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Water 2026
Tacoma, Washington • May 6-8

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From Pipes to Protection: Tackling Water Quality and Lead & Copper Compliance

- What the Flush? Advanced Water Quality Monitoring and Condition Mitigation
- I Have My Lead and Copper Inventory—Now What?

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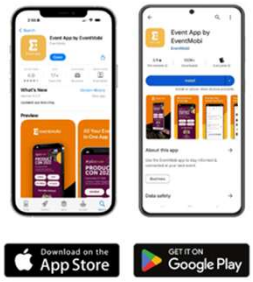
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Introduction

Daniel Broussard | Tacoma Water
Water Quality Specialist

Chris McMeen | Confluence Engineering Group
Sr. Project Manager

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7

Overview - Project

- Background of Tacoma Water System
- History of Tacoma's Unidirectional Flushing
- What We Learned About Our System
- Attempts to Address & Manage Sediment
- Different Methods Investigated
  - What We Learned
  - What We Selected
- Q&A

8

8

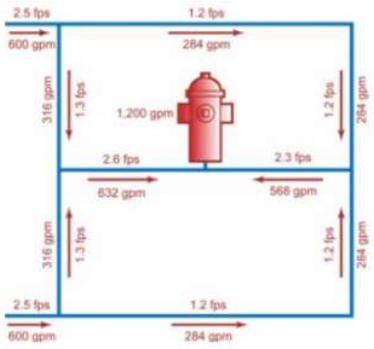
Overview - Flushing

- **Conventional (spot) flushing**
  - Turn over bulk water (to address low chlorine, customer complaints, etc.)
  - Generally low to modest velocity flow (< 2 fps)
- **Dead-end flushing**
  - Remove stagnant water
  - Generally low velocity flow (< 1 fps)
- **Unidirectional Flushing (UDF)**
  - Main cleaning (remove hydraulically mobile accumulation)
  - Generally higher velocity flows 4 – 6 feet per second (fps)

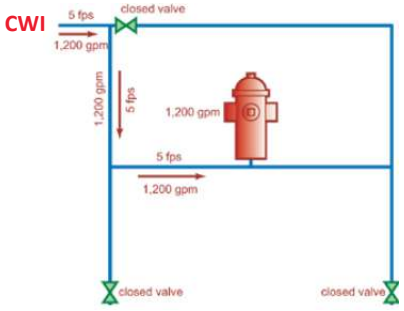
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Overview - Flushing

- **Conventional Flushing (CF)**
  - Spot Flushing
  - Dead-End Flushing
  - Automatic Flushing Stations
  - No valve closures (usually)

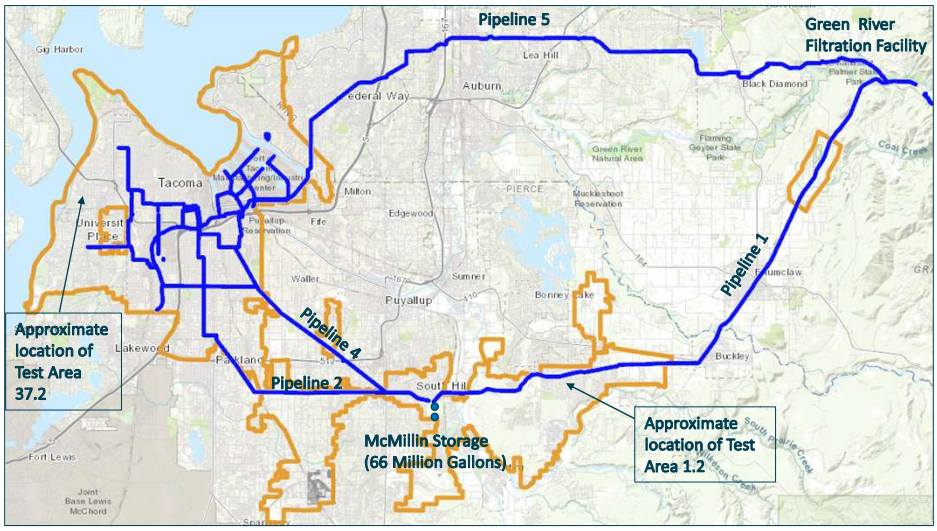


- **Unidirectional Flushing (UDF)**
  - Area-wide from **clean water interface (CWI)**
  - Moving clean water in one, controlled direction



10

Background of Tacoma Water System



11

11

History of Tacoma's Unidirectional Flushing

- **1998 – Successful Pilot near St. Joseph's Hospital**
- **1999 – First year of flushing program**
  - 10% system flushed in Pierce County
- **2000 – Second year of flushing program**
  - 10% system flushed in SE corner of Tacoma
- **2007- The 2nd Unidirectional flush crew was brought on**
- **Currently (2) crews dedicated full time**
  - 2021 & 2022 – Both crews completed the 6th cycle of flushing the entire system

