
# USING MICROBIAL SOURCE TRACKING IN AN URBAN SETTING TO AID IN THE IDENTIFICATION OF STORM/SANITARY LATERAL CROSS-CONNECTIONS.

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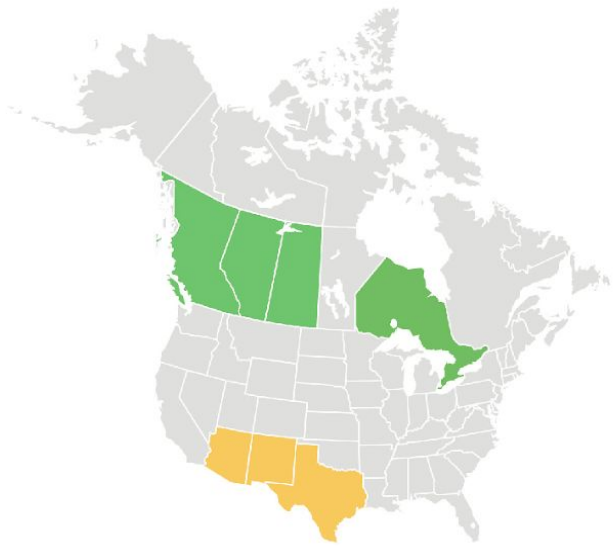
National Water and Wastewater Conference – Tuesday, November 4, 2025


# Agenda

- EPCOR, City of Edmonton and North Saskatchewan River background
- EPCOR collection systems, cross connection overview
- MST overview
- Storm sewer outfall MST screen
- Tracing cross connections
- Case Studies
- Summary

# EPCOR Utilities Inc.

- Electricity distribution/transmission, water & wastewater treatment for City of Edmonton (plus surrounding areas for water)
- ~3700 Employees
- Operates as a private company
- City of Edmonton is the sole shareholder
- Operates 1 WWTP and 2 WTPs in Edmonton
- Water source is the North Saskatchewan River
- Also have operations outside of Edmonton



**EPCOR Operations**

- Water
- Wastewater
- Natural Gas
- Electricity
- Commercial/Industrial
- Regulated Retail Service Territory

**Alberta**

1. Canmore
2. Chestermere
3. CNRL Albian Sands Muskeg River and Jackpine
4. Edmonton
5. Edmonton Metropolitan Region
6. Harmony
7. Kananaskis
8. Red Deer County
9. Strathmore

**Alberta and British Columbia**

10. TransMountain Pipeline

**British Columbia**

11. Britannia Mine
12. French Creek

**Saskatchewan**

13. Regina

**Ontario**

14. Aylmer
15. Collingwood
16. Darlington
17. Southern Bruce


**Arizona**

18. Agua Fria
19. Anthem
20. Chaparral
21. Havasu / Parker
22. Luke 303
23. Mohave
24. Paradise Valley
25. Rio Verde
26. Rio Verde Foothills
27. San Tan
28. Sun City
29. Sun City West
30. Tubac
31. Willow Valley

**New Mexico**

32. Edgewood
33. Thunder Mountain
34. Clovis

**Texas**

35. Blue Sky
36. Sandow
37. 130 Pipeline
38. Vista Ridge

August, 2025

# Edmonton, Alberta

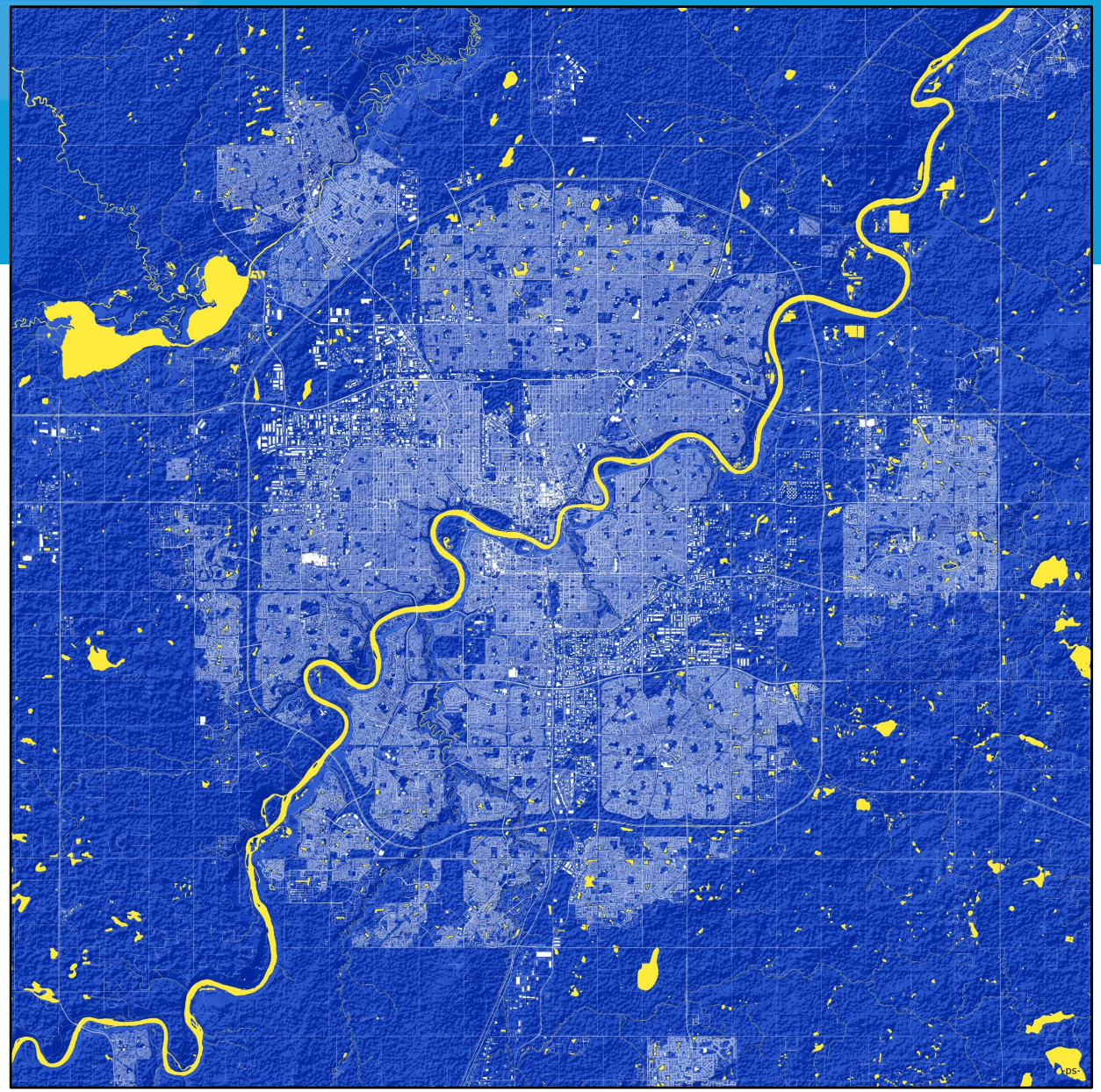
- Capital of Alberta, Canada
- 1M people, 1.4M in Edmonton Metro region
- North Saskatchewan river runs through the middle of the city
- Oldest parts of the city from around 1900

