Maximizing Your Investment

City of Lorain Collection System Optimization Eliminates SSOs

Ohio Water Environment Association

June 24, 2015

Mary Garza – City of Lorain

Laura McGinnis, P.E. – ARCADIS

Tim Ruggaber, P.E. - EmNet

Speakers

Laura McGinnis (ARCADIS) – Collection system planning and regulatory support

Tim Ruggaber (EmNet, LLC) – Lead Optimization Strategist

Mary Garza (City of Lorain) – Utilities Director

Learning Goals

- Learn how the City established a real time data system
- Understand what information the City collected, and how was it used
- Explain what data is necessary to perform an optimization study
- Describe the challenges and benefits of real time data

Topics

- **Lorain**
- Moving Forward
- Optimization
- Lessons Learned & Next Steps

Lorain – "The International City"

- Mouth of the Black River and Lake Erie
- Population ~ 64,000
- Industrial & Steel Town

Separate Sanitary Sewer System

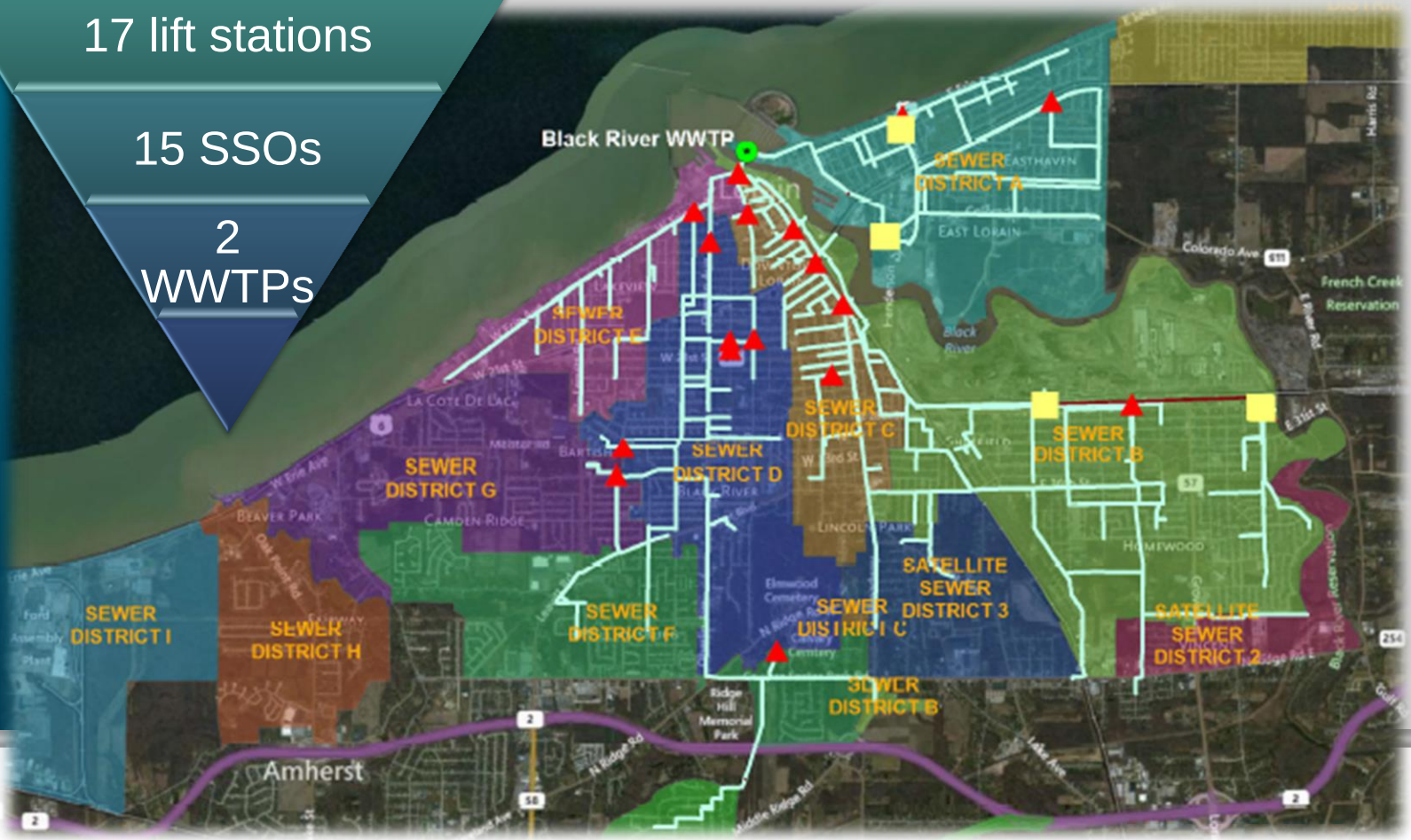
270 miles of gravity sewers

9 miles of force mains

17 lift stations

15 SSOs

2 WWTPs



1974	• First NPDES permit issued
1981	• SSES documented excessive I/I
1984	• NPDES renewed • Ohio EPA issued Findings & Orders
1985	• General Plan Submitted • Second WWTP Constructed (relieved overloading at WWTP, but not SSOs)
1995	• New NPDES Permit issued; required SSOs be monitored and required all SSOs be eliminated by 2001
2000-2007	• Constructed retention basins and relief sewers

2005
- Revised Findings & Orders to reconsider downtown retention basin

2006
- Flow monitoring & collection system modeling
- Preliminary tunnel recommendation to meet wet weather storage needs

2011
- US EPA steps in
- SSO monitoring overhauled

2012
- Tunnel construction begins

2014
- US EPA issues Administrative Consent Order
- System optimization recommendations

2016
- Tunnel operational (expected)

Topics

- Lorain
- **Moving Forward**
- Optimization
- Lessons Learned & Next Steps

SSO Monitoring Take 1

Visual Inspections

- Every SSO, every storm
- One time check
- Labor intensive
- High cost
- Only minimal data
- No dry weather data
- No context for data

SSO Monitoring Take 2

Permanent Flow Monitors

- 11 SSOs metered
- Several unmetered SSOs
  - Thought to be inactive
- More data
  - Dry Weather and Wet Weather events recorded
- Spent 3 days/month downloading
- Delayed data
- No dry weather overflow protection
- Lacked context
- Conjecture, not solutions

SSO Monitoring Take 3

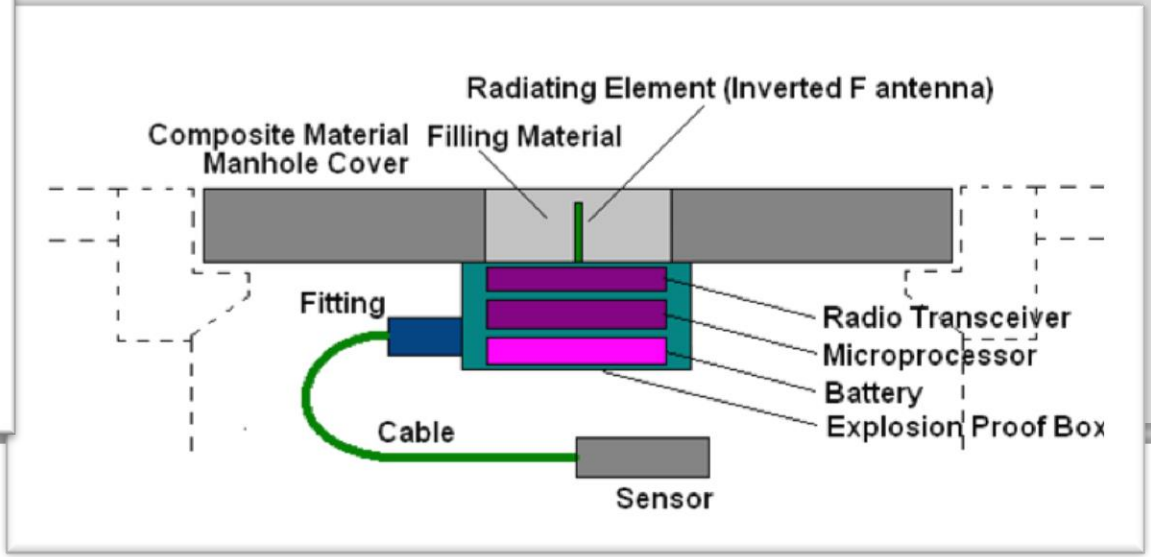
Permanent Flow Monitors with Real Time Decision Support Systems

- 15 SSOs metered
- Web-based real time data
- Alerted to dry weather overflows
- Decreased man-hours
- Context!
- Increased confidence!

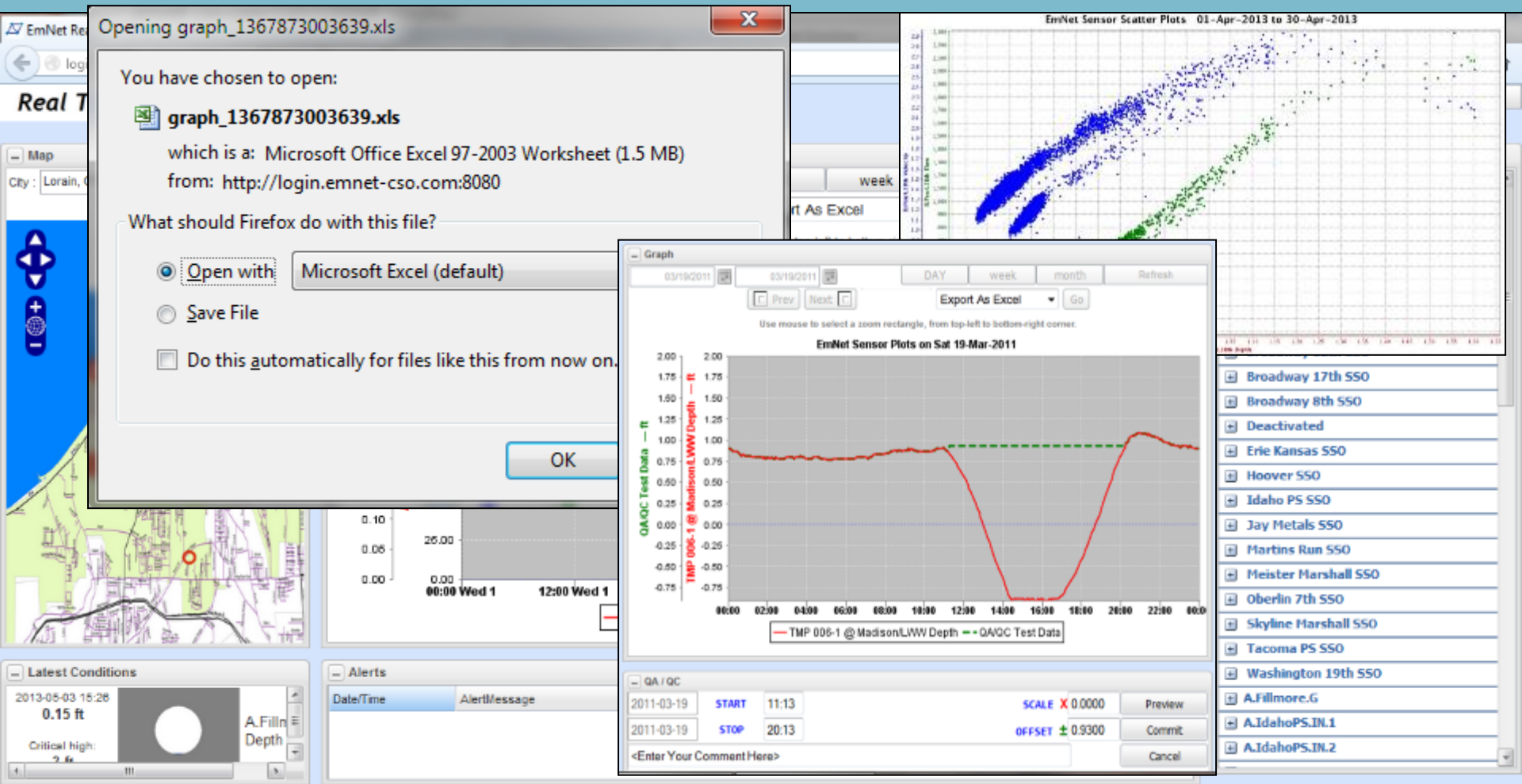
ARCADIS

Real Time Data Collection

- Deployed December 2011
- Computerized manhole covers
- 1 year battery life
- Cellular enabled
- Connect to any sensor
- Measure data every 5 min
- Dry weather – 3 hour upload
- Overflow – Real time upload
- Kick off real time alerts!



