Environmental Since OTCO 1964 Training Center

The Latest Innovation in Leak Detection for Gravity and Pressure Sewers
March 23, 2022 – Marietta, OH

M.E. SIMPSON Co., Inc.

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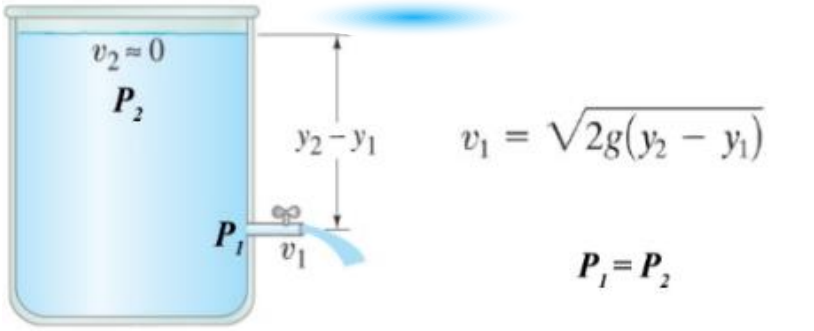
electro scan inc.

electroscaninc.

Machine-Intelligent Infiltration Location & Quantification

How Does It Work?

Torricelli's Law + Ohm's Law



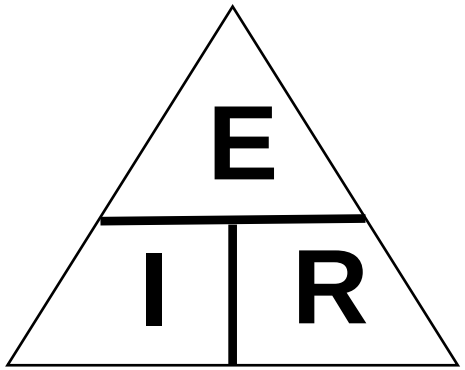
$$v_1 = \sqrt{2g(y_2 - y_1)}$$

$$P_1 = P_2$$

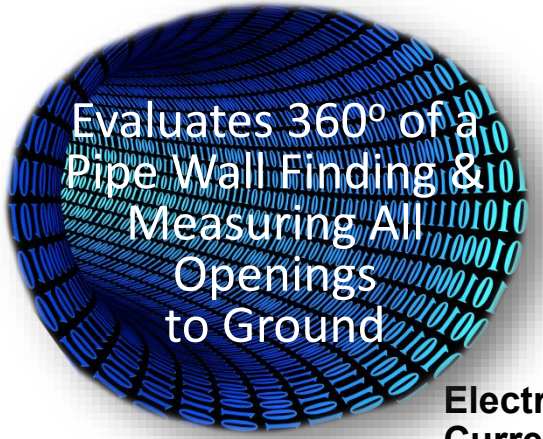
$$P_1 + (\tfrac{1}{2})\rho(v_1)^2 + \rho g y_1 = P_2 + (\tfrac{1}{2})\rho(v_2)^2 + \rho g y_2$$

E = IR ; I = E/R ; R = E/I

Where:
"E" *volts*
"I" *amps*
"R" *ohms*



The Science of Low Voltage in a Sewer Pipe



Electro Scan Inspection Van

Jet Truck

Electric Current Meter

Grounding Source

Voltage Source

Water = Conductor

Probe Cable

Resistance = ACP, Brick, CIPP, Concrete, FRP, HDPE, PE, PCCP, PVC, RCP, SRP, VCP

Electro Scan Probe

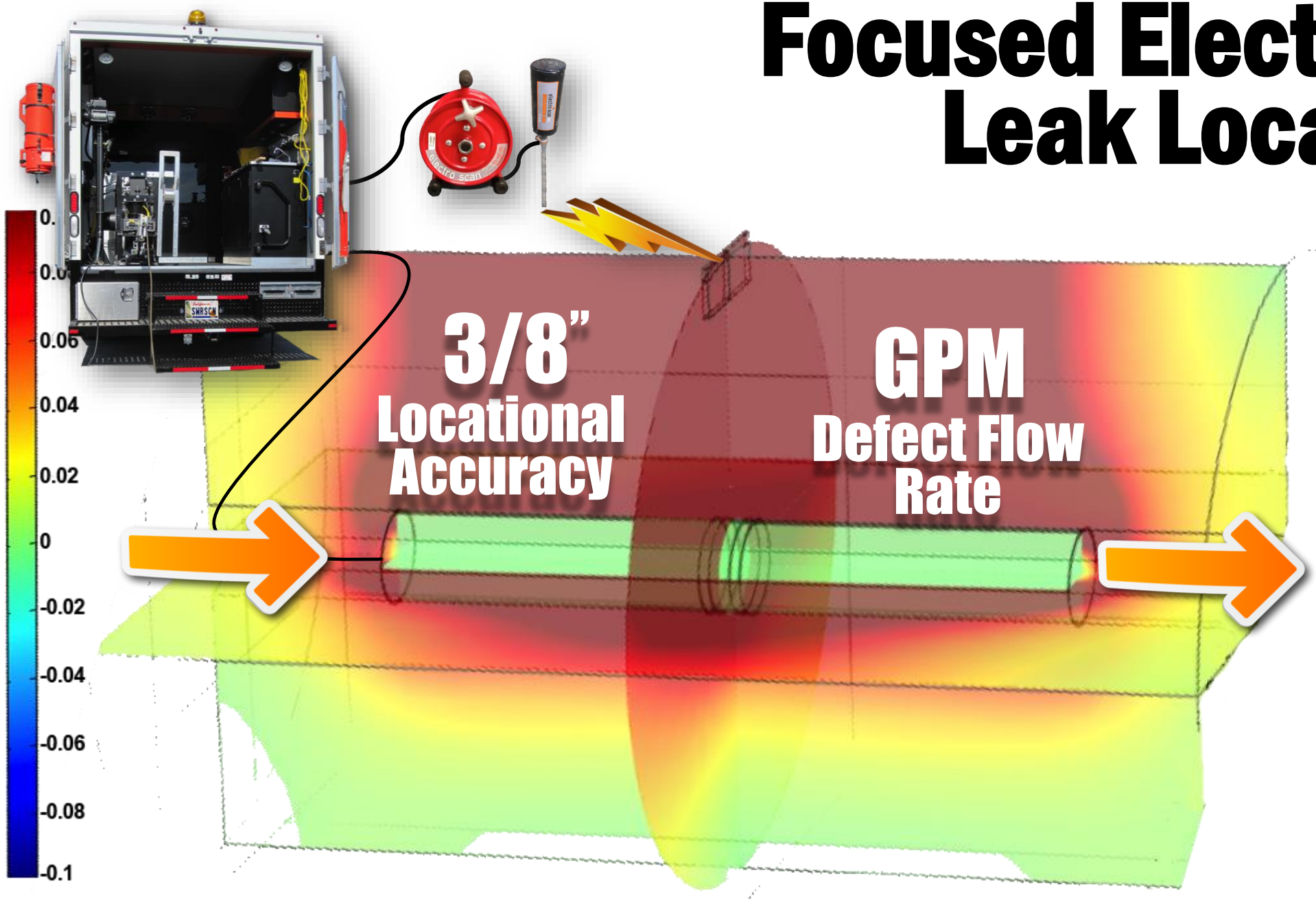
Sliding Funnel Plug

Low Voltage – 40mA

High Frequency

Equipment Uses 24v DC, w/Probe output of 11v AC.

Focused Electrode Leak Location FELL



amazon web services™

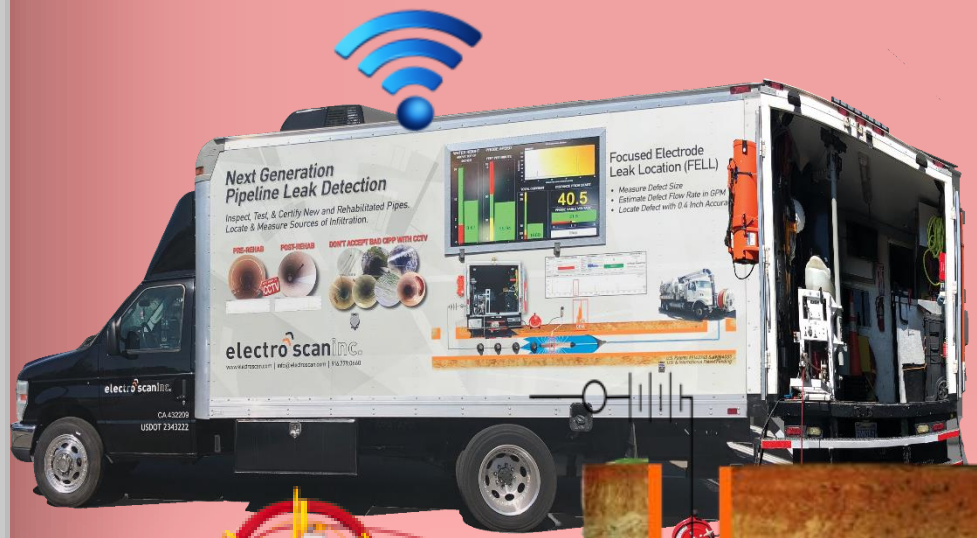
criticalsewers®

+ a b | e a u

FIRE WALL

FIRE WALL

Results In Minutes



SAP HANA infor

Innovyze® WinCan

ORACLE®

Total # of Defects

% of Pipe Defective by Length

Estimated Leakage Rate

electro scan

DEFECTS		% OF DEFECT LENGTHS
Small	12	0.0135
Medium	6	0.0104
Large	28	0.1023
All Defects	46	

GPM SUMMARY	
Minor	5.000
Moderate	26.800
Severe	188.650
Total GPM	220.450
GPD	317,448
GPD IDM	969,697
Minor %	1.90%