# North Saskatchewan River (NSR)

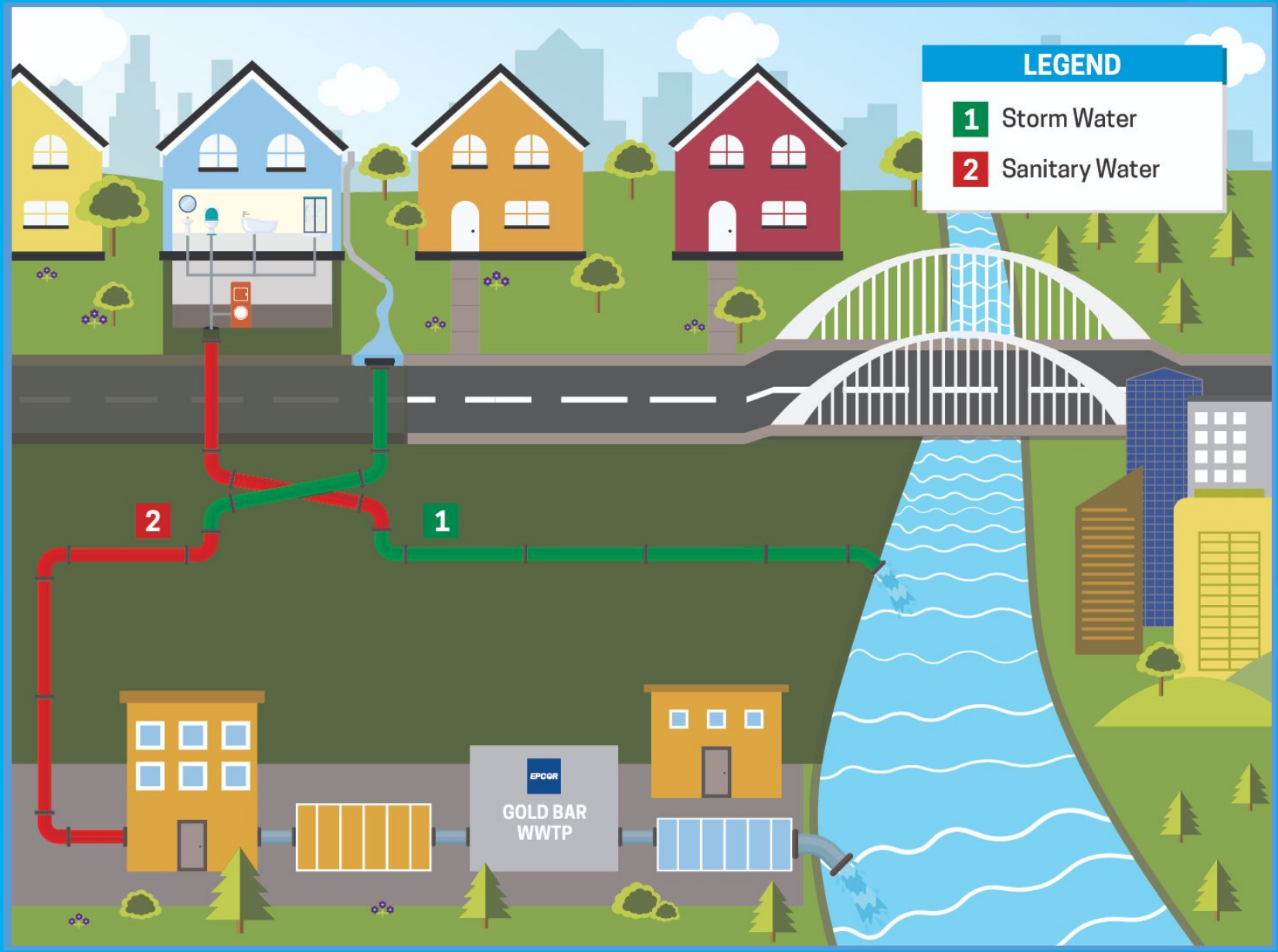
- Glacier fed
- Joins with S. Saskatchewan river
- Flows to Hudson Bay
- Limited human activity upstream of Edmonton
- Large seasonal variability in turbidity

# Collection Systems

- Oldest parts of the city have combined collection pipes (storm + sani)
- Combined system represents (< 20% of pipe length)
- For >80% of city the collection systems are separate