Real Time Web Portal

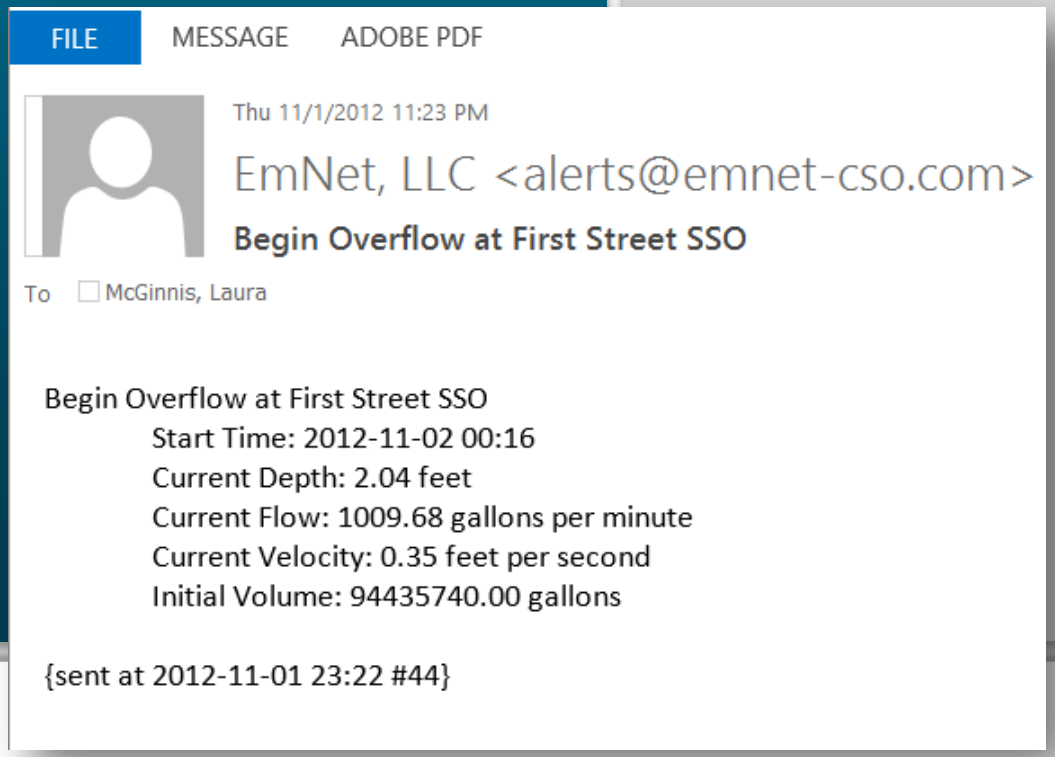


- Available anywhere, anytime
- Time and space context

ARCADIS

Real Time Data Gives the City Knowledge to Make Decisions

- Know *when* events occur
  - Start/end alerts
  - Real time data
- Know *where* events occur
  - Perennial overflows
  - Rogue overflows



FILE MESSAGE ADOBE PDF

Thu 11/1/2012 11:23 PM

EmNet, LLC <alerts@emnet-cso.com>

Begin Overflow at First Street SSO

To McGinnis, Laura

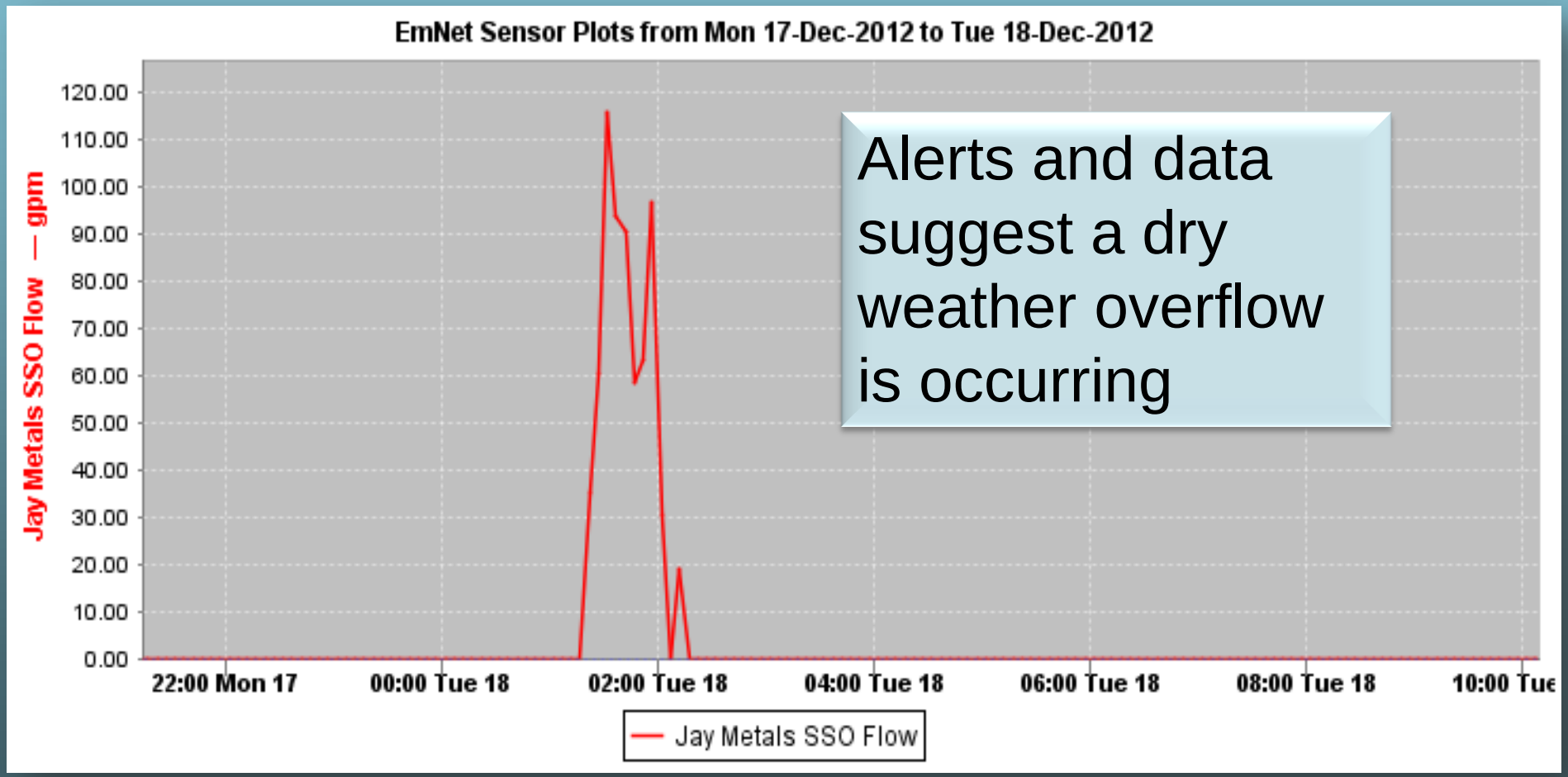
Begin Overflow at First Street SSO
Start Time: 2012-11-02 00:16
Current Depth: 2.04 feet
Current Flow: 1009.68 gallons per minute
Current Velocity: 0.35 feet per second
Initial Volume: 94435740.00 gallons

