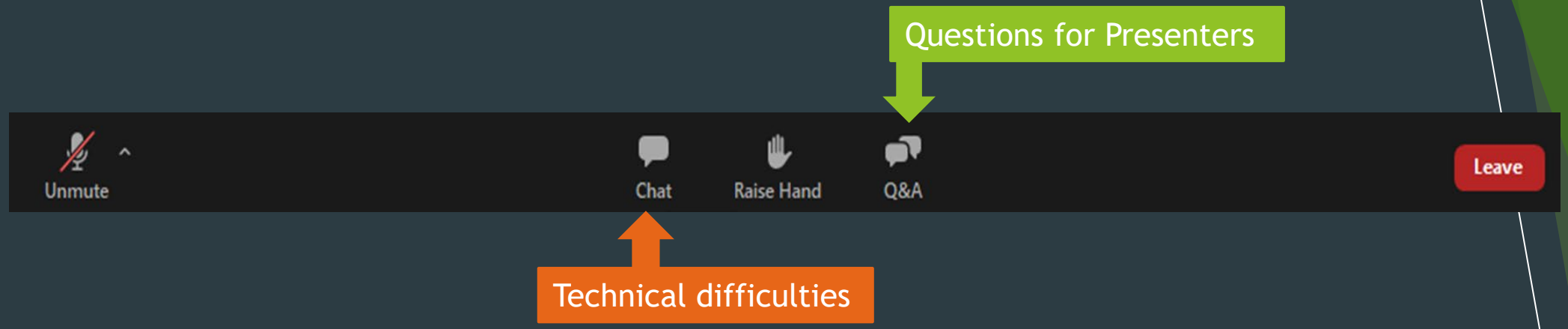
Smart Sewer Systems and Smart Data Infrastructure

December 7, 2021

Webinar Logistics



- **To ask a question:** Type your question in the Q&A box. We will take questions at the end of the webinar.
- **Technical difficulties:** If you are having technical difficulties, please send a message through the Chat to Katie Harrison (Zoom Support), or email Kathryn.Harrison@erg.com.
- **Slides:** A PDF of these slides are available in the Chat.
- **Recording:** Please note that we are recording this webinar and will make it available via EPA's website: https://www.epa.gov/npdes/combined-sewer-overflows-policy-reports-and-training.

Disclaimer

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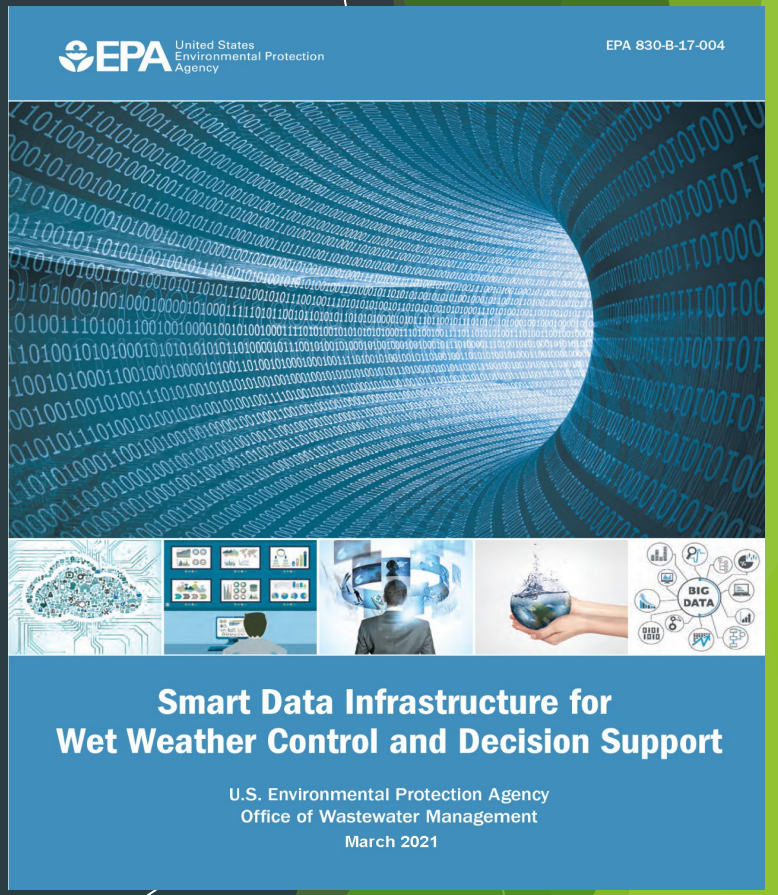
Technical Assistance

- U.S. EPA can provide a range of assistance including the following:
  - EPA's small CSO community spreadsheet-based tools
    - CSO Model
    - Long-Term Control Plan Review Checklist
    - Post-Construction Compliance Monitoring Checklist
  - Regulatory/compliance questions
  - Troubleshooting operation and maintenance problems
  - Asset management training
  - Smart sewer and smart data infrastructure training
  - Monitoring and modeling training

If you are interested or have questions, please contact Mohammed Billah, Kathryn Kazior and EPA's contractors Adam Orndorff and Sam Arden

Smart Data Infrastructure for Wet Weather Control and Decision Support

- Share how municipalities, utilities, and related organizations can use advanced technologies and monitoring data to support both wet weather control and decision-making in real time or near real time
- This document highlights the technologies currently available and provides case studies to describe some of the possible ways municipalities and utilities implement the technologies
- https://www.epa.gov/sites/default/files/2018-08/documents/smart_data_infrastructure_for_wet_weather_control_and_decision_support_-_final_-_august_2018.pdf



Tim Braun

Xylem Inc.

Clean Water Utility Challenges

Utility managers must make key operational decisions today and plan infrastructure investments for generations to come.

Customer and Community

- Serve all rate-payers equitably
- Protect the most vulnerable
- Protect property, deliver high level of service, instill trust

Regulatory and Environmental

- Minimize/eliminate sewage discharges to the environment, and to public or private property
- Protect and serve the treatment plant

CapEx

- Building capital improvement programs to serve current and future generations

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There is no shortage of data – unlocking it is the challenge

CURRENT STATE

Many digital solutions are one-size-fits-all
yet out-of-the-box software doesn't adapt to solve complex operational wastewater network problems.

Hydraulic models are a start
but mathematical representations alone don't tell the whole story. Utilities require actionable insights based on live, dynamic conditions.

The path to optimized wastewater network performance

Create Visibility
to network capacity, in real-time, to address challenges as they arise

Predict Flows
with confidence based on dynamic network activity

Optimize Capacity
with scalable, data-driven and actionable intelligence

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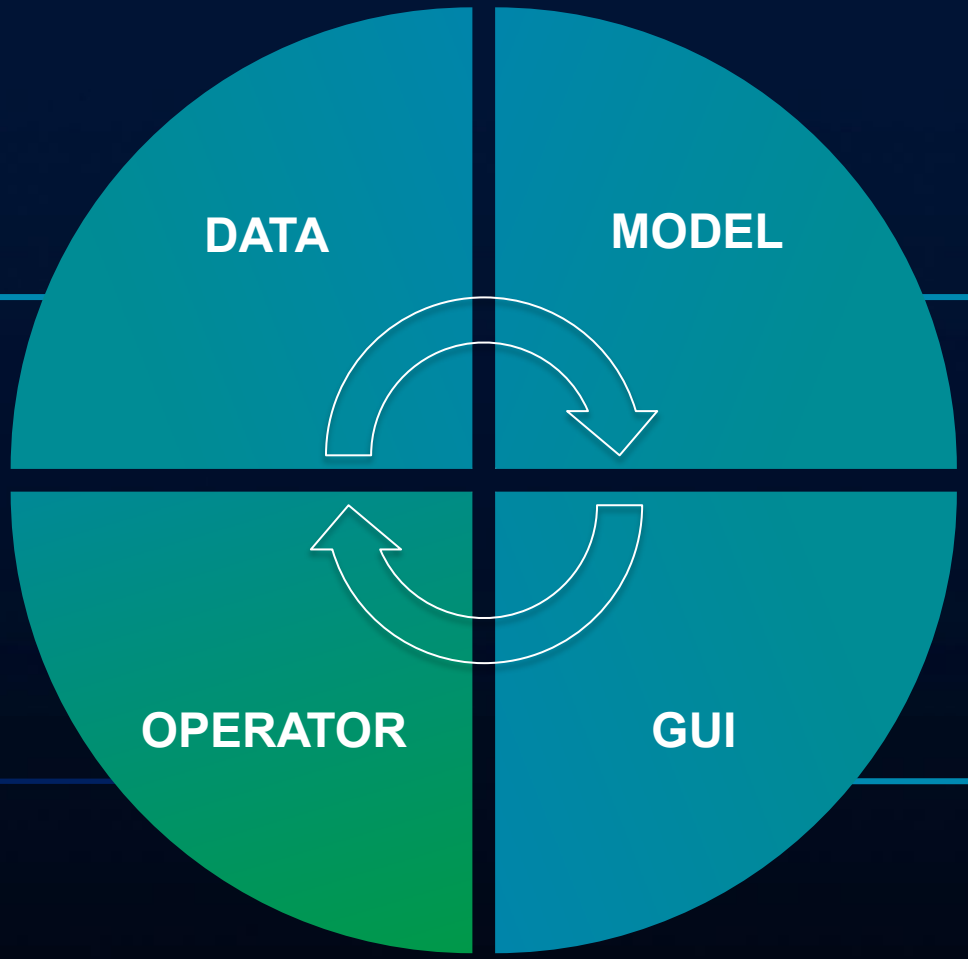
Real Time Decision Support System

Framework for building RT-DSS in urban water infrastructure and treatment works

- *Sensor Data*
- *Enterprise Data*
- *Forecast Data*
- *Collect, Manage, Host*



- *Hydraulic & Hydrological*
- *DW/WW Plants*
- *Risk/Consequence of Failure*
- *Digital Twin*

- *System Knowledge*
- *Actionable Guidance*
- *Ultimate Decision Maker*
- *Supervisory Oversight*

- *Interactive Data Analytics Tools*
- *RT-DSS Dashboards*
- *GIS Mapping of Large Datasets*
- *Data-Driven Intelligence*

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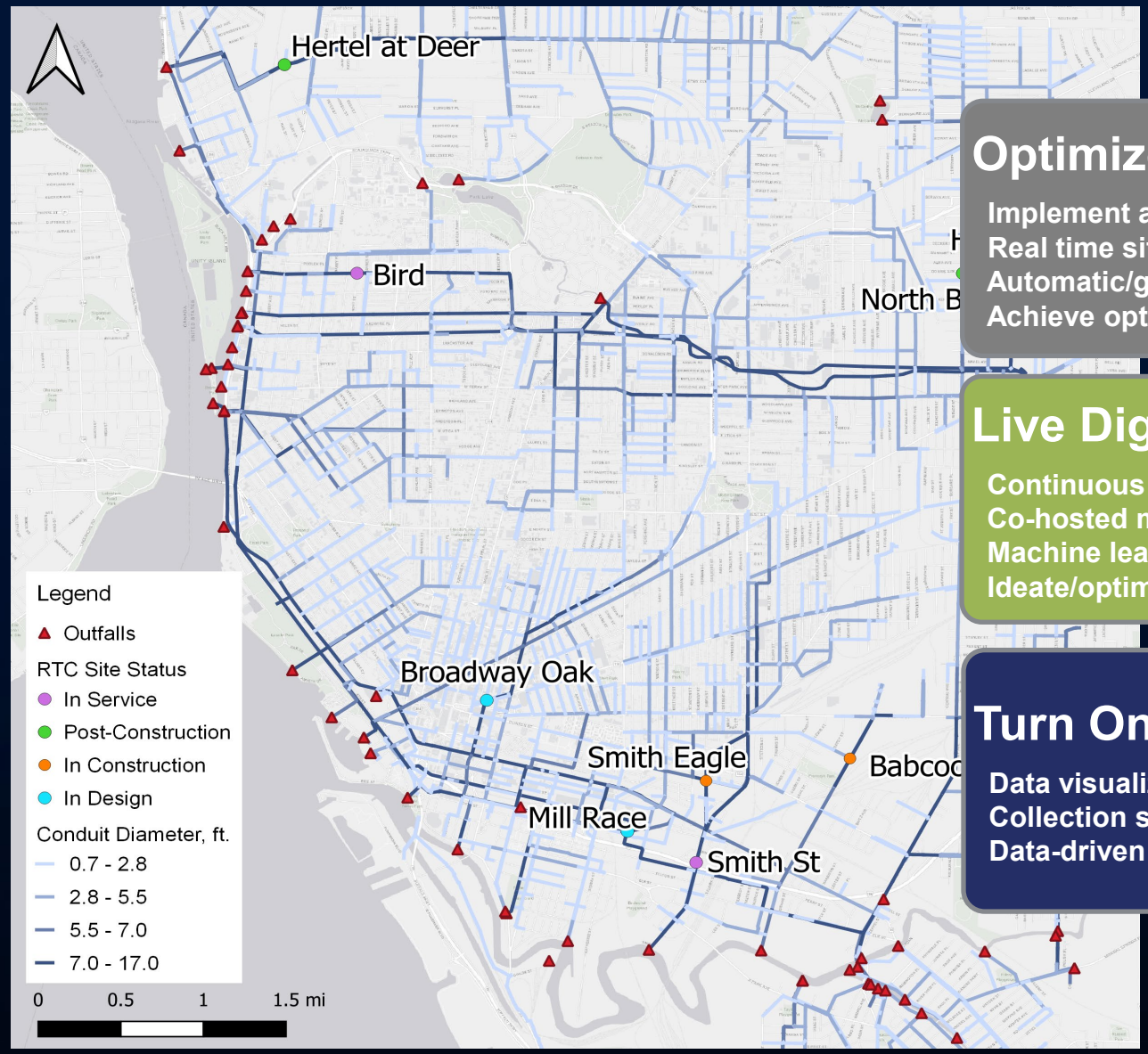
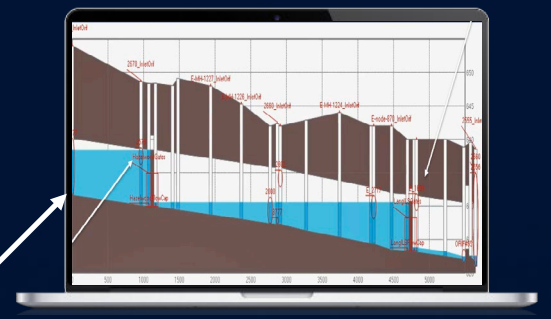
RT-DSS Roadmap



Optimize & Operate

Implement and operate coordinated control
Real time situational awareness
Automatic/guidance mode
Achieve optimal system performance



Live Digital Twin

Continuous real time modeling
Co-hosted models & sensor data
Machine learning hydrology calibration
Ideate/optimize for coordinated control

Turn On the Lights!