DIAMETER & DISTANCE

8

216.00 ft

OPERATOR INFO

Tech Electroscan

Project

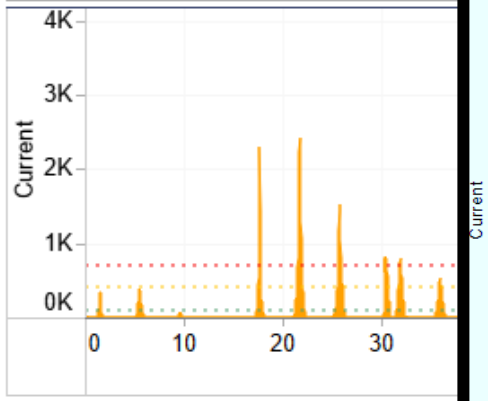
Demo

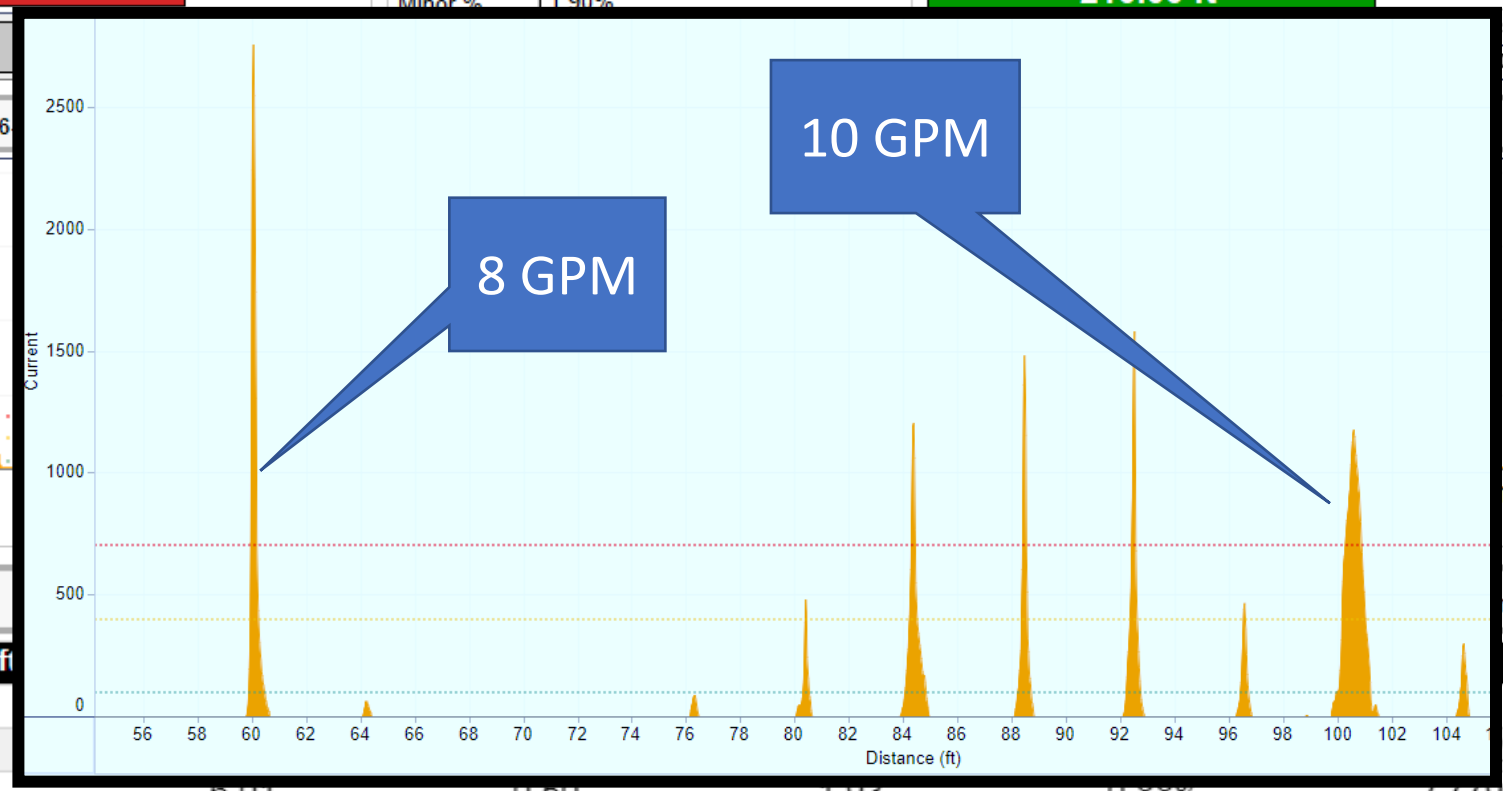
Job

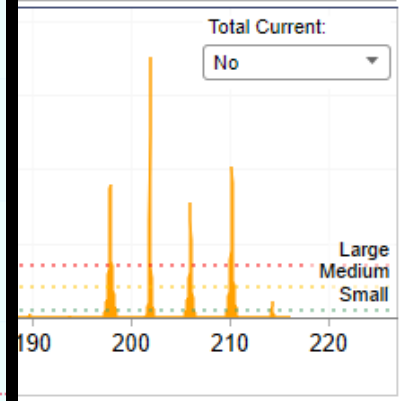
Demo

spheric Test	Scan Start
017 9:13:52 AM	7/25/2017 12:03:06 PM

DEFECT CURRENT Mainline ID: 16







DEFECT BY LOCATION

Defect Grade	Defect Start (ft					GPD/IDM
S	0.05					704
S	1.53					4,619
S	5.51	6.01	0.50	1.93	0.88%	2,779	8,490
L	17.70	18.35	0.65	6.23	2.83%	8,971	27,404
L	21.75	22.76	1.00	10.00	4.54%	14,400	43,987

Are There Standards?

Low Voltage Conductivity

Designation: F2550 – 13 (Reapproved 2018)

Standard Practice for Locating Leaks in Sewer Pipes By Measuring the Variation of Electric Current Flow Through the Pipe Wall[1]

INTRODUCTION

Infiltration of groundwater into a sewer through defects in the pipe can considerably increase the operation and capital costs of a sewer system. Exfiltration of sewage out of a sewer pipe may cause degradation of aquifers and shoreline waters. Accurate location, measurement, and characterization of all potential pipe leak defects are essential inputs for cost-effective design, testing, and certification of pipe repairs, renewal, and new construction. While commonly used sewer leak assessment methods, such as air and water pressure testing, represent cost effective methods to provide overall Pass/Fail pipe assessments, their inability to provide accurate location and size of leaks, particularly at individual joints and service connection, limit their use in remediation and rehabilitation decision support.

1. Scope

1.1 This practice covers procedures for measuring the variation of electric current flow to detect and locate potential pipe leaks in pipes fabricated from electrically nonconductive materials such as brick, clay, concrete, and plastic pipes (that is, reinforced and non-reinforced). The method uses the variation of electric current flow through the pipe wall to locate defects that are potential water leakage paths either into or out of the pipe.

1.2 This practice applies to mainline and lateral gravity flow storm sewers, sanitary sewers, and combined sewers with diameters between 3 and 60 in. (75 and 1500 mm). The pipes must be free of obstructions that prevent the probe passing through the pipe.

1.3 The scanning process requires access to sewers, filling sewers, and operations along roadways that are safety hazards. This standard does not describe the hazards likely to be encountered or the safety procedures that must be carried out when operating in these hazardous environments. (7.1.3) There are no safety hazards specifically associated with the use of an electro-scan apparatus that complies with the specifications provided in this standard. (6.7 and 6.10.)

1.4 The measurement of the variation of electric current requires the insertion of various items into a sewer. There is always a risk that due to unknown structural conditions in the sewer such items may become lodged in the pipe or may cause the state of a sewer in poor structural condition to further deteriorate. This standard does not describe methods to assess the structural risk of a sewer.

1.5 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.6 This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and to determine the applicability of regulatory limitations prior to use.

1.7 This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

2. Terminology

2.1 Definitions of Terms Specific to This Standard:

2.1.1 lateral, n—sewer pipe connecting the common sewer collection system to the user.

2.1.2 mainline, n—pipe that is part of the common sewer collection system.

[1] This practice is under the jurisdiction of ASTM Committee F36 on Technology and Underground Utilities and is the direct responsibility of Subcommittee F36.20 on Inspection and Renewal of Water and Wastewater Infrastructure.

Current edition approved Aug. 1, 2018. Published August 2018. Originally approved in 2006. Last previous edition approved in 2013 as F2550-13. DOI: 10.1520/F2550-13R18.

2018

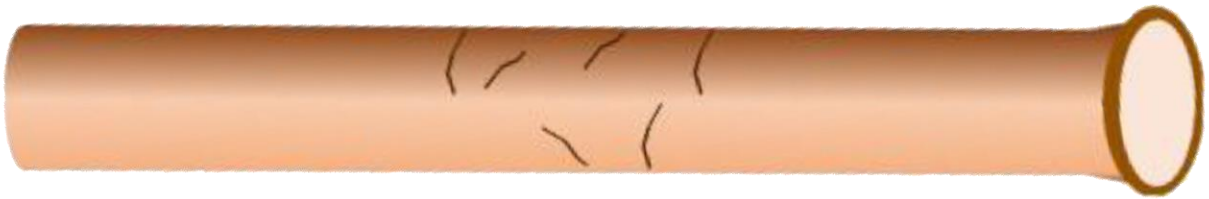
Focused Electrode Leak Location FELL

2006, 2013, 2018

Why Is ‘FELL’ Better?

RANDOM

CONCENTRATED



CAMERAS MISS 80-100% OF LEAKS AT CRACKS.

What About Leak Accuracy & Repeatability?