12

What We Learned About Our System

- We remove a lot of sediment
- We see shorter Initial Flush times and higher Cl2 Residuals
- We see redeposition when large mains are affected
- We ARE NOT achieving optimal flow rates for many 12" Mains



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Attempts to Address & Manage Sediment

- We Put Together a Committee to Address Sediment Management
- We Looked at How Mains Are Being Flushed

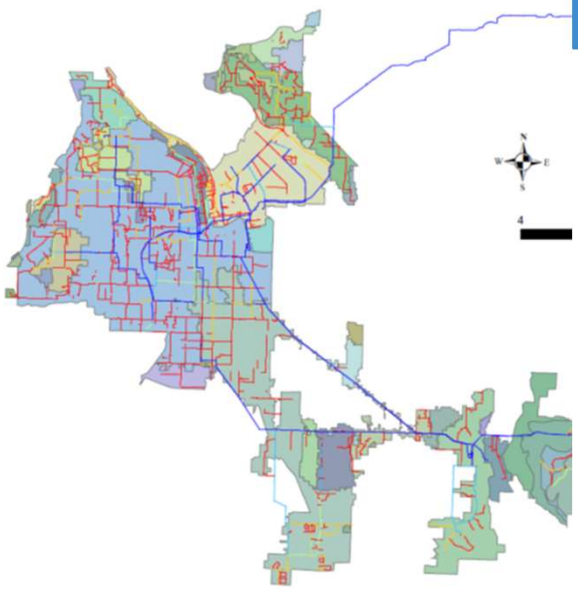


Figure 1: Map of Tacoma Water System

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Different Methods Investigated

- **Neutral Output- Discharge Elimination System (NO-DES)**
- **Ice Pigging**
- **Conventional Main Swabbing**

15

15



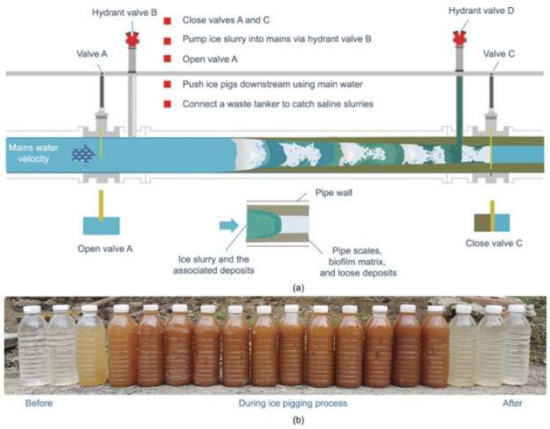
What We Learned – NO-DES

- **Effectiveness**
- **Multipurpose Use**
- **Cost**
- **Main Size**

16

What We Learned – Ice Pigging

- **Effectiveness**
- **Large Mains**
- **Cost**
- **Sole source company**



17

17



What We Learned – Conventional Main Swabbing

- **Effectiveness**
- **Risks**
- **Cost**

18



We Needed Help to Decide

We needed consulting to help us decide which direction to go

19

19

Who We Selected

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20

Tacoma Water Mains Cleaning Program



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Confluence – Tacoma Water Approach

1. Provide a review of Tacoma Water's flushing practices in the distribution system
2. Design and support a distribution system field evaluation of cleaning performance (unidirectional flushing + swabbing)
3. Assess nature and magnitude of pipe wall deposit accumulation in 72" and 60" sections of transmission Pipeline 5

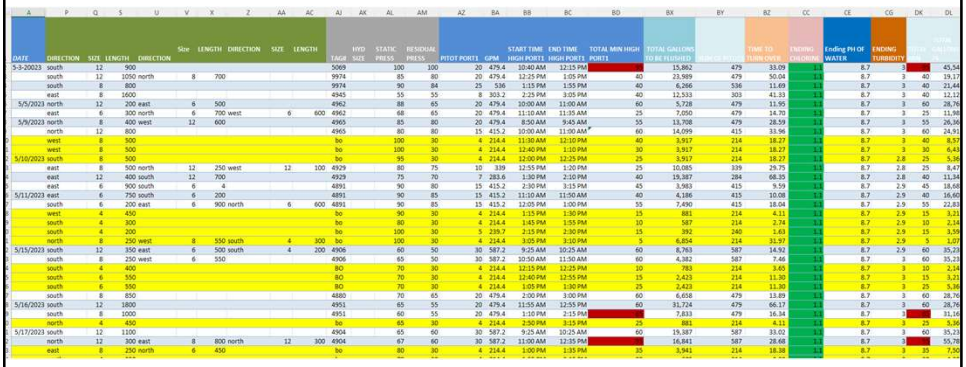
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1. Review Starts with the Data



