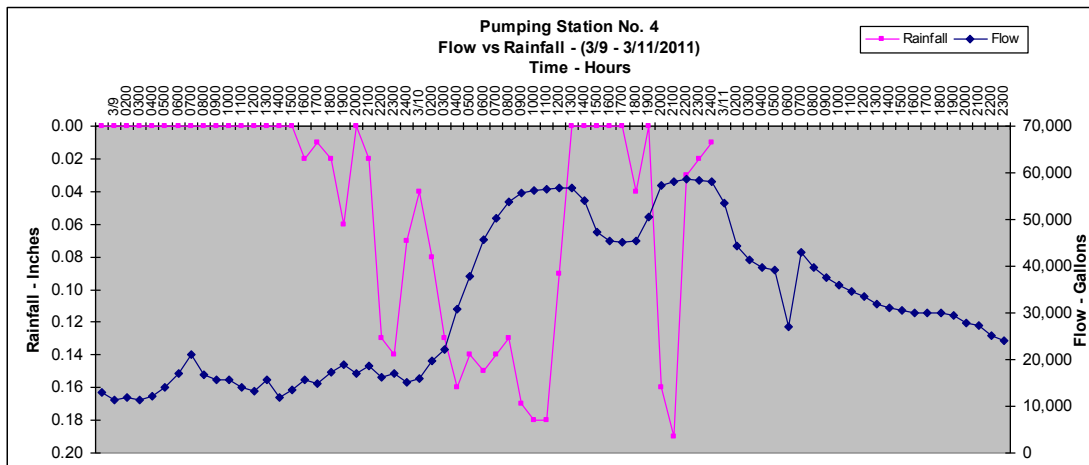


Figure 3.Hydrograph of Pump Station 4 hourly flows and rainfall, pre-Electro Scan

HTMA and their engineers needed to identify those areas to focus their rehabilitation efforts. However, they were concerned that CCTV would not locate all the leaks (unless they were actively leaking), and additionally would be slower and more expensive, due to the fact they would have to bypass pump, thoroughly clean, then set up and maintain traffic control throughout the multiple days on site. With Commerce Street carrying a significant amount of traffic, the Authority could not close it for long periods of time. HTMA and their engineers, Barton and Loguidice, reached out to Electro Scan after seeing results from some of their previous projects, and sensed that this investigation technique could help find the issues that other technologies had failed to.

Process & Production

Work began the morning of May 21, 2014. Since the technology does not require an empty or clean pipe to perform the inspection, work was able to begin immediately, even though the 14 inch diameter sewer was flowing about half full. All the pipe segments were scanned using Electro Scan's ES-620 system which was integrated into a standard CUES Industries CCTV truck. From the upstream manhole, the probe was moved through the pipe downstream using a Vactor Jet Truck. The Jet Truck also provided water to the probe to allow it to complete its examinations of the pipe wall via focused electrical current. A proprietary 14" Sliding Funnel Plug kept the water in place, allowing for very limited water waste by re-using the same water for multiple pipe segments. Figure 4 shows an example of the process.

