Using A Hydraulic Model To Identify Inflow Into The Sanitary Sewer System

1

LOUIS C. LAMBE

- Passaic Valley Sewerage Commission, 1988 – Present (36+ Years)
- BS in Civil Engineering from NJIT
- Licensed Collection System Operator, C- 4
- Teacher of Advanced Wastewater Collection Systems
- Civil Engineer / Wastewater Professional
- New Jersey Water Environment Association - Senior Delegate
- Co-Author on two Operator Training Manuals

2

OUTLINE FOR DISCUSSION

- PVSC Flow Metering
- Conversion to Paperless Recorders
- Hydraulic Model vs Observed Flow
- Belleville Discovery
- East Orange Revelation
- Questions and Discussion

3

PVSC Flow Metering System

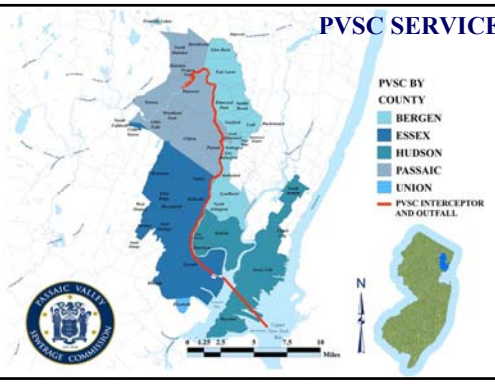
4

WHY PVSC MEASURES FLOW?

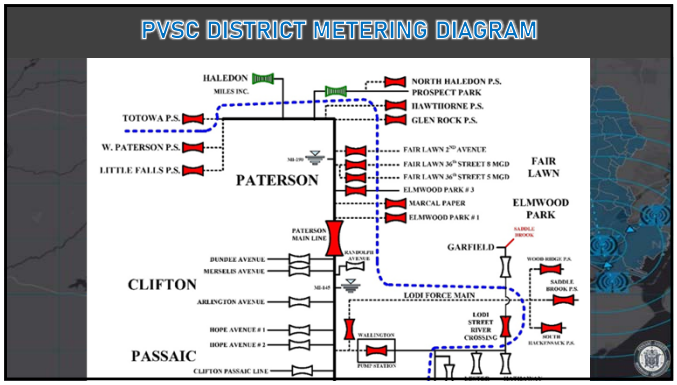
- Accurate & Fair User Charge Billing
- Planning & Construction
- Infiltration & Inflow (I&I) Analysis
- Modelling Our Network
- Model Calibration

5

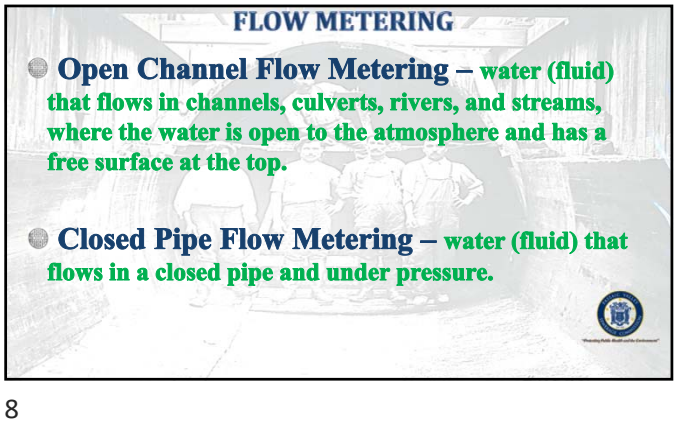
PVSC SERVICE AREA



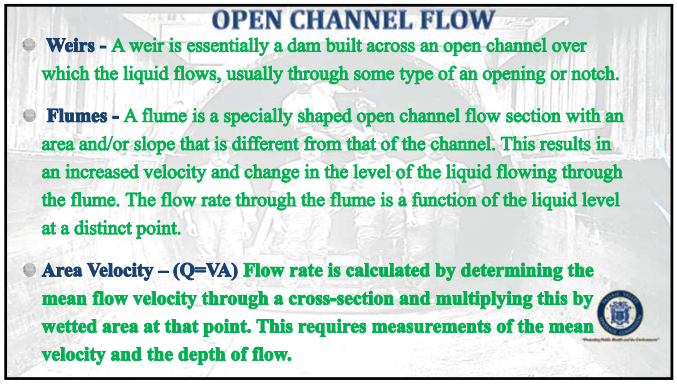
6


PVSC DISTRICT METERING DIAGRAM
HALEDON
MILES INC.
TOTOWA P.S.
W. PATERSON P.S.
LITTLE FALLS P.S.
PATERSON
NORTH HALEDON P.S.
PROSPECT PARK
HAWTHORNE P.S.
GLEN ROCK P.S.
FAIR LAWN 2ND AVENUE
FAIR LAWN 36TH STREET 8 MGD
FAIR LAWN 36TH STREET 5 MGD
ELMWOOD PARK # 3
MARCAL PAPER
ELMWOOD PARK # 1
FAIR LAWN
ELMWOOD PARK
GARFIELD
CLIFTON
DUNDEE AVENUE
MERSELIS AVENUE
ARLINGTON AVENUE
LODI FORCE MAIN
LODI STREET RIVER CROSSING
HOPE AVENUE # 1
HOPE AVENUE # 2
PASSAIC
CLIFTON PASSAIC LINE

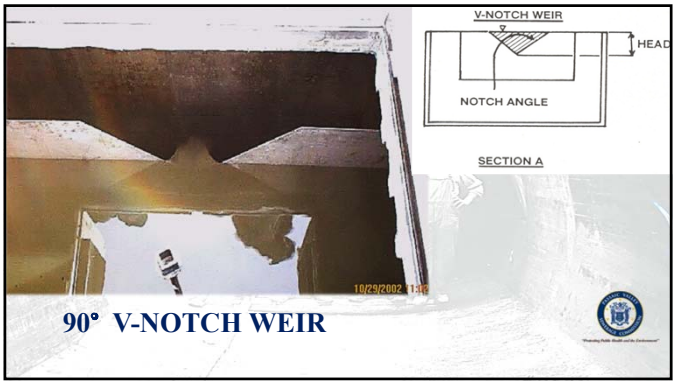
7


FLOW METERING
Open Channel Flow Metering – water (fluid) that flows in channels, culverts, rivers, and streams, where the water is open to the atmosphere and has a free surface at the top.
Closed Pipe Flow Metering – water (fluid) that flows in a closed pipe and under pressure.

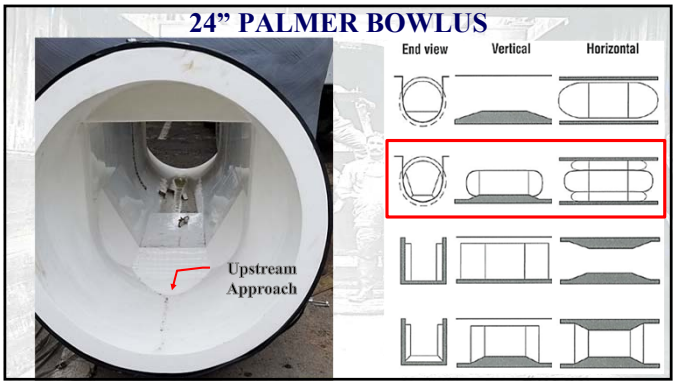
8


OPEN CHANNEL FLOW
Weirs - A weir is essentially a dam built across an open channel over which the liquid flows, usually through some type of an opening or notch.
Flumes - A flume is a specially shaped open channel flow section with an area and/or slope that is different from that of the channel. This results in an increased velocity and change in the level of the liquid flowing through the flume. The flow rate through the flume is a function of the liquid level at a distinct point.
Area Velocity – (Q=VA) Flow rate is calculated by determining the mean flow velocity through a cross-section and multiplying this by wetted area at that point. This requires measurements of the mean velocity and the depth of flow.