Data visualization/mapping
Collection system user interface
Data-driven predictive maintenance

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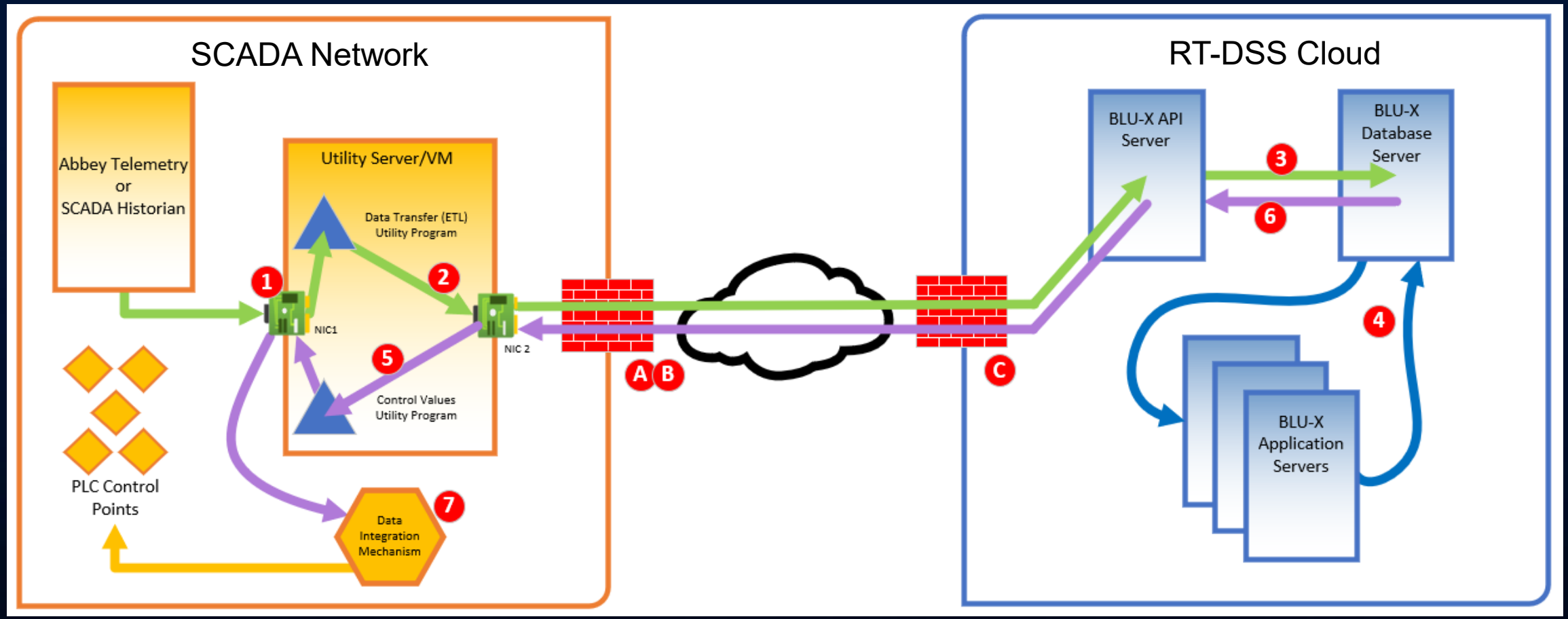
Sample RT-DSS Architecture



The Next Big Category in Water!

FUTURE STATE

RT-DSS is the next big industry category

Dozens of communities have already paved the way, demonstrating the power of decision science applied to legacy infrastructure and built on the foundation of existing IT assets.

How did we live without it?

The communities utilizing RT-DSS/Smart Data Infrastructure already can't imagine life without it.

Regulatory support

The regulatory agencies have supported this framework and approach for years validated by recent events.

Stacia Eckenwiler

City of Columbus, Ohio

Department of Public Utilities

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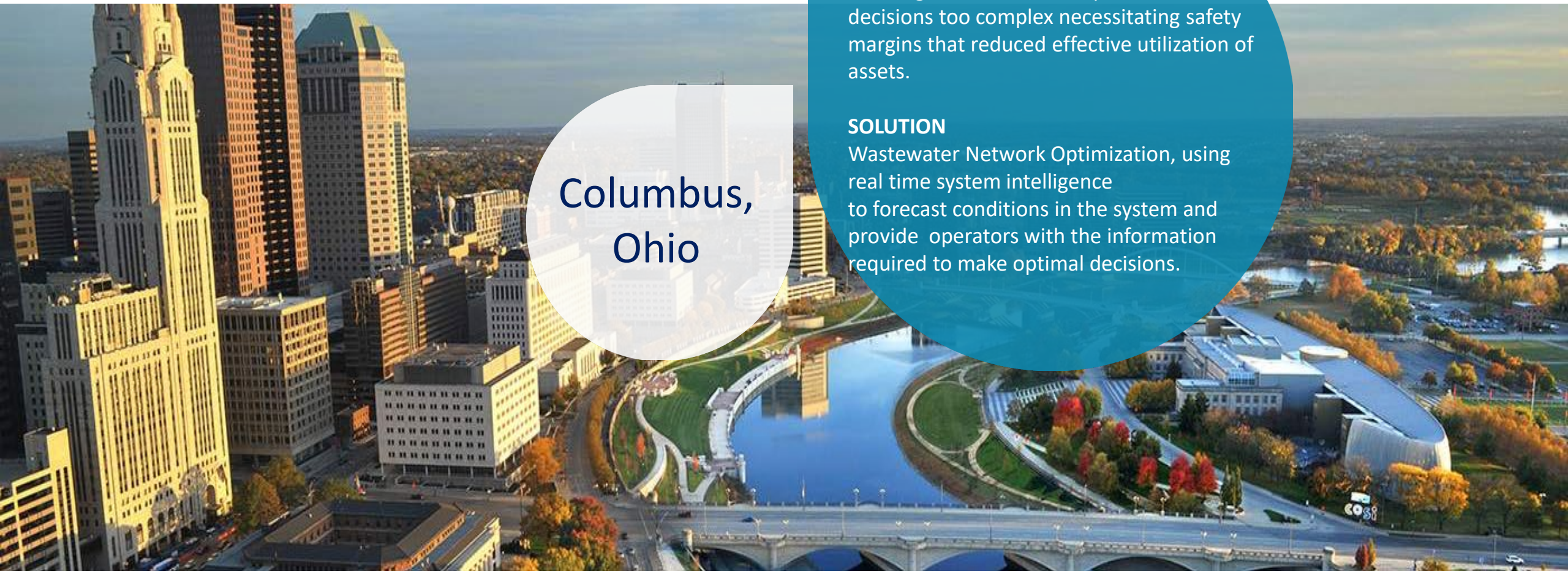
Real Time Control



Columbus, Ohio

CHALLENGE
A complex system of interconnected treatment, sanitary, and combined sewerage facilities made operational decisions too complex necessitating safety margins that reduced effective utilization of assets.

SOLUTION
Wastewater Network Optimization, using real time system intelligence to forecast conditions in the system and provide operators with the information required to make optimal decisions.

City of Columbus, Ohio and Our Customers

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- Population: 900,000+ citywide, 2.1M+ total with surrounding communities
- Largest city in Ohio, state capital
- 14th largest city nationally
- Direct Customers: 274,963 residential and 4,783 commercial customers
- 24 contract communities

City of Columbus Division of Sewerage and Drainage

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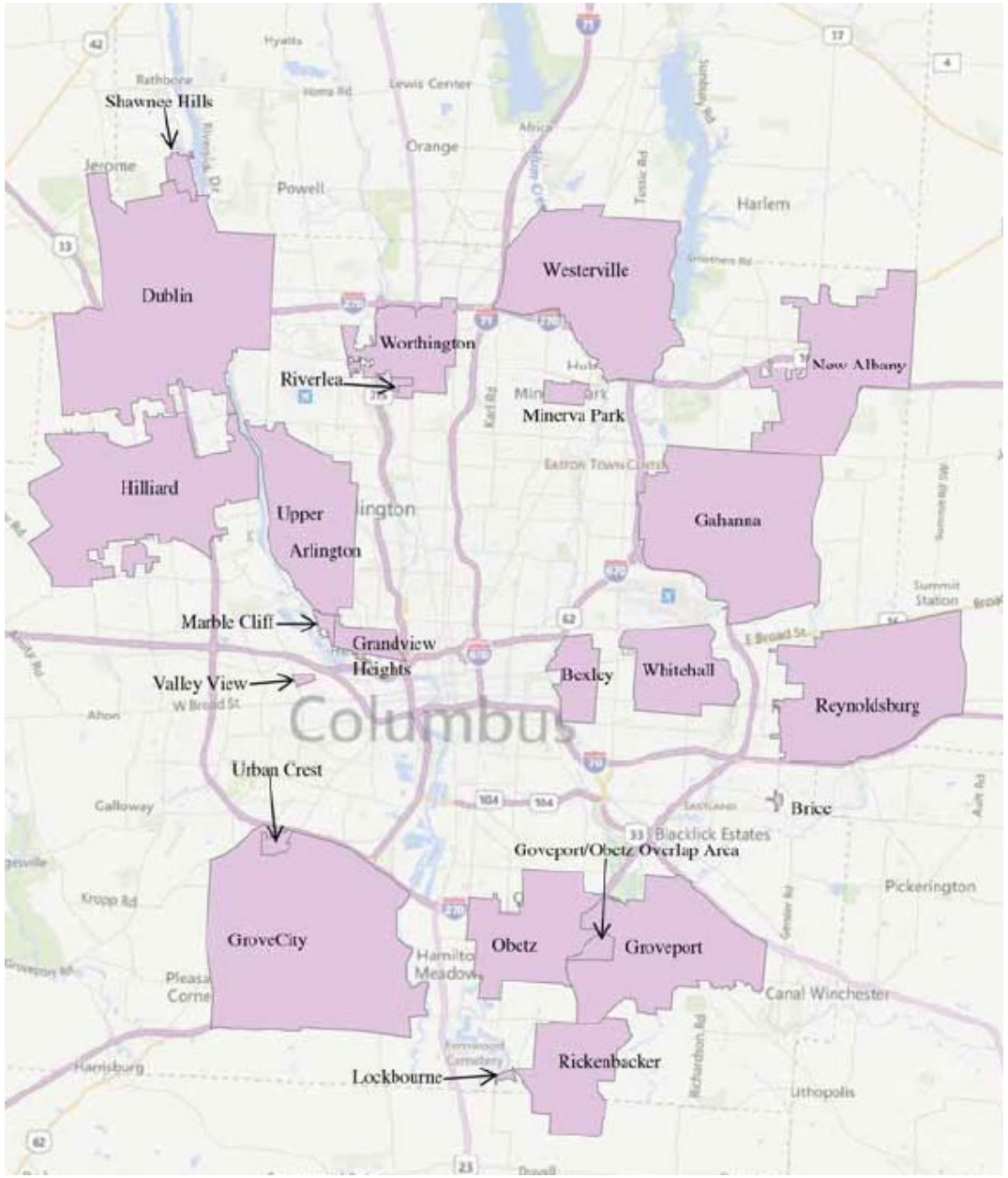
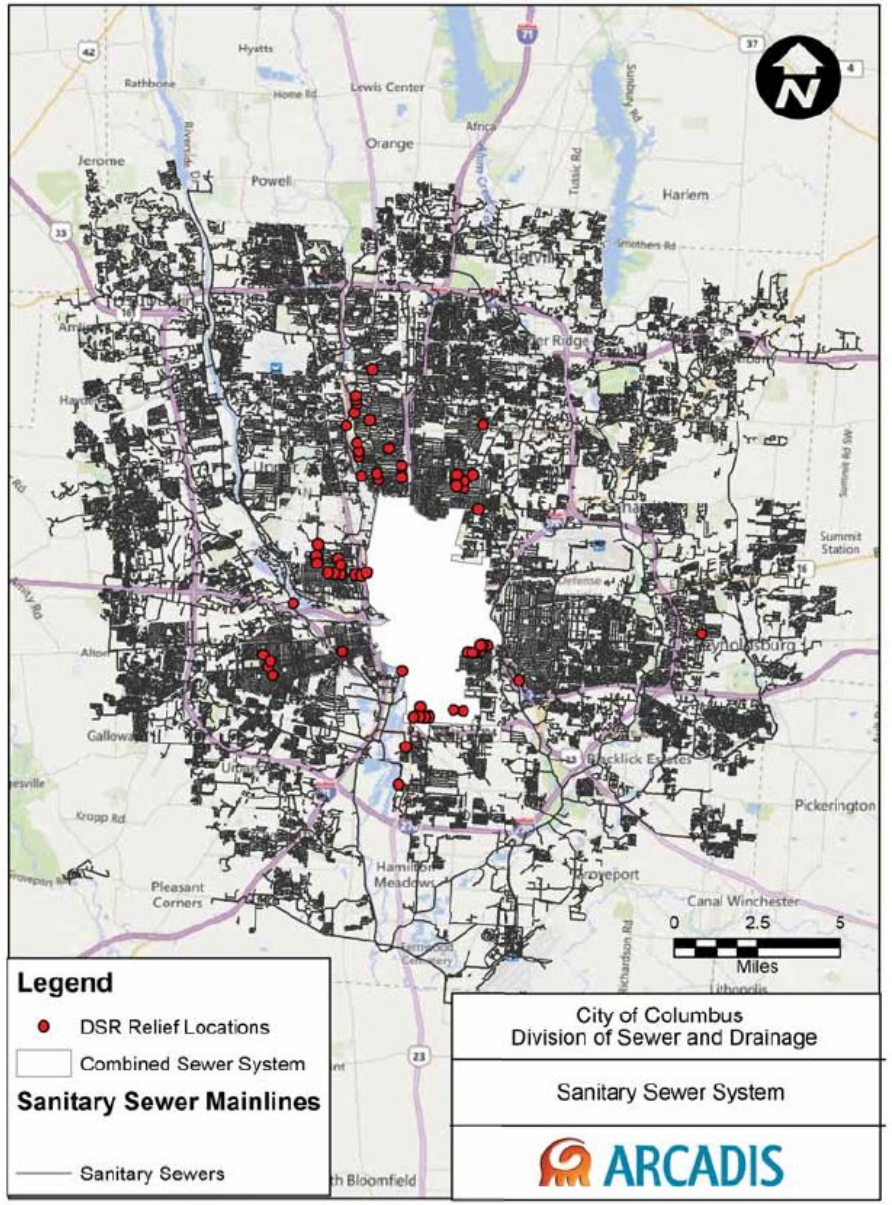
- $300M Operating Budget
- 2,782 miles of Sanitary
- 1,757 miles of Storm
- 167 miles of Combined
- 2 Wastewater Treatment Plants
  - Jackson Pike WWTP: 150 MGD
  - Southerly WWTP: 330 MGD
  - Chemically Enhanced Primary Treatment (CEPT): 110MGD
- OARS tunnel 4.5 miles, 20’ diameter CSO conveyance/65 MG storage

