2017 National Watershed & Stormwater Conference

Welcome to the Conference

- Continuing Education Credits – We are offering PDHs for our national watershed and stormwater conference. A registered attendee must watch the entire webcast to be eligible to earn a pdf Certificate of Completion that will be sent out after webcast to the person who registered for the webcast. The certificate will indicate the Number of PDH hours earned. The varying nature of certification requirements for each state means we cannot guarantee that CEU's will be awarded and it is up to the individual to determine if CEU's or PDH's will be awarded based on the policies of their local certifying board. Email webcast@cwp.org with questions.

2017 National Watershed & Stormwater Conference

To Adjust How the Slides Appear on Your Screen – To make the slide area larger, go to Full Screen under the Meeting Tab.

To Answer a Poll Question – Polling questions appear during the webcast. To answer a poll question, click on the radio button to the left of your answer and click submit. Do not type your answer in the chat box.

To Ask a Question – The right corner of the screen contains a Q&A chat box. Type your question in the box and click on the send question icon to submit it. We will try to answer as many questions as possible during and after the webcast.

2017 National Watershed & Stormwater Conference

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2017 National Watershed & Stormwater Conference

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2017 National Watershed & Stormwater Conference

Thanks to Our Hub Location Funders

Omaha — Douglas County, Nebraska, 1854

Philadelphia — National Fish and Wildlife Foundation, NFWF

Boston — Opti: active intelligence | clean water

2017 National Watershed & Stormwater Conference

Webcast Team

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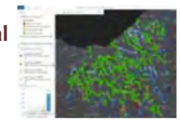
2017 NATIONAL WATERSHED & STORMWATER CONFERENCE
Connecting Practitioners to Innovative Ideas

National Webcast 3: Emerging Tools in Watershed Protection, Restoration & Implementation

Collaborative GIS-centric Field Data Collection Used by NEORSD for Regional Stormwater Management Program



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April 4, 2017

Discussion Topics

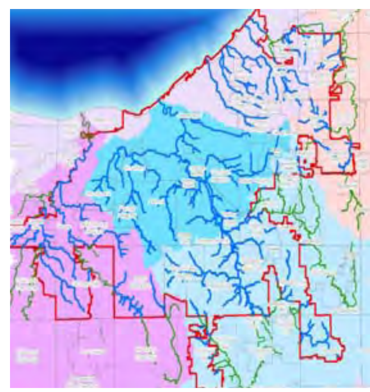
1. Overview
2. …ations
3. GIS Tools
4. Lessons Learned

Overview – Regional Stormwater Management Program

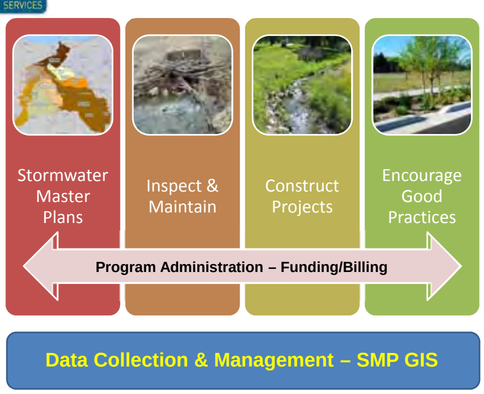
Goal – Addressing flooding, erosion, and water quality problems

Target – Regional Stormwater System (420 Miles)

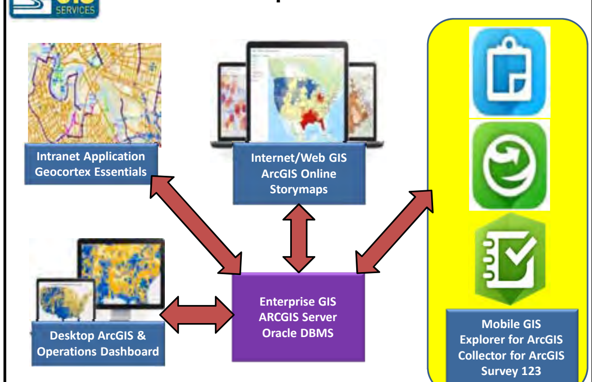
Service Area – 350+ Sq. Mi.



Overview – Program Components



NEORSD Enterprise GIS Platform Overview



NEORSD Enterprise GIS Platform Overview

GIS Data & Tools are available:

Anytime (~24/7/365)
Anywhere (with Internet Access)
Any device (desktop, tablet, phone)

Business decisions don't wait till you are at your desk…

Survey 123

Discussion Topics

1. Overview
2. …ations
3. GIS Tools
4. Lessons Learned

…ations

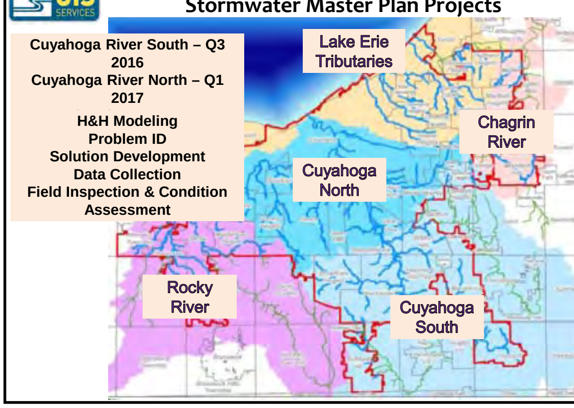
- Innovations – Changes in something established, especially by introducing new methods, ideas, products or processes
- Foundation – Adaptable foundation to support current and future watershed management & SMP initiatives
- Collaborations – Work together to enhance project results
- Implementations – GIS Tools able to be developed and implemented very efficiently, consistently and cost-effectively
- Information – GIS Tools enhance Access, Analysis, Reporting and Management (AARM) functions to support decision making
- Administration – Project and Program administration tasks made more effective, efficient and transparent

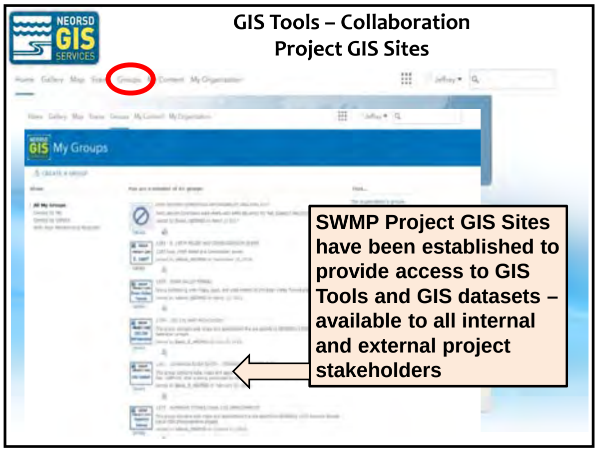
Discussion Topics

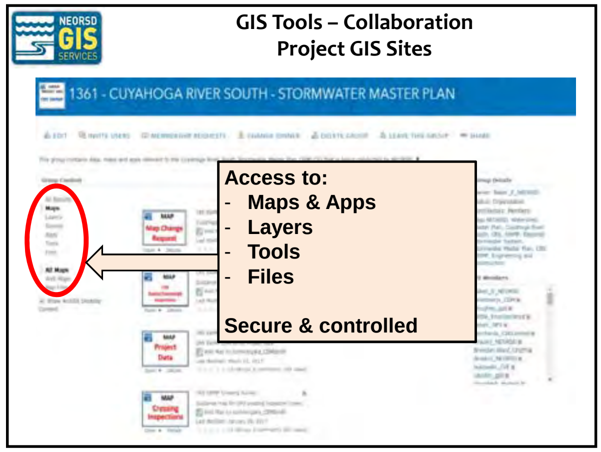
1. Overview
2. …ations
3. GIS Tools
4. Lessons Learned

GIS Tools – Innovation
NEORSD – WebGIS Platform

GIS Tools – Foundation
Stormwater Master Plan Projects

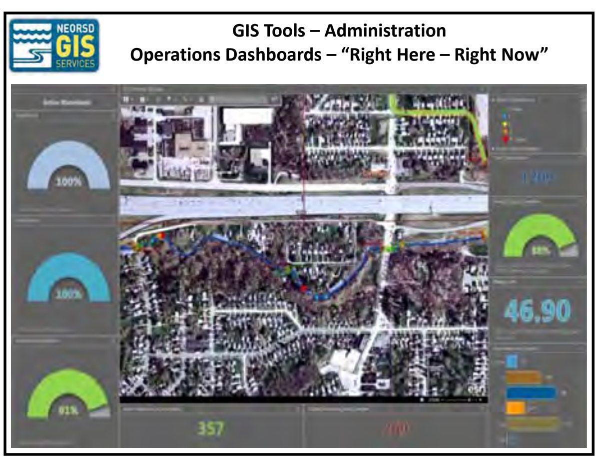


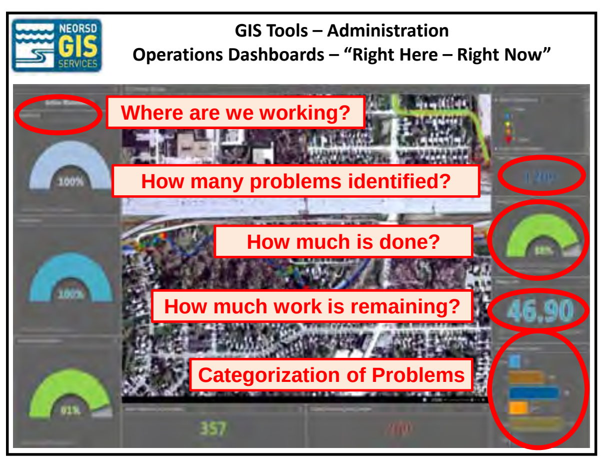

GIS Tools – Collaboration
Project GIS Sites
SWMP Project GIS Sites have been established to provide access to GIS Tools and GIS datasets – available to all internal and external project stakeholders


GIS Tools – Collaboration
Project GIS Sites
1361 - CUYAHOGA RIVER SOUTH - STORMWATER MASTER PLAN
Access to:
- Maps & Apps
- Layers
- Tools
- Files
Secure & controlled

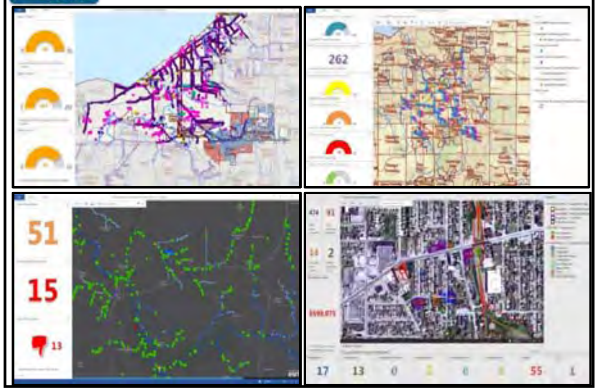

GIS Tools – Implementations
Data Collection – Collector for ArcGIS


GIS Tools – Implementations
Data Collection – Survey 123 for ArcGIS


GIS Tools – Administration
Operations Dashboards – "Right Here – Right Now"
46.90
357


GIS Tools – Administration
Operations Dashboards – "Right Here – Right Now"
Where are we working?
How many problems identified?
How much is done?
How much work is remaining?
Categorization of Problems
46.90
357

GIS Tools – Administration
Operations Dashboards – "Right Here – Right Now"



GIS Tools – Information
Access – Multiple Datasets – Multiple Sources

Internal (Enterprise) Sources
- RSS Assets (Multiple classes)
- Storm/Sanitary Sewers
- Model Info (Inputs & Outputs)
- Monitoring Locations
- HSTS Locations
- IDDE Information (WQ Issues)
- SWIM Inspections
- BTU Assets & Assessments
- Problem Locations
- And So On…

External Sources
- Basemap/Boundary Layers
- Parcel Information
- Facility Information
  - As-Builts
  - Inspections
- Topography/Lidar
- Community Information
- State & Federal Information
- Project Datasets
- And So On…

GIS Tools – Information
Access – StoryMaps – Watershed Information

GIS Tools – Information
Access – StoryMaps – Grant Projects

GIS Tools – Information/Administration
Funding – Fee Administration

Discussion Topics

1. Overview
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4. Lessons Learned

Lessons Learned - Summary

Be Aware
- Administration/Planning
- Awareness/Buy-In
- Education/Training
- Evolution/Enhancements
- Formal/Informal Communication
- Permissions/Rights
- New World
  - Devices
  - Functions/Tools
  - Resources

Benefits
- Awareness/Availability
- Collaboration
- Communication
- Confidence (Accuracy/Currency)
- Efficiency (Delivery/Decisions)
- Effectiveness/Productivity
- Return on Investment
- Scalability/Sustainability
- Understanding

Today (2017) & Tomorrow (2018)

Continue providing: **Smarter Apps**

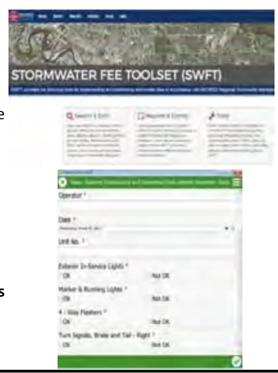
To support: **Smarter Decisions**

Customers: **Better Services & Awareness**

Application Development	Communication & Outreach	Operational Awareness	Administration
Continue optimization, integration, tool use	User Awareness & Education	Project Management Dashboards	Best Practices Documentation
Survey 1-2-3 Workforce	Open Data Public Apps	Executive Management Dashboards	ArcGIS Online Featured Maps Gallery

NEORSD – WebGIS Platform – Top 5 Uses

1. **Asset Management**
   - Inventory, Inspection & Condition Assessment
2. **Stormwater Program**
   - Fee Development, Customer Service
3. **Projects – Data Collection & Management**
   - 3 SMPs, 2 SSESs - $30M – Data Collection
4. **Internal – Departmental Workflows**
   - Custom Maps/Apps – e.g. Property Interests
5. **Internal Data Collection/Map Changes**



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Michael Baker INTERNATIONAL — *We Make a Difference*

Unmanned Aircraft Systems: Mapping and Inspection Applications

Srini Dharmapuri PhD, CP

Michael Baker INTERNATIONAL

Agenda

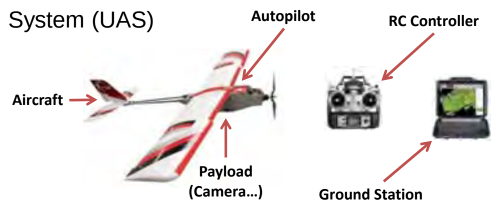
- **Introduction**
- **Technical Issues**
- **Project Results**
- **FAQ**

We Make a Difference

Introduction

What's in a Name?

- Unmanned Aerial System (UAS)



Preferred terminology of the FAA

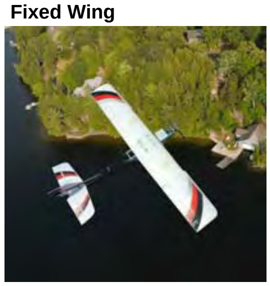
What's in a Name?

Technical Issues

General Types

Multi Rotors

Fixed Wing



Types of UAS

- Multi Rotors
  - Strengths
    - Vertical takeoff
    - Hovering capability
    - Camera gimbals
    - Simple to fly manually
  - Considerations
    - Short flight times (<20min)
    - Hard landing with fail
    - Low payload weight
- Fixed Wing
  - Strengths
    - Hand launch capability
    - Long flight times (>40min)
    - Loiter capabilities
    - Soft landing with failsafe
  - Considerations
    - No payload stabilization
    - Glide to loss with fail
    - Best in programmed flight

4/3/2017 42

Suitability

Multi Rotors	Fixed Wing
▪ Video Documentation ▪ Bridge Inspection ▪ Construction Site Monitoring (Video) ▪ Architectural Modeling ▪ Fly-through Animations ▪ Stack Inspections ▪ Tower / Pole Surveys ▪ Site Mapping (< 5 acres)	▪ Watershed, Site Mapping (< 160 acres) ▪ Land Dev Mapping ▪ Construction Site Monitoring (Mapping) ▪ Corridor Mapping • Transportation • Utility ▪ Environmental Mapping ▪ Agricultural Mapping

Fixed-Wing sUAS

Precision Hawk Lancaster III
Multiple Sensor Capability (RGB, IR, LIDAR, etc.)
Flight Duration: 45-Minute
Acquisition Footprint: @ 100-Acre (each battery)
Line of Sight Operational Range
Operational Ceiling: 12,000'
Fully-Autonomous Flight Capability (w/override failsafe)
Semi-Automated Flight Planning

sUAS

- TOPCON Falcon 8
  - High-resolution Camera
  - Automated Collision Avoidance
  - Inspections/Monitoring/Volumetrics

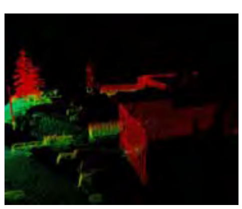
UAS Data Processing

Rebirth of Photogrammetry - Point clouds from imagery

. . It's all About the point cloud.

