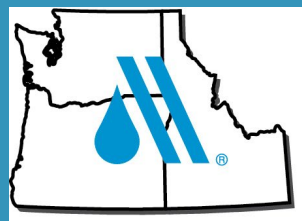

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Machine Learning / Artificial Intelligence Applications for Small Systems

Michael Grimm, P.E.

West Slope Water District

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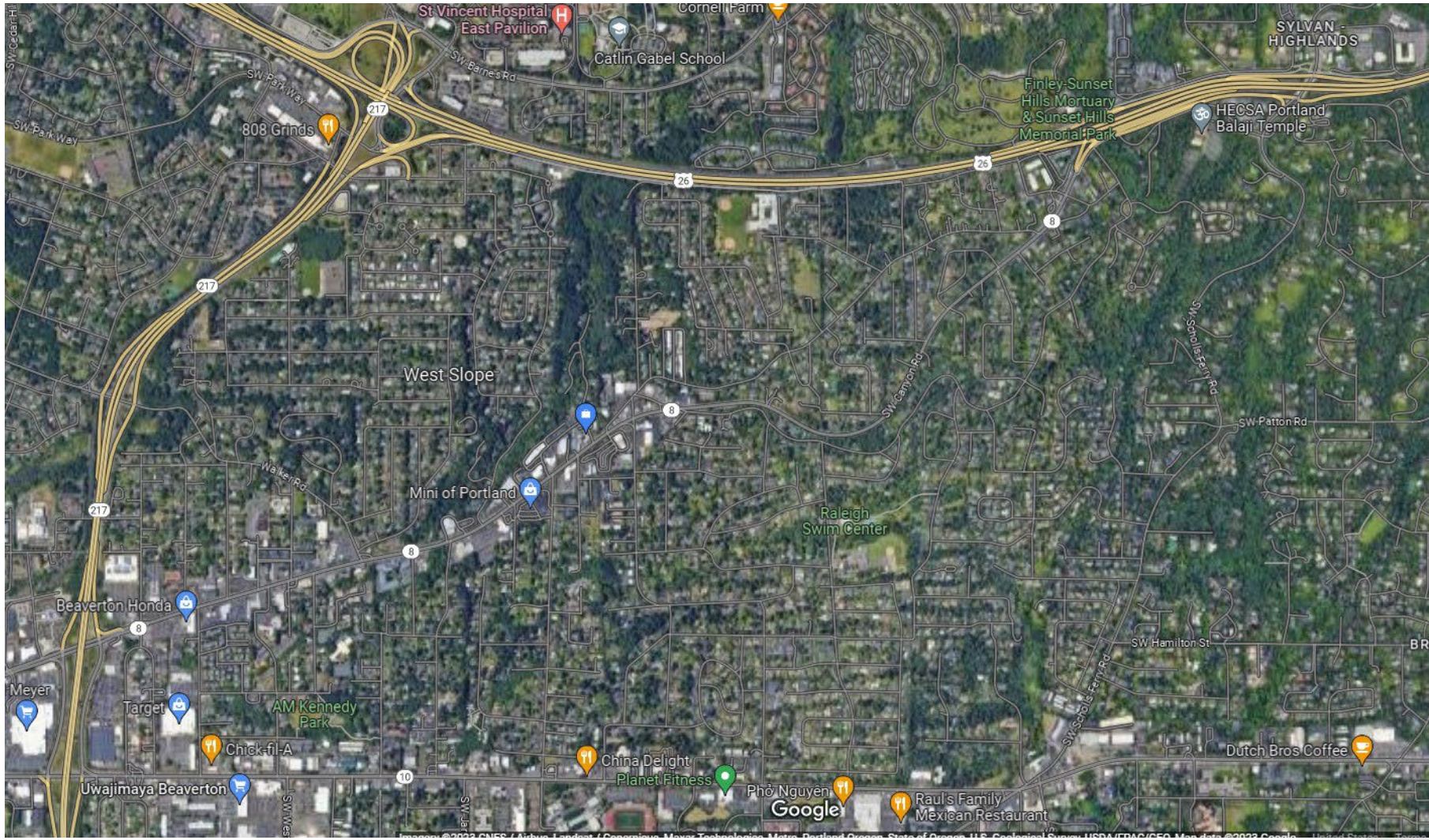
West Slope WD

Serves 11,000 customers.
Maintain 3,250 customer accounts.
Mostly residential.
Some commercial accounts.
Surrounded by Portland, Tualatin Valley WD, and Beaverton.
Estab. in 1922



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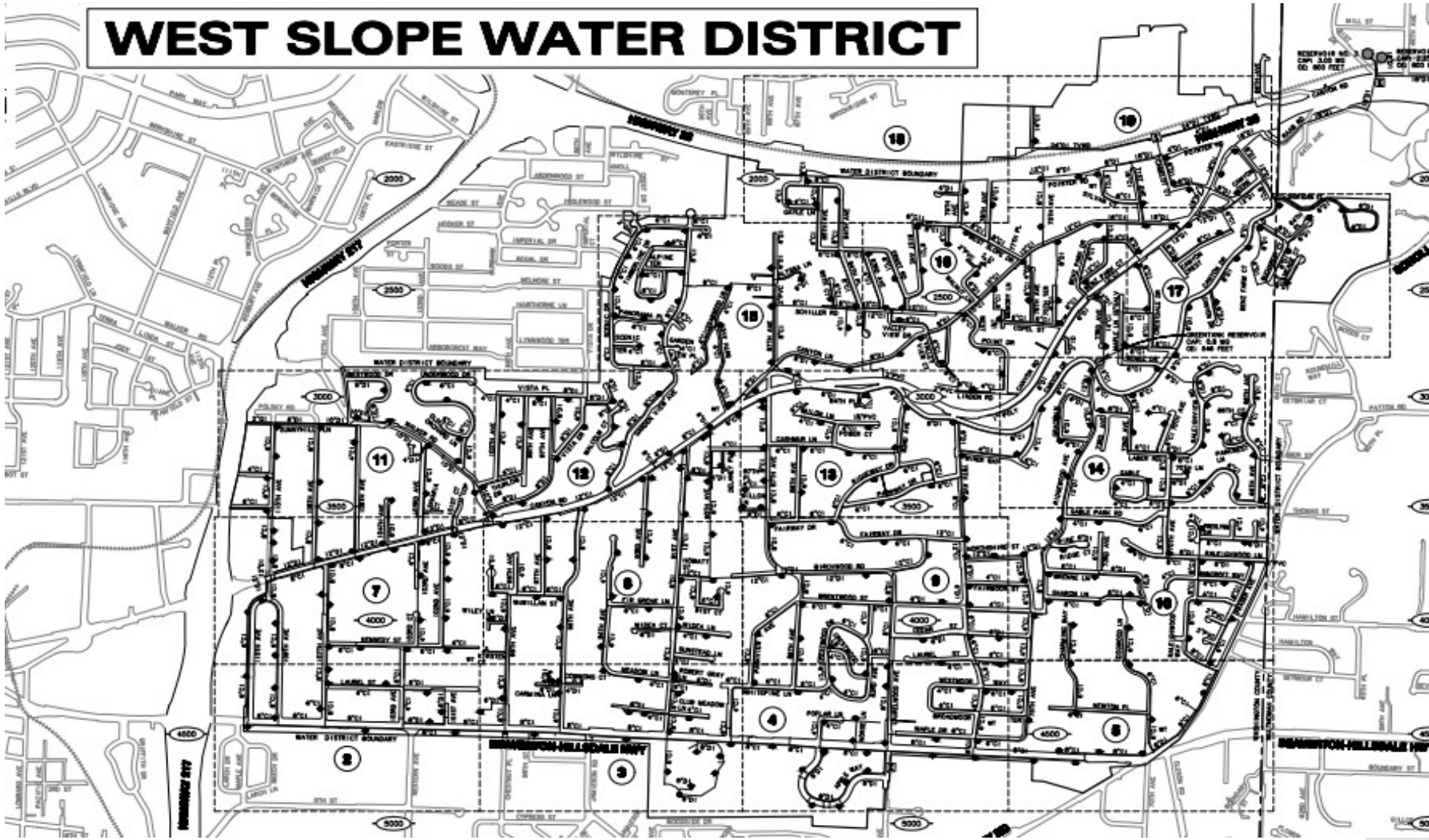
West Slope WD