9


V-NOTCH WEIR
HEAD
NOTCH ANGLE
SECTION A
90° V-NOTCH WEIR

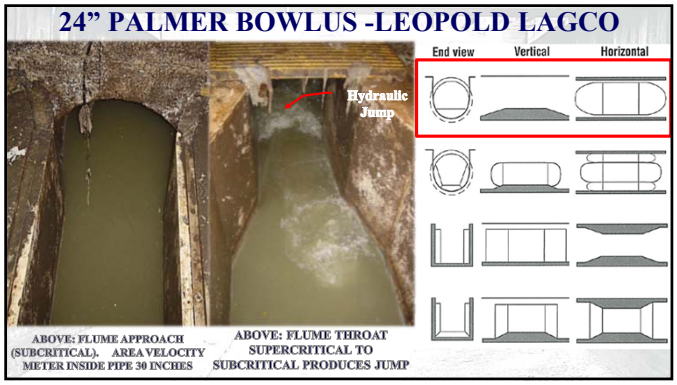
10


24" PALMER BOWLUS
End view
Vertical
Horizontal
Upstream Approach

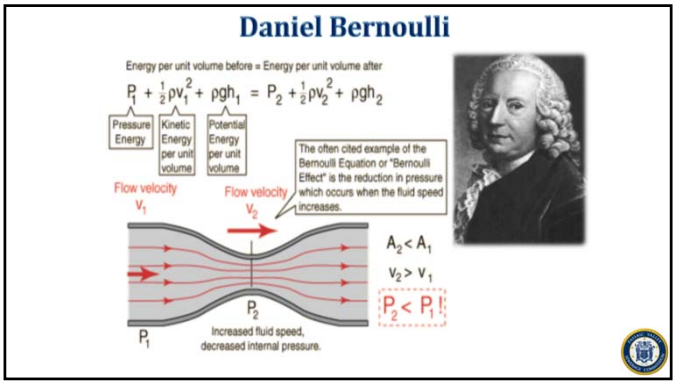
11


24" PALMER BOWLUS
William Street
Upstream Approach
Flow

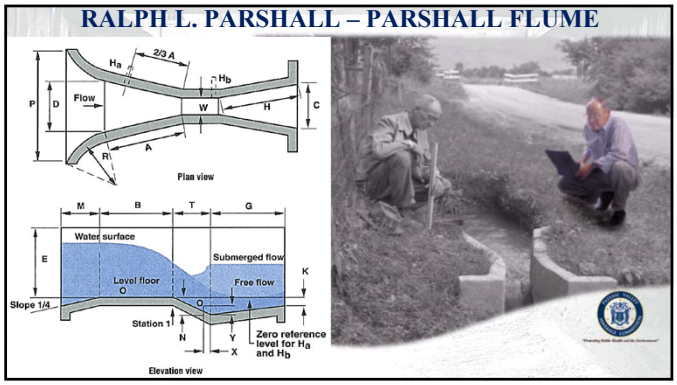
12



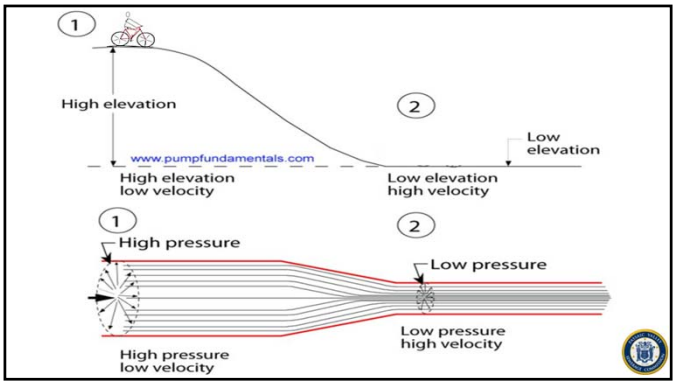
13



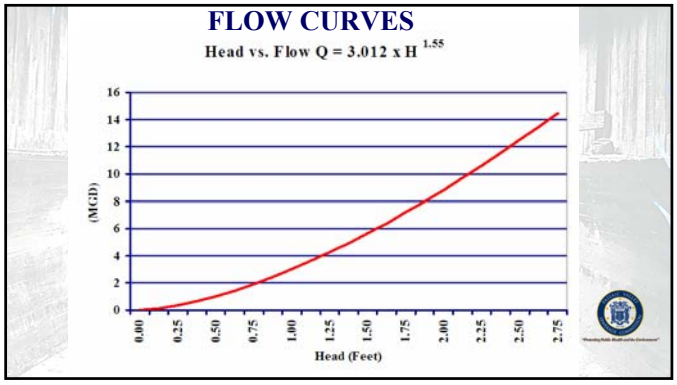
16



14



17



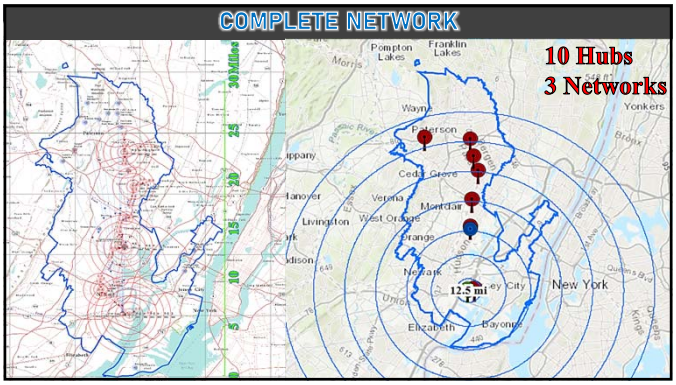
15

18

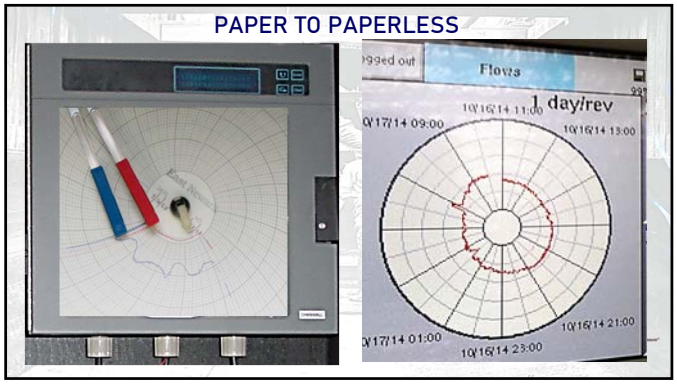
19

22

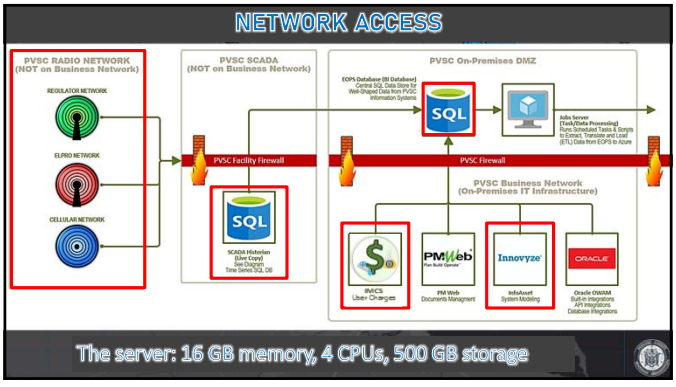
20



23

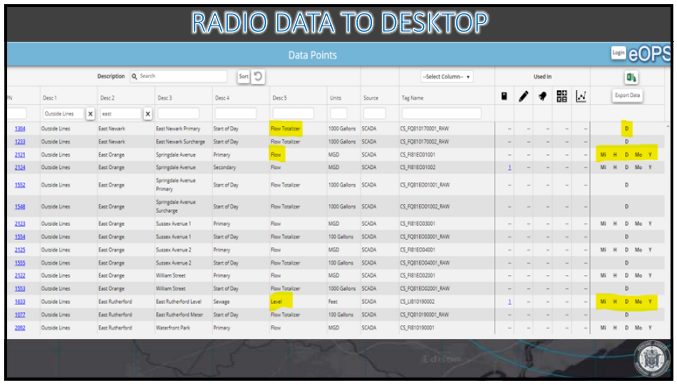


21

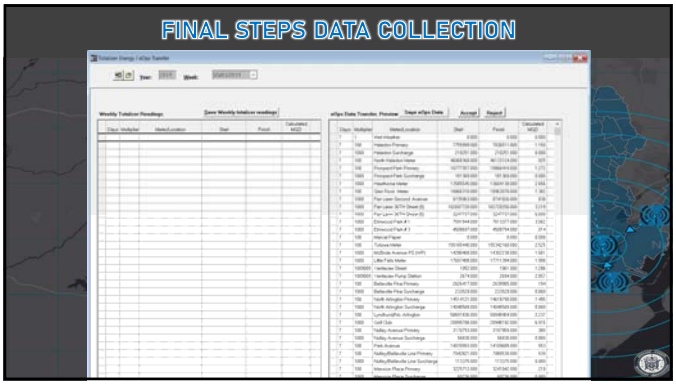


24

NJWEA - Fall Tech Transfer 2024 – Infiltration and Inflow

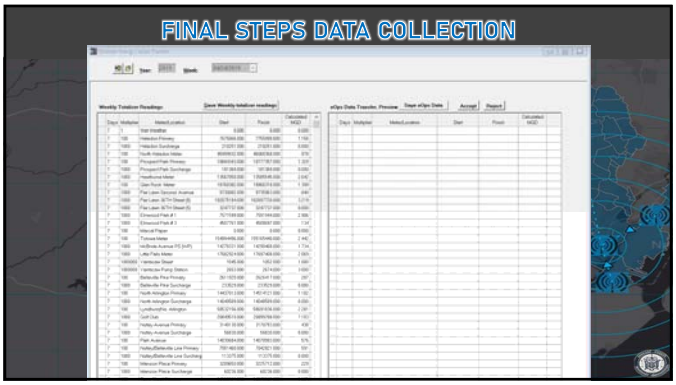


25

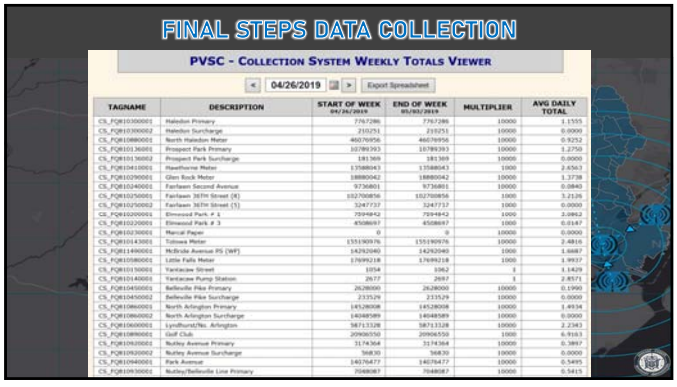


28

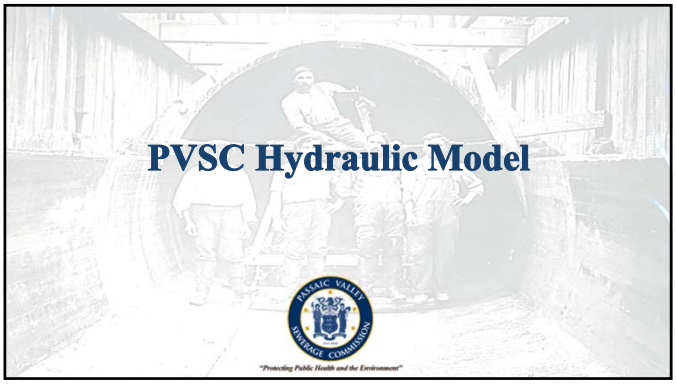
26



29



27



30

NJWEA - Fall Tech Transfer 2024 – Infiltration and Inflow

