NJWEA - Fall Tech Transfer 2024 – Infiltration and Inflow

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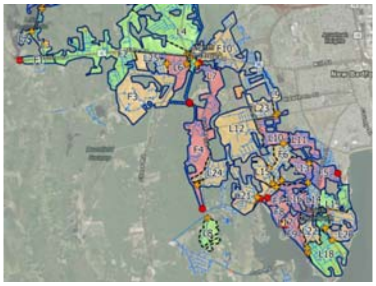

NJWEA 2024 Fall Technology Transfer Seminar

Locating and Quantifying I/I Economically and Rapidly Using Flow and Level Sensors

Town of Dartmouth, MA

Jessamyn Ingram, Assistant Engineer, Hazen & Sawyer

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Background

- Town of Dartmouth, Massachusetts
  - Population: 33,000
- Collection system built in the 1990s
- DPW observed signs of potential inflow and infiltration (I/I)
  - Increased sewer pump station runtimes after wet weather
  - Elevated flow at the wastewater treatment plant after wet weather

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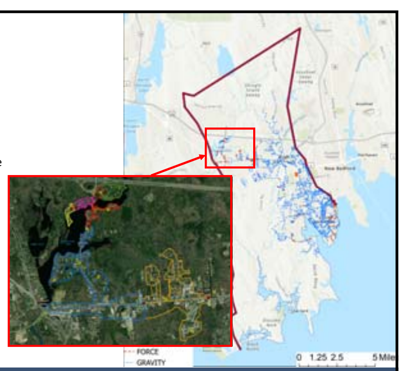
Background

- Two previous I/I studies performed in the Lake Noquochoke area
  - First study (2018) was inconclusive because of unusually dry weather
  - Second study (2019) showed some evidence of I/I but nothing considered "excessive"
- DPW continued to observe signs of I/I



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Project Goals

- Investigate the entire town
- Determine where I/I is occurring
- Quantify the amount of I/I present

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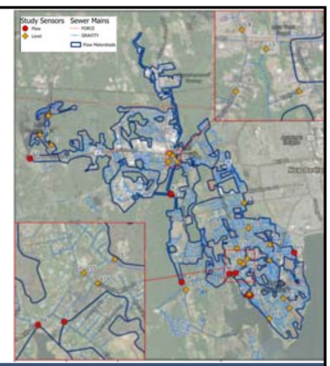
Approach

- To achieve cost-effective broad geographic coverage, Hazen developed a monitoring program that utilized both flow meters and level sensors
- One rain gauge was deployed at the town wastewater treatment plant
- Flow meters measured the volume of I&I occurring within a region of the system
- Flow metersheds were subdivided by level sensors
- Level sensors determine the probability of I/I sources existing in an area
- Flow meters and level sensors were deployed in two phases



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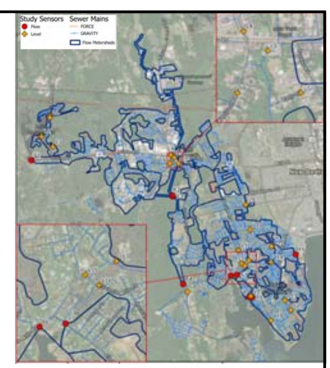
Monitoring Program: Phase 1 Configuration

- 9 flow meters
- 20 level sensors
- Deployed for 2.5 months (Feb – April 2024)
- 10 rain events occurred



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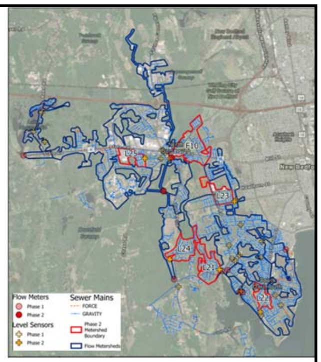
Monitoring Program: Phase 2 Configuration

- 1 flow meter
- 5 level sensors
- Deployed for 1 month (May 2024)
- 6 rain events occurred