Point Cloud

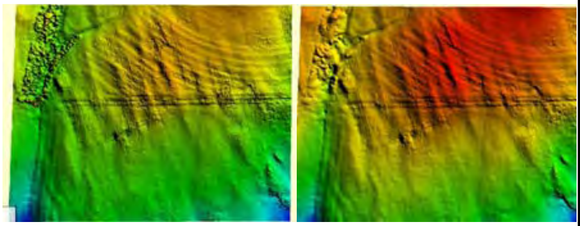
- **Point Cloud:**
  - ❖ A set of data points usually defined by X, Y, and Z values in a 3D coordinate system
  - ❖ Intended to represent the external geographic surfaces
  - ❖ Point clouds are most commonly created by LiDAR systems, but can be generating from photographic images, too



Point Cloud

- ➢ LiDAR Point Cloud
  - ▪ Active sensor generates signal/return
- ➢ Aerial Photo/Imagery
  - ▪ Passive sensor measures and records naturally reflected daylight
  - ▪ Semi Global Matching (SGM) –uses two overlapping image create a point clouds as
  - ▪ Accuracy of the point cloud depends on the accuracy of the images (scale, flying height, etc.)
- ➢ More points penetrating the canopy = more detailed DEM.

DSM/DEM



Project Results

Mapping Project Results using PH

Location: Harford Landfill, MD

Area: 30 acres

Flying Height: 70m

Total Exposures : 692

Native resolution : 3 cm

Number of missions : 1

Time for collection : 30 minutes. Prep time 1 – 1.5 hours.

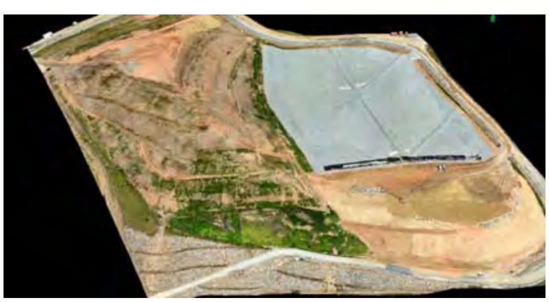
Number of Controls established: 24

Number of Controls used in the processing: 12

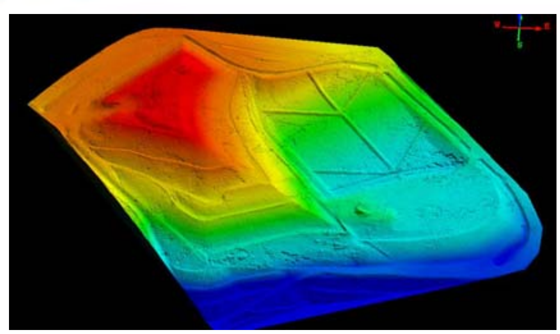
Number of controls used in Accuracy Analysis: 12

Mapping Project Results Using PH

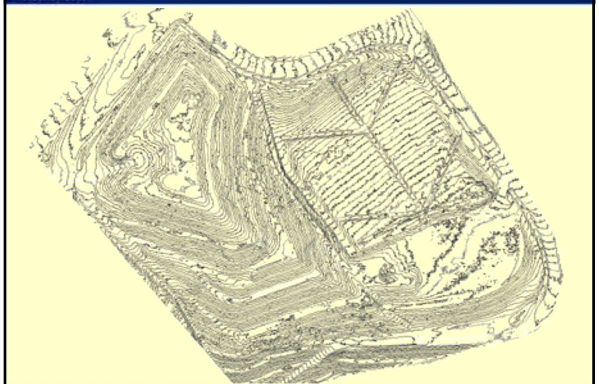
Mapping Project Results Using PH



Mapping Project Results Using PH



Mapping Project Results Using PH



Inspection Applications

https://www.youtube.com/MichaelBakerUAS

FAQ

Ease of use in a particular application?
Easy to deploy and collect the data and process. You need to have an aircraft, a FAA certified pilot and the site is suitable for flying.

Does it require specialized a consultant to implement or to use?
You need to have FAA certified pilot and people who have the mapping background. Some state laws will require the product to be sign and seal off.

How long did it take to put into use?
Time to implement is very less, Few days and not weeks.

Is it costly?
No. VTOL equipment around 6k and software 6 – 10k.
Based on the data, the UAS cost should be around 60% - 70% of the conventional mapping cost (Photogrammetry)

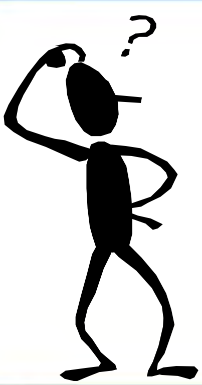
What are the benefits to its use;

Easy to deploy, maintain and very quickly results can be produced. There is a cost efficiency in using UAS.

Is it likely to be obsolete due to software/hardware upgrades?
Partly yes.

Is there a large maintenance price tag.?
No. There is no big price tag.

Questions



Questions

Emerging Tools in Watershed Protection, Restoration, and Implementation

New Approaches to Flood Control, Water Quality, and Combined Sewer Overflow with Continuous Monitoring and Adaptive Control

Center for Watershed Protection
2017 National Stormwater Conference
April 4, 2017

Opti

Emerging Tools in Watershed Protection, Restoration, and Implementation

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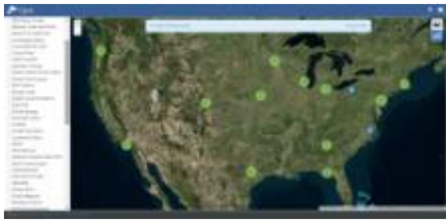
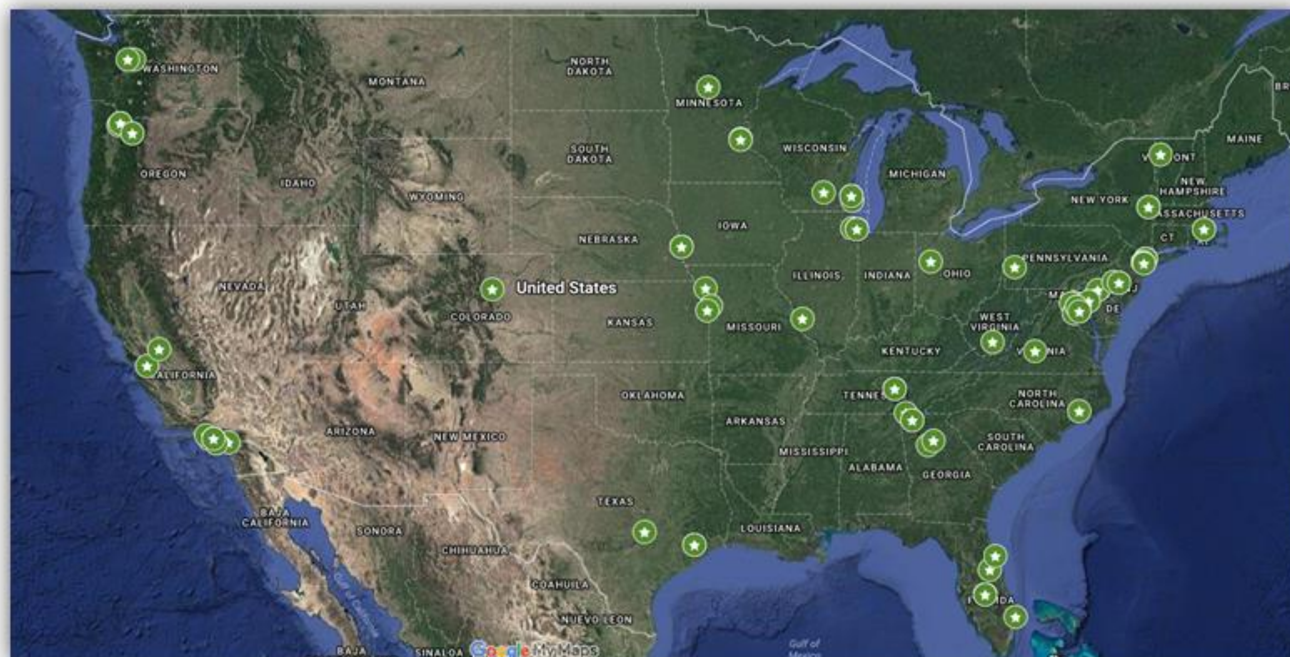


Opti
active intelligence | clean water

About Opti



- Initial research by NOAA, EPA, WERF in 2007
- Full commercialization of technology in 2014 – Opti Formed as an Independent Company
- Deployed over 130 commercial and public projects across 21 states
- >40M gallons storage under active management

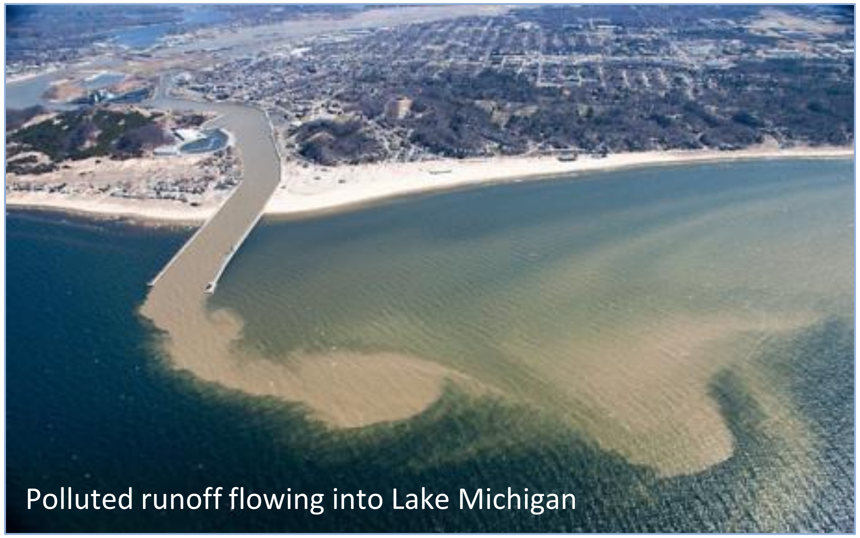
Regulatory Approvals

CMAC for the Enhancement and
Conversion of Existing Best Management Practices

Maryland Department of the Environment
01/27/2016

Chesapeake Bay Program
11/15/2016

The Problems We Address in New Ways



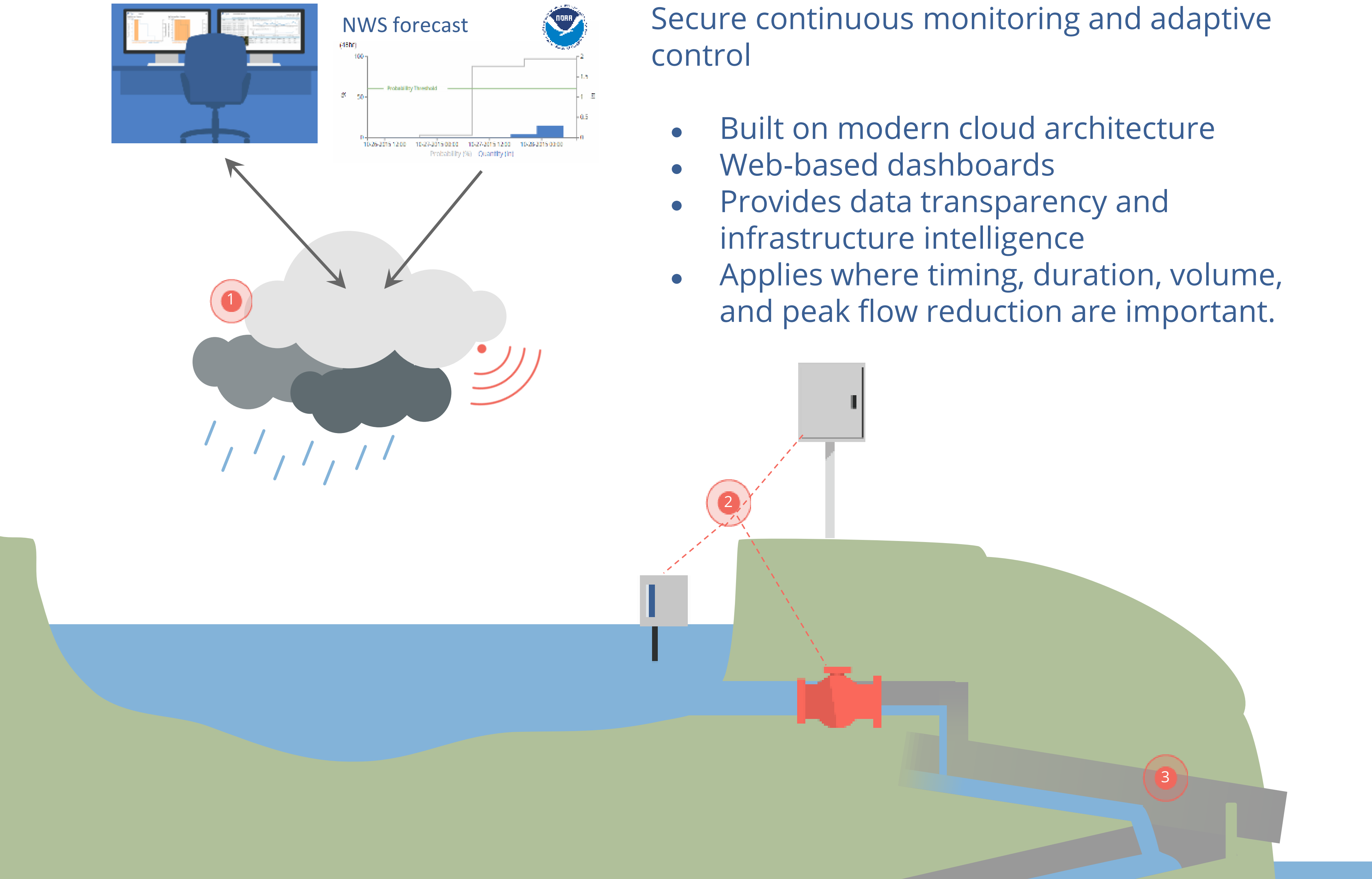
Polluted runoff flowing into Lake Michigan

Flooding

Toxic Algal Bloom caused by runoff

Discharge of raw sewage and runoff

How does CMAC Function?



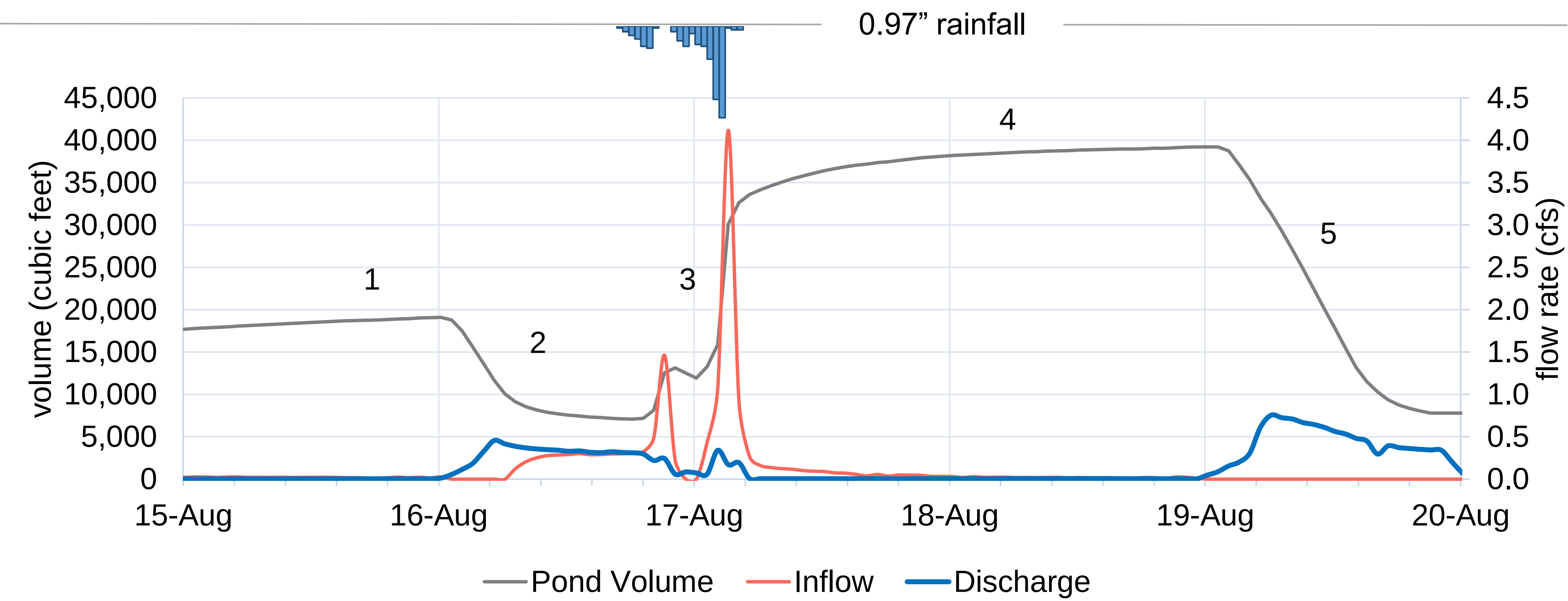
Secure continuous monitoring and adaptive control

- Built on modern cloud architecture
- Web-based dashboards
- Provides data transparency and infrastructure intelligence
- Applies where timing, duration, volume, and peak flow reduction are important.