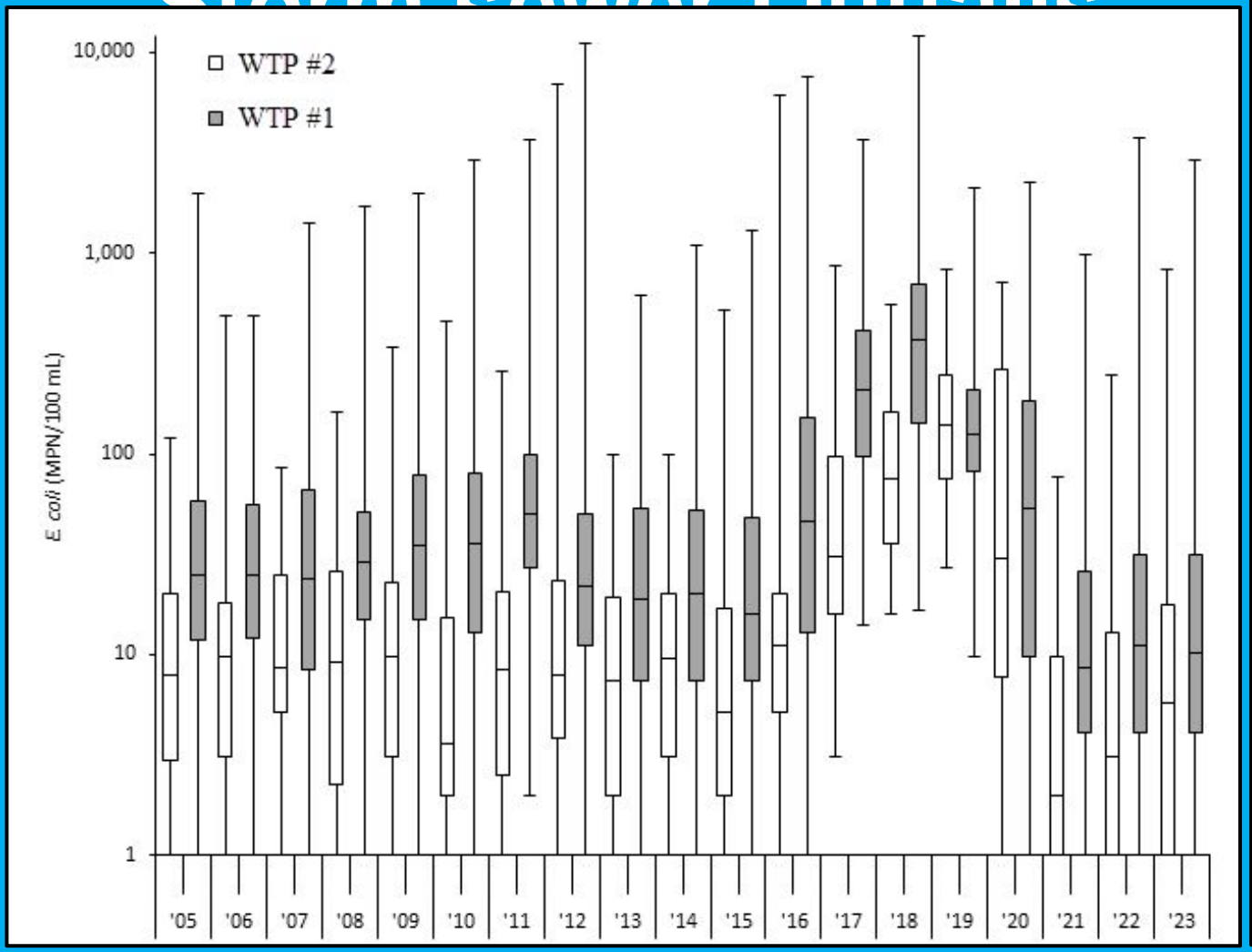


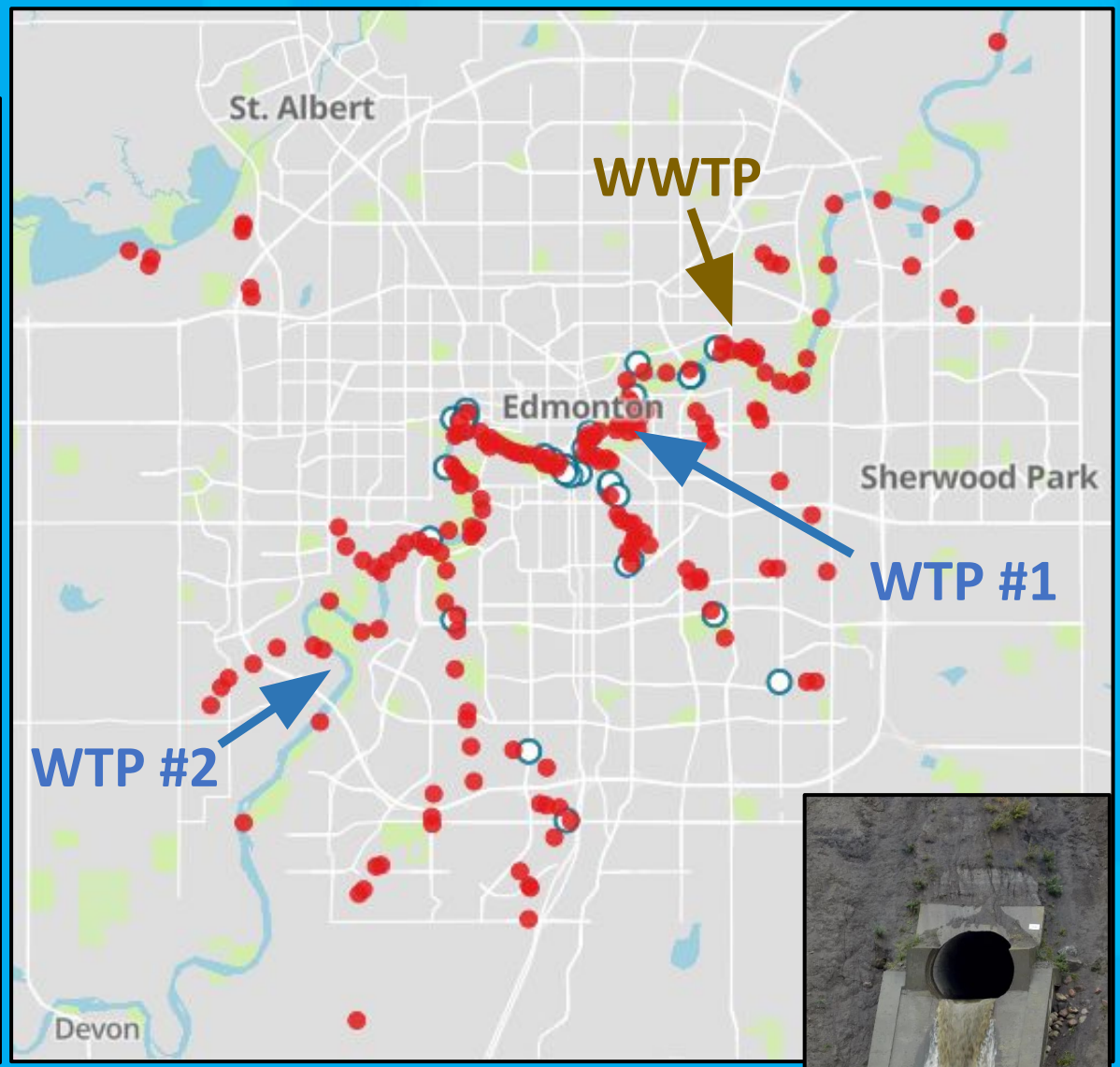
# EPCOR Collection Systems




- Sewer Types:
  - Storm
  - Sanitary
- Stormwater returns to NSR
- Sanitary is treated at WWTP prior to release back to NSR