{sent at 2012-11-01 23:22 #44}

Some growing pains though…

ARCADIS

Phantom Overflows

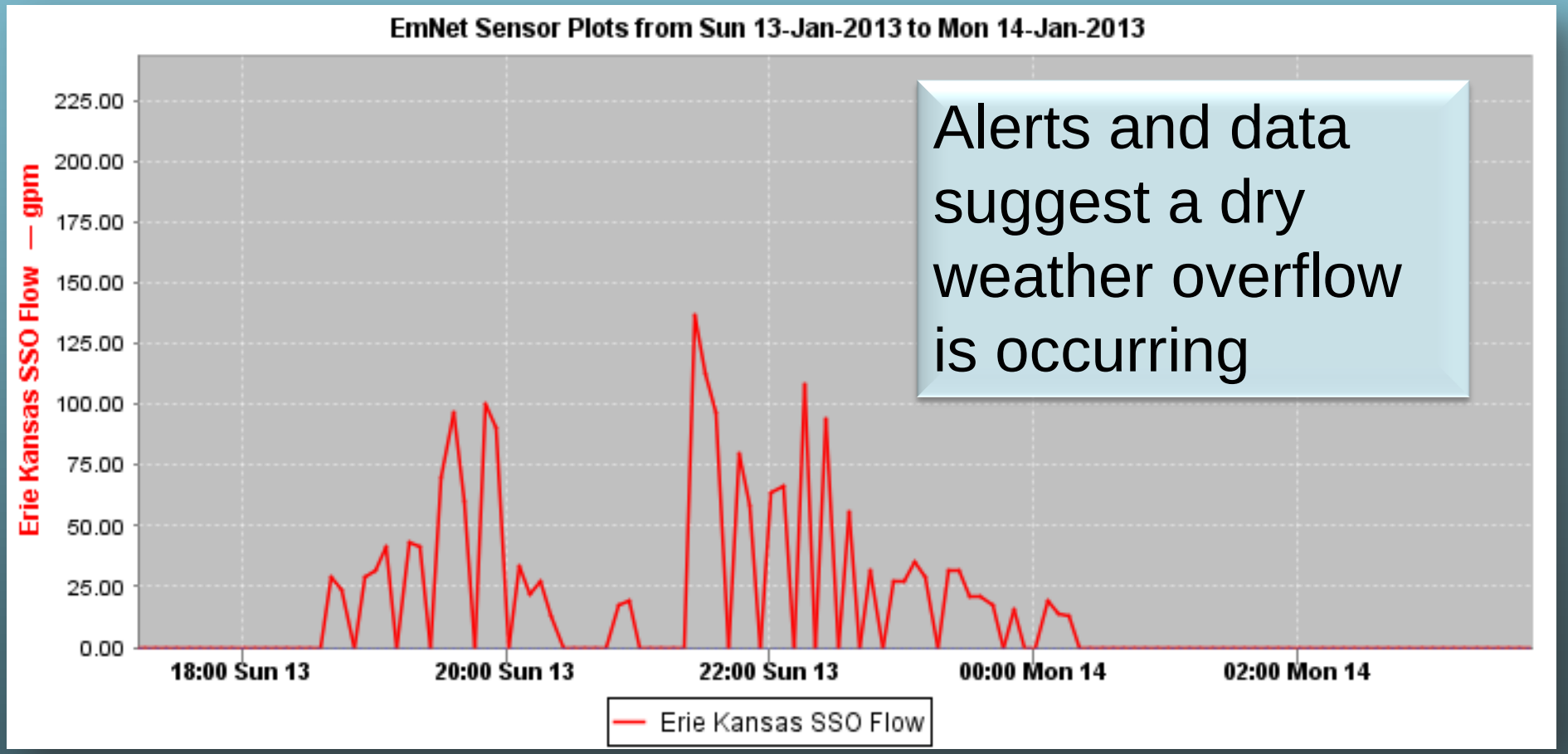


Phantom Overflows

No flow over the weir to the SSO

But flow in the outfall pipe…

Another Phantom Overflow



Another Phantom Overflow

No elevated sanitary sewer flows into the outfall pipe

Phantom Alerts

- Real time data alerted City to potential SSOs during dry weather
- City sent field crew to investigate
- City found no excessive flows and weir not overtopped
- So, what happened?
  - Outfall primarily a stormwater outfall with I/I
    - Solution – temporarily close SSO to confirm no negative impact
  - Catch basins tributary to outfall pipe caused interference with sensor
    - Solution - relocate sensor
- Benefits
  - City better understands system
  - Identifies potential SSOs to close
  - Answers to questions!

Real Time Data as a Backup Plan

- SCADA and Flow Monitors work together
- Five pump stations have associated SSOs
- Real time alerts flagged irregular SSO activations during both Dry and Wet Weather

Real Time Data as a Backup Plan

- Actions
  - Checked against SCADA
  - Field crew investigated
- Benefits
  - Identified pumping issues
  - Identified equipment failures
  - Allowed City to improve pump operation rules
  - Allowed City to mitigate dry weather overflows quickly!

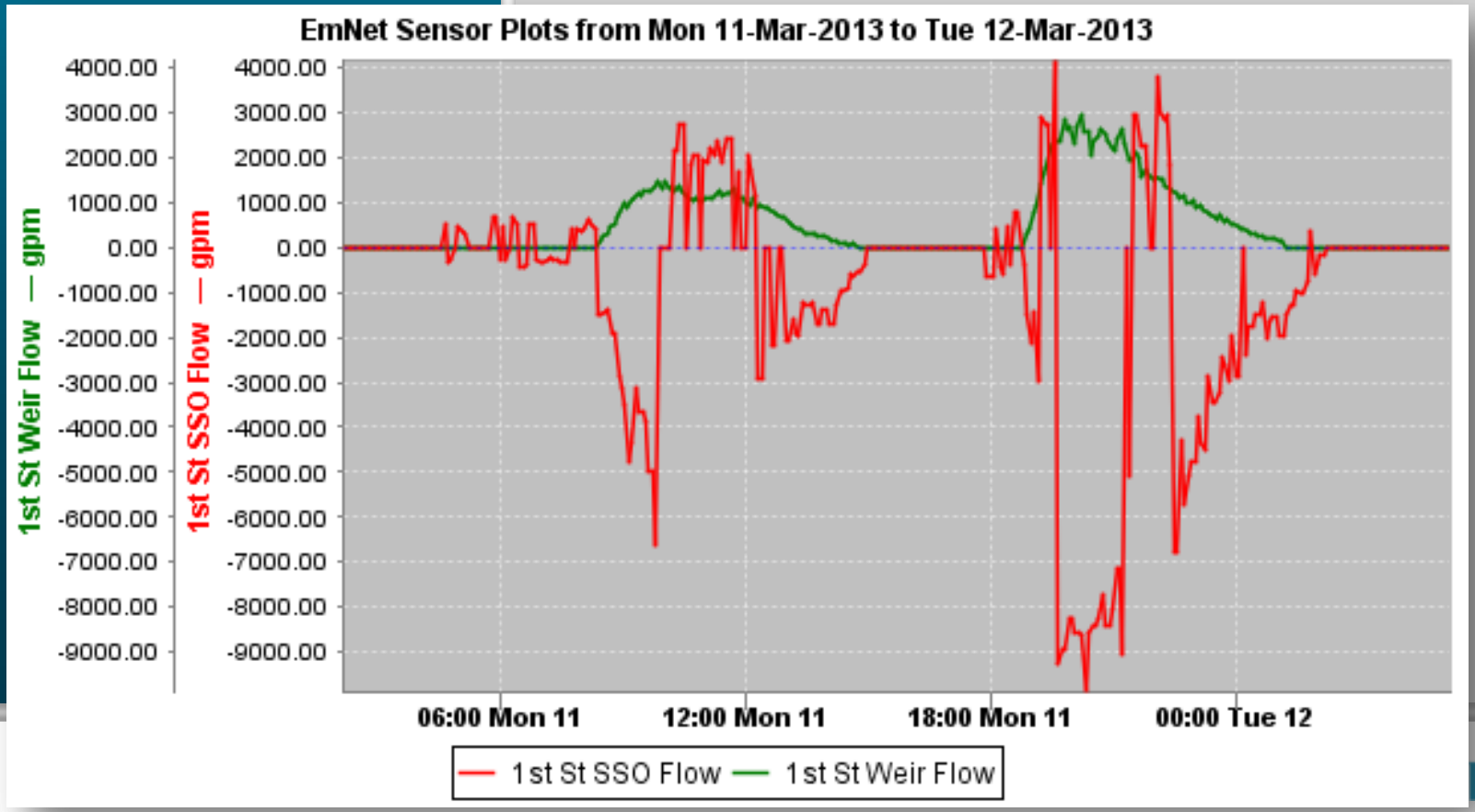
Rogue System Failures

- Real time alerts during dry weather
- Negative velocity recorded
- City field verified
- Found stormwater backflowing over sensor into sanitary sewer
- Diver inspected and found collapsed outfall pipe!
- City repaired the outfall pipe
- Benefit
  - Reduced stormwater volume sent to the WWTP!

ARCADIS

Suspect Alerts

- Real time alerts with data suspicious
  - Outfall pipe vs. in system
- City field verified during wet weather events
- Visual inspection not conclusive, initially…



Wave Action

- Backflow from Lake Erie/Black River
- Outfall elevation below water surface, currently
- SSO to be eliminated at completion of the tunnel
- Benefit
  - Less volume treated at the WWTP!

ARCADIS

SSO Flow Monitoring

- Every SSO's overflows examined and documented
- SSO data used to generate required reports and overflow notifications
- Sensors repositioned to give the best information
- Many SSOs are not activating during large events
  - City has plugged one SSO
  - More planned

From Guesswork to Answers

- Distinguish true overflows from phantoms
  - Compliance
  - True baseline → Right solutions
- Maintain sensor accuracy
- 300+ personnel-hours saved per year
- Focused inspections and results

Back to the Downtown Retention Basin…

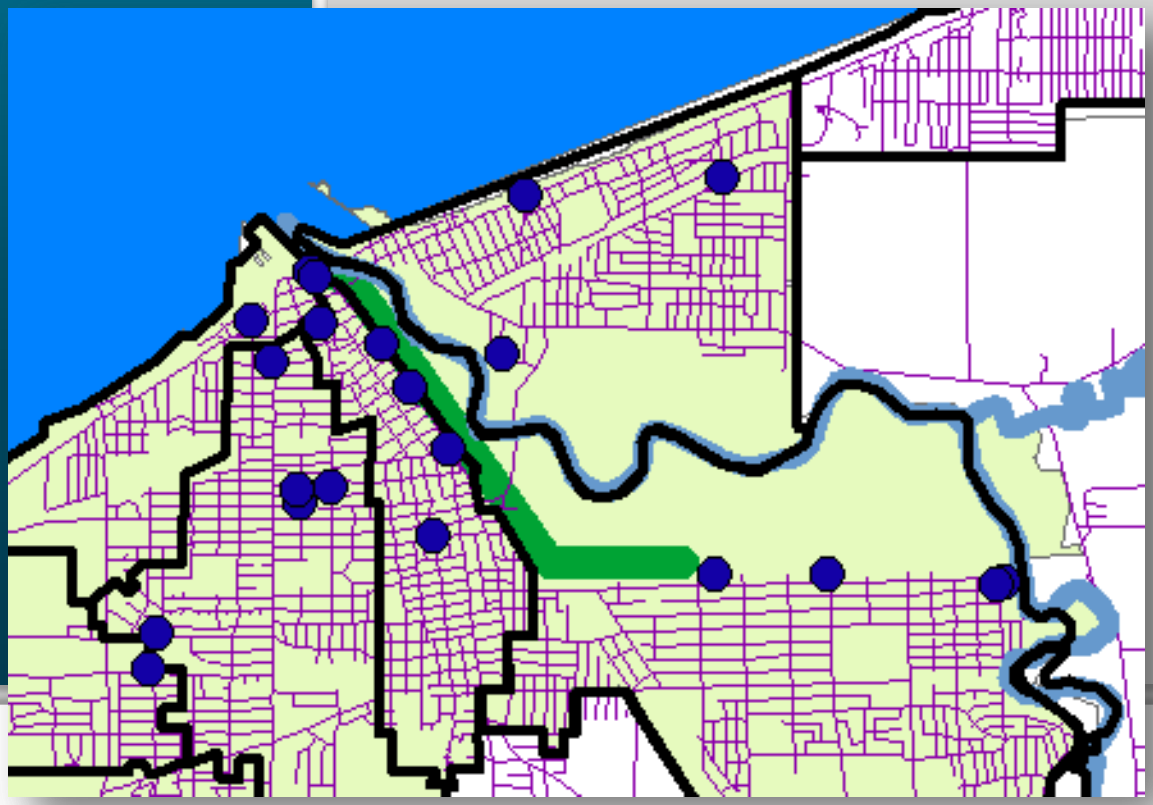
Downtown Retention Basin

- Eliminate largest SSO
- 7.8 MG above ground basin proposed
- Planned to be placed on prime riverfront/lakefront property

ARCADIS

Back to the Downtown Retention Basin…

- City proposed to reconsider options
- Study recommended storage tunnel
  - 13 MG
  - 19’ diameter
  - 5,560 feet
  - New emergency overflow structure



ARCADIS

Tunnel

Tunnel construction began 2012

- Diversion from west side interceptors
- Close existing SSO
- Flexibility to adapt to future collection system projects

Tunnel

- Two pass system
- TBM finished
- Shafts excavation complete
- Currently placing concrete & liner

Tunnel

- Operational in 2016
- Largest SSO will be closed!

Now What?

- Now that we know which SSOs are active and the events that trigger SSOs, what's the next step?
- How should the tunnel be operated to further eliminate and reduce SSOs?
- Would I/I reduction reduce SSOs?
- Can SSOs be closed without fear of creating water-in-basement issues?

OPTIMIZATION!