Established to bring safe water & fire protection to dairy farmers in 1920s.
Original pipe was 2-4 inch steel.
2/3 of the system is cast iron installed 1945-55.
All pipe installed after 1972 is ductile iron.
System pressures are 75-125 psi.



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What We Do – the Hats We Wear

Main Repair, Meter Reading, Meter Installs & Repairs, Field Locates, Valve Mtce., Valve Turning & Flushing, Customer Service Requests,

AR / Customer Payments , WQ Sampling & Monitoring, Construction Inspection, Engineering Project Management, Emergency Response, Budget Preparation, Acct. Payable, Financial Audit Report, Public Outreach, Strategic Planning & Leadership, Equipment Mtce., and Asset Management (basic form)

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Hats That Others Wear for Us

IT, Billing System Software, Website Hosting, Water Bill Printing and Mailing, Human Resources, Engineering Design, Graphic Artistry, Legal Counsel, SCADA Design and Cybersecurity Protection, Water Conservation (RWPC), Payroll, Financial Audits, Public Outreach, Large Control Valve Inspection-Repair-Replacement

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… it would be easy if that's all there was …
… but there is more to do …

- Replacing pipe as it ages
- Affording the replacement of old pipe
- Compiling a customer service line material inventory

What's the best way to accomplish these tasks with very limited resources by staff ***already*** busy with limited financial resources?

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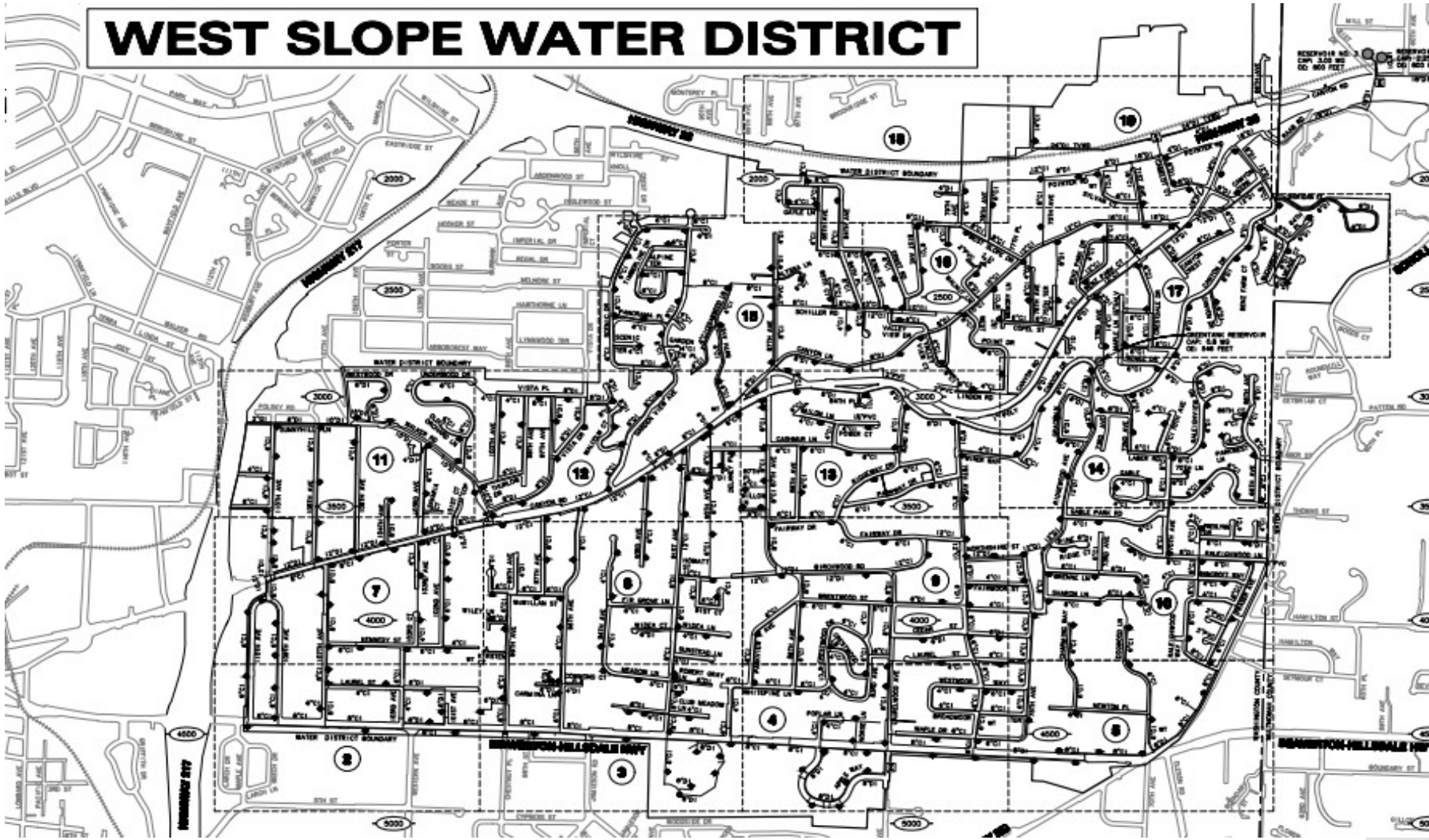
Quick Review