1. Low Accuracy
Low Repeatability

CCTV

2. Low Accuracy
High Repeatability

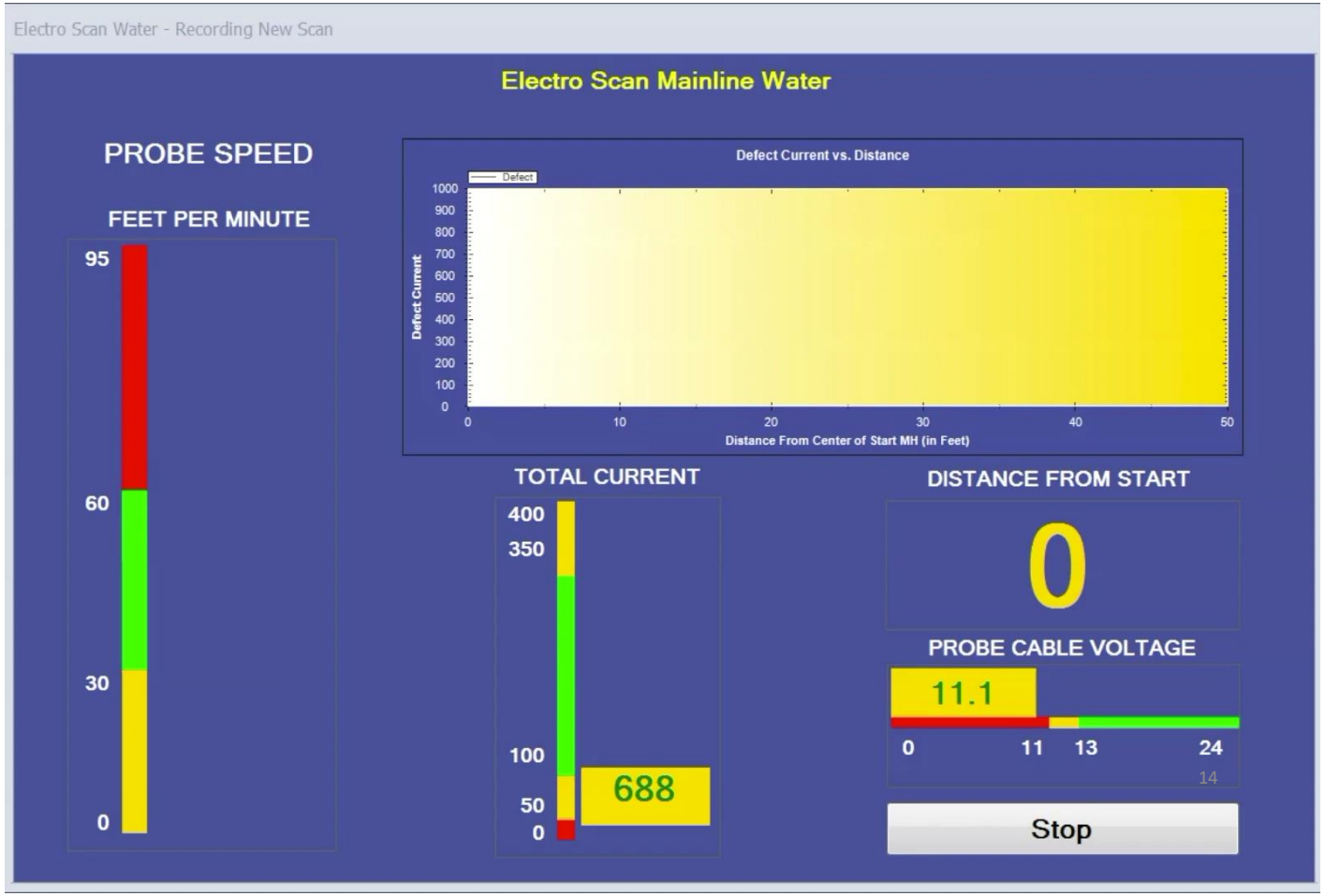
FLOW METERS

3. Medium Accuracy
Low Repeatability

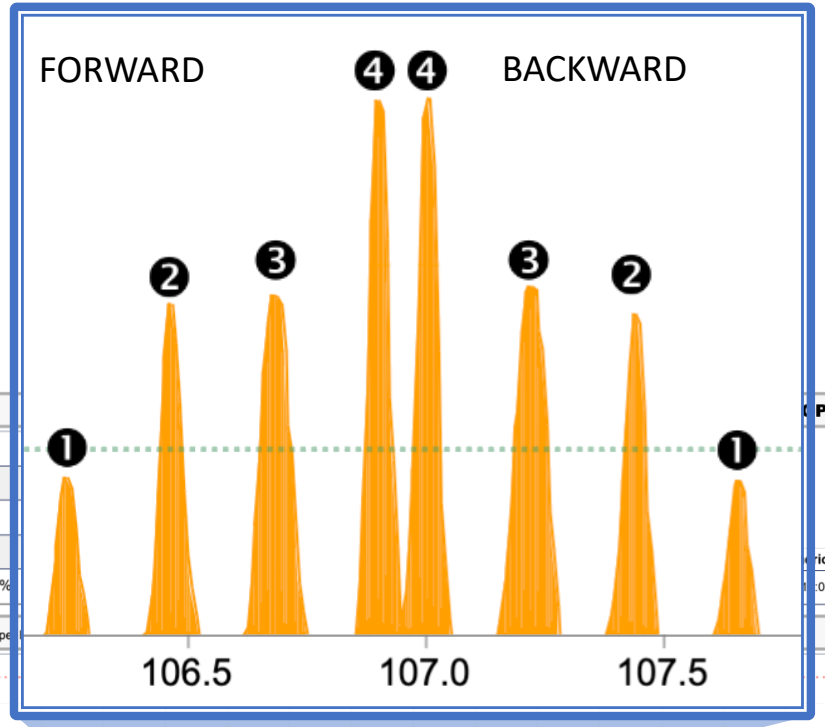
SMOKE

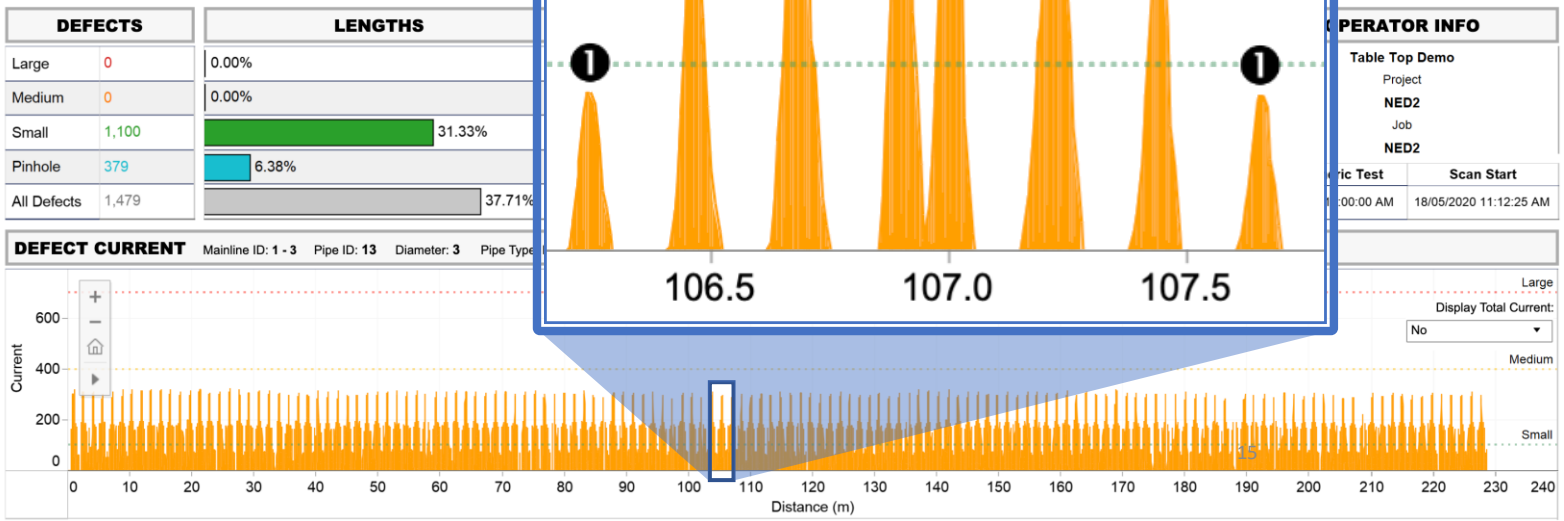
4. High Accuracy
High Repeatability

ELECTRO SCAN



Conductivity Benchmark Testing For Finding Leaks in Plastic Pipe





Electro Scan's Use of Ohms Law Provides Unmatched Data Repeatability.

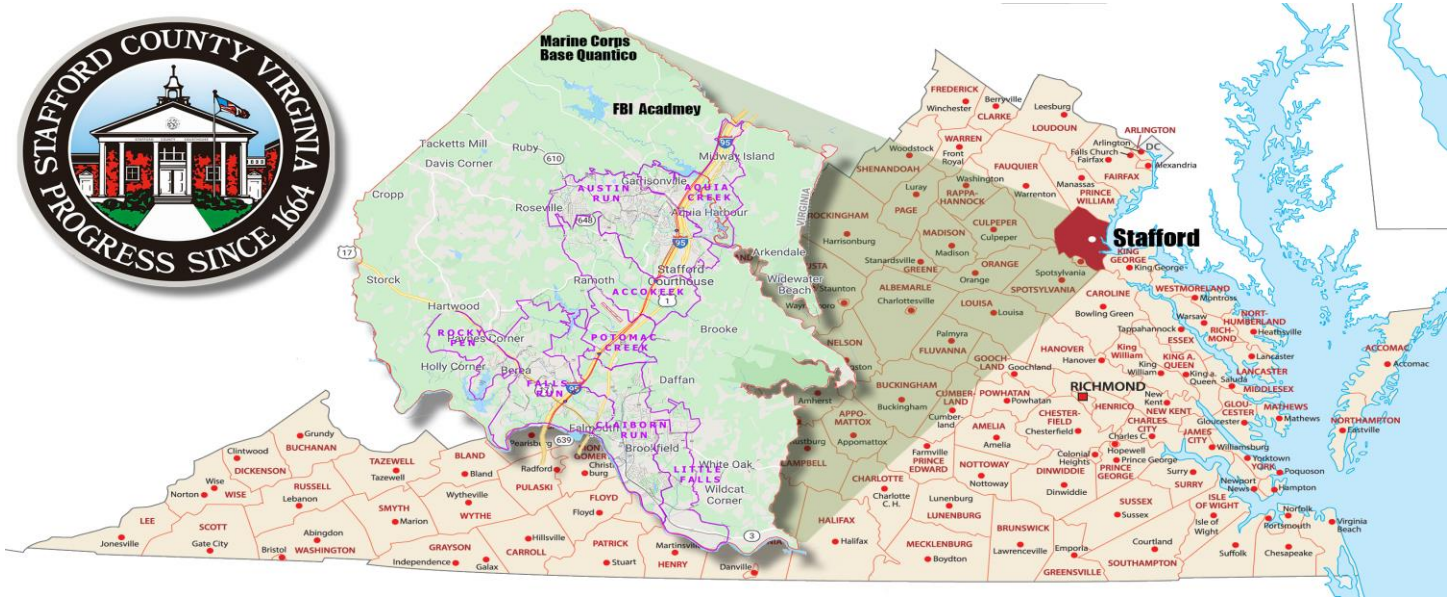
About Stafford County

History of the Aquia Harbor:

1. Infiltration has been a large issue since 1970's.
2. 80% of Pipe is ACP and balance PVC
3. Extensive 20+ years long CCTV and Flow Monitoring have never been able to "SOURCE" the I&I and reduce CSO Pump Station issues, now under Consent Decree. Daily Flows of 3 MGD, rain event over 12 MGD, plant is permitted for 10 MGD
4. Pipes are located below sea level to 100 Vertical Feet

Key Highlights

Population Served	149,110
Miles of Sewer Mains	549
Miles of Water Mains	679
Number of Pump Stations	94
Wastewater Treatment Capacity (MGD)	18



Project Overview

Electro Scan Field Results

Background & Goals

Stafford County aims to use focused electrode leak location (FELL) technology to locate pipeline defects that are often undetected or improperly identified by traditional CCTV assessment. Electro Scan Inc. reviewed all inspection results and provides this executive summary, including major findings and recommendations. Electro Scan's technology precisely locates and measures pipeline defects in gallons per minute, which will help Stafford County to prioritize future rehabilitation efforts.

Project Summary & Key Results

Electro Scan Inc. conducted FELL inspection in the Stafford County. A total of eighty-four (84) mainlines were inspected over the course of the project. Inspections took place in February 2020 – a total of 8 inspection days.

As shown in Table 1, Electro Scan inspected 84 pipes or 20,002 linear feet and located a total of 4,300 individual defect locations as well as 245 "pinholes" which contribute an estimated defect flow of 5,282 GPM or 7,605,864 GPD.

Table 1: Stafford County Electro Scan Demonstration Summary Results

	Scans	Footage	Pinholes*	Defects	GPM	GPD
Total:	**84**	**20,002**	**245**	**4,545**	**5,282**	**7,605,864**

Out of the 84 pipes inspected, 15 pipes are leaking an estimated 100 GPM or higher each. However, the worst pipe (30-0108 – 30-0107) has been determined to have the potential of leaking nearly 645.00 GPM by itself.

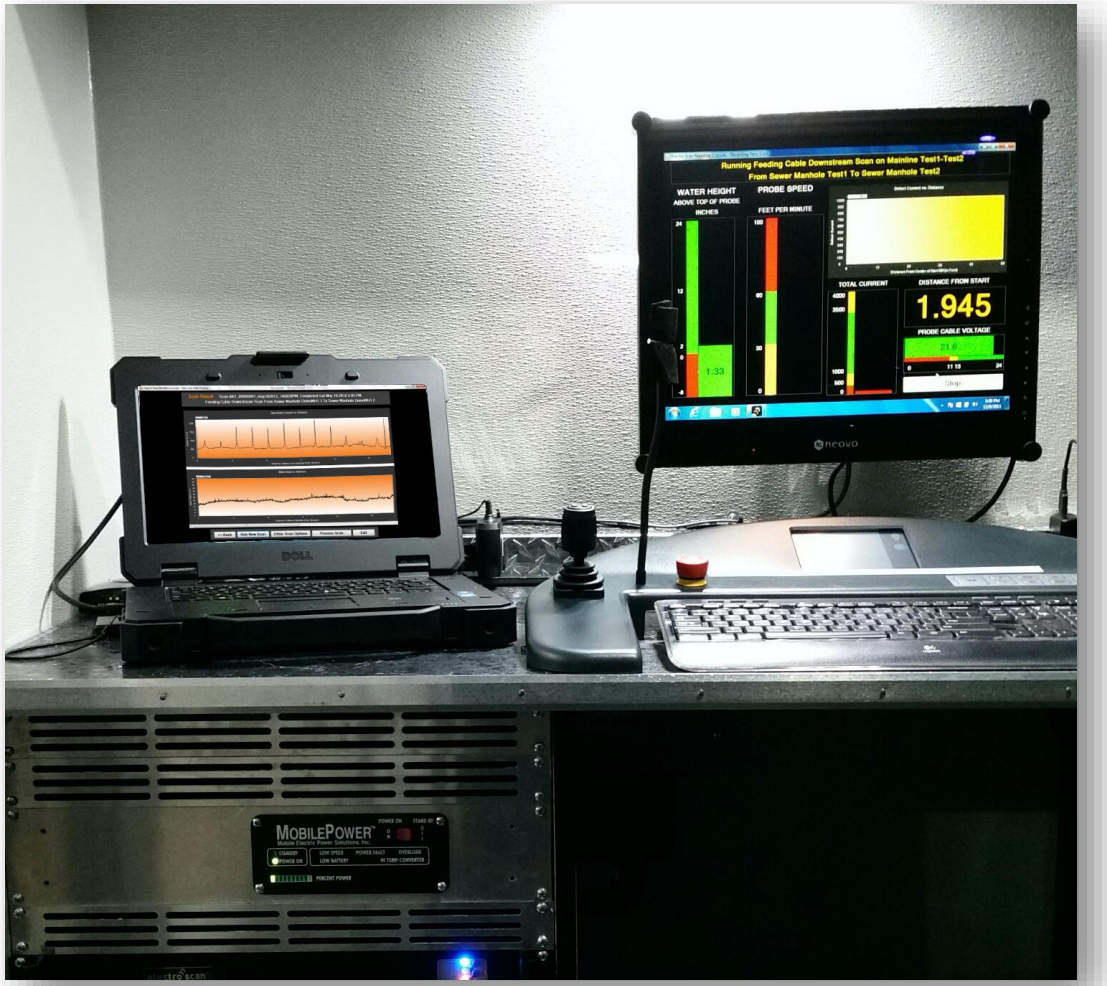
Findings also show that **the worst 10 pipes for this project make up 12% of the linear footage but contribute 55% of the total defect flow**. As shown on the next page, based on FELL Defect Flow Analysis, 39% of Total Footage contributes 85% of Total GPM.

Further Information

While CCTV inspection provides a visual recording of internal pipe conditions, Electro Scan's findings represents a more dependable method to find & measure defects in the pipe wall and at joints. Please refer to the Appendix for additional information. All work was completed in accordance with the 7th Edition, Volume 1, of the Operations and Maintenance of Wastewater Collection Systems manual, with all locations accurate to within 1 cm (0.4m in) & ±30% accuracy of its defect flow calculations which assume a 1ft head & 1% pipe gradient. All reporting was prepared in accordance with ASTM F2550-13 (2018).

* Pinhole defects are only valid for Cured-In-Place Pipe and Plastic Pipes.

Summary Results



Dual Real-Time Machine-Independent (i.e. NO MANUAL OBSERVATIONS OR CODING) Field Data In-Vehicle Recording.

84	Mainlines FELL Tested
20,002	Linear Footage
245	Total Pinholes
4,545	Total Defects
5,282	Gallons Per Minute*
7,605,864	Gallons Per Day*
6	Pipes With Less Than 1 GPM
20	Pipes With 1 – 10 GPM
28	Pipes With 10 – 50 GPM
15	Pipes With 50 – 100 GPM
15	Pipes With More Than 100 GPM

*All defect flow results are ±30%, assuming an avg. groundwater condition of 1ft. head and 1% pipe gradient

Project Assessment By Defect Flow

Ranked by FELL Leakage Rate = 39% of Footage Contributes 85% of GPM

Ranking Critical Sewers® By Gallons Per Minute

A key factor in discontinuing the use of CCTV 1-5 Ratings Systems, recommended by the National Association of Sewer Service Contractors (NASSCO), a for-profit trade association, is its inability to accurately provide a hydraulic defect rating for pipelines.

Essential to rank the most critical pipes to repair or rehabilitate to reduce infiltration, FELL's ability to rank all pipes by GPM, represents a game changing capability to address & measure pre- and post-rehabilitation effectiveness.