# Storm sewer Outfalls

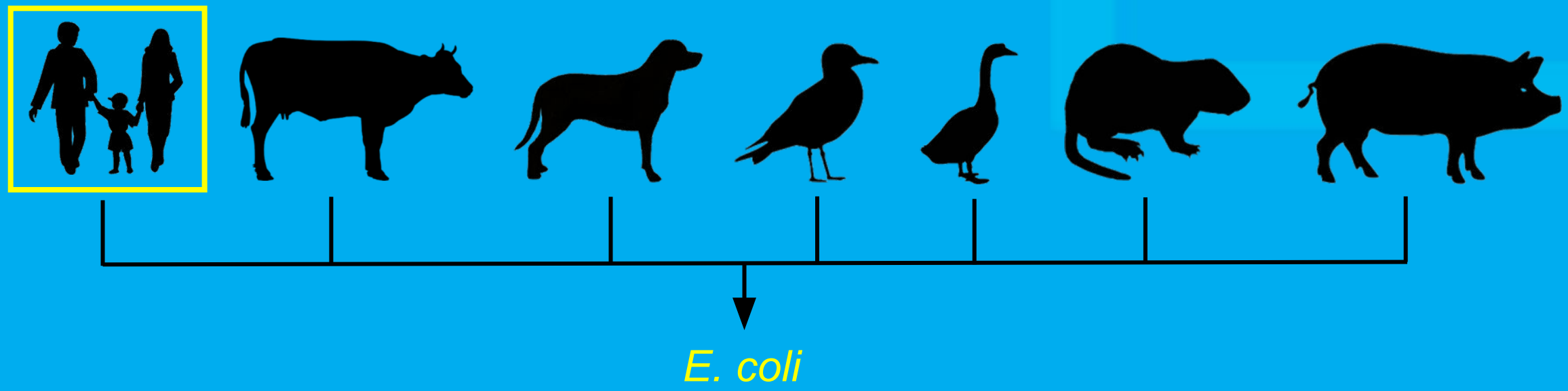



- Cross connections (Xcons) lead to loadings into river (nutrients, solids, pathogens)
- How to monitor outfalls? (*E. coli* higher at WTP#1)

# Indicator Organisms

- Used to give an indication of recent pollution
- We historically have used *E. coli* by culture (how much is too much?)
- What does it tell us about source? Answer = little
- To identify human sewage in stormwater we need to use a human-specific marker (PCR-based assays work well)

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# Microbial Source Tracking by PCR

This is a hypothetical example of the specificity of probe-based quantitative PCR and how it will only amplify AND detect specific fragments of DNA from an environmental DNA extract with 2 primers and a probe.

- Exponential Amplification of DNA fragments (DNA photocopier)
- Targeted
- Quantitative (vs. standards)
- Highly specific

- Many human-associated MST markers exist
- One of the most commonly used is called HF183 (targets a bacterium found in the human gut)

# Sample Processing

- Collect stormwater sample (outfalls and manholes)
- Transport to lab
- Filter sample onto polycarbonate membranes
- Extract DNA (no purification, bead mil
- Perform qPCR (software quantifies)
- Lab process takes < 6 hours
- Can test for multiple targets on same DNA extracts
- We test for *Enterococcus (general)* &


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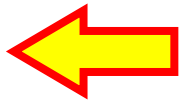
# SSO Outfall Screen by HF183 qPCR

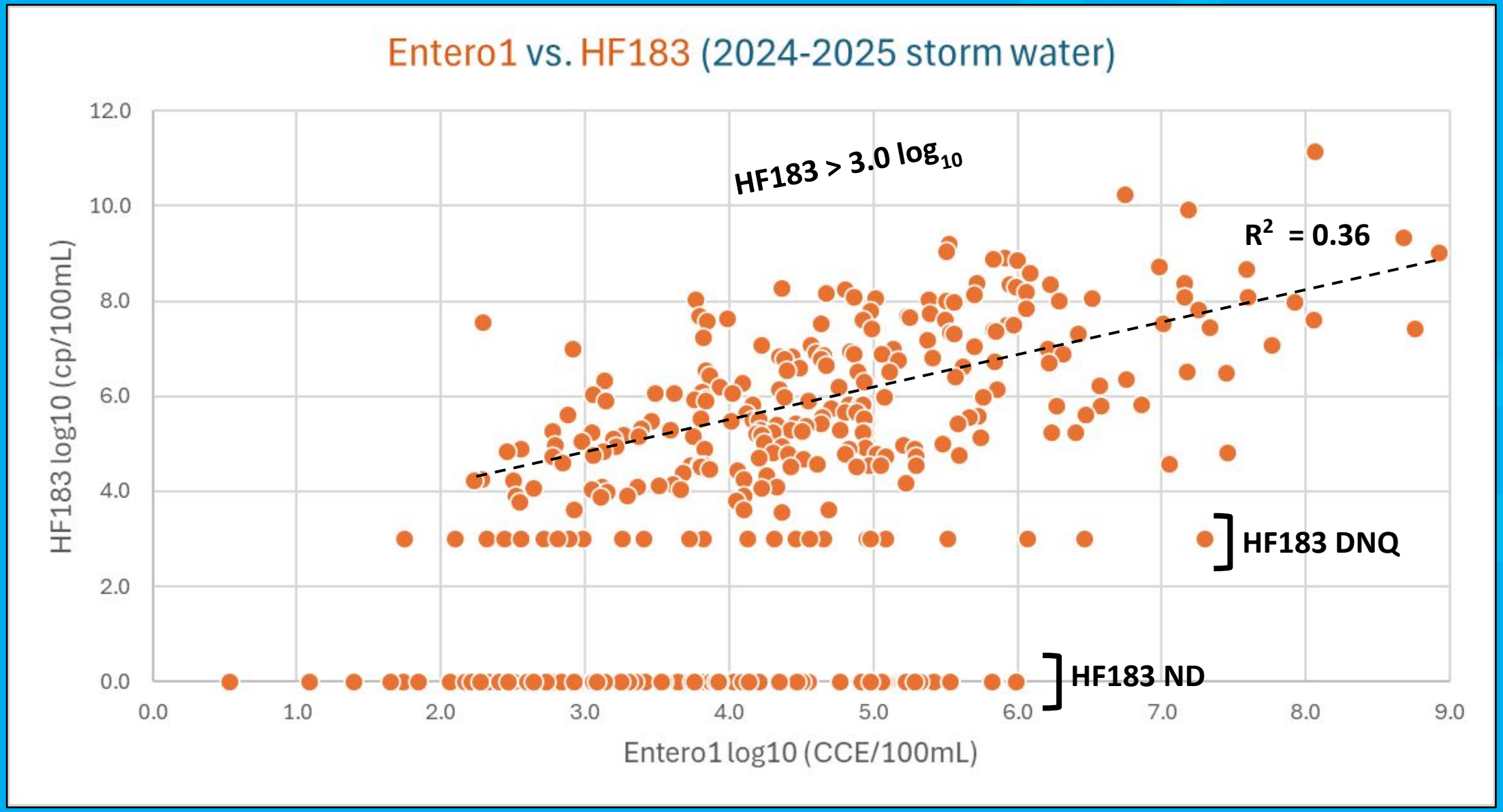
- Summer / Fall 2023
- 260 SS outfalls inspected
- 159 SS outfall samples collected (had base flow)
- 67/159 SSOs positive for HF183 (42%) (=25% of total SSOs)
- Categorize outfalls for investigation based on HF183 concentrations

| Priority | HF183 (copies/100 mL) | # |
|---|---|---|
| **High** | > $10^6$ | 12 |
| **Med** | $10^5$ – $10^6$ | 15 |
| **Low** | < $10^5$ | 39 |