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Rainfall – Phase 1

- Rain Event Definition:
  - Min 0.25in / 24 hr
  - 48 hr dry period between events
- All events less than 1-yr return period

Event No.	Start Date	Duration (hours)	Total Depth (inches)	Hourly Peak Intensity (in/hr)
1	2/15/2024	50.75	0.59	0.12
2	2/27/2024	27.25	1.7	0.36
3	3/2/2024	18.25	1.45	0.32
4	3/6/2024	28.25	1.43	0.72
5	3/9/2024	8.75	1.45	0.52
6	3/23/2024	14.5	1.55	0.52
7	3/27/2024	37.5	1.94	0.28
8	4/2/2024	125	2.45	0.48
9	4/11/2024	22.25	0.59	0.36
10	4/20/2024	31.5	0.32	0.24

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Rainfall – Phase 2

- Storm on May 15th was of high intensity

Event No.	Start Date	Duration (hour)	Total Depth (inches)	Hourly Peak Intensity (in/hr)
1	5/5/2024	12.25	0.48	0.16
2	5/8/2024	46.5	1.11	0.96
3	5/15/2024	73.25	5.26	0.96
4	5/23/2024	3	0.60	0.76
5	5/27/2024	4.25	1.24	1.24
6	5/30/2024	9.75	0.58	1.6

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Methodology

Rainfall Derived Inflow and Infiltration (RDII)

- "R-value" or "Capture Coefficient"
- Quantity of rainwater that enters the sewer system during rainfall
- ***R* > 5% indicates excessive RDII, R > 3% indicates medium response**

Peak Wet Weather Flow Ratio

- Highest flow during wet weather divided by the average dry weather daily flow
- **Higher numbers indicate more I/I response, but not normalized based on size**

Ground Water Infiltration (GWI)

- Infiltration that occurs during dry weather
- **> 4,000 GPD/IDM indicates excessive groundwater infiltration, >2,000 GPD/IDM indicates medium infiltration**

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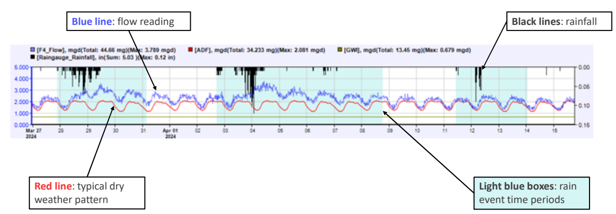
Data Analysis



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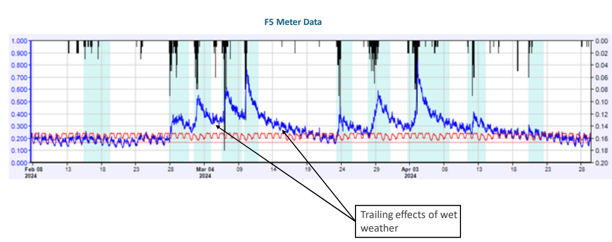
Data Analysis – Storm Definition



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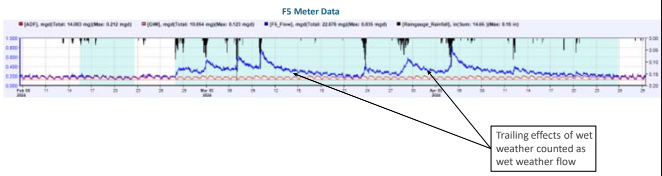
Data Analysis – Capturing Extended Responses



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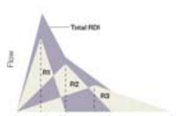
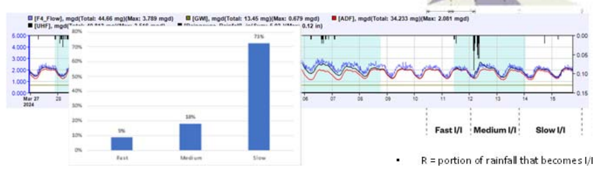
Identification of Potential I/I Sources Based on Response Time