Assets are interconnected, leading to a variety of complex options for controlling the system.





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Columbus' WWMP Journey

- 2005 – Wet Weather Management Plan to comply with CO
  - Extensive new infrastructure
  - Eliminate sanitary sewer overflows (SSOs)
  - Reduce combined sewer overflows (CSOs)
- 2012/2013 – Reanalysis of the WWMP
- 2015 – Integrated Plan and WWMP Update Report
  - Blueprint Columbus (green infrastructure, I/I reduction)
  - OSIS Augmentation and Relief Sewer (OARS)
  - Chemically Enhanced Primary Treatment (CEPT) at Southerly WWTP
  - Real-time Control

Jackson Pike and Southerly CSO/Bypass Activations 2015-2021

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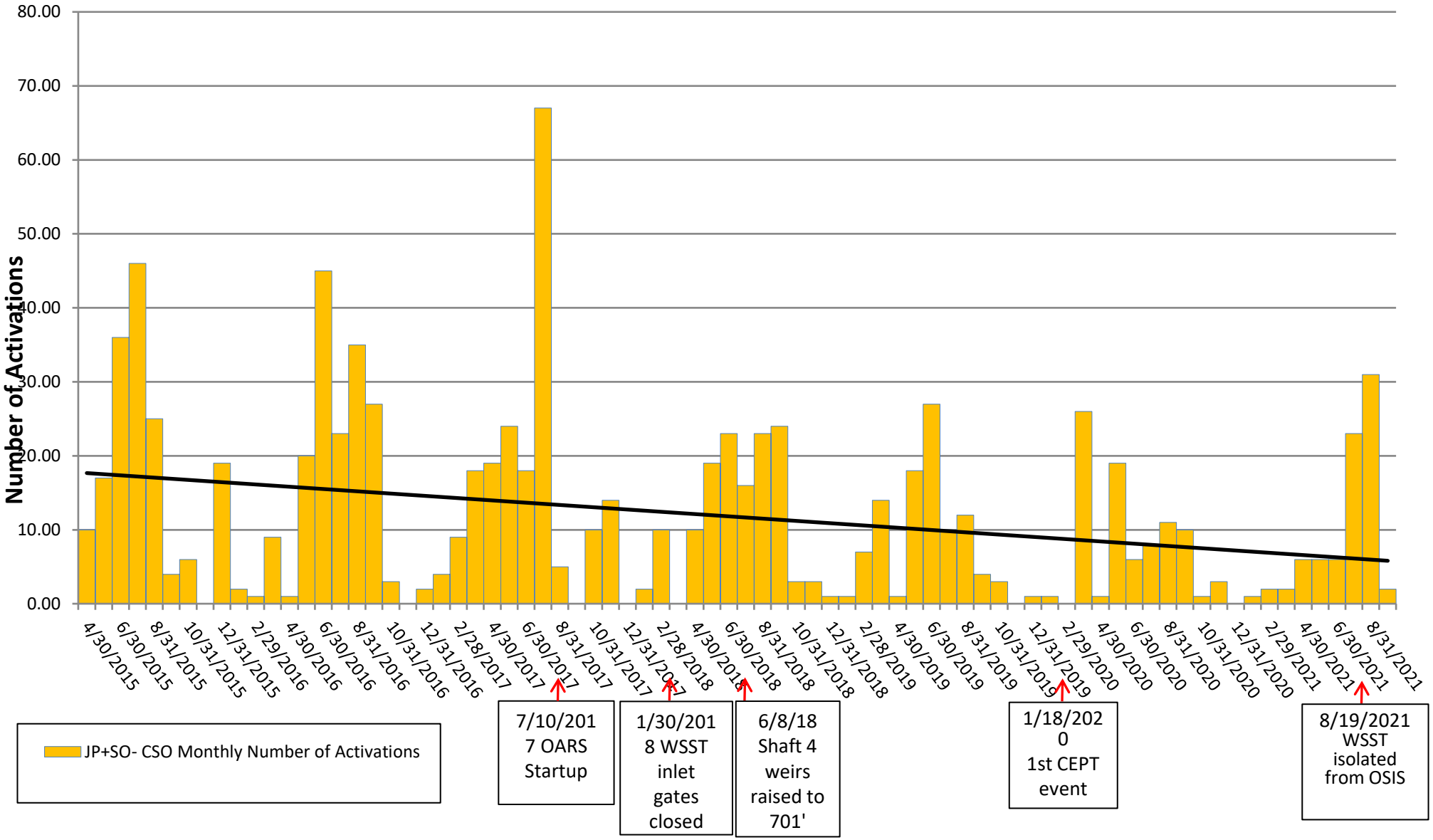

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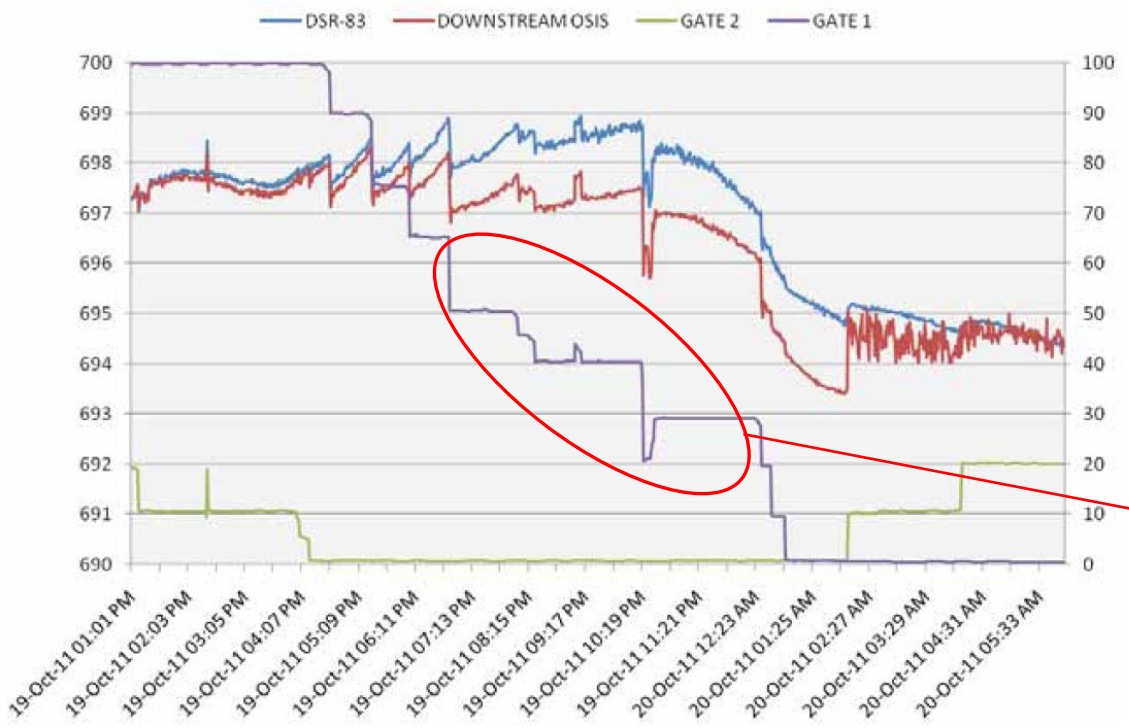
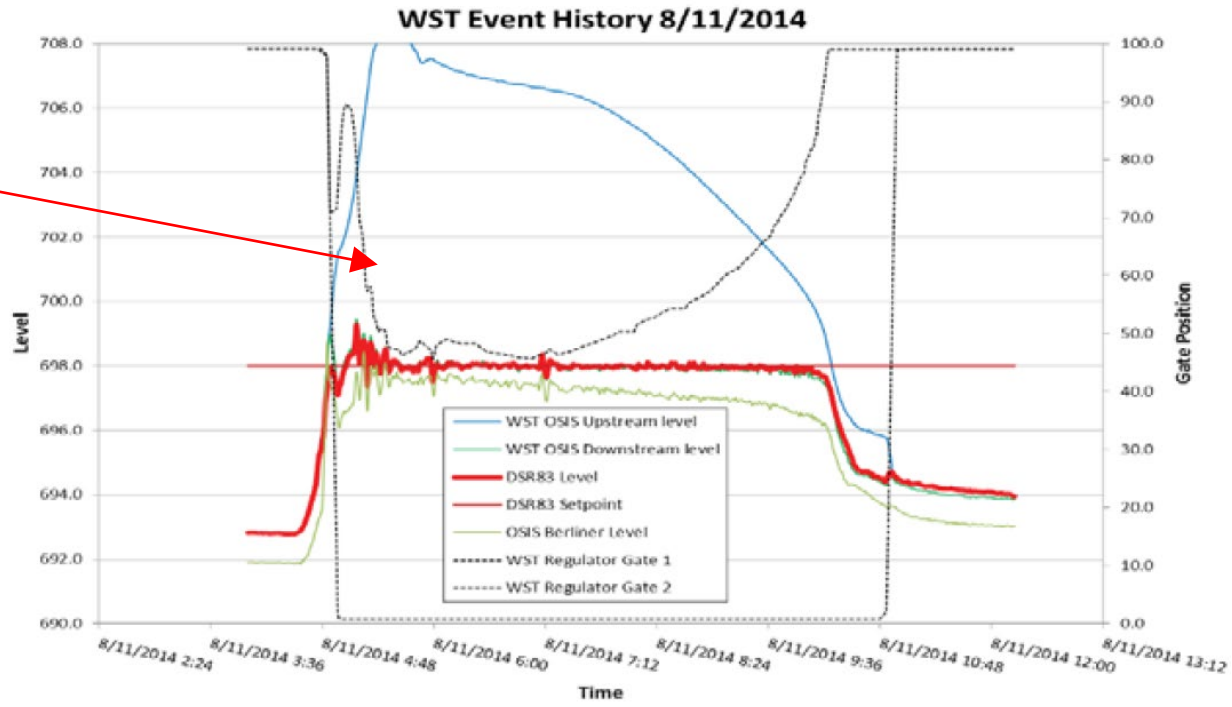
Where it all began…