DATE	DIRECTION	SIZE	LENGTH	DIRECTION	Size	LENGTH	DIRECTION	SIZE	LENGTH	TAGE	HYD SIZE	STATIC PRESS.	RESIDUAL PRESS	PITOT PORT1	GPM	START TIME HIGH PORT1	END TIME HIGH PORT1	TOTAL MIN HIGH PORT1	TOTAL GALLONS TO BE FLUSHED		TIME TO TURN OVER	ENDING CHLORINE	Ending PH OF WATER	ENDING TURBIDITY	TOTAL GALLONS
5-3-20023	south	12	900							5069		100	100	20	479.4	10:40 AM	12:15 PM		15,862	479	33.09	1.4	8.7	3	45,54
	south	12	1050	north	8	700				9974		85	80	20	479.4	12:25 PM	1:05 PM	40	23,989	479	50.04	1.4	8.7	3	40	19,17
	south	8	800							9974		90	84	25	536	1:15 PM	1:55 PM	40	6,266	536	11.69	1.3	8.7	3	40	21,44
	east	8	1600							4945		55	55	8	303.2	2:25 PM	3:05 PM	40	12,533	303	41.33	1.3	8.7	3	40	12,12
5/5/2023	north	12	200	east	6	500				4962		88	65	20	479.4	10:00 AM	11:00 AM	60	5,728	479	11.95	1.3	8.7	3	60	28,76
	east	6	300	north	6	700	west	6	600	4962		68	65	20	479.4	11:10 AM	11:35 AM	25	7,050	479	14.70	1.3	8.7	3	25	11,98
5/9/2023	north	8	400	west	12	600				4965		85	80	20	479.4	8:50 AM	9:45 AM	55	13,708	479	28.59	1.4	8.7	3	55	26,39
	north	12	800							4965		80	80	15	415.2	10:00 AM	11:00 AM	60	14,099	415	33.96	1.3	8.7	3	60	24,91
	west	8	500							bo		100	30	4	214.4	11:30 AM	12:10 PM	40	3,917	214	18.27	1.3	8.7	3	40	8,57
	west	8	500							bo		100	30	4	214.4	12:40 PM	1:10 PM	30	3,917	214	18.27	1.4	8.7	3	30	6,43
5/10/2023	south	8	500							bo		95	30	4	214.4	12:00 PM	12:25 PM	25	3,917	214	18.27	1.3	8.7	2.8	25	5,35
	east	8	500	north	12	250	west	12	100	4929		80	75	10	339	12:55 PM	1:20 PM	25	10,085	339	29.75	1.3	8.7	2.8	25	8,47
	east	12	400	south	12	700				4929		75	70	7	283.6	1:30 PM	2:10 PM	40	19,387	284	68.35	1.3	8.7	2.8	40	11,34
	east	6	900	south	6	4				4891		90	80	15	415.2	2:50 PM	3:15 PM	45	3,983	415	9.59	1.3	8.7	2.9	45	18,68
5/11/2023	east	6	750	south	6	200				4891		90	85	15	415.2	11:10 AM	11:50 AM	40	4,186	415	10.08	1.3	8.7	2.9	40	16,60
	south	6	200	east	6	900	north	6	600	4891		90	85	15	415.2	12:05 PM	1:00 PM	55	7,490	415	18.04	1.3	8.7	2.9	55	22,83
	west	4	450							bo		90	30	4	214.4	1:15 PM	1:30 PM	15	881	214	4.11	1.3	8.7	2.9	15	3,21
	south	4	300							bo		80	30	4	214.4	1:45 PM	1:55 PM	10	587	214	2.74	1.3	8.7	2.9	10	2,14
	south	4	200							bo		100	30	5	239.7	2:15 PM	2:30 PM	15	392	240	1.63	1.3	8.7	2.9	15	3,59
	north	8	250	west	8	550	south	4	300	bo		100	30	4	214.4	3:05 PM	3:10 PM	5	6,854	214	31.97	1.3	8.7	2.9	5	1,07
5/15/2023	south	12	350	east	6	500	south	4	200	4906		60	50	30	587.2	9:25 AM	10:25 AM	60	8,763	587	14.92	1.3	8.7	2.9	60	35,23
	south	8	250	west	6	550				4906		65	50	30	587.2	10:50 AM	11:50 AM	60	4,382	587	7.46	1.3	8.7	3	60	35,23
	south	4	400							BO		70	30	4	214.4	12:15 PM	12:25 PM	10	783	214	3.65	1.3	8.7	3	10	2,14
	south	6	550							BO		70	30	4	214.4	12:40 PM	12:55 PM	15	2,423	214	11.30	1.3	8.7	3	15	3,21
	south	6	550							BO		70	30	4	214.4	1:05 PM	1:30 PM	25	2,423	214	11.30	1.3	8.7	3	25	5,36
	south	8	850							4880		70	65	20	479.4	2:00 PM	3:00 PM	60	6,658	479	13.89	1.3	8.7	3	60	28,76
5/16/2023	south	12	1800							4951		65	55	20	479.4	11:55 AM	12:55 PM	60	31,724	479	66.17	1.3	8.7	3	60	28,76
	south	8	1000							4951		60	55	20	479.4	1:10 PM	2:15 PM		7,833	479	16.34	1.3	8.7	3	35	31,16
	north	4	450							bo		65	30	4	214.4	2:50 PM	3:15 PM	25	881	214	4.11	1.3	8.7	3	25	3,39
5/17/2023	south	12	1100							4904		65	60	30	587.2	9:25 AM	10:25 AM	60	19,387	587	33.02	1.3	8.7	3	60	35,23
	north	12	300	east	8	800	north	12	300	4904		67	60	30	587.2	11:00 AM	12:35 PM		16,841	587	28.68	1.3	8.7	3	35	55,79
	east	8	250	north	6	450				bo		80	30	4	214.4	1:00 PM	1:35 PM	35	3,941	214	18.38	1.3	8.7	3	35	7,50