> 1% sewage

# *Enterococcus* vs. HF183 in storm water

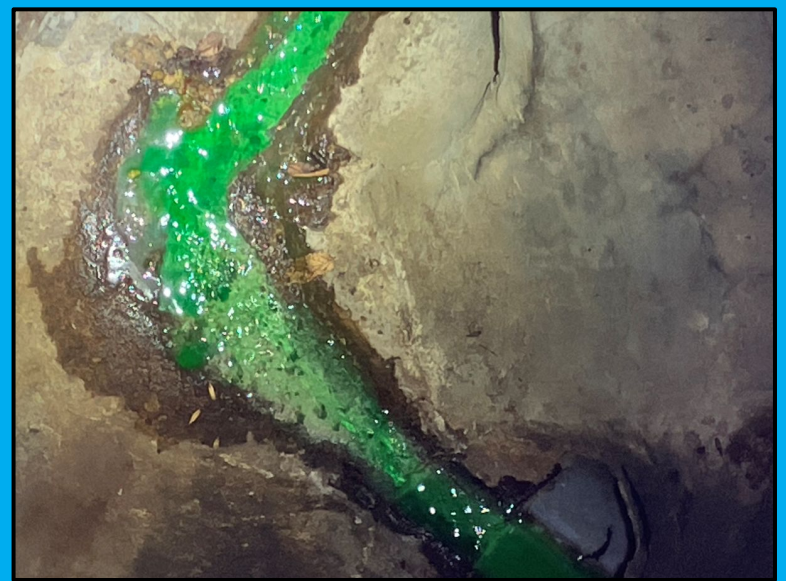


# Tracing a cross connection

- What can start an investigation?
  - odour complaints
  - visual observation of potential sewage during routine activities
  - high *E. coli* numbers
  - high HF183 at outfall
- Sample at upstream manholes at branches in network
- Screen samples by HF183 qPCR
- Use HF183 concentration to guide search area (to ~1 block area)
- Start dye testing building(s)
- When identified, send letter to property owner requesting remediation

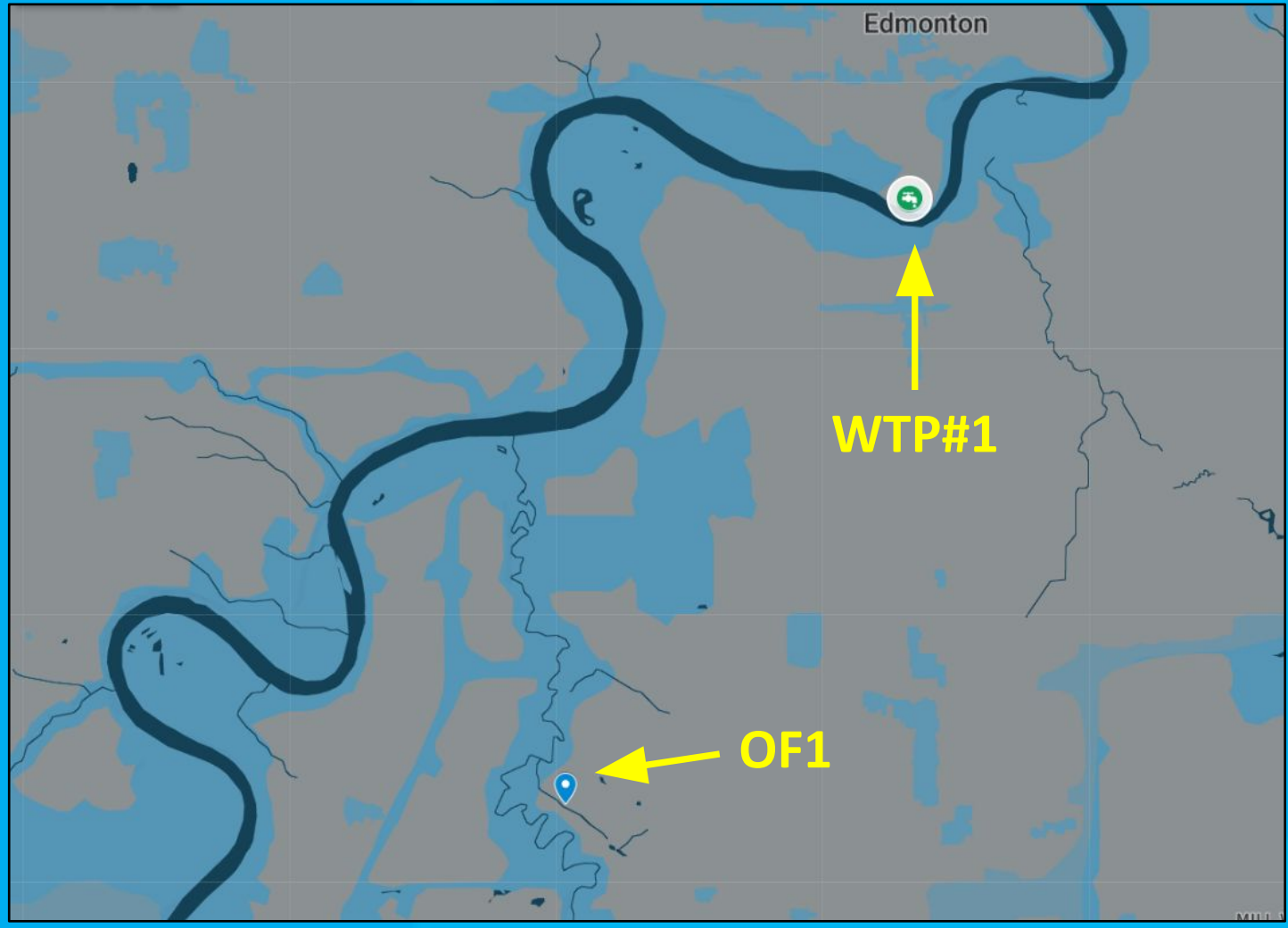
# Dye Testing

- Flush environ. safe dye(s) down toilets in premise
- Monitor storm and sanitary manholes outside
- Presence of dye in the storm MH is positive confirmation of a cross connection
- On private side, owner is responsible for repair