Table 2: Stafford County Electro Scan Results By Defect Flow in Gallons per Minute (GPM)

	GPM Range	# of Pipes	Length	Cum Length	% Total	GPM	CUM GPM	% of Total
TOTAL		84	20,002	20,002		5,282	5,282	
1	100 - 645	15	3,790	3,789.8	19%	3,464.8	3,464.8	66%
2	50 - 100	15	4,000	7,789.6	39%	1,034.2	4,499.0	85%
3	25 - 50	12	2,879	10,669.0	53%	427.5	4,926.5	93%
4	15 - 25	8	1,760	12,429.1	62%	155.6	5,082.2	96%
5	10 - 15	8	2,078	14,506.9	73%	97.7	5,179.8	98%
6	5 - 10	9	2,524	17,031.3	85%	68.6	5,248.4	99.4%
7	2.5 - 5	6	1,061	18,092.4	90%	22.9	5,271.3	99.8%
8	1 - 2.5	5	1,278	19,370.6	97%	8.9	5,280.2	100.0%
9	0.6. - 1	2	133	19,504.1	98%	1.4	5,281.6	100.0%
10	0.2 - 0.5	1	39	19,542.8	98%	0.2	5,281.8	100.0%
11	0.1	1	115	19,657.9	98%	0.1	5,281.9	100.0%
12	0.0	2	345	20,002.5	100%	-	5,281.9	100.0%

Source: Critical Sewers® is a registered tradename by Electro Scan Inc.

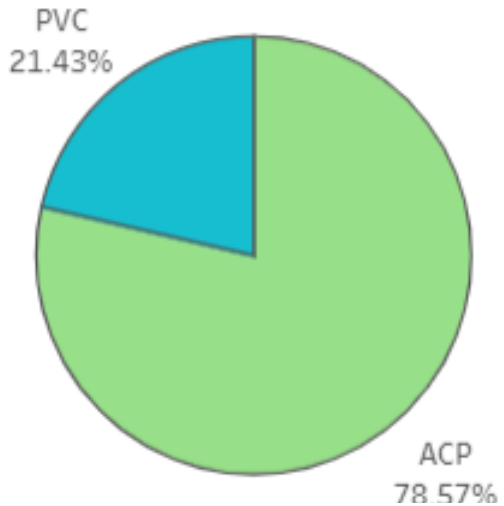
Summary Results By Pipe Type Comparison

Table 3: Stafford County Electro Scan Results By Pipe Material

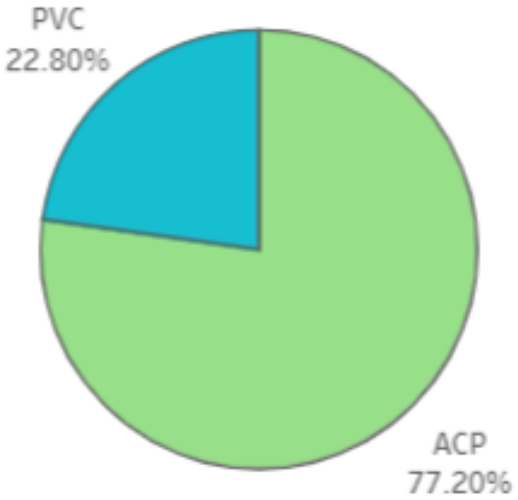
Pipe Type	Diameter	Scans	% of Scans	FELL Length	% of Length	Large	Medium	Small	Pinhole	Total Defects	% of Defects	Total GPM	% of GPM
ACP	8	52	61.90%	12,274	61.36%	132	361	2,936	0	3,429	75.45%	4,303.50	81.48%
	10	6	7.14%	1,351	6.76%	5	43	358	0	406	8.93%	524.66	9.93%
	12	4	4.76%	624	3.12%	5	23	219	0	247	5.43%	270.80	5.13%
	20	4	4.76%	1,192	5.96%	9	5	125	0	139	3.06%	83.45	1.58%
		66	78.57%	15,441	77.20%	151	432	3,638	0	4,221	92.87%	5,182.41	98.12%
PVC	8	13	15.48%	3,892	19.46%	5	5	67	216	293	6.45%	94.28	1.78%
	12	5	5.95%	670	3.35%	0	0	2	29	31	0.68%	5.16	0.10%
		18	21.43%	4,561	22.80%	5	5	69	245	324	7.13%	99.44	1.88%
	Grand Total	84	100.00%	20,002	100.00%	156	437	3,707	245	4,545	100.00%	5,281.85	100.00%

Summary Results Percentages by Pipe Material

SCANS



LENGTH



DEFECTS

GPM

Summary Results Ranked By GPM

Worst 10 Pipes Contribute 55% of Estimated Defect Flow

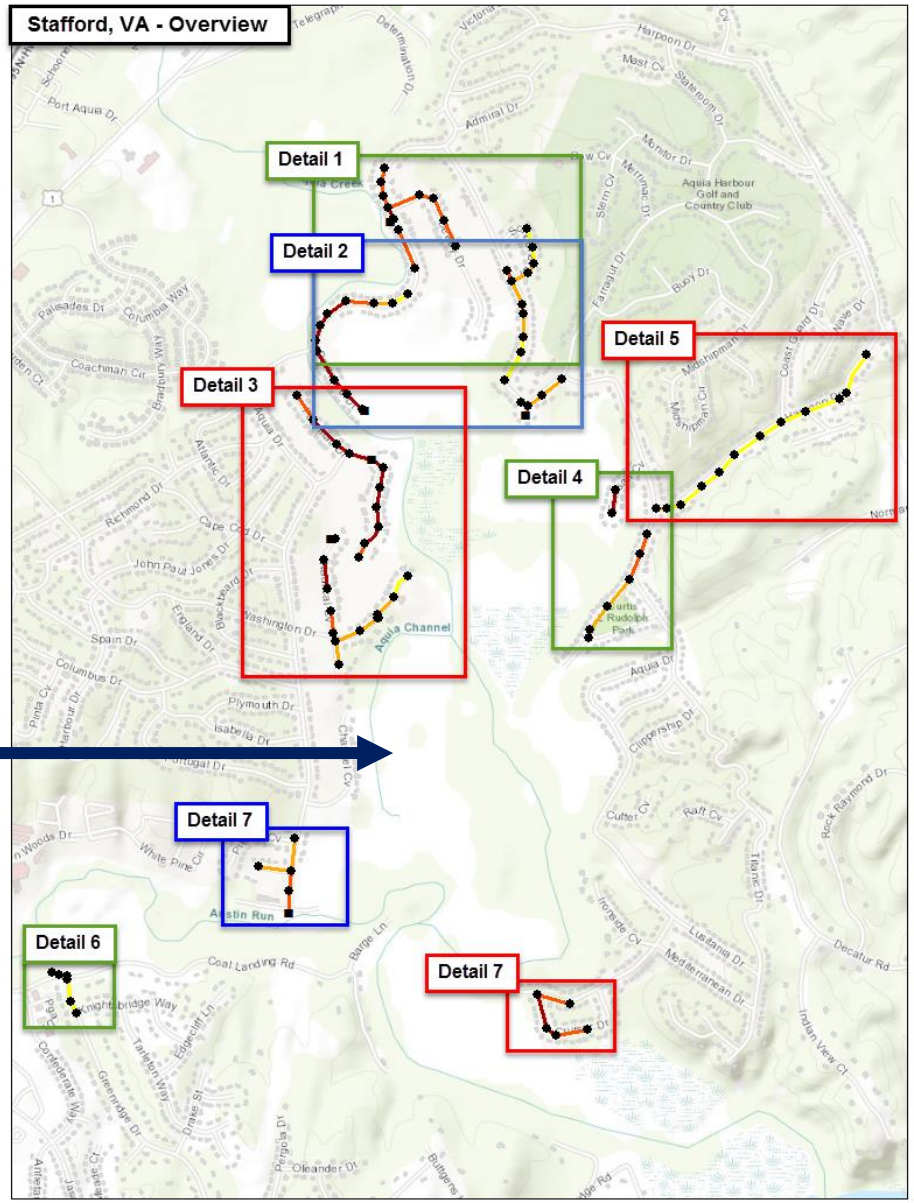
	Scans	Footage	Pinholes	Defects	GPM	GPD
Total:	**84**	**20,002**	**245**	**4,545**	**5,281.85**	**7,605,864**

Date	Mainline ID	Pipe ID	Pipe Type	Diameter	Distance (ft)	Pinhole	Small	Medium	Large	Total Defects	GPM	GPD	GPD IDM
2/20/2020	30-0108 - 30-0107	30-0108 - 30-0107	ACP	8	315.1	0	133	53	25	211	645.00	928,800	1,945,713
2/19/2020	31-0102 - 31-0101	31-0102 - 31-0101	ACP	8	363.3	0	101	24	20	145	341.53	491,803	893,391
2/12/2020	31-0216 - 31-0215	31-0216 - 31-0215	ACP	8	204.0	0	138	33	15	186	331.29	477,058	1,543,476
2/14/2020	28-0108 - 28-0102	28-0108 - 28-0102	ACP	8	383.0	0	216	30	8	254	325.72	469,037	808,313
2/14/2020	28-0101 - PS-028	28-0101 - PS-028	ACP	8	227.9	0	94	19	11	124	303.08	436,435	1,264,191
2/12/2020	31-0217 - 31-0216	31-0217 - 31-0216	ACP	8	219.2	0	108	33	7	148	236.91	341,150	1,027,112
2/19/2020	31-0221 - 31-0220	31-0221 - 31-0220	ACP	10	164.1	0	78	26	3	107	226.38	325,987	1,048,811
2/20/2020	30-0107 - 30-0106	30-0107 - 30-0106	ACP	8	224.0	0	124	12	2	138	177.03	254,923	751,203
2/19/2020	31-0215 - 31-0214	31-0215 - 31-0214	ACP	8	103.9	0	69	18	3	90	158.66	228,470	1,451,291
2/19/2020	31-0112 - 31-0111	31-0112 - 31-0111	ACP	12	170.9	0	109	12	3	124	156.29	225,058	579,449
2/26/2020	35-0120 - 35-0118	35-0120 - 35-0118	ACP	8	503.6	0	105	16	0	121	132.99	191,506	250,992
2/12/2020	29-0102 - 29-0101	29-0102 - 29-0101	ACP	8	185.5	0	93	13	3	109	120.31	173,246	616,265
2/12/2020	29-0113 - 29-0112	29-0113 - 29-0112	ACP	8	236.0	0	110	4	1	115	105.69	152,194	425,643
2/19/2020	31-0220 - 31-0219	31-0220 - 31-0219	ACP	10	266.9	0	79	8	0	87	102.92	148,205	293,179
2/19/2020	31-0214 - 31-0213	31-0214 - 31-0213	ACP	8	222.5	0	80	6	1	87	101.01	145,454	431,422

Where the Pipe is MATTERS

Summary Results Elevation and GPM Maps

Potomac River
Tidally Influenced



Lowest ¼ of Pipes
(-4.1 to 3.8 ft*)

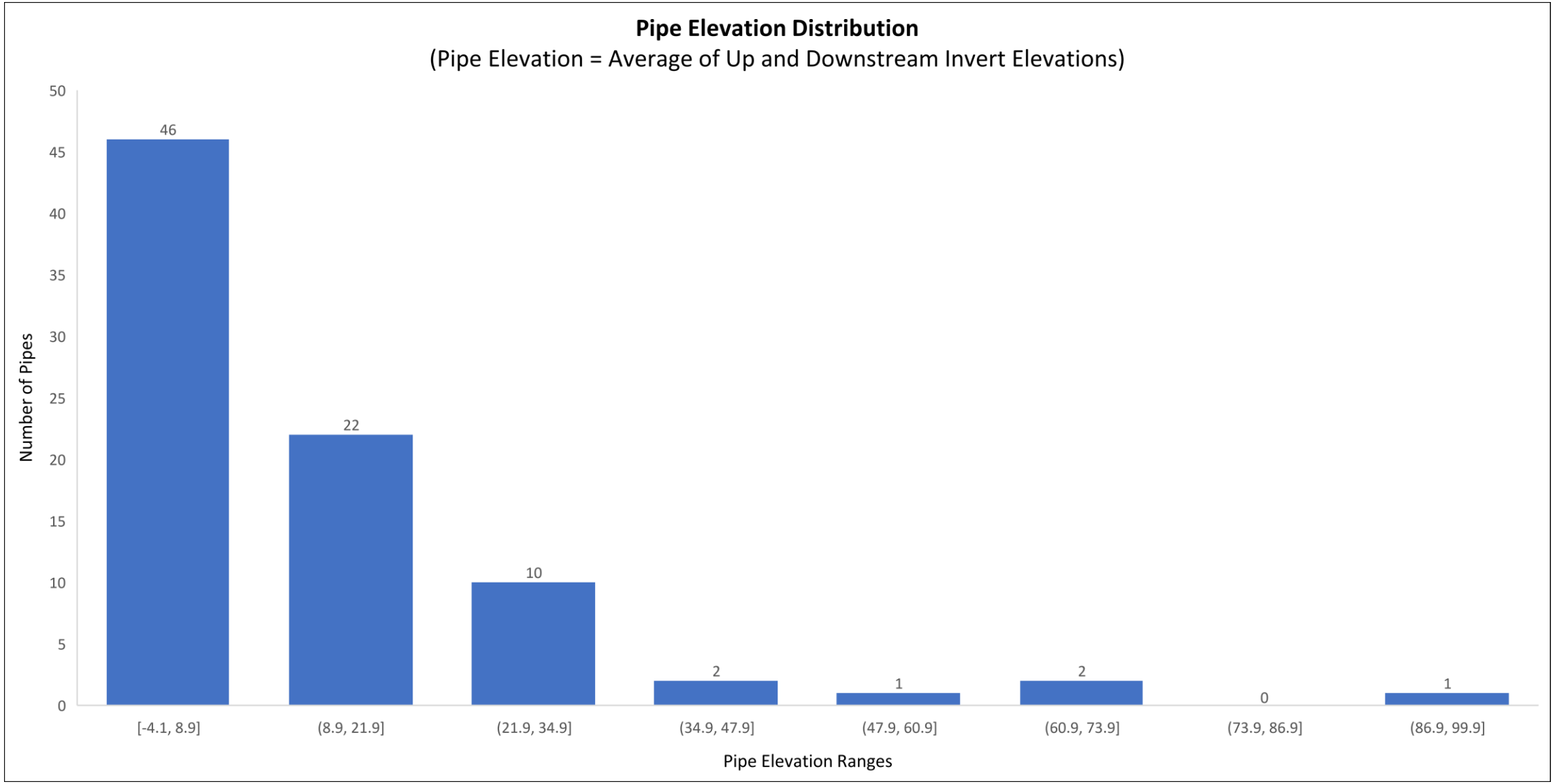
2nd Lowest ¼ of
Pipes (4.1 to 7.4 ft)