The First Pain Point

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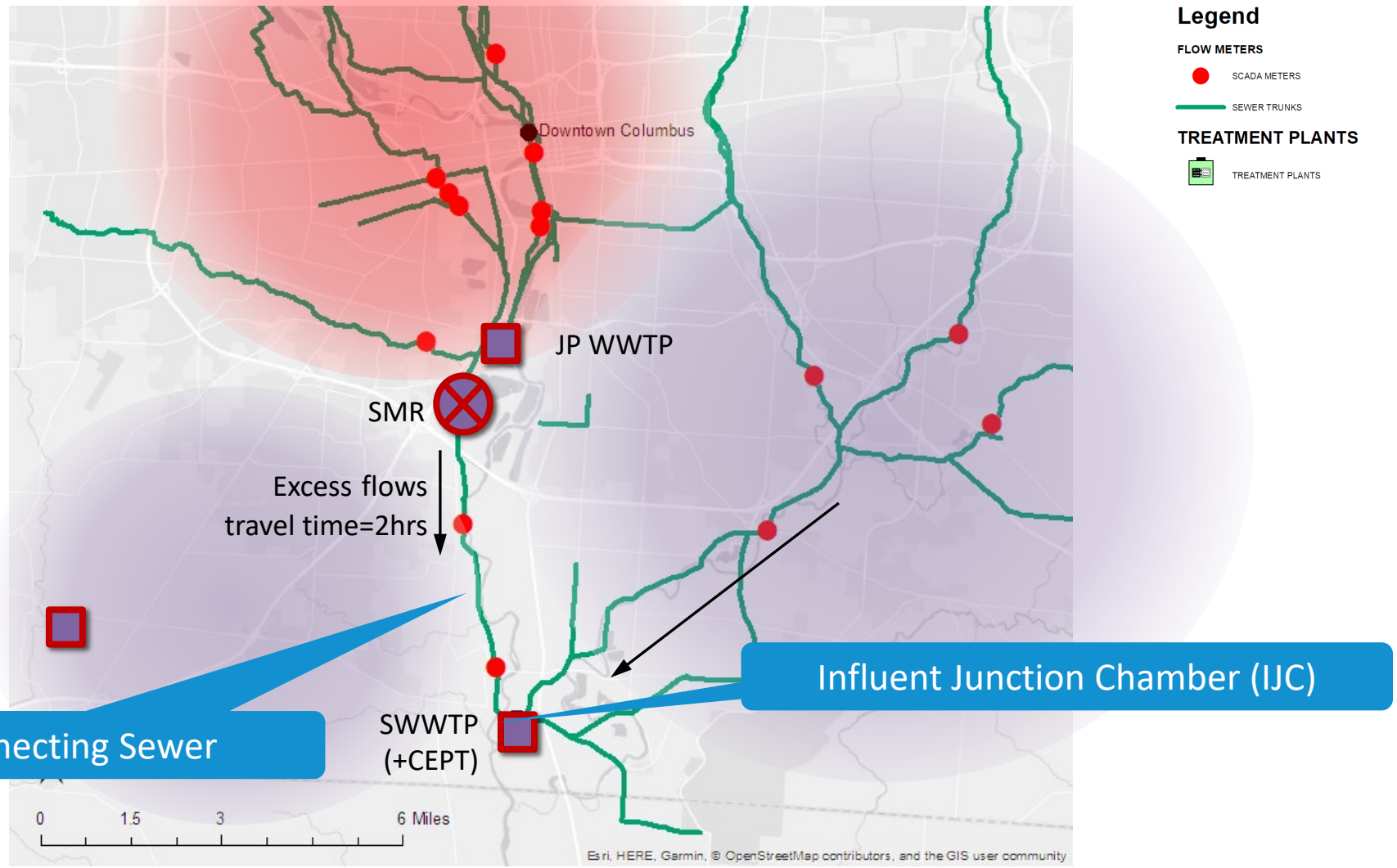
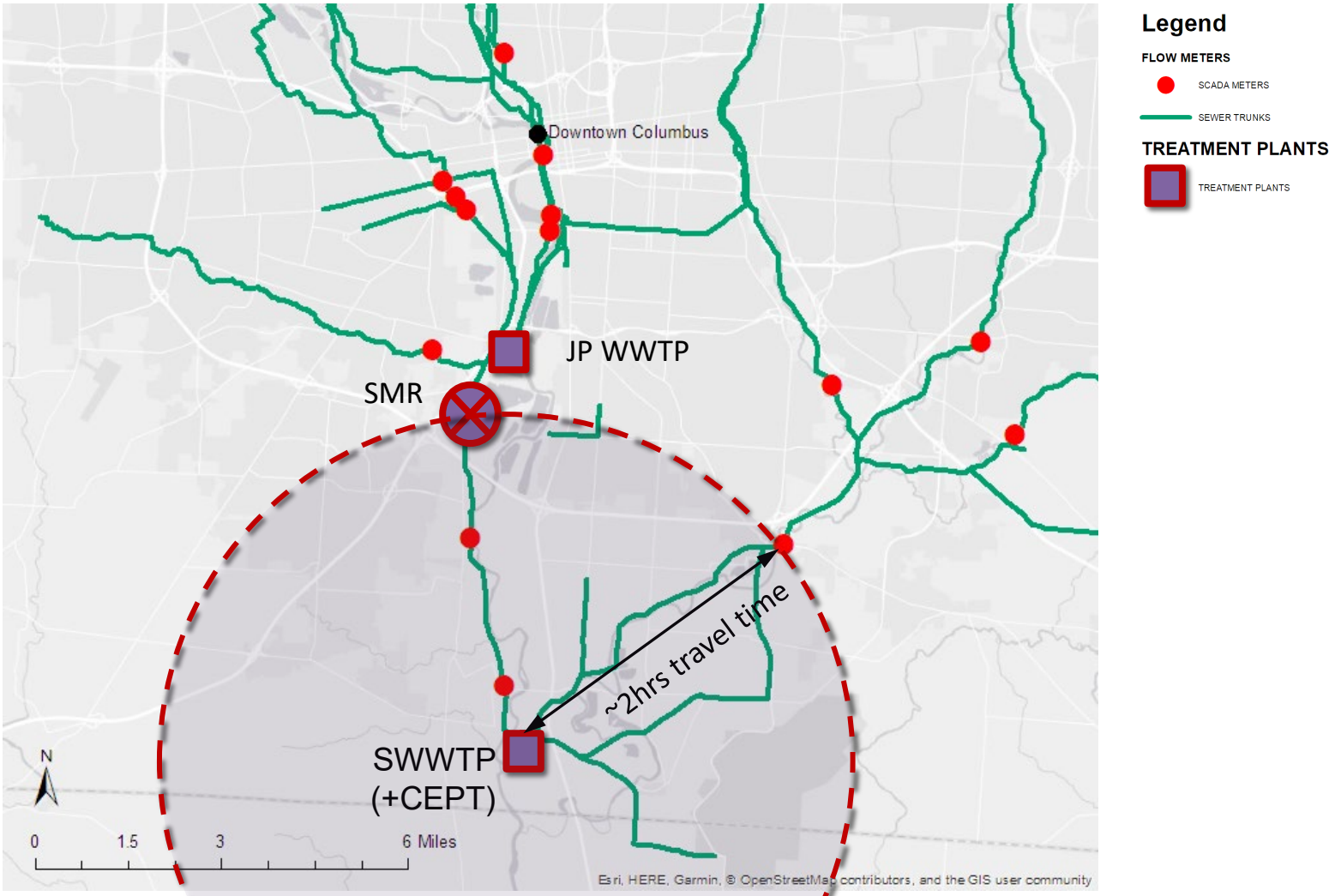


Solution = IJC Prediction



IJC Prediction Performance Assessment – May 9

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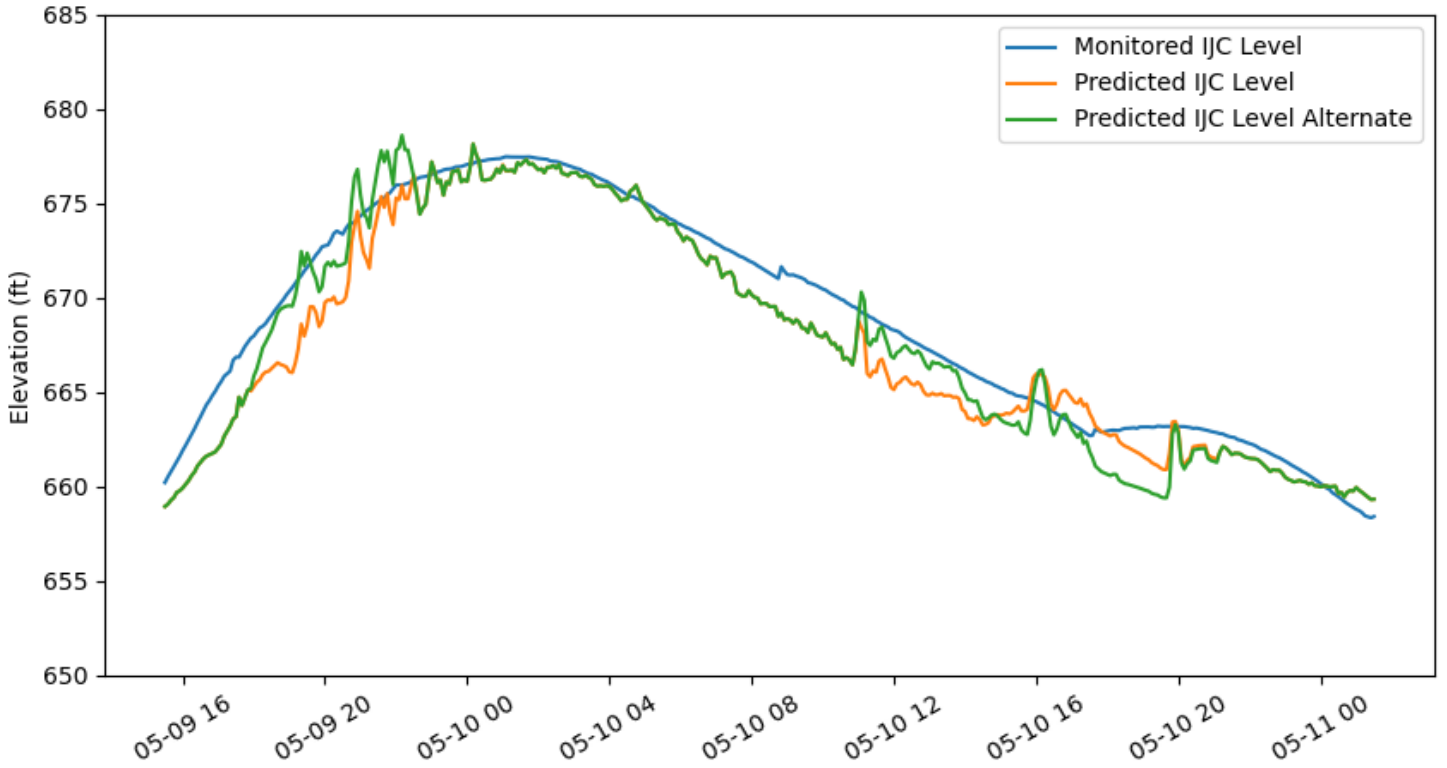
Qualitative observation:

- Peak levels predictions are good
- Underpredicts both rising and falling limb

	Predicted	Alternate Predicted
NSE	0.91	0.93
R^2	0.95	0.96



CEPT Prediction - Performance

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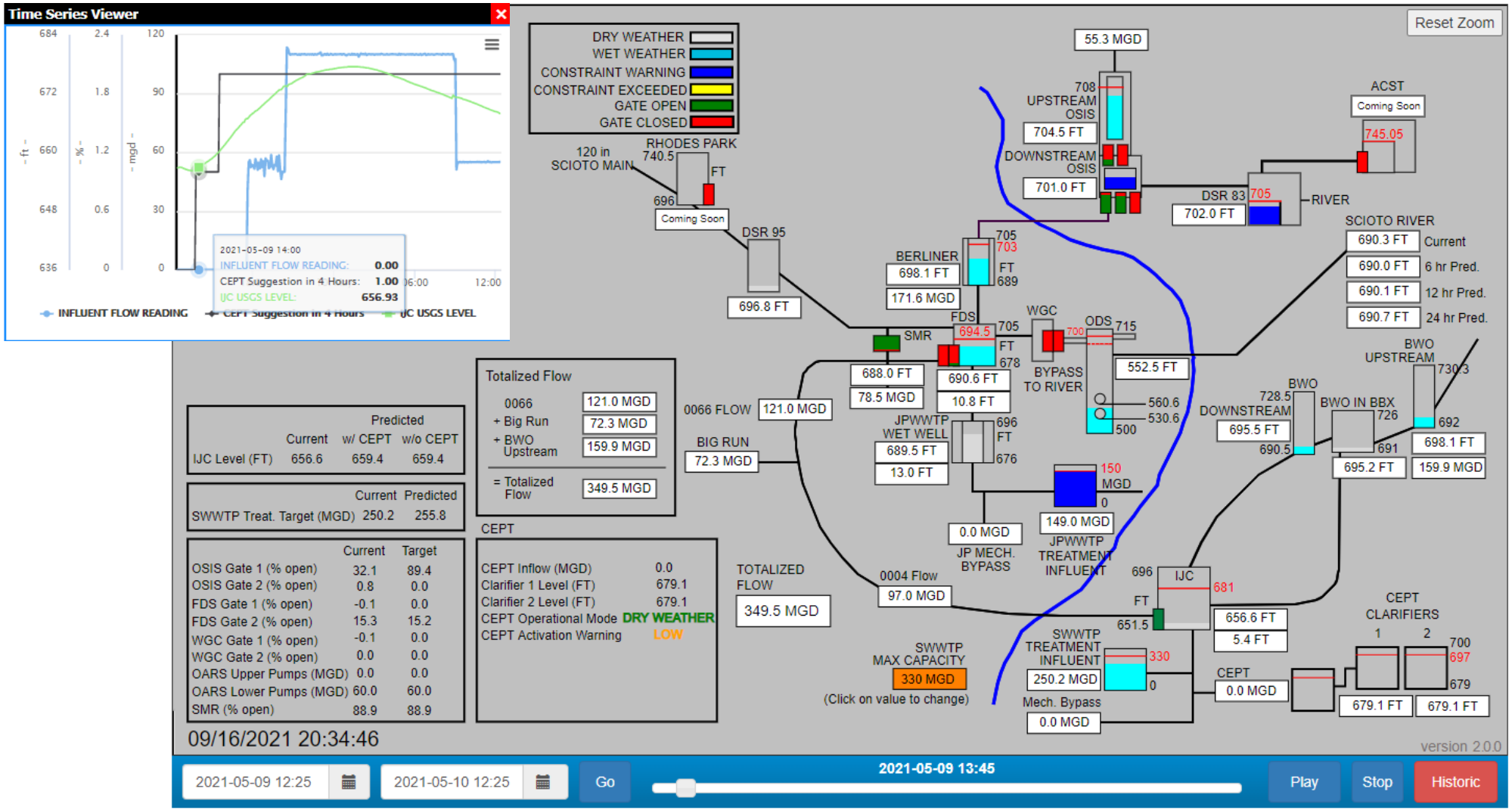