Field View of Hardware Components

How CMAC works

1. Read forecast
2. Prepare for incoming runoff
3. Manage discharge during wet weather
4. Meet retention goals
5. Manage discharge to return to dry weather level



Types of Stormwater Infrastructure/Assets Opti Controls

North Bethany, OR (Clean Water Services)

Conowingo Elementary School, Conowingo, MD
Rainwater Harvesting Cistern

Frost Pond (Dry), Prince George's County, MD (NFWF)

University Blvd Pond, Silver Spring, MD (NFWF)

Brooklyn Botanical Garden, NYC

Case Study 1: Philadelphia
CSO mitigation on private property

8-acre drainage area
Adaptively Controlled Retention

amec foster wheeler

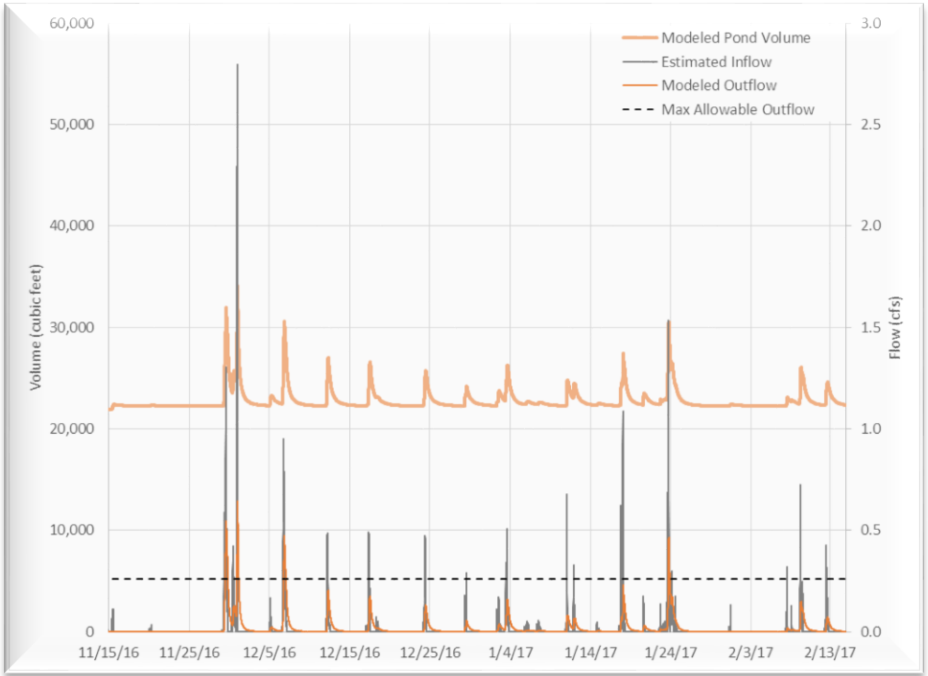
PHILADELPHIA WATER

Opti

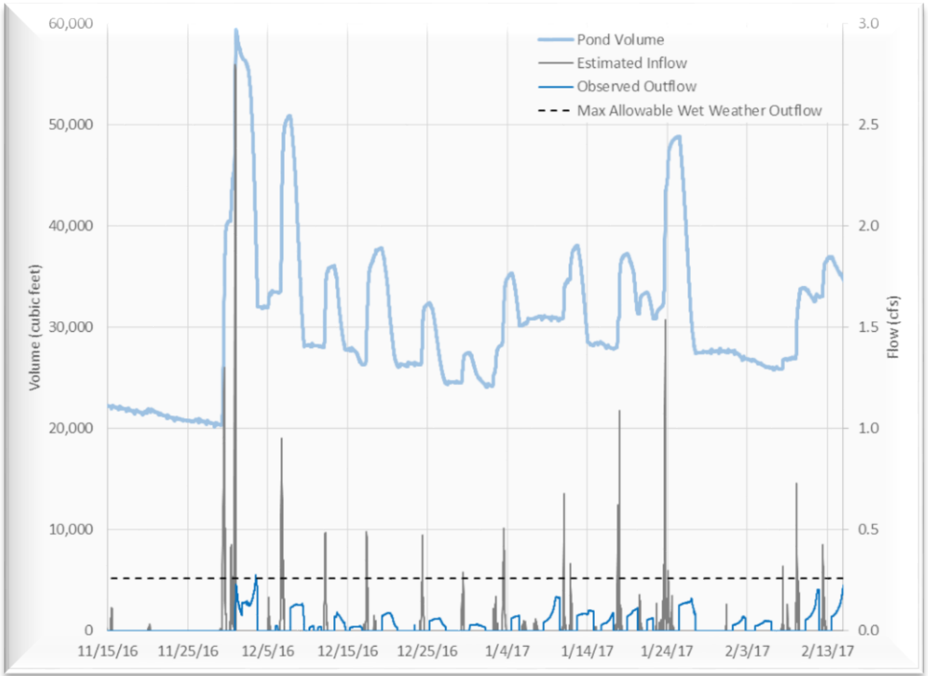
CMAC in Philadelphia

Performance Analysis (Data from Philadelphia)

Modeled pond volume and flows with passive outlet control

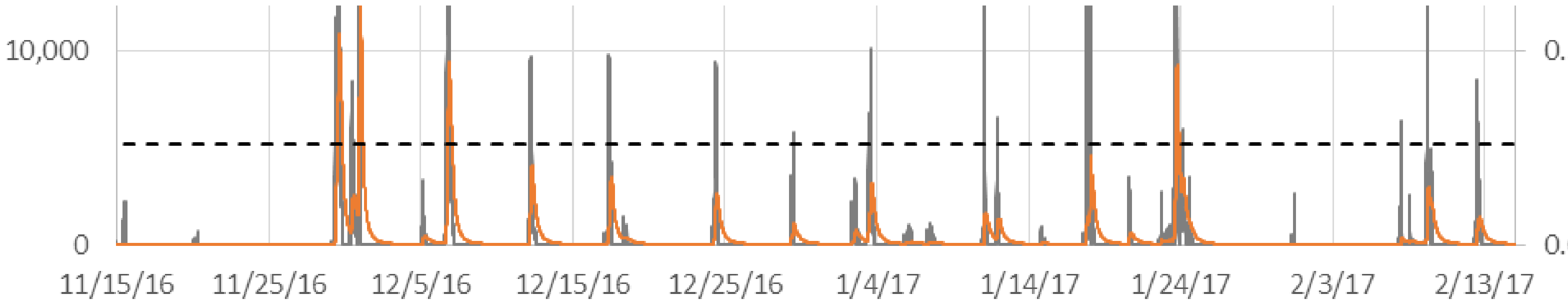


Observed pond volume and flows with Opti system control

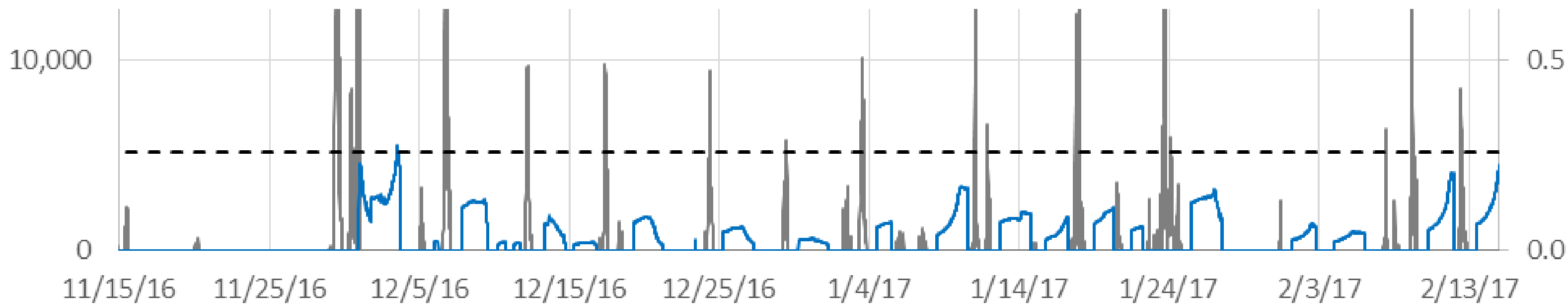


- CMAC system exceeded PWD's criteria for wet weather site discharge by completely avoiding wet weather outflow for nearly all rain events.
- In total, during a period with approximately 1.01 million gallons of runoff generated from 14 storm events, the system prevented 0.97 million gallons of water from entering the combined sewer during wet weather.

Performance Analysis (a closer look at flow)



Modeled flows with passive outlet control



Observed flows with Opti system control

CMAC resulted in a 96% reduction in wet weather flow volume (1.01M gallons of runoff to 40K gallons)

Case Study 2: Johnson County Stormwater and Lenexa, KS

water quality + flood control retrofit

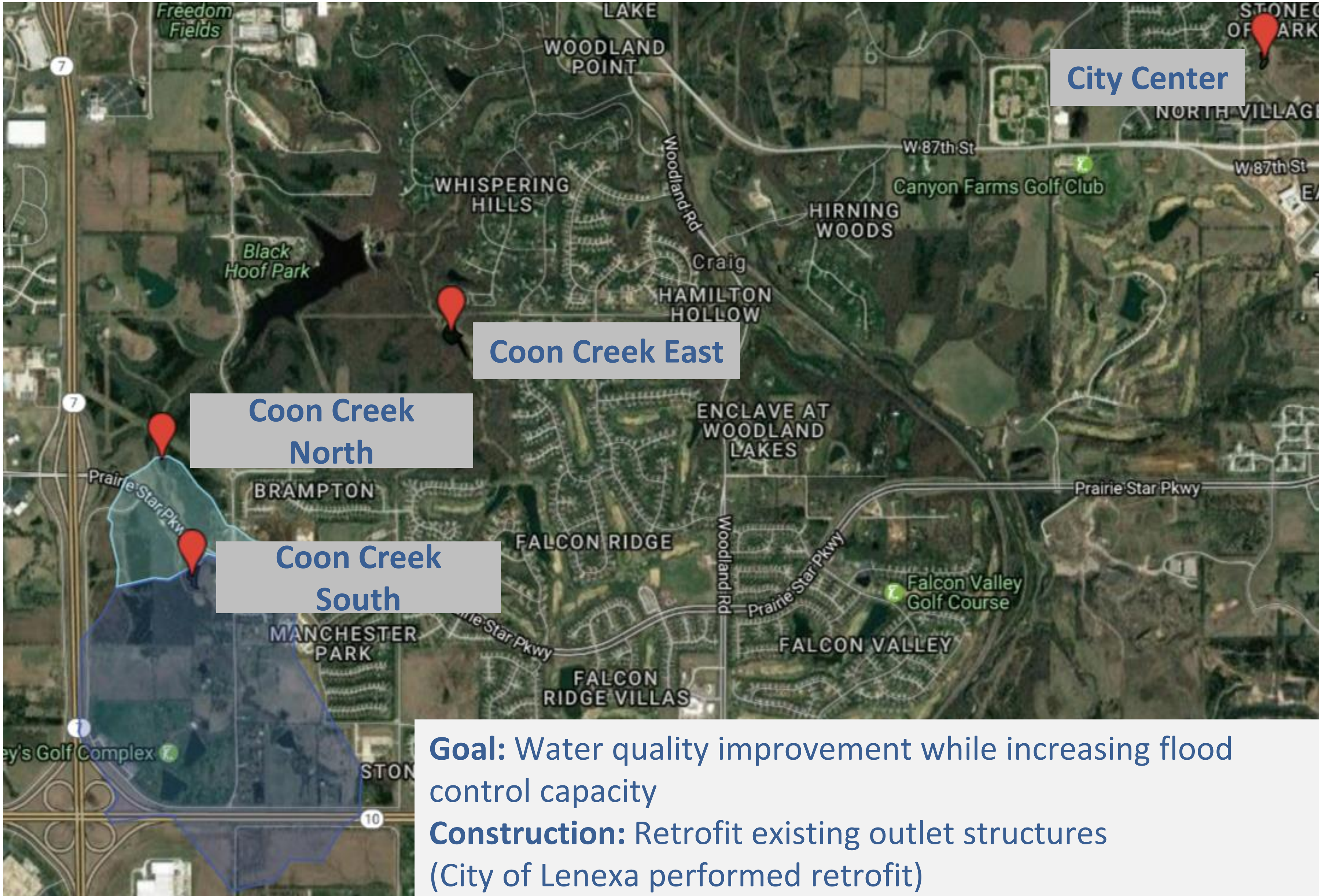
Adaptively Controlled Retention

Lenexa KANSAS

LIFT
Leaders Innovation Forum for Technology

Opti

CMAC in Lenexa, KS



Goal: Water quality improvement while increasing flood control capacity

Construction: Retrofit existing outlet structures (City of Lenexa performed retrofit)

CMAC in Lenexa, KS

CMAC in Lenexa, KS

CMAC in Lenexa, KS

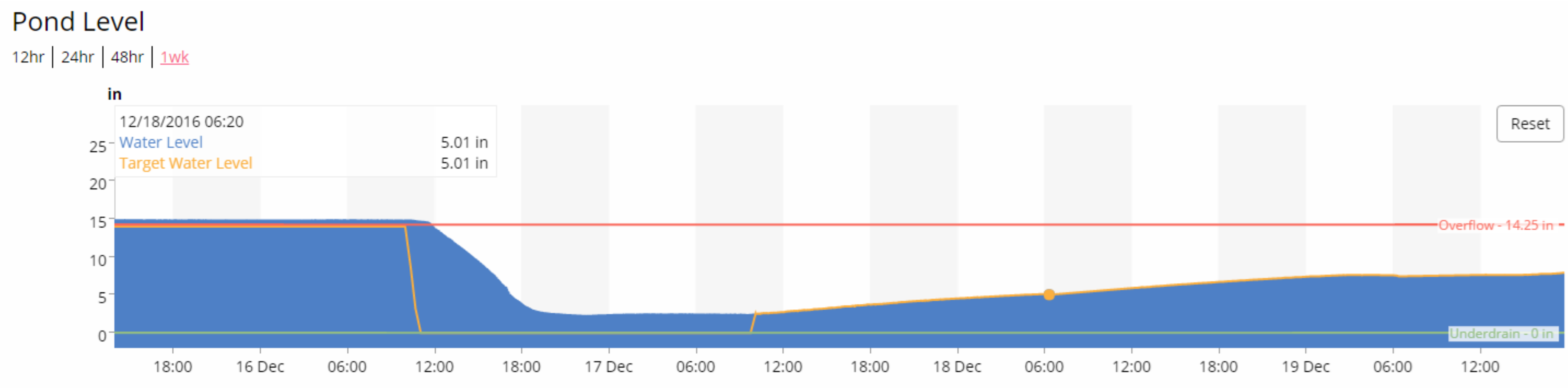
CMAC in Lenexa, KS

CMAC Simplified Logic

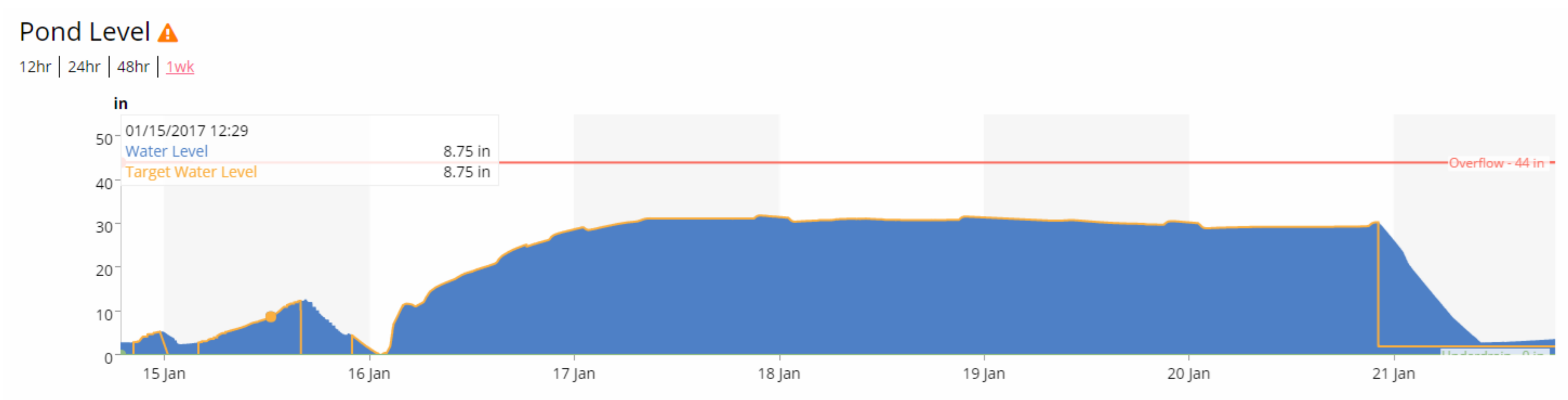
- **Coon Creek Ponds** – Release Before Forecasted Storm
- **Coon Creek North and South** – Adjust release timing and watershed area to maximize benefit of facilities in the same watershed
- **City Center** – Allow storm to fill pond above permanent pool, release after retention period