# Case Study #1

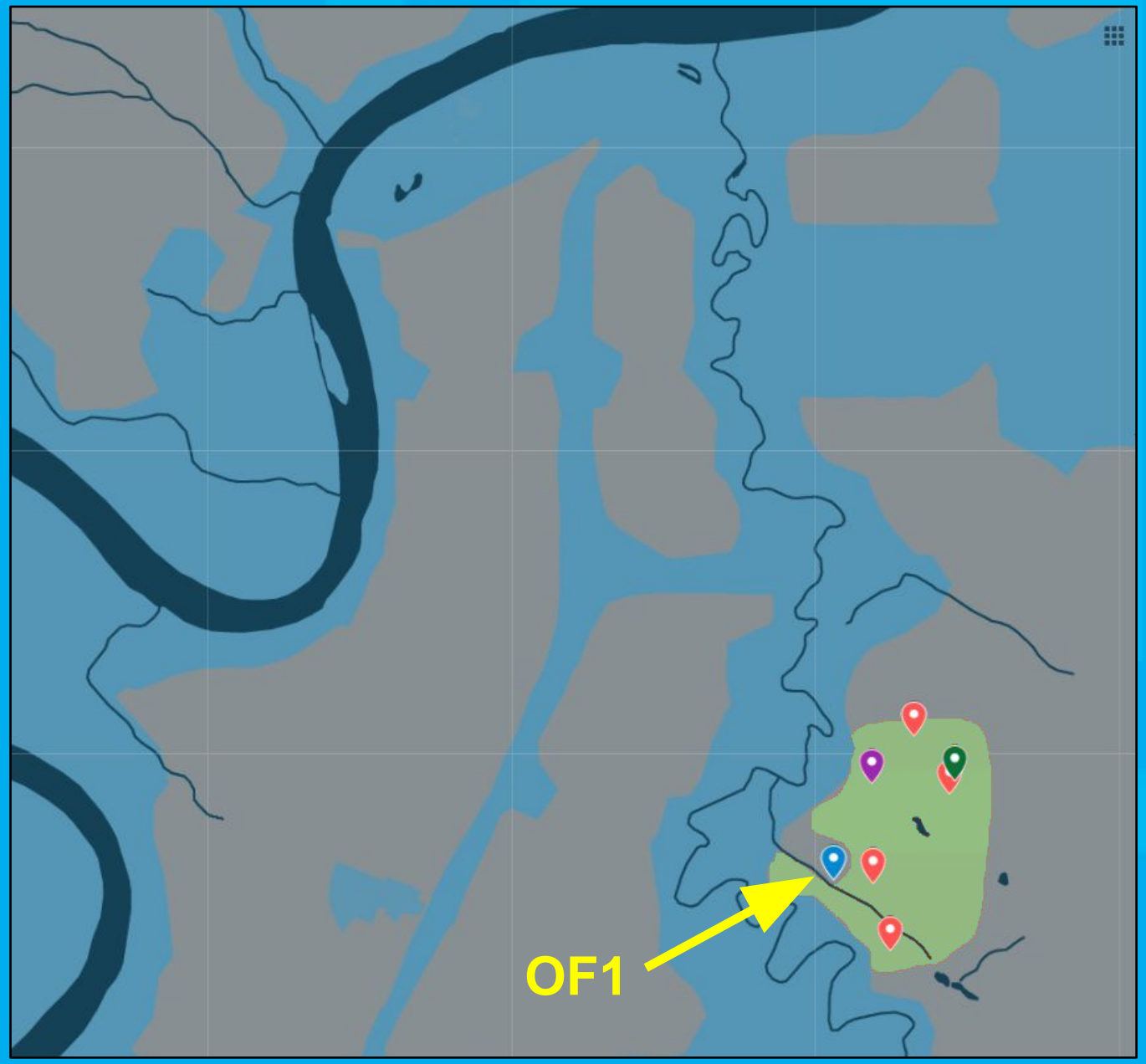
- OF1 drains into Whitemud Creek
- Network = 10.4 km of pipe (small)
- Some odour complaints while crew was collecting samples
- HF183 = $5.4x10^7$ cp/100mL
- ~30% sewage



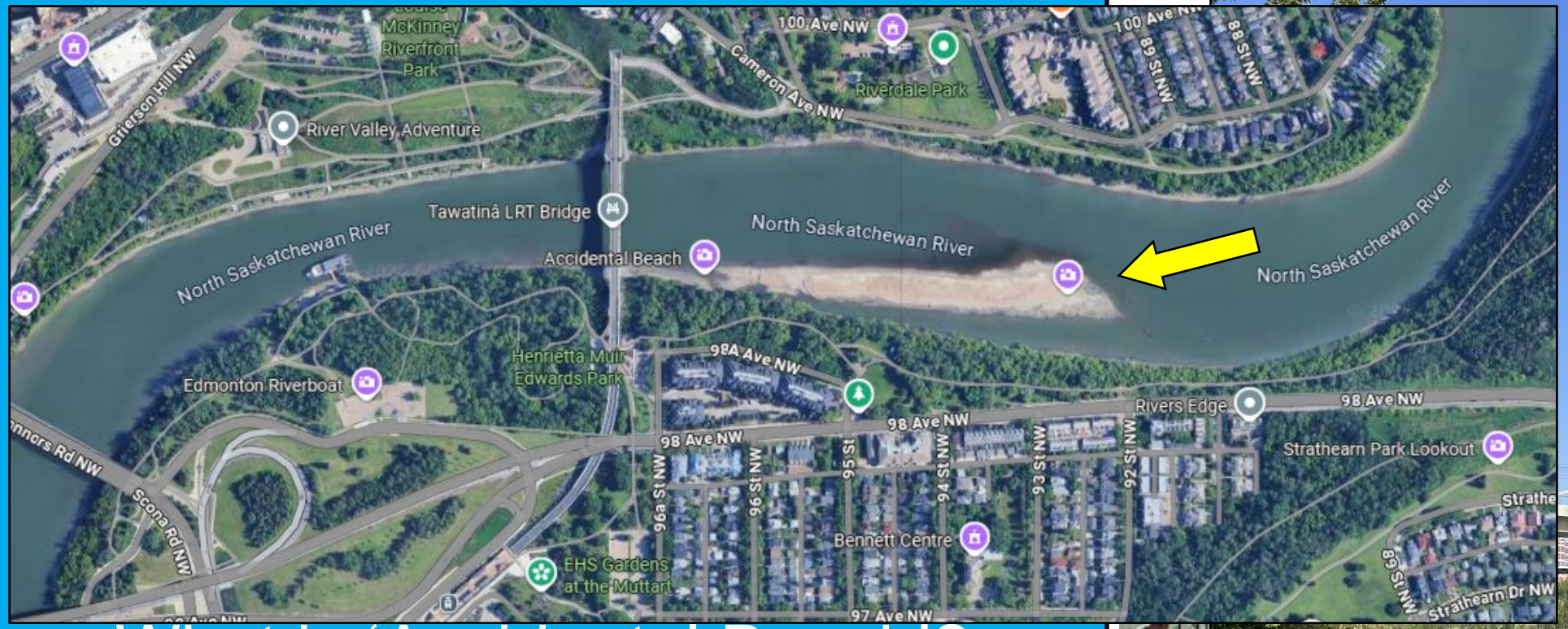

- Performed 83 dye tests in neighbourhood (~300 houses in network)

# Case Study #1

- 6 deficiencies identified:
- 1 set of broken services (green)
- 5 Xcons
  - 4 infills (red)
  - 1 original build (purple)
  - 500 g excreta/person/day x 4 people x 365 days x 48 years = ~35 tonnes
- 6/6 deficiencies fixed by July 2024




- Aug, 2025 – OF1 = $1.1 \times 10^8$ cp/100 mL (~20 new infills since 2024)




- What is ‘Accidental Beach’?