PVSC Hydraulic Model

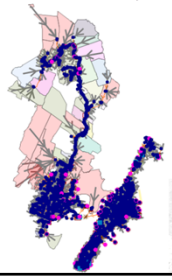
- 10/15/2020 Kick Off Meeting with Innovyze
- Original Model Built for Long Term Control Plan (2015)
- Sites aggregated for simplicity (1 curve) disaggregated
- Adapt Model for specific purpose and diverge from LTCP
- Connect eOPS Data To ICM Live Model (SmartCover)
- First Results March of 2021

31

Disaggregate Combined Curves

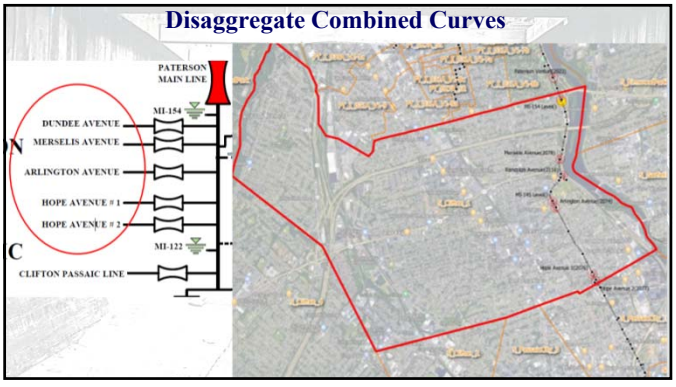
The following metering sites, the flows are monitored in several pipes. For these, both the individual and combined flow will be compared in the model. (TODO: add the combined TVD)

Diagram	meter1	meter 2	meter3
SECOND RIVER	2014	2015	2016
PASSAIC CHAMBER	2021	2022	
Fairlawn 36th St	2097	2098	
SOUTH KEARNY P.S.	2024	2027	



32

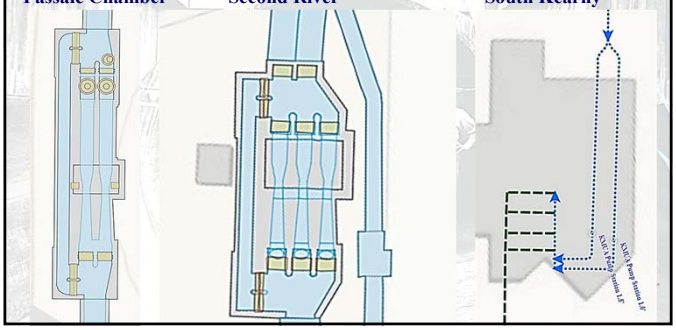
Disaggregate Combined Curves



33

Disaggregate Combined Curves

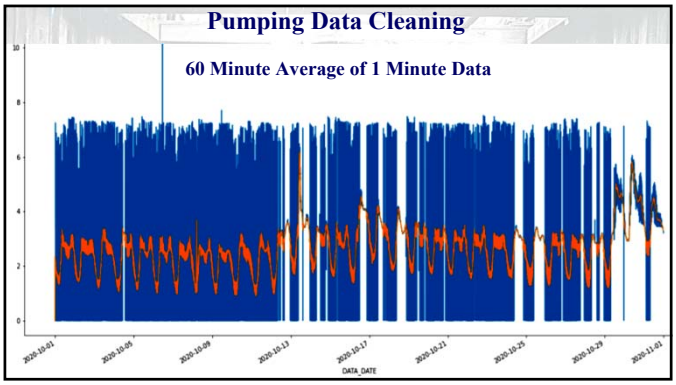
Passaic Chamber | Second River | South Kearny