CMAC Preliminary Storms

Coon Creek East – December 17

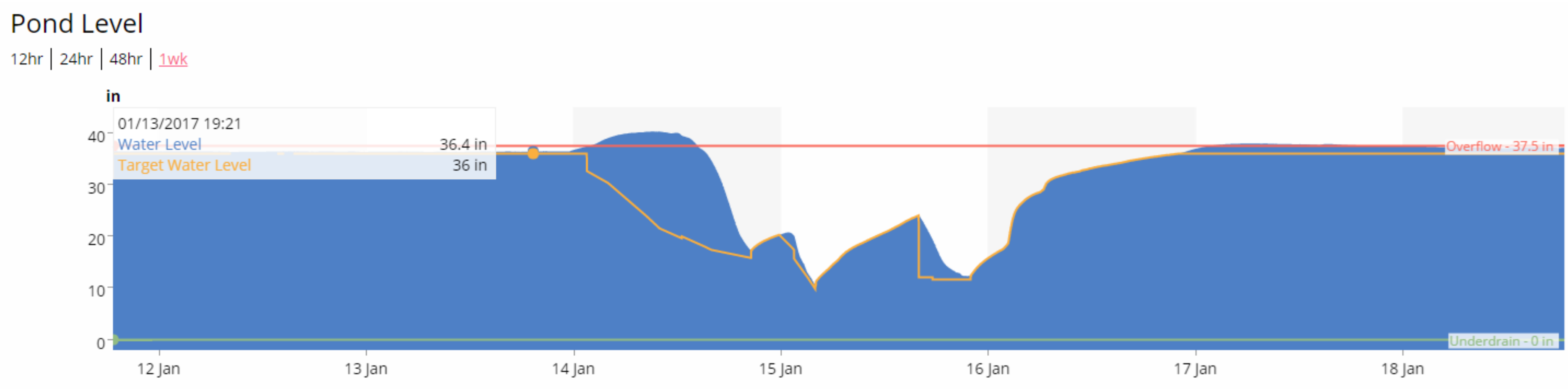


City Center – January 15

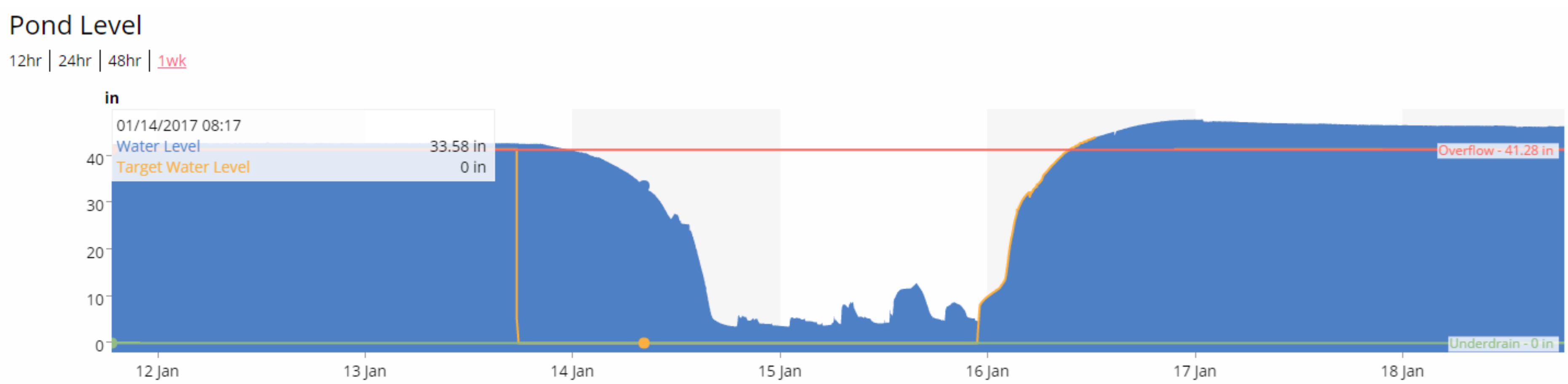


CMAC Preliminary Storms

Coon Creek North – January 15



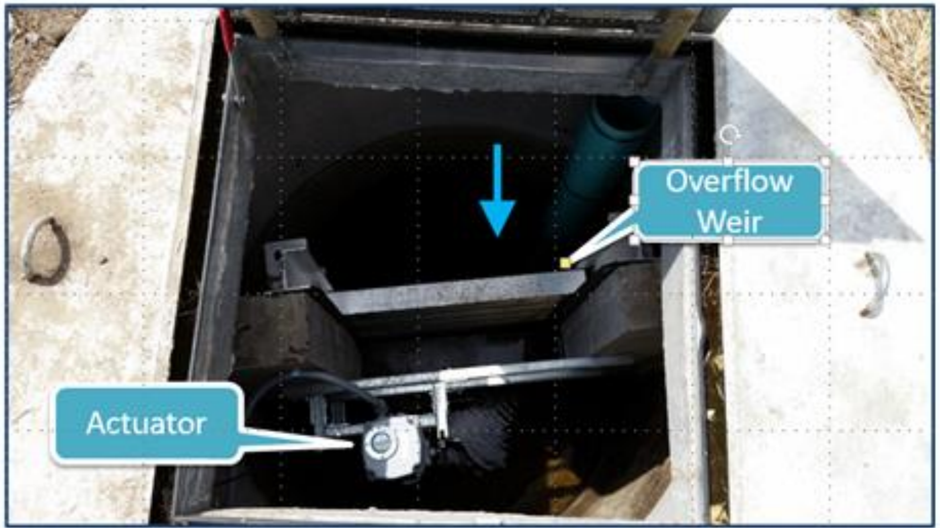
Coon Creek South – January 15



Case Study 3: Curtiss Pond
Capitol Region Watershed District, MN
flood control retrofit

Adaptively Controlled Retention

Adaptive Control of Existing Storage for Flood Reduction



How CMAC Operates for Curtiss Pond (Flood Control Retrofit of Existing Wet Storage)

Case Study 4: Clean Water Services, OR

flow-duration control + peak control + water quality

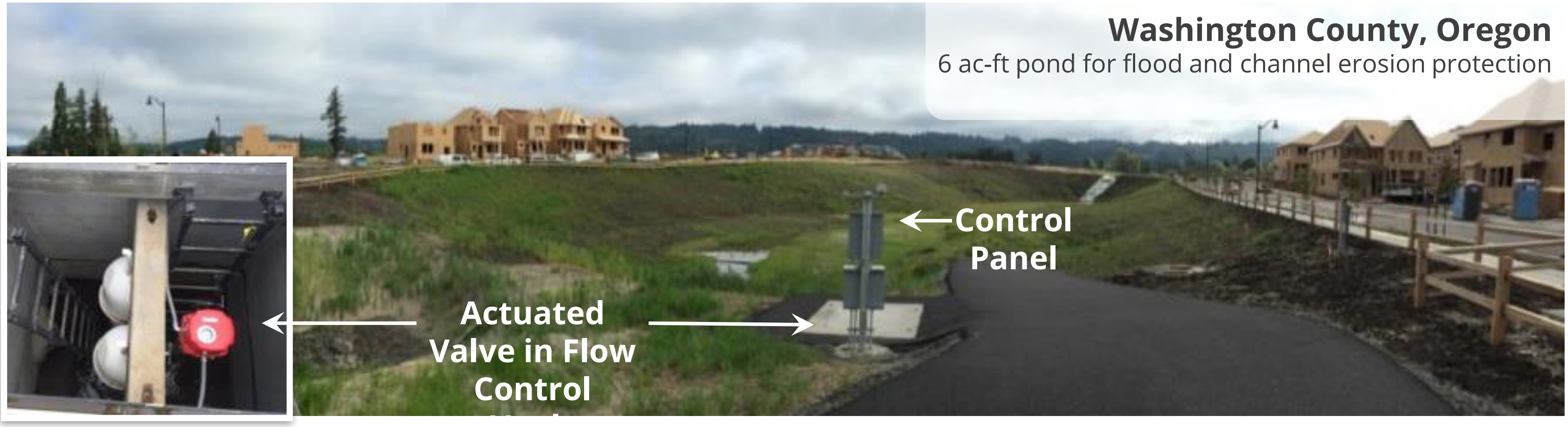
2M Gallons
Adaptively Controlled Detention/Retention

Geosyntec consultants

Clean Water Services

Opti

Portland, OR - Flow Control & Hydrograph Matching

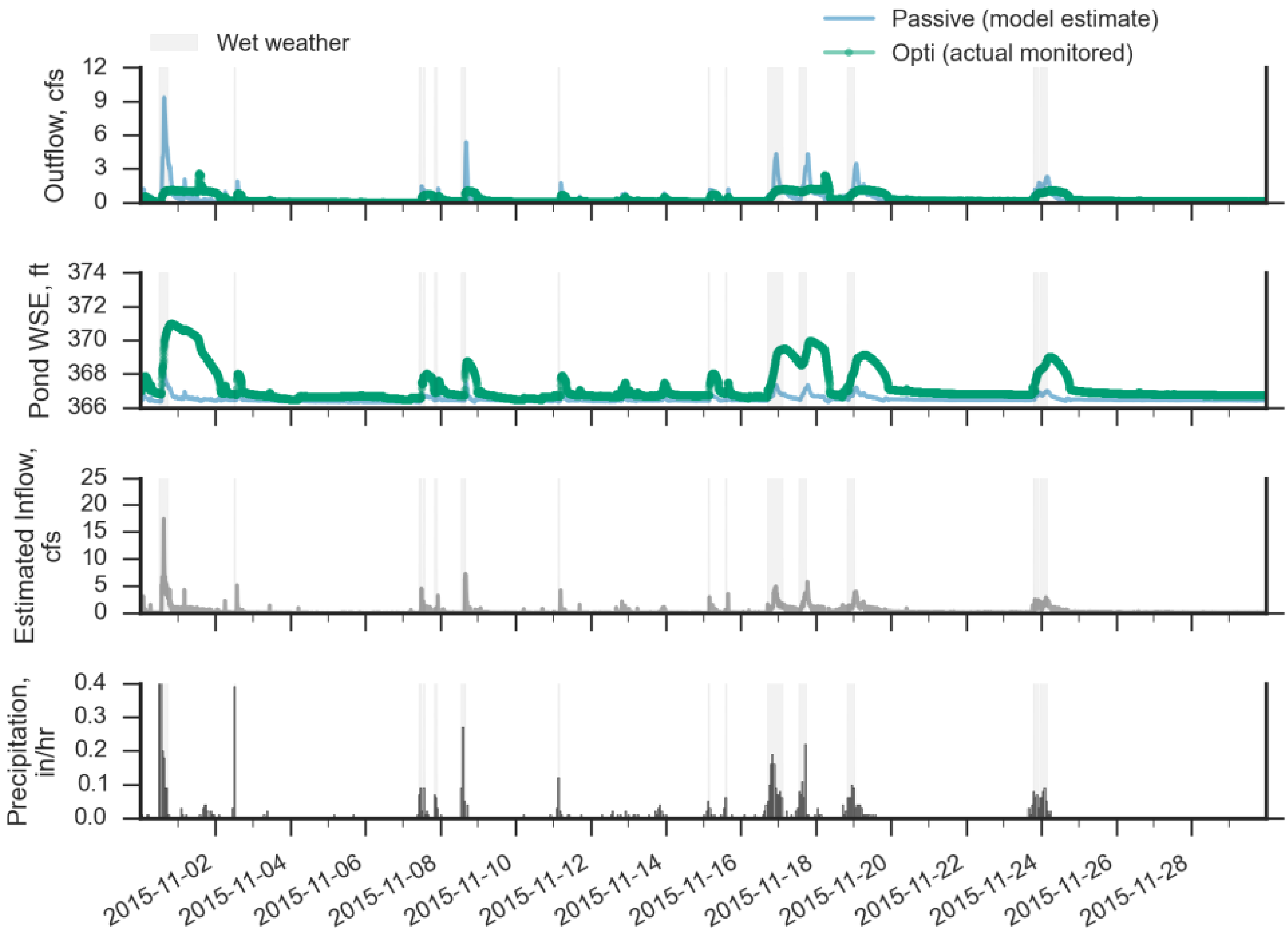


Based on continually updated precipitation forecasts, automated valve controls discharge to achieve **flow-duration goals**