Understand System Dynamics

- Temporary flow monitors
- Detailed collection system model
- Confirm retention basin and pump station operation protocols
- System characterization
- Build future conditions

ARCADIS

Data Collection

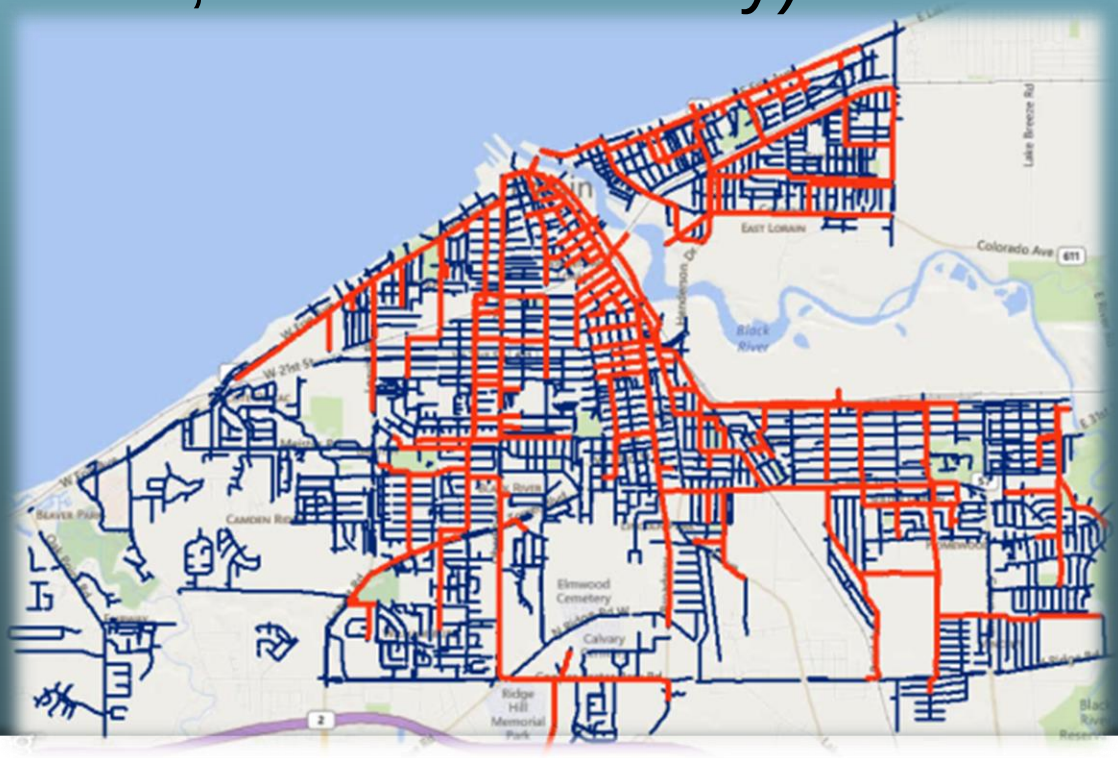
Flow and Rainfall Monitoring

- 34 Temporary Flow Monitors
- 16 SSO Monitors
- 3 Rain Gauges
- 6 City Rain Gauges
- 12 Months
- Review for Data Quality
- Identify Wet Weather Events

Model Development

Hydraulics

- Manhole and Pipe Network (GIS)
- Pump Stations, Regulators, Retention Basins, SSOs (As-Builts, Details from City)

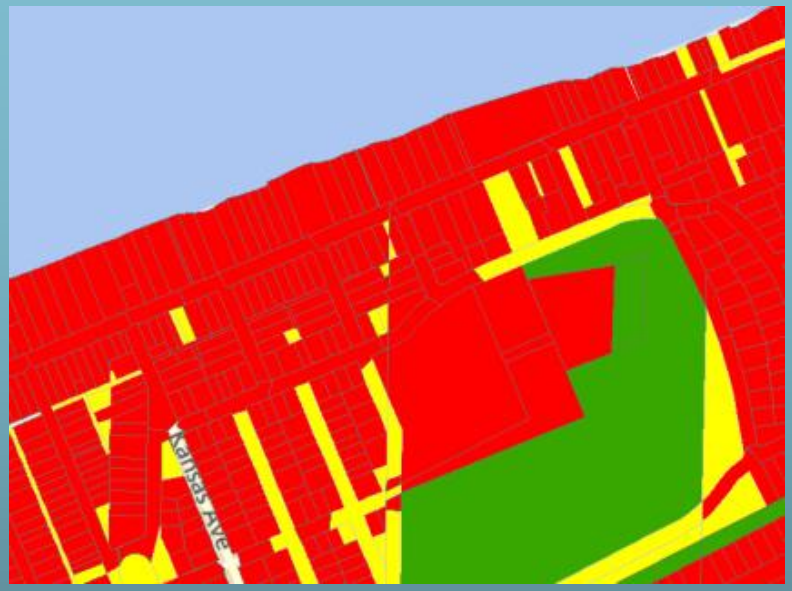


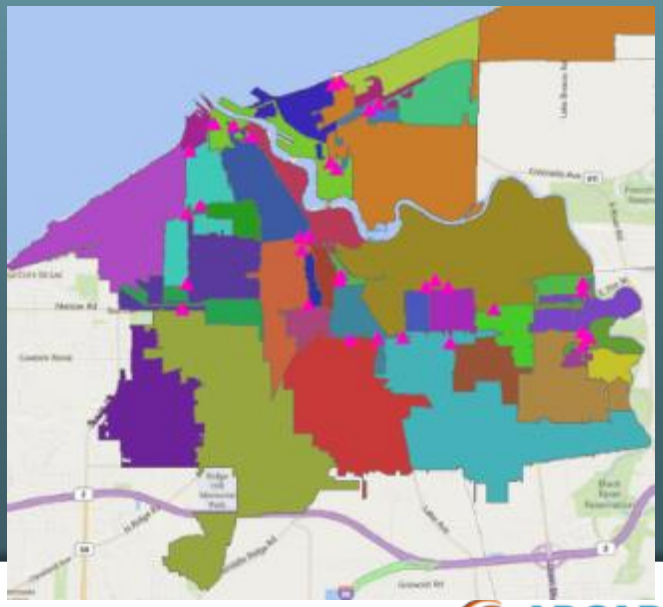
ARCADIS

Model Development

Hydrology

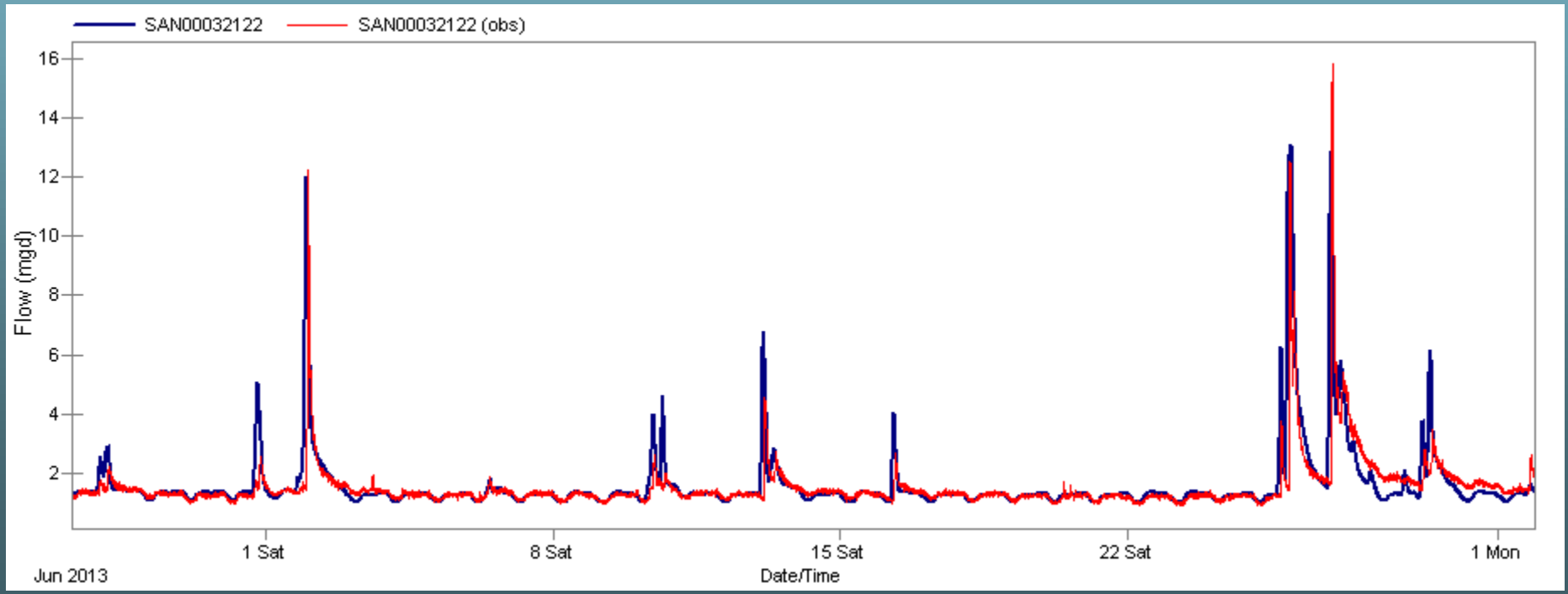
- Define Sanitary Sewersheds
  - Serviced
  - Non-serviced
  - Open
- Develop dry weather flow patterns and flows
- Assign initial parameters to mimic I/I based on flow monitoring data





Model Calibration

Influent to Pearl Avenue Pump Station



Topics

- Lorain
- Moving Forward
- **Optimization**
- Lessons Learned & Next Steps

Optimization Study

Finally! Ready to optimize the system!