34

Pumping Data Cleaning

60 Minute Average of 1 Minute Data

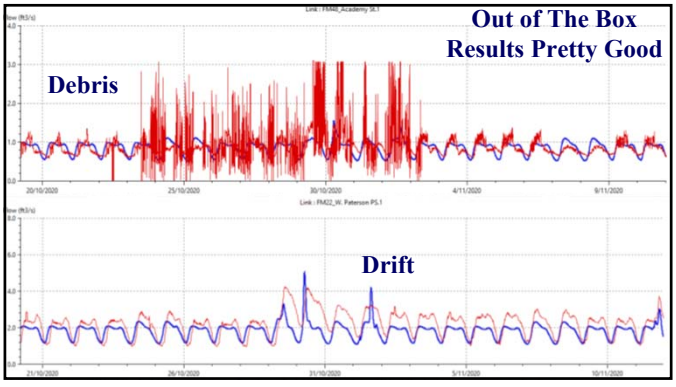


35

Out of The Box Results Pretty Good

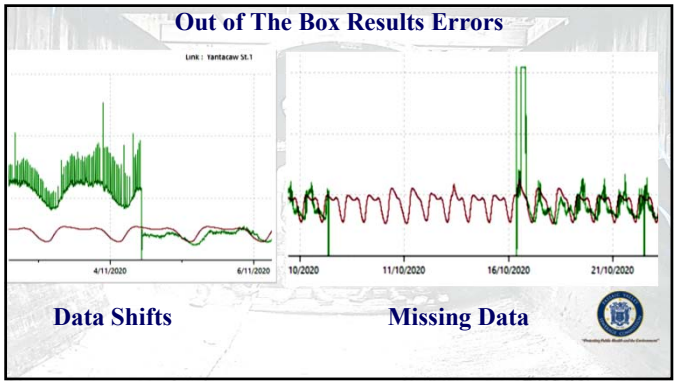
Debris

Drift

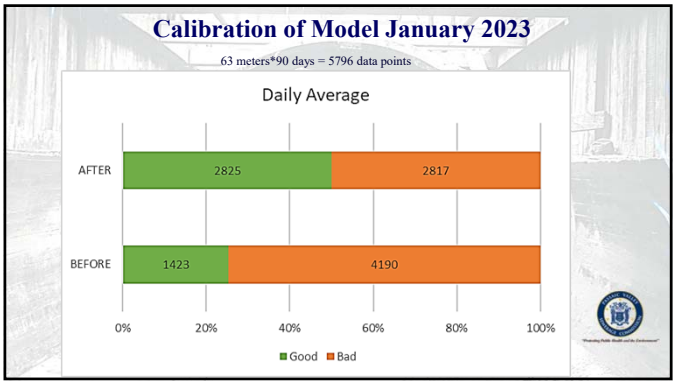


36

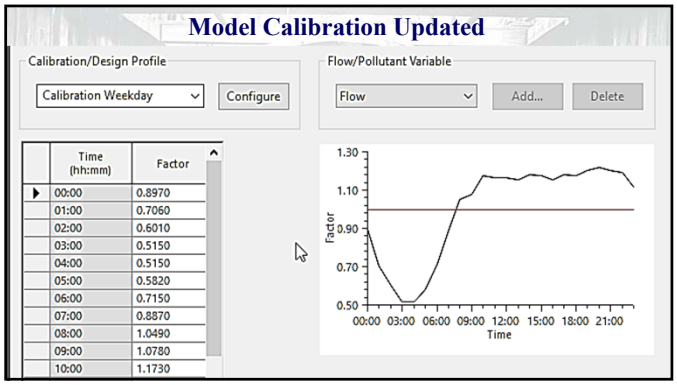
NJWEA - Fall Tech Transfer 2024 – Infiltration and Inflow



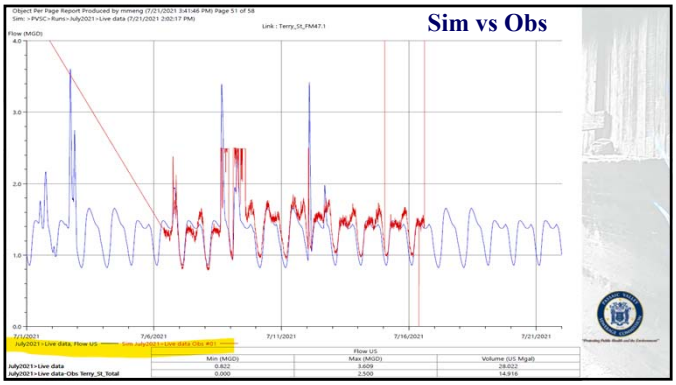
37



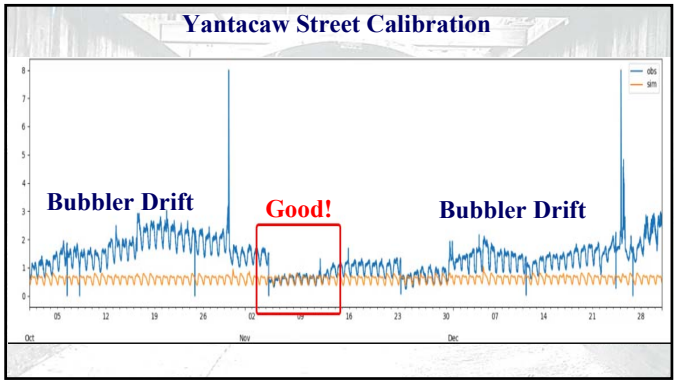
40



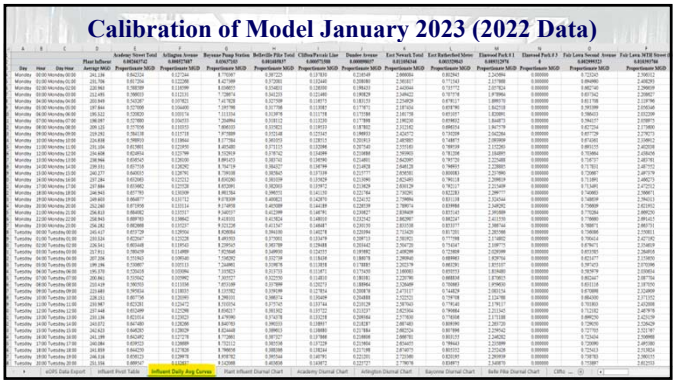
38



41



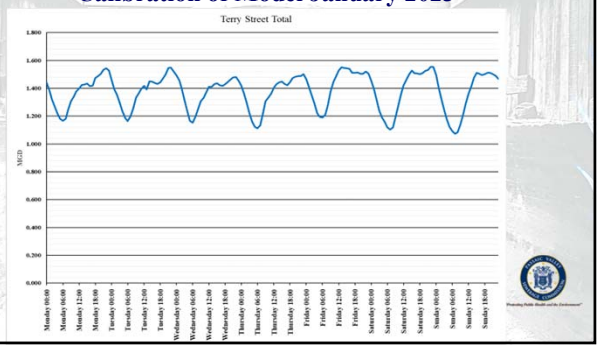
39



42

NJWEA - Fall Tech Transfer 2024 – Infiltration and Inflow

Calibration of Model January 2023



43

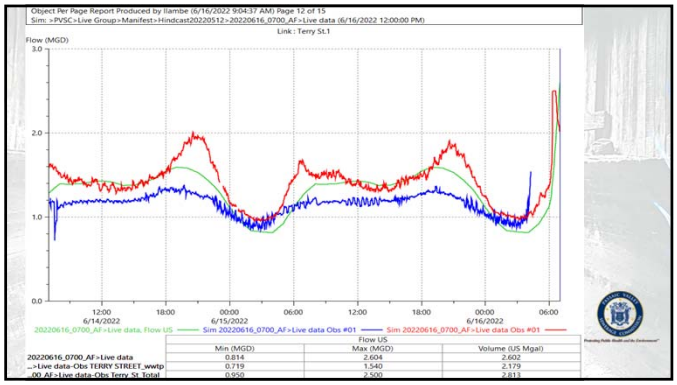
CMOM REMINDER

CMOM = "Capacity Assurance, Management, Operations, & Maintenance"

~ is a flexible, dynamic framework for municipalities to identify and incorporate widely accepted wastewater industry practices to:

1. **Better manage, operate, and maintain collection systems**
2. **Investigate capacity constrained areas of your system**
3. **Respond to sanitary sewer overflow (SSO) events**
4. **Proactively prevent sanitary sewer overflows**