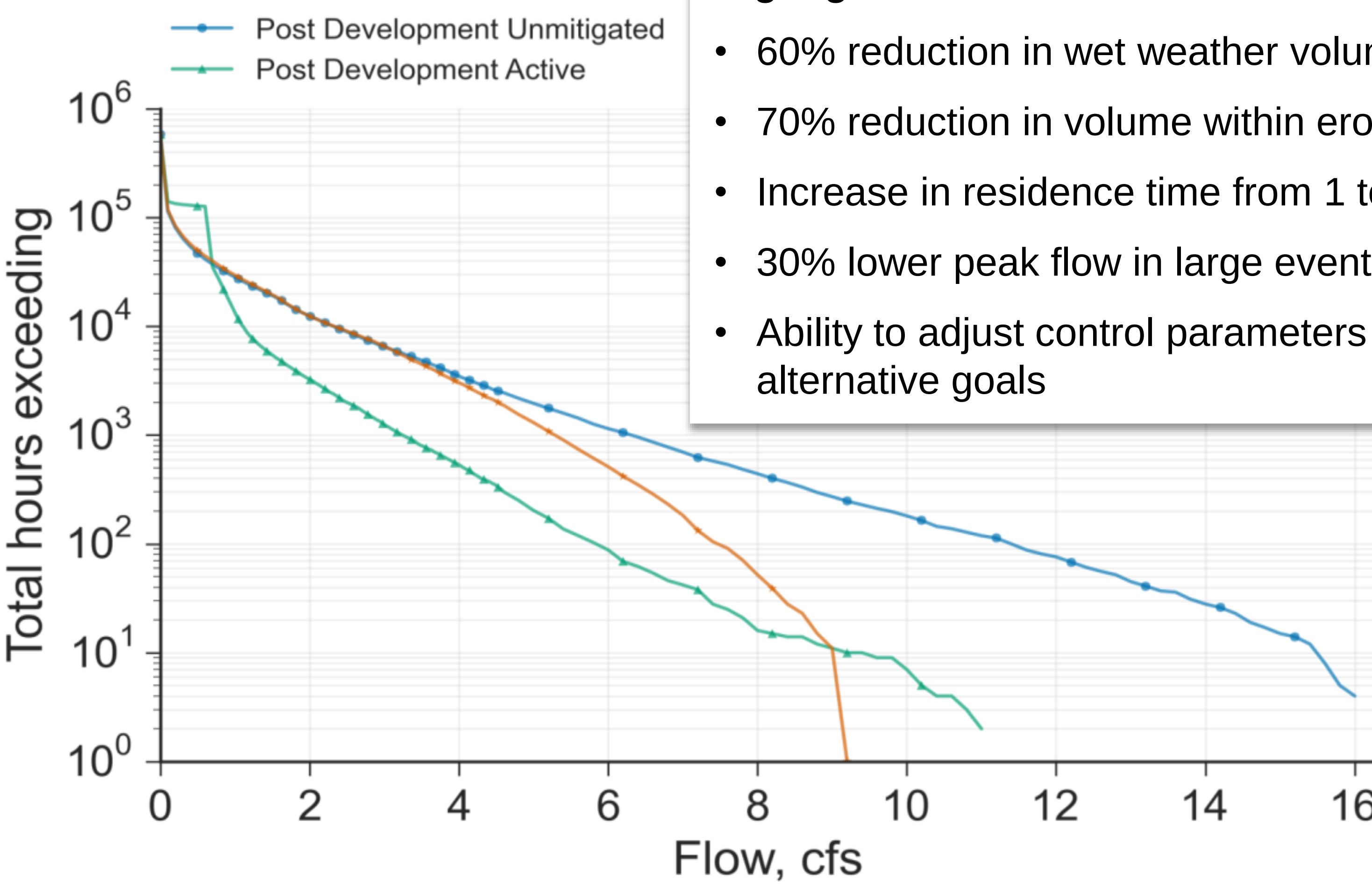
Clean Water Services

Geosyntec consultants

Flow Control & Hydrograph Matching



Flow-Duration Control



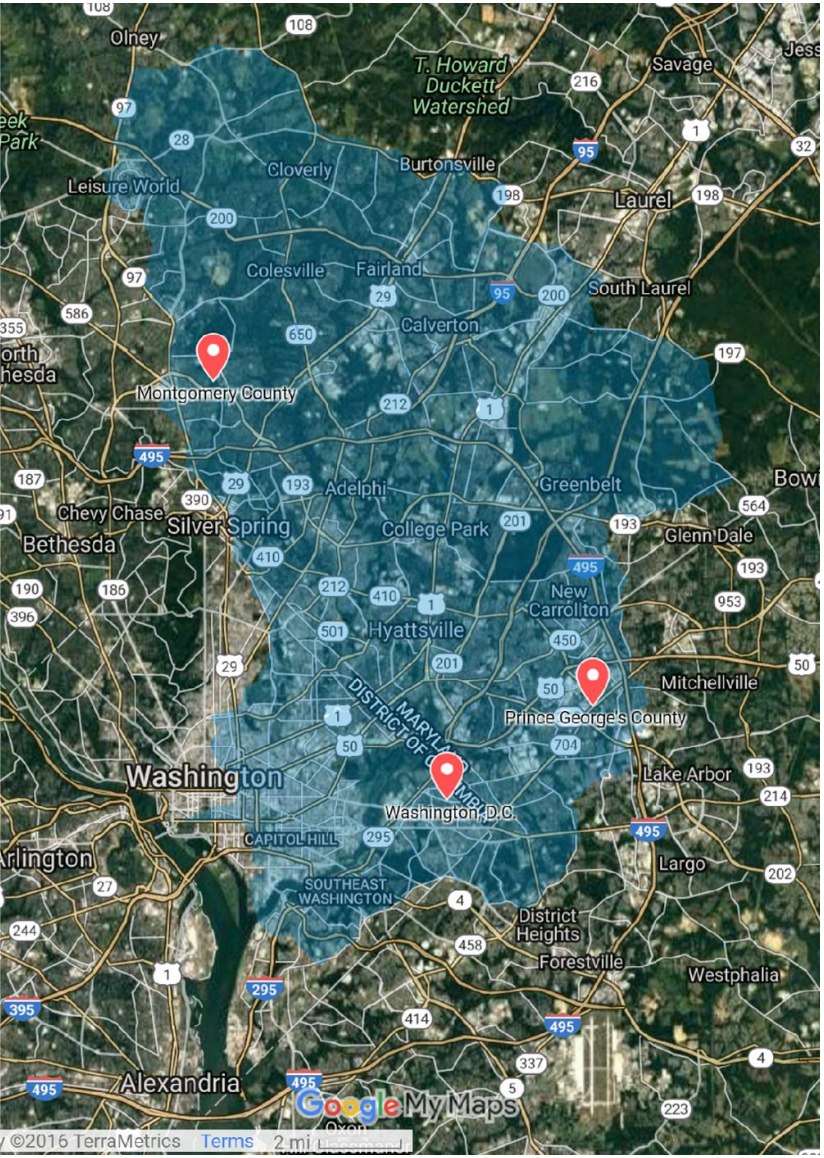
Highlights

- 60% reduction in wet weather volume
- 70% reduction in volume within erosive flow range
- Increase in residence time from 1 to 19 hours
- 30% lower peak flow in large events
- Ability to adjust control parameters to target alternative goals

Case Study 5: Anacostia Watershed
Prince George’s County, MD
peak flow reduction + water quality

2 ac-ft
Adaptively Controlled Detention/Retention

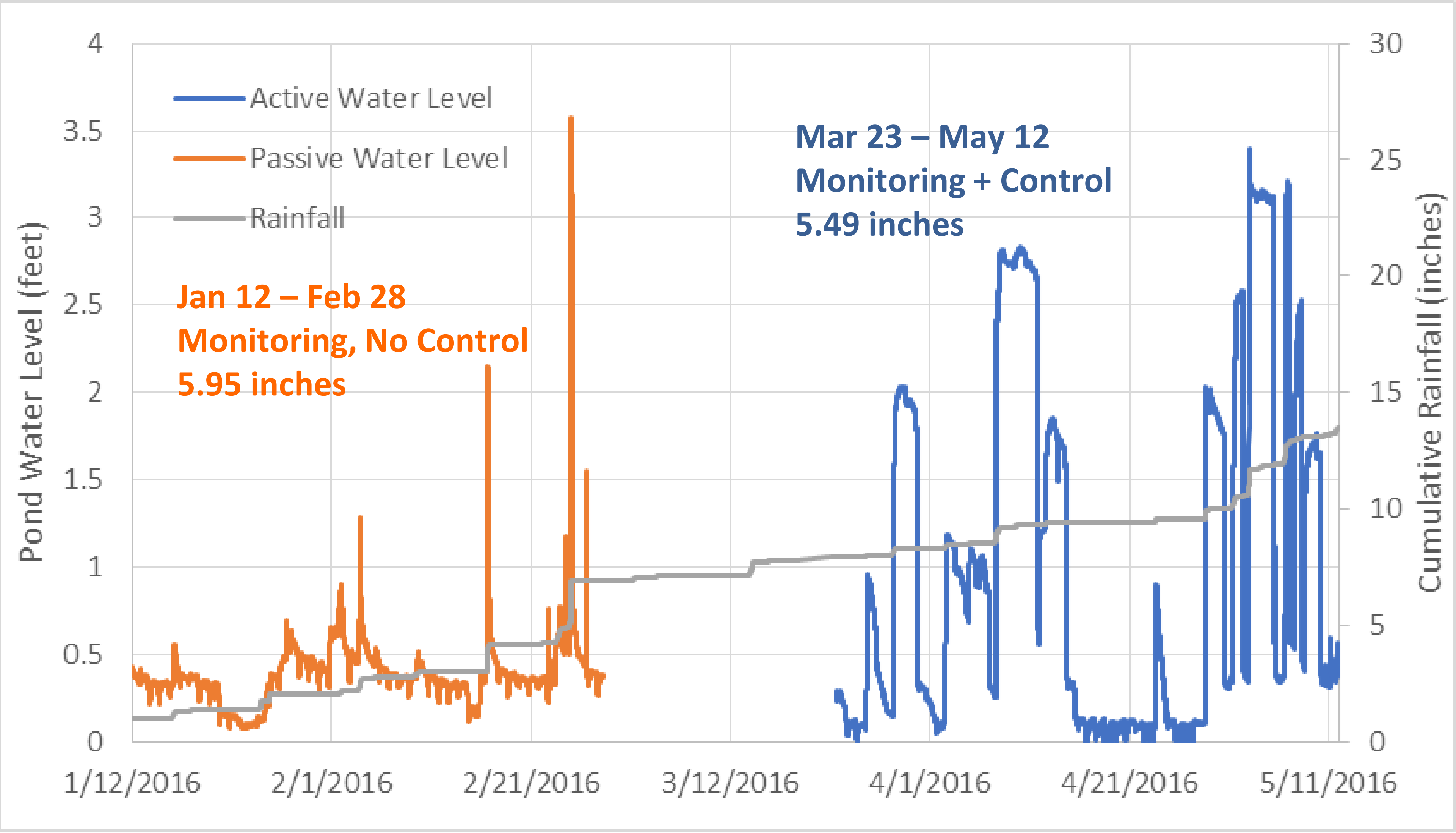
Performance Study – Anacostia River Watershed



- 3 CMAC retrofits (2 ponds)
- Prince George's County
  - Frost Pond
  - 2 ac-ft dry pond
  - 60 acre drainage; 32% imp.
  - Built 1988
- Montgomery County
  - University Blvd Pond
  - 15 ac-ft wet pond
  - 440 acre drainage; 36% imp.
  - In line on Sligo Creek
- Ponds retrofit November 2015

Performance Study – Frost Dry Pond

Frost Dry Pond– Hydraulic Monitoring



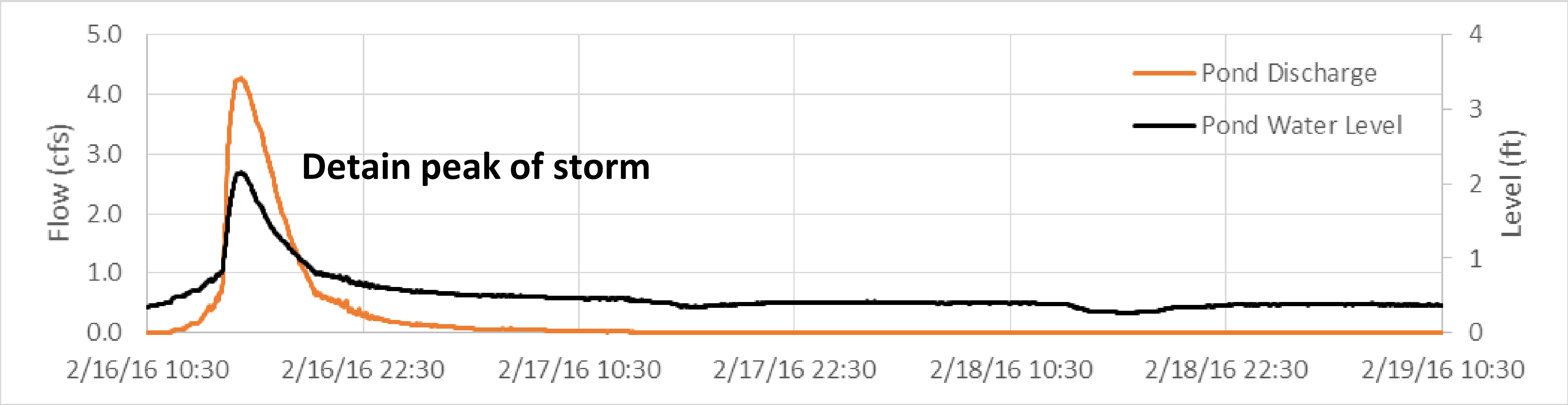
Frost Dry Pond – Enhanced Performance

	No Control	Forecast-Based CMAC Control
Total Rainfall (in)	5.95	5.49
Total Runoff (CF)	336,481 C = 0.23	279,310 C = 0.26
Total Discharge (CF)	305,840	197,243
Total Infiltration and ET (CF)	30,803 9%	81,524 29%
Average Retention Time (hrs)	4.0	18.2

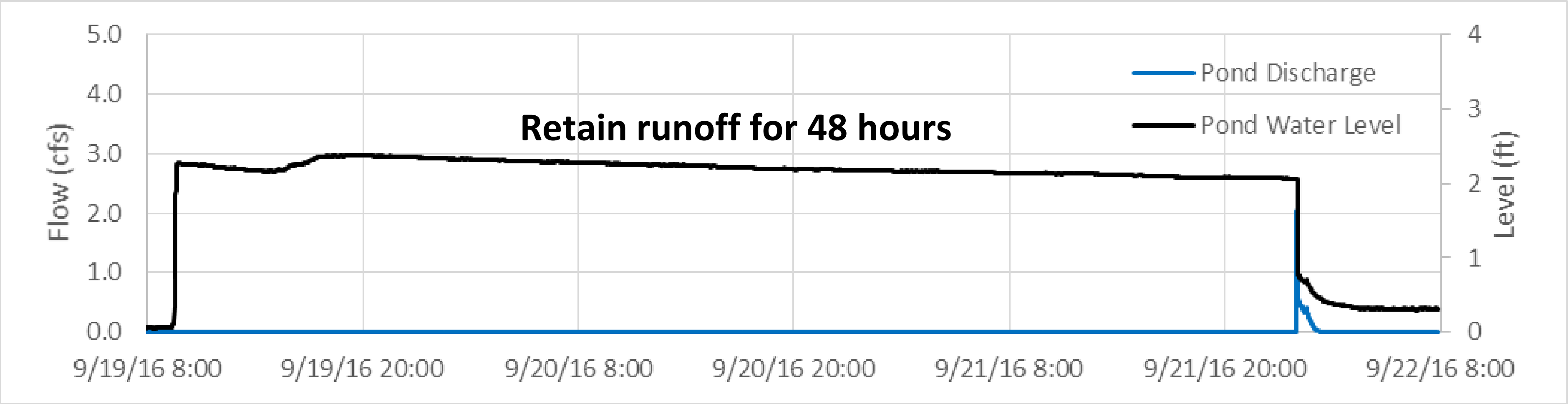
The CMAC retrofit increases infiltration and ET by extending the retention time, also providing a mechanism for increased settling and nutrient uptake.