- The distribution of I/I by response time was analyzed for each flow meter
- How quickly a metershed responds to wet weather is correlated to the predominant sources of I/I within the region





- R = portion of rainfall that becomes I/I
- T = Time to peak inflow
- K ~ Length of response

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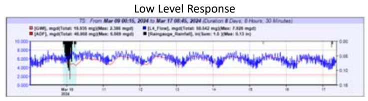
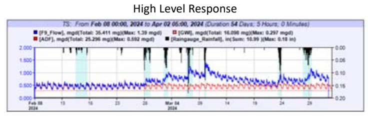
Level Sensor Analysis

- Regional level response to wet weather indicates where I/I is most likely to occur
- Probability categories (low, medium, high) do not consider I/I volume

Low Level Response



High Level Response



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Results: I&I Metrics

Capture Coefficient: >3% is medium, >5% is high
GPD/IDM: >2000 is medium, >4000 is high

Meter	Capture Coefficient	GPD/IDM	Wet Weather Peak Ratio	I/I Intensity Category
F1	0.6%	1481	4.66	Low
F2	1.4%	1469	2.01	Low
F3	2.8%	2324	2.45	Medium
F4	5.1%	0	25.88	High
F5	14.2%	4947	3.60	High
F6	3.8%	1015	4.73	Medium
F7	6.5%	5133	13.77	High
F8	6.3%	1918	3.24	High
F9	3.8%	2266	2.53	Medium
F10	0.88%	2609	1.80	Medium

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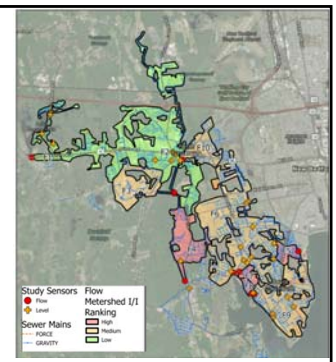
I/I Ranking by Flow

- I/I volume categories determined as shown on the previous slide
- Southern regions of the town generally have more wet weather response



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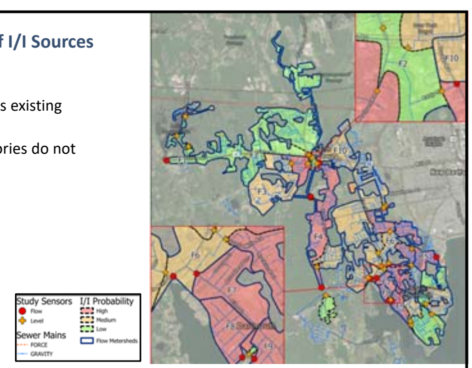
Regional Probability of I/I Sources Existing

- Probability of I&I sources existing based on level data
- These probability categories do not consider I/I volume



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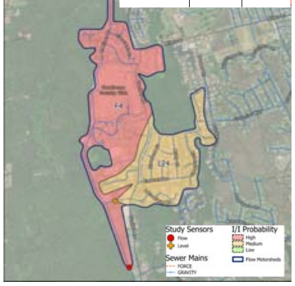
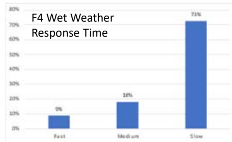
Wet Weather Response: Flow Metershed F4

Average Wet Weather Peak Ratio	Capture Coefficient	GPD/IDM (NET)
25.88	5.1%	0





Primary sources of I/I in F4 are slow responding to wet weather, indicating sources such as sump pumps and broken pipes.

