How the Internet of Things Can Help Communities Better Manage Stormwater

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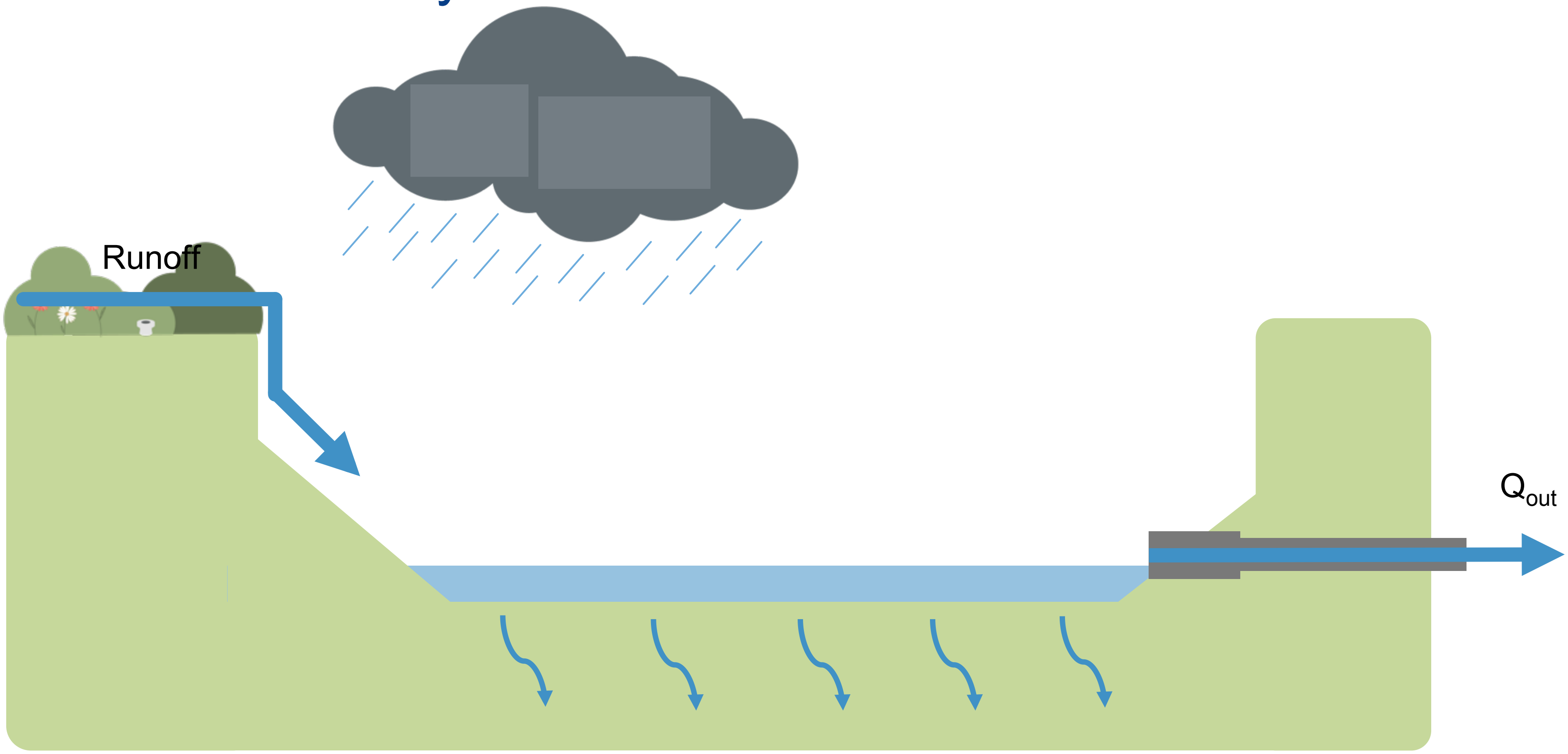
Outline

- Why real-time control for stormwater?
- How does it work?
- Modeling results
- Case studies

Why Real-Time Control?