Frost Dry Pond – 1 inch Rainfall Event

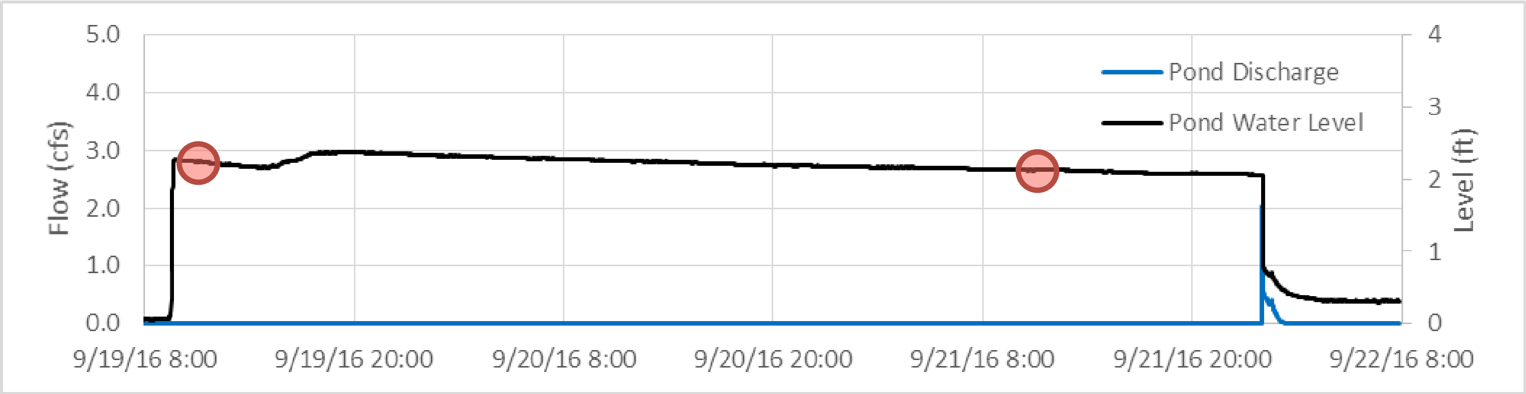
No Outflow Control



CMAC Retrofit



Frost Dry Pond – September 19, 2016 Rainfall Event



9/19/2016 9:35AM

9/21/2016 10:04AM

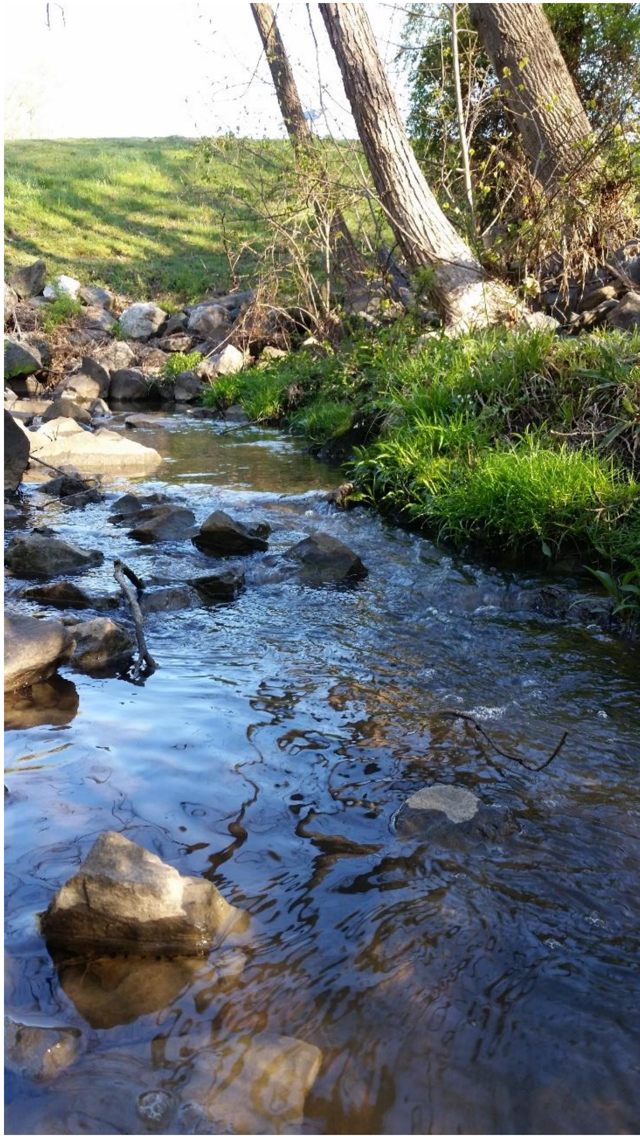
Case Study 6: Montgomery County, MD

peak flow reduction + water quality

15 ac-ft

Adaptively Controlled Detention/Retention

Performance Study – University Blvd Wet Pond



University Blvd Wet Pond – Monitoring 2015 to 2017

Continuous

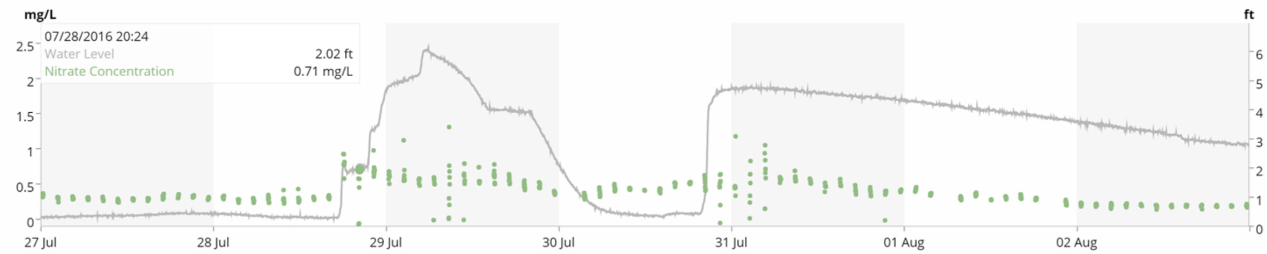
- Water level
- Rainfall
- Temperature
- Conductivity
- pH
- Turbidity
- Nitrate
- TSS

