ARCADIS Design & Consultancy for natural and built assets

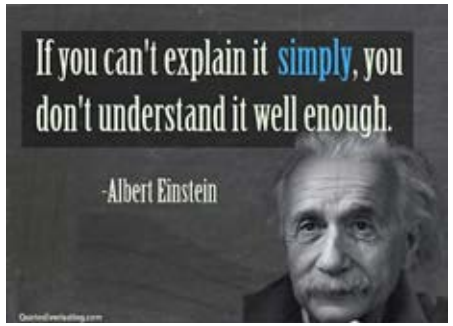
WESTERN LEHIGH SEWER PARTNERSHIP 2019 MODEL RECALIBRATION

Recalibration Overview

August 2020

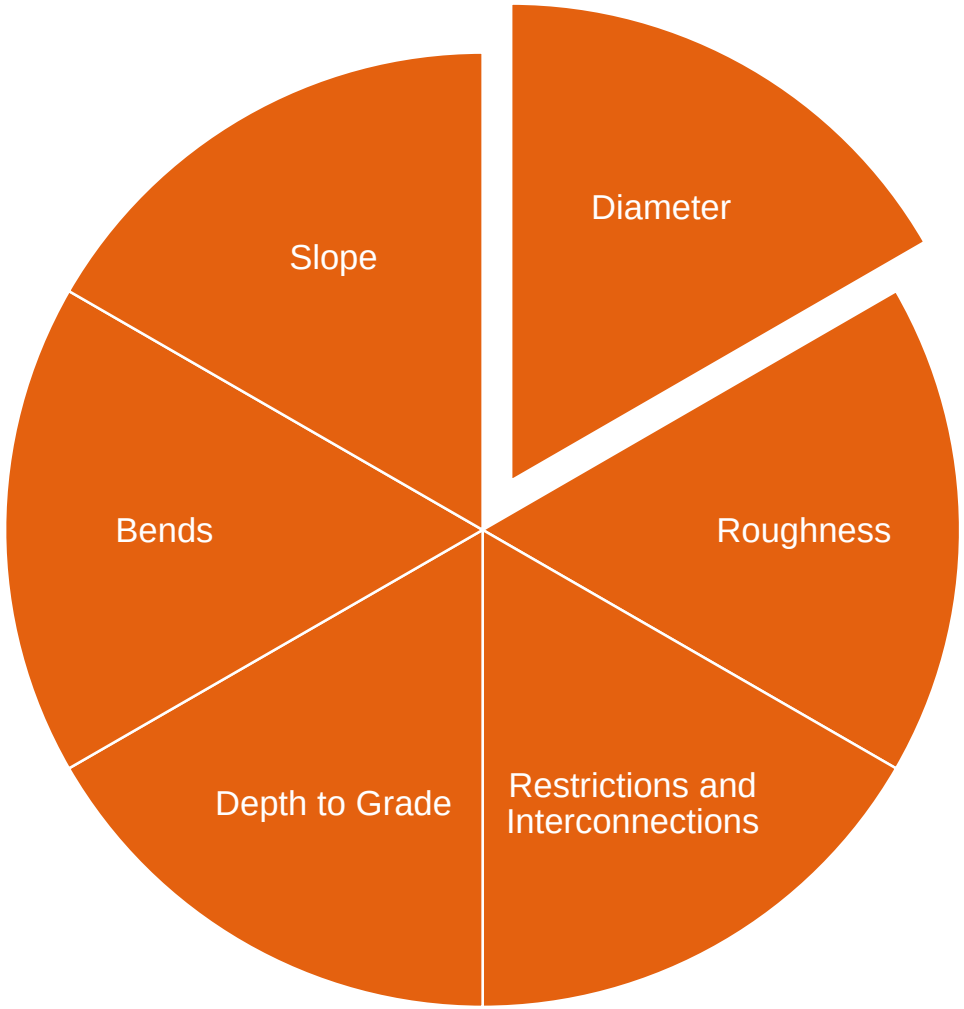
Agenda

- What is a dynamic hydraulic sewer model?
- What is a model used for?
- What are steps to modeling?
- Where is model strong and weak?
- What are the things we are doing now with the calibrated model?
- What are future modeling efforts?



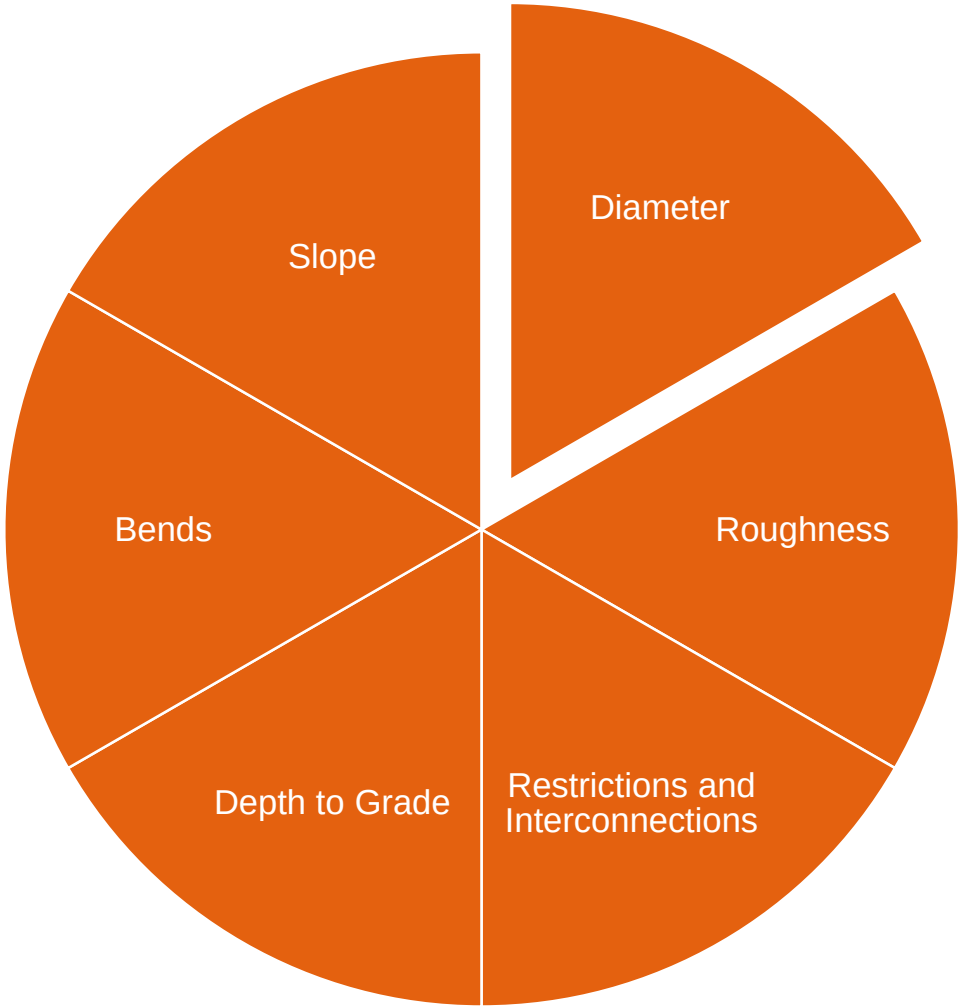
What is a dynamic hydraulic sewer model?

A sewer model is a digital twin of sewer system

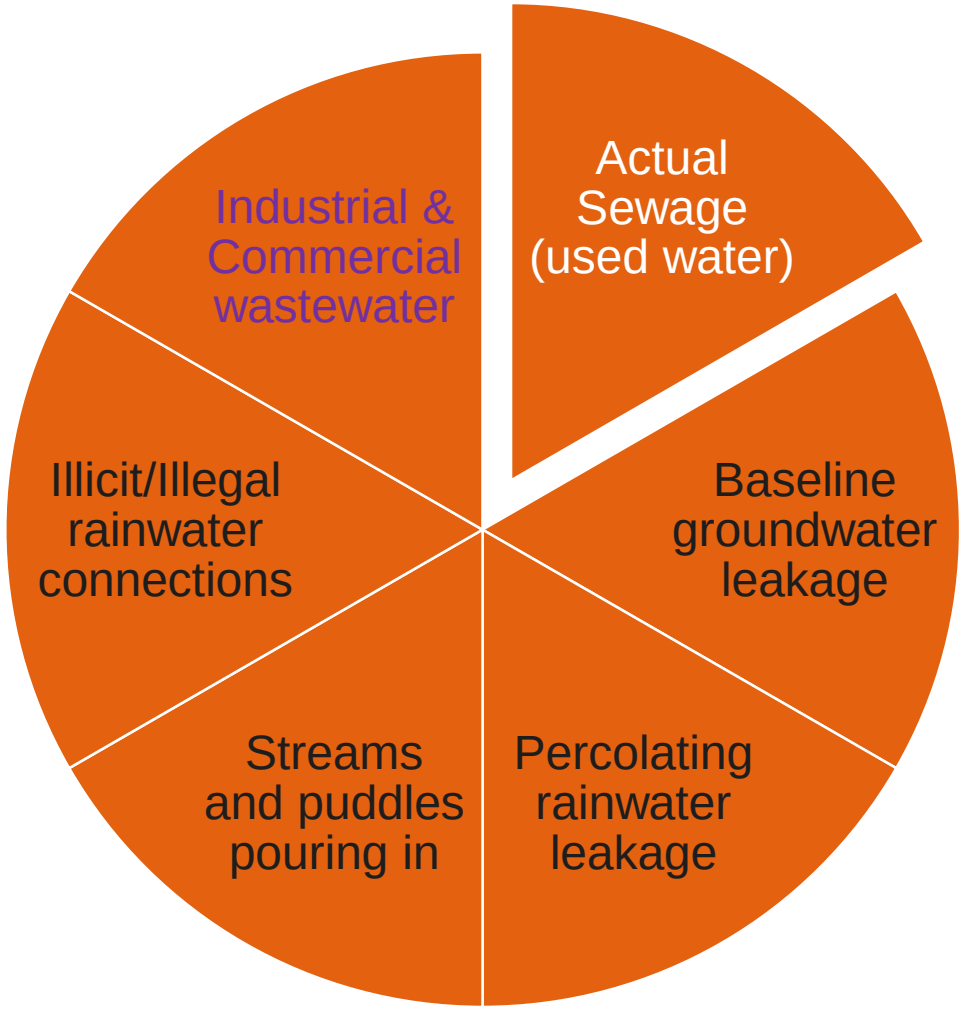


Physical Attributes of Pipes

A sewer model is a digital twin of sewer system



Physical Attributes of Pipes



What's in the Pipe

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What is a model used for?

Current Performance

- Blockages
- Flow restrictions
- Undersized pipes
- Available capacity
- Pump station demand
- Basement backups
- Dry weather backups
- Wet weather overflow locations
- Inflow locations
- Reliability

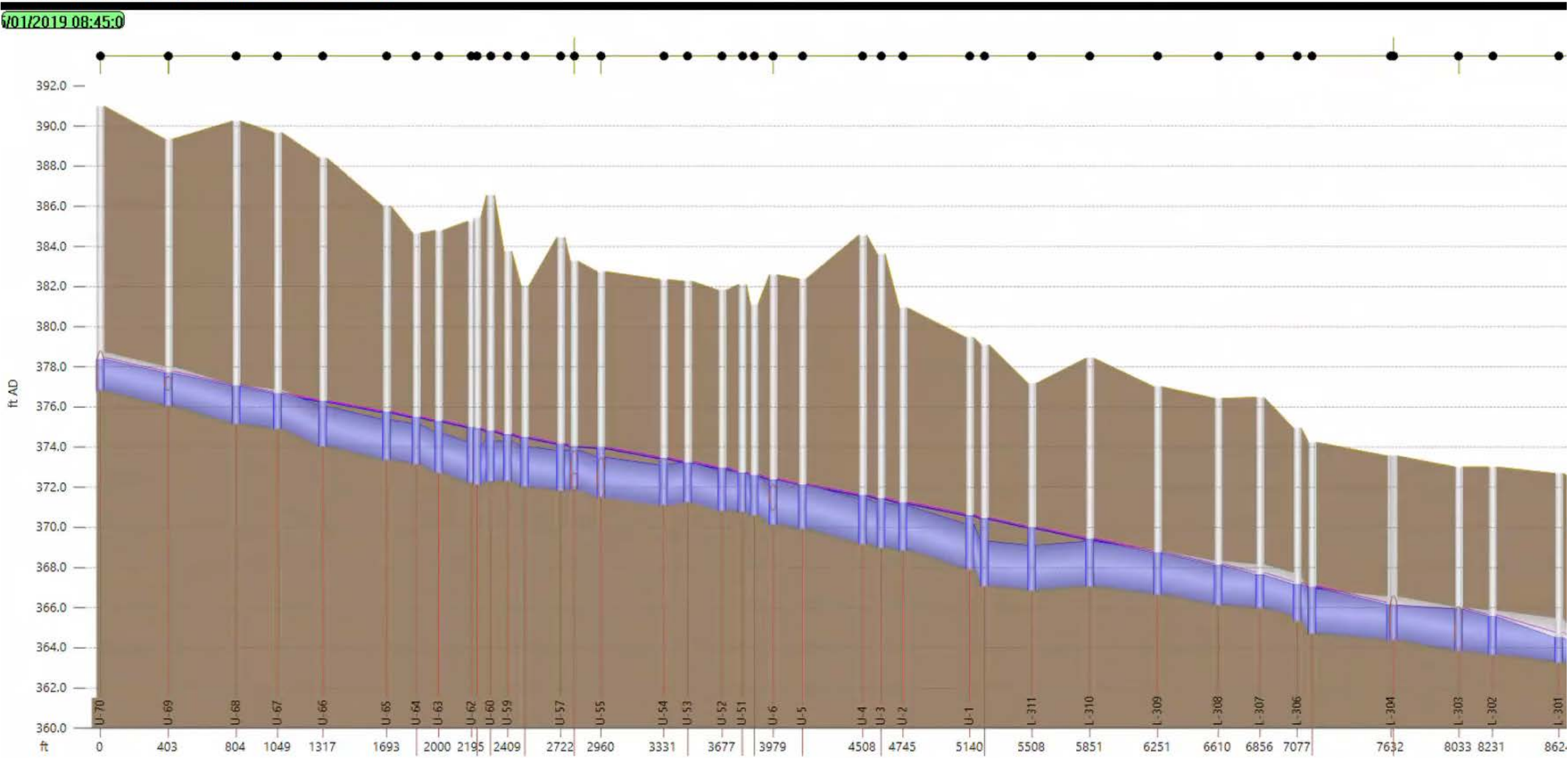
What is response to large rain events?

How does it handle extended wet periods (ala 2018-2019)?

How good is its Level of Protection?