46



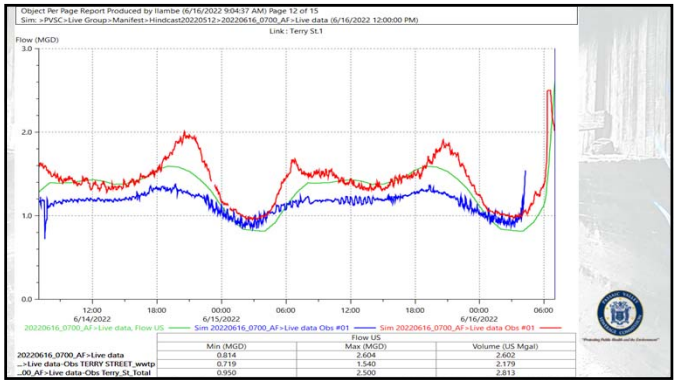
44

SYSTEM CAPACITY EVALUATION

The system operator should have a program in place to:

1. **Periodically evaluate the capacity of the sewer system in both wet and dry weather flow**
2. **Ensure the capacity is maintained as it was designed.**
3. **Identify the location of wet weather related SSOs, surcharged lines, basement backups, and any other areas of known capacity limitations**

47



45

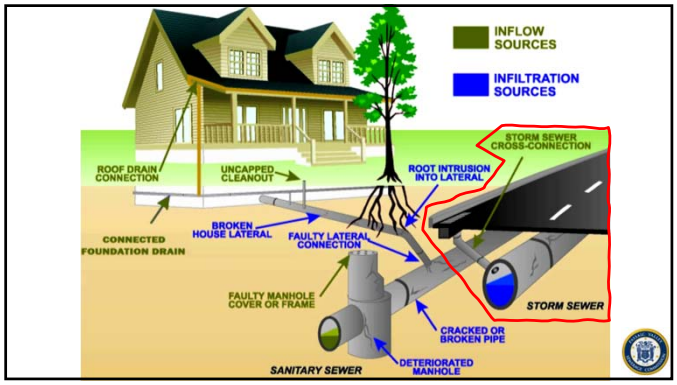
SYSTEM CAPACITY EVALUATION

System Operator should have a program to evaluate the capacity of the sewer system in both wet and dry weather flow:

1. **Water vs Wastewater Relationship**
2. **Dry vs Wet Weather Flow Comparison**
3. **Observed Flow vs Modeled Flow**

48

NJWEA - Fall Tech Transfer 2024 – Infiltration and Inflow



49

Part III – Regulations Concerning Industrial Users

Passaic Valley Sewage Commission

SUBPART 2 – Pretreatment Regulations

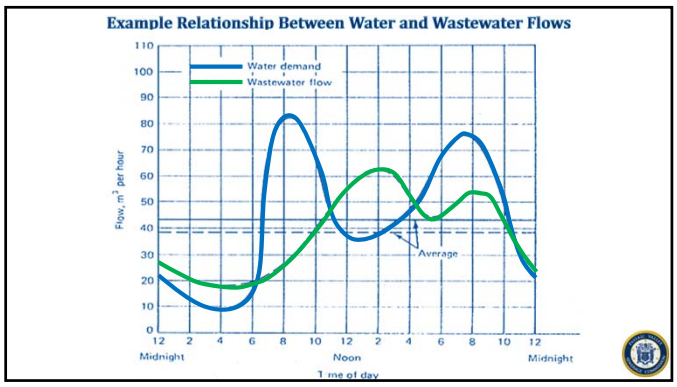
SECTION 312 – Prohibited Industrial Wastes

312.1

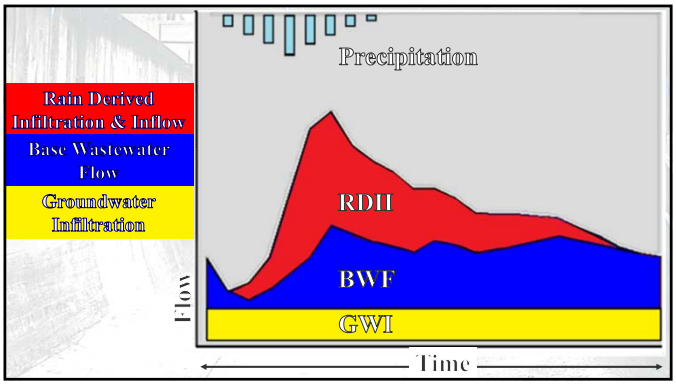
No Person shall discharge or deposit or cause or allow to be discharged or deposited into the Treatment Works or public sewer, the following:

(p) Stormwater - Any stormwater, whether contaminated or uncontaminated, unless specifically authorized by PVSC in accordance with Sections 301, 303 and 602 of these Rules and Regulations.

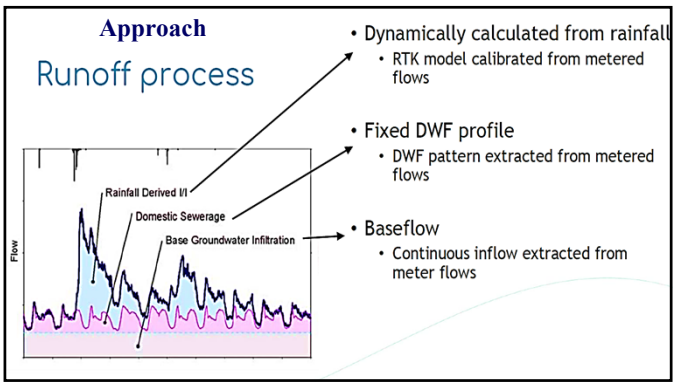
50



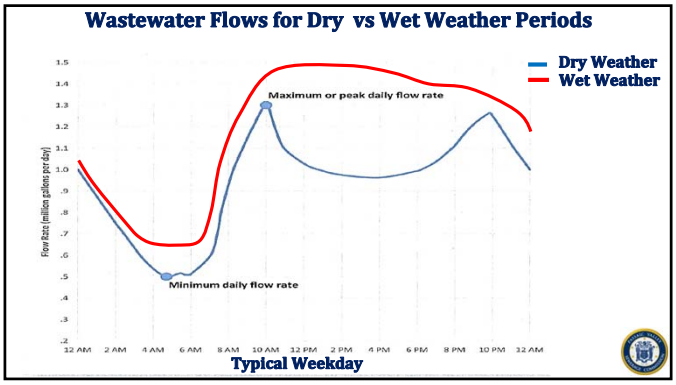
51



53

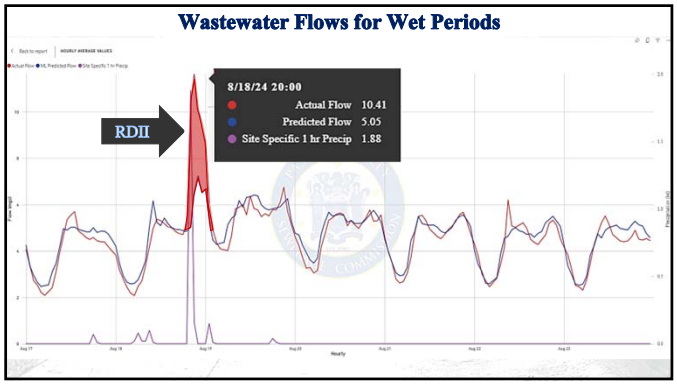


54

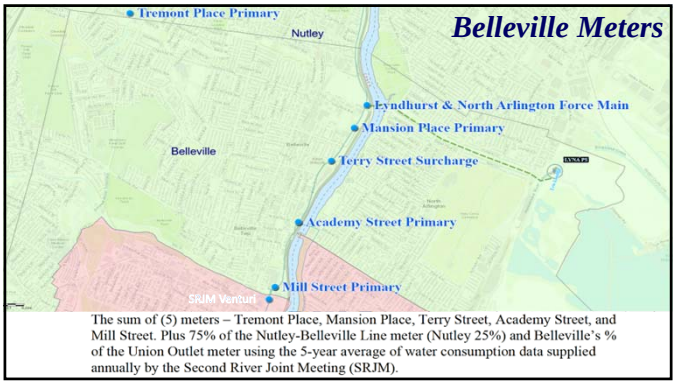


52

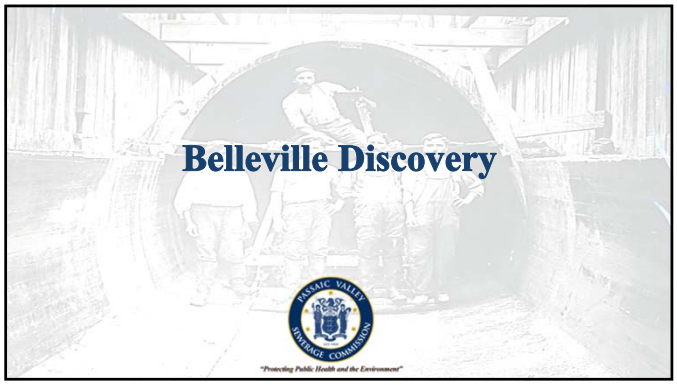
NJWEA - Fall Tech Transfer 2024 – Infiltration and Inflow