Grab Sampling

- Flow
- TSS
- Nitrogen
- Phosphorus

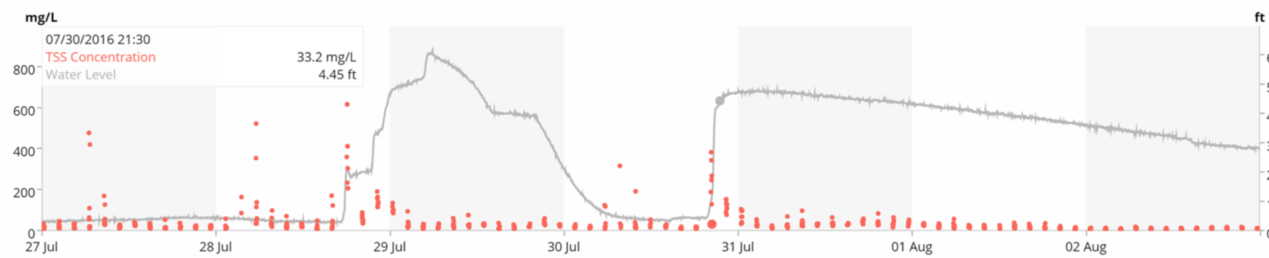
Pond Level and Nitrate

12hr | 24hr | 48hr | 1wk



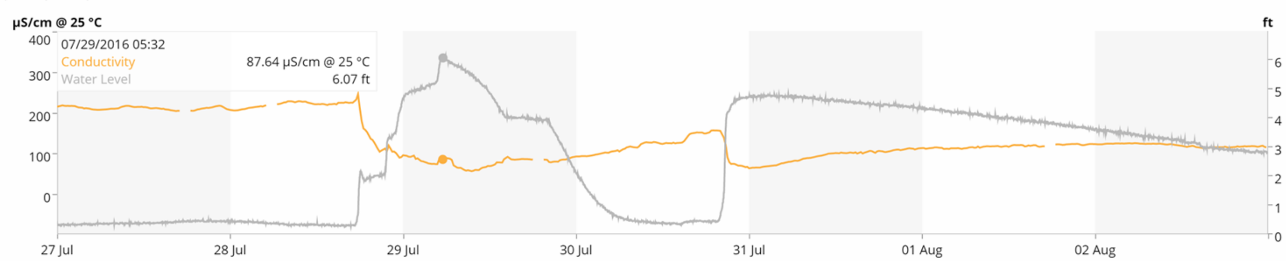
Pond Level and TSS

12hr | 24hr | 48hr | 1wk

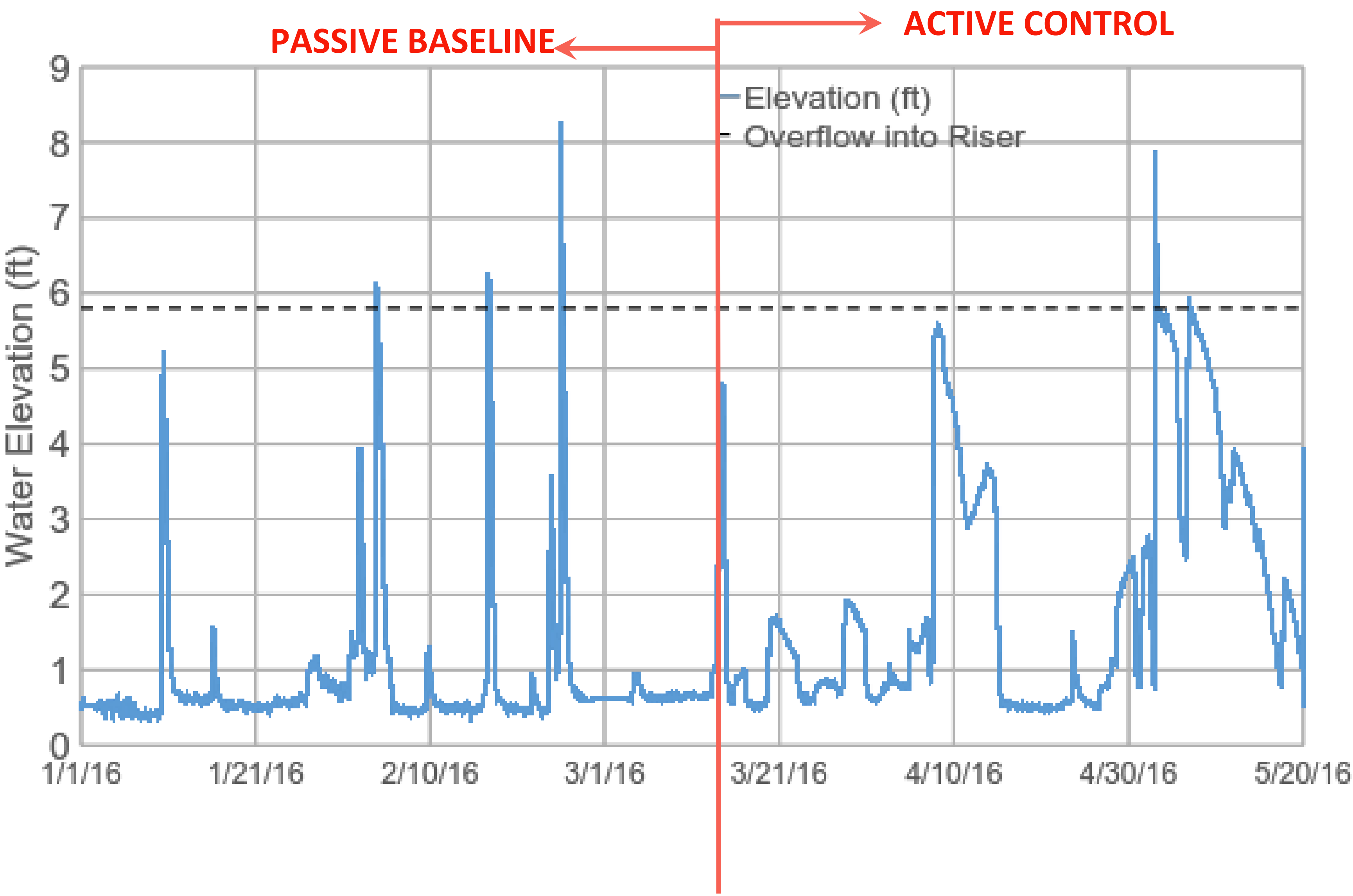


Pond Level and Conductivity

12hr | 24hr | 48hr | 1wk

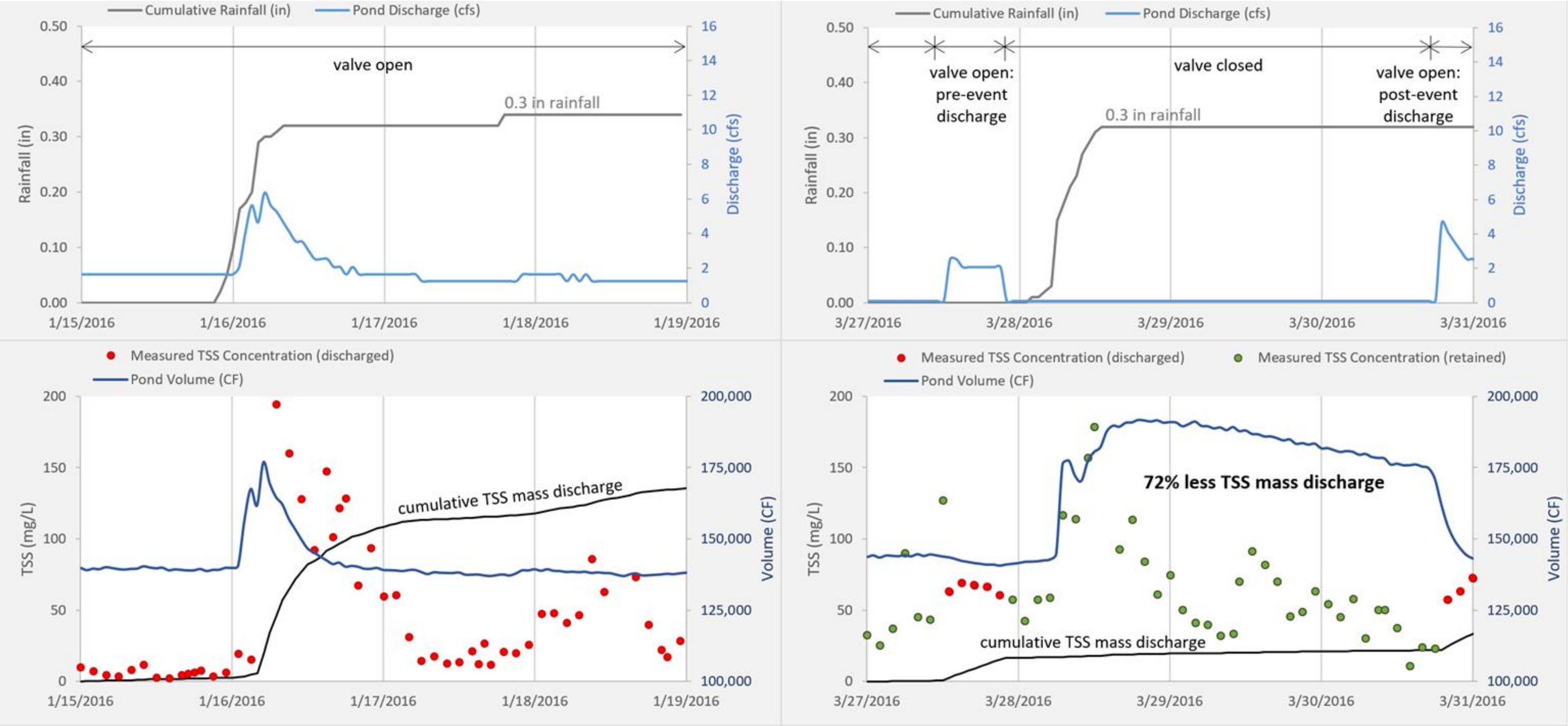


University Blvd Wet Pond – Hydraulic Monitoring

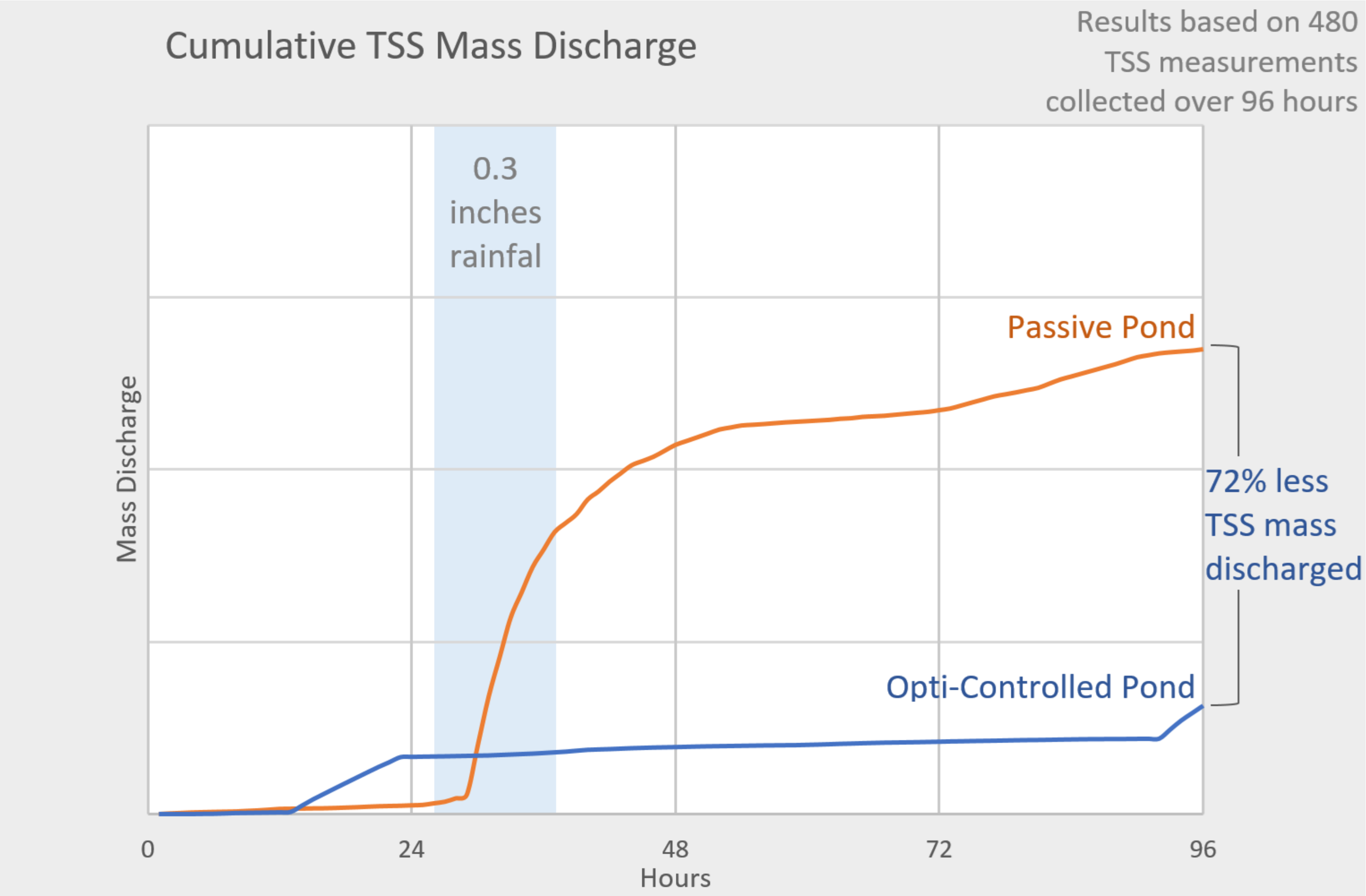


University Blvd Wet Pond – TSS Removal Comparison

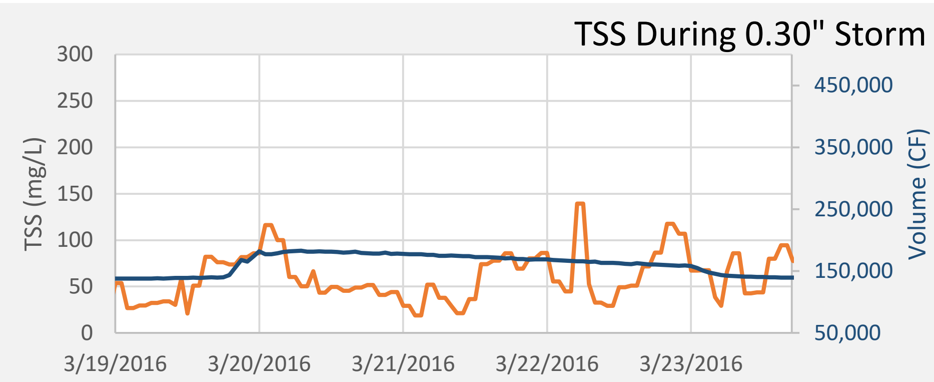
Passive Baseline | **Active Control**

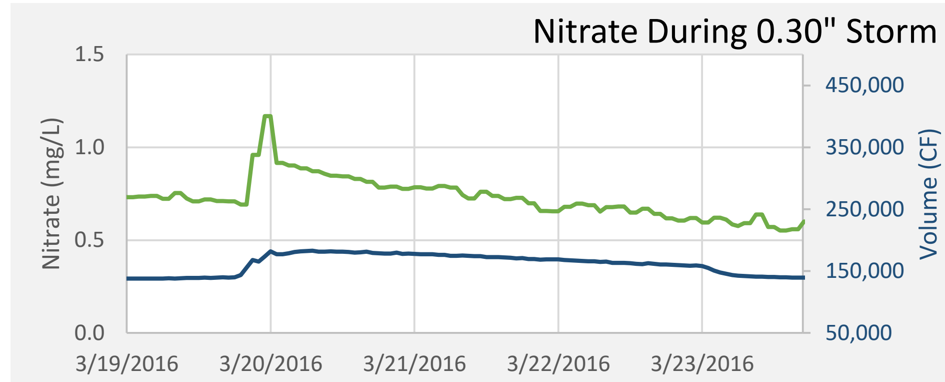


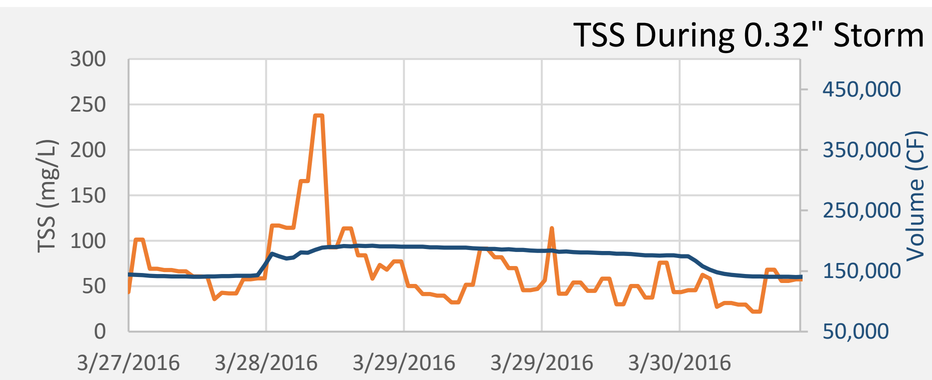
University Blvd Wet Pond – TSS Removal

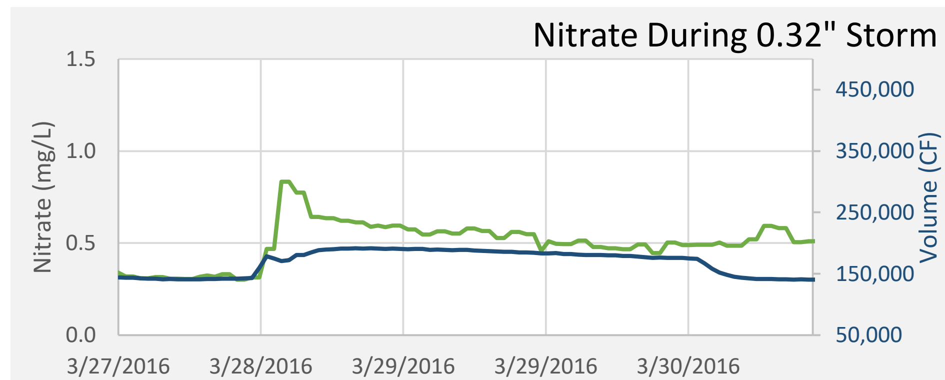


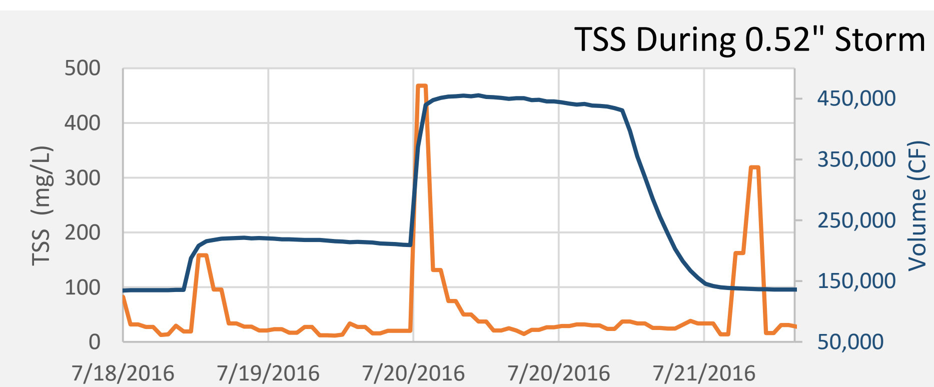
University Blvd Wet Pond – Pollutant Removal

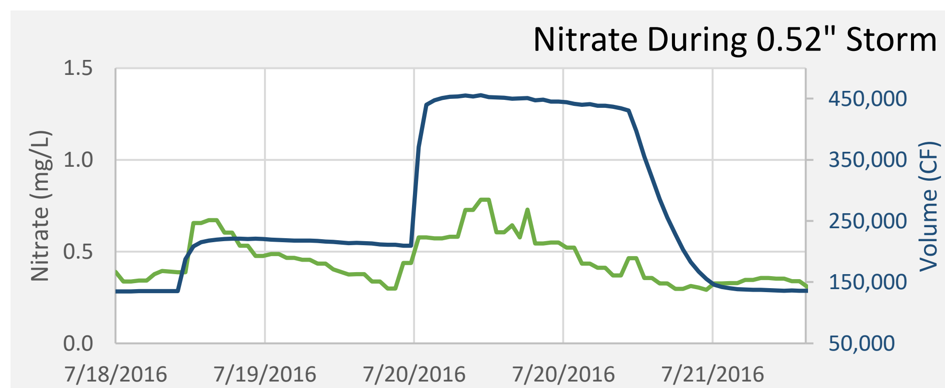






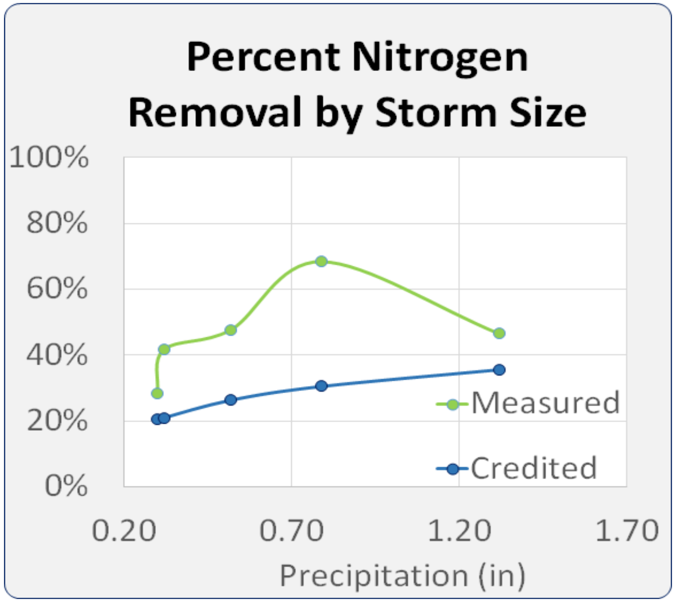


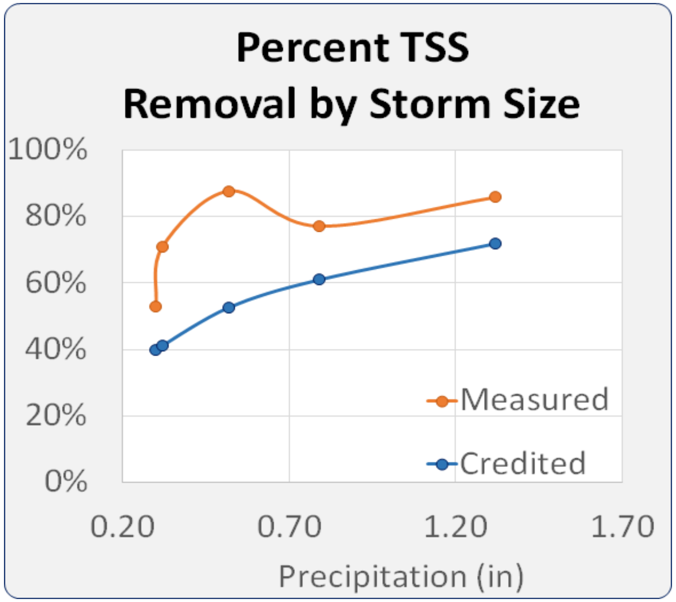




University Blvd Wet Pond– DRAFT Pollutant Removal

Storm Size	Nitrogen Percent Removal		Storm Size	TSS Percent Removal	
	CMAC	**MDE Wet Pond***		**CMAC**	**MDE Wet Pond***
0.30	28%	20%	0.30	53%	40%
0.32	42%	21%	0.32	71%	41%
0.52	48%	26%	0.52	88%	53%
0.79	68%	30%	1.0	77%	61%
1.32	47%	36%	2.5	86%	72%





*Credits given for water quality volumes in Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated, MDE,2014

Case Study 7: EPA Headquarters

rainwater harvesting + cso mitigation

6K Gallons

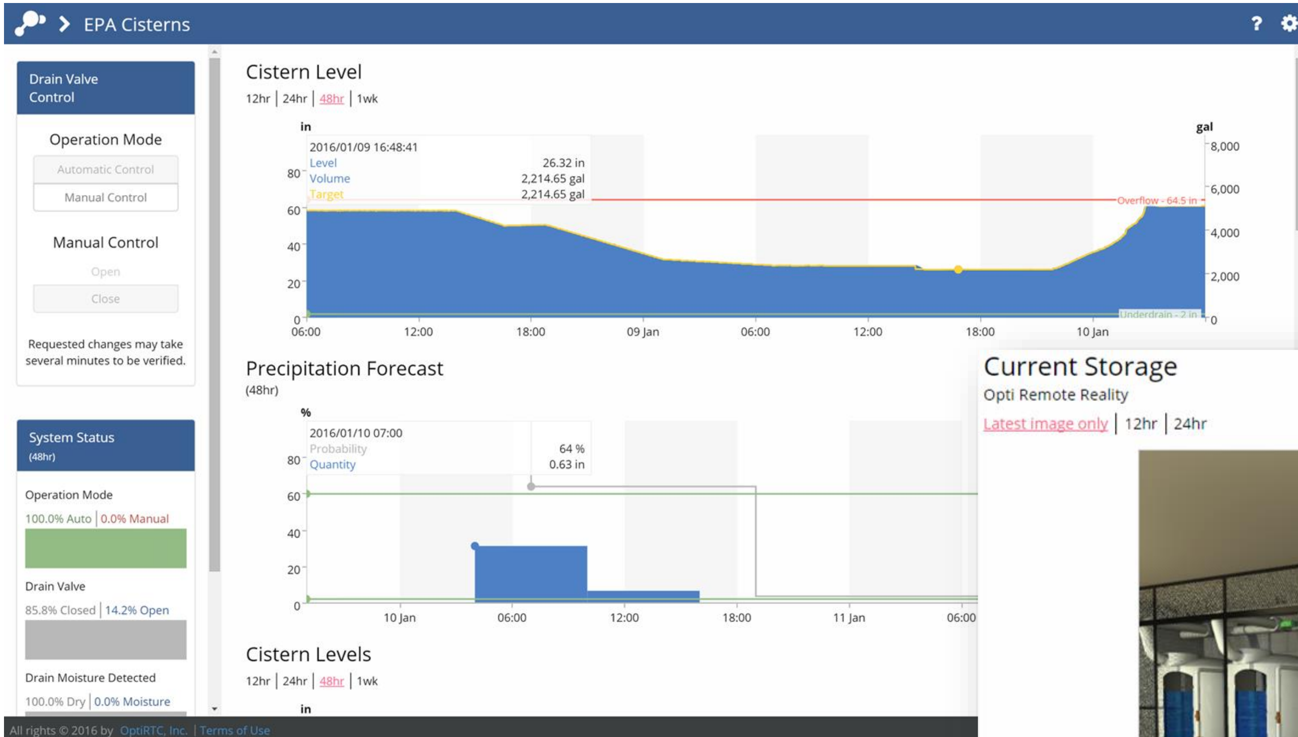
Adaptively Controlled Cisterns

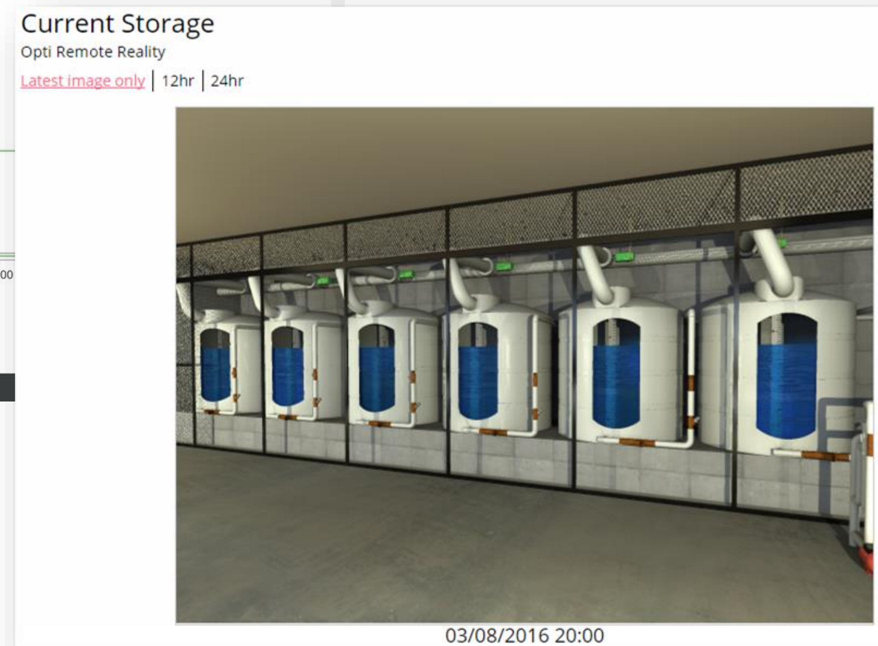
Intelligent Stormwater Detention to Mitigate CSOs

EPA Headquarters, D.C.