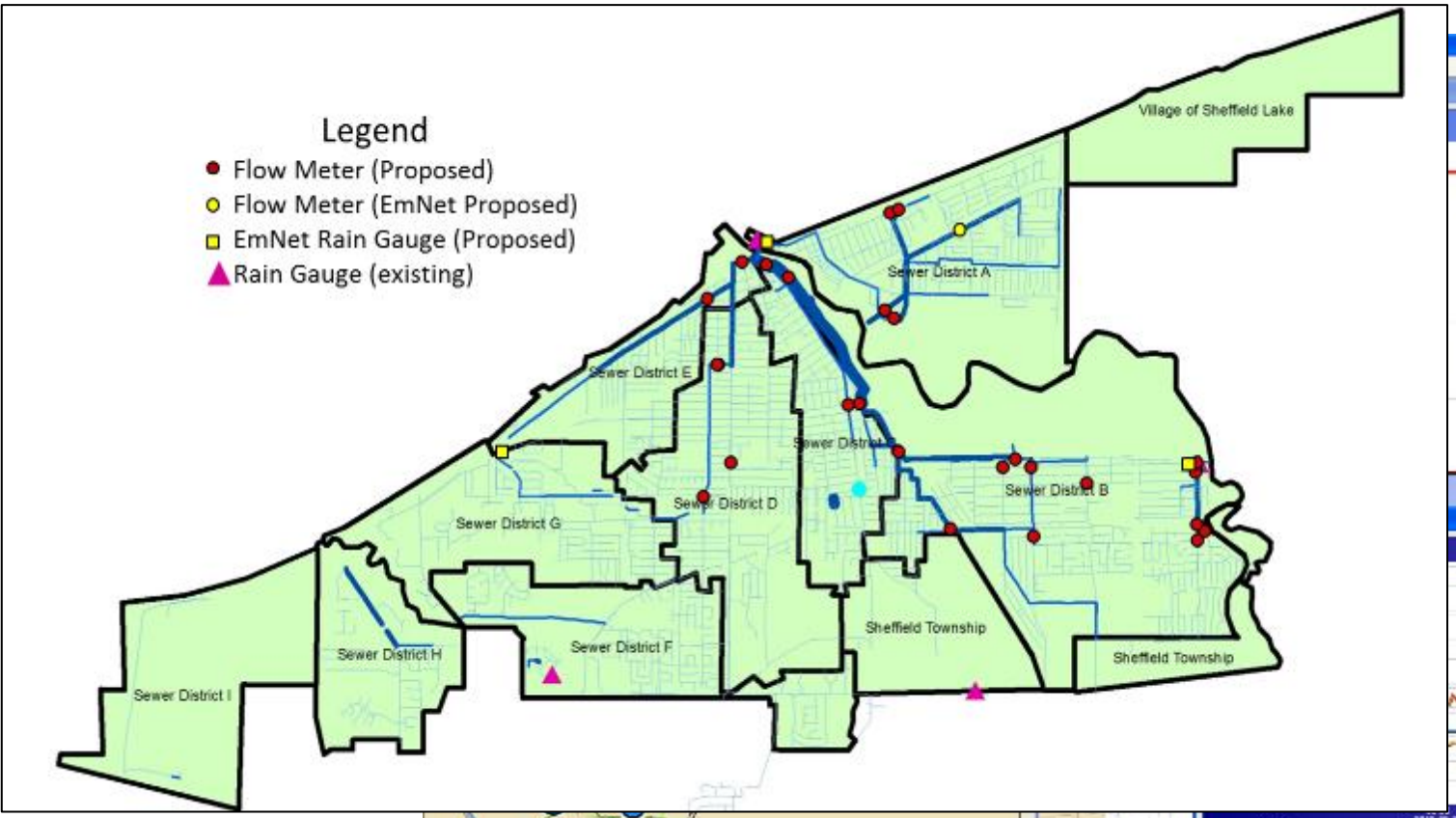
- ✓ Data
- ✓ Understand System Hydraulics
- ✓ Operational Rules

Optimization Goals

- Fully utilize the collection system before any overflows
- Maximize treatment
- Minimize overflows
- Eliminate SSOs whenever possible

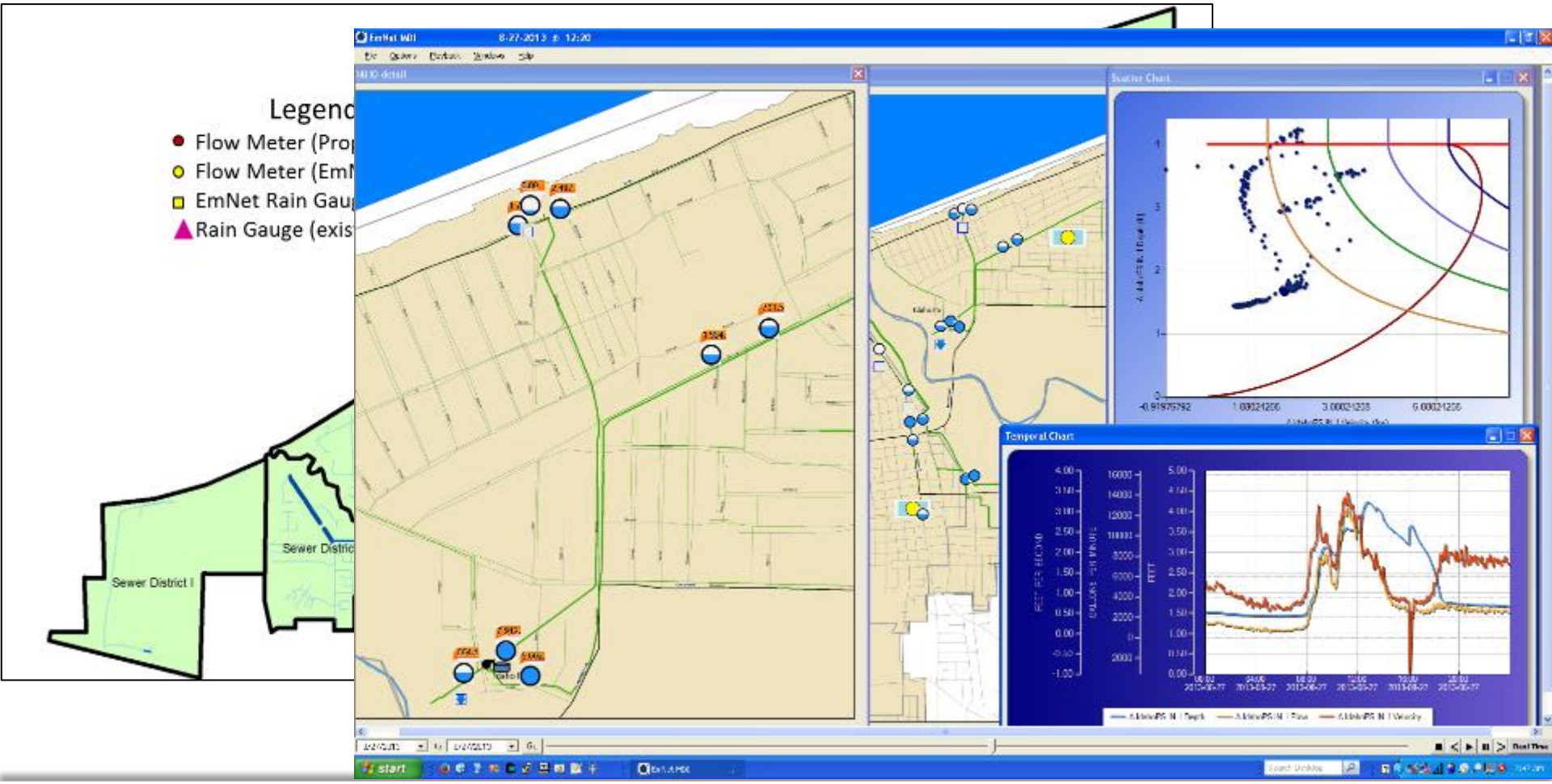
Step 1: Turn on the Lights!

EmNet uses monitoring systems to visualize data and create comprehensive real-time dashboards integrated with SCADA



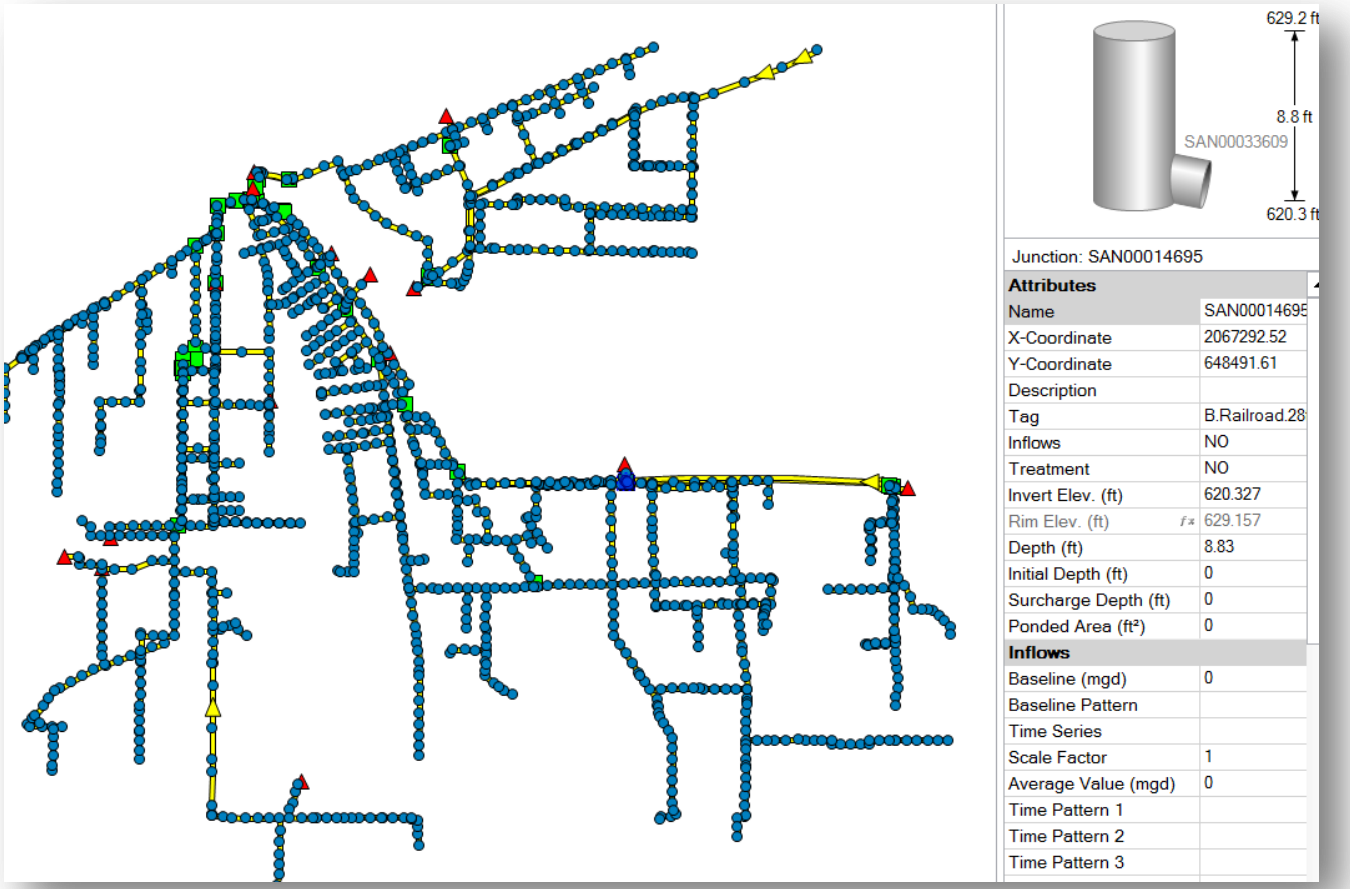
Step 1: Turn on the Lights!