Current performance is function of base load and rainfall frequency/intensity

Media Playback Audio Video Subtitle Tools View Help



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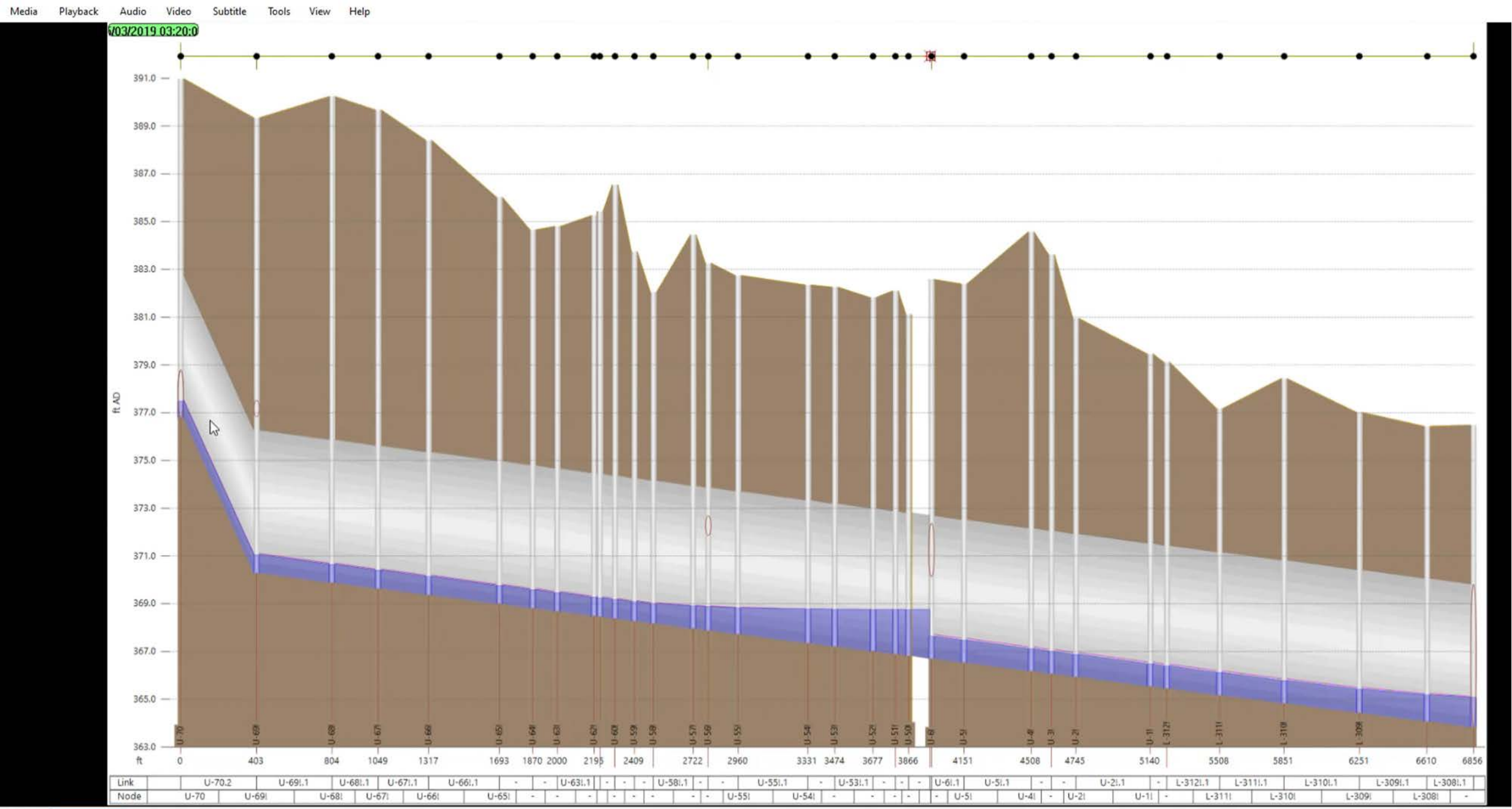
Node	-	U-69	U-68	U-67	U-66	U-65	-	-				-	-		U-55	U-54	-	-			-	U-5	U-4		U-2	U-1	-	L-311	L-310	L-309	L-308	-	-	L-305	-	-	L-303	L-302	L-301

Future Performance

- Converting farms to houses and warehouses
- Adding more hauled waste
- Losing a big industry
- Adding big industry
- Aging (leaking) pipes
- Weather changes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Future infrastructure needs

- Estimating reductions from sewer collection system rehab
- Estimating reductions from private property leakage reductions
- What and where are conveyance capacity improvements needed
- When to install capacity improvements
- Replacement vs parallel
- Correctly sizing interceptors, pump station, tanks
- Determining impact on treatment plants
- Determining impact on downstream signatories

Alternative analyses are like experimenting to find best formula

Force Mains Summary	
New Pipe Diameter (in)	Total Length (ft)
10	12,752
12	13,553
15	5,581
18	8,048
21	5,804
36	41,107
42	10,625
Total	97,470

Gravity Mains Summary		
New Pipe Diameter (in)	Total Length (ft)	Number of Segments
15	959	7
18	2,370	10
24	4,320	23
42	1,488	9
Total	9,137	49

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Lehigh County Authority
Sanitary Sewer Capacity Assurance and Rehabilitation Program

00247545 - ALTERNATIVE 3 - KISS MODEL - 2040 FORCE MAINS

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May 2015

	Spend Year	LCA's Portion of Spend Year Capital
WLI Trunkline Rehab	2016	$ 820,000
Park Pump Station Refurbishment	2018	$ 2,842,991
WLI Main Rehab 2	2018	$ 3,446,050
Park Force Main Refurbishment	2019	$ 3,201,057
Park Force Main Extension	2020	$ 2,551,597
Phase 1 COA EQ Tanks	2020	$ 5,657,041
Park Force Main	2027	$ 23,554,139
Park Pump Station	2028	$ 18,816,676
Phase 2 COA EQ Tanks	2029	$ 14,129,738
Kecks Bridge Park Interceptor	2030	$ 27,779,985
Upper Milford Relief Trunk Line	2032	$ 7,424,496
AMTL Relief Trunk Line	2034	$ 8,879,518
Ancient Oaks Interceptor	2036	$ 37,146,122
Phase 3 COA EQ Tanks	2040	$ 12,977,609

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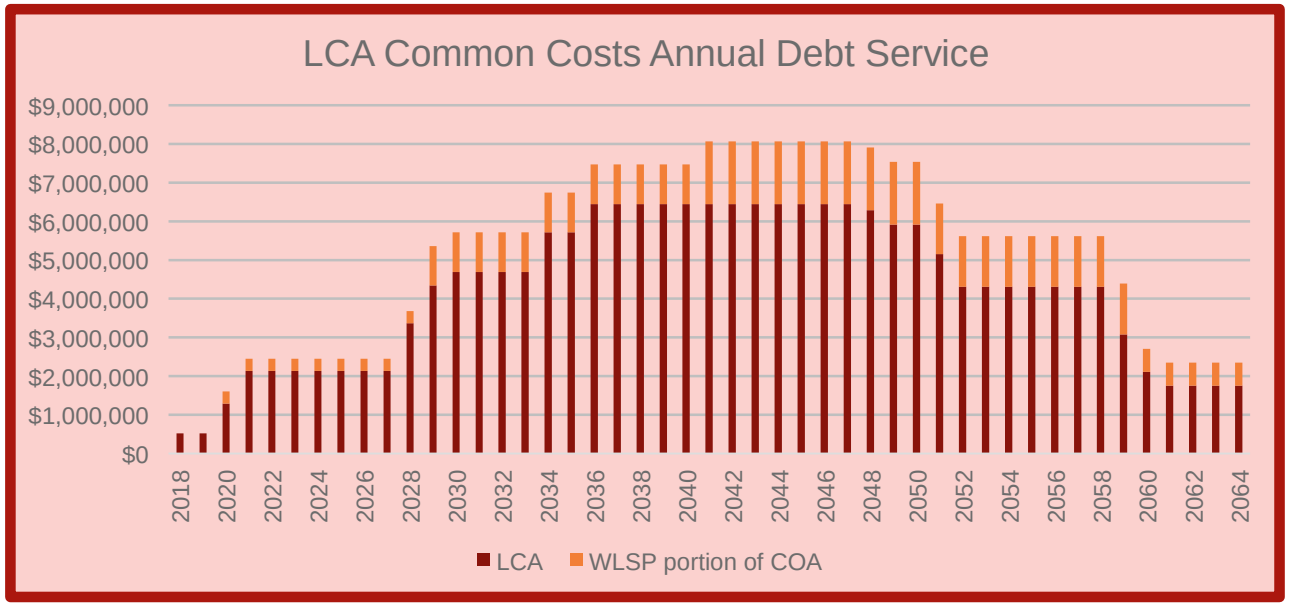
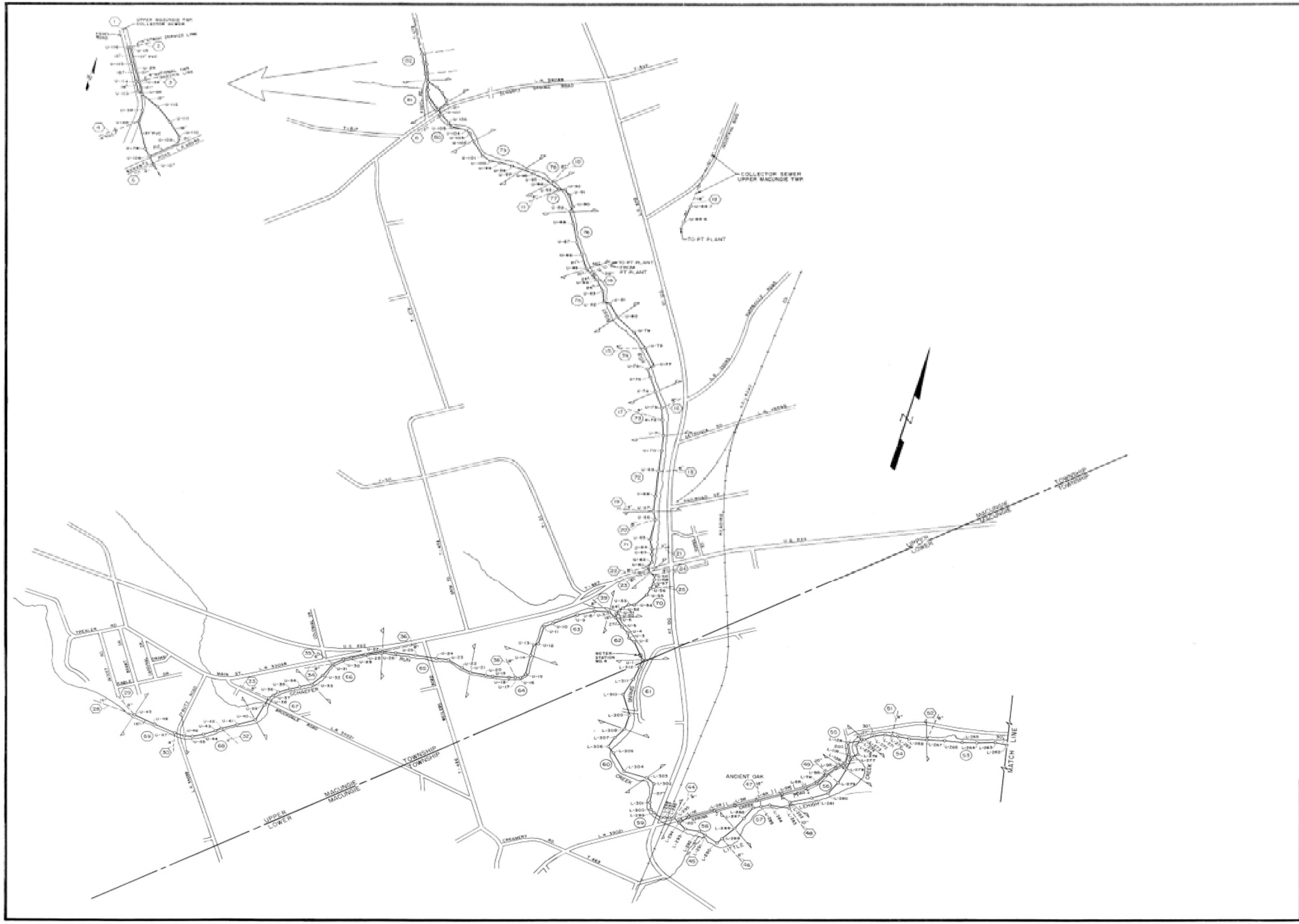
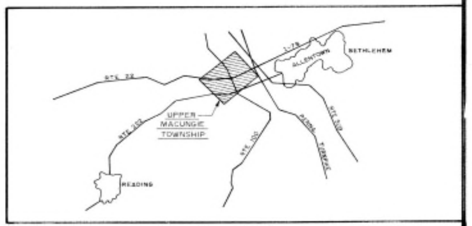
Capital Planning and Cash Flow



What are steps to modeling?

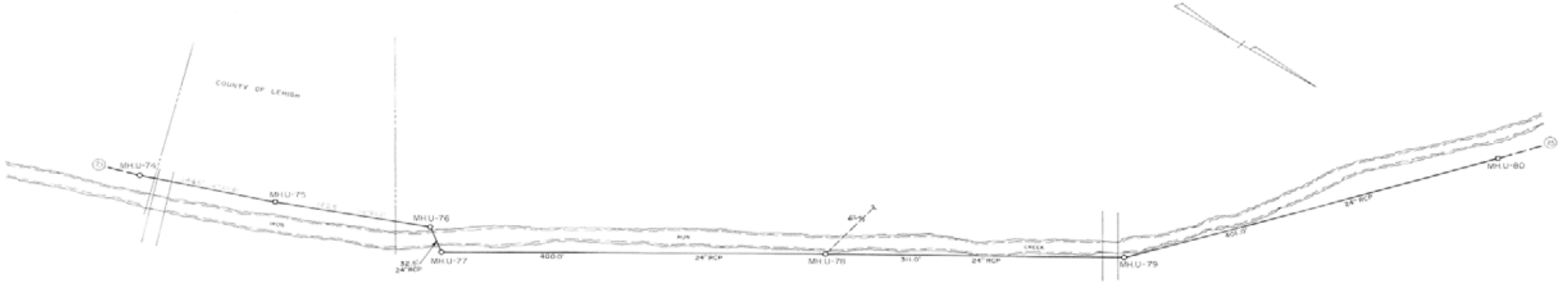




LOCATION MAP

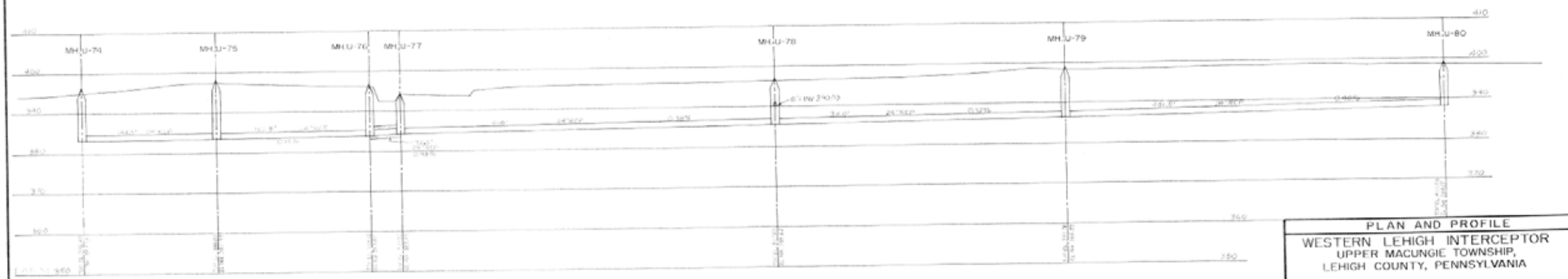
LEHIGH COUNTY AUTHORITY INTERCEPTOR SEWER

SCALE: 1" = 800'	LEHIGH COUNTY AUTHORITY P. O. BOX 3348 1053 SPRUCE ROAD WESCOSVILLE, PENNA. 18106		PROJECT NO.
DWN. BY: C.R.D.			DATE: JUNE 1991
CKD. BY: S.R.	REV.1 1/7/92 C.R.D. ADDED SEWER CONNECTION NUMBERS	REV.2	DWG. NO.
REV.3	REV.4	REV.5	REV.6 / SHEET



° PLAN °

SCALE: 1" = 50'



° PROFILE °

SCALE: HORIZ. - 1" = 50'
VERT. - 1" = 10'

NOTE:
PIPELINE INVERTS & SLOPES ARE BASED ON L.C.A. FIELD SURVEY, COMPLETED SUMMER OF 1989. SEE SHEET NO. FOR ORIGINAL AS-BUILT INFORMATION.