1. Better performance
2. More economical use of space + assets
3. Continuously monitored infrastructure



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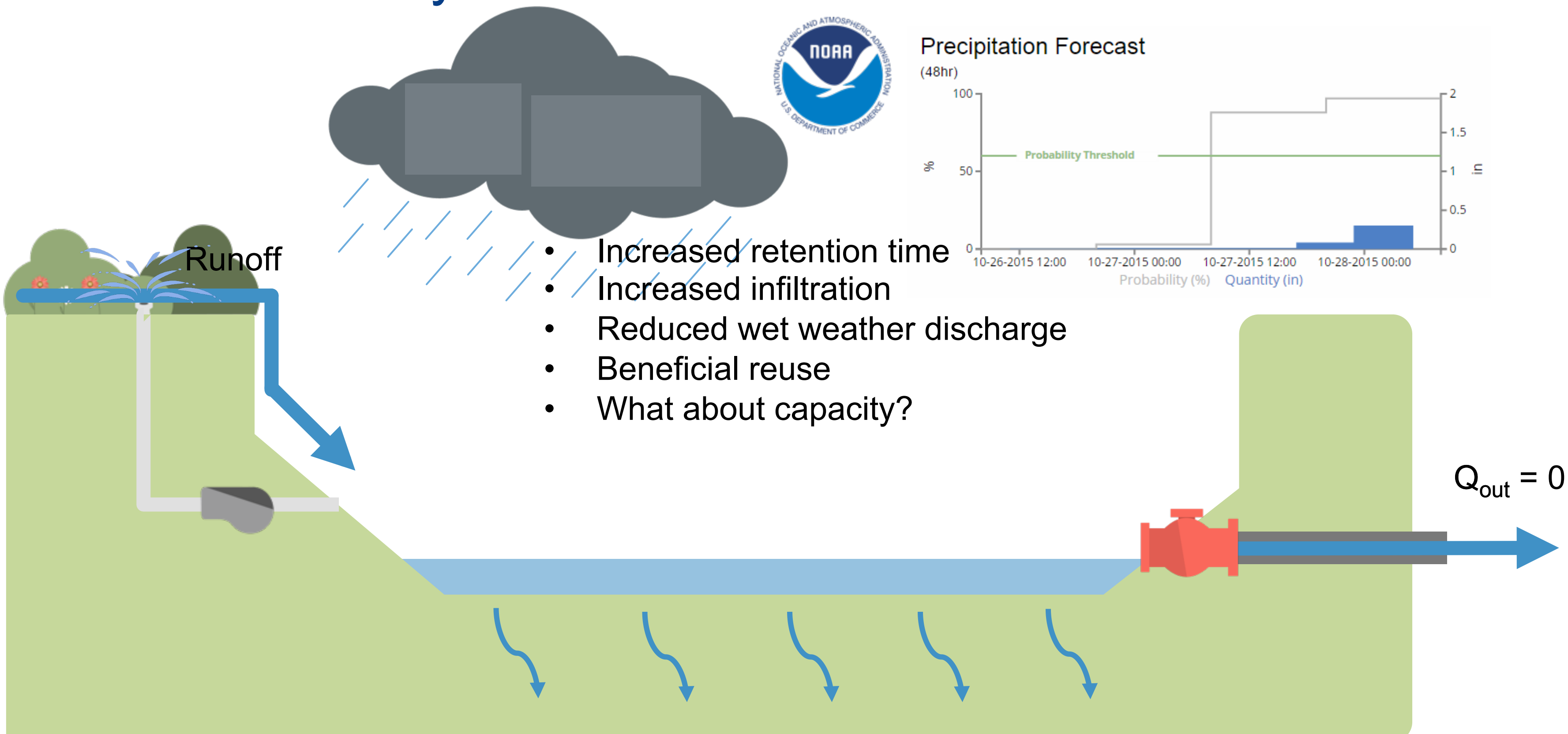
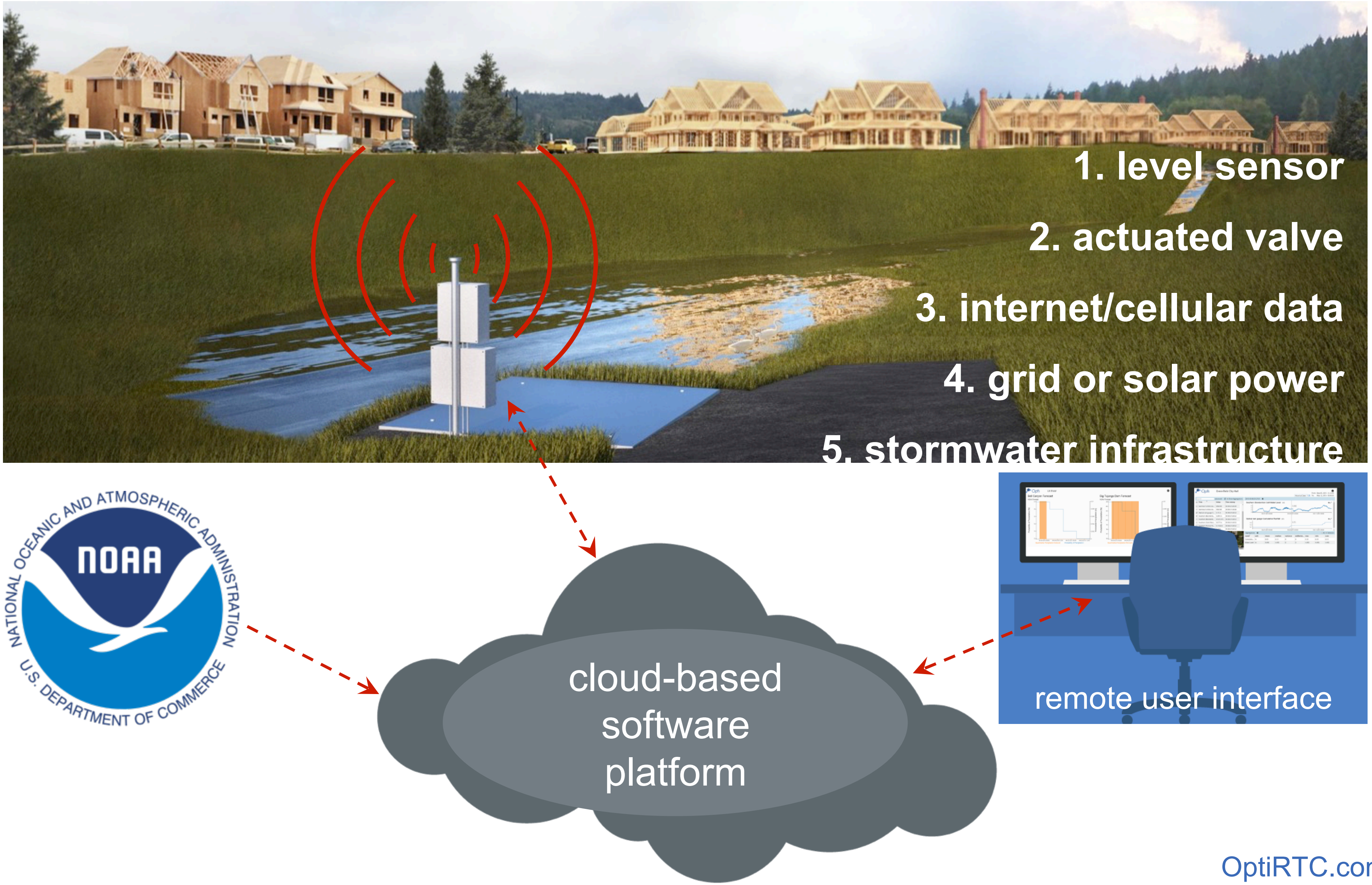
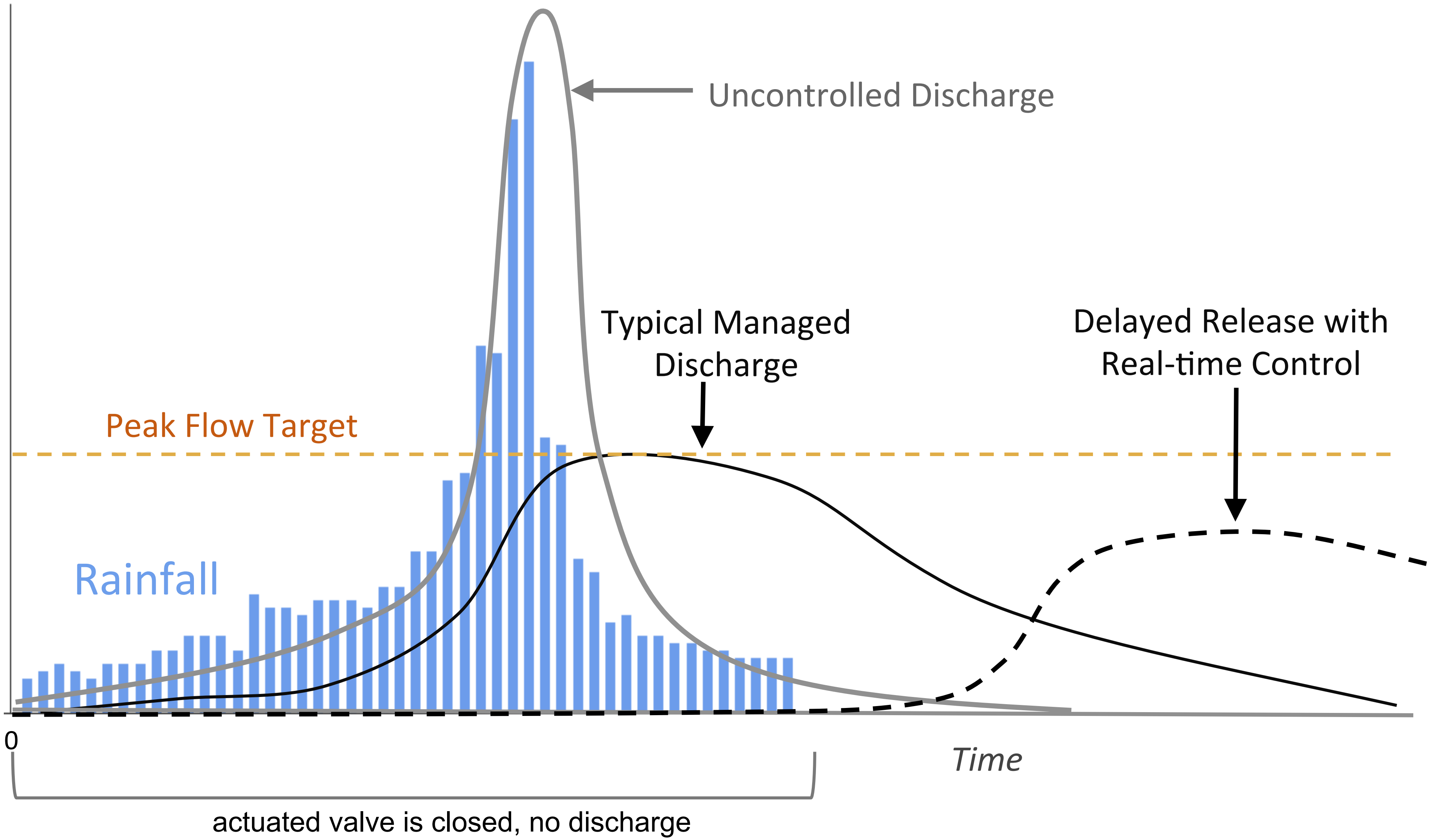


- Increased retention time
- Increased infiltration
- Reduced wet weather discharge
- Beneficial reuse
- What about capacity?