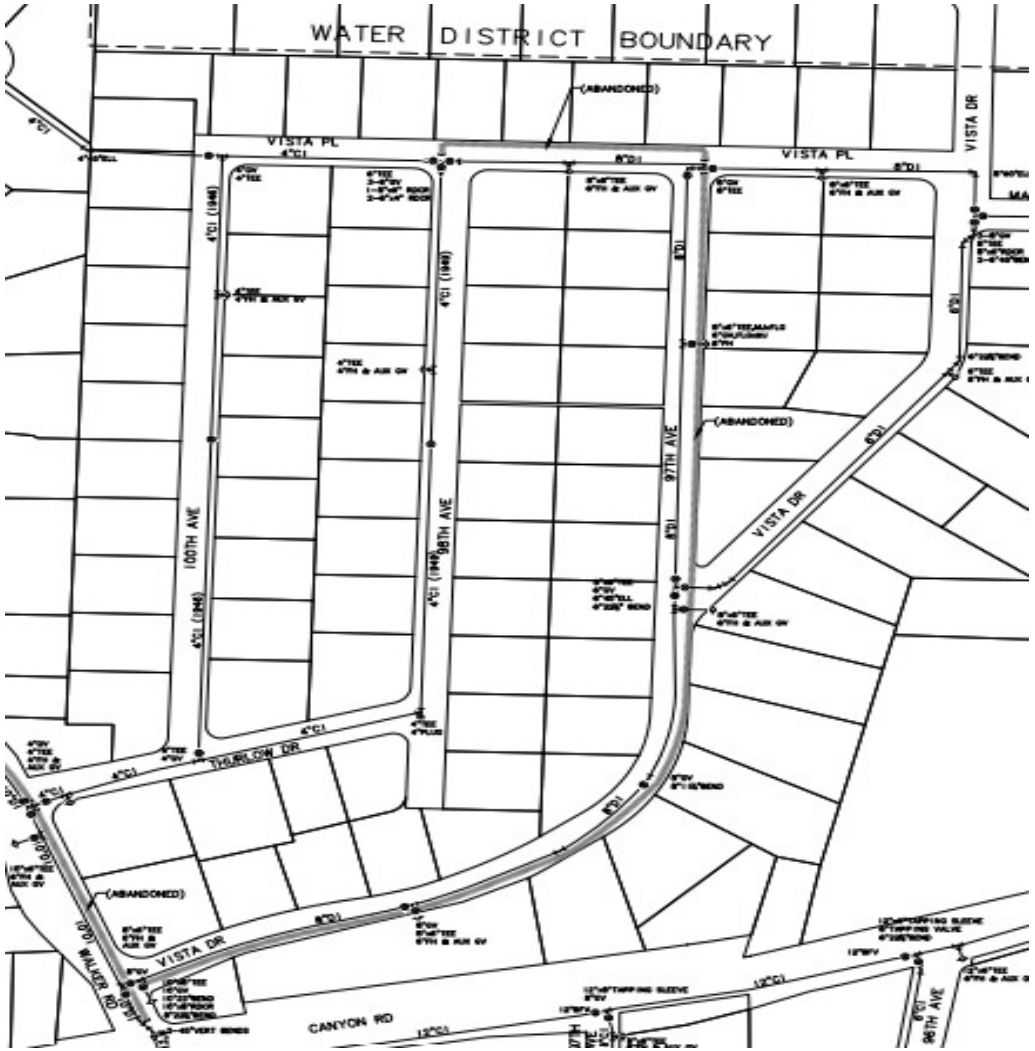
The oldest pipe in the District is about to turn 80 years old and it's unrestrained cast iron

In 2023 dollars, West Slope would need to spend $1.1 million annually for the next 4 decades for a total of $44 million just to replace the cast iron pipe



Starting Point?

Does the squeaky wheel get the first grease? Since 2012, we have repaired broken water mains in this small area 7 times !!!
But this is a literal dead end to our District!
What priority is placed here?



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Break Data 2012-23

41 water main breaks
Average of 2.9 / year for 48 miles of pipe.
2017 AWWA Benchmark Survey normalizes break data for 100 miles of pipe, and the median is 4.3 breaks per 100 miles.
West Slope break data normalized to 100 miles = 6.6 breaks/year