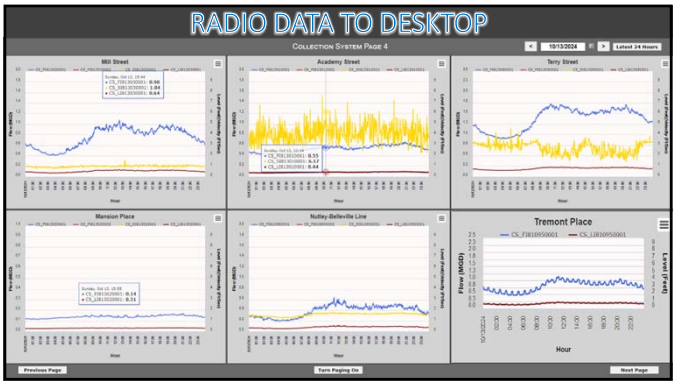
55



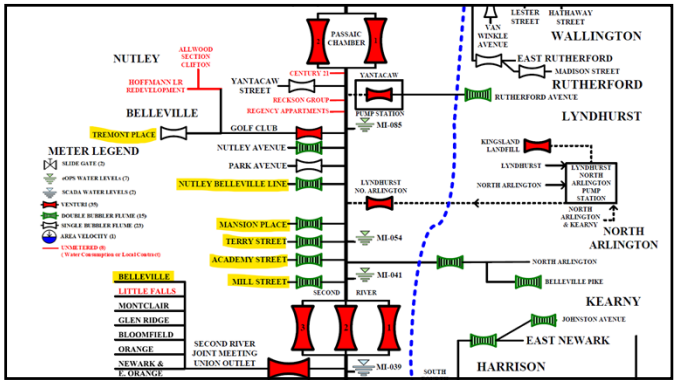
58



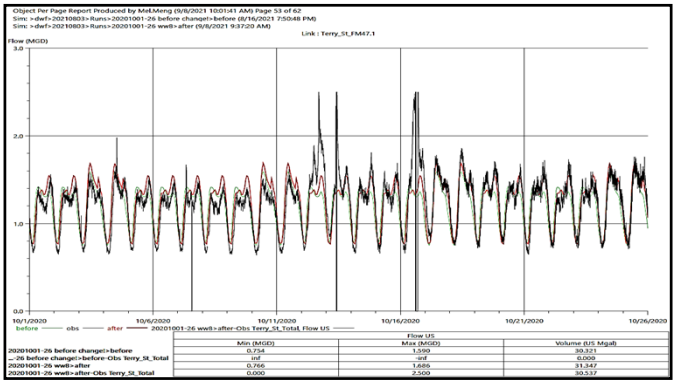
56



59

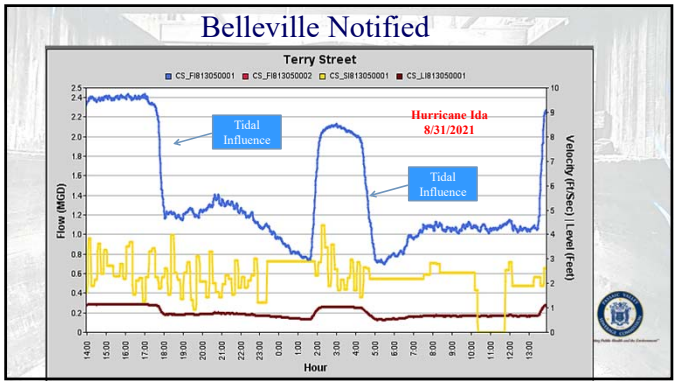


57

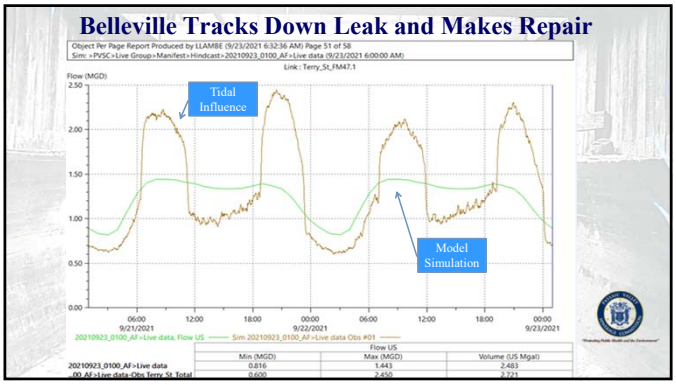


60

NJWEA - Fall Tech Transfer 2024 – Infiltration and Inflow



61



64

Problem Is Back Notified Belleville

The graph below is your actual flow pattern compared to the model simulation for the last two days. Green is simulated data and the brown is observed data. Everything above the green line is extraneous flow which is costing Belleville money. At peak, there is about a 1 MGD delta. Over the coarse of 6 hours per tide or 12 hours per day this equates to about ½ a million gallons per day being charged to Belleville. In dollars, this could cost you approximately $5,200 per week over what you would normally be billed.

62

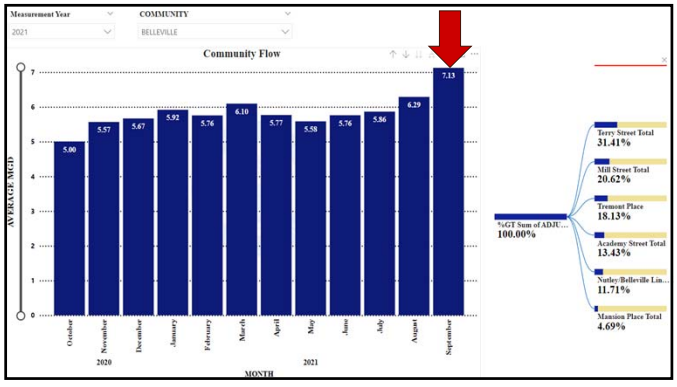
Problem Is Back Notified Belleville - November 2022

Tom,
Terry Street has started spiking with the high tide again. It started after the recent heavy rain. Please check the local storm outfalls for a gate stuck open. This might stop the intrusion. PVSC still expects you to eliminate this cross connection once you locate it. As you are aware, Belleville is paying for this intrusion of extraneous flow because it is going through the meter and into our system. I remind you of our Rules and Regulations against extraneous flow. Thanks in advance for your attention to this ongoing problem.
Louie

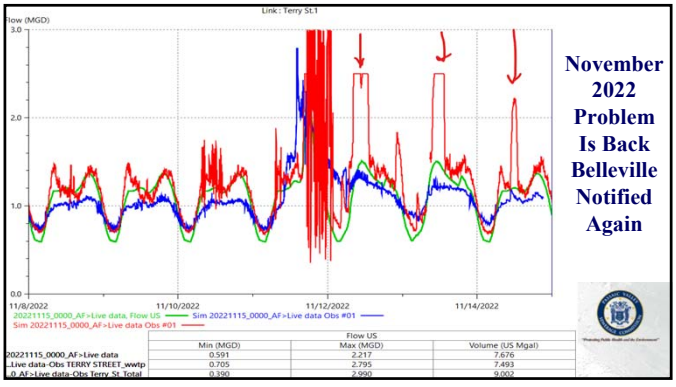
312.1
No Person shall discharge or deposit or cause or allow to be discharged or deposited into the Treatment Works or public sewer, the following:

(p) Stormwater - Any stormwater, whether contaminated or uncontaminated, unless specifically authorized by PVSC in accordance with Sections 301, 303 and 602 of these Rules and Regulations.