- 6,000 gallons of storage for roof drainage
- Prevents discharge to combined sewer during rain events

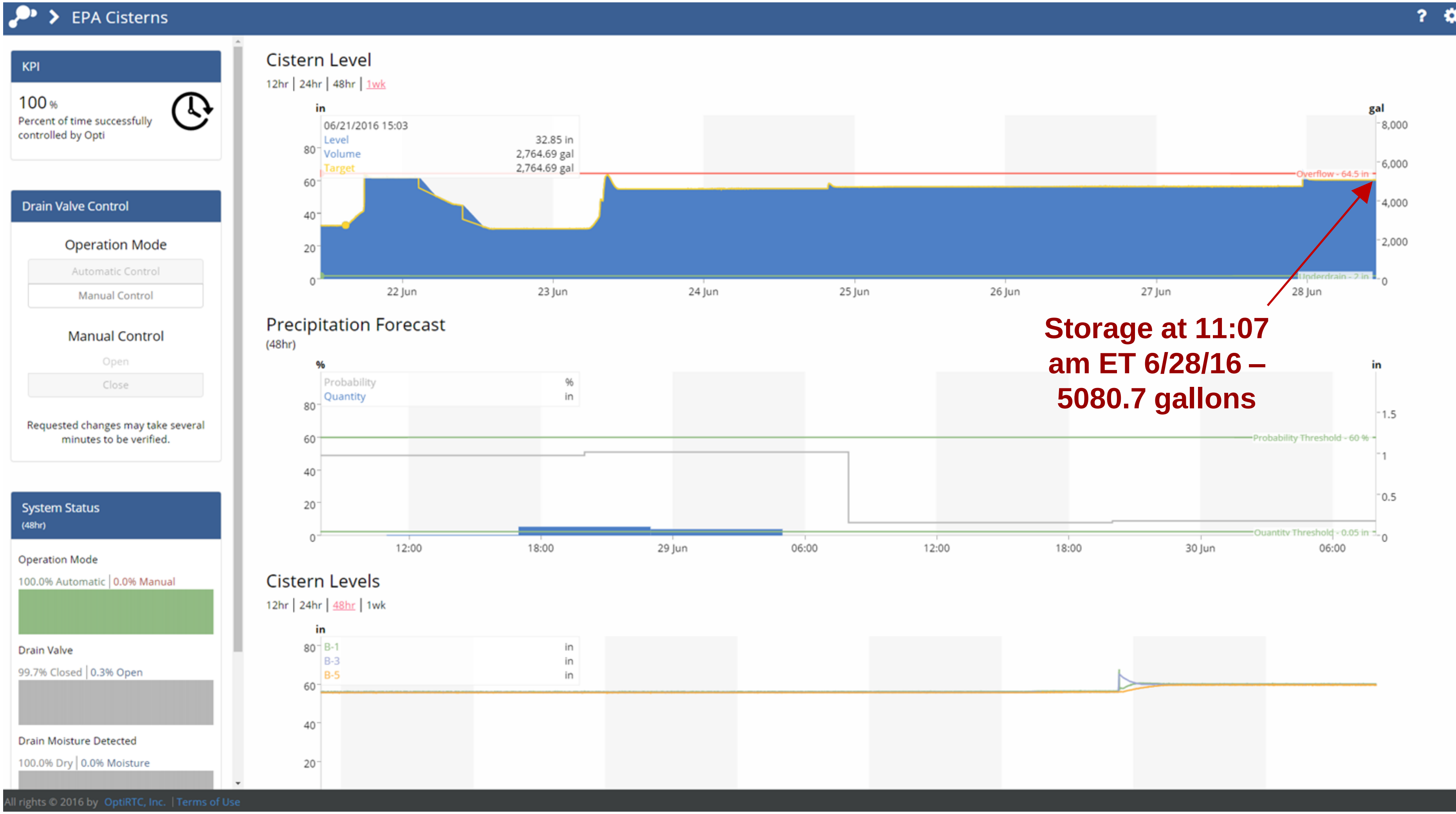
Intelligent Stormwater Detention to Mitigate CSOs





- 2 years in operation
- No significant irrigation demand
- **175K+ gallons** wet weather flow prevented to combined sewer by CMAC

EPA HQ Cisterns Example Event



Continuous Simulation Results for Entire US

Opti

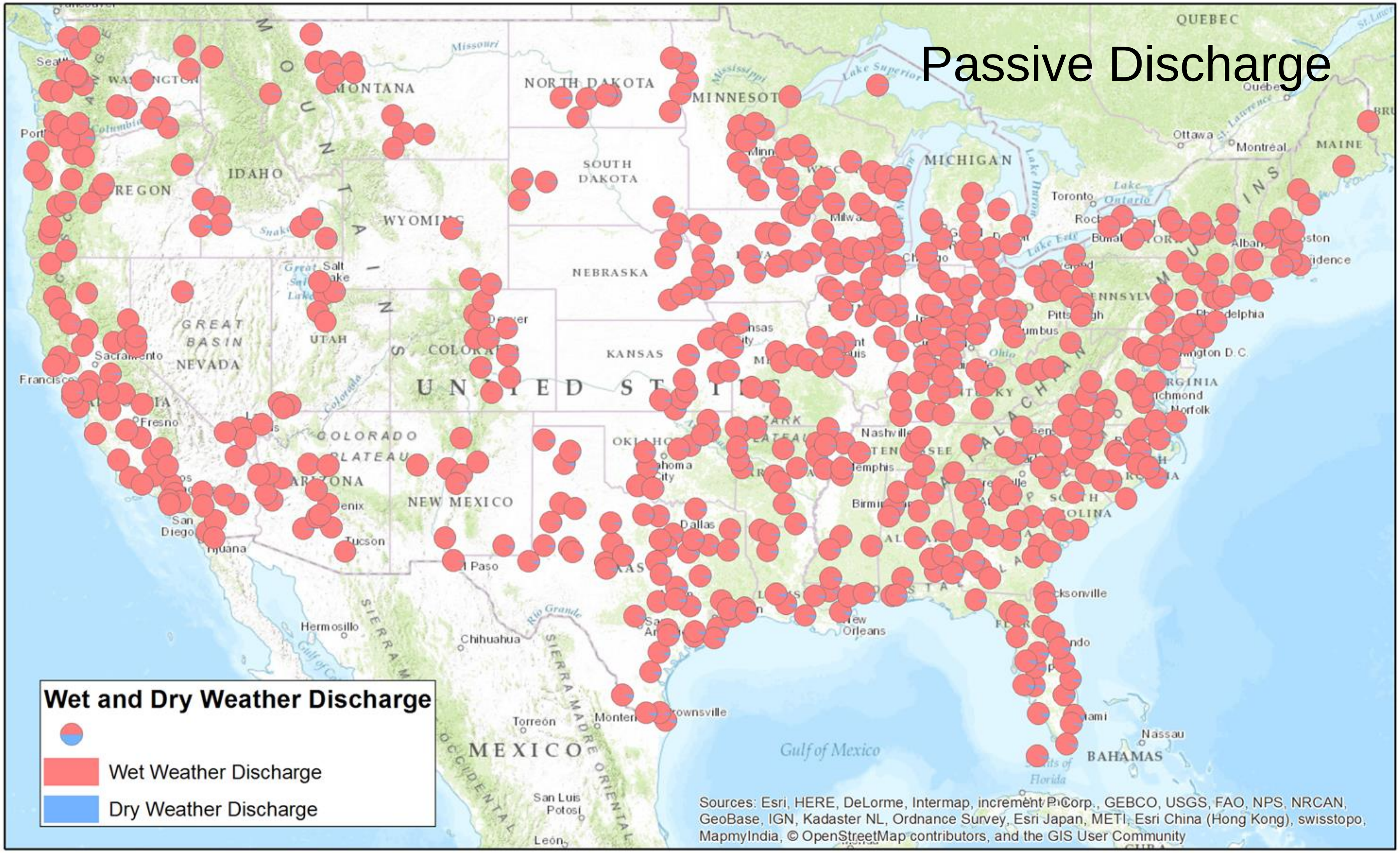
Results from Continuous Simulation Modeling Performance of Opti in Chicago

Simulation	Metric	Passive Storage	Opti Active Storage
CSO	Average wet weather discharge	0.045 cfs	0.018 cfs
	Average wet weather discharge during inflow > 0.25 cfs	0.262 cfs	0.164 cfs
	Wet weather capture	2%	63%
	Percent time runoff retained	2%	92%

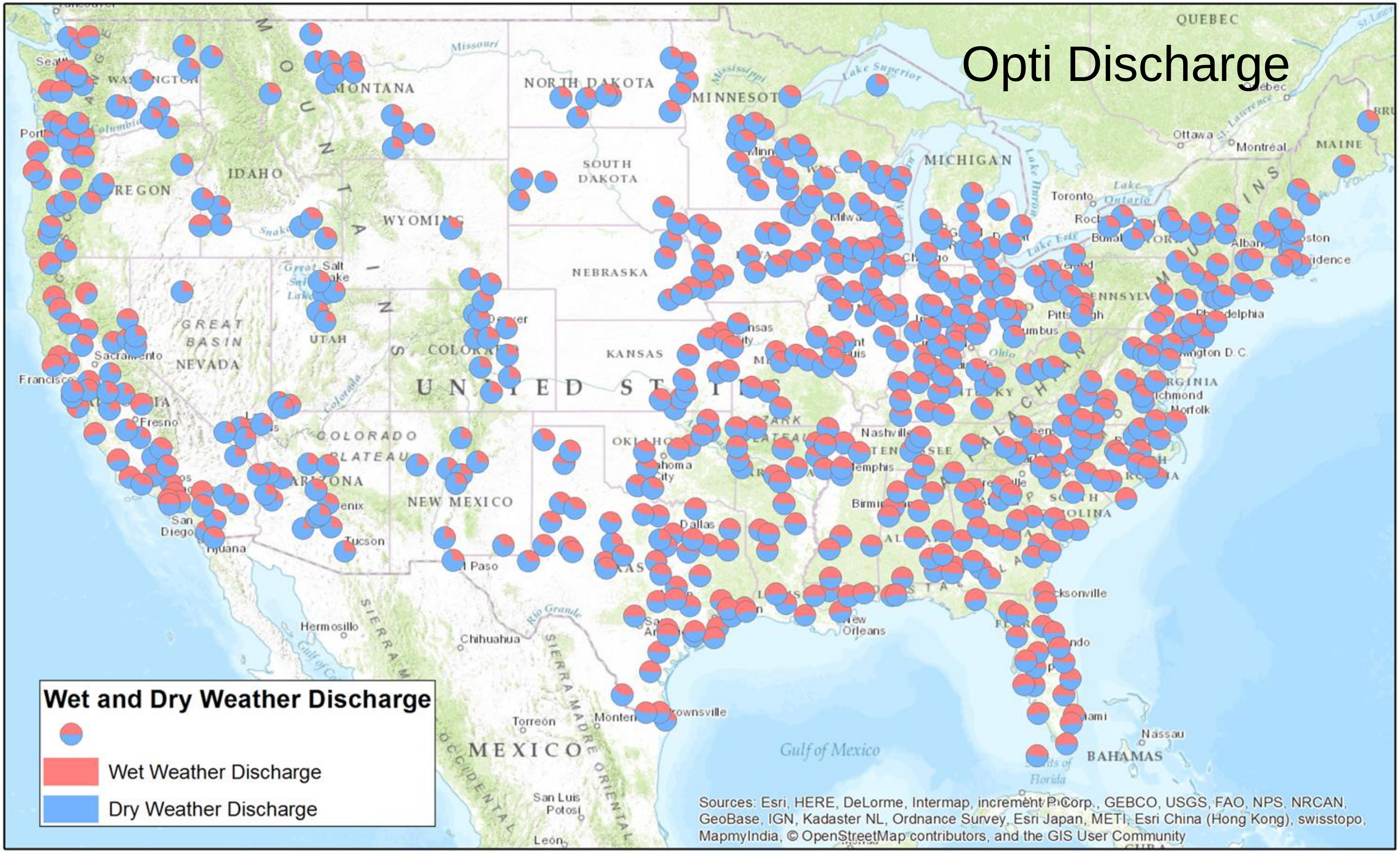
Note: averages shown for 1 inch storage size

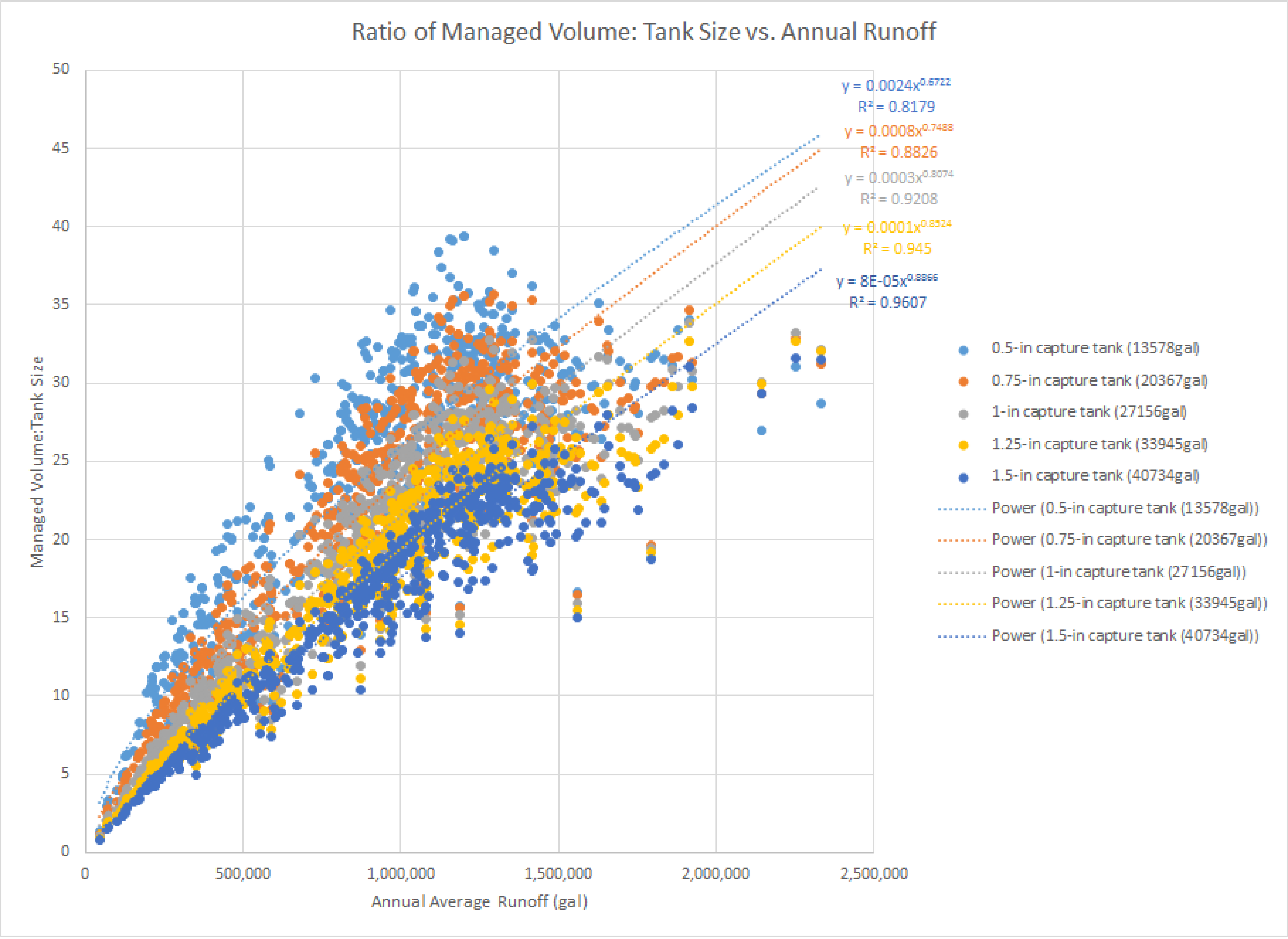
1: No withdrawals were simulated. In the passive system, no water was available for use because the outflow valve was always open. In the Opti system, water captured and not released during wet weather was considered available for use. The value shown is the annual average capture volume.

Volume Discharged During Wet vs. Dry Weather



Volume Discharged During Wet vs. Dry Weather





Ratio of Managed Volume: Tank Size vs. Annual Runoff
Managed Volume:Tank Size
Annual Average Runoff (gal)
0
5
10
15
20
25
30
35
40
45
50
0
500,000
1,000,000
1,500,000
2,000,000
2,500,000
y = 0.0024x^0.6722
R² = 0.8179
y = 0.0008x^0.7488
R² = 0.8826
y = 0.0003x^0.8074
R² = 0.9208
y = 0.0001x^0.8524
R² = 0.945
y = 8E-05x^0.8866
R² = 0.9607
0.5-in capture tank (13578gal)
0.75-in capture tank (20367gal)
1-in capture tank (27156gal)
1.25-in capture tank (33945gal)
1.5-in capture tank (40734gal)
Power (0.5-in capture tank (13578gal))
Power (0.75-in capture tank (20367gal))
Power (1-in capture tank (27156gal))
Power (1.25-in capture tank (33945gal))
Power (1.5-in capture tank (40734gal))

Questions & Contact

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mquigley@optirtc.com

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Metro Washington Council of Governments
Maryland-National Capital Park and Planning Commission
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Montgomery County, MD
US EPA
Capitol Region Watershed District