How does real-time control work?



How does real-time control work?



Nationwide Modeling Assessment

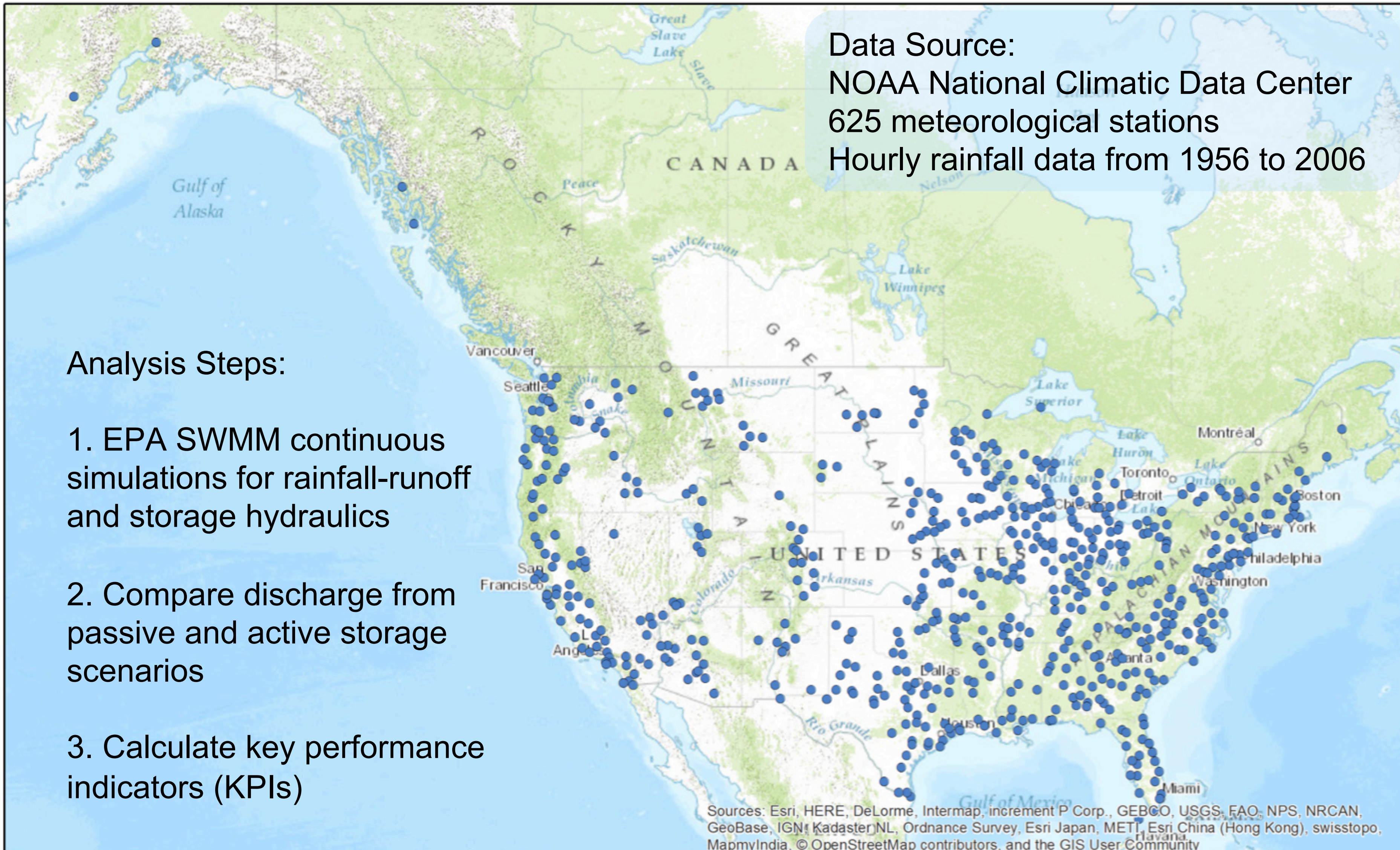
Data Source:
NOAA National Climatic Data Center
625 meteorological stations
Hourly rainfall data from 1956 to 2006

Analysis Steps:

1. EPA SWMM continuous simulations for rainfall-runoff and storage hydraulics

2. Compare discharge from passive and active storage scenarios

3. Calculate key performance indicators (KPIs)



SWMM Model Setup

625 stations nationwide

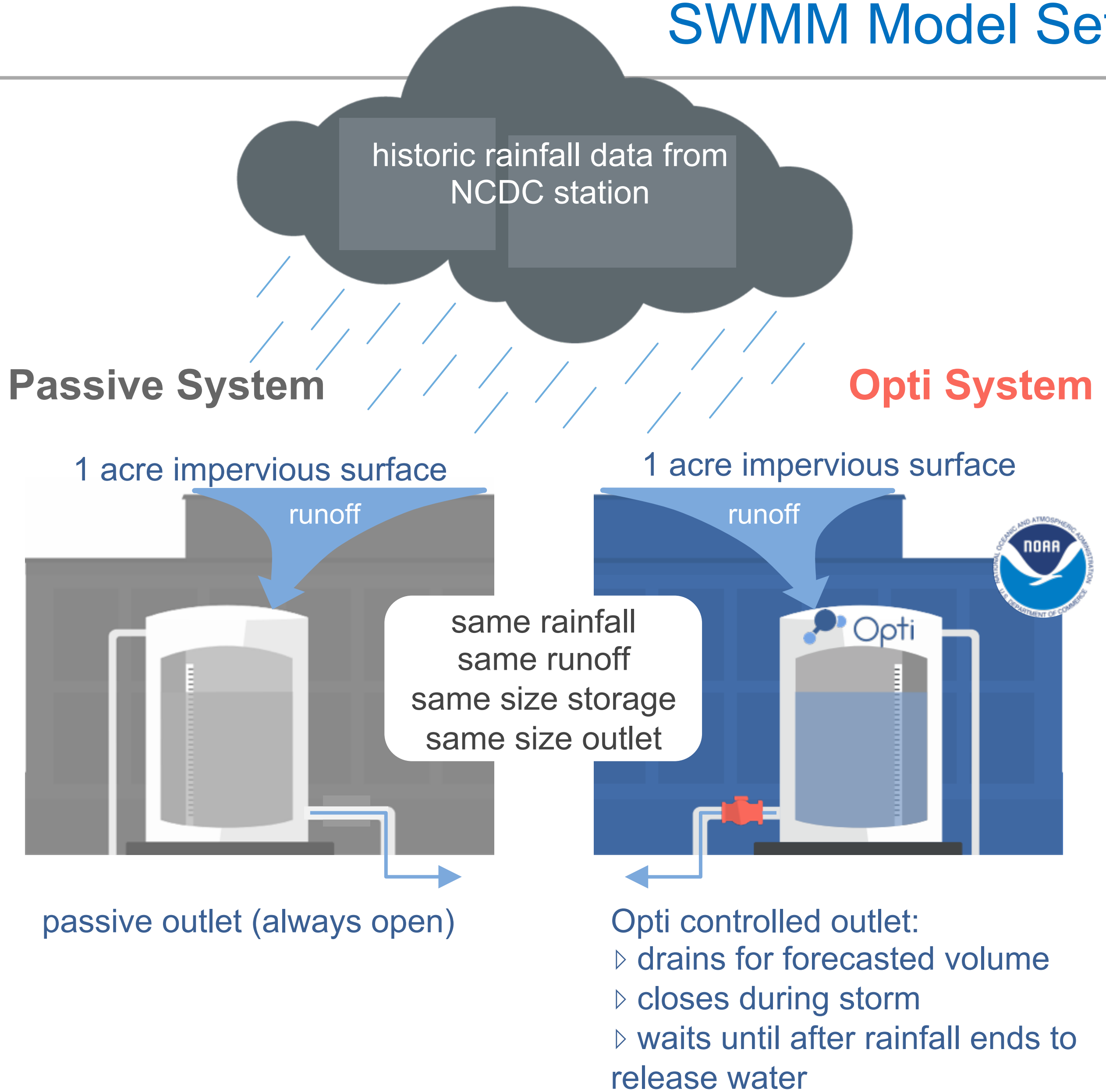
5 storage sizes from 0.5” to 1.5” rainfall over drainage area (13,000 to 40,000 gal; representative design storms)