Log of Water Main Breaks by Year (2012-Present)								# of Water Breaks by Year	
Date of Break	Location of Break	Pipe Diameter (inches)	Pipe Type	Date of Pipe Installation	Pipe Age (Years)	Water Loss (Gallons) (GPM x Minutes)		Year	# of Breaks
2010	4345 SW 96th Avenue	6	Cast Iron	1946	77			2010	1
2011	4570 SW 99th Avenue	6	Cast Iron	1947	76			2011	1
2012	3485 SW 106th Avenue	4	Cast Iron	1956	67			2012	2
2012	2575 SW 83rd Avenue	4	Cast Iron	1955	68			2013	5
2013	3385 SW 98th Avenue	4	Cast Iron	1949	74			2014	2
2013	3225 SW 98th Avenue	4	Cast Iron	1949	74			2015	2
2013	3145 SW 98th Avenue	4	Cast Iron	1949	74			2016	9
12/2013	7770 SW Fairmoor Street	4	Cast Iron	1950	73			2017	2
2013	3135 SW Gardenview Street	8	Cast Iron	1961	62			2018	1
2014	7535 SW Fairmoor Street	4	Cast Iron	1950	73			2019	4
12/2014	3000 SW Raleighview Drive	8	Ductile Iron	1973	50			2020	2
2015	3595 SW 106th Avenue	4	Cast Iron	1946	77			2021	3
11/2015	3160 SW 100th Avenue	4	Cast Iron	1946	77			2022	2
11/2016	8325 SW Crestwood Avenue	4	Cast Iron	1949	74			2023	5
01/2016	7550 SW Laurel Street	4	Cast Iron	1951	72			2024	
01/2016	4320 SW 75th Avenue	6	Cast Iron	1950	73			2025	
12/2016	3905 SW 75th Avenue	6	Cast Iron	1950	73				
12/2016	10010 SW Thurlow Street	6	Cast Iron	1962	61				
2016	8585 SW Milon Lane	6	Cast Iron	1948	75			**Total**	41
12/2016	8615 SW Canyon Road	8	Cast Iron	1948	75				
12/2016	2575 SW 84th Avenue	8	Cast Iron	1956	67			**Average/Year**	2.9
2016	8430 SW Katherine Lane	8	Cast Iron	1957	66				
11/2017	4025 SW 75th Ave (on Brentwood)	4	Cast Iron	1954	69			**Avg/Yr/100 mi**	6.6
11/2017	3105 SW 98th Avenue	4	Cast Iron	1949	74				
12/2018	2525 SW 84th Avenue	4	Cast Iron	1956	67		**AWWA BM**	**Median**	4.3
02/2019	10500 SW B-H Highway	8	Cast Iron	1946	77			**75th %tile**	1.4
11/2019	8000 SW B-H Highway	8	Cast Iron	1946	77			**25th %tile**	12.6
03/2019	3575 SW 106th Avenue	4	Cast Iron	1946	77				
12/2019	6710 SW Parkwest Lane	4	Cast Iron	1966	57			External pipe corrosion / buried pov	
10/2020	7645 SW Copel Street	6	Cast Iron	1945	78			Significant external pipe corrosion	
11/2020	7030 SW Gable Parkway	6	Cast Iron	1960	63	102,000			
01/2021	4625 SW Poplar Lane	4	Cast Iron	1950	73	681,120			
04/2021	3135 SW Gardenview Street	8	Cast Iron	1961	62				
11/2021	4325 SW 96th Avenue	6	Cast Iron	1946	77	25,000			
12/2021	3660 SW 106th Avenue	4	Cast Iron	1946	77	80,000			
05/2022	8530 SW Gayle Lane	4	Cast Iron	1957	66	3,052,800	40 gpm for 53 days; 57,800 gpd		
08/2022	3135 SW Gardenview Street	8	Cast Iron	1961	62	250,000	Lost 0.15 MG in less than 30 minutes		
02/2023	4245 SW 99th Avenue	6	Cast Iron	1947	76	90,000	From SCADA		
02/2023	4445 SW 99th Avenue	6	Cast Iron	1947	76	260,000	Total over 2 days … from SCADA		
02/2023	6708 SW Bancroft	4	Cast Iron	1947	76	15000	No significant water loss		
03/2023	4645 SW 78th Avenue	6	Cast Iron	1949	74	20,000	No significant water loss		
03/2023	3105 SW 100th Street	4	Cast Iron	1946	77		No significant water loss		

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Table Top Evaluations Are Good, but …

Main Break – August 2022
Started around 9:30 AM.
About 60 homes were out of water quickly.
We lost 0.15 MG in the first 20 minutes … 0.25 MG total
By 6 PM, we had a new pipe section was installed

- There are a lot of competing metrics that we cannot adequately account for and compare equally
- Besides age, pipe material, and break history, what weight do we give other "unquantifiable" metrics?
- While Table Top evaluations are thought to be less than 20% accurate at predicting the next pipe failures, we need more certainty if we are staring at $44 million in capital expenditures by 2063.
- At AWWA's 2020 "virtual annual conference", we discovered a new tool … a company called Fracta.

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Fracta: A New Company on the US Scene

- Parent corporation resides in Japan
- Has several years of artificial intelligence and machine learning experience in Japan and Asia
- The asset assessment and management team is a talented, energetic, and young force
- Fracta's pipe algorithm accounts for over 25 individual metrics simultaneously including soil type, area fault lines & slides, proximity to stray current, etc. to create a total business risk exposure
- We furnished Fracta with an ArcGIS file from our hydraulic model, pipe age, pipe type & size and all the break data we had recorded since 2012

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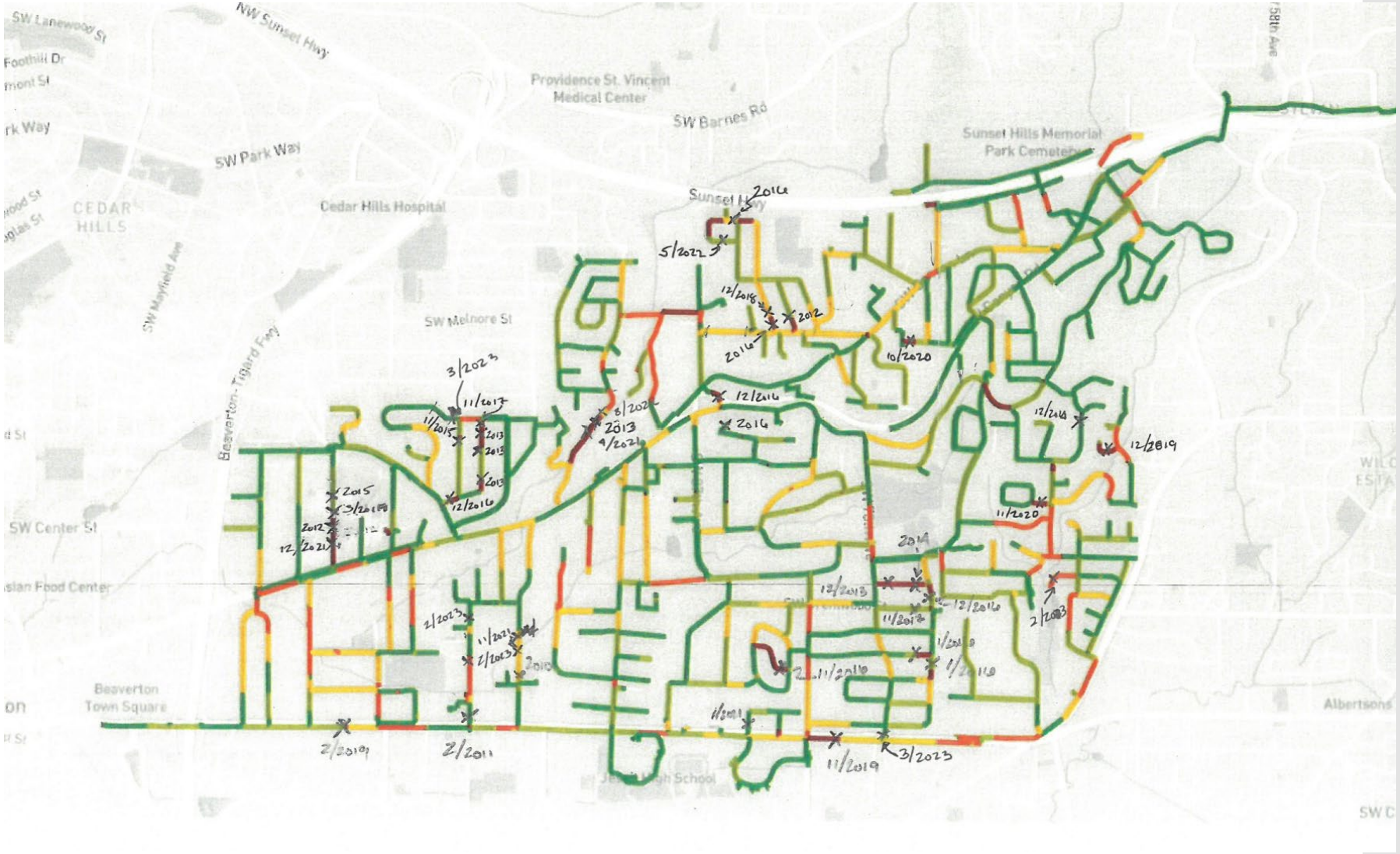
Fracta Analysis