(13 OF 21)

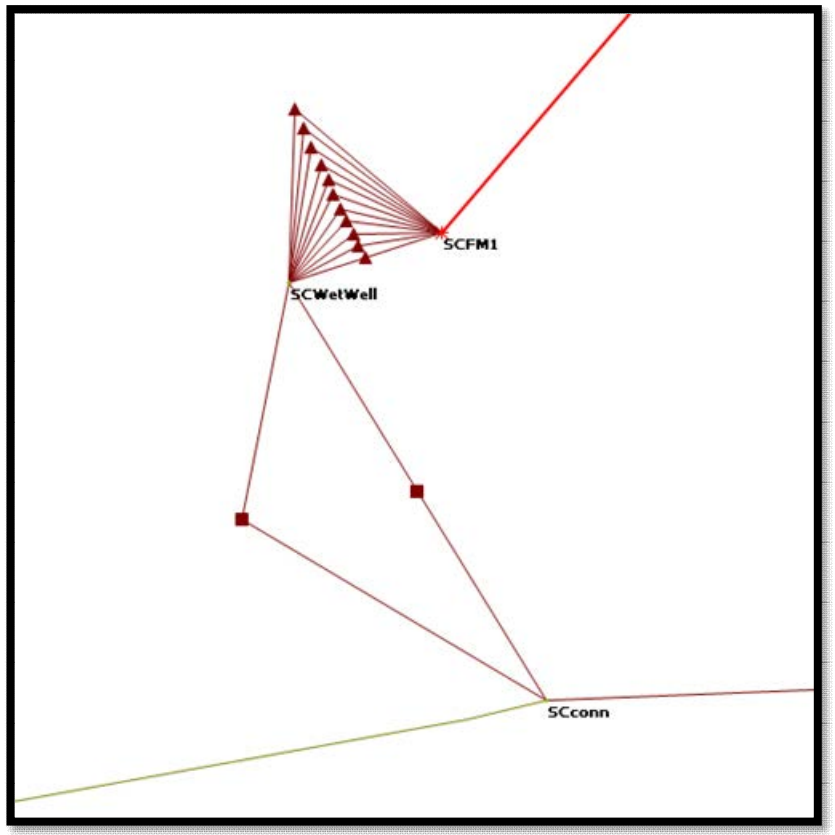
PLAN AND PROFILE

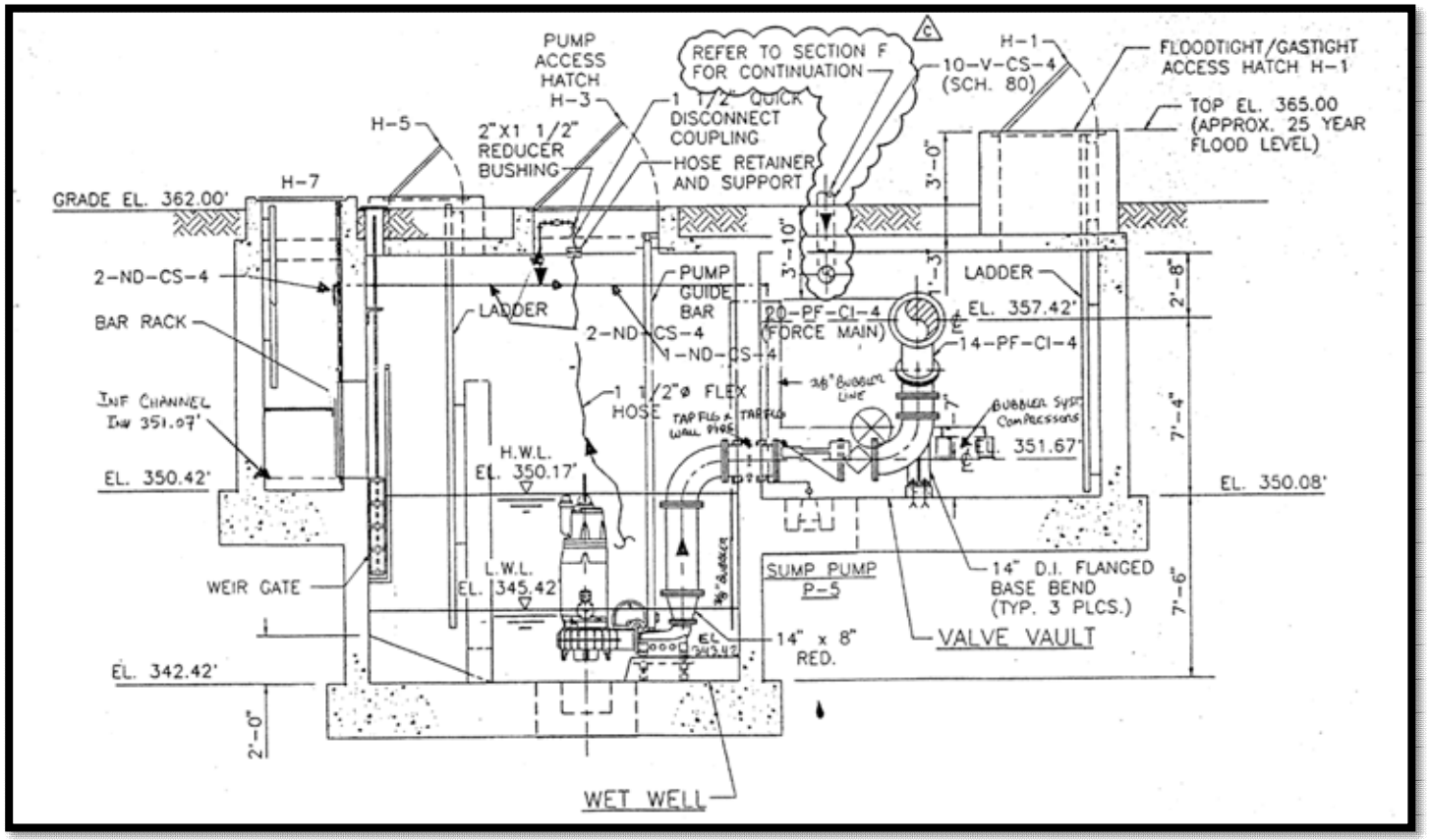
WESTERN LEHIGH INTERCEPTOR
UPPER MACUNGIE TOWNSHIP,
LEHIGH COUNTY, PENNSYLVANIA

SCALE: AS SHOWN	LEHIGH COUNTY AUTHORITY P. O. BOX 3348 1053 SPRUCE ROAD WESCOSVILLE, PA. 18106	PROJECT NO.
DWN BY: C.R.D.		DATE: 5/2/91
CKD BY: S.R.	REV.1 / REV.2	DWG. NO.
REV.3	REV.4 / REV.5	REV.6 / SHEET NO. 74 OF 85