2 different logic scenarios:

▷ maximize retention time for water quality improvement and/or beneficial reuse (*retain water until next storm, discharge rate is 48 hours from full*)

▷ avoid wet weather discharge to eliminate overflows and flooding (*release water 2 hours after storm, configurable, discharge at 0.25 cfs*)

over 12,000 simulations



Key Performance Indicators

Simulation	Metric	Calculation
Water Quality: Maximize Retention Time	Average retention time for water quality improvement	Flow-weighted average of water age for every drop that is discharged
	Average water available for use	Water in storage during dry weather
	Average wet weather storage utilization	Average percent full during wet weather
	Percent time runoff retained	Hours when rainfall is occurring and discharge equals zero
CSO/Flooding: Minimize Wet Weather Discharge	Average wet weather discharge	Average discharge flow rate during wet weather
	Average wet weather discharge during inflow > 0.25 cfs	Average discharge flow rate with inflow is greater than 0.25 cfs
	Wet weather capture	Total inflow not discharged during wet weather
	Percent time runoff retained	Hours when rainfall is occurring but with zero discharge

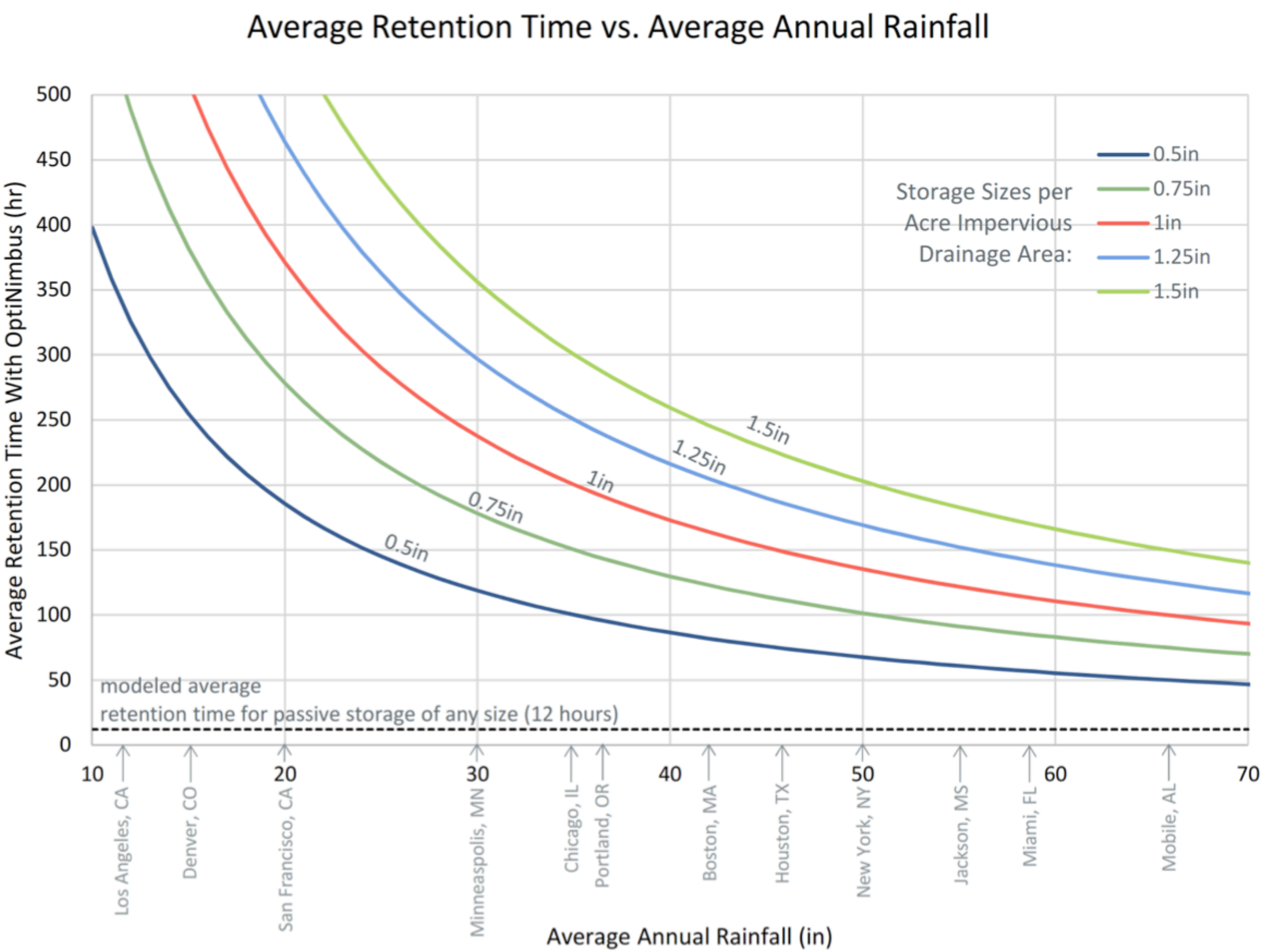
Median values for all 625 stations

Simulation	Metric	Passive Storage	Opti Active Storage
Water Quality: Maximize Retention Time	Long term average retention time	12 hours	196 hours
	Average water available for use[1]	0	590,000 gal/acre/year
	Average wet weather storage utilization	26%	68%
	Percent time runoff retained	3%	59%
CSO/Flooding: Minimize Wet Weather Discharge	Average wet weather discharge	0.052 cfs	0.021 cfs
	Average wet weather discharge during inflow > 0.25 cfs	0.265 cfs	0.171 cfs
	Wet weather capture	2%	61%
	Percent time runoff retained	2%	91%

Note: median values 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.