2nd Highest ¼ of
Pipes (7.7 to 17.1 ft)

Highest ¼ of Pipes
(17.5 to 87.4 ft)

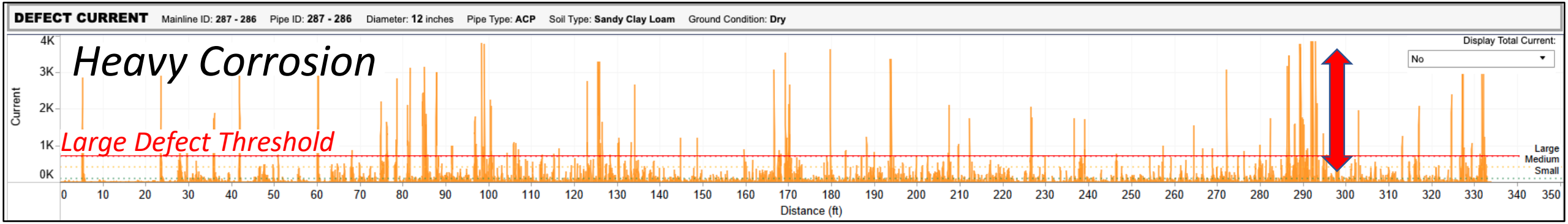
*average invert
elevation of pipe

Summary Results Pipe Elevation Distribution



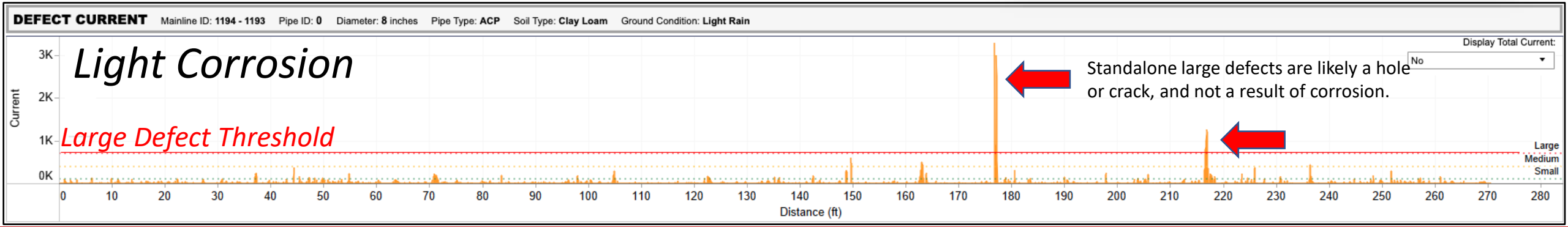
Evaluating ACP and H2S damage & Pipe RUL

Asbestos Cement Pipe Corrosion Levels Measured by FELL

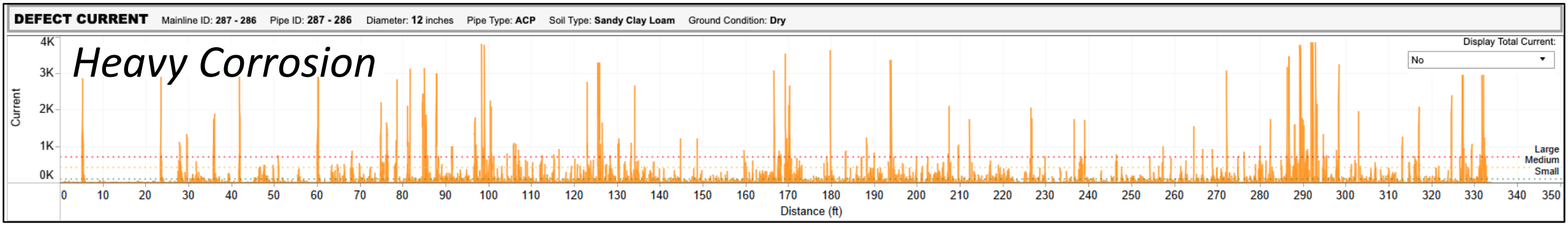


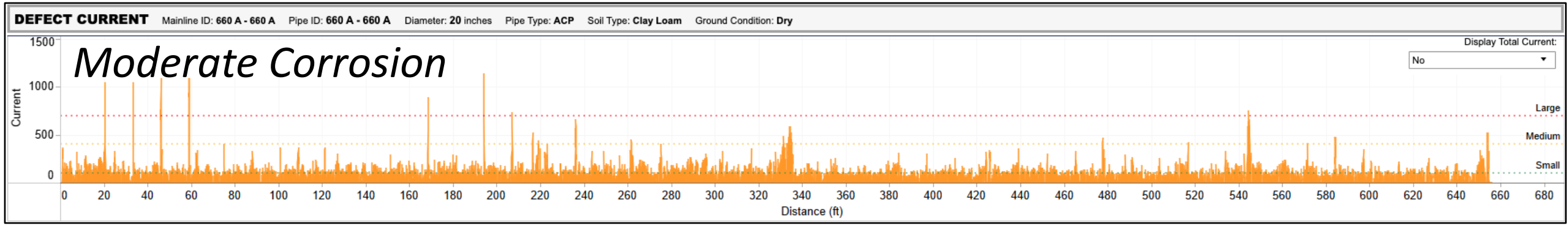
Characteristics of heavily corroded ACP Pipe include:

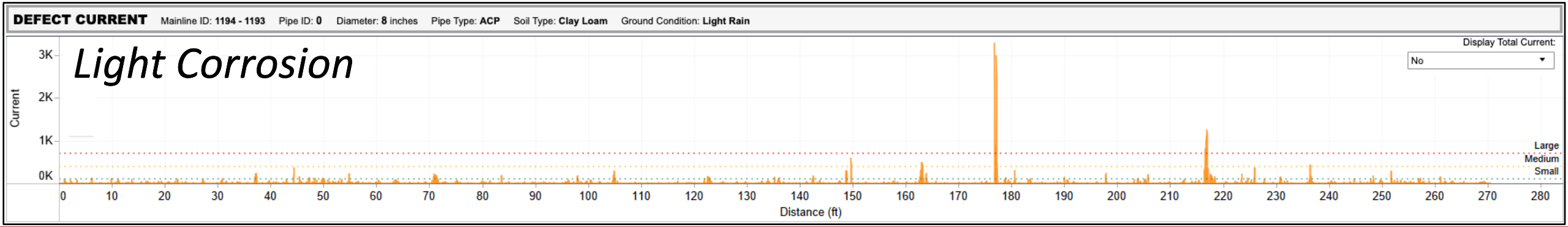
1. Electric current frequently spikes over the *Large Defect Threshold* indicating electric current easily passing through the pipe wall
2. Electric current defects present throughout the pipe as seen above
3. Evenly spaced defects, indicative of leaky joints, are not easily identifiable.
4. High GPM AND high defect count are often indicators of heavy corrosion.