Spring Creek Pump Station

Pump Curves – 11 pumps with fixed capacity of 1 mgd

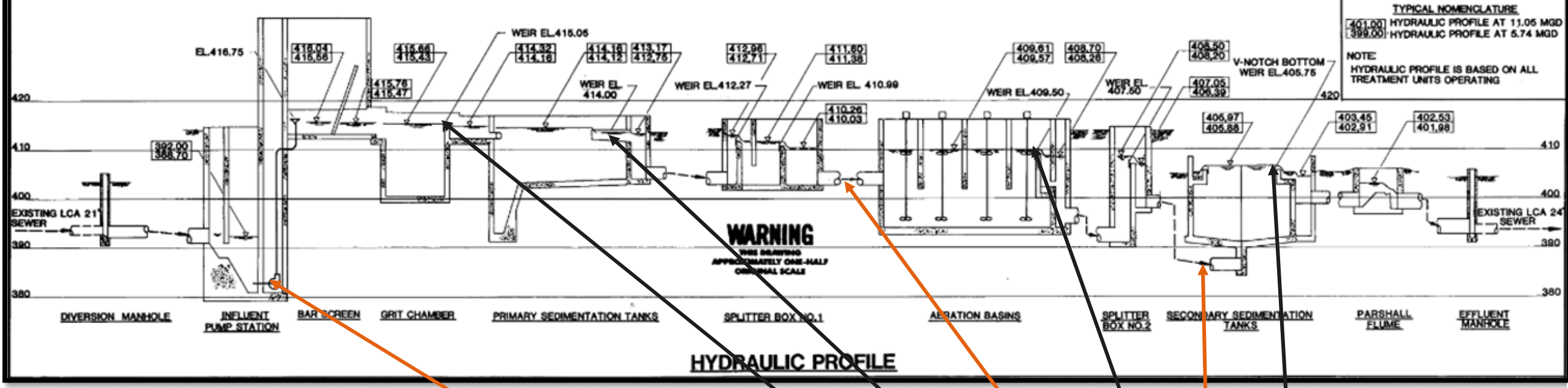


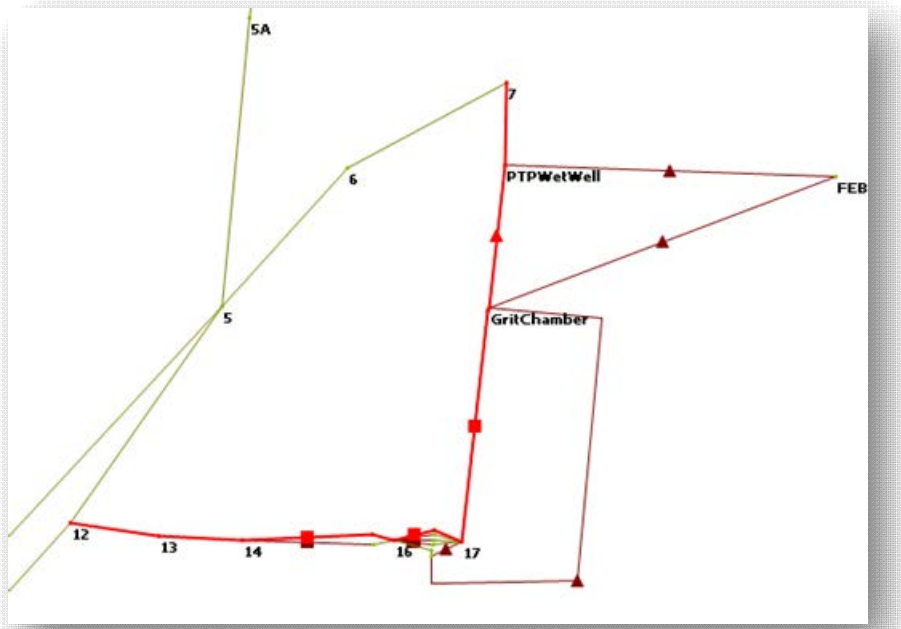


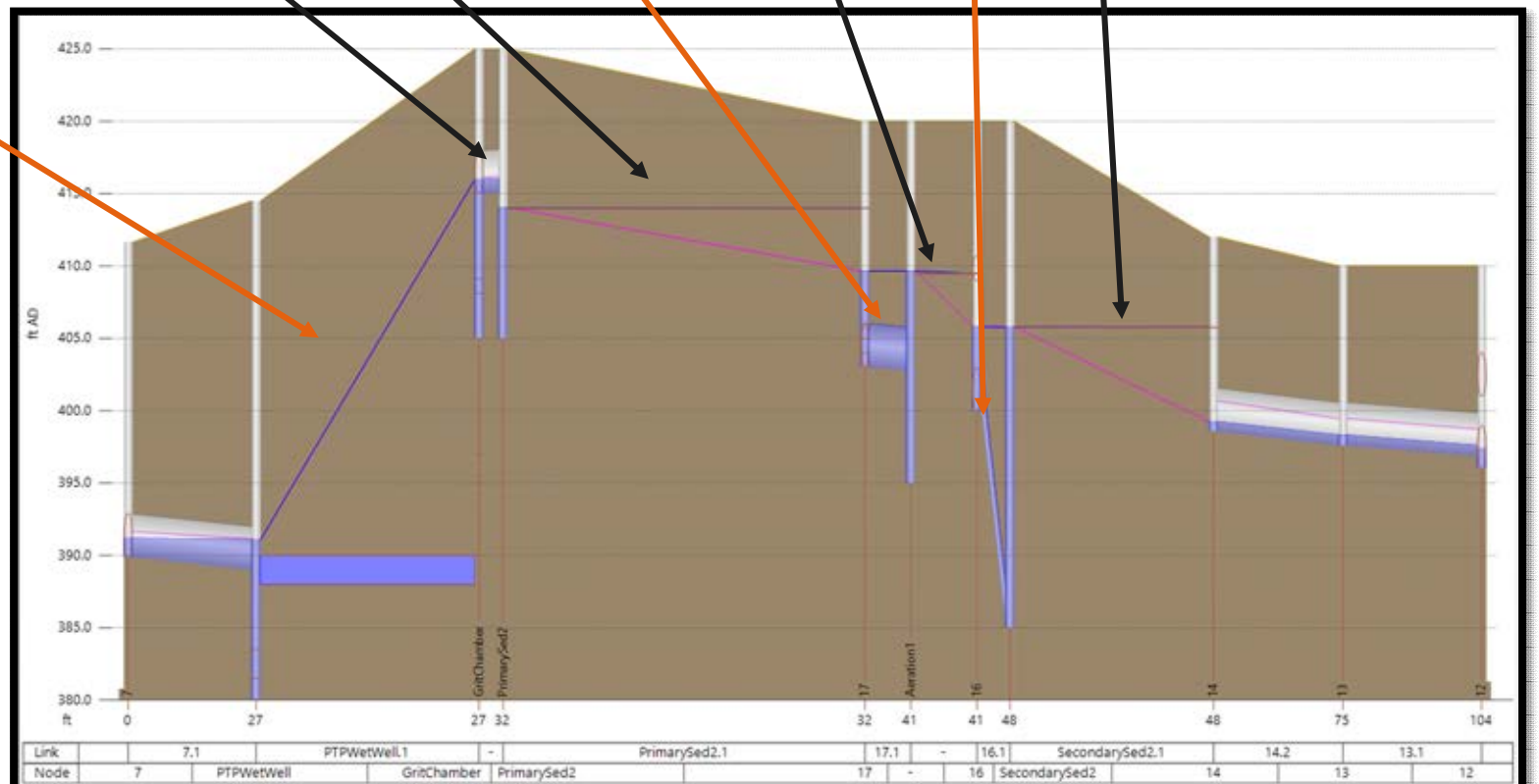
No RTC Control

Wet Well and Pump Curves

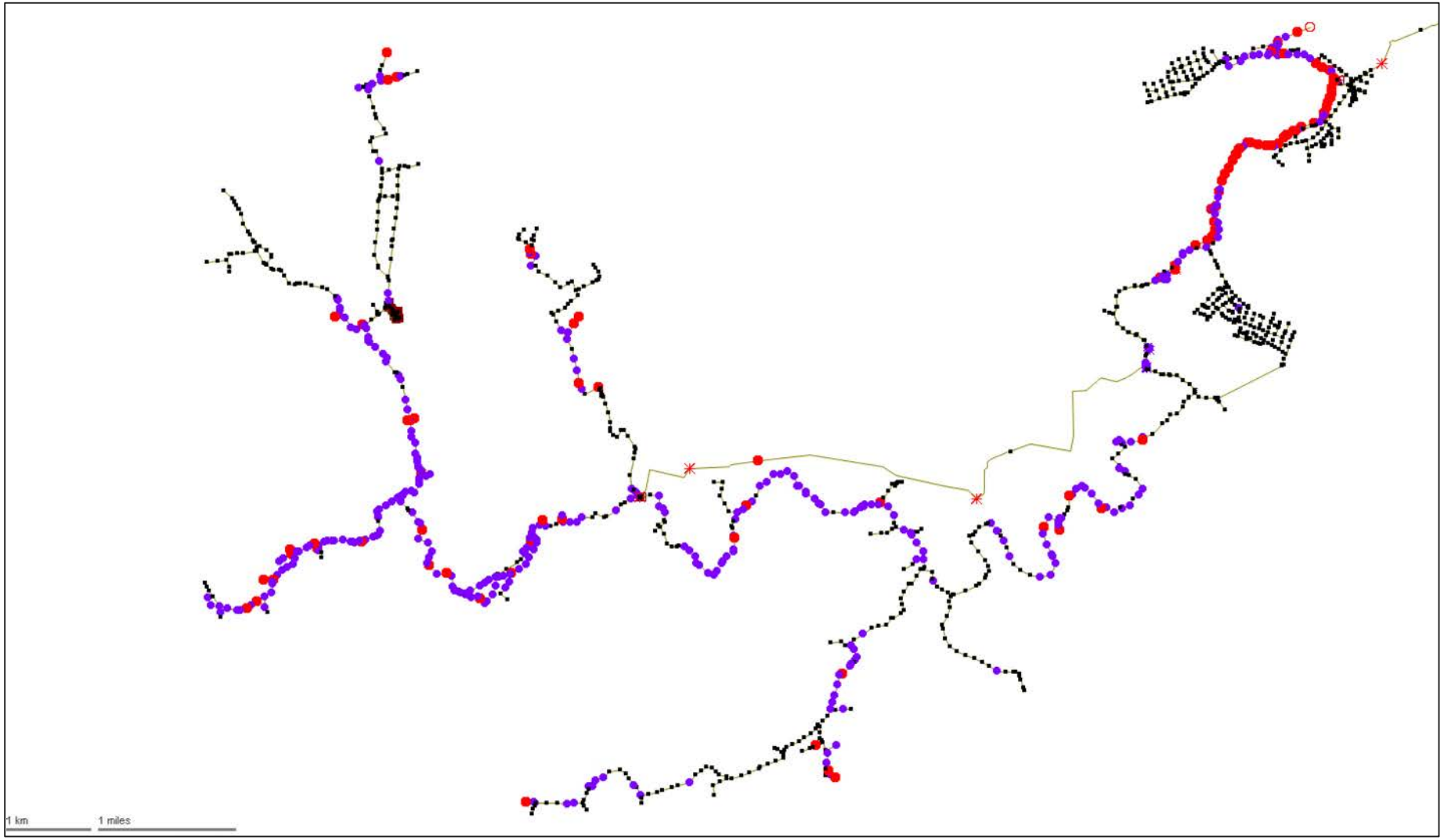
Pretreatment Plant

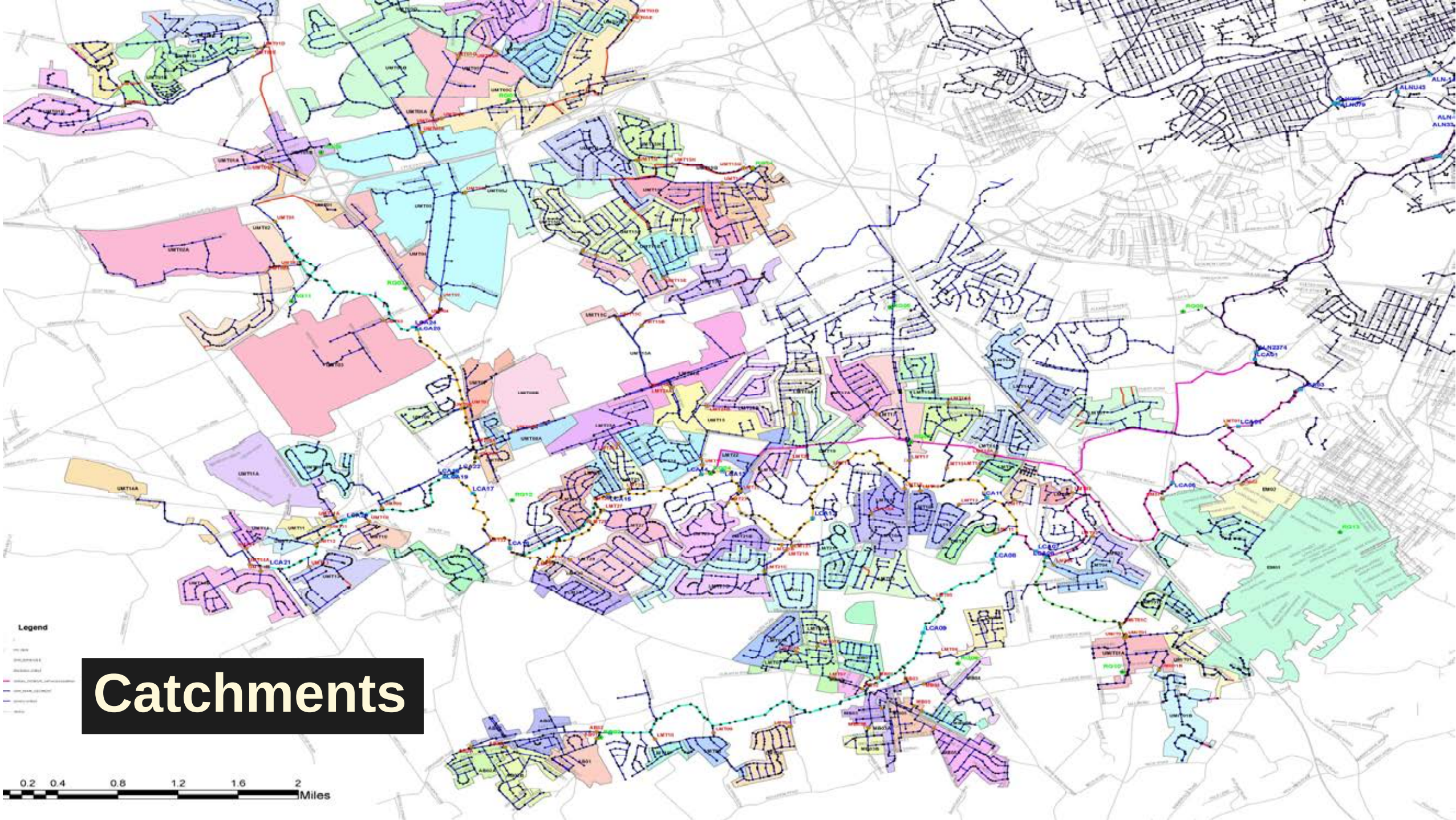


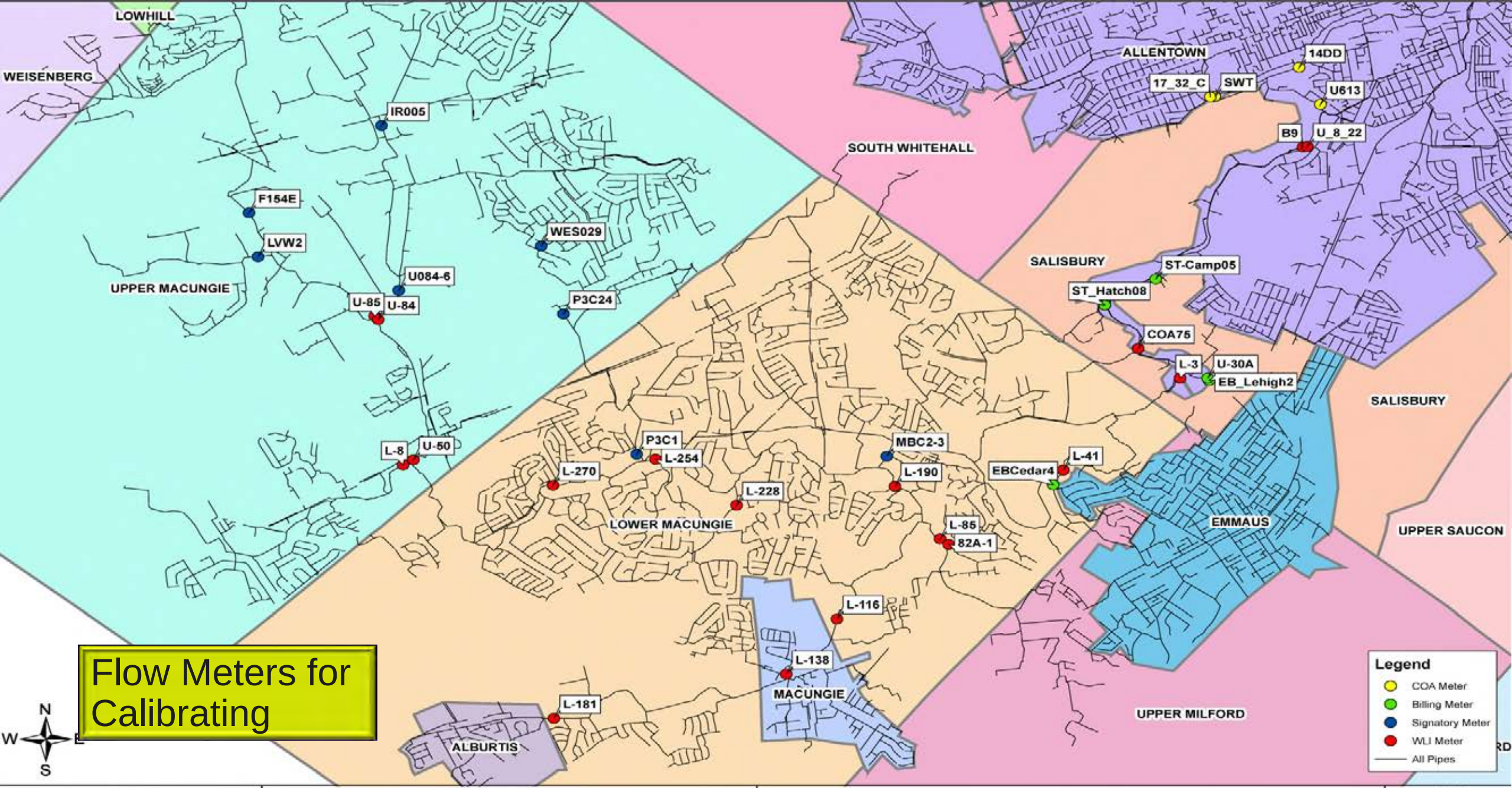




Model Extents




Legend
Catchments
0.2 0.4 0.8 1.2 1.6 2
Miles



Flow Meters for Calibrating

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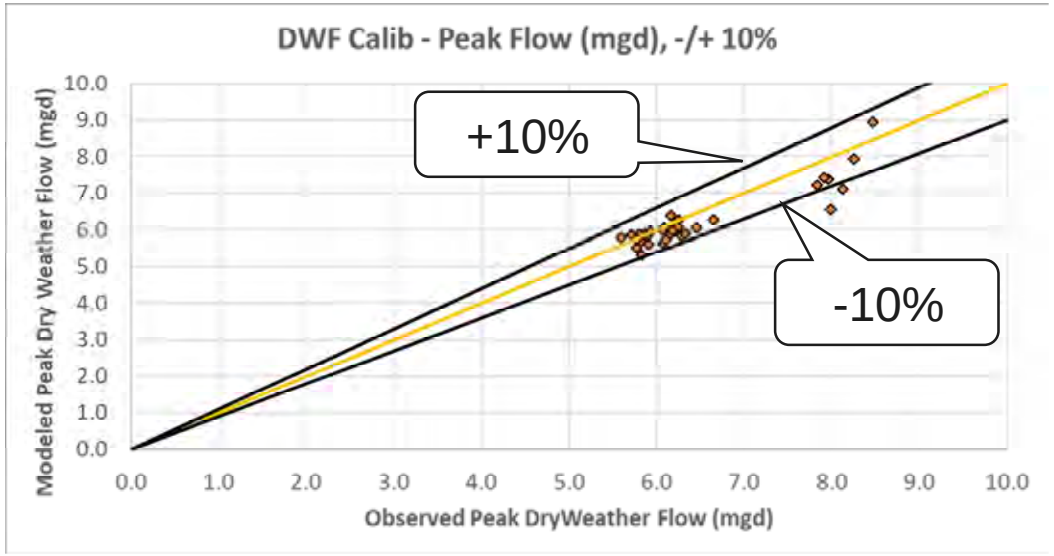
Lehigh County Authority
Sanitary Sewer Capacity Assurance
and Rehabilitation Program

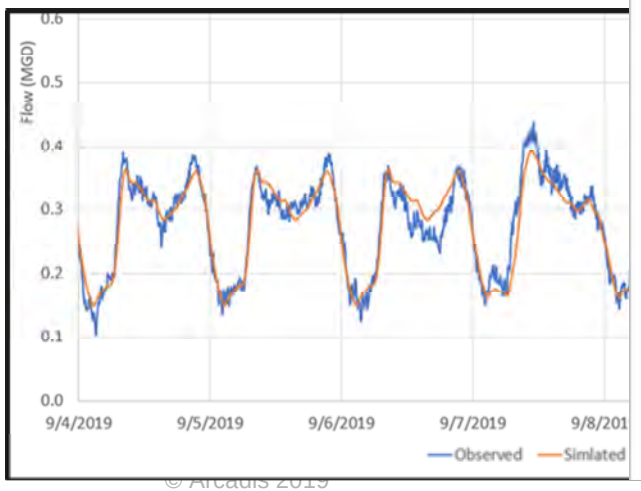
WLSP 2019 FLOW METER LOCATIONS

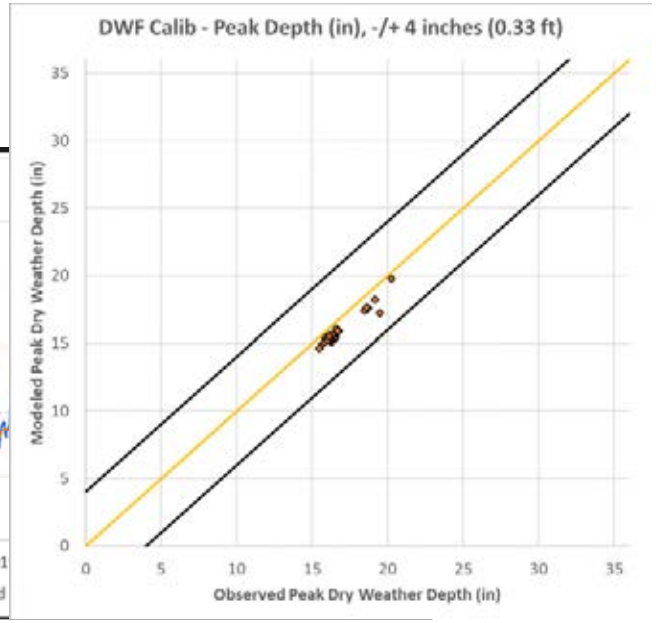
NOVEMBER 2018

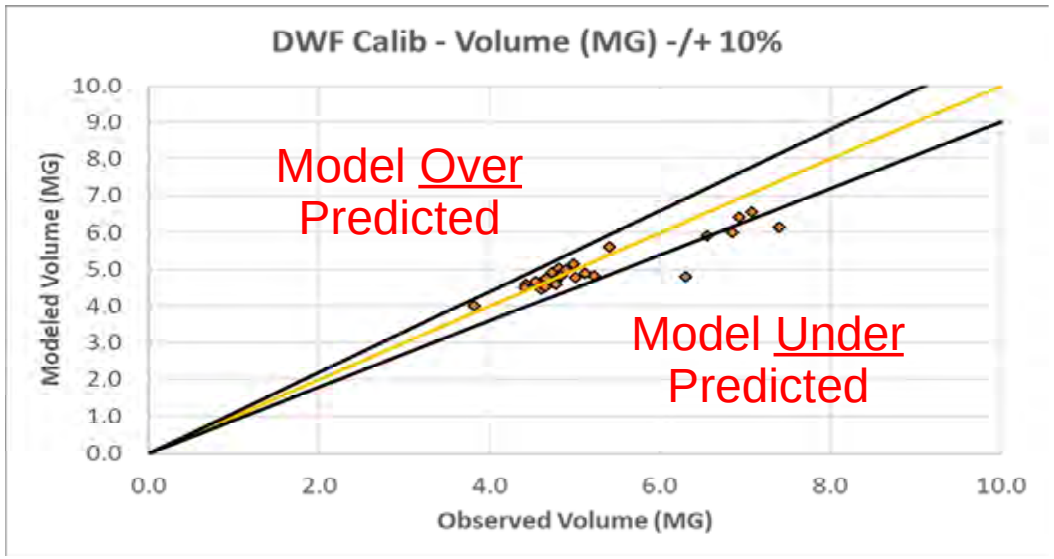
Dry Weather Calibration Guidelines

Parameter	Guidelines
Peak Flow Rate	-10% to +10% of measured
Flow Volume	-10% to +10% of measured
Peak Depth	± 0.33 ft at non-surcharged locations -0.33 ft to +1.67 ft at surcharged locations
Shape	The shape of modeled and metered curves should be similar for flow.