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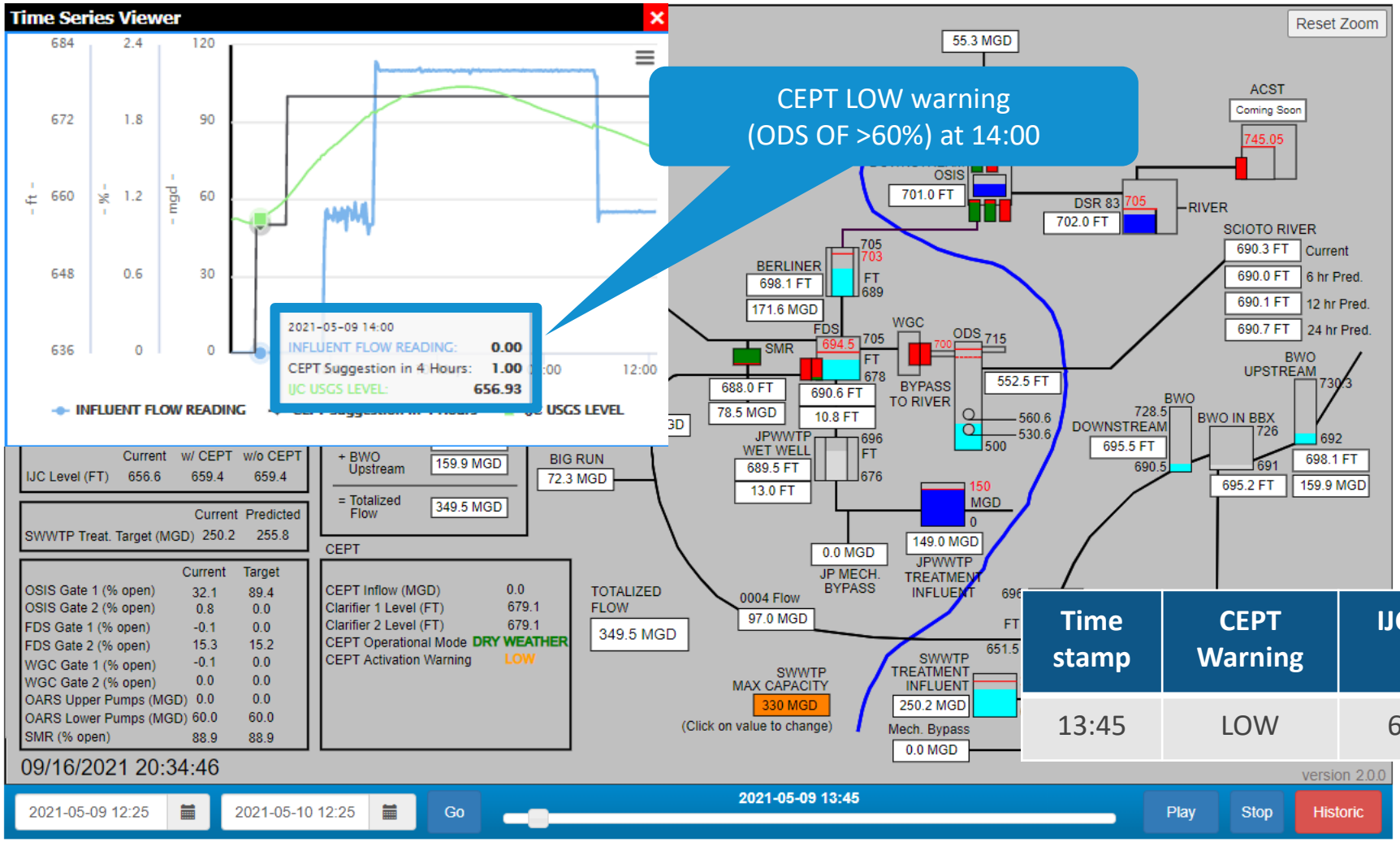

Time stamp	CEPT Warning	IJC Level	T+
13:45	LOW	656.93	00:00

CEPT Prediction - Performance

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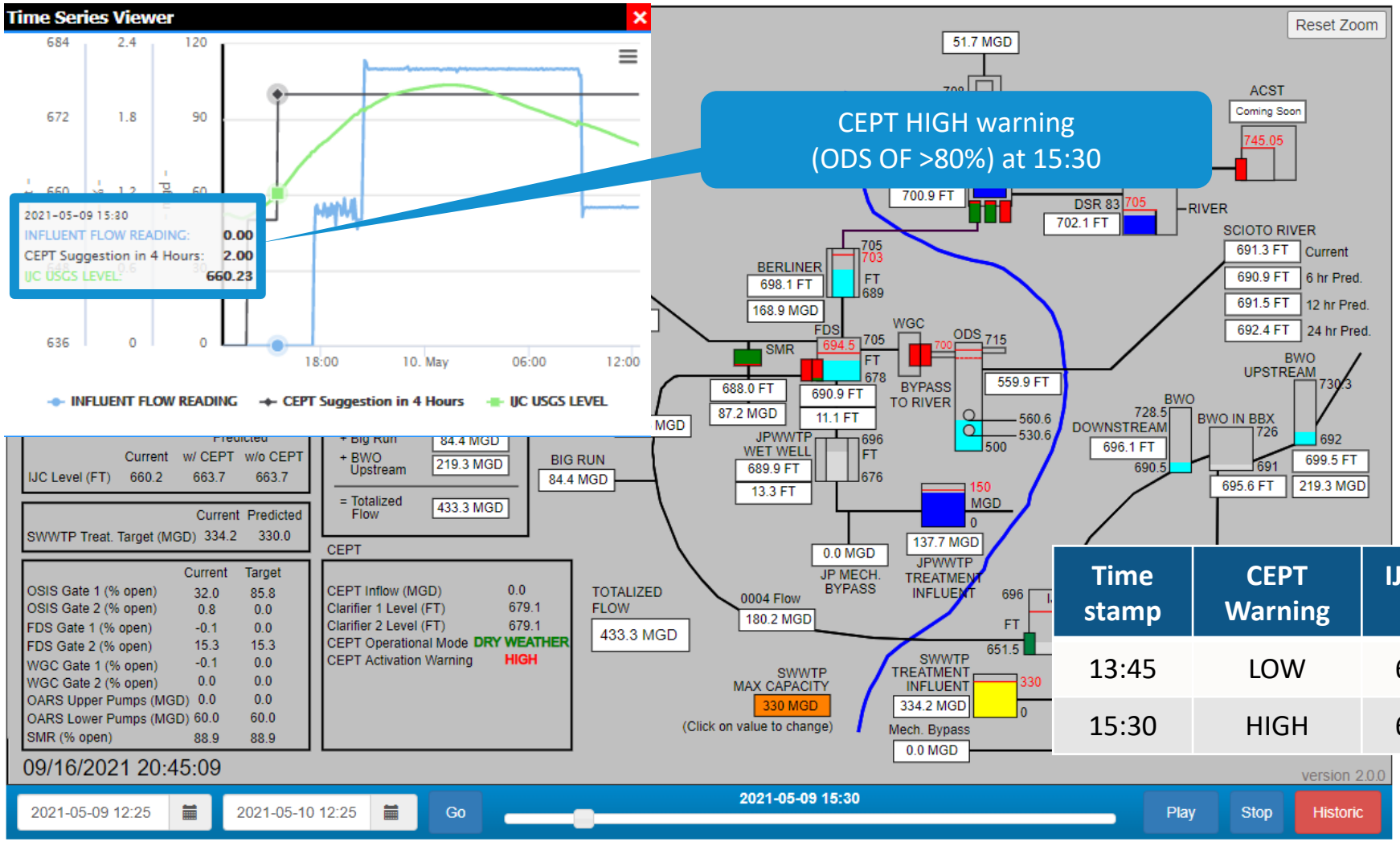

Time stamp	CEPT Warning	IJC Level	T+
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15:30	HIGH	660.23	01:45

CEPT Prediction - Performance

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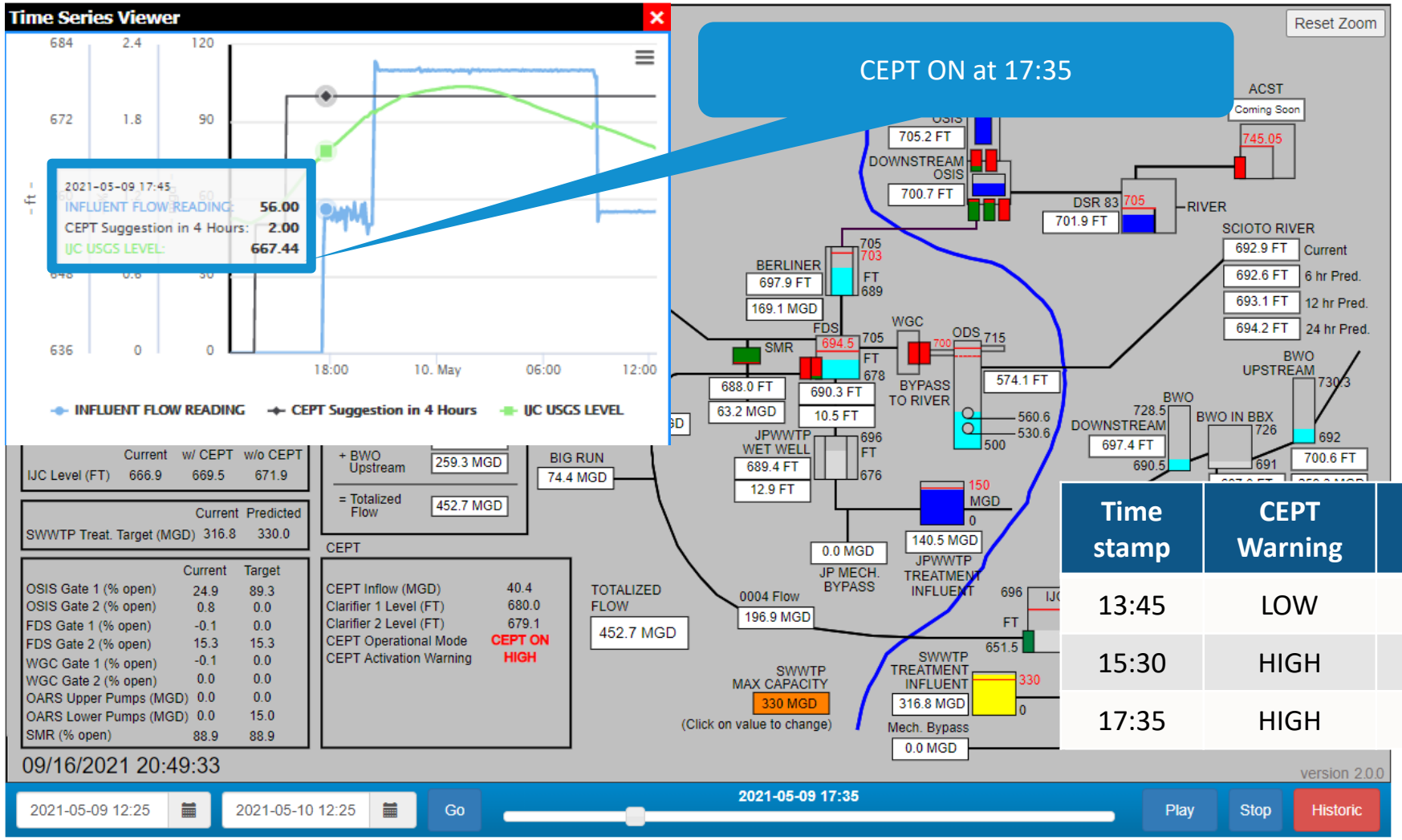

Time stamp	CEPT Warning	IJC Level	T+
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15:30	HIGH	660.23	01:45
17:35	HIGH	667.44	03:50