EmNet uses monitoring systems to visualize data and create comprehensive real-time dashboards integrated with SCADA



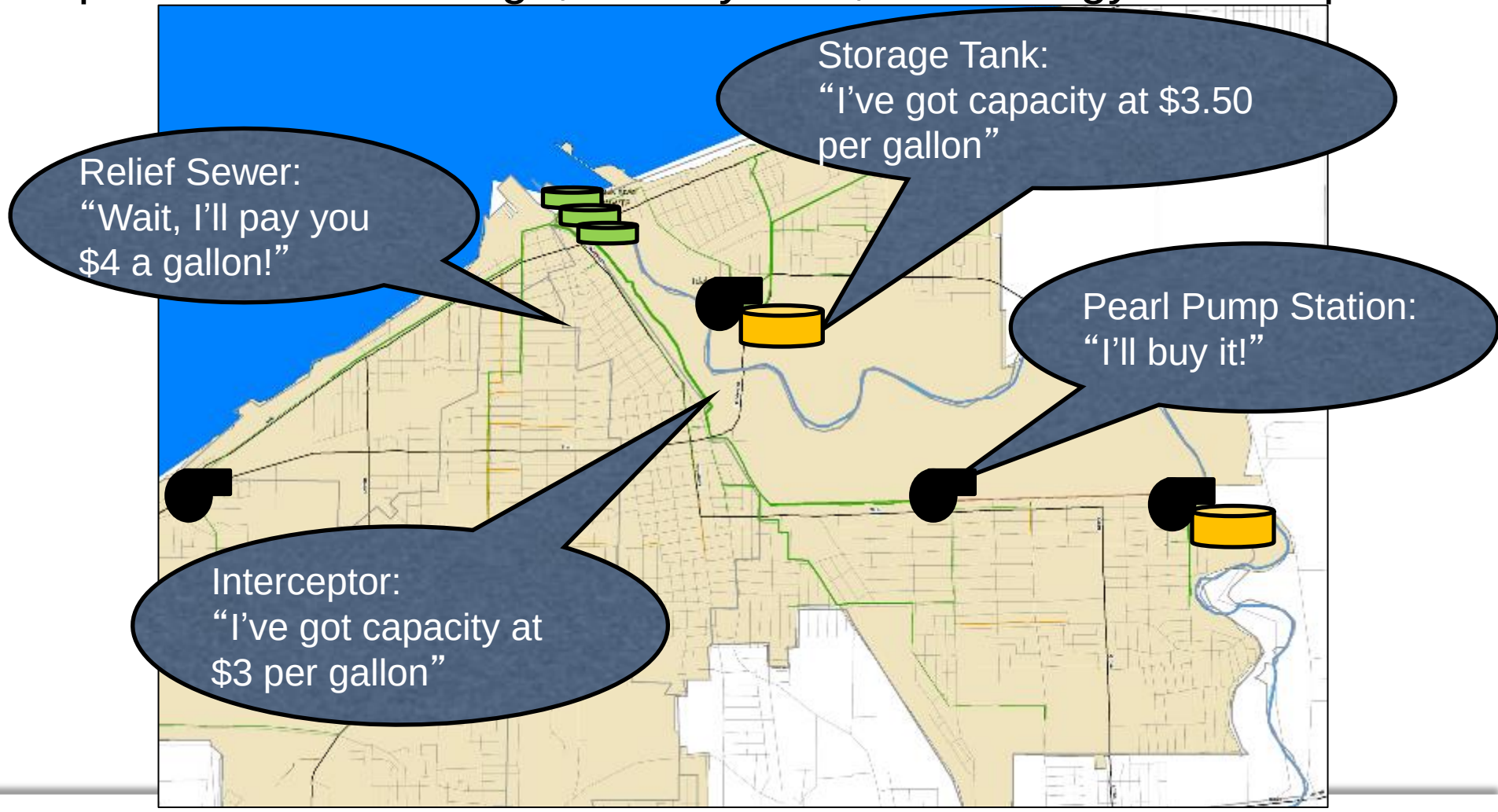
Step 2: Bring in the Model

We integrate the model to compare, predict, and analyze real time data and information



Step 3: Optimization

Agent-based computing generates rules to achieve global optimization of storage, conveyance, and energy consumption.

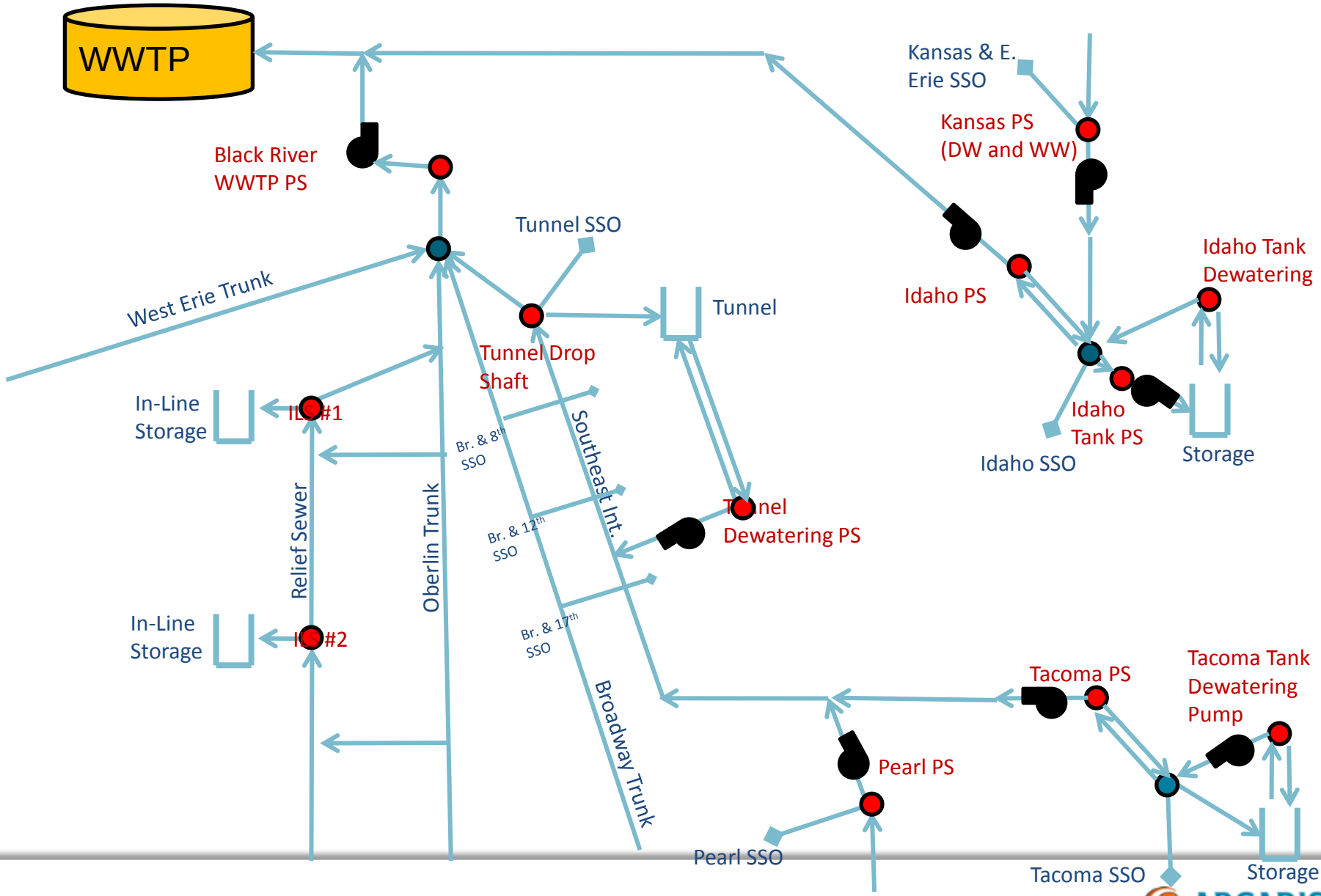


ARCADIS

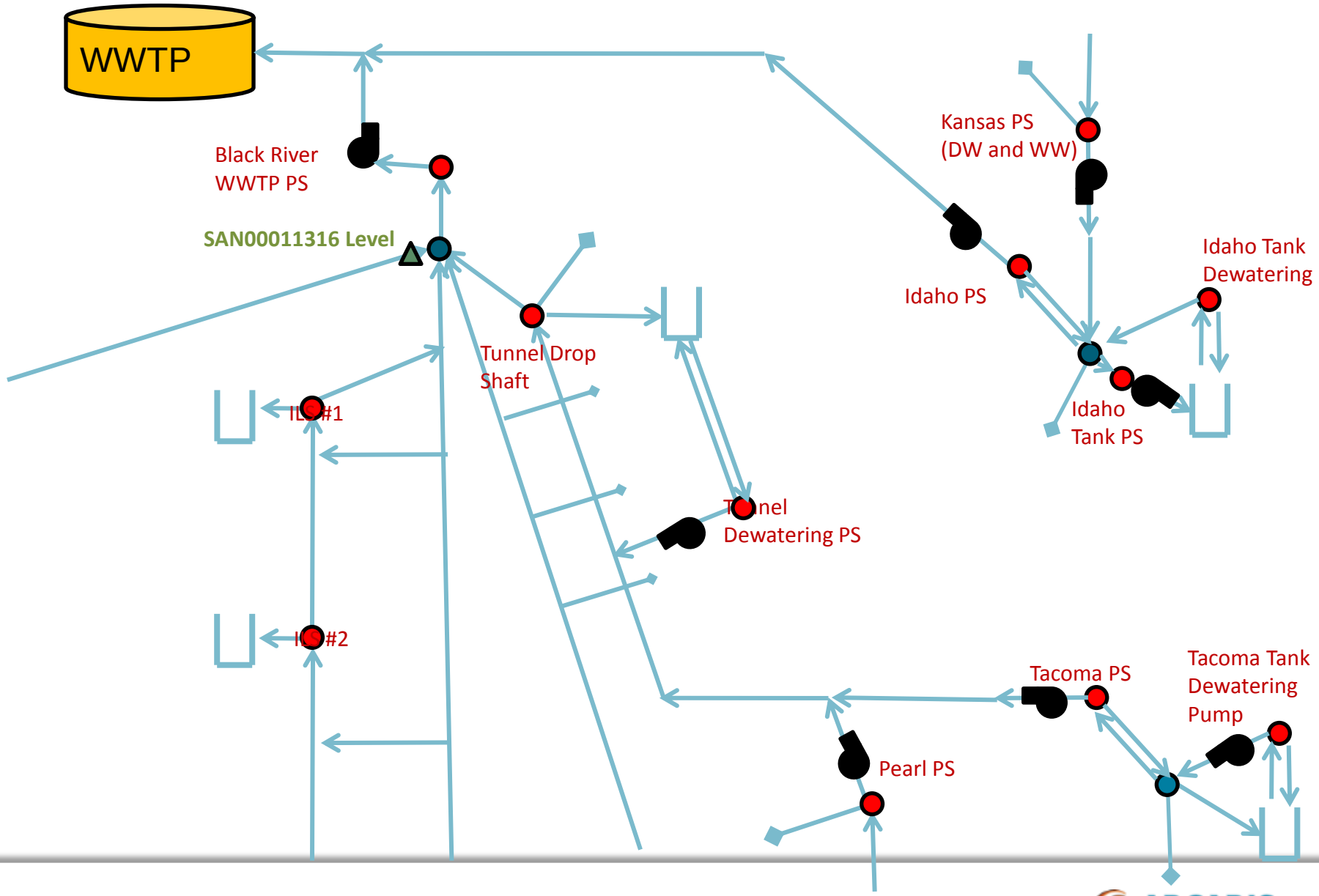
Storm Events Used for Analysis

Source	Description	Original Antecedent Dry Days	Peak Intensity	Reason for Selection
6/25-26/2013 storm event	1.12-1.14" in 8 hour	9		Just under 1 yr storm event, Idaho, Pearl, and Tacoma SSOs Activate
8/27-28/2013 storm event	1.4" in 6hr to 2.7" in 6hr	2		Largest storm during monitoring period, 2yr to 10yr storm event
9/20-21/2013 storm event	1.96" in 24 hr	4		Double peak storm event
2 yr. 6 hr. design storm	1.83" in 6 hr	NA	0.79"/hr	Design storm for tunnel design
10 yr. 1 hr. design storm	1.68" in 1 hr	NA	4.15"/hr	Regulatory goal for no SSOs