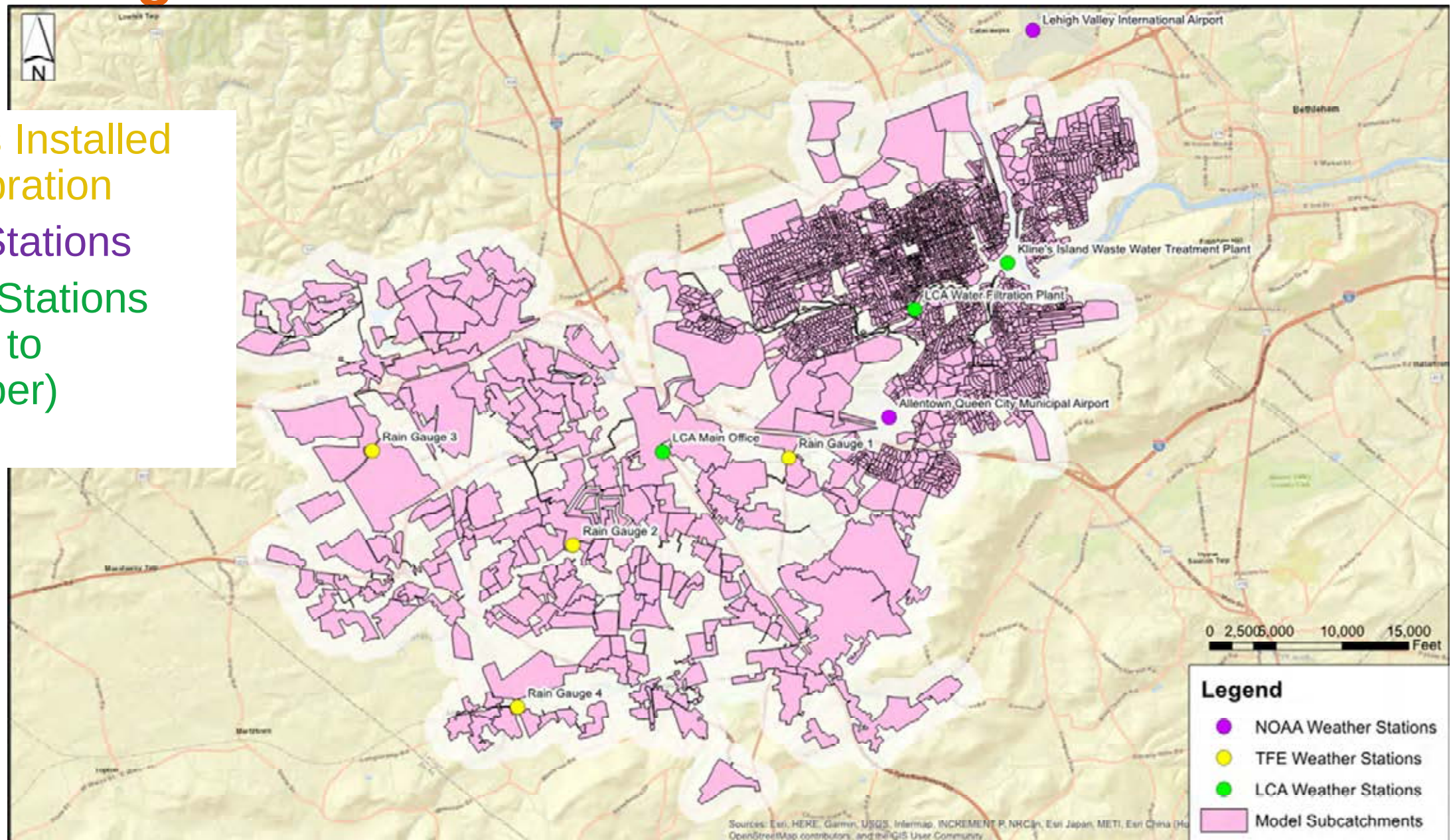




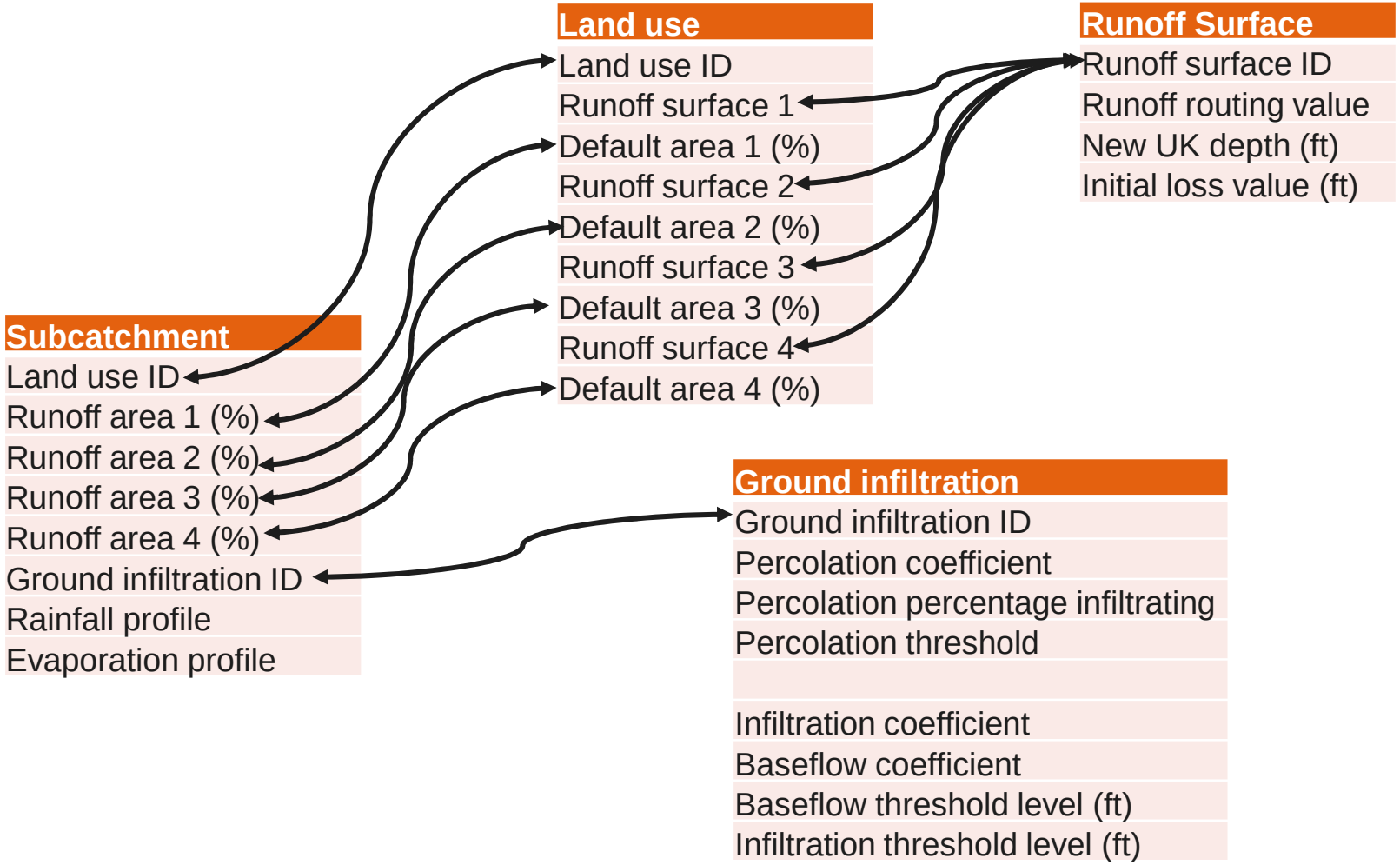
But sometimes, it rains

Rain Gauge Data Source and Locations

- Stations Installed for Calibration
- NOAA Stations
- County Stations (August to November)



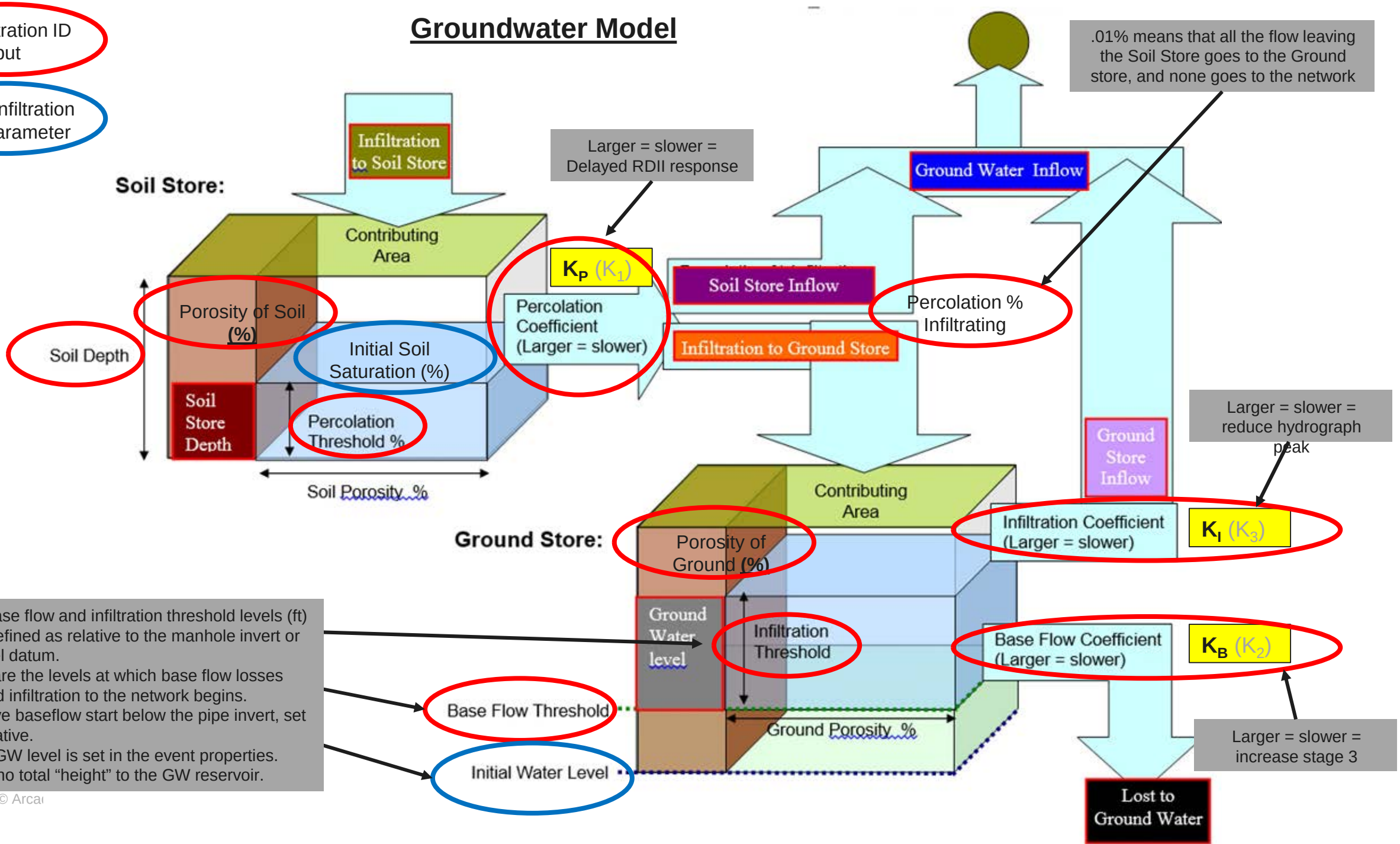
ICM Sub-Catchments Grid RDII



Groundwater Model

GW Infiltration ID Input

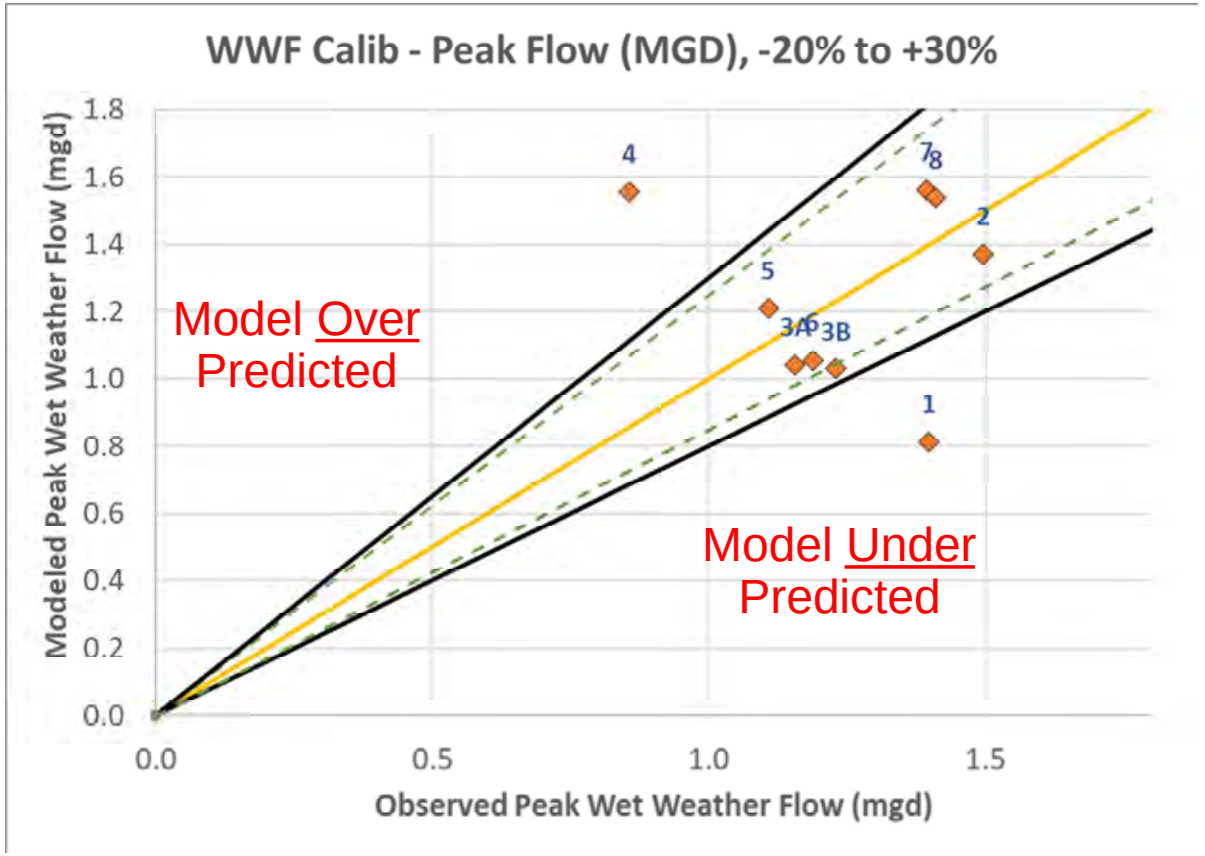
Ground Infiltration Event Parameter



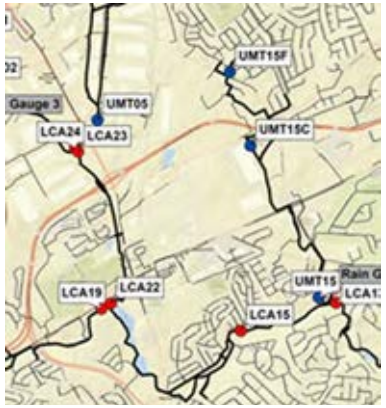
1- The base flow and infiltration threshold levels (ft) can be defined as relative to the manhole invert or the model datum.
2- They are the levels at which base flow losses begin and infiltration to the network begins.
3- To have baseflow start below the pipe invert, set it as negative.
4- Initial GW level is set in the event properties. There is no total “height” to the GW reservoir.

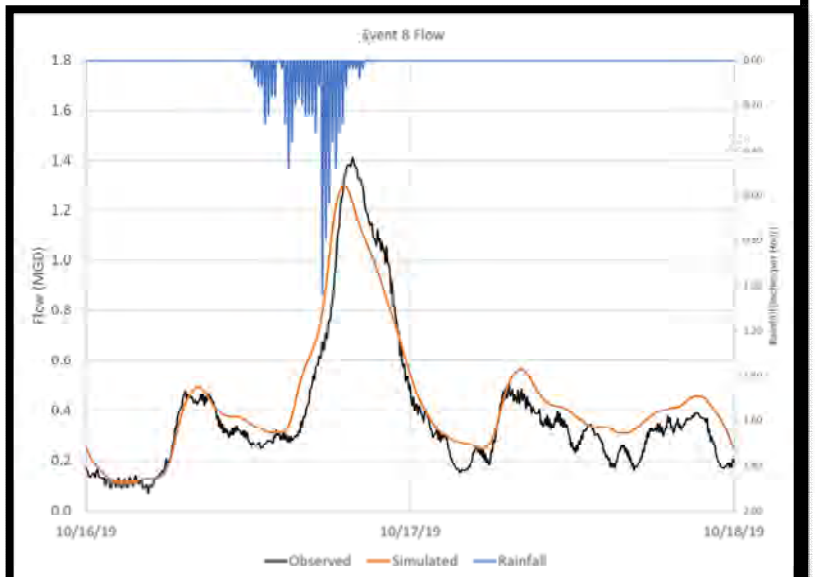
Wet Weather Calibration Guidelines

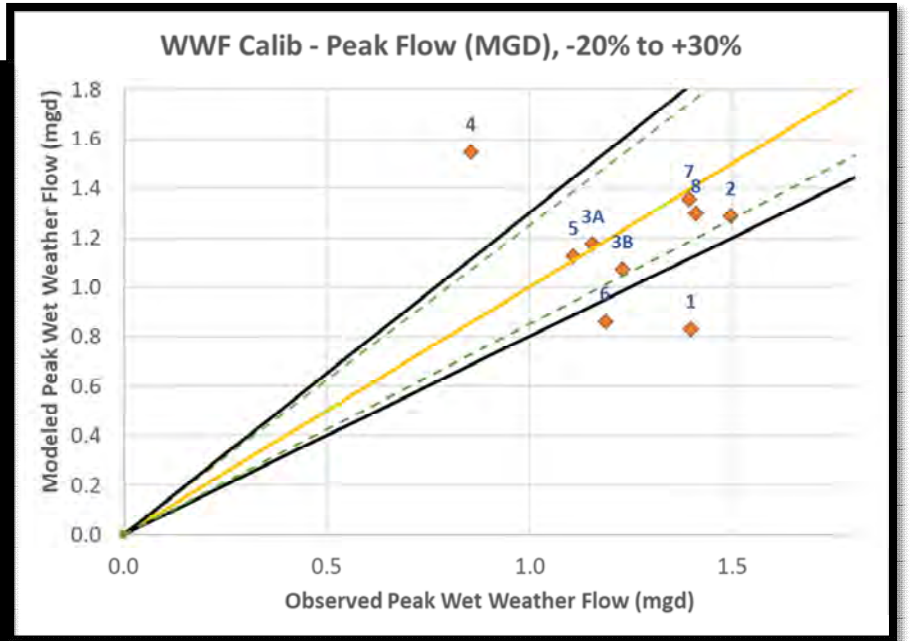
Parameter	Guidelines 2010(LCA)	WaPUG
Peak Flow Rate	-20% to + 30% of measured	-15% to +25% of measured
Flow Volume	-20% to +30% of measured	-10% to +20% of measured
Peak Depth	-0.33 ft to +1.67 ft at surcharged locations ± 0.33 ft at non-surcharged locations	No Change
Shape	The shape of modeled and metered curves should be similar for flow.	No Change