CEPT Prediction - Performance

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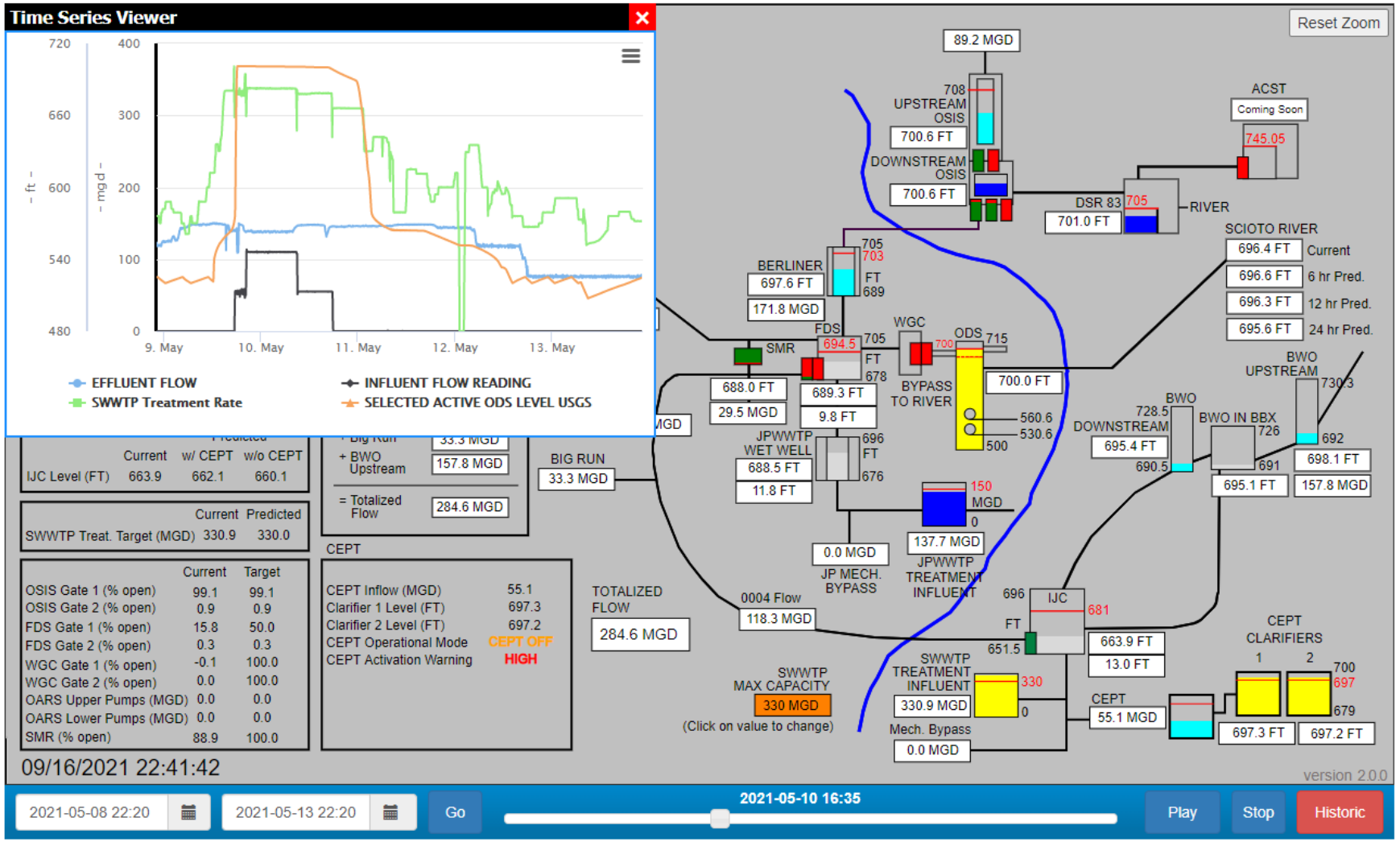

Achievements

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Technical Achievements

- Reduction in system-wide overflow
- Confidently use CEPT only when needed and have the information to readily prove that to others
- Weaknesses in the sensor network have been addressed by adding backup sensors to support the reliable predictions
- We continue to seek opportunities for improvements

Organizational Achievements

- Plant staff own the solution and are leading the progress
  - Success and addressing pain points has built trust and enthusiasm
  - Now the plants are recommending the RT-DSS to sewer maintenance for floodwall operations
- Huge improvements in coordination between facilities
  - Operations, engineering, and leadership are informed and engaged to further optimize operations
  - Consultants are supporting with system optimization, modeling, SCADA, and planning

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Thank You!

Stacia Eckenwiler, PE

Assistant Administrator

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OJ McFoy

Buffalo, New York Sewer Authority

BUFFALO
SEWER AUTHORITY

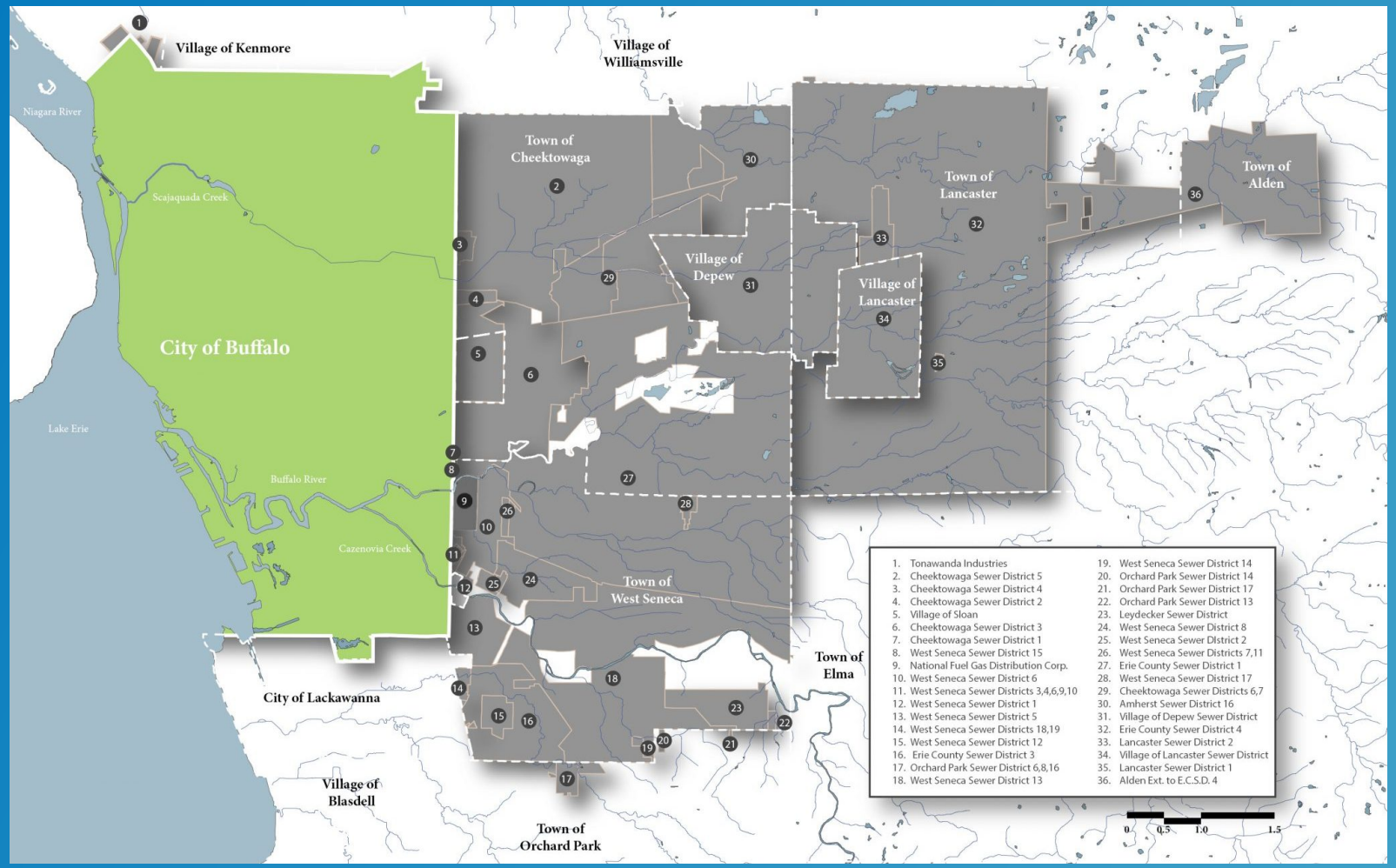
Real Time Control

Smart Sewer Systems and Smart Data Infrastructure

December 2021

BUFFALO
SEWER AUTHORITY

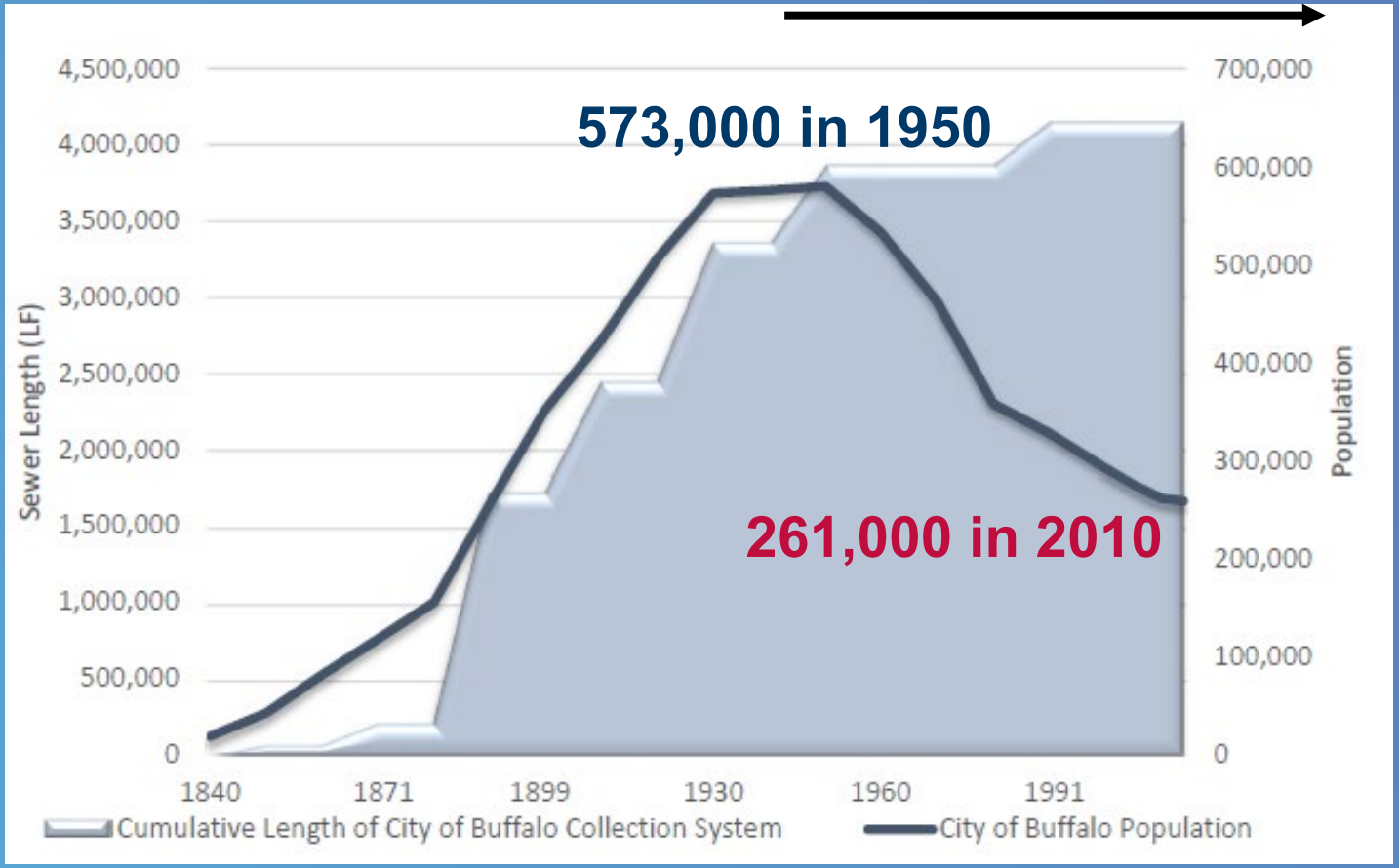
Buffalo Sewer Authority Overview



- Established in 1935
- Services the Buffalo, NY and 11 surrounding municipalities (> 550,000 people)
- 110 sq. mi of coverage, 850 mi of sewer pipe
- Annual operating budget of $60 million
- Long Term Control Plan (LTCP) approved in 2014 to be completed in 20 years, 97% of wet weather flows to be captured upon completion

Why Real Time Control / In-line Storage?

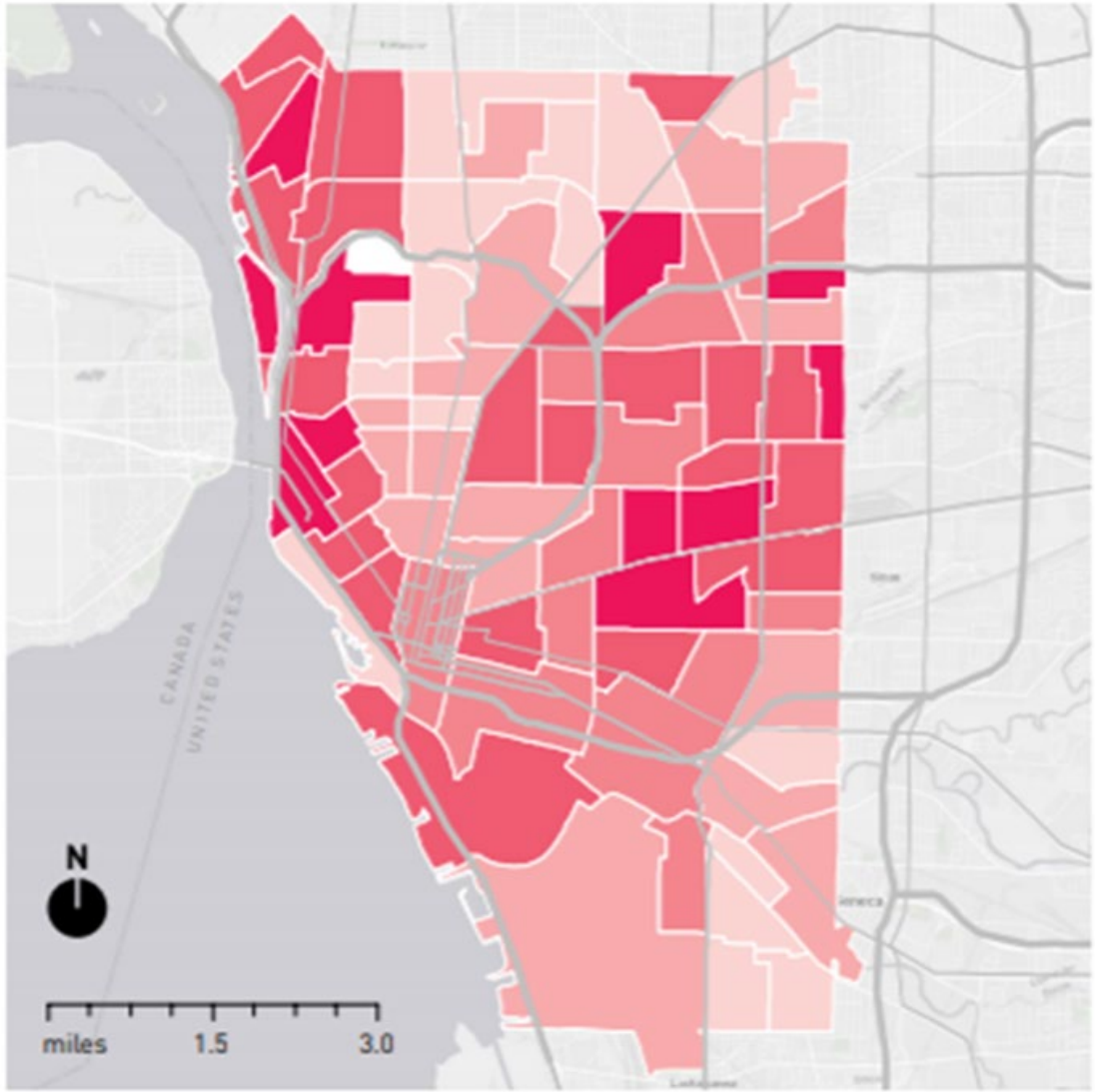
55% Population decrease
Industry decrease