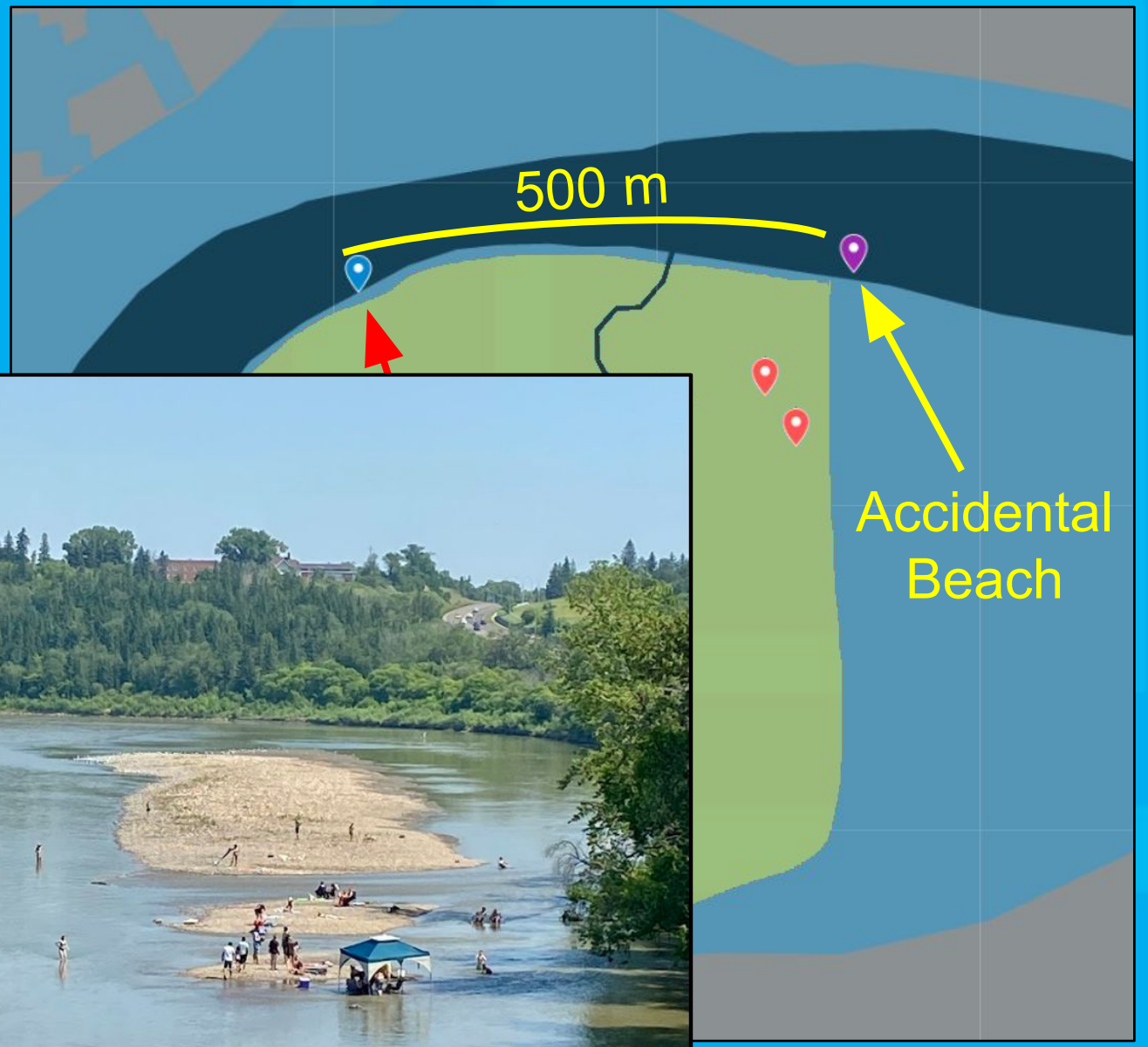
- Construction of LRT bridge pilings altered river flow
- Created sand bars in the river
- Not an official recwater beach