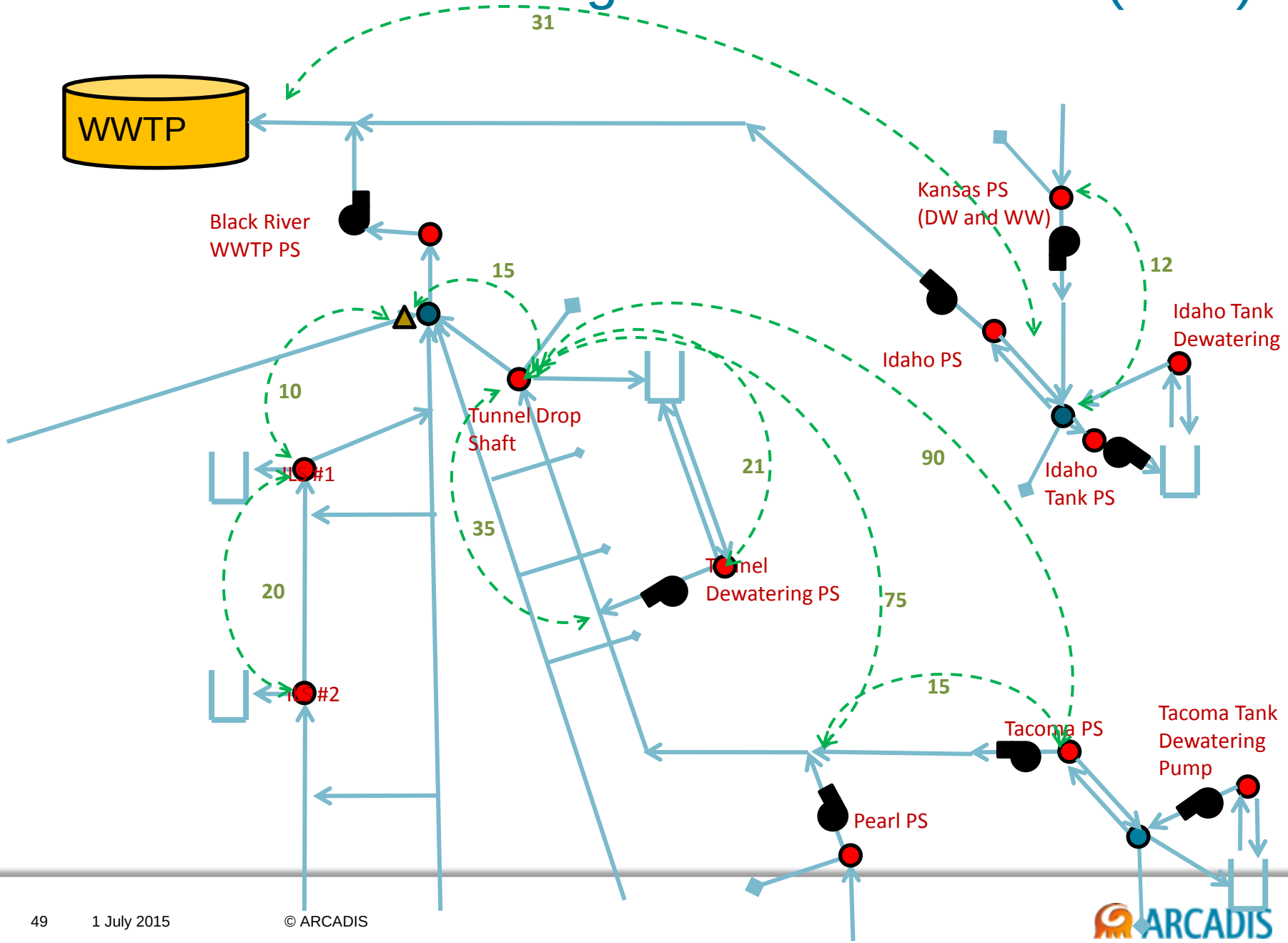
Control Flow Diagram Control Options



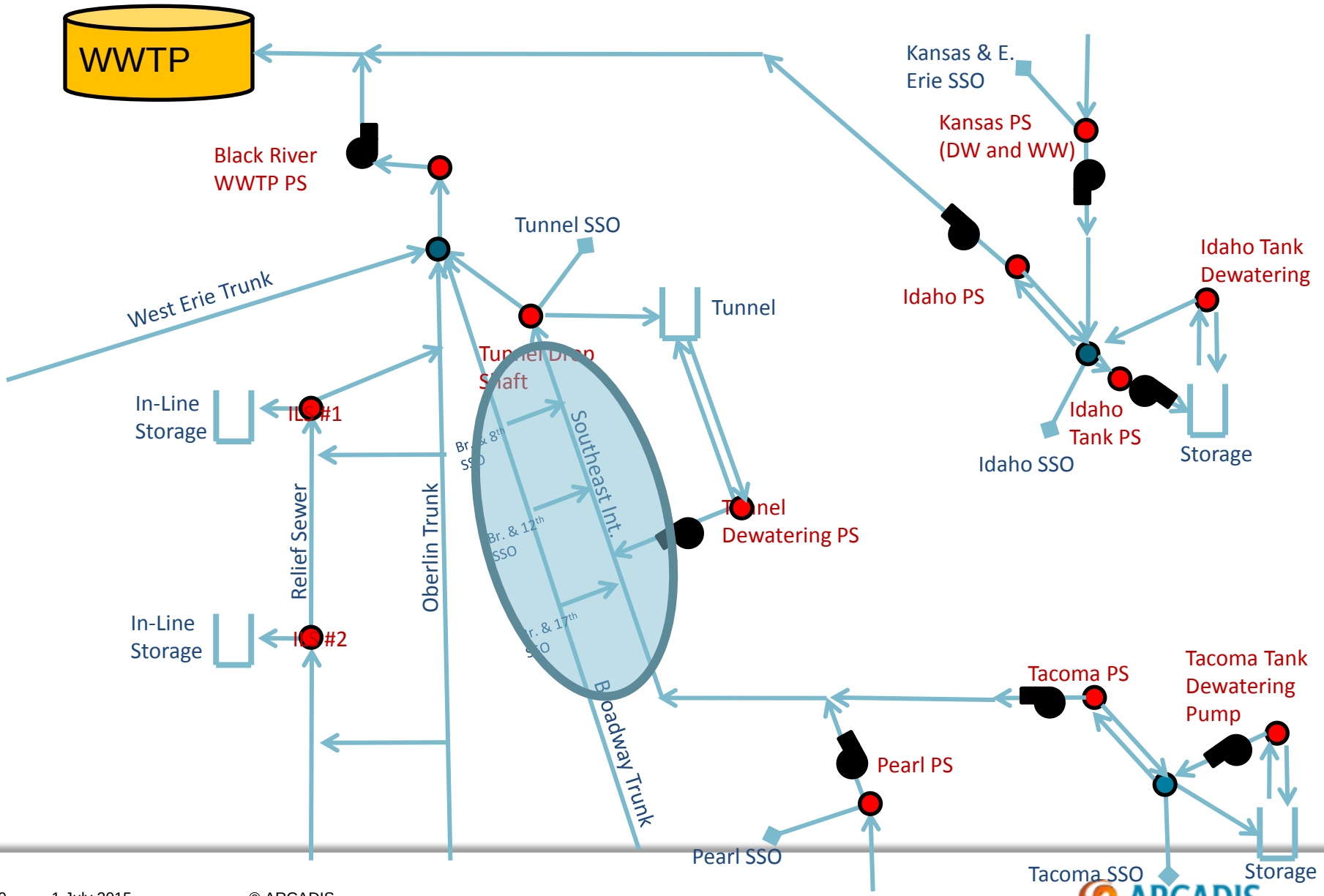
Control Flow Diagram Constraints



Control Flow Diagram Transit Times (min.)