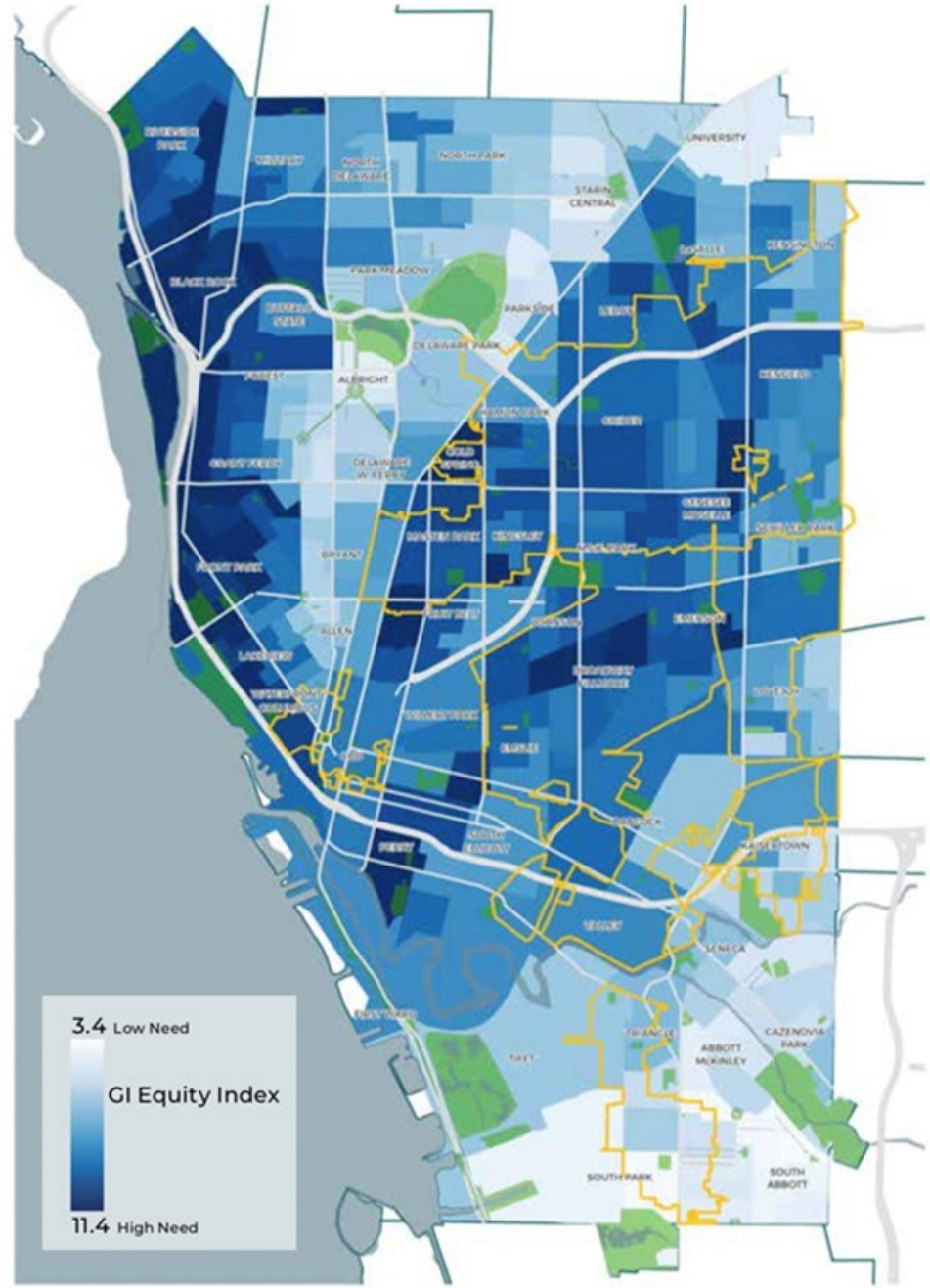


8 major trunklines were more than half empty during the peaks of the largest expected storm events in a typical year

Percent population below poverty level by census tract, Buffalo, 2017.

< 17% | 17%–27% | 27%–36% | 36%–45% | 45% >





Buffalo Sewer Authority's Smart Sewer Program Objectives

Maximize use of collection system storage

Identify additional real-time control (RTC) opportunities

Continuous system improvements

Buffalo Sewer Authority's Smart Sewers

2010

Up to 16 RTC projects were recommended as part of BSA's LTCP.

2014

With promising model results for RTC and green infrastructure improvements, BSA was able to negotiate $145 million out of their LTCP.

2016

Lang Ave. & Bird Ave. in-line storage structures become the first operational RTC sites in BSA's system.

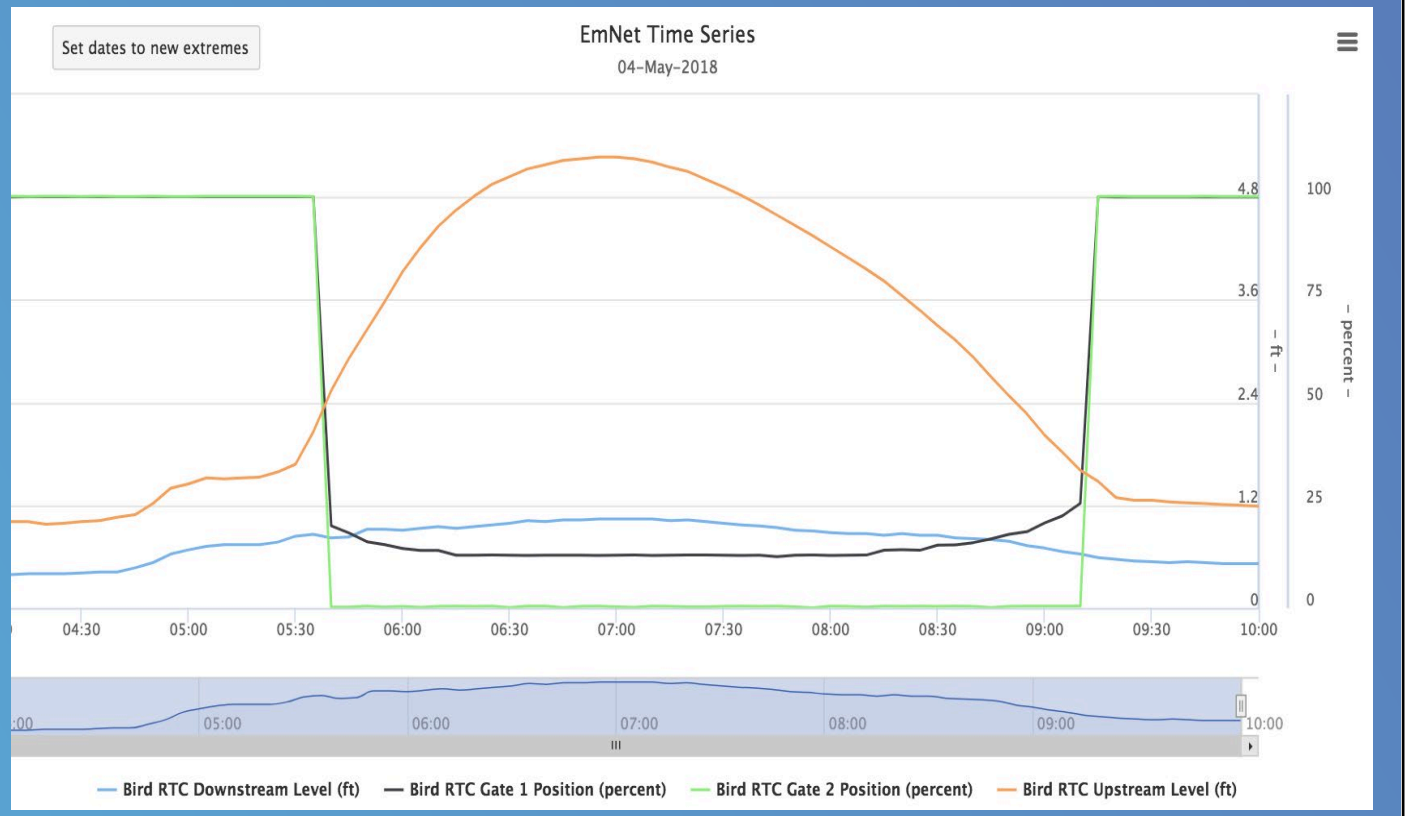
2020

With 6 operational RTC sites, BSA prevented 108 Sewer Patrol Point (SPP) activations in 2020.

2024

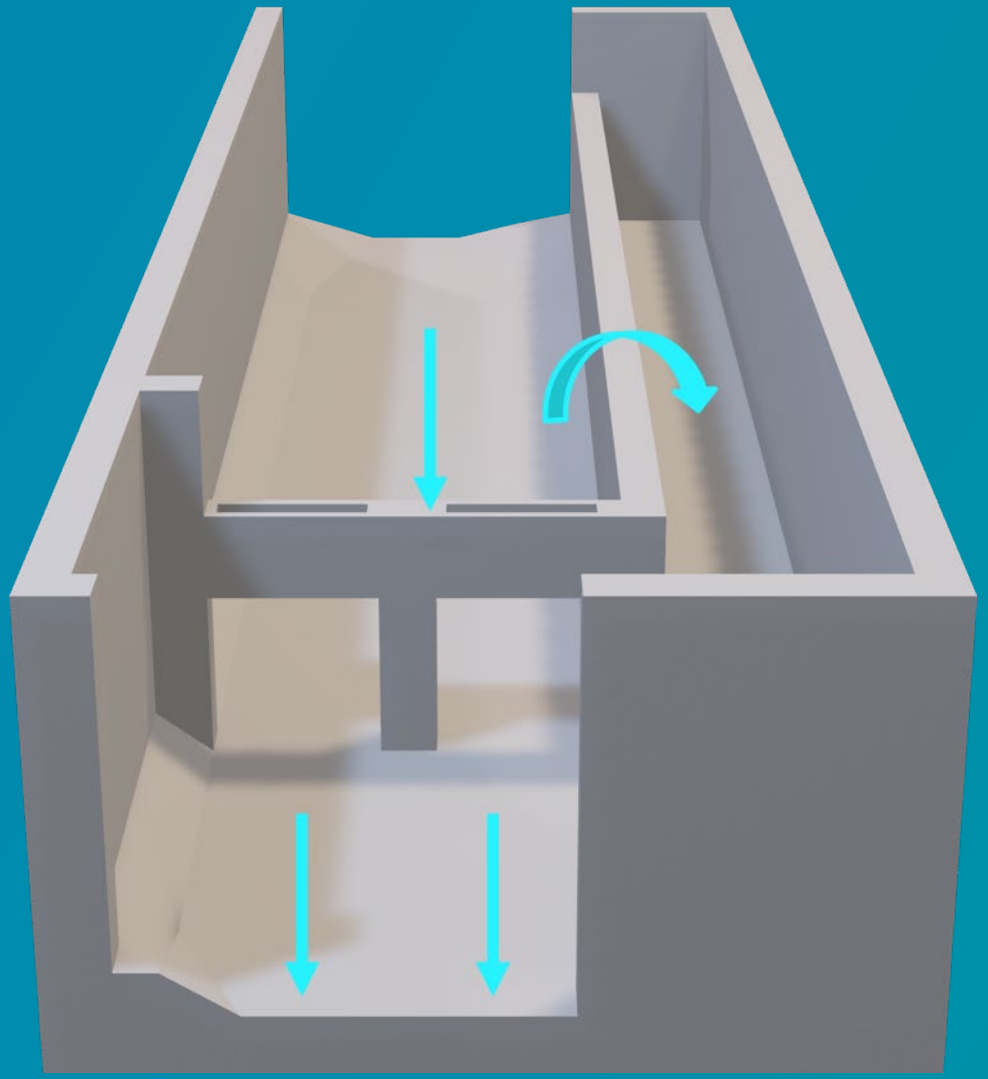
BSA plans to build and commission the remaining RTC sites by 2024 on an adaptive management basis.