Algorithm uses data from West Slope as well as surrounding utilities that it can find and other data from other entities such as DOGAMI.
Annual subscription allows us to submit data all year long and run 1-2 model runs with their algorithm.
The first run was in 2022.



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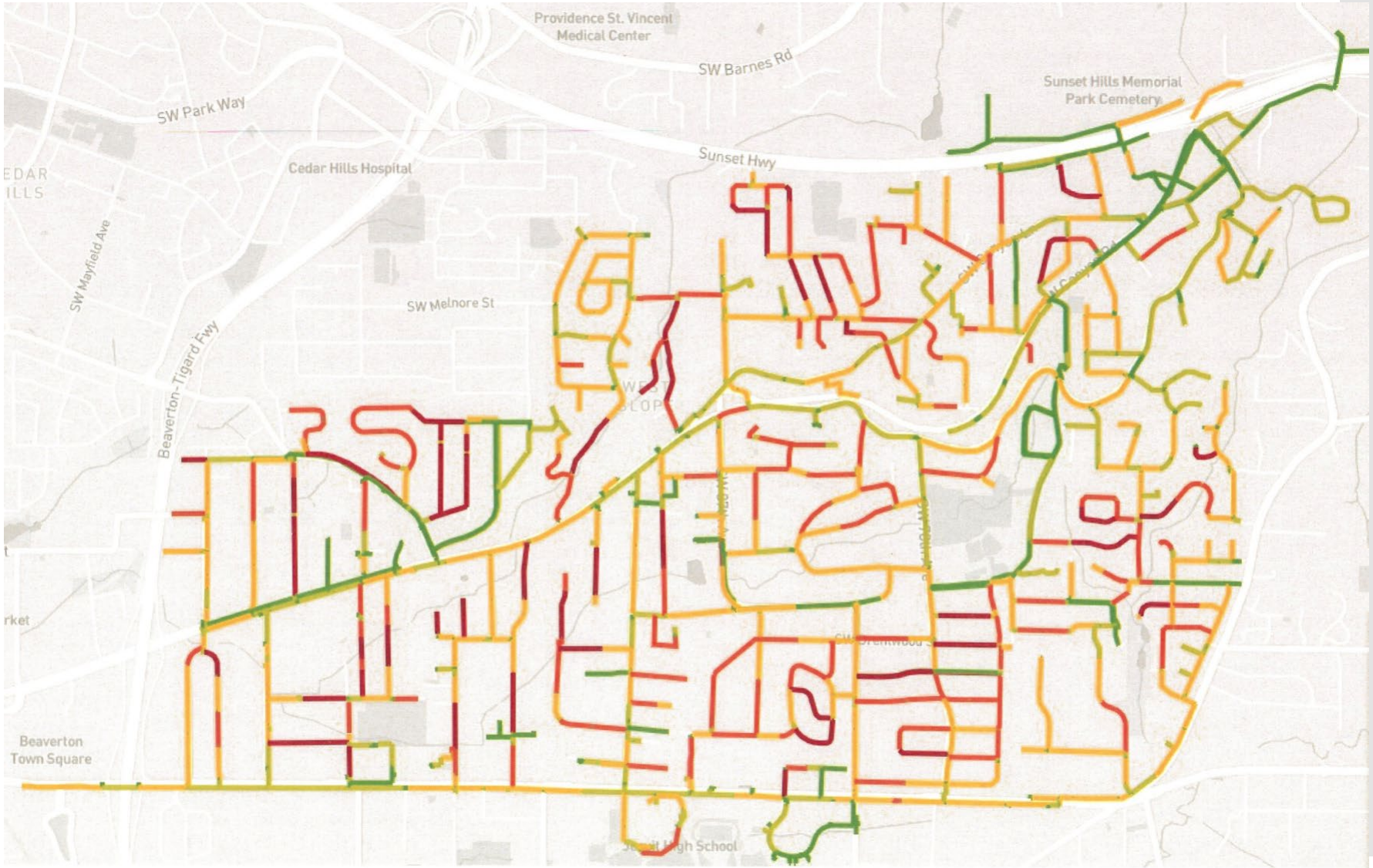
… and this run was made April 2023

What happened inside of one year?

Did the distribution system really get THAT much worse?