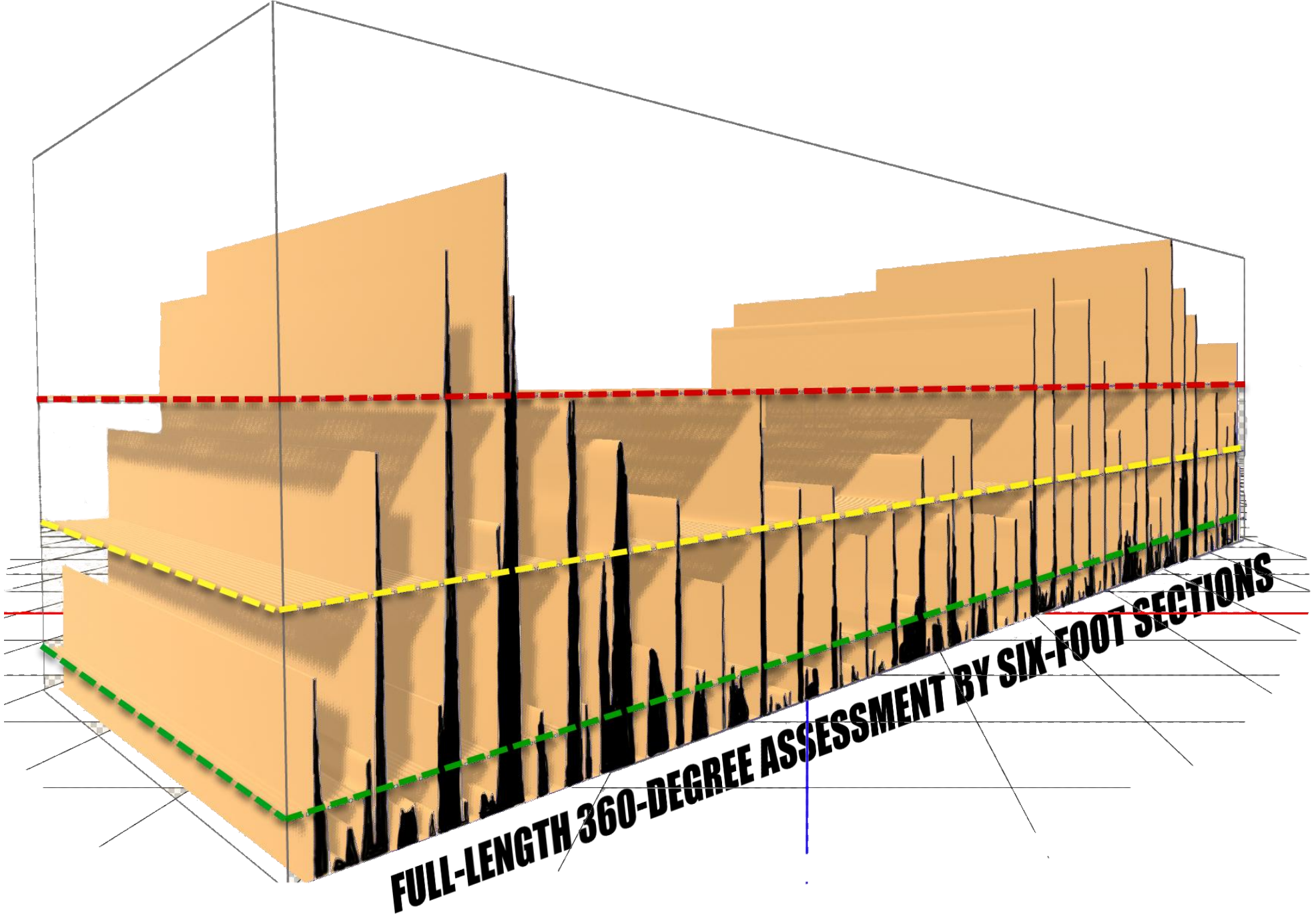


Asbestos Cement Pipe Corrosion Levels Measured by FELL



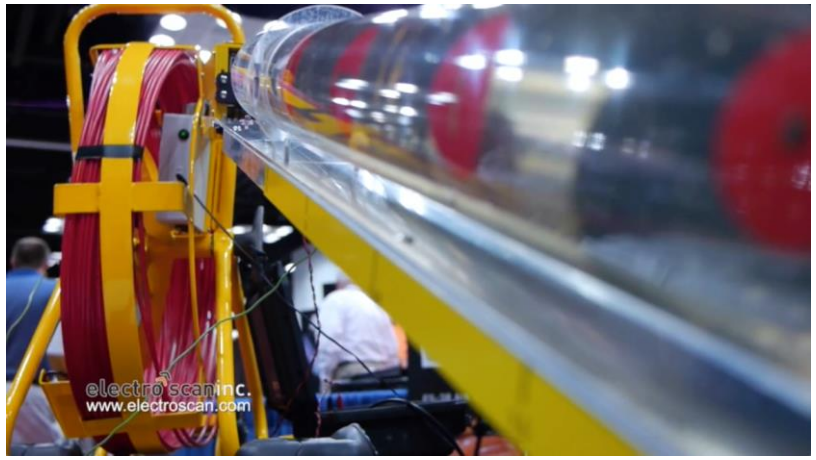






PVC Pipe at Stafford

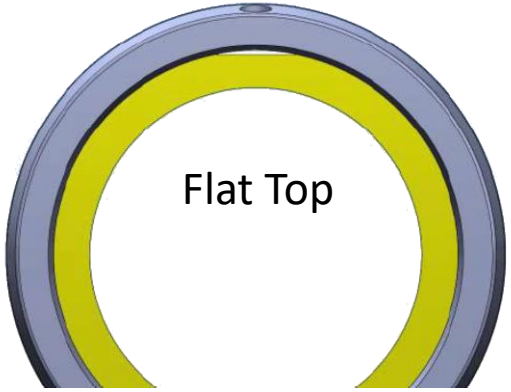
Plastic Pipe

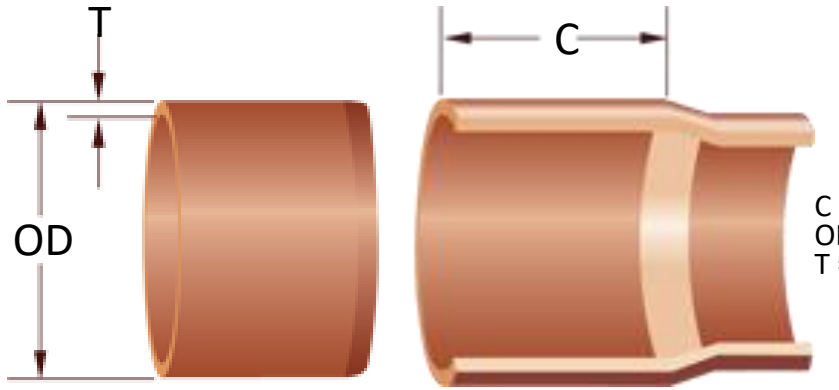


FELL Benchmark Testing of Plastic Pipe (2012) in accordance with ASTM F2550-13 (2018).

Electro Scan is unique in its ability to accurately & consistently locate & measure defects in plastic pipes, including but not limited to Acrylonitrile Butadiene Styrene (ABS), Cured In-Place Pipe (CIPP), Chlorinated Polyvinyl Chloride (CPVC), Fiberglass Reinforced Pipe (FRP), High Density Polyethylene (HDPE), Medium Density Polyethylene (MDPE), Polyethylene (PE), Polypipe (PLP), Polypropylene (PP), Polyvinyl Chloride (PVC), and Spiral Wrap Pipe (SRP).

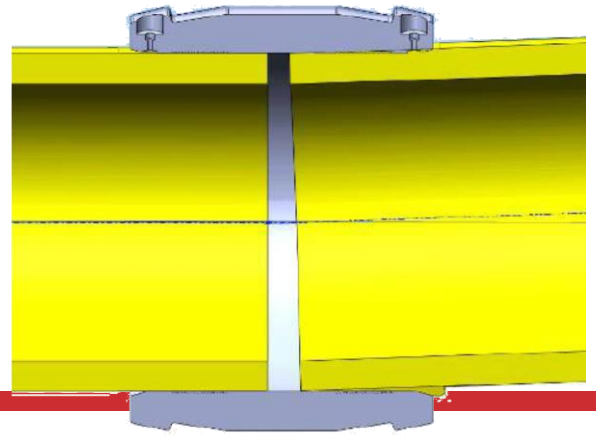
Most Common Defects in Plastic Pipes





C = Joint Length
OD = Outside Diameter
T = Wall Thickness

Misaligned Joint Resulting in Axial Defection

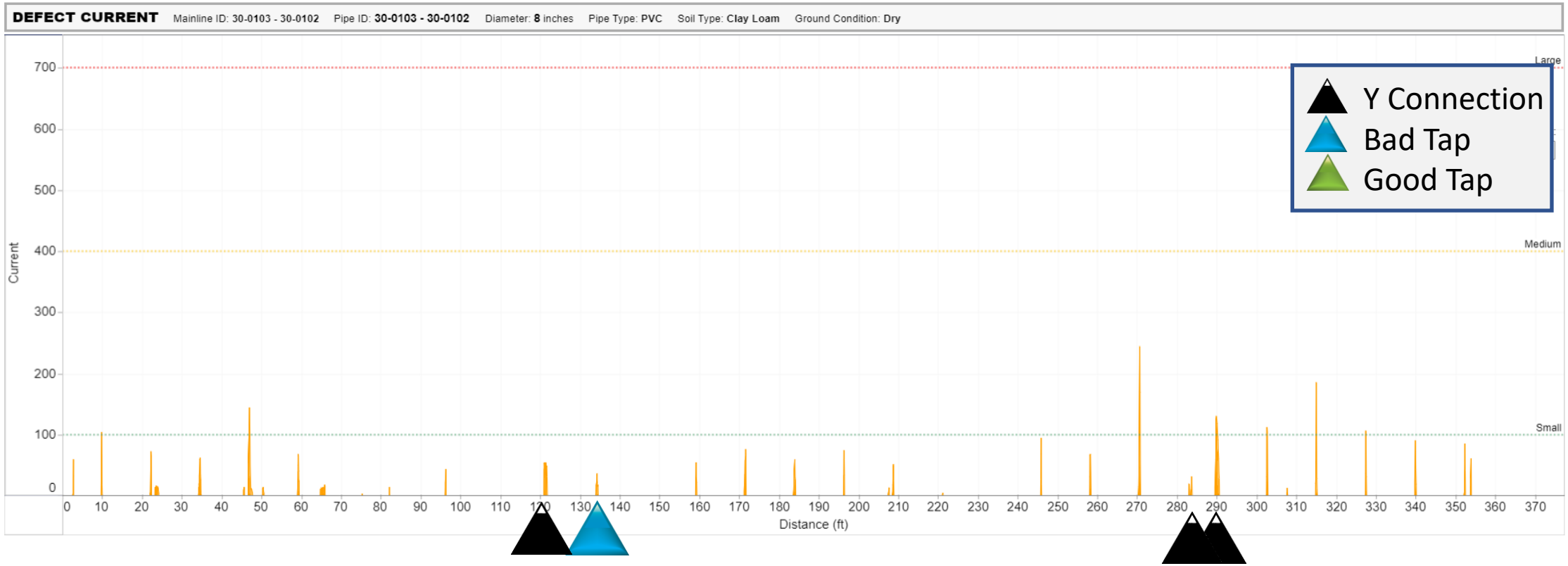


Plastic Pipe

PVC Tap vs. Connection Defect

30-0103 – 30-0102

DEFECTS		LENGTHS	GPM SUMMARY		DIAMETER & DISTANCE	OPERATOR INFO
Large	0	0.00%	Severe	0.000	8	Electro Scan Services
Medium	0	0.00%	Moderate	1.240		Project
Small	7	0.65%	Minor	5.370		FELL Sewer Infiltration Investigation
Pinhole	18	0.95%	Total GPM	6.610		Job
All Defects	25	1.61%	GPD	9,518	359.00 ft	Aquia Harbour Low Elevation Gravity Sewers
			GPD IDM	17,482	0 50 100 150 200 250 300 350	Atmospheric Test: 2/20/2020 8:37:28 AM
			Severe %	0.00%		Scan Start: 2/20/2020 12:56:11 PM
			Moderate %	18.76%		
			Minor %	81.24%		

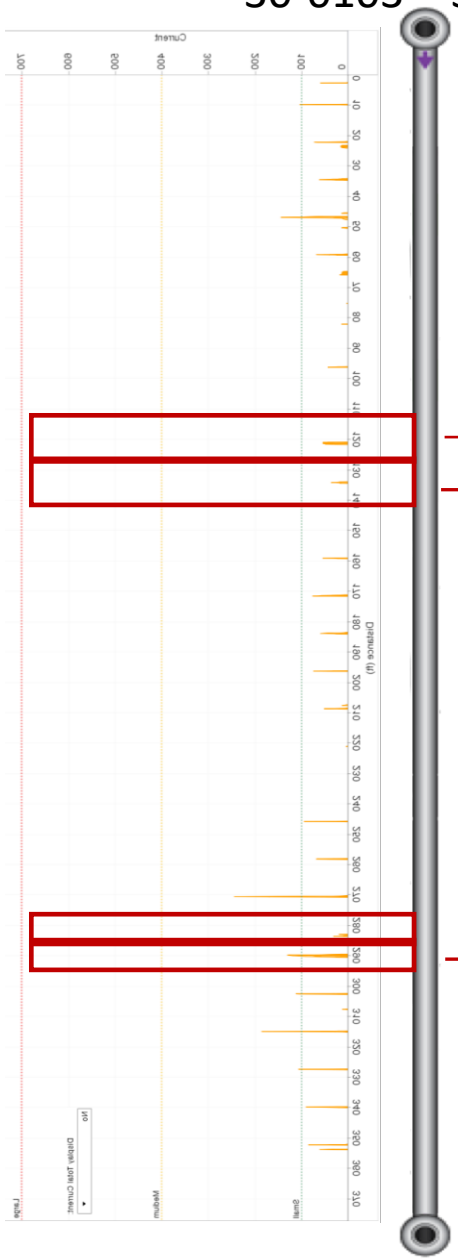


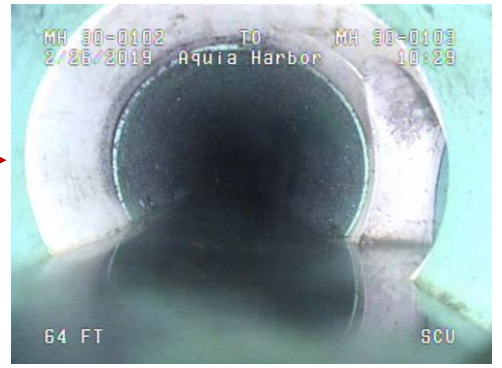
Plastic Pipe

30-0103 – 30-0102

One (1) Y Connection
One (1) Defective Tap

One (1) Y Connection
One (1) Y Connection





Project Comparison Legacy CCTV vs FELL

FELL vs. CCTV Comparison

FELL TOTAL DEFECTS[1]

1,443

1. FELL completed by ELECTRO SCAN INC., in accordance with ASTM F2550-13 (2018) by certified FELL operators that used its machine-intelligent probes to automatically locate sources of infiltration, each measured in Gallons per Minute (GPM).

CCTV TOTAL DEFECTS[2]

35

2. CCTV corresponds to 21 sewer mains that recorded FELL and CCTV surveys, including 82 observations that recorded only 35 defects that were infiltration-related.

FELL vs. CCTV Comparison

Key Highlights

- 21 of 84 Sewer Mains had both FELL & CCTV.
- 35 of 82 observations were Infiltration-related.
- FELL found 1,443 defects compared to 35 defects found using CCTV inspections.
- FELL estimated 1,891 GPM from sources of infiltration.
- Seven (7) Sewer Mains represented 81% of Defect Flow.
- CCTV Defects as a Percent of FELL Defects = 2.4%
- CCTV Missed 98% 'Sources of Infiltration.'