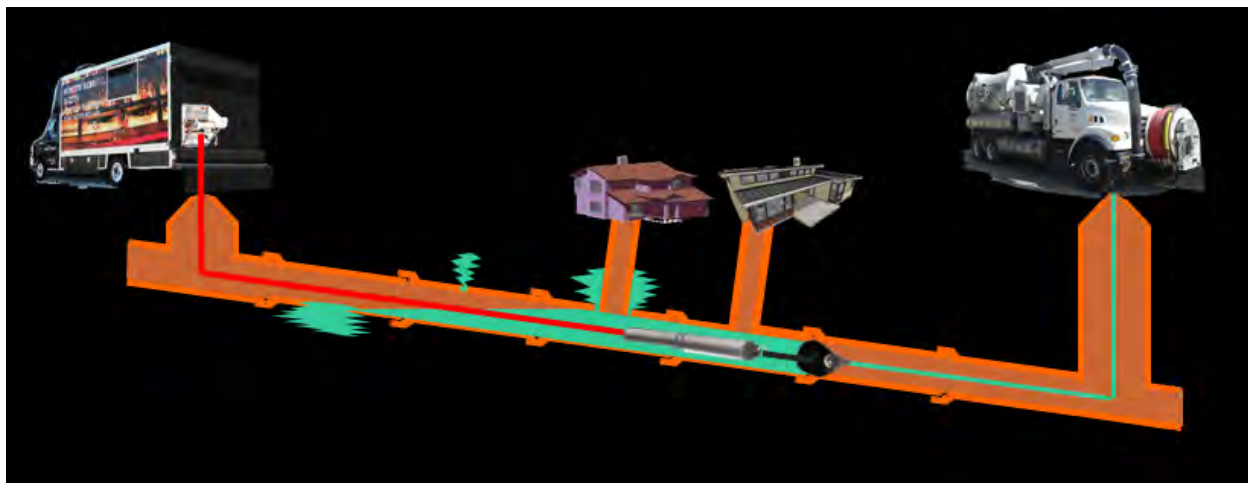


Figure 4: Simulation of Electro Scan process

Immediately after commencing scanning, large defects were detected within the first pipe segment, and it appeared the entire 1,000+ feet of pipe was defective, as suspected. However, after the first 60 feet, the defects subsided and occurred only occasionally, mostly at joints, and with low estimated infiltration rates.

While the scanning did not proceed as quickly as had been anticipated, the entire run of pipe was scanned within three (3) hours. Reasons for the slower production included waiting for traffic control to reconfigure and a situation where one of the Electro Scan Sliding Funnel Cones was shot through a downstream manhole, temporarily trapping it in the pipe, and causing a 20 minute delay. However, the entire scanning process was able to be completed in the time it would normally have taken to set up bypass pumping if the lines were to have been inspected via CCTV.

That afternoon, the operation was mobilized on Fern Lane to inspect the 10" PVC interceptor that was suspected of having high sources of infiltration. The 905 lf of pipe (4 segments) was scanned in under 1-1/2 hours. Figure 5 shows the creek adjacent to the pipe that was being scanned.



Figure 5: Scanning the PVC pipes adjacent to the creek, which was suspected to be the cause of the pipe infiltration.

3. RESULTS

Commerce Street

- Electro Scan identified **51** locations of potential infiltration (defects) throughout the lengths of the pipes scanned (1,080 feet), for an average of 13 defects per pipe.
- Total estimated leakage of the pipes inspected in this section represents 23 gallons per minute, or **almost 33,120 gpd**, $\pm 40\%$ accuracy, assuming a 1 foot head.
- Average estimated flow through each defect is 0.44 gallons per minute (635 gpd), occurring approximately a little over every 21 feet.

This section of pipes was suspected of being a significant contributor of infiltration to the system, and ultimately, was shown by this method of low-voltage leak locating to not be of great concern. In fact, almost 70 percent of the possible infiltration points in this entire section were identified as occurring within the first 60 feet of one pipe (2A07 to 2A06). With higher flows in these pipes, stagnant H₂S gas did not appear to be a problem, as the walls of this section of AC pipe were not as porous as typically seen by Electro Scan results in other AC collection sewers.

The defects found in the individual segments of sewer are presented in Table 1.

Table 1. Commerce Street Electro Scan Data Summary

Manhole From	Manhole To	Distance (Ft)	Number of Defect Counts				Total GPM			
			Small	Medium	Large	Total	Minor	Moderate	Large	Total
2A07	2A06	280	12	1	9	22	5.84	10.09	0.00	15.93
2A06	2A05	305	13	0	0	13	2.89	0.00	0.00	2.89
2A04	2A03	395	10	0	1	11	2.25	0.00	0.00	2.25
2A05	2A04	100	4	0	1	5	1.44	0.00	0.00	1.44
Total Group Defect Flow (GPM):										22.51

Table 2. Commerce Street Approximate Electro Scan vs. CCTV Cost Analysis

CCTV					Electro Scan				
Operation	Cost (\$)	per	Unit	Total	Operation	Cost (\$)	per	Unit	Total
Mobilization	\$1,000.00		1 ea	\$1,000.00	Mobilization	\$1,000.00		1 ea	\$1,000.00
Traffic Control	\$85.00		10 hour	\$850.00	Traffic Control	\$85.00		4 hour*	\$340.00
Bypass Pumping	\$800.00		10 hour	\$8,000.00	Bypass Pumping	N/A		setups	N/A
Cleaning	\$1.00		905 feet	\$905.00	Cleaning	N/A		feet	N/A
Televising	\$2.00		905 feet	\$1,810.00	Scanning	\$3.00		1080 feet	\$3,240.00
Total Cost \$12,565.00					Total Cost \$4,580.00				

*minimum charge

Table 2 presents a comparison of the anticipated CCTV cost and the same segments being inspected using the Electro Scan method. For approximately 1/3 the estimated cost of CCTV (assuming the Electro Scan inspection was a paid project), Electro Scan provided the quantitative data identifying the major defects and their location to HTMA. The Authority is currently working with their engineers and in-house repair team to determine the best method for repair, and subsequently schedule repair/rehabilitation for the 60' section of defective.