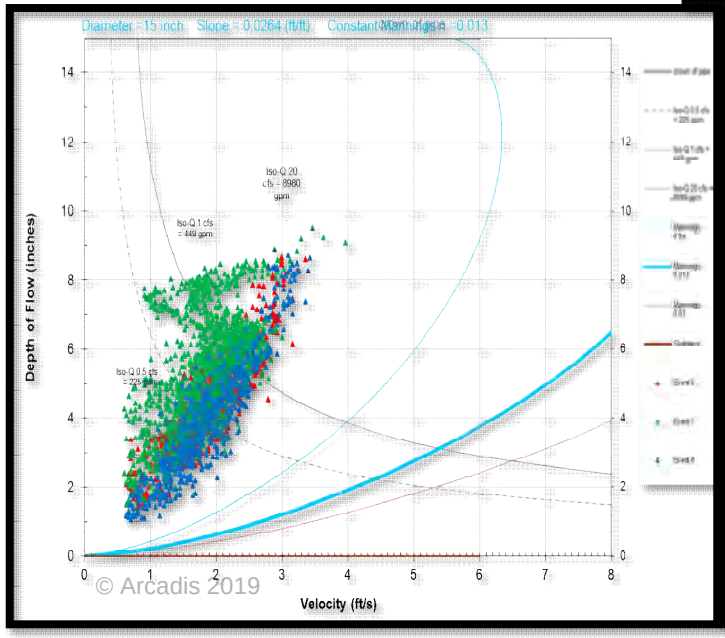


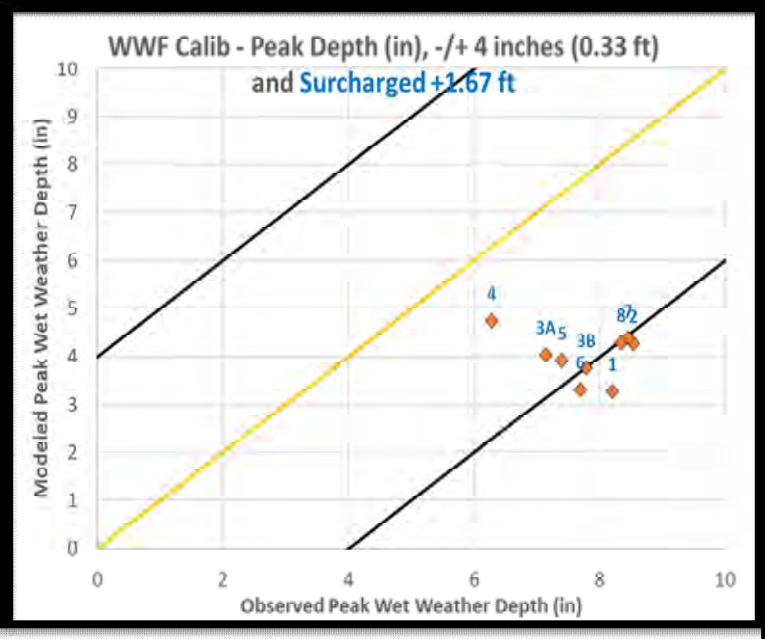
1. Flow Meter UMT15F

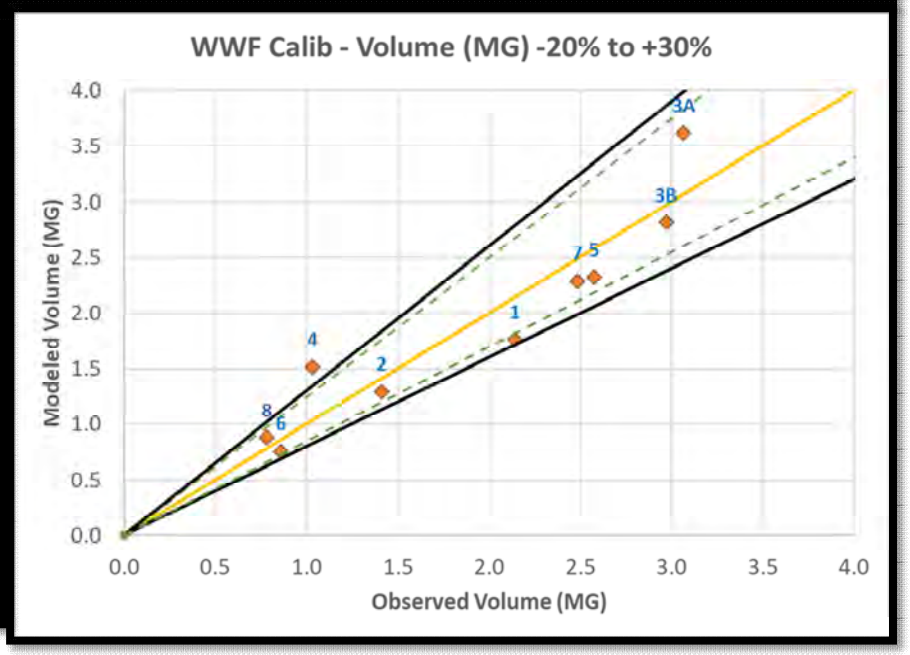




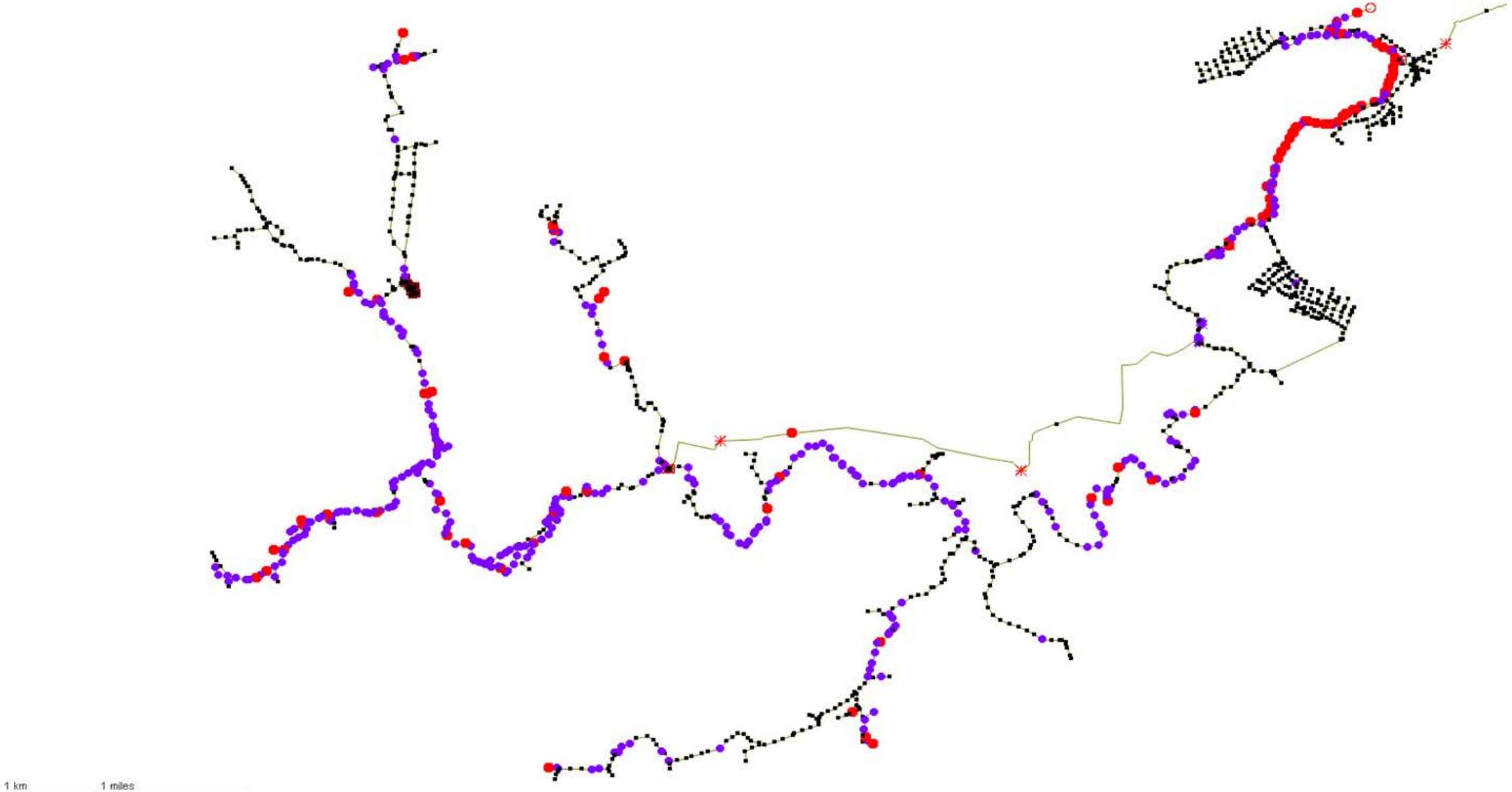








Results



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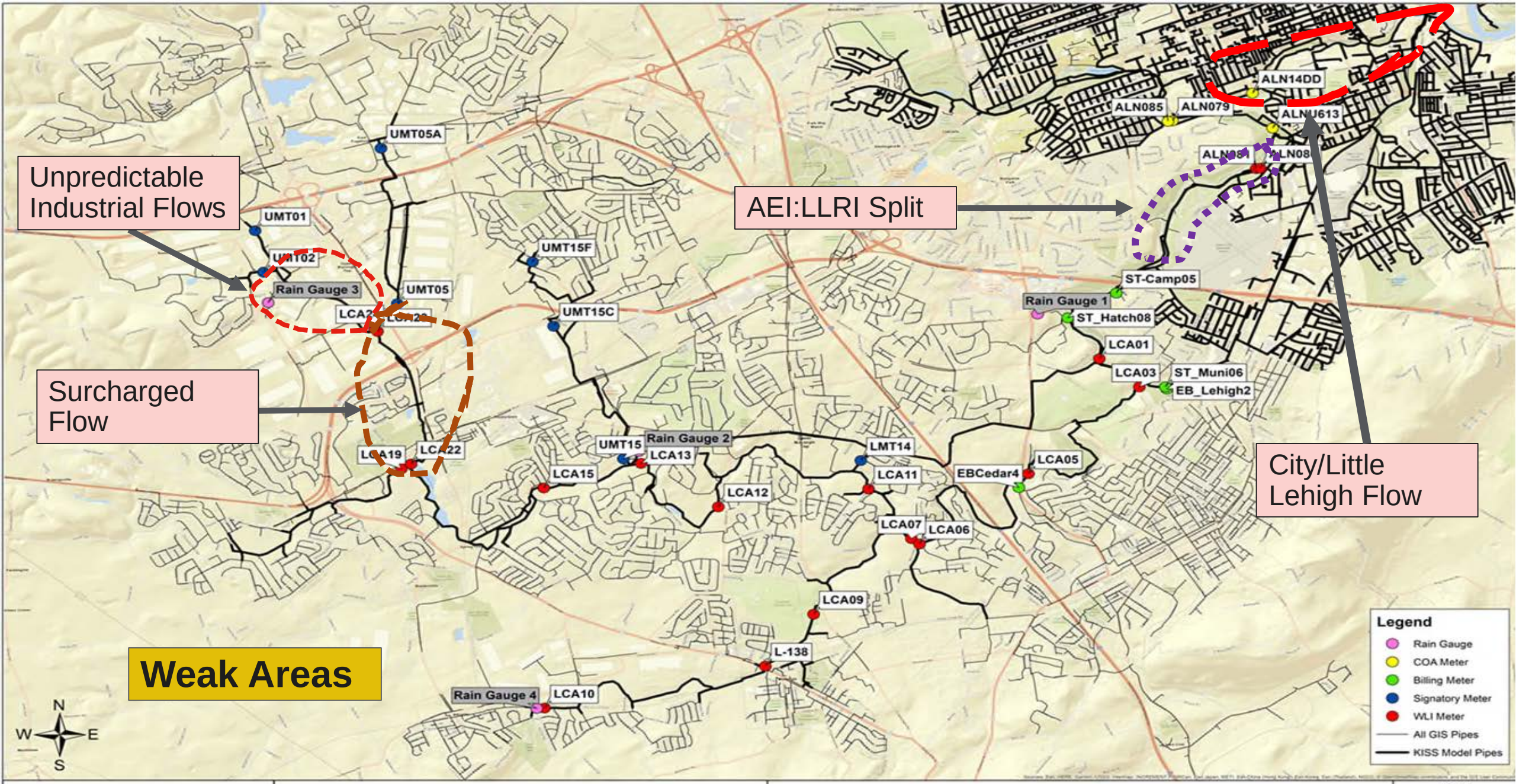
Where are WLSP model's strengths and weaknesses?



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Lehigh County Authority
Sanitary Sewer Capacity Assurance