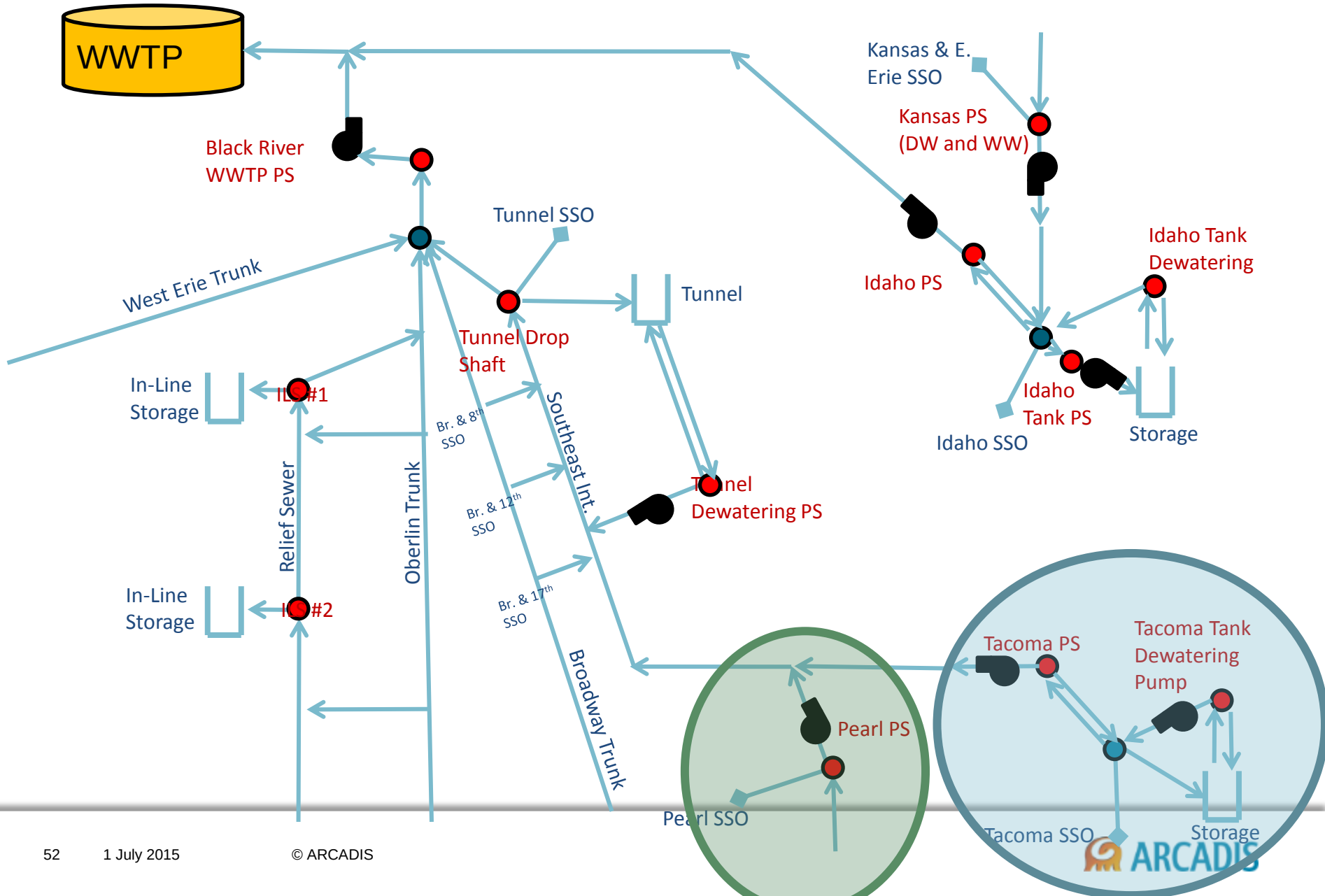
Broadway Avenue SSOs



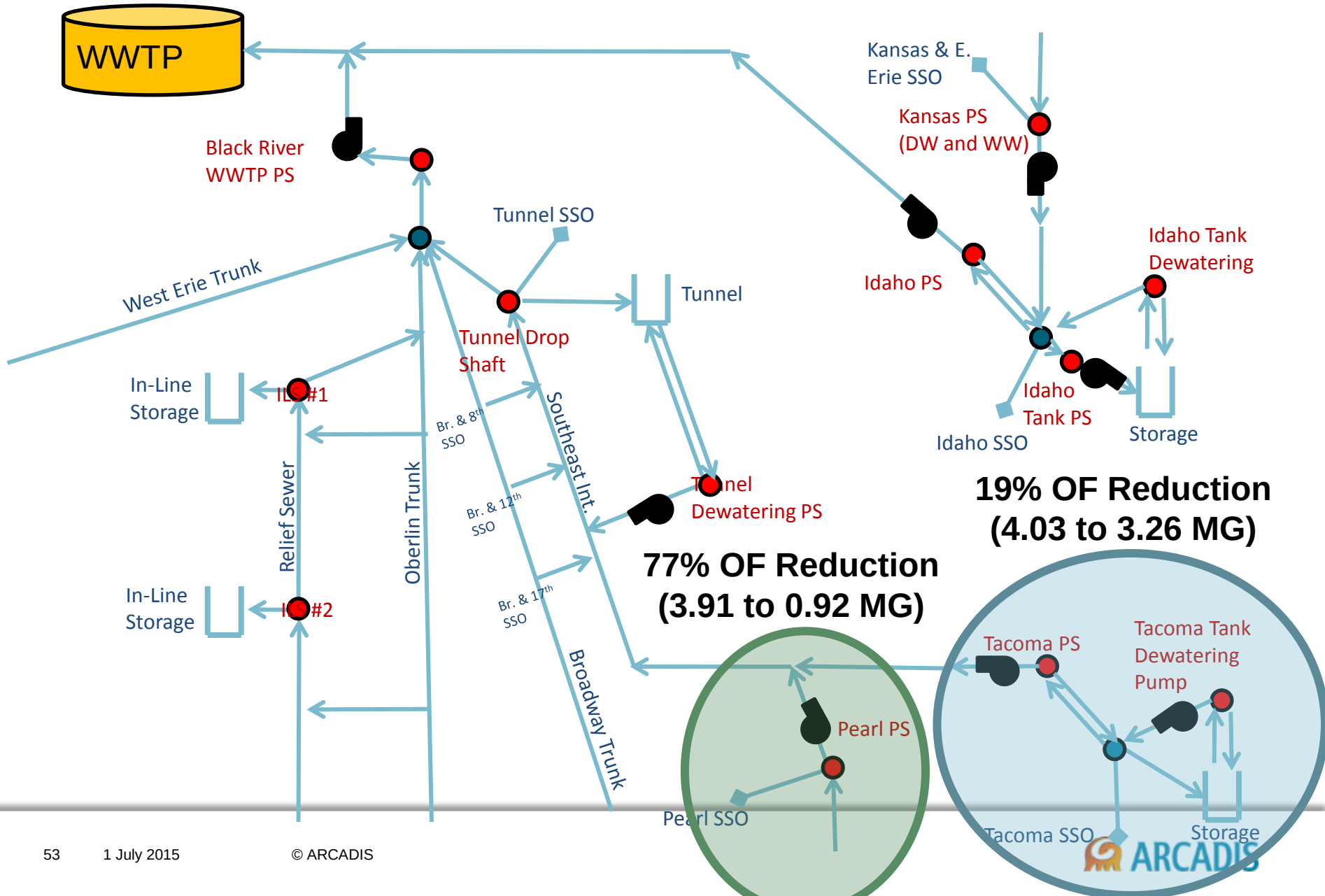
Broadway Avenue SSOs

- Strategy: Connect outfall pipes to SE Interceptor
- Constraint: D/S flooding
- Improvement: Pipe connections, other control points address flooding concern
- Expected Result: **SSO Elimination**

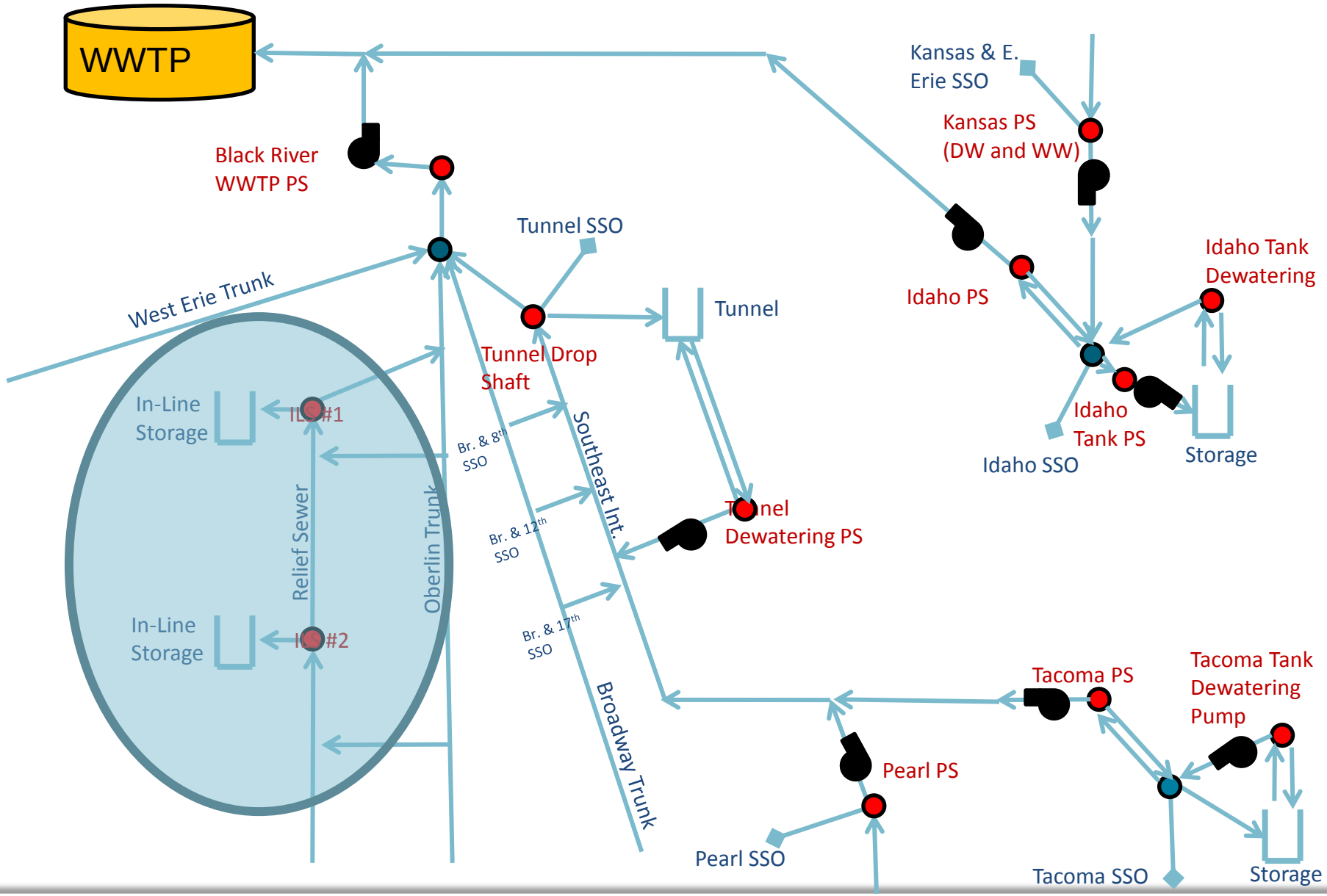
Southeast Lorain



Southeast Lorain



Relief Sewer



Relief Sewer

- Strategy: Store water to reduce flooding
- Constraint: Downstream flooding, upstream HGL
- Improvement: Two in-line storage areas, raise Oberlin weir to 2.5', upsize two pipes D/S of Washington and 20th
- Expected Result:
  - Address Broadway OF volume (2.36 MG)
  - **17% flooding reduction** (0.63 - 0.52 MG)
  - **Eliminate Oberlin SSO (0.06 MG)**
  - **Eliminate Washington & 20th SSO (0.15 MG)**

Summary Results (excluding Idaho)

SSO	Baseline Overflow Volume (MG)	Revised Overflow Volume (MG)	% Reduction	Improved # of Activations	Improved # of Activations
Tacoma	4.03	3.26	19%	3	3
Pearl	3.92	0.82	77%	5	3
Broadway & 12th	1.35	0	100%	5	0
Broadway & 17th	0.81	0	100%	2	0
Broadway & 8th	0.20	0	100%	3	0
E. Erie and Kansas	0.18	0	100%	3	0
Washington & 20th	0.15	0	100%	2	0
Oberlin & 7th	0.06	0	100%	2	0
Hoover	0.01	0.01	0%	1	1
Tunnel SSO	-	-	-	-	-
Skyline & Marshall	-	-	-	-	-
Meister & Marshall	-	-	-	-	-
TOTAL	**10.71**	**4.09**	**62%**	**26**	**7**

Remaining SSOs After Optimization

- 10 yr. 2 hr. storm event
  - Tacoma SSO (1.82 MG)
  - Pearl SSO (1.50 MG)
  - Idaho (w/ Erie) SSO (5.33 MG)

Solutions to Reduce Remaining Pearl SSO (1.50 MG)

- Increase Pearl pumping to full capacity
  - 0.73 MG OF Reduction
  - Excessive HGL on SE Int.
- Increase pumping capacity and remove SE Int. bottlenecks
  - 0.50 MG OF reduction
- Storage or I/I reduction may still required
  - 0.23 MG remaining

Conclusion

- Optimization analysis resulted in:
  - 62% overflow reduction
  - Elimination of all but 3 SSOs
- Remaining SSOs can be contained with additional I/I removal, storage, and conveyance improvements
- Pinpointed improvements drastically reduce large future projects

Topics

- Lorain
- Moving Forward
- Optimization
- **Lessons Learned & Next Steps**

Lessons Learned

- Quality data is key to assessing system
- Clearly define the utility's operational goals, constraints and long range plans
- Expect the unexpected, and look outside the box

What's Next for the City?

- Complete tunnel construction
- Continue to monitor SSOs and identify SSOs to physically close
- Confirm pump stations operate as intended
- Implement recommended optimization strategies

Contact

Laura McGinnis (ARCADIS) – laura.mcginnis@arcadis-us.com

216-298-5244

Tim Ruggaber (EmNet, LLC) – truggaber@emnet.net

574-855-1012

Mary Garza (City of Lorain) - Mary_Garza@cityoflorain.org

440-204-2227