Even with all costs being equal, it is unlikely that CCTV would be able to find all the defects in the pipe that could contribute to infiltration, due to the limitations of visual observations. The quantity of potential infiltration on this particular pipe shows how Electro Scan was able to objectively locate and measure defects to help make better inspection and rehabilitation decisions in addition to minimizing the consulting engineering dollars to be spent.

Fern Lane

- Electro Scan identified only ten (10) locations of potential infiltration (defects) throughout the lengths of the pipes scanned (905 feet), for an average of less than three (3) defects per pipe.
- Total estimated leakage of the pipes inspected in this section represents only about four (4) gallons per minute, or approximately 5,700 gpd, ±40% accuracy, assuming a 1 foot head.
- Average estimated flow through each defect is 0.4 gallons per minute (570 gpd).

As mentioned earlier in the report, whenever the creek adjacent to this pipe flooded, the lift station saw significant increases that corresponded almost directly with the water levels. This section of pipes, although suspected of being significant contributors of infiltration to the system, were shown by Electro Scan be in good shape overall with low levels of potential infiltration (Table 3). With the Electro Scan results ruling out significant infiltration, the focus (and rehabilitation money) of these segments can now be directed fully at addressing what is likely the issue with these pipes – inflow – without spending additional money on other inspections, such as CCTV (Table 4).

Table 3. Fern Lane Data Summary

	Manhole From	Manhole To	Distance (Ft)	Number of Defect Counts				Total GPM			
				Small	Medium	Large	Total	Minor	Moderate	Large	Total
7	P04A04	P04A03	285	1	4	1	6	2.37	0.00	0.00	2.37
10	P04A07	P04A04	265	1	0	1	2	0.09	1.20	0.00	1.29
11	P04A02	P04A01	290	2	0	0	2	0.29	0.00	0.00	0.29
12	P04A03	P04A02	65	0	0	0	0	0.00	0.00	0.00	0.00
Total Group Defect Flow (GPM):											3.95

Table 4. Fern Lane Approximate Electro Scan vs. CCTV Cost Analysis

CCTV					Electro Scan				
Operation	Cost (\$)	per	Unit	Total	Operation	Cost (\$)	per	Unit	Total
Mobilization	\$1,000.00	1	ea	\$1,000.00	Mobilization	\$1,000.00	1	ea	\$1,000.00
Bypass Pumping	\$800.00	10	hour	\$8,000.00	Bypass Pumping	N/A		setups	N/A
Cleaning	\$1.00	905	feet	\$905.00	Cleaning	N/A		feet	N/A
Televising	\$2.00	905	feet	\$1,810.00	Scanning	\$3.00	905	feet	\$2,715.00
Total Cost				\$11,715.00	Total Cost				\$3,715.00

With only one pipe (P04A04 to P04A03) showing any signs of defects, these pipes were placed low on the list of pipes to receive rehabilitation attention. If it is decided to address these sources, spot repair methods will probably suffice. HTMA will continue to monitor this section as it utilizes Electro Scan to compile additional sewer condition assessments in this area before prioritizing defects and developing and implementing a progressive I&I repair program.

The Next Step

With the results from these two sections of pipe, plus a third section of pipe that showed severe leakage, below a storm swale (see Figure 6), HTMA decided to invest in both an ES-620 Electro Scan system, which would integrate into their UEMSI CCTV system, and an ES-38 system for lateral investigations.