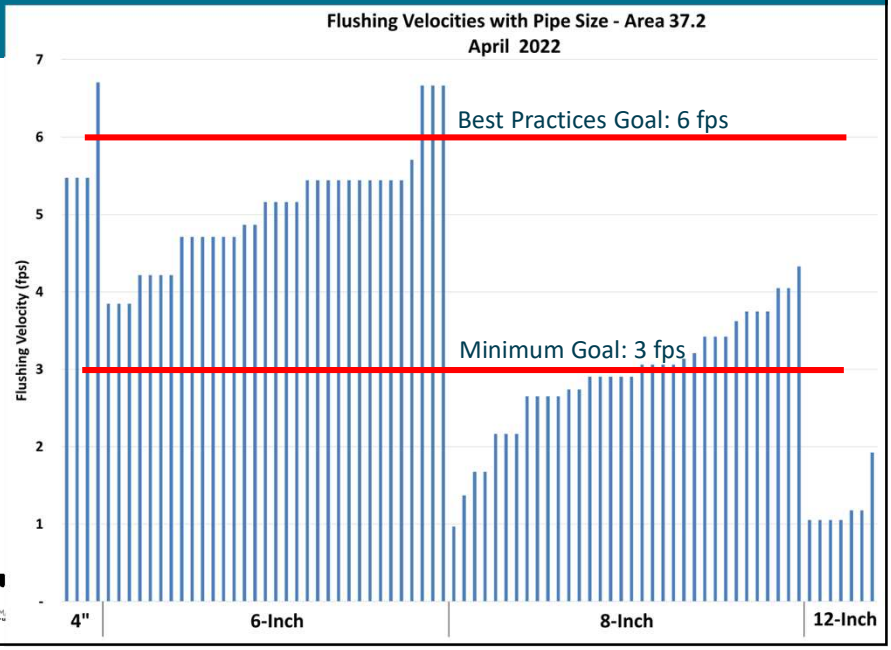
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Review of Tacoma Water Practices – Flushing Velocity

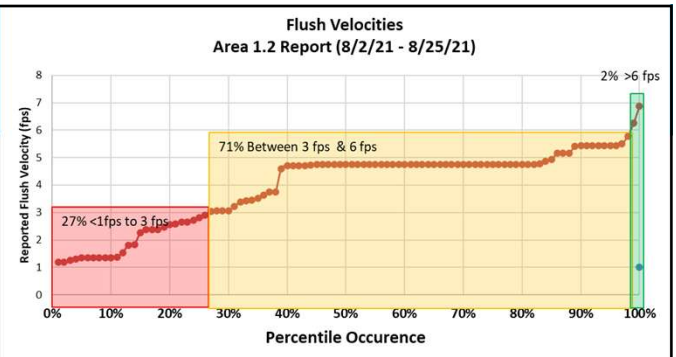


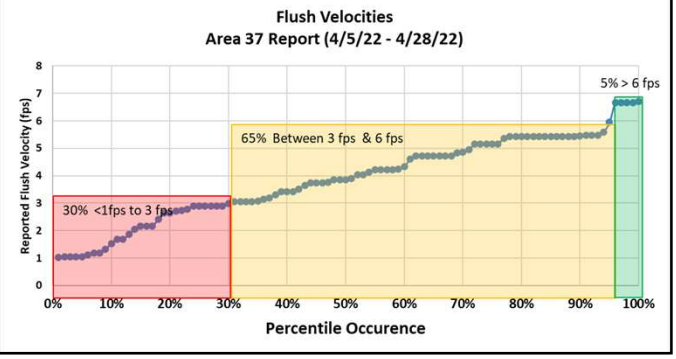
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Flushing Velocity