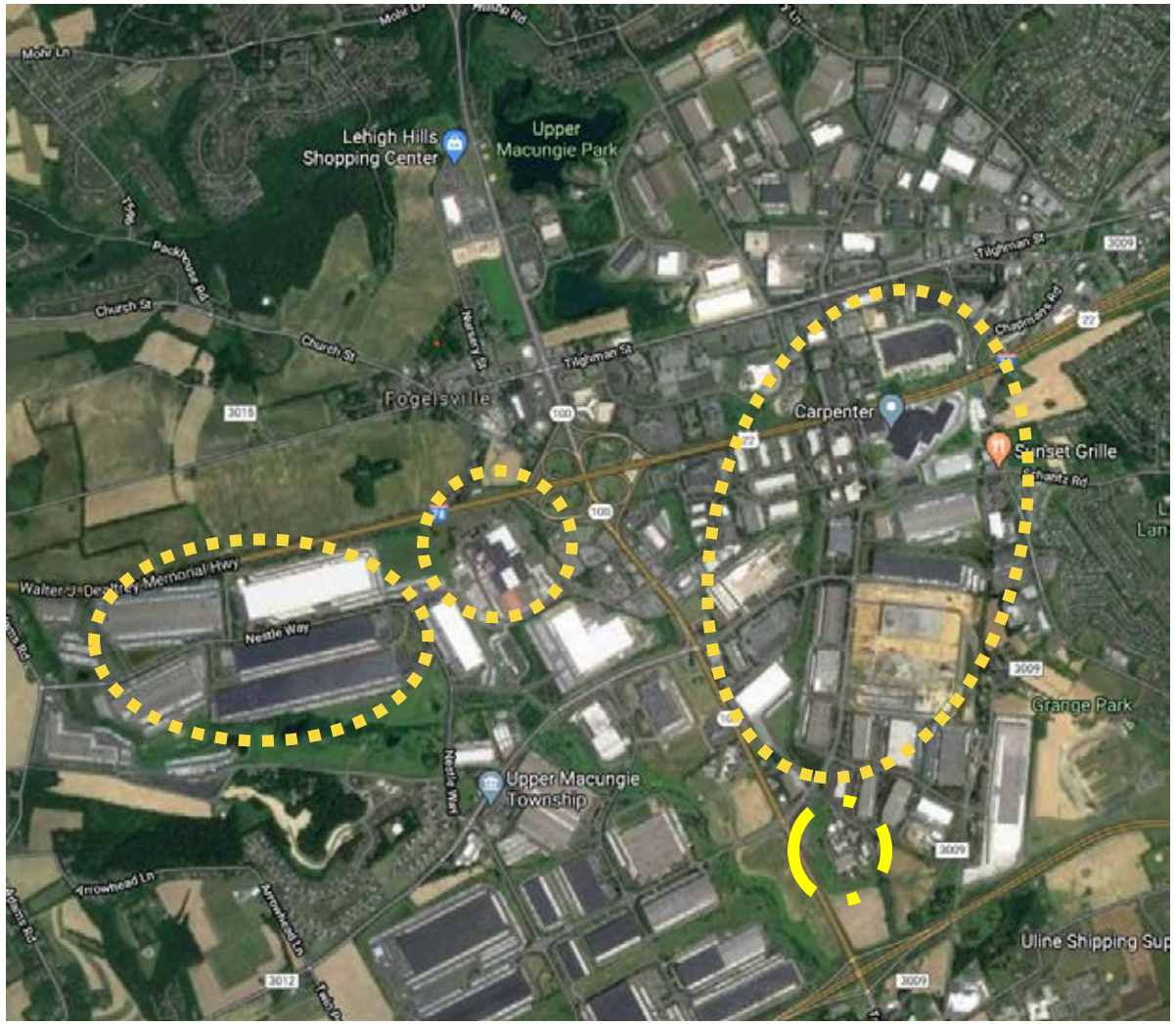
WLSP 2019 FLOW METER LOCATIONS

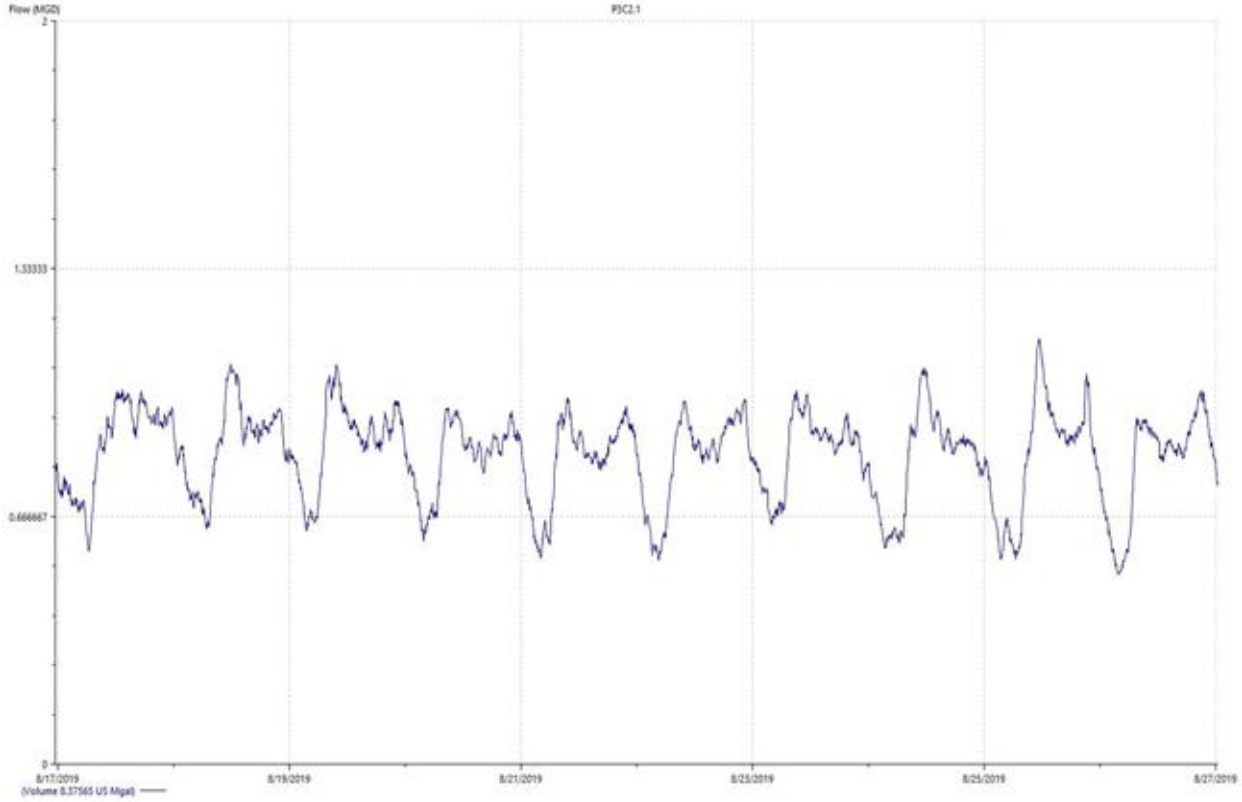
ARCADIS

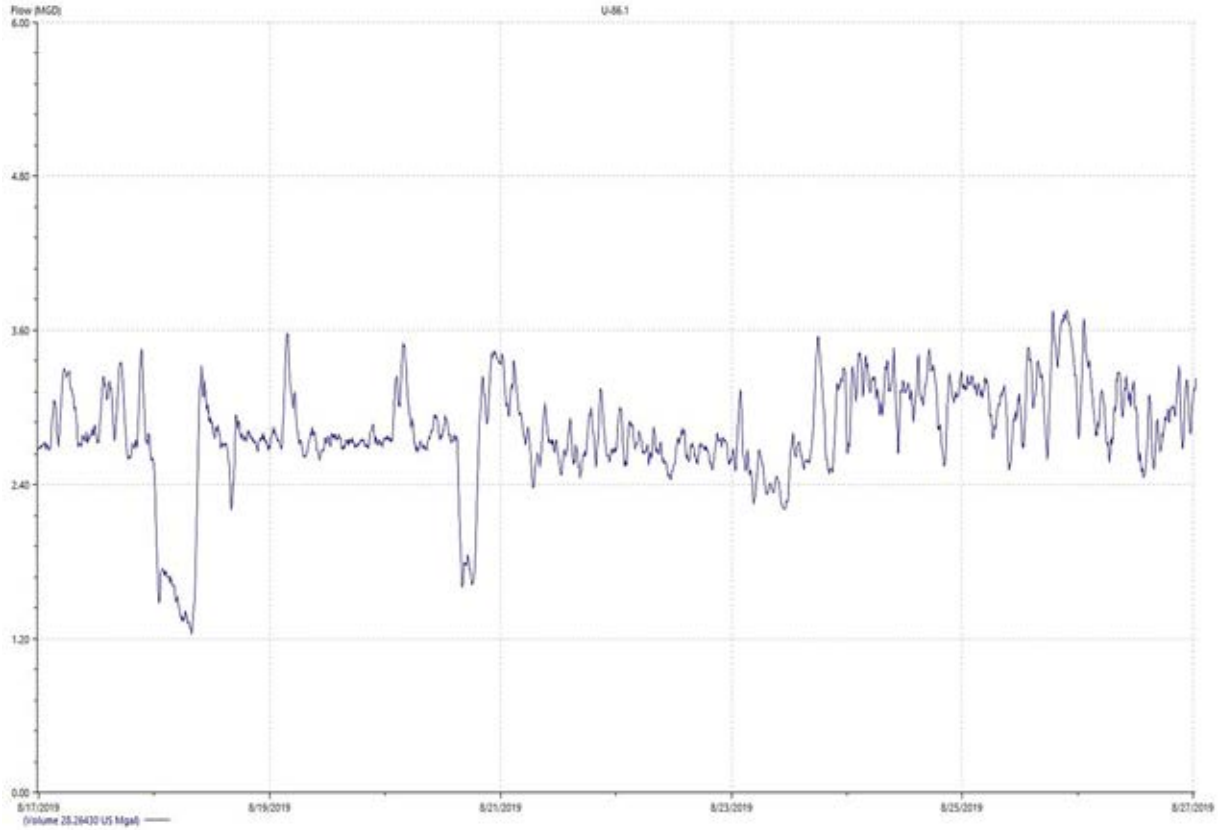
NOVEMBER 2019

Weakness – Upstream of Pretreatment Plant

- Flow to Pretreatment Plant is very accurate on weekly and sometimes daily basis, but hour to hour is a median type of performance predictor
  - Typical of highly industrial areas. Nothing can be done about this







Normal Diurnal Curve

Industrial Diurnal Curve

Weakness – Upstream of Pretreatment Plant

1. Flow to Pretreatment Plant is very accurate on weekly and sometimes daily basis, but hour to hour is a median type of performance predictor
   - Typical of highly industrial areas. Nothing can be done about this
2. Very high levels of leakage coming into Upper Iron Run Trunkline during metering
3. Impact of residential flows muted
4. High surcharges in UIRTL muted rainfall response
5. PTP parshall flume underreporting during peak flows

PTP segregation will require high, low, and average runs to evaluate impact

PTP direct discharge scenarios will require high, low, and average runs to evaluate impact

2021 recalibration will provide better response to rainfall characterization (assuming normal rainfall patterns)

Weakness – PTP to Trexlertown

- Flow from PTP to Trexlertown impacted by extreme surcharging
  - Made for chaotic flow patterns
  - Brenigsville and IRTL flows combat each other all day long
  - Muted response to rainfall because no way to increase
    - Overflows were occurring regularly

Trexlertown Interceptor design will require high, low, and average runs to evaluate impact

2021 recalibration will provide better response to rainfall characterization (assuming normal rainfall patterns)

Weakness – Allentown Emmaus Interceptor : Little Lehigh Relief Interceptor Split

- Flow between these two interceptors flowing into Park Pump Station don't conform to meter data
  - Mass balance and depth often are out of sync
    - Multiple cross connections
    - Siphons
    - Debris

Doesn't impact total balance of flows to PPS

Will need to be resolved before the AEI is replaced ~2030

Weakness – LCA to City's Little Lehigh Interceptor

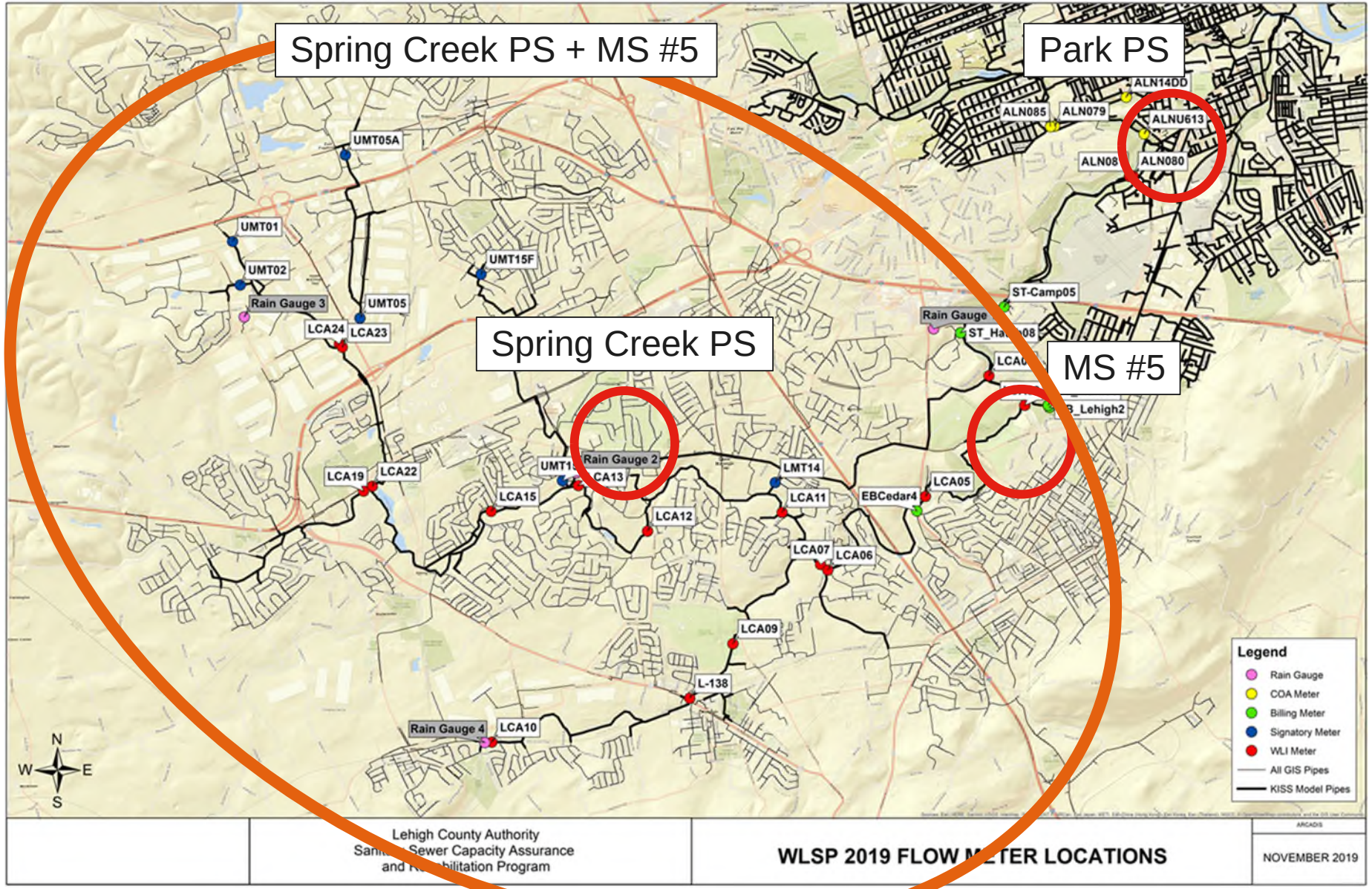
- Cedar Creek, Cedar Creek Relief, Allentown Emmaus, and Little Lehigh Interceptors don't add up and depths don't match meter data
  - Surcharged manholes
  - Debris
  - Mass balance just never works.
    - Moving meter locations in 2021

LCA impact on LLI is well modeled, but rest of contributors are not

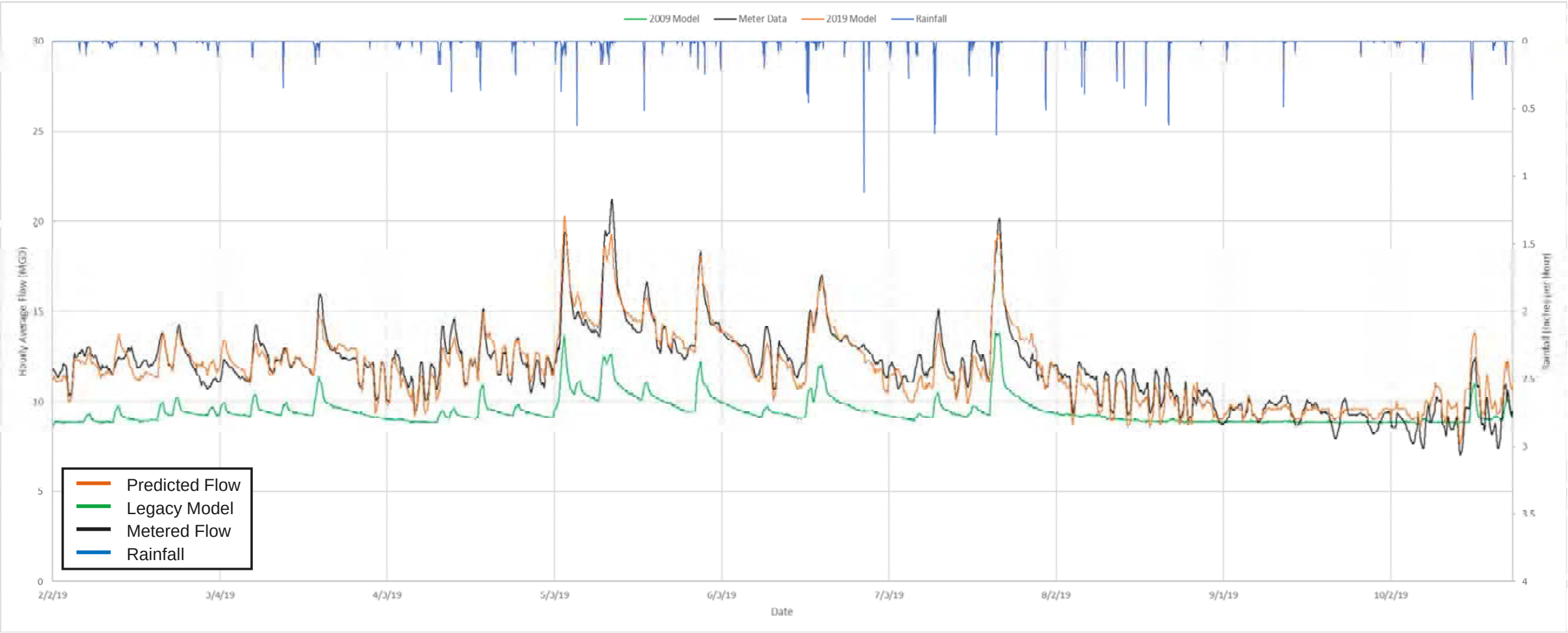
Strengths

- LCA wet weather and dry weather hourly flows to City interceptors
- Park Pump Station split of flows to Little Lehigh Interceptor
- Spring Creek Pump Station split of flows to Western Lehigh Interceptor
- Meter Station 5
- Alburtis Macungie Trunkline
- Upper Milford Trunkline
- Big improvement over 2009 model
- Handles extreme variations in weather/groundwater (New Normal)