Bird Avenue RTC



During wet weather, downstream sensors indicate its time to begin storing
The gates alternate with each event – one closes while the other modulates

Minimizing Equipment Failure Risk



Looking upstream from downstream end of North Bailey in-line storage chamber

RTC sites are designed with redundancies and fail safes to minimize the risks associated with equipment failures

- If gates fail closed:
  - Emergency relief weir maintains level below surcharging risk level
  - “Gate fail to move” alert is sent
- If gates fail open:
  - Flow continues on the same path it would have prior to RTC implementation
  - “Gate fail to move” alert is sent
- If sensor data is out of range/communication loss:
  - RTC PLC logic uses redundant sensor data if available
  - Automatically returns to Auto-Local mode if currently in Auto-Remote mode

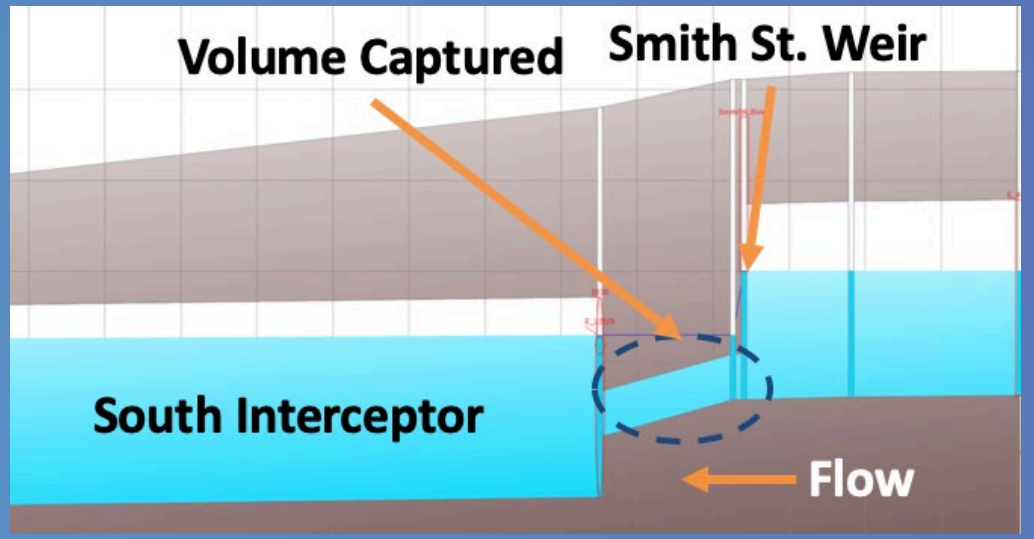
Coordinated Real Time Control

Lang Ave

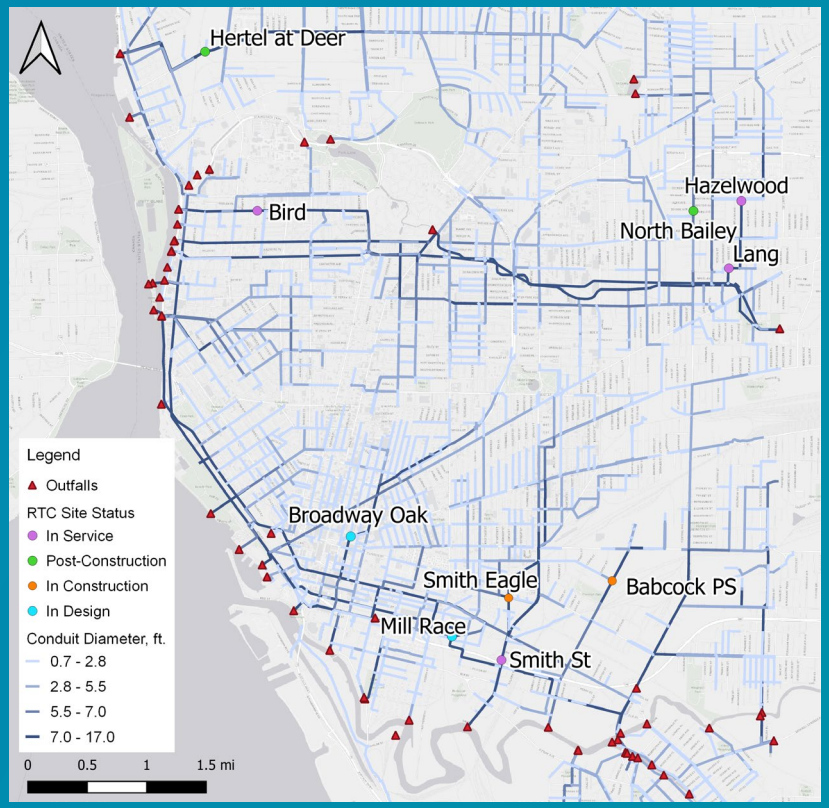
Hazelwood

Real Time Control Strategies:

- Coordinated In-line storage
- Pump station optimization/storage
- Capturing overflow volume
- Dynamic underflow



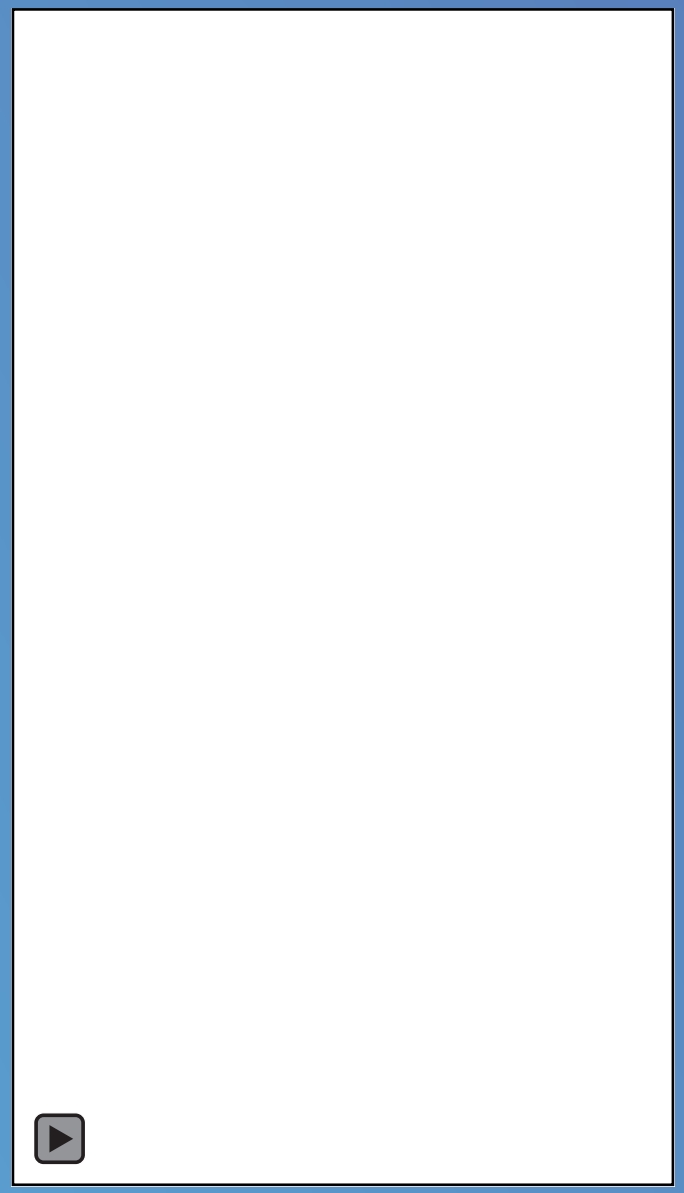
RTC Sites

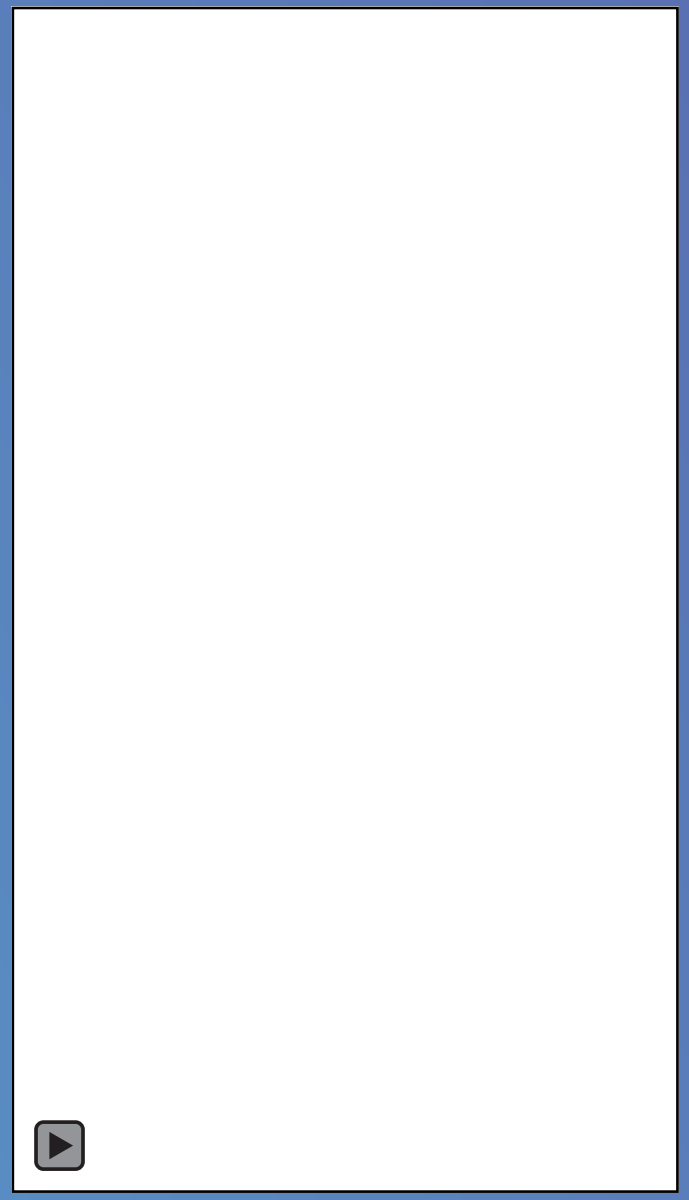


Fully Commissioned:
•Smith St, Lang, Hazelwood, and Bird
Completed, undergoing tuning:
•North Bailey and Hertel at Deer
In Construction:
•Smith Eagle and Babcock Pump Station
In Design:
•Broadway Oak and Mill Race

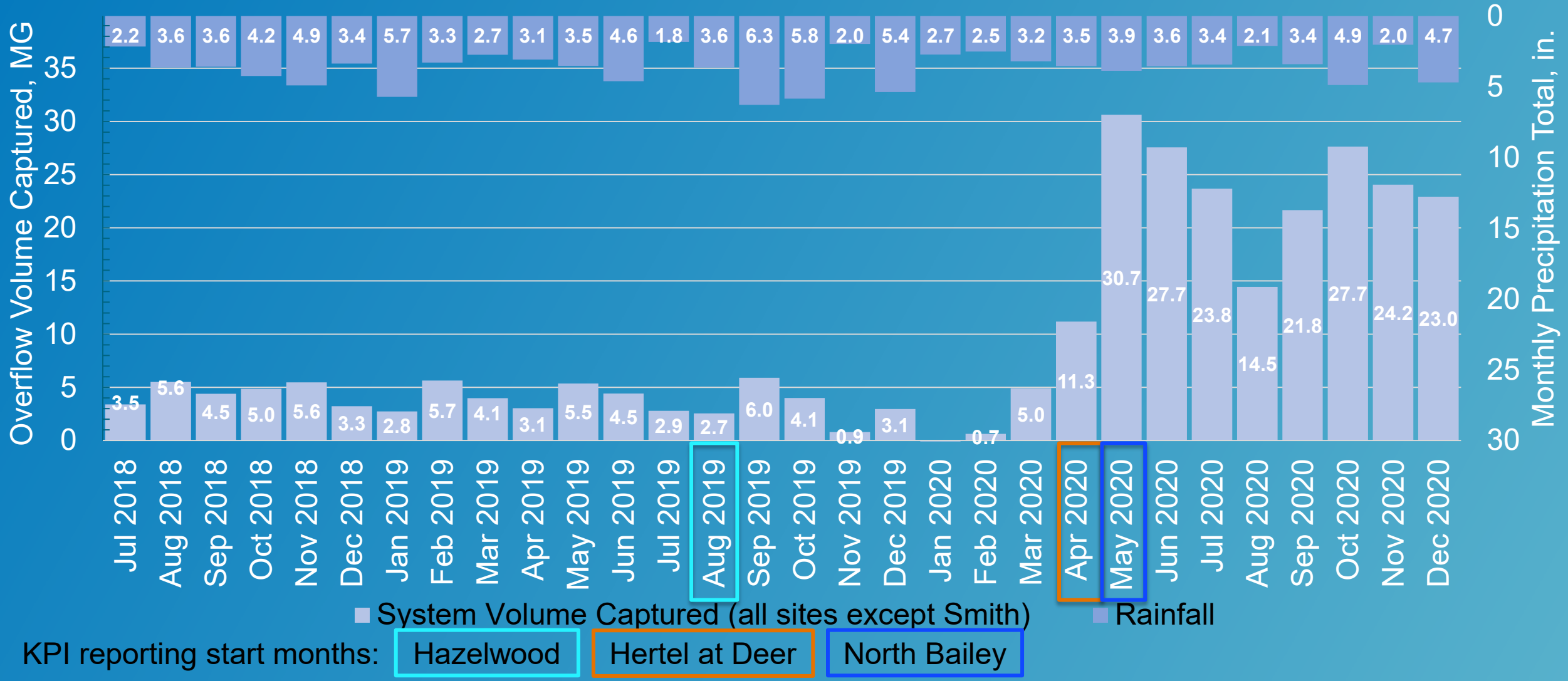
Hertel at Deer RTC Construction Fall 2019 Commissioned January 2020

Hertel at Deer – Post Construction Monitoring





RTC Performance Bird, Lang, Hazelwood, Hertel at Deer, North Bailey



KPI reporting start months: Hazelwood | Hertel at Deer | North Bailey

Next Steps

- In-progress deployment of citywide sensor network to improve performance
- Empower operations with improved predictive maintenance
- Complete remaining in RTC sites by 2024
- Augment operating system with AI embedded boundary conditions and expand coordinated control

Hertel at Deer RTC Commissioning, January 2020

Thank You!

For more information:

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Questions and Answers