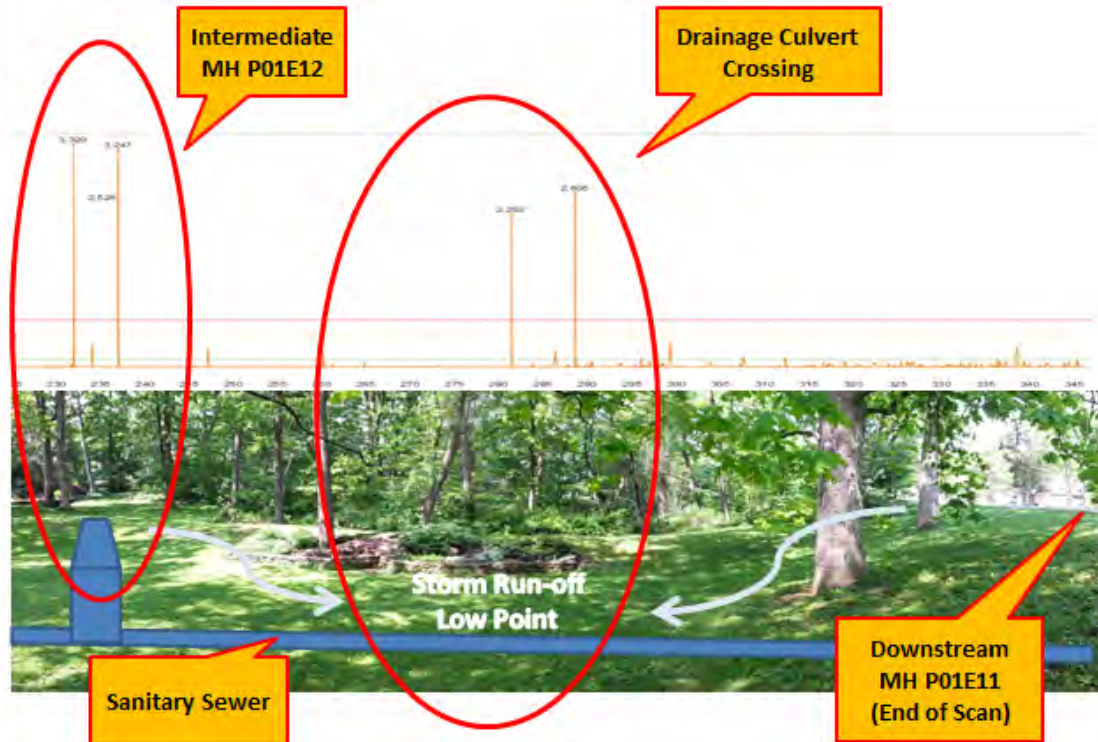


Figure7: Scan graph for third section of pipe showing large leaks located directly below a drainage swale.

Ongoing Investigations

In the 3-month time frame that HTMA has been using their ES-620 system the Authority has discovered several situations that caused their pre-Electro Scan rehabilitation decisions to be revisited. One, in particular, was an 8” AC pipe that had defects that were previously discovered with CCTV and repaired by making four (4) point repairs (two leaking joints and two leaking wye connections). HTMA repaired what could be physically seen and identified in a wet weather event of nearly 1” of rain. Figure 8 shows CCTV pictures of two of the four leaks that were repaired.

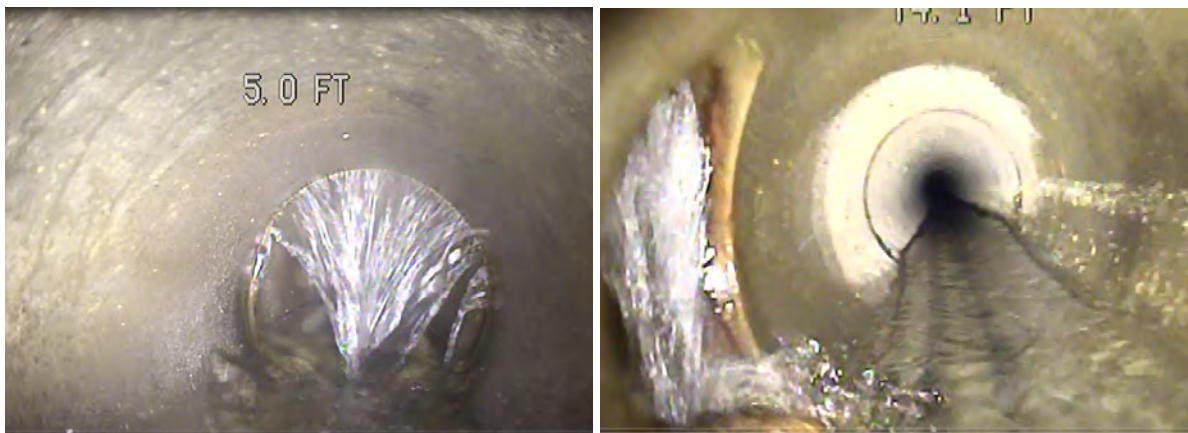


Figure 8: CCTV screenshots of two leaks identified and repaired by digging and replacing

However, as a post-evaluation inspection, HTMA electro scanned the two sections of pipe where point repairs had been made by in-house crews. It was revealed that although the spot repairs had been effective, the remainder of the pipe was in poor condition and in need of rehabilitation, as shown in Figure 9. In addition to 3 ½ days labor and materials to make the repairs, the cost for road restoration work alone amounted to \$7,970. HTMA believes that if

the Agency had purchased and utilized Electro Scan before these repairs were made, the Electro Scan technology would have allowed the Authority to make better educated decisions, both structurally and financially. HTMA Management feels that in hindsight, owing to the Electro Scan results, a better approach would have been to CIPP line these two sections of pipe; this approach would have undoubtedly yielded better post-scan evaluation results. HTMA repaired what could physically be seen and identified during the major storm event.