FELL

No. of FELL Surveys w/Corresponding	DEFECT FLOW		DEFECTS
	Ranked By GPM / GPD		Total Defects
Total	GPM	GPD	Total Defects
21	1,901	2,737,210	1,443

Pinhole	122
Small	1,128
Medium	142
Large	51
Total FELL Defects	**1,443**

CCTV

Infiltration-Related CCTV Observations	CCTV Observations	CCTV Report Availability	
Total	Total	Available	Not Available
35	82	21	63

20	CC	Crack, Radial
1	CL	Crack, Longitudinal
2	LJ	Leaking Joint
4	OJ	Offset Joint
3	OT	Offset Tap Connection
4	H	Hole in Pipe
1	R	Roots, Light Roots
0	IG	Infiltration Gushing
35	**TOTAL INFILTRTION OBSERVATIONS**	

FELL vs. CCTV Comparison

Stafford County, Virginia
Comparison of FELL vs. CCTV Inspection

FELL

Total Number of Surveys	Date of FELL Survey			ELECTRO SCAN IDENTIFICATION: Detailed Identification on Electro Scan Inc.'s Critical Sewers® Cloud			NUMBER OF DEFECTS: Defects Identified With Unique FELL-based GPM Defect Flow					DEFECT FLOW: Ranked By GPM / GPD		
84	Date	Pipe Diameter	Pipe Type	Footage	Mainline ID	Electro Scan ID	Pinhole	Small	Medium	Large	Total Defects	GPM	GPD	% Cum GPM
				20,002		TOTALS	245	3,707	436	156	4,544	5,281.85	7,605,669	
				25%		*% FELL Defects for Sewers Surveyed by FELL & CCTV*	50%	30%	33%	33%	32%	36%	36%	
21 - FELL WITH CCTV				5,031			122	1,128	142	51	1,443	1,901	2,737,210	100%
1	2/20/20	8	ACP	315.1	30-0108 - 30-0107	feb202020_104107AM_srv1_00000001	0	133	53	25	211	645.0	928,800	34%
2	2/14/20	8	ACP	227.9	28-0101 - PS-028	feb142020_094917AM_srv1_00000001_L	0	94	19	11	124	303.1	436,435	50%
3	2/20/20	8	ACP	224.0	30-0107 - 30-0106	feb202020_113231AM_srv1_00000001_L	0	124	12	2	138	177.0	254,923	59%
4	2/12/20	8	ACP	185.5	29-0102 - 29-0101	feb122020_150532PM_srv1_00000001_L	0	93	13	3	109	120.3	173,246	66%
5	2/12/20	8	ACP	236.0	29-0113 - 29-0112	feb122020_125856PM_srv1_00000001_L	0	110	4	1	115	105.7	152,194	71%
6	2/14/20	8	ACP	244.0	28-0102 - 28-0101	feb142020_094917AM_srv1_00000001_L	0	85	9	0	94	97.8	140,875	76%
7	2/12/20	8	ACP	333.9	29-0104 - 29-0103	feb122020_143229PM_srv1_00000001	0	112	9	0	121	95.0	136,800	81%
8	2/12/20	8	ACP	399.9	29-0103 - 29-0102	feb122020_150532PM_srv1_00000001_L	0	109	5	3	117	91.8	132,120	86%
9	2/20/20	8	ACP	228.5	30-0106 - 30-0105	feb202020_113231AM_srv1_00000001_L	0	61	4	0	65	68.1	98,021	90%
10	2/13/20	8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	85,694	93%
11	2/12/20	8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	41,155	94%
12	2/20/20	8	ACP	194.0	30-0105 - 30-0104	feb202020_121227PM_srv1_00000001_L	0	34	0	0	34	24.1	34,762	96%
13	2/12/20	8	ACP	148.8	29-0110 - PS-029	feb122020_133943PM_srv1_00000001_L	0	32	0	1	33	22.4	32,270	97%
14	2/20/20	8	ACP	120.3	30-0104 - 30-0103	feb202020_121227PM_srv1_00000001_L	0	13	1	0	14	11.7	16,848	97%
15	2/11/20	8	PVC	382.0	05-0112 - 05- 0111	feb112020_090706AM_srv1_00000001_1	88	5	1	0	94	11.5	16,618	98%
16	2/12/20	8	ACP	230.0	29-0111 -229-0110	feb122020_133943PM_srv1_00000001_L	0	21	0	0	21	11.4	16,402	98.5%
17	2/20/20	12	PVC	269.7	30-0101 - 30-0100	feb202020_133625PM_srv1_00000001	10	2	1	0	13	8.9	12,874	99.0%
18	2/19/20	12	ACP	113.6	31-0110 - 31-0223	feb192020_153056PM_srv1_00000001	0	11	1	0	12	8.5	12,240	99.5%
19	2/20/20	8	PVC	267.4	30-0102 - 30-0101	feb202020_130900PM_srv1_00000001	13	4	0	0	17	5.0	7,171	99.7%
20	2/13/20	8	ACP	54.7	22-0101 - PS-22	feb132020_144816PM_srv1_00000001	0	5	0	0	5	2.9	4,190	99.9%
21	2/12/20	8	PVC	257.9	35-0200A - 35-0200	feb122020_090038AM_srv1_00000001_1	11	4	0	0	15	2.5	3,571	100.0%

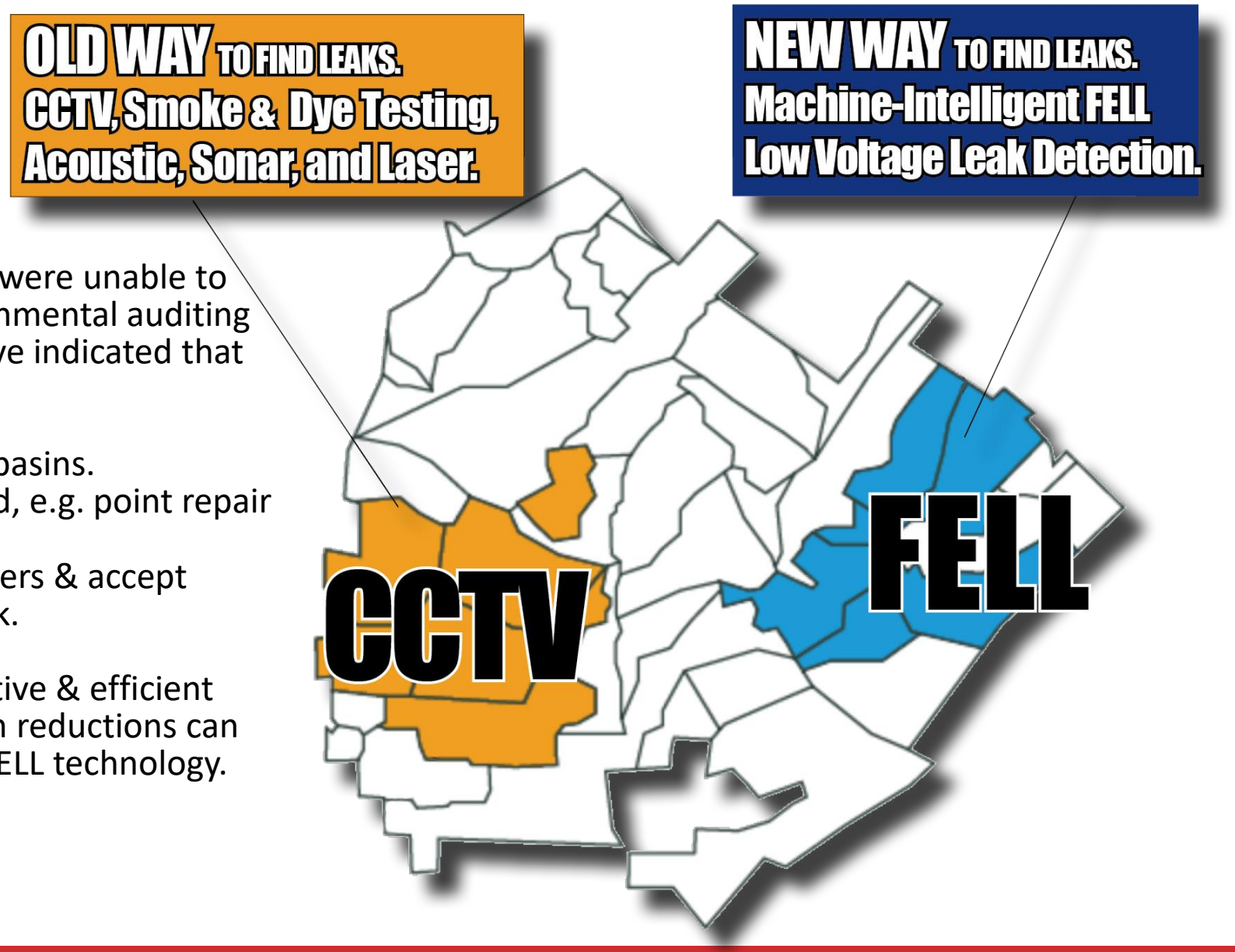
Seven (7) Sewer Mains Represent 81% of Infiltration.

CCTV

#	CCTV REPORTS: Available	CCTV REPORTS: Not Available	Total CCTV Observations	TOTAL INFILTRATION-RELATE	Crack, Radial (CC)	Crack, Longitudinal (CL)	Leaking Joint (LJ)	Offset Joint (OJ)	Offset Tap (OT)	Hole in Pipe (H)	Roots, Light Roots (R)	Infiltration (Gushing, Runner, Dripper) (IG)	TOTAL NOT INFILTRATION RELAT	Water Level (WL)	Attached Deposits, Greas (DEG)	Material Changes (MC)	Tap Connection, OK (TC)	Minor Belly (MB)	Survey Abandoned (SA)
					INFILTRATION-RELATED DEFECTS								NON-INFILTRATION OBSERVATIONS						
TOTALS	21	63	82	35	20	1	2	4	3	4	1	0	47	0	1	2	41	2	1
	25%		100%		Infiltration-Related Defect Observations								57%	Non-Infiltration Observations					
1	1		2	2	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0
2	1		4	3	2	0	0	1	0	0	0	0	1	0	0	0	0	0	1
3	1		2	2	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
4	1		6	4	4	0	0	0	0	0	0	0	2	0	0	0	1	1	0
5	1		4	0	0	0	0	0	0	0	0	0	4	0	0	0	4	0	0
6	1		1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0
7	1		5	3	1	0	0	0	1	0	1	0	2	0	0	0	2	0	0
8	1		10	4	2	0	0	0	0	2	0	0	6	0	0	0	6	0	0
9	1		3	3	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0
10	1		9	9	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	1		1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
12	1		1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
13	1		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	1		2	1	1	0	0	0	0	0	0	0	1	0	0	0	0	1	0
15	1		9	1	0	0	0	0	1	0	0	0	8	0	0	0	8	0	0
16	1		3	0	0	0	0	0	0	0	0	0	3	0	0	0	3	0	0
17	1		7	1	0	1	0	0	0	0	0	0	6	0	0	2	4	0	0
18	1		1	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0
19	1		5	0	0	0	0	0	0	0	0	0	5	0	0	0	5	0	0
20	1		1	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0
21	1		6	0	0	0	0	0	0	0	0	0	6	0	0	0	6	0	0

FELL vs. CCTV Comparison

Reliance on inaccurate pipe condition assessment can severely compromise needed reductions in infiltration, in addition to miss applying CAPEX.



Recent benchmark studies where other cities were unable to achieve desired infiltration reductions, environmental auditing of flow monitoring and initial CCTV results have indicated that agencies may:

1. Rehabilitate the wrong locations, areas, or basins.
2. Utilize an appropriate rehabilitation method, e.g. point repair v. full line.
3. Accept rehabilitation with major leaks in liners & accept poorly restored service connection that leak.

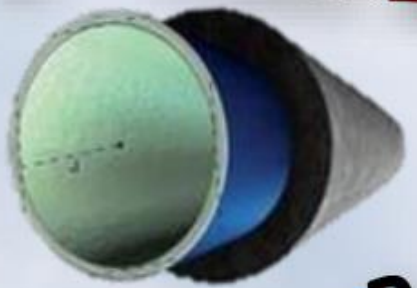
While a number of factors contribute to effective & efficient CAPEX selections, pre- and post-rehabilitation reductions can now be measured using machine-intelligent FELL technology.