65

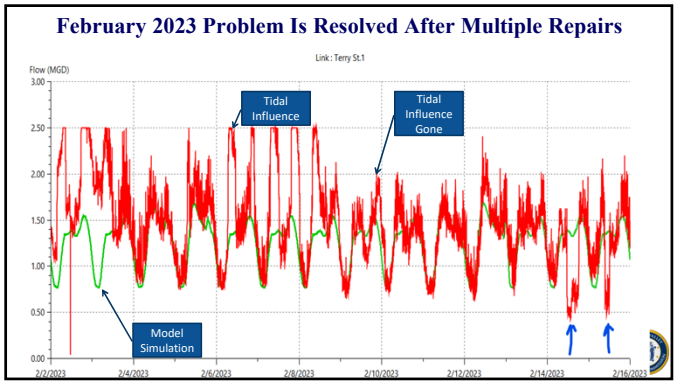


63

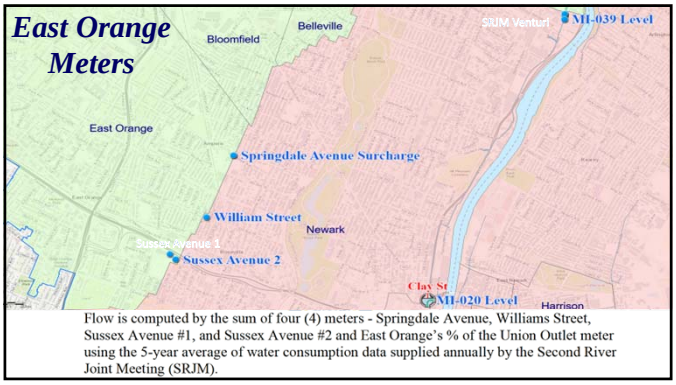


66

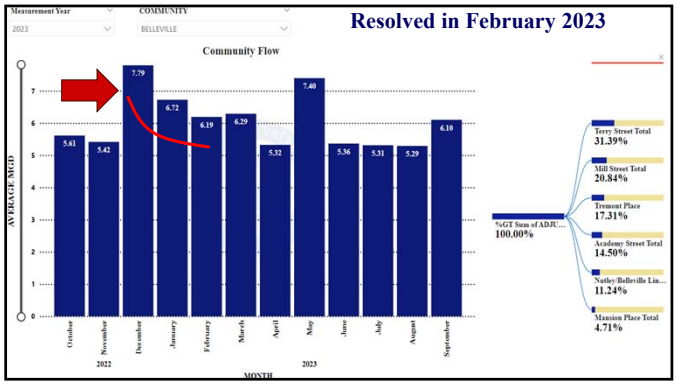
NJWEA - Fall Tech Transfer 2024 – Infiltration and Inflow



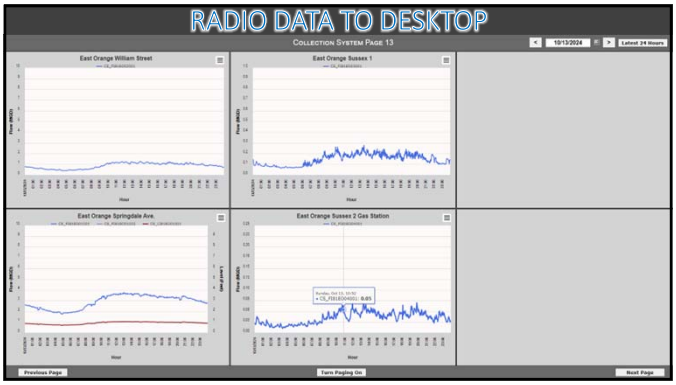
67



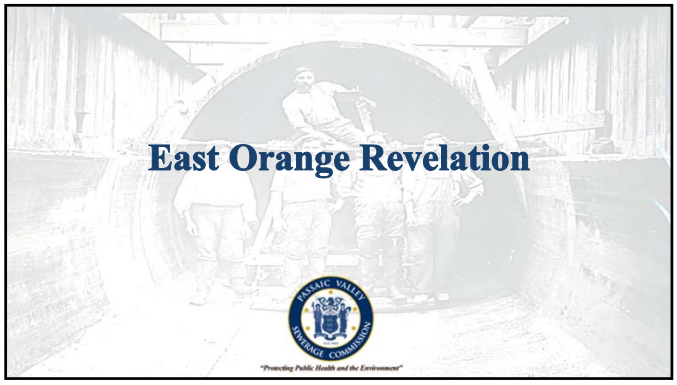
70



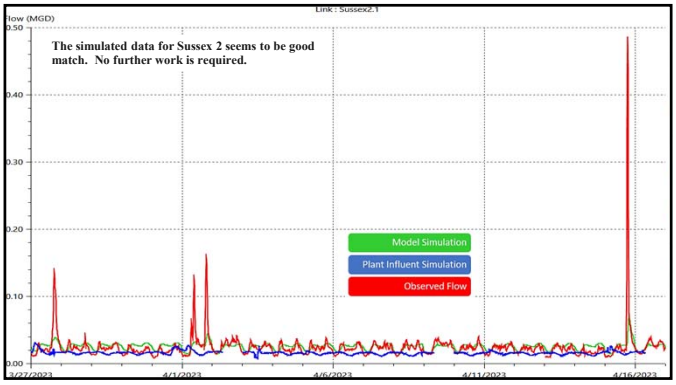
68



71



69



72

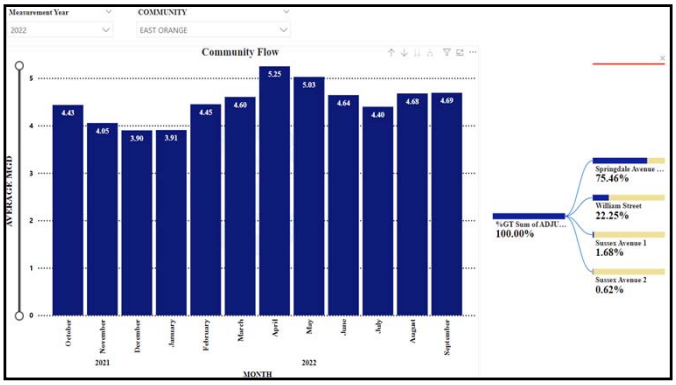
NJWEA - Fall Tech Transfer 2024 – Infiltration and Inflow

Subject: East Orange Sussex 2 Flow Meter
Date: Tuesday, January 18, 2022 9:21:00 AM
Attachments: image003.png

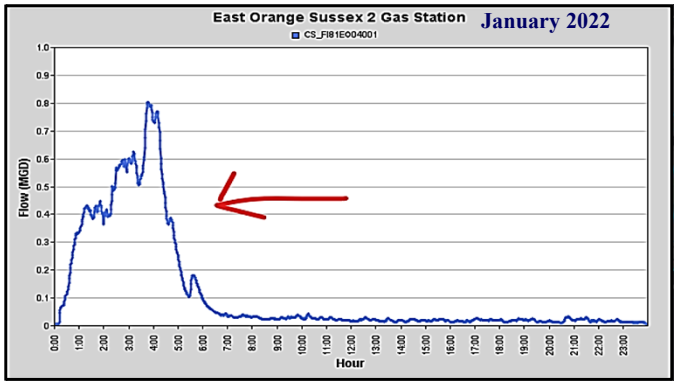
January 2022

Tom,
Good Morning and Happy New Year. An interesting and unexpected thing happened during this weekend's storm. The flow through the Sussex 2 flow meter went from a flow rate of 10,000 gallons per day up to 800,000 gallons per day during the event. The Sussex 1 flow meter did not show any sign of surcharging during the same period which leads me to believe that there is potentially some cross connected catch basins in this small subarea that are flowing through your sanitary sewer. This area is supposed to be separated and should behave as Sussex 1 did in these conditions. Please investigate and eliminate this source of storm flow from the collection system. Please let me know if you have any questions regarding this matter.
Louie