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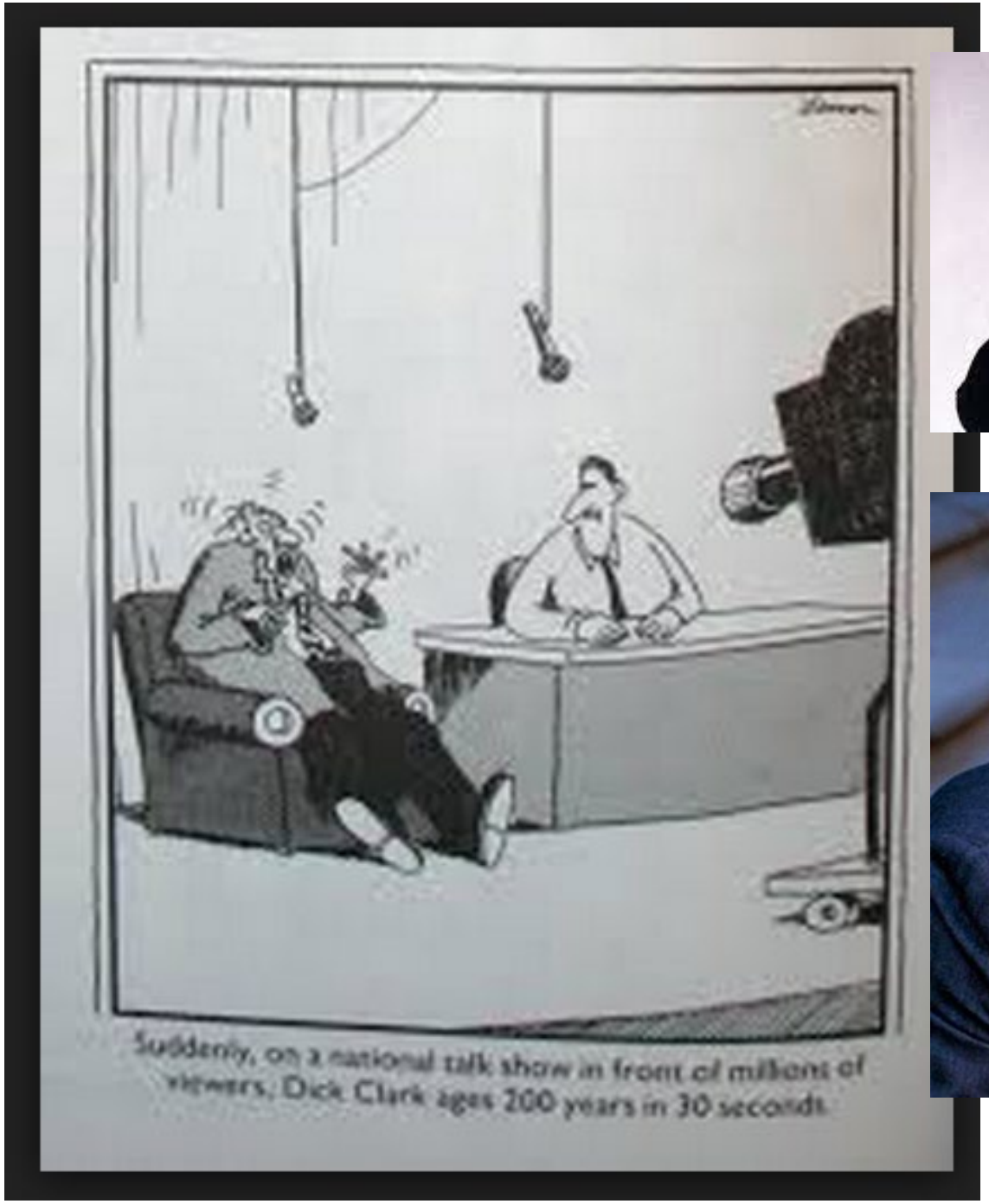
The amount of RED lines in this 2023 analysis made it seem like the distribution system aged and rocketed to brink of destruction in just one year … Did that really happen?

Stay tuned !!



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Before the main break happened … the worst we had seen in decades at West Slope in terms of ***potential*** water loss and damage … Fracta had already run their algorithm for us …

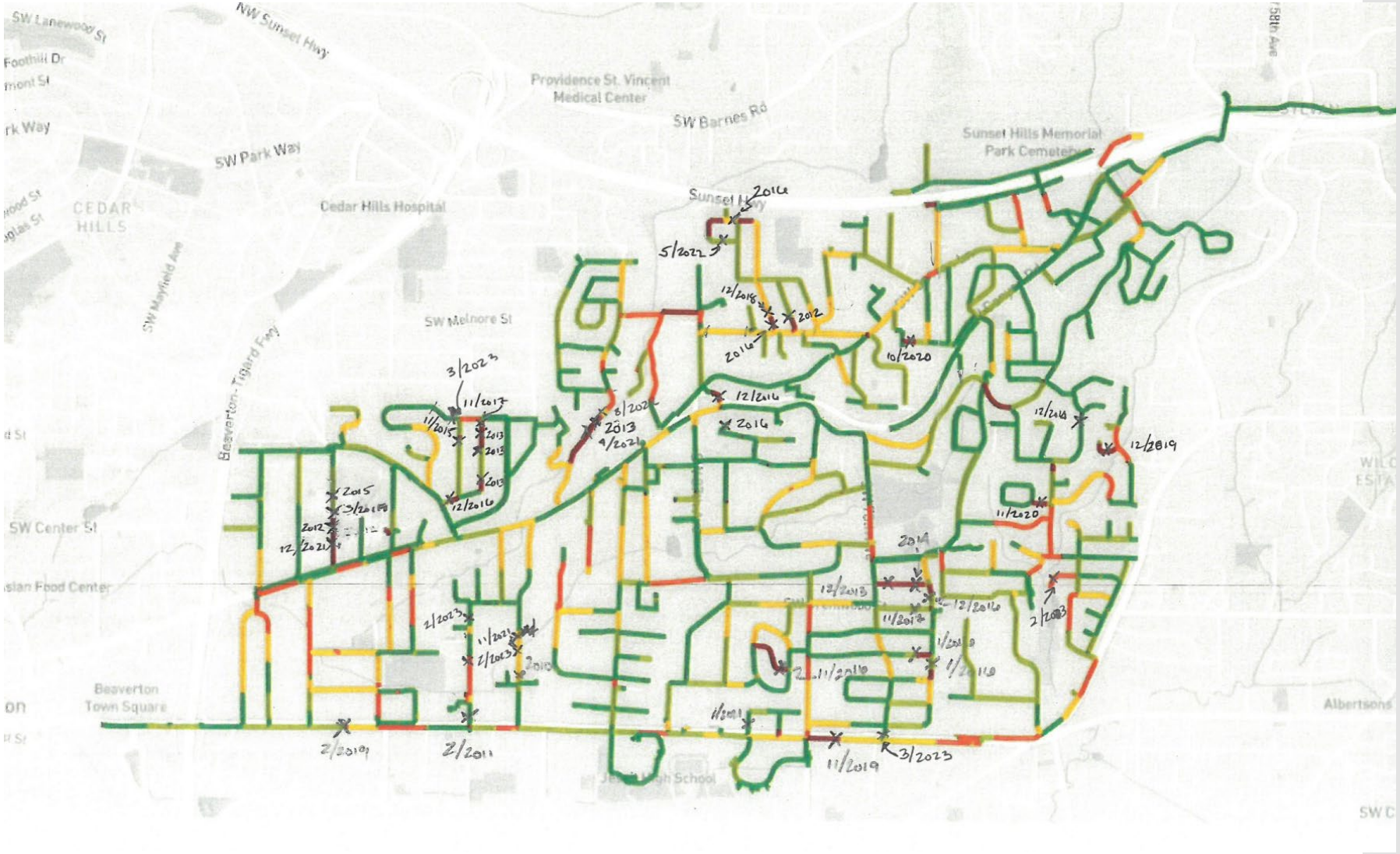
Remember the August 2022 Main Break?