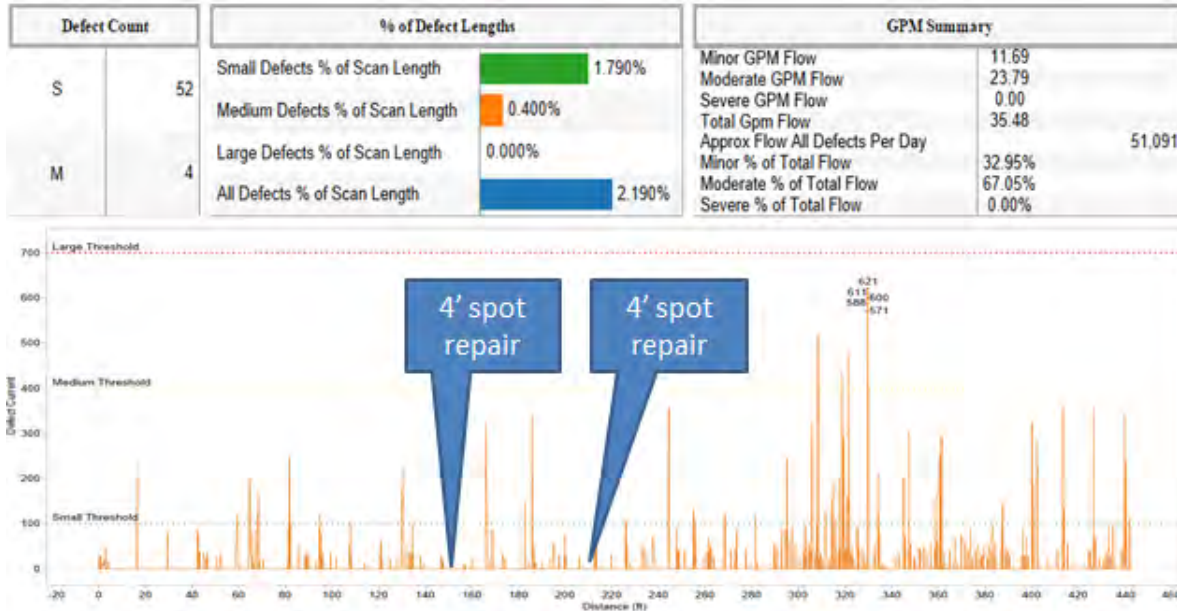


Figure 9: Scan graph showing the effectiveness of the spot repairs, but leaks in the pipe beyond the repairs.

HTMA has never been directly under a consent order and the Authority has expressed their desire to take a proactive and progressive approach to I&I reduction. The Authority believes that if it can lower its average daily flow and wet weather flows with the condition assessment approach: identify, evaluate, prioritize and repair, it can strive to achieve the following:

- Sustain available capacity for long term planned growth
- Lower sewage treatment costs
- Successfully manage I&I to avoid penalties from the Inter-municipal Agreement for exceeding the capacity allocation
- Police itself to avoid any necessity for an environmental agency regulatory order

HTMA believes the biggest advantage in owning the Electro Scan technology is that it can essentially recreate its own wet weather events by utilizing the low-voltage leak locating technology year round (providing it is warm enough that the water in the jet truck will not freeze) by including it into the weekly routines. Being proactive rather than reactive when it comes to I&I reduction will benefit both the community and Hamilton Township Municipal Authority long term. Electro Scan will enable HTMA to more effectively prioritize rehabilitation efforts and create a more targeted CCTV inspection program. While Electro Scan will not be able to tell the complete story of what is happening within the pipe, the addition of the technology helps paint a more complete picture to allow the Agency to evaluate and approach rehabilitation to sustain the integrity of the system, both structurally and financially, for years to come. It will also assist the Authority in planning and implementing a long term, progressive rehabilitation program.

4. REFERENCES

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