Average Retention Time by Annual Rainfall



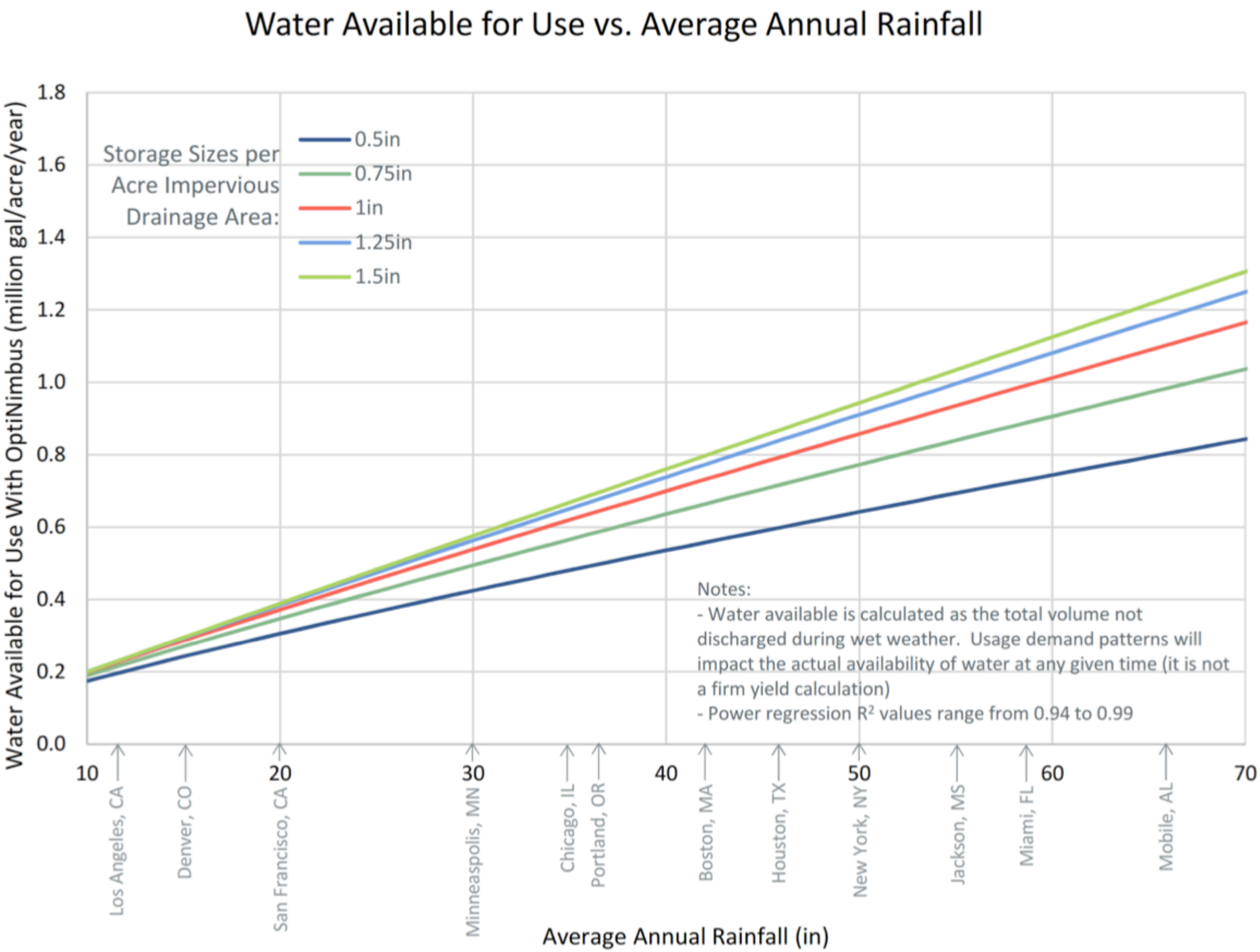
Each NCDC station modeled has an average annual rainfall

The results show a very strong correlation between long term average retention time and average annual rainfall for each site

This plot shows the regression lines for each storage size, allowing for estimating possible retention times based on average rainfall, with Opti active discharge

Passive discharge scenarios achieve only 12 hours retention time, on average, because most storms to not fill the storage unit

Available Water for Reuse by Annual Rainfall



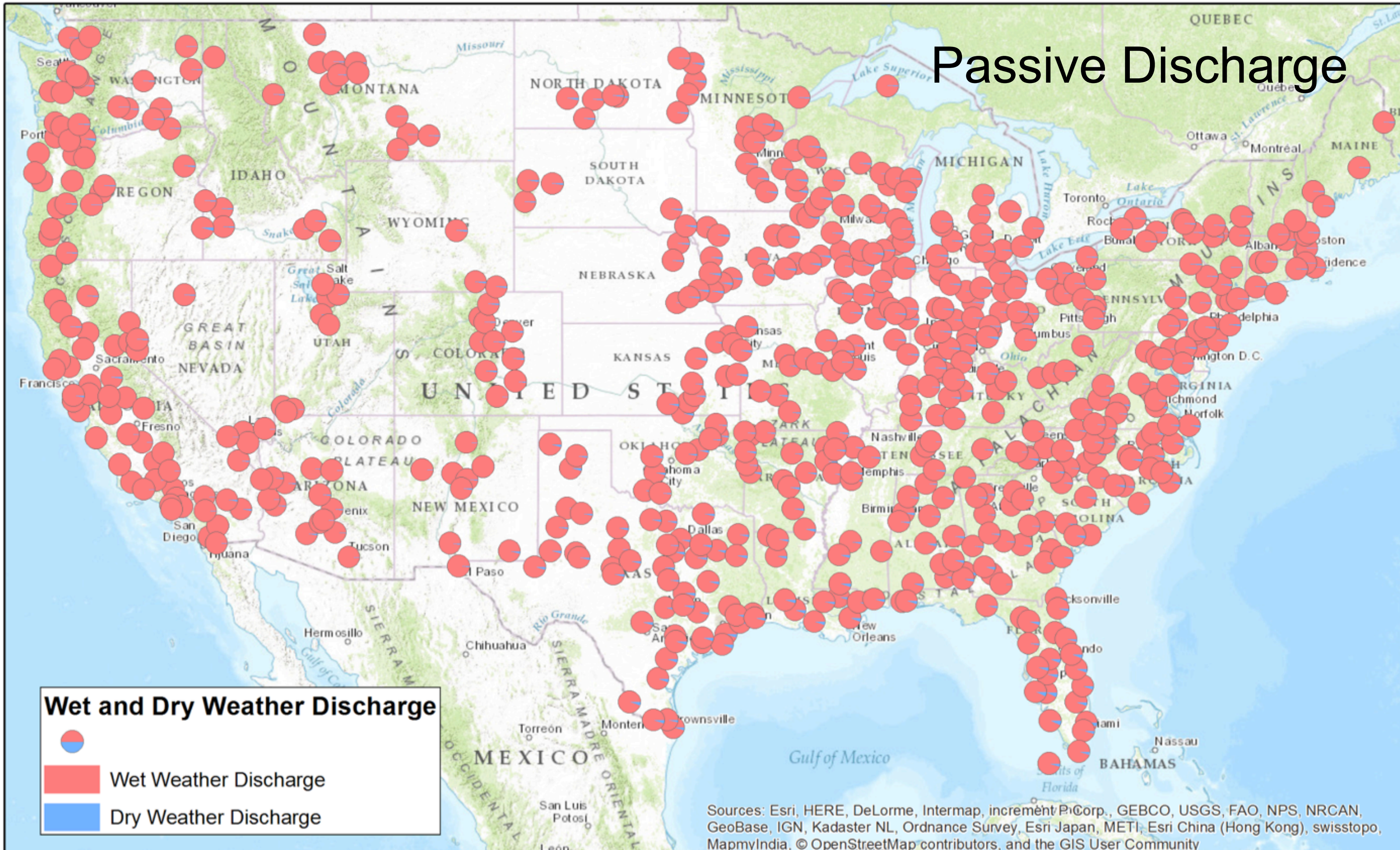
Each NCDC station modeled has an average annual rainfall

The results show a very strong correlation between the total water stored during dry periods and the annual rainfall