# Case Study #2

- 2.5 x$10^6$ cp/100 mL HF183 @ OF50

- Xcons identified in 2 different condo buildings

- 1 repaired in June, 2024
- 1 repaired Aug, 2025

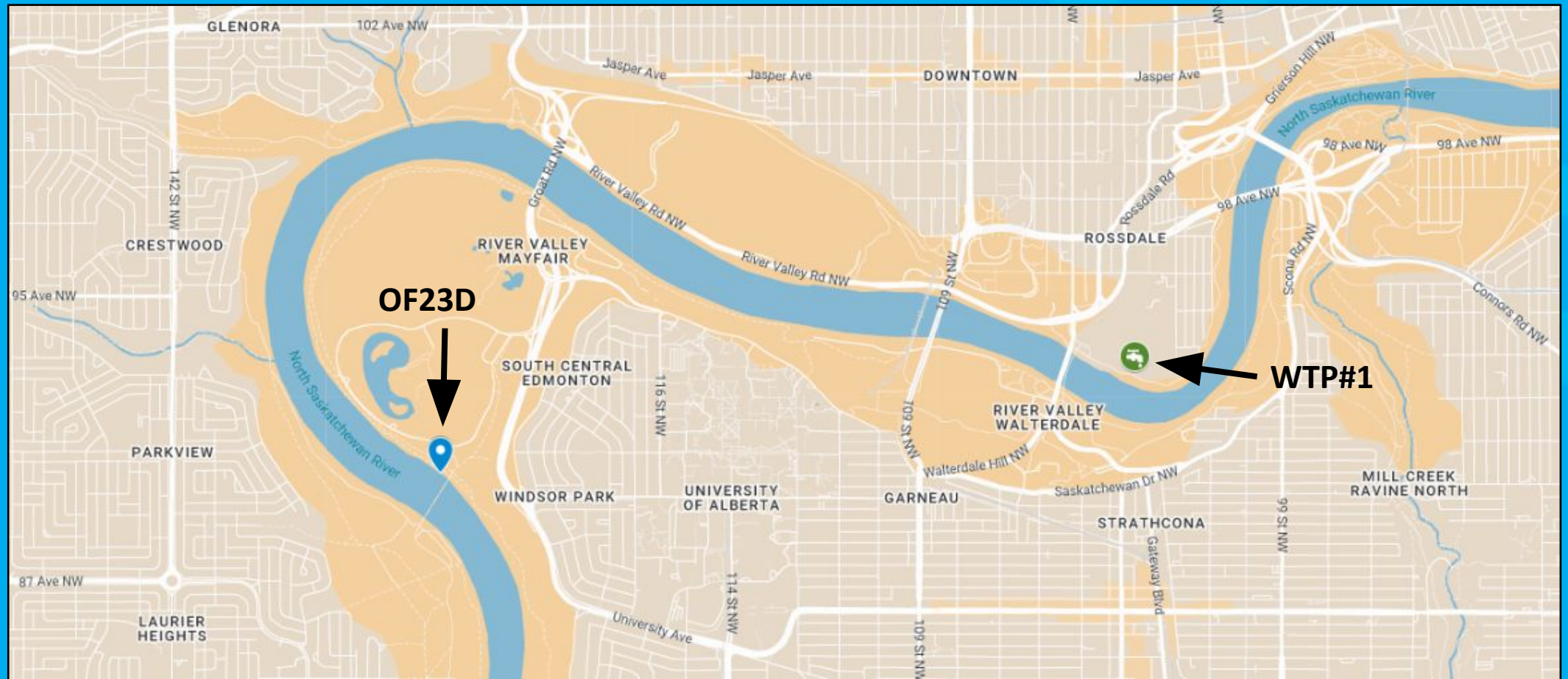




Accidental Beach, 2024

# Case Study #3

- OF23D
- ~5km upstream of WTP#1

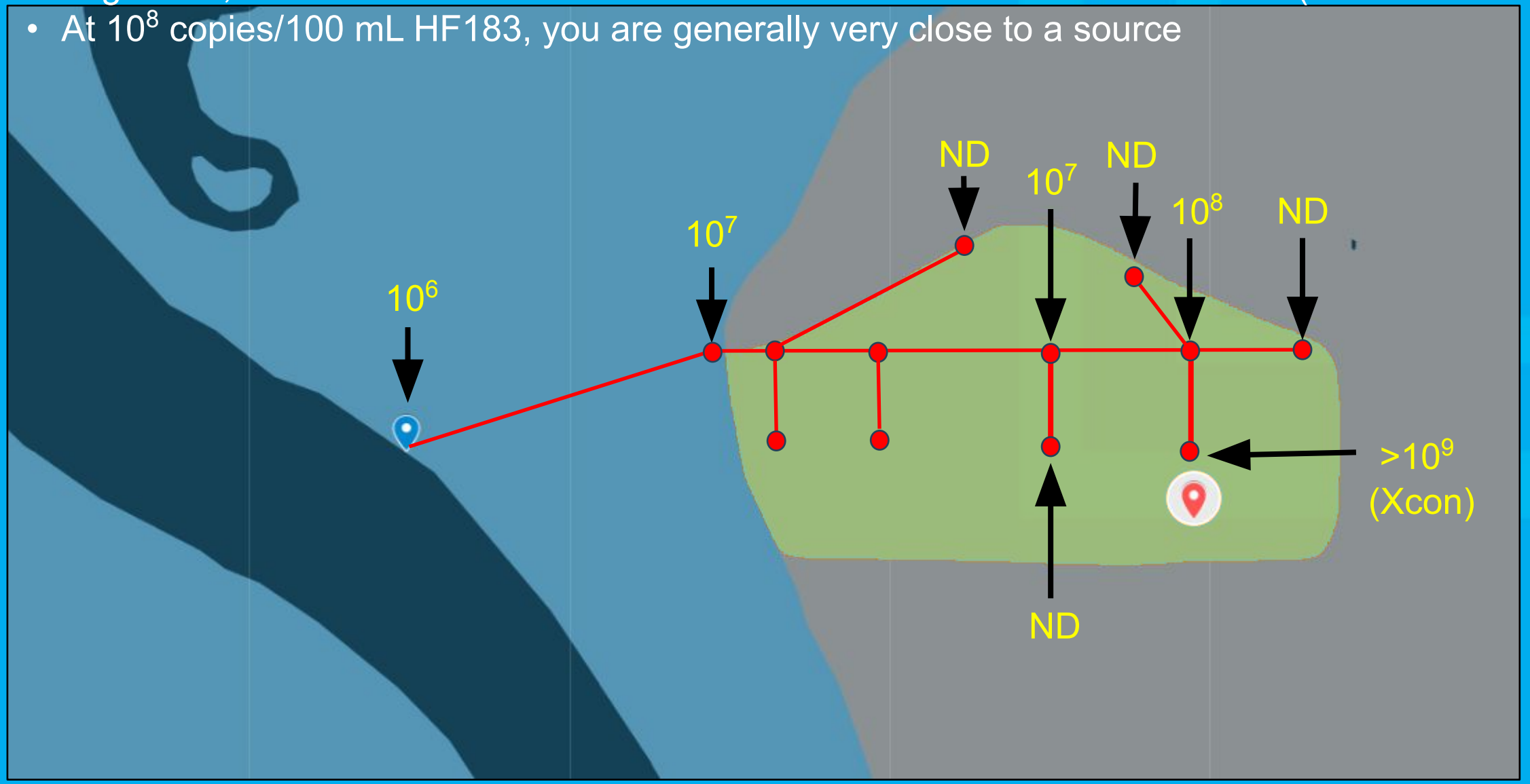


# Case Study #3

- OF23D = 11 km of pipe (small)
- HF183 @ 7.8 x$10^6$ cp/100 mL (~5% sewage)
- Xcon identified 1.1 km from outfall in 3 story condo complex

# Case Study #3

- In general, we see at least 100x increase of HF183 from outfall to the source (in small networks)
- At $10^8$ copies/100 mL HF183, you are generally very close to a source



# Case Study #3

- Storm MH on private side had visible sewage
- Restrictor plate kept most of the solids in MH
- Xcon in plumbing stack inside condo
- Repaired Nov, 2024


# The Numbers

- # of stormwater samples tested by PCR in 24 months = 663
- PCR inhibition rate = 2%
- cost per sample = ~$12 (supplies only)
- # of SSOs +ve for HF183 = 67/159 (42%)
- all samples +ve for HF183 = 399/663 (60%)
- # of Xcons identified in 24 months = 42 (= 20,000 – 30,000 kg/year of sewage)
- # of Xcons found from HF183 testing = 15 (36%)

# Summary

- HF183 qPCR testing gives confirmation of human sewage in stormwater
- HF183 qPCR has added a new tool to our investigation toolbox
- EPA Method 1611 that lacks DNA purification step keeps costs low
- PCR inhibition not a major issue if careful about volumes filtered (filter 2 – 20 mL max)
- PCR allows rapid screening of many samples to narrow down search for cross connections to a small area
- Majority of cross connections identified to date are in infill properties

# Acknowledgements


- EPCOR Industrial Wastewater Inspection team
- EPCOR Quality Assurance laboratory team


Thank You!