- Fracta listed this small section of the distribution system as a Very High Business Risk Exposure (BRE)
- This section of pipe was not one we were that concerned with prior to August 2022

Replacing this pipe is now our next project

In 2022, the horizon looked manageable to us

A few projects here and there that we mostly knew about were potential issues



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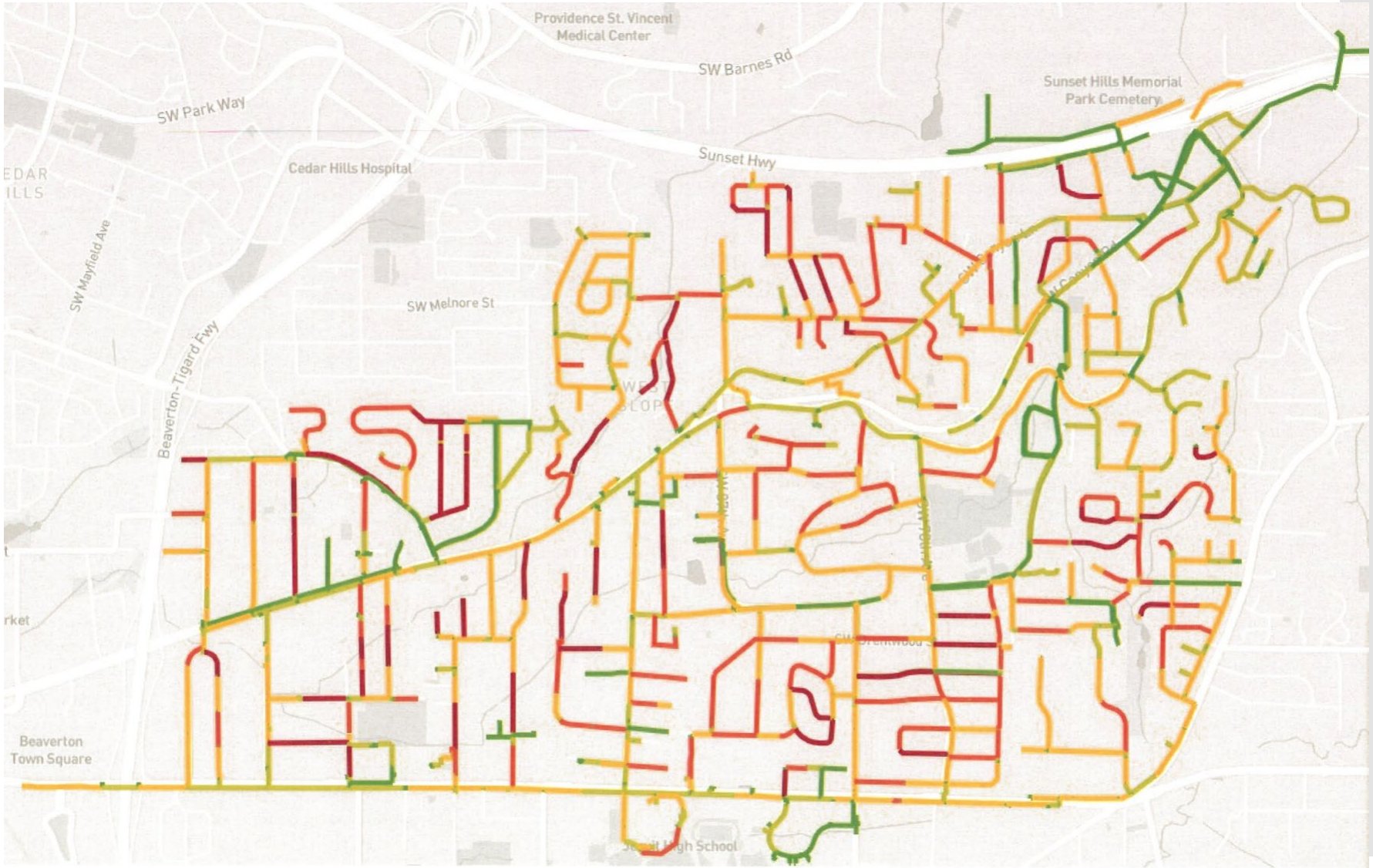
… but THIS horizon does not seem all that manageable at first glance

Where do we start?

Yes, we know … we eat the Elephant one bite at a time … but from which end?



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What Are the Components of Fracta's BRE Dashboard Map?

- Main components are the Consequence of Failure (CoF) and the Likelihood of Failure (LoF)
- In simple form, CoF x LoF = BRE
- What Fracta's AI/ML algorithm does is quantify what seems unquantifiable to West Slope
- West Slope can sift the "Red Lines" further by working with Fracta to refine their CoF assessment
- For instance, Fracta's analysis does not consider the customers on each pipe segment nor the potential capital projects by other entities in that region

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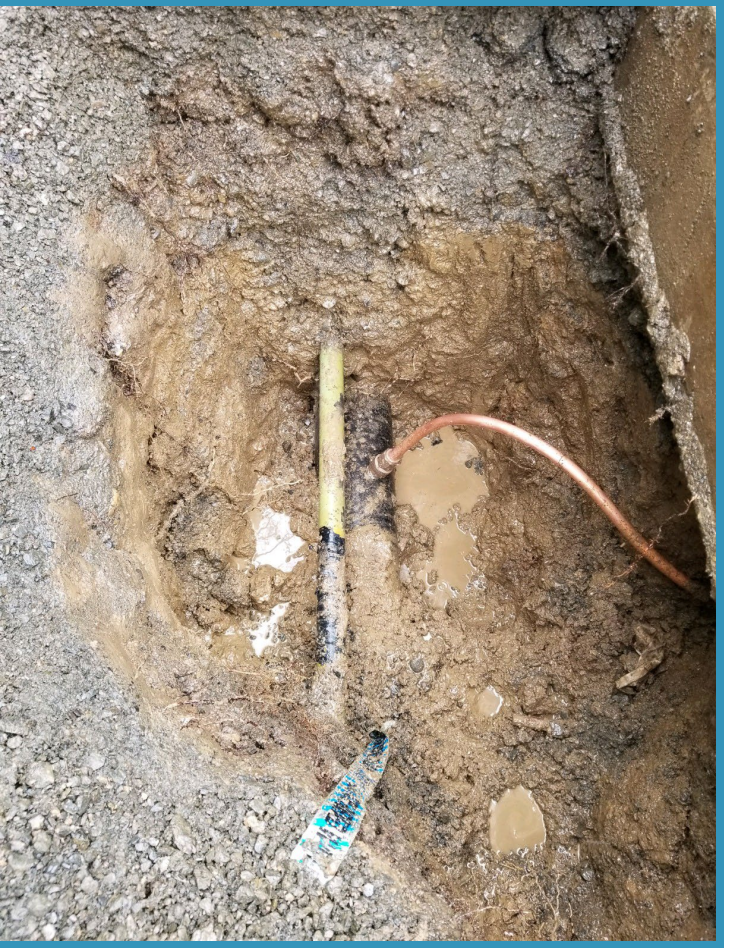