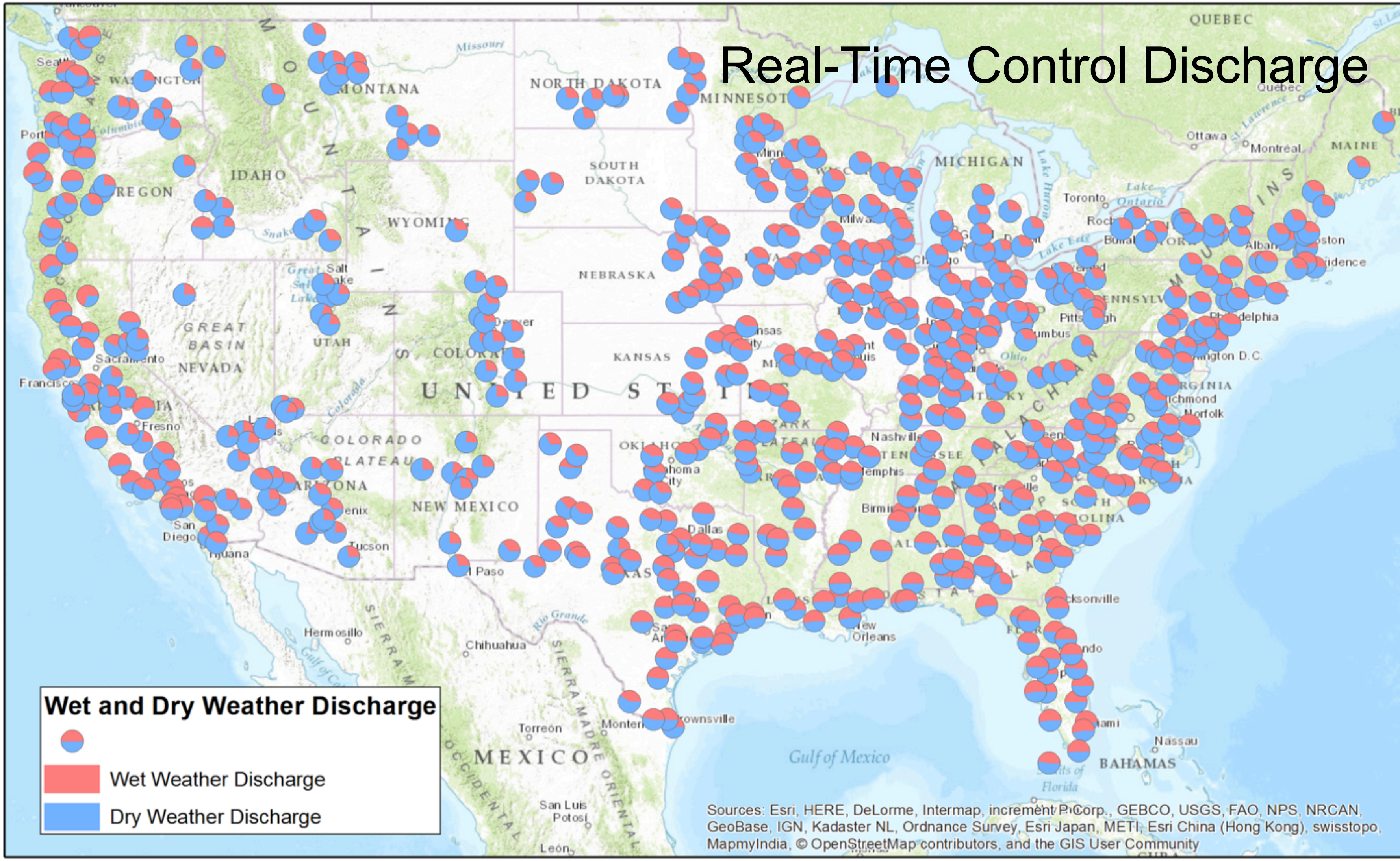
This plot shows the regression lines for each storage size, allowing for estimating possible reuse benefits based on average rainfall, with Opti active retention and discharge

Passive discharge scenarios do not allow for reuse because the runoff cannot be stored for longer than the passive discharge time (48 hours max)

Volume Discharged During Wet vs. Dry Weather



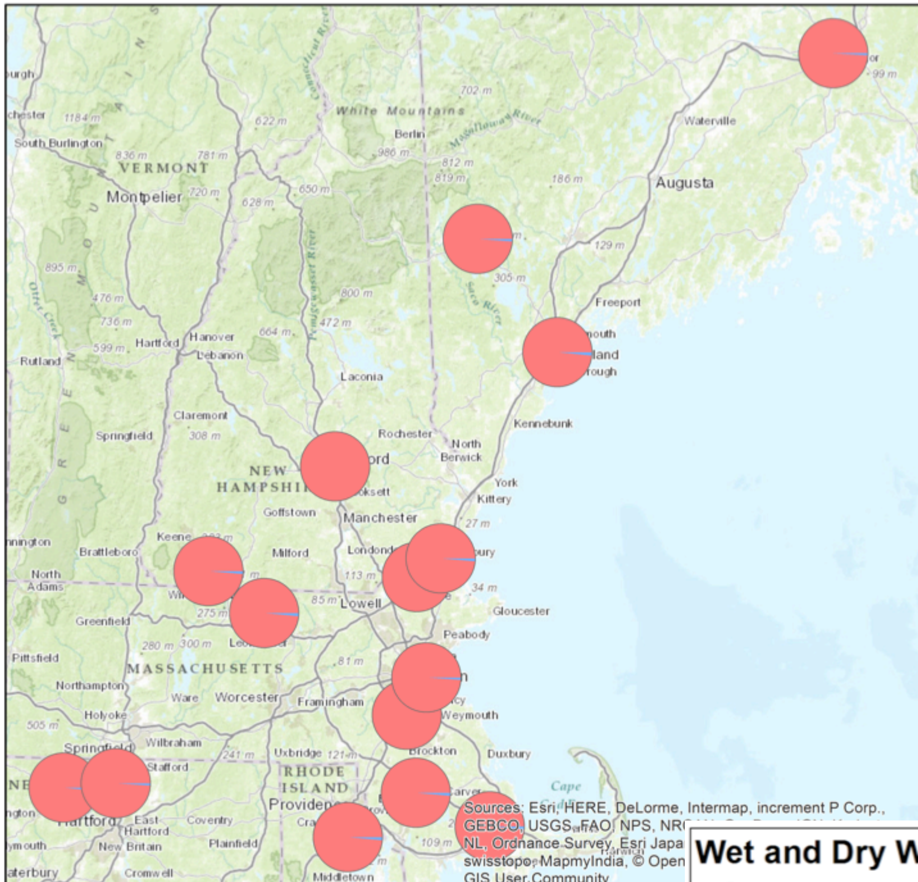
Volume Discharged During Wet vs. Dry Weather