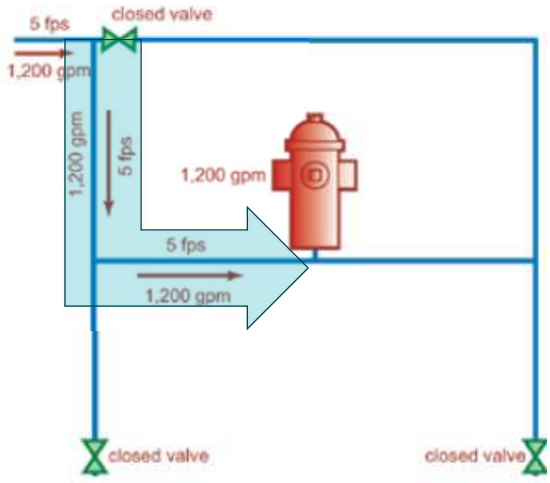
- Majority (~70%) flushes between 3-6 fps
- Mostly 4" and 6" – some 8"
- Only 2% - 5% of flushes exceed 6 fps – all 6" pipe





25

Review of Tacoma Water Practices - Flushing Volume

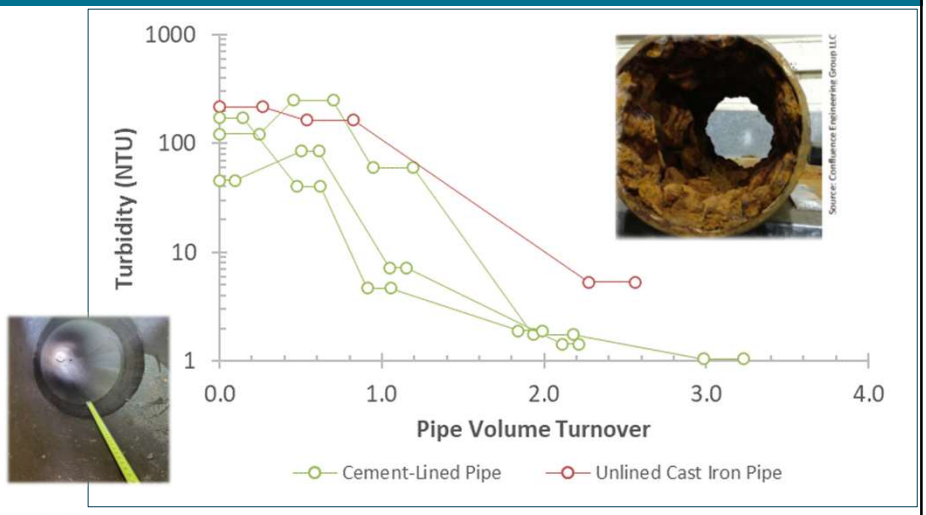


- Definition of a Pipe Volume (PV)
  - The amount of water in the segment of pipe being flushed
  - Shaded Example: 1,000 feet of 8" pipe contains 2,611 gallons = 1 PV