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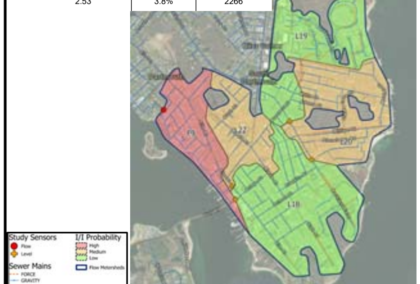
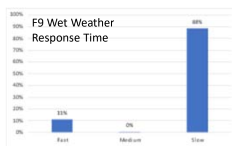
Wet Weather Response: Flow Metershed F9

Average Wet Weather Peak Ratio	Capture Coefficient	GPD/IDM (NET)
2.53	3.8%	2266





Primary sources of I/I in F9 are slow responding to wet weather, indicating sources such as sump pumps and broken pipes, with some fast-responding sources, indicating sources such as catch basins or area drains.

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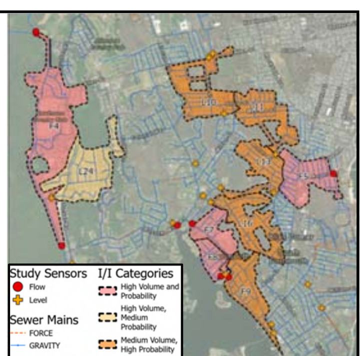
Priority Regions for Further Study

- 10 sub-regions are of high priority for further efforts due to their wet weather responses
- The high-priority areas include approximately 30 miles of sewer pipes, 20% of the Town's system



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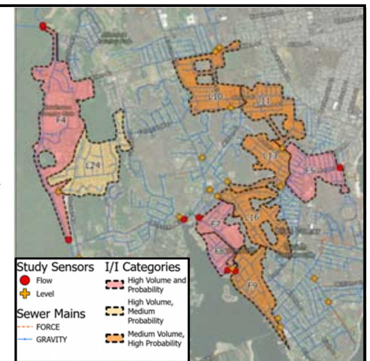
Priority Regions for Further Study

- In all 10 high-priority regions, I/I predominantly responds slowly to wet weather
- Slow I/I response to wet weather indicates the most important sources of I/I in these regions are likely to be:
  - Sump pump connections
  - Infiltration into pipe or manhole defects



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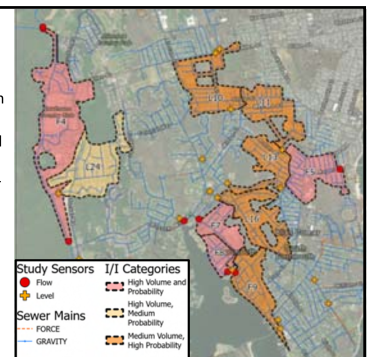
Next Steps in Priority Regions

- Building inspections to locate illicit drain connections (including sump pumps).
- CCTV inspection of sewers to locate and quantify defects.
- Sewer smoke testing to locate improper connections from roof drains, catch basins, etc.
- Dye testing of roof drains, catch basins, etc. to locate improper connections.



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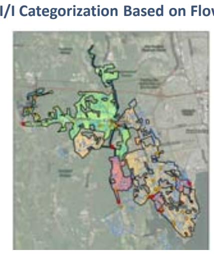
I/I Categorization Based on Flow



High or Medium I/I regions make up:

- 80 miles of pipe
- Two thirds of the town's system

I/I Priority Regions Based on Flow & Level

Priority regions make up:

- 30 miles of pipe
- 20% of the town's system

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Takeaways

- Determining meter locations is critical to project success
  - Collaborating with the asset owner is very helpful to learn about areas of interest
  - Operators usually have regional insights about signs of I/I (pump station runtimes, nuisance flooding reports, etc)
- Combining level and flow data allows us to cover a wide area geographically with level sensors but have I/I metrics and flow volumes that can only be reliably calculated with flow meters
- Having town-wide data from a single study gives a complete picture, as compared to several smaller investigations over multiple years

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Questions

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Acknowledgments:

Tim Barber, DPW Director, Town of Dartmouth
Sandie Waterman, DPW Assistant Director, Town of Dartmouth

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