Validating Changing Climate Responsiveness



2019 | Calibrated Vs Legacy



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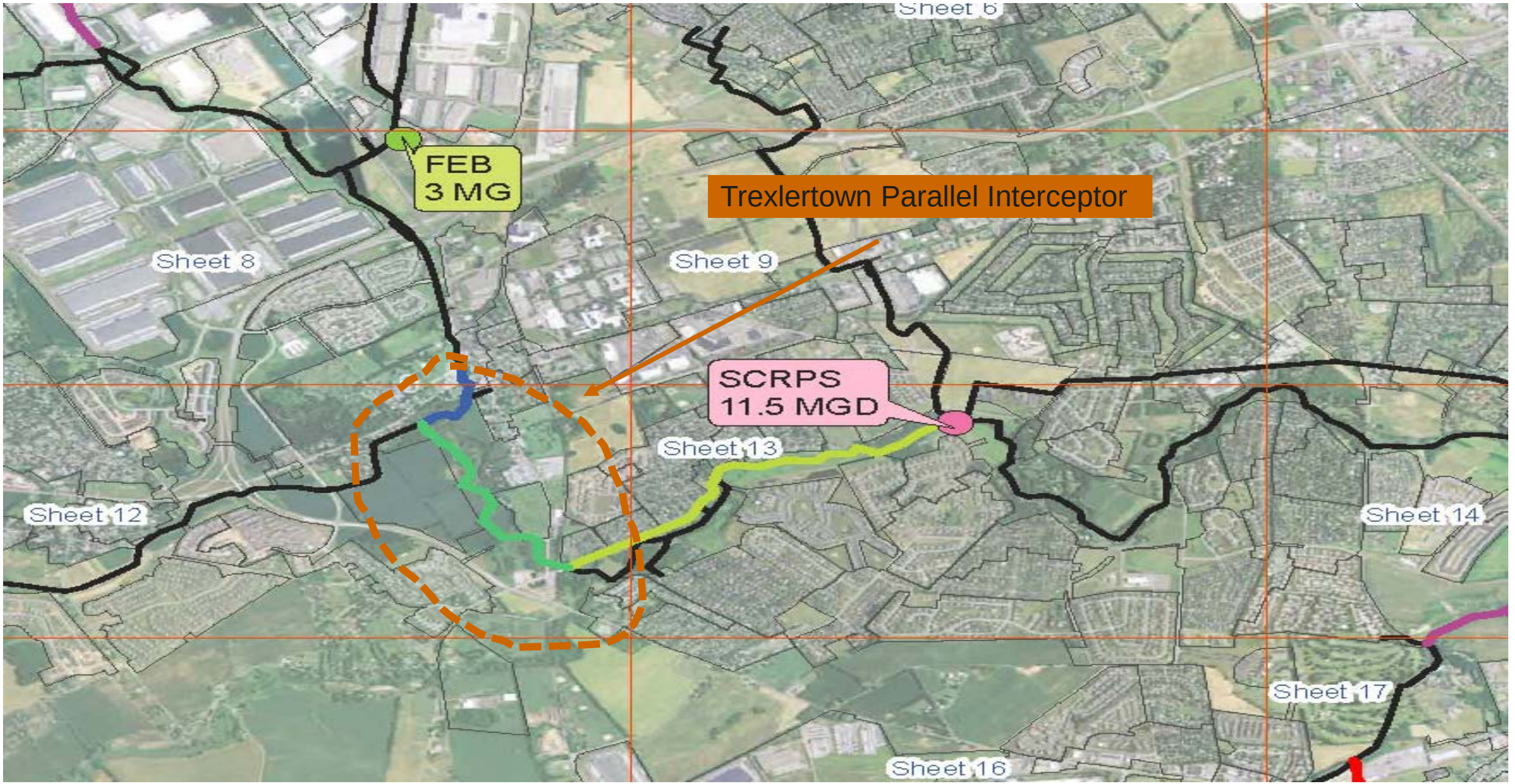
What are the things we are doing now with the calibrated model?

Some things can’t wait

- WLI is overloaded and can’t take either wet conditions (ala 2018-2019) or much more new development
- Need to develop our regulatory position wrt climate conditions
- Pretreatment Plant is at capacity
- Need to decide if direct discharge from PTP can work, and at what cost

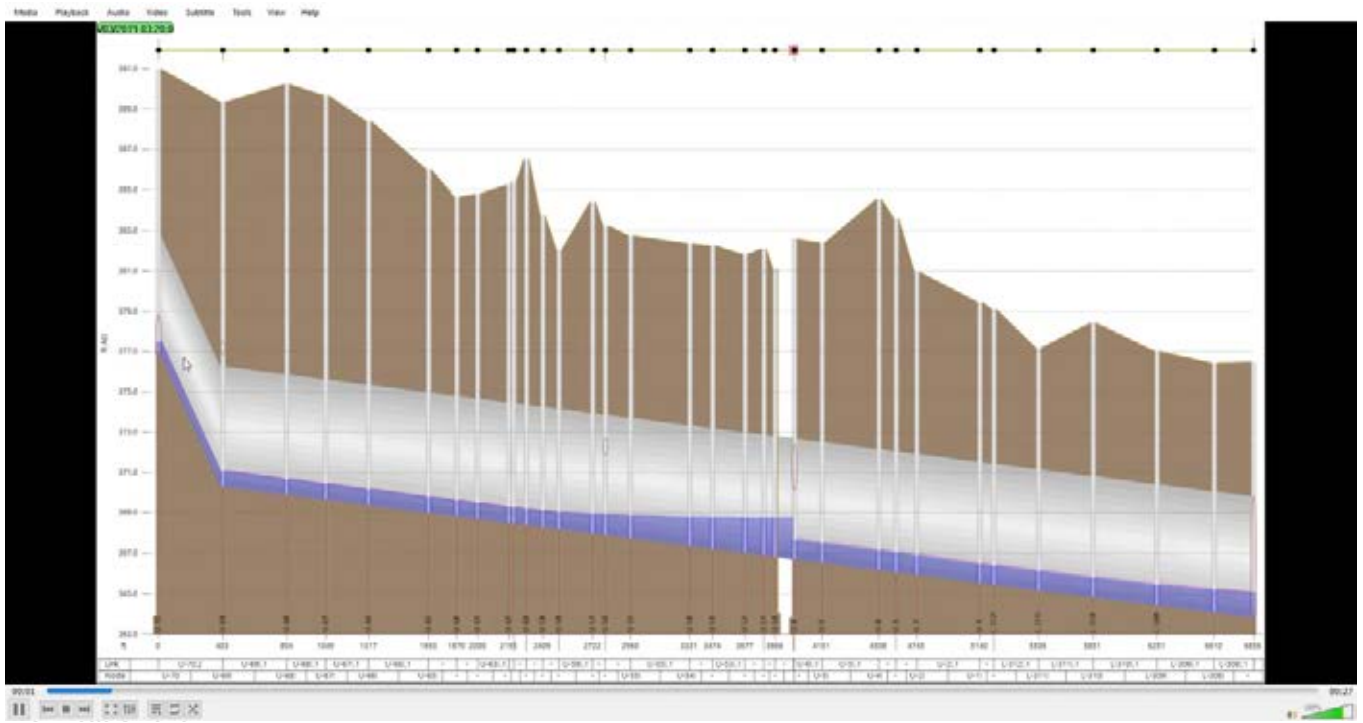

FEB
3 MG
Trexlertown Parallel Interceptor
SCRPS
11.5 MGD
Sheet 6
Sheet 8
Sheet 9
Sheet 12
Sheet 13
Sheet 14
Sheet 16
Sheet 17

Trexlertown Interceptor/In-line Storage

- Interceptor from Gun Club through to Spring Creek Road grossly surcharges throughout day in 2018-2019
-

Trexlertown Interceptor/In-line Storage

- Need model to determine hydraulic basis of design
  - Engineering has requested 21 scenarios
    - Alignment, sizing, impact on downstream flows



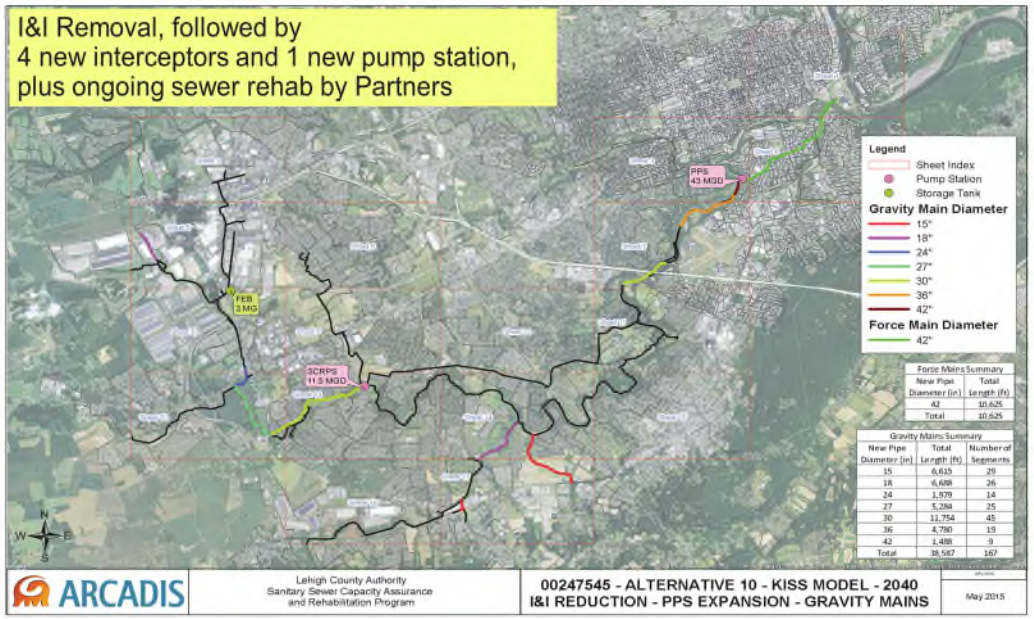
Interceptor upgrade is out of normal sequence of construction

Need to prove no increase in peak flows to City

Is 2018-2019 the “New Normal” …..and what will it cost?

- Dry day flows were up 30% in August 2018 to May 2019 due to frequent though unremarkable rain showers
- Rainy day flows impacts were also up significantly
- PADEP indicates 2018-2019 are the conditions around which capital planning should be conducted

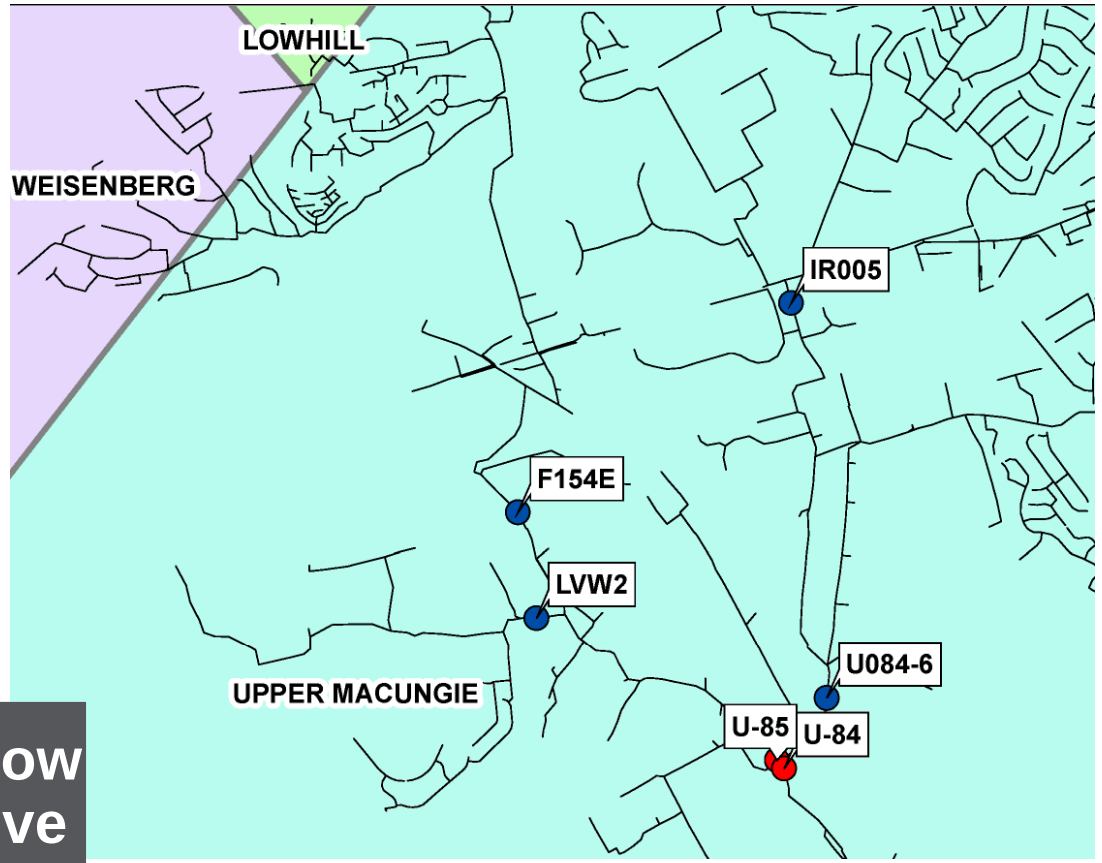
Compare 2018-2019 10-year storm infrastructure demands against 2009 flow demands



How much more will this regulatory fiat cost?

Ensure Pretreatment Plant capacity available for industry growth

- PTP capacity is 4.8 MGD (5.7 MGD is we stop accepting truck waste)
- Dry day flows into PTP for 1Q20 averaged 5 MGD, was above 6 MGD 15% of the time, and regularly daily peaked above 7 MGD
- Flows were so high as to be unmeasurable in 2018



Segregating residential flow from industrial flow prevent expensive PTP expansion and improve wet weather protection of PTP

Can Pretreatment Plant NPDES discharge yield better long-term sewer solution?

- Reduced wet peak and dry day expansion costs at Kline’s Island
- Reduced conveyance improvements?

Need to evaluate costs implications, starting with what costs are incurred and/avoided at Kline's Island and at PTP

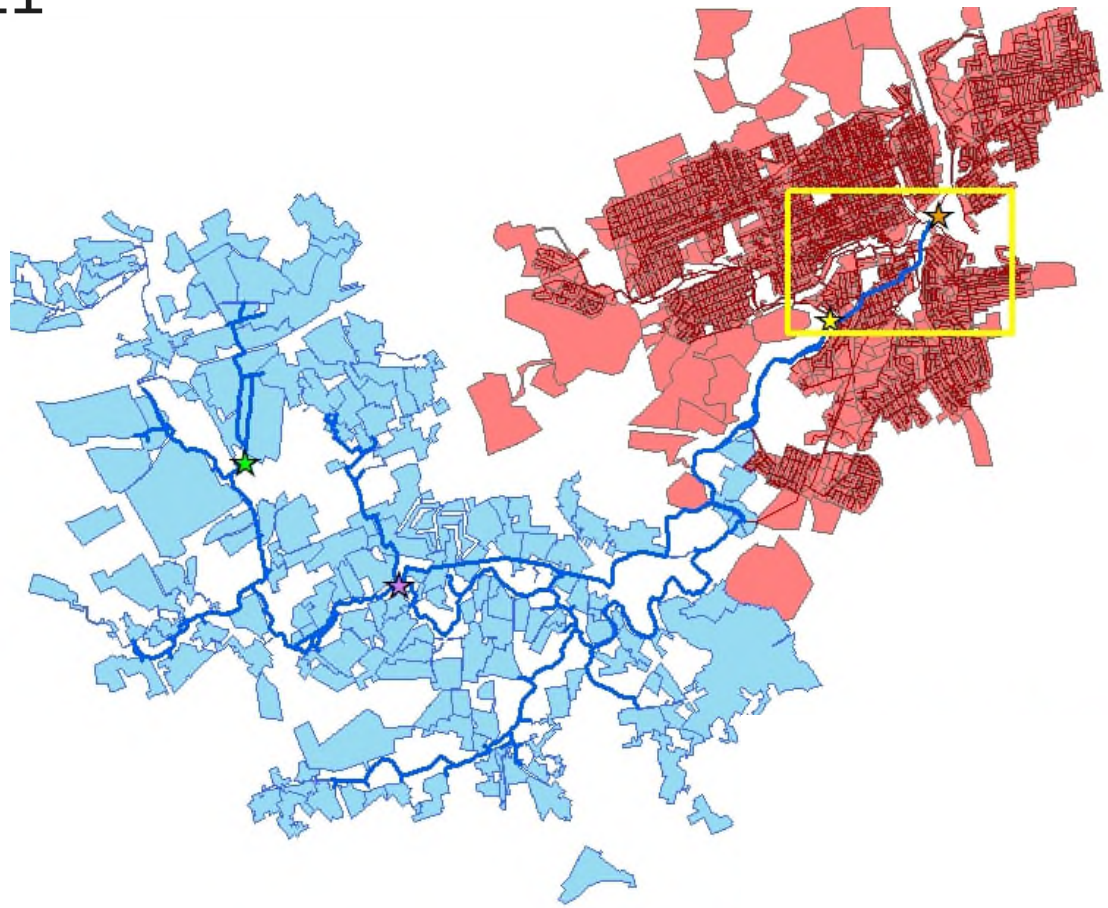
What’s next for flow characterization?

2020 WLSP Source Reduction Flow Monitoring

- ~40 meters installed at locations selected by Alburtis, Macungie, Upper Macungie, and Lower Macungie
- Metering will help them scope final phase (laterals and tap) of their individual Source Reduction Programs
  - SRP's slated to be completed by end of 2025
  - Regulators may dictate faster pace (537 process)

2021 Metering – Characterization – Model Calibration of full KISS model

- More than 100 meters used to calibrate 2021 KISS model
- Connect calibrated WLPS model to expanded KISS model
- Will use 9 – 12 meters in WLI to tie calibrated model to KISS model
  - Mostly existing permanent meters
  - Ensures commonality of data
  - Will improve WLSP model too



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Discussion