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26

Flushing Volume to Endpoint Goals



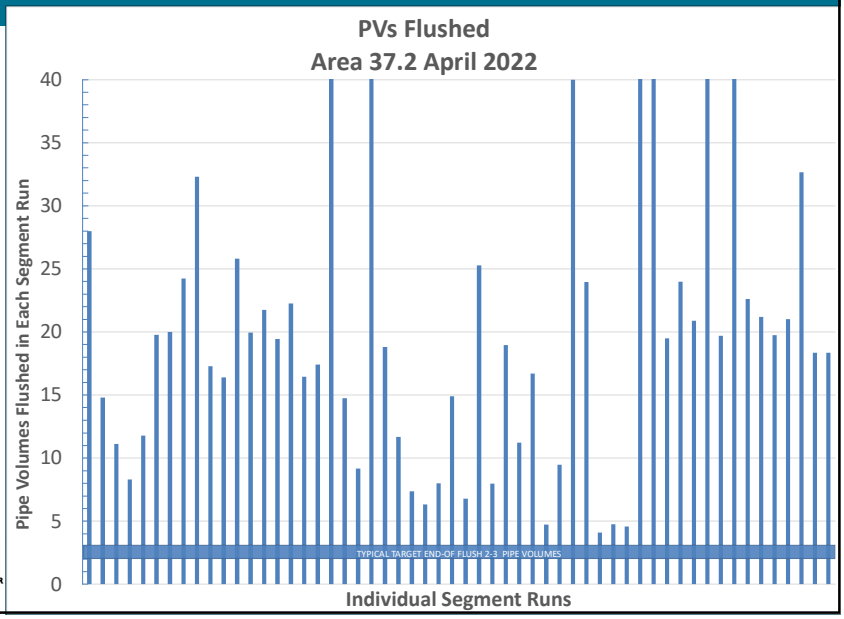
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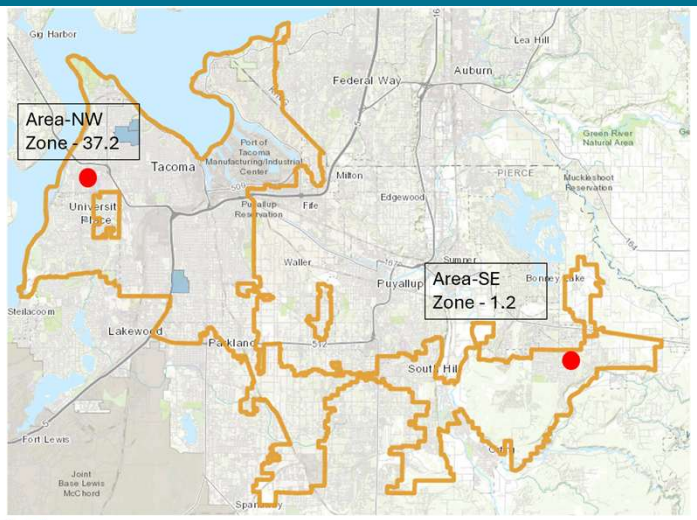
Review of Tacoma Water Practices – Flushing Volumes



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2. UDF & Swabbing Field Evaluation



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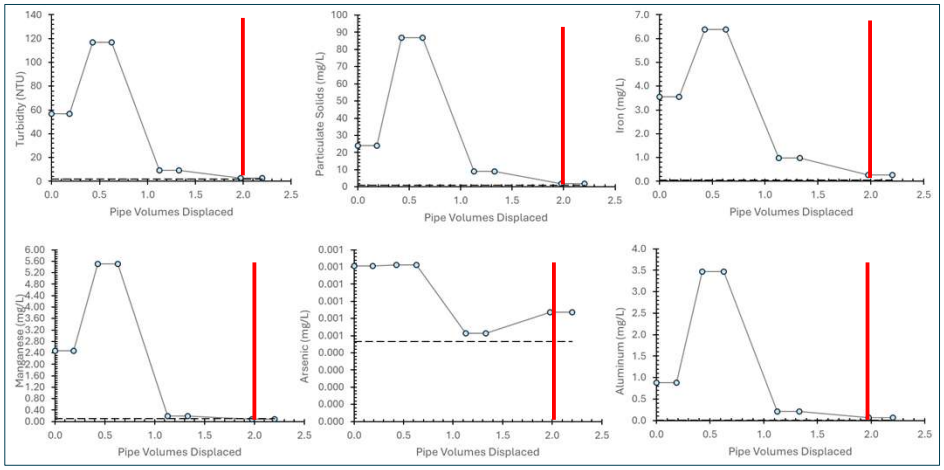
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MH1

Flushing Volumes – As expected
Sequence #3 Area 37.2 – Multiple parameters



2 Pipe Volumes

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Slide 30

MH1 For trial work we actually do measure for these parameters? Are you referring more to what TW usually collects?
Michael Hallett, 2026-03-11T14:59:47.255

CM1 0 Narrative modified
Chris McMeen, 2026-03-11T15:07:44.027



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UDF & Swab Water – The Visual



UDF & Swabbing discharge profile samples collected for Sequence #3 Area 37.2

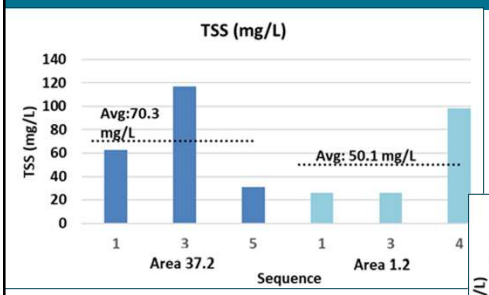
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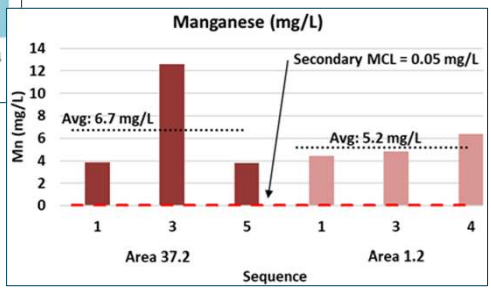
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UDF Example Removals