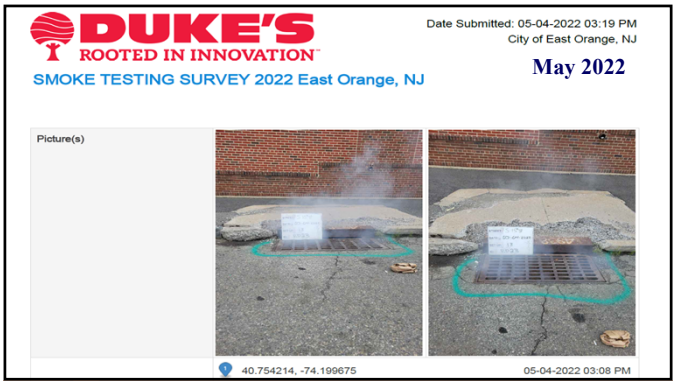
73



76



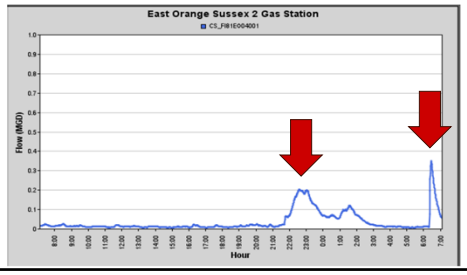
74



77

Good Morning Tom,
Any updates on this investigation? This wasn't as big a storm but it definitely had an influence on this small system. If you want to discuss this please give me a call. I have some ideas to quickly identify the cross connection if you are interested.
Louie

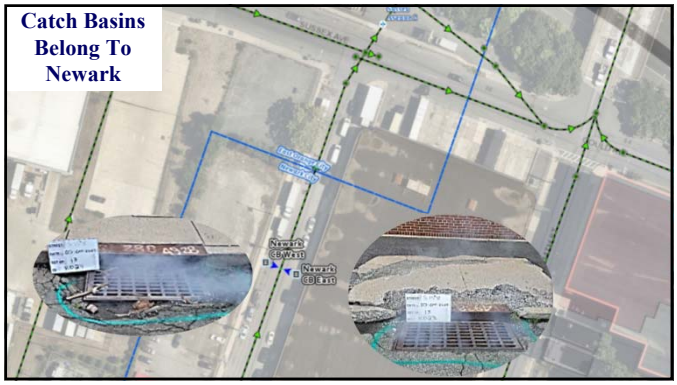
January 2022



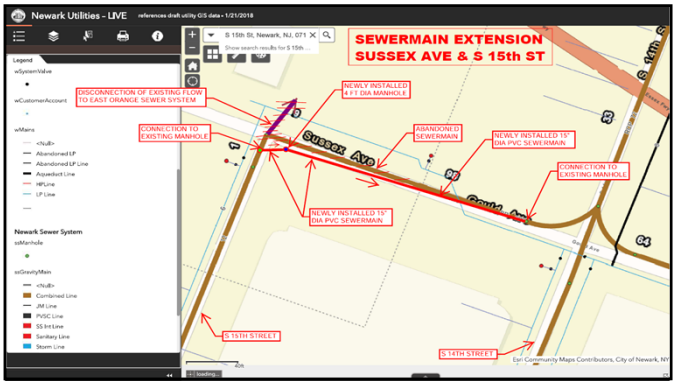
75

78

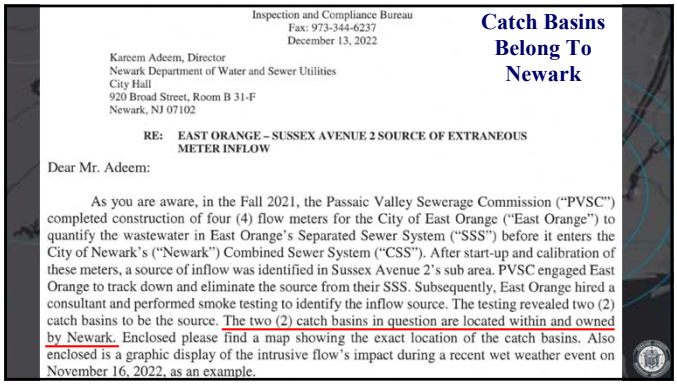
NJWEA - Fall Tech Transfer 2024 – Infiltration and Inflow



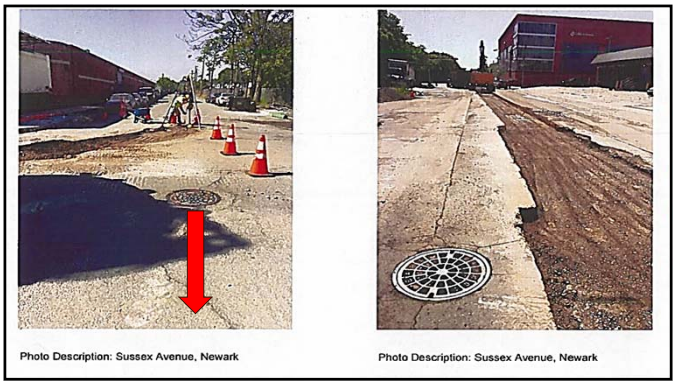
79



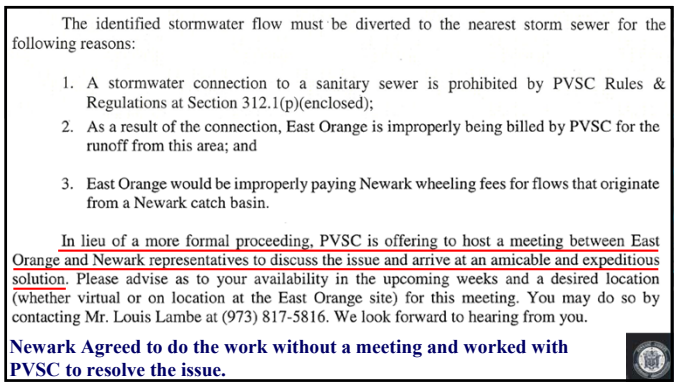
82



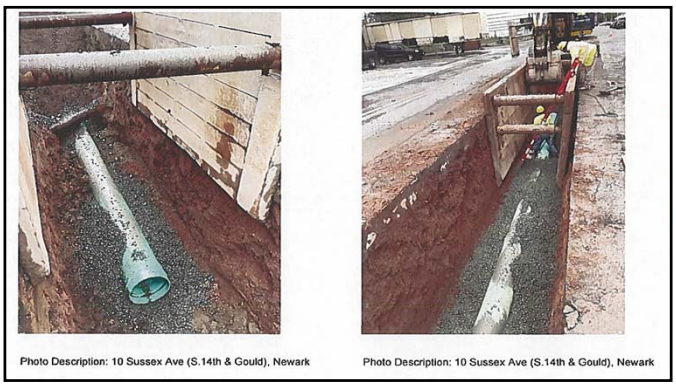
80



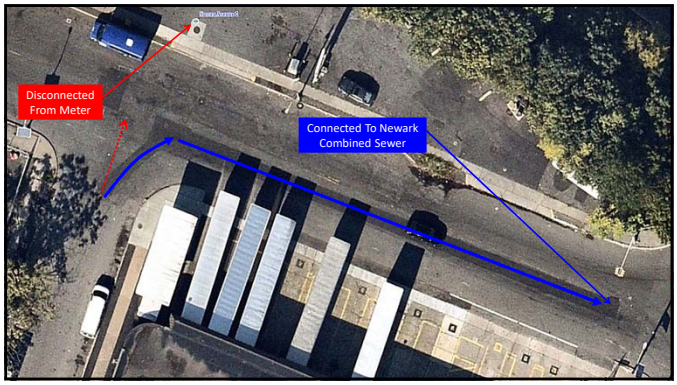
83



81



84


Disconnected From Meter
Connected To Newark Combined Sewer

85


Questions and Discussion
PASSAIC VALLEY SEWERAGE COMMISSIONERS
"Protecting Public Health and the Environment"

86