ZIONSVILLE

Electro Scan Demo Report

Zionsville, IN

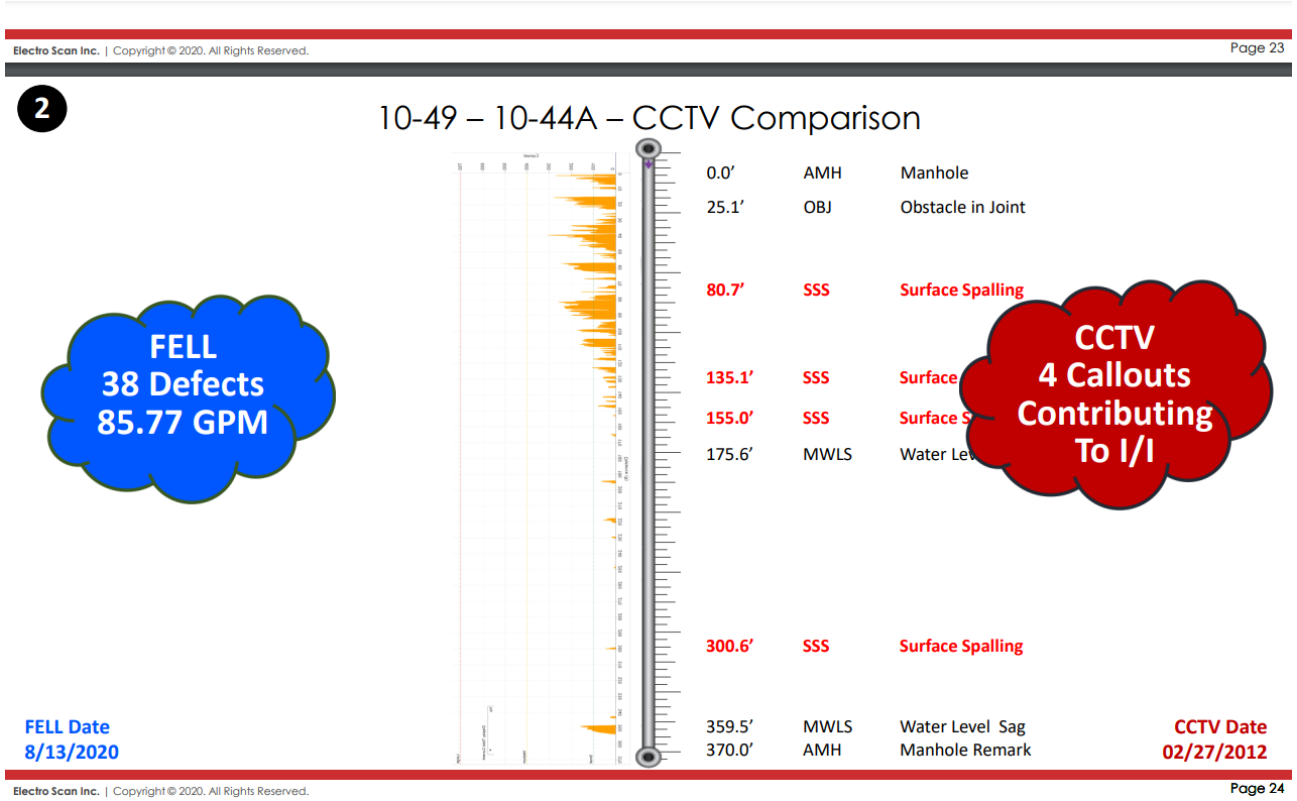
Field Work: 08/13/2020



electro scaninc.

Summary of Zionsville Data

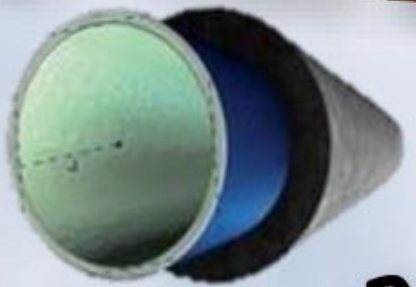
- 2 VCP segments
- 594 feet
- 71 defects
- 183 gpm leakage
- 263,000 gpd
- Compare to CCTV



Electro Scan Demo Report

Michigan City, IN

Field Work: 10/27/2021



electro scaninc.

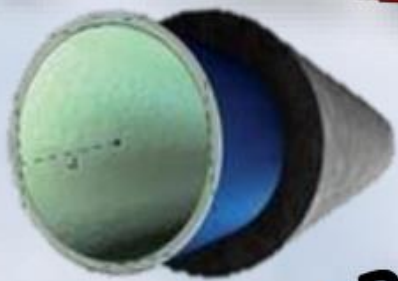
Summary of Michigan City Data

- 1 VCP, 1 PVC segment
- 713 ft
- 69 defects all VCP
- 30 gpm all VCP
- 43,000 gpd
- Compare to CCTV
- 40-yr old PVC was perfect
- Werewolves of London

Electro Scan Demo Report

Village of Buffalo Grove, IL

Field Work: 03/23/2021



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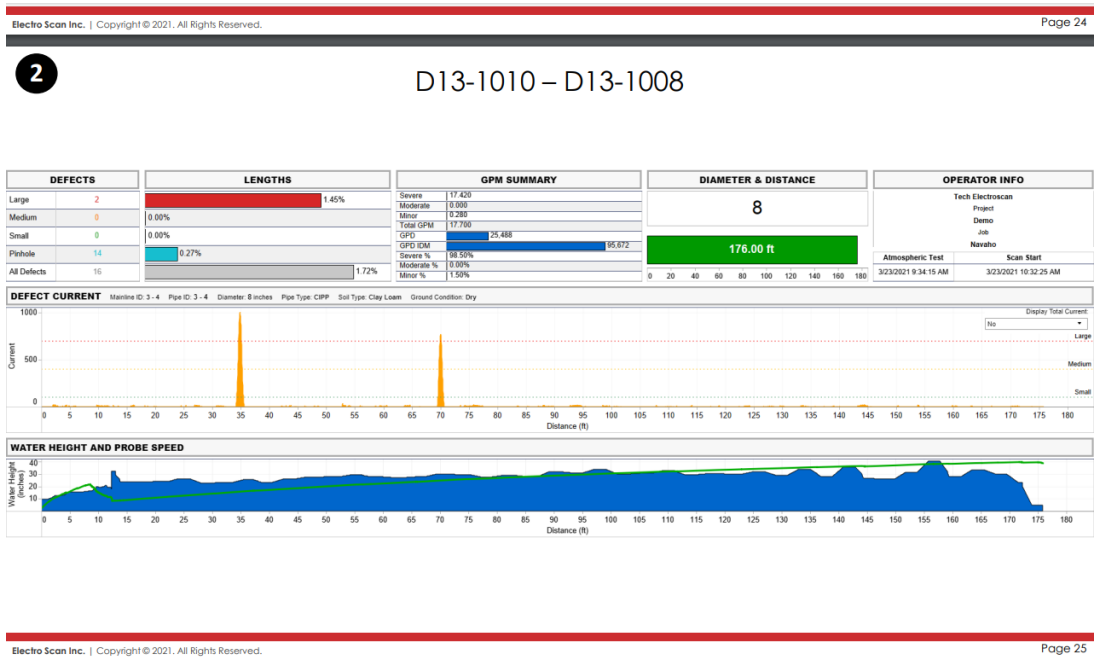
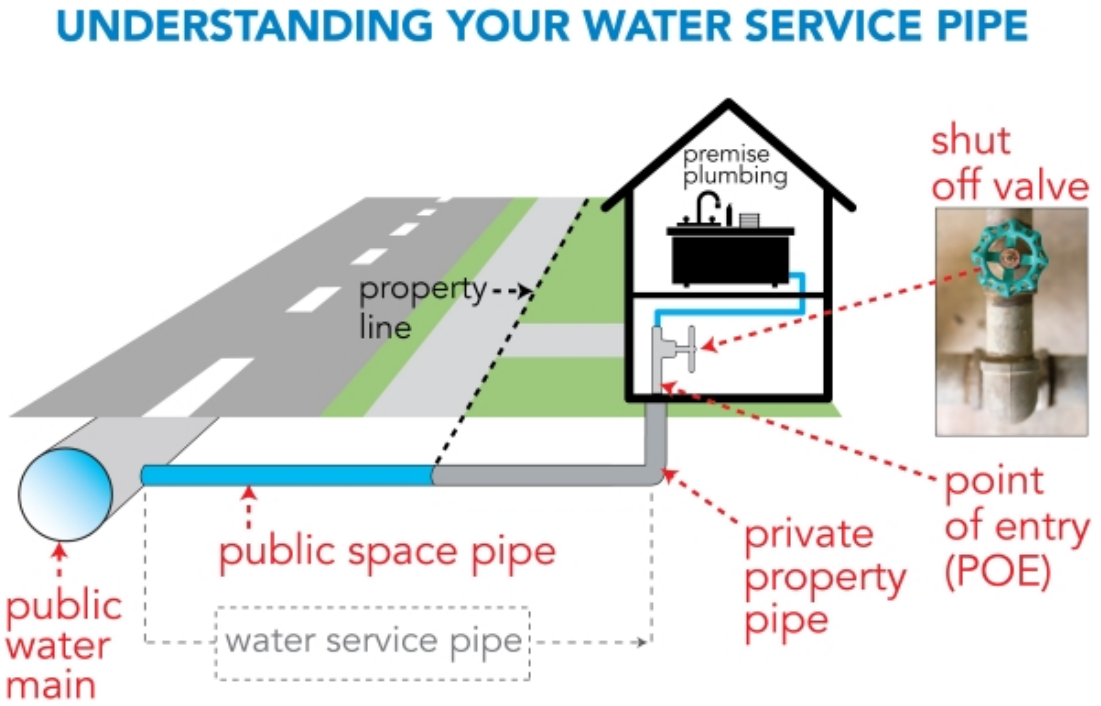
Summary of Buffalo Grove Data

- 6 segments: VCP, CIPP, PVC
- 1,417 ft
- 249 defects
- 259 gpm
- 373,000 gpd
- Worst 2 segments > 1.5 X rest
- Identified CIPP deficiencies



Potential Uses for Electro Scan Technology

- Gravity sewer leakage
- Pressure sewer leakage
- Potable water leakage
- Pipe condition assessment
- CIPP line post installation inspection
- Lead service line verification



GovTech 100 Company 2019

RED HERRING N. AMERICA 100 WINNER 2019

FAST COMPANY 2019

MOST INNOVATIVE COMPANIES

UKSTT 2015 BEST SMALL PROJECT

NASTT

wef 2013 Most Innovative Product

AWWA M77 ELECTRO SCAN

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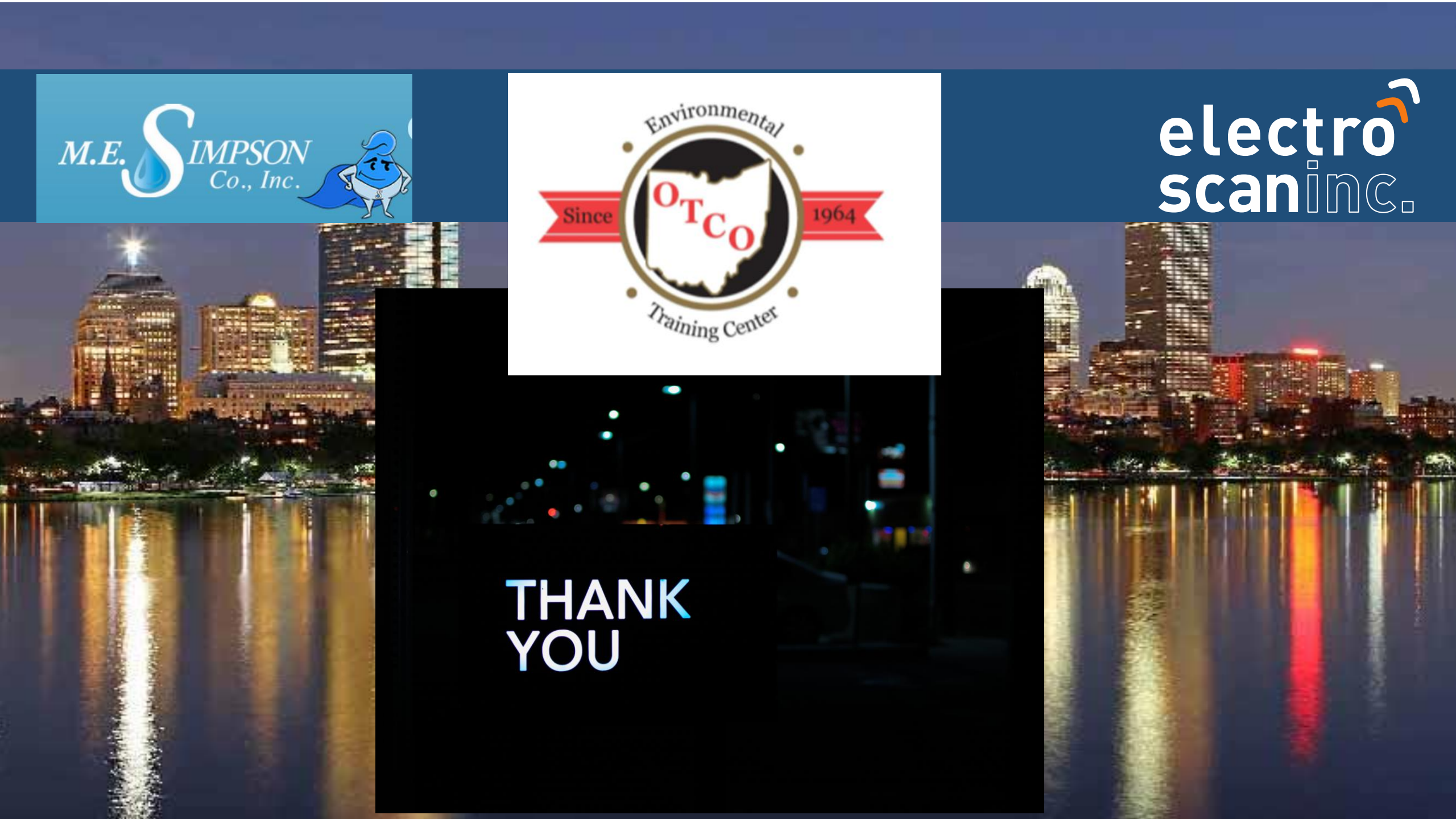
20 May 2019 | Special To United Utilities Innovation Lab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THANK YOU