What Are the Components of Fracta's BRE Dashboard Map?

- West Slope can also help to further refine Fracta's LoF assessment by knowing more about & managing the District's assets
- Gathering good condition assessment data would greatly improve the LoF quality and validity
- Developing an AM program from nothing would appear to be ***ANOTHER*** overwhelming task
- Old thought: Small systems do not have the funds or capacity to develop an AM program

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Starting an AM Program from Scratch

- At a conference, West Slope discovered Frontier Precision, a company geared for small systems.
- Frontier Precision has developed a menu-driven field collection software to record asset condition assessment information.
- The program matches the ArcGIS data file of the District's distribution system hydraulic model with Google Maps and GPS data using satellite technology. First launch for West Slope: 5/3/2023
- No office data entry needed … can all be done in the field including adding photos and files.

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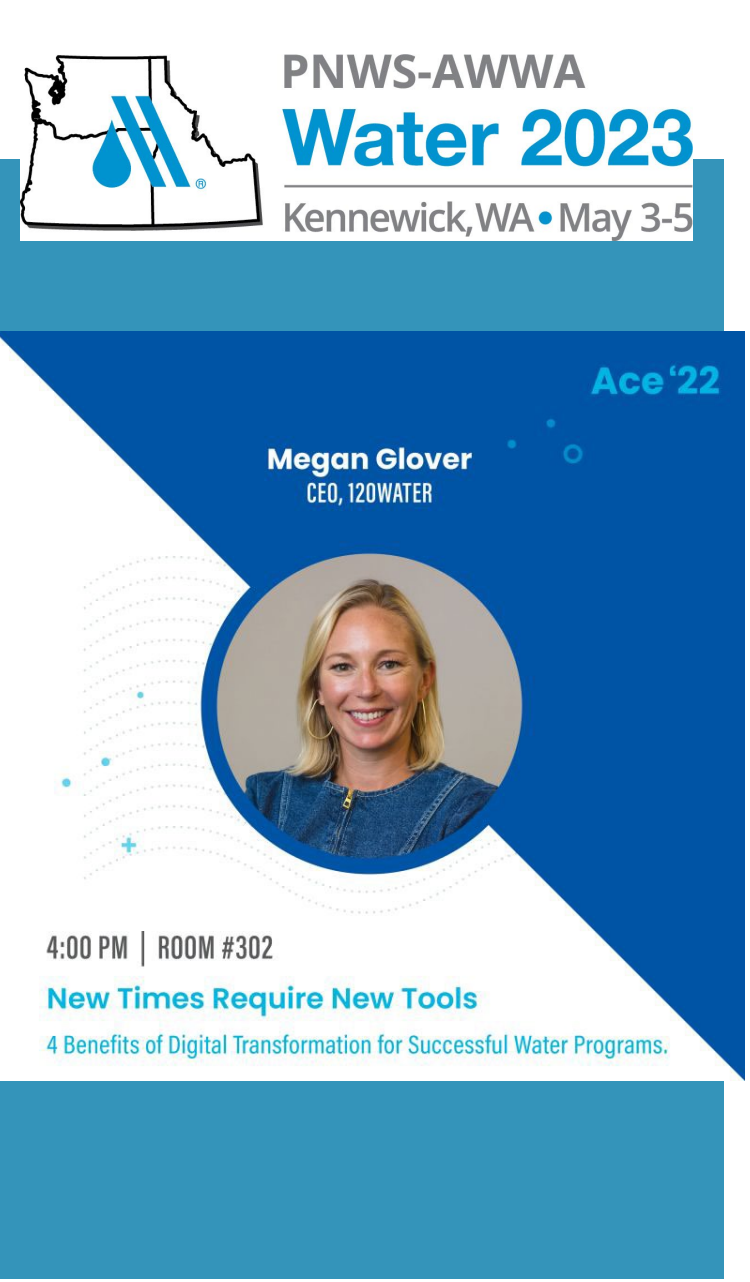
Customer Service Line Inventory

To comply with the EPA's requirement, West Slope has gathered pipe material data from every connection on either side of the meter. We're 99% certain what's on our side of the meter. We have ZERO documentation of what the customer has (no install data, no plumbing code data, etc.). We maintenance our meter vaults annually, so it makes sense to use that time to take a closer look.



Customer Service Line Inventory

- At the same virtual conference we learned of Fracta, we learned about 120Water.
- 120Water is able to organize whatever data we provide and help West Slope inventory service lines of unknown material.
- Being able to validate service line material using AI/ML technology will keep us from having to excavate behind ***every*** meter where the service line material is unknown. We can validate 85% of the customer service line material now. Validating the unknown 15% is the task at hand.
- The first look at West Slope's dashboard: 5/2/2023

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How Can West Slope Afford this Technology?

- Fracta: 3-yr contract $2,400/yr
- Frontier Precision: 1-time equipment cost = $1,300
- Frontier Precision: 1st year cost = $4,500; Years 2+ cost = $2,500; ESRI subscription = $1,100/yr; Catalyst licensing cost for satellite technology = $2,200/yr
- 120 Water subscription cost = $10,000/yr

How can West Slope afford NOT to seize the opportunity to use tools like thes?

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West Slope WD
Our Awesome Staff!

General Manager
Operations Manager
Finance Manager
Customer Service Rep
Three Distribution
System Operators

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Thanks for attending today's session!

May the 4th be with you

Questions ?

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