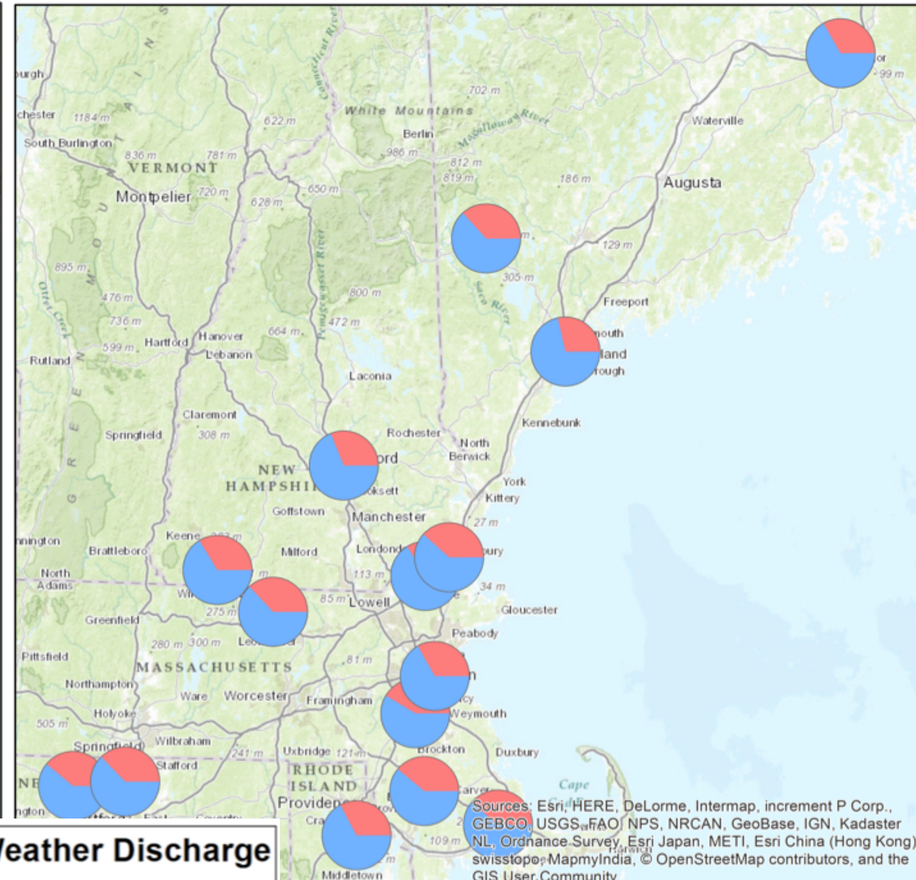
Opti

Volume Discharged During Wet vs. Dry Weather

Passive



Real-Time Control



Wet and Dry Weather Discharge

- Wet Weather Discharge
- Dry Weather Discharge

OptiRTC.com

Summary Statistics for 1 inch Storage

Logan Airport KPIs

Simulation	Metric	Passive Storage	Opti Active Storage
Water Quality: Maximize Retention Time	Long term average retention time	12 hours	171 hours
	Average water available for use[1]	0	720,000 gal/acre/year
	Average wet weather storage utilization	25%	68%
	Percent time runoff retained	3%	63%
CSO/Flooding: Minimize Wet Weather Discharge	Average wet weather discharge	0.046 cfs	0.016 cfs
	Average wet weather discharge during inflow > 0.25 cfs	0.255 cfs	0.147 cfs
	Wet weather capture	1%	65%
	Percent time runoff retained	3%	93%

Note: median values shown for 1 inch storage size

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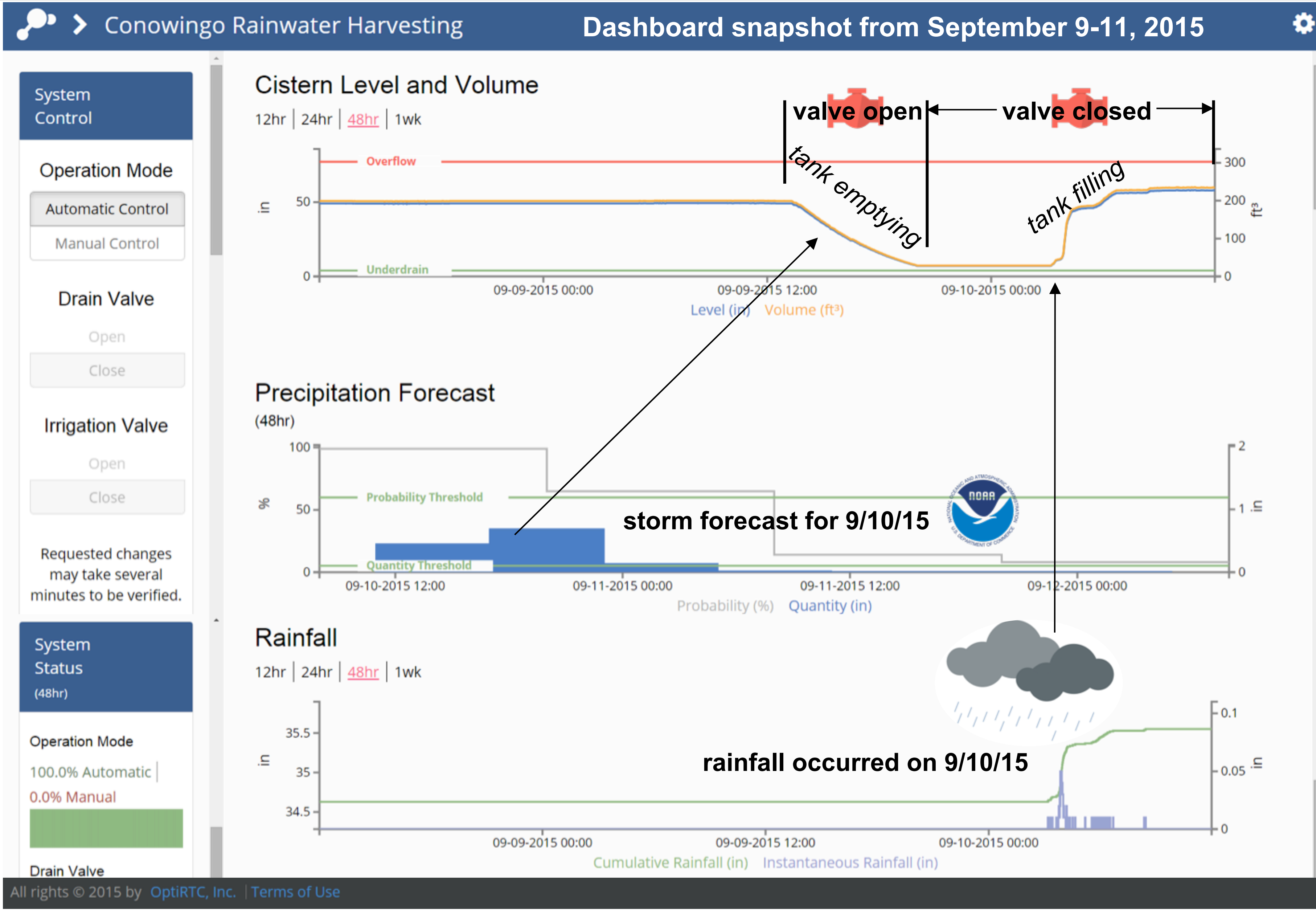
Case Studies