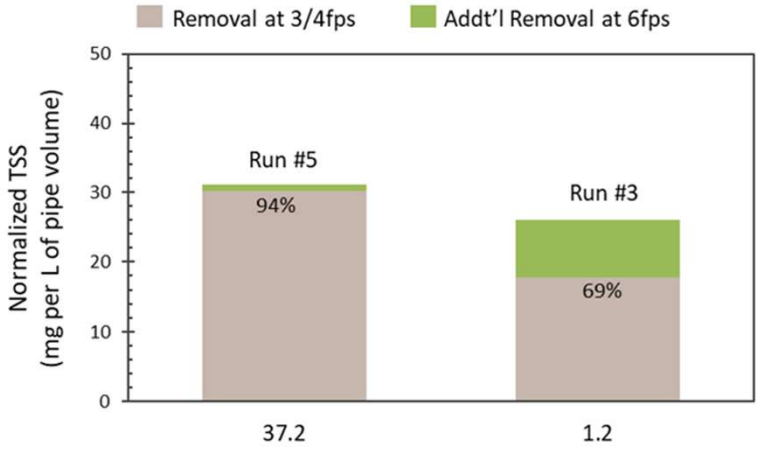
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UDF Removal – Comparing Velocities



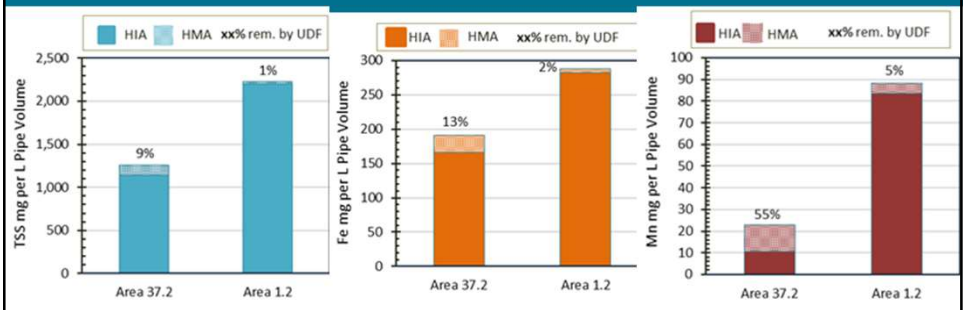
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34

Comparing UDF & Swabbing Removals



- For suspended solids & iron, 9 – 13% of the material was hydraulically mobile in Area 37.2, removable by flushing alone. All contaminants were less removable in Area 1.2
- Manganese was generally more hydraulically mobile, and removable.
- Vast majority of the material present was not amenable to hydraulic removal – required swabbing

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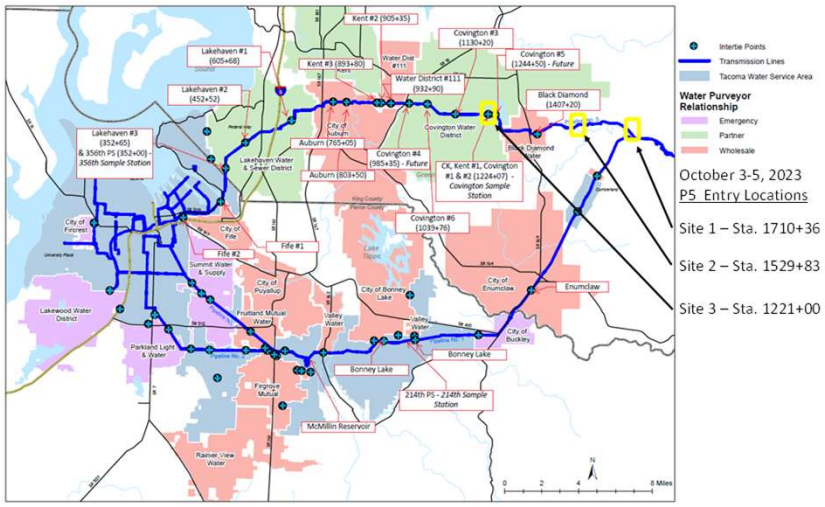
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The Transmission Pipeline Challenge