Examples of using real-time control to meet multiple objectives

Stormwater Capture & Reuse

Opti

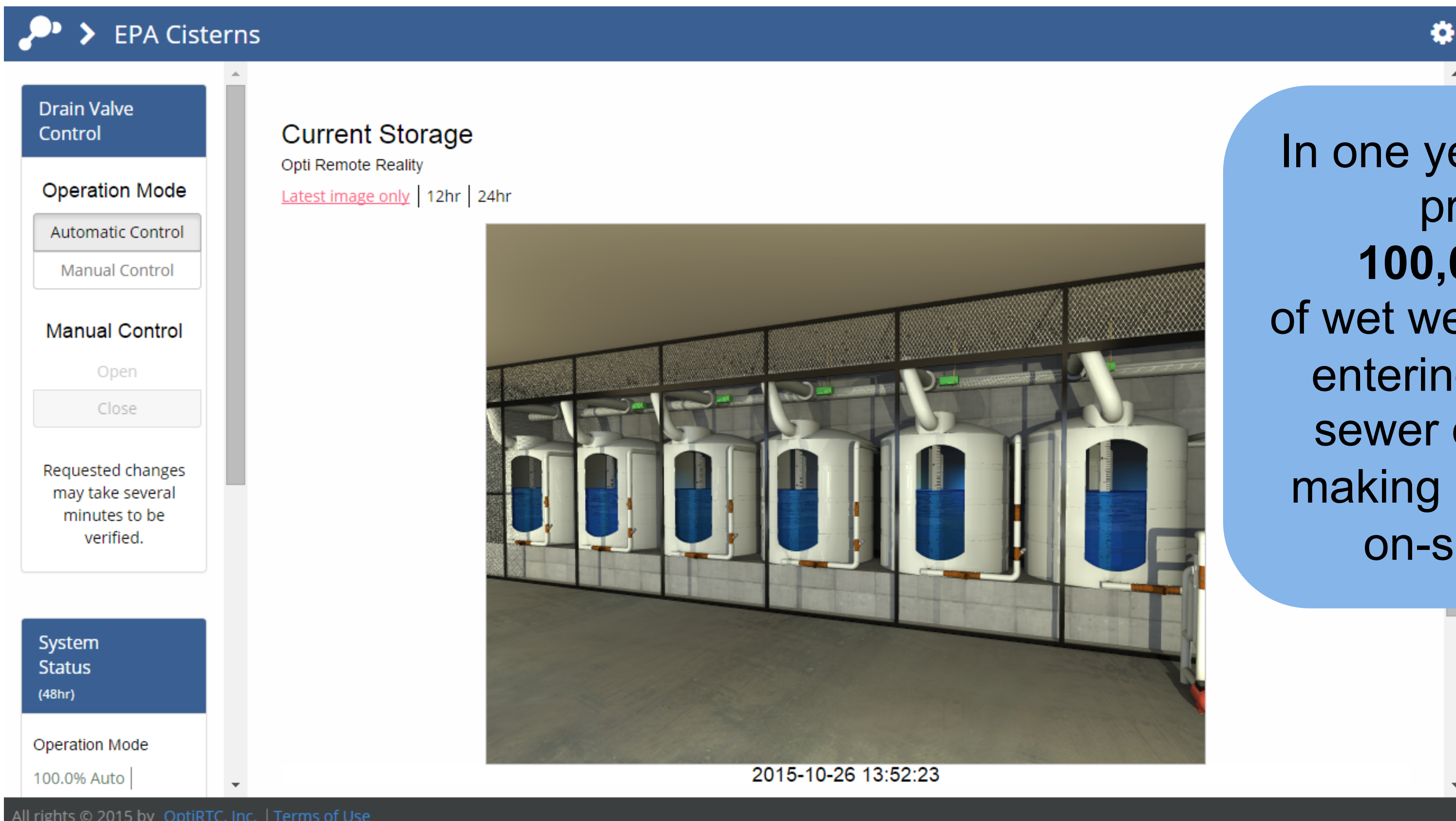
Stormwater Capture & Reuse



CSO Mitigation & Reuse at EPA Headquarters

1. **Stormwater reuse**
2. **Prevent wet weather flow to combined sewer**

- Six 1,000 gallon underground cisterns
- Cisterns remain full except in advance of rain events



In one year, the system prevented **100,000 gallons** of wet weather flow from entering a combined sewer overflow area making it available for on-site irrigation

Retrofit for Increased Water Quality Benefit

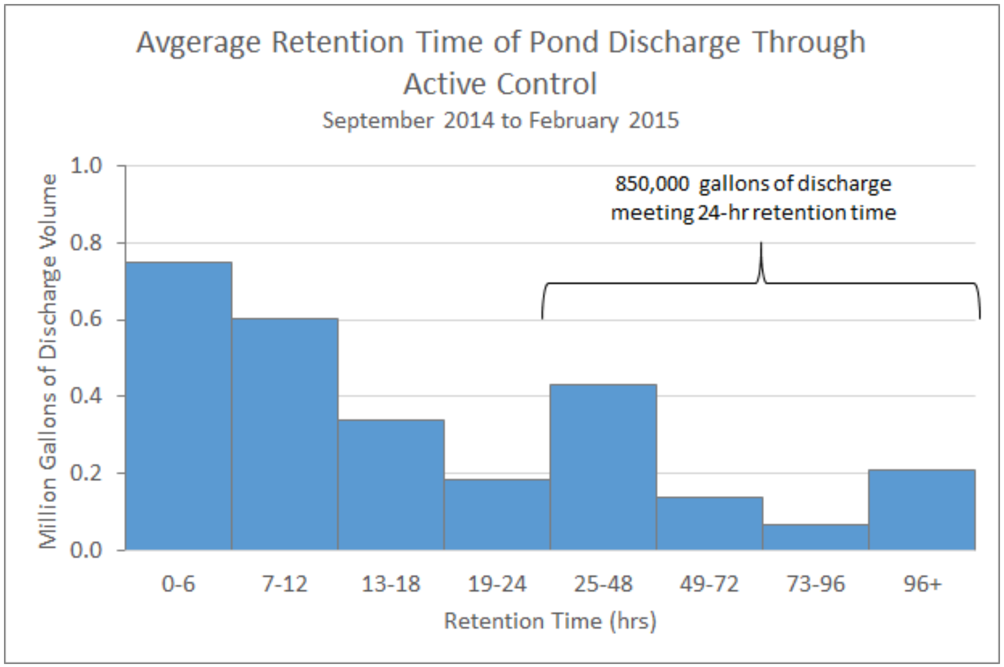
- 120 acre drainage area
- Runoff from 0.2” in storm event or 0.12” of impervious storage
- Very small existing pond
- Did not have an original water quality control purpose

1. Reduce erosive flows
2. Improve downstream water quality

Butternut Creek Project completed in partnership with Clean Water Services, Geosyntec Consultants, and Opti

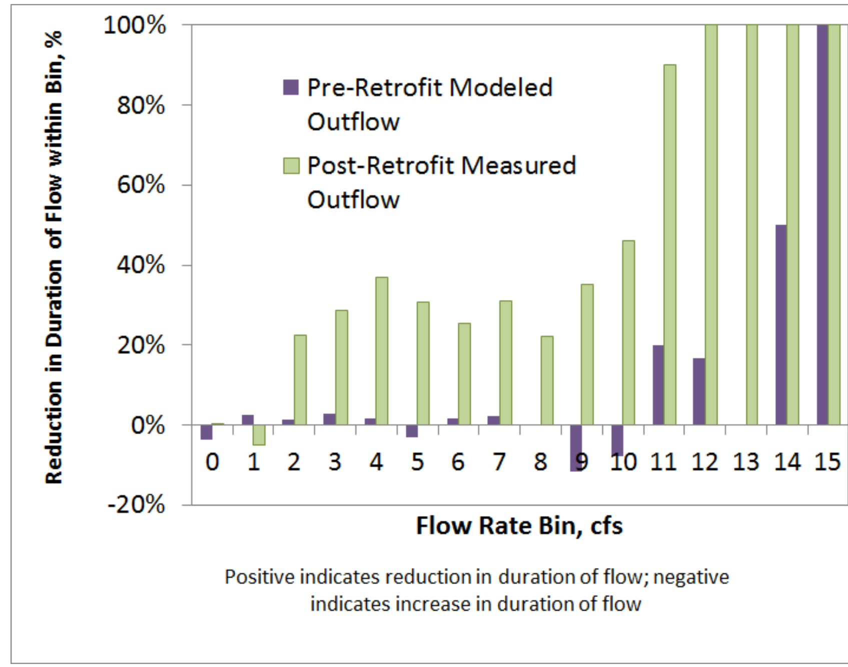
Monitoring Data: Quantify Performance Metrics

Water Quality



0.1 watershed inches of storage - dramatic increases in retention time for a very small facility

Stream Restoration



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Summary of Real-Time Stormwater Control

- Low cost sensors and data connectivity
- Forecast-based decisions maximize stormwater infrastructure potential

Increase

- Retention time 6-10x
- Wet weather capture by more than 60%
- Reportable performance data

Decrease

- Wet weather discharge rate by > 50%
- Required control volume
- Erosive flows & flooding

Discussion

Contact Information

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More materials and information: http://library.optirtc.com/