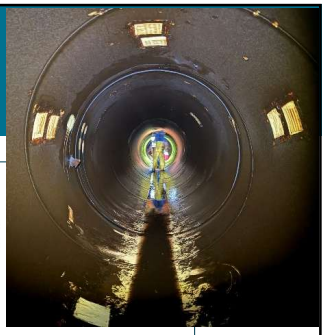
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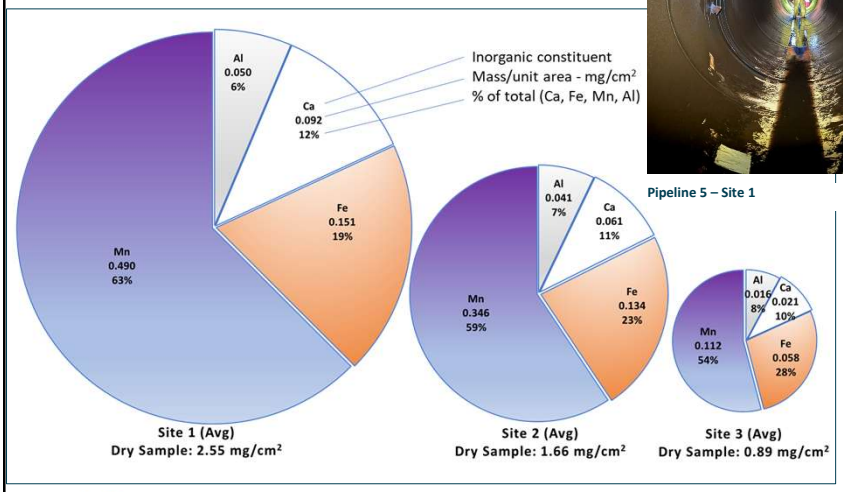
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36

The Transmission Pipeline Challenge



Pipeline 5 – Site 1



Samples were analyzed for 32 contaminants; manganese, iron, calcium and aluminum were 92-96% of the mass in all samples

37

37

Summary Observations

- Tacoma is well resourced, invested and engaged in UDF operations
- Some opportunity to improve equipment use and sequence planning
- Although flushing velocities could likely be increased, and removal improved, current operations are removing material
- By tracking pipe volumes flushed and flushed water quality, significant efficiencies can be realized in terms of volumes flushed, and time required
- Crews are now capable of implementing foam swabbing if particularly problematic areas warrant
- Major Transmission Pipelines can serve as sinks, and periodic sources of loading for suspended solids and inorganic metals; consider cleaning capability in pipeline design

38

38

Main Swabbing - Video

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Initial Swab



Final Swab



39

39

Q & A

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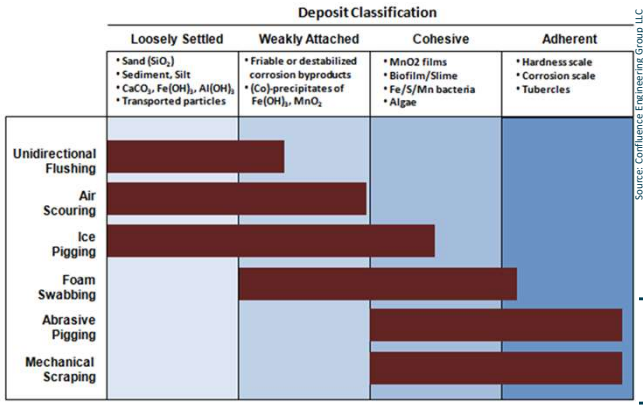
Extra Slides

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41

Select the Right Technique for the Job



These are "rehabilitation" techniques and require re-lining!

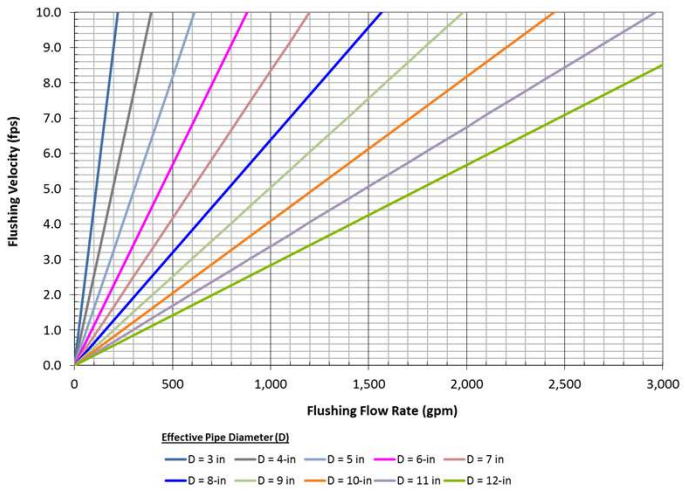
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Hydraulic Conversion Chart



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