Presentation to the Chesapeake Bay Program Urban Stormwater Work Group

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Continuously Monitored and Adaptive control (CMAC) Retrofits for Approved BMP Types

Not a new technology - relies on existing approved BMPs for treatment, but has significant additional benefits:

Benefits of Continuous Monitoring

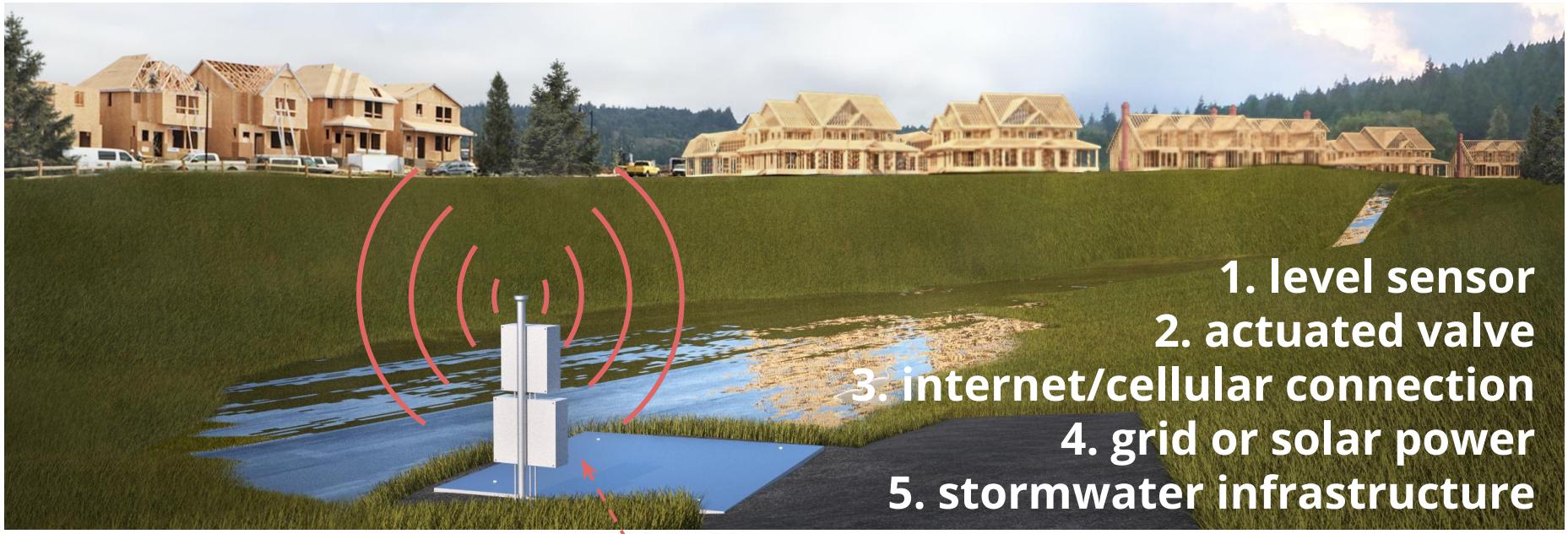
- Direct verification of performance.
- Auditable performance and supporting data without additional cost.
- Increasing uptime of facilities through notification of operational issues.
- Reduce maintenance costs without sacrificing performance.

Benefits of Adaptive Control

- Dramatically improving water quality from facilities by increasing residence time and/or improving unit process effectiveness (e.g., settling, denitrification).
- Reduce the frequency of flooding events.
- Enabling robust adaptable construction designs that are less dependant on site specific conditions.
- Allowing for updated operation to adapt systems to for future climatic conditions or changes in site characteristics.
- Utilizing an entire facilities storage volumes for the full range of storm event sizes.
- Intelligently detain flows in combined sewer systems for release during non-critical periods.
- Restoring pre-development hydrology (i.e., flow-duration matching) by actively modulating release rates based on forecast information.
- Increasing the volume retained on site.
- Maintaining ecological base flows.
- Allowing for changes to operation without major redesign or reconstruction.

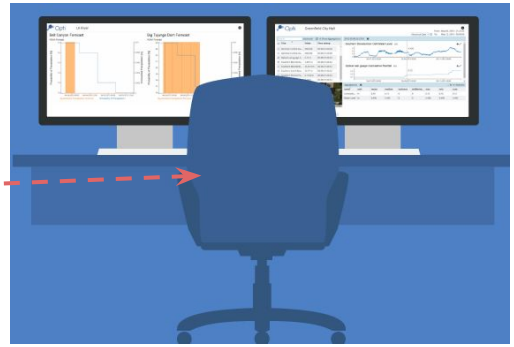
Continuous and adaptable stormwater management

Combine sensor data, weather forecasts, and algorithms to optimize stormwater infrastructure through active, cloud-based control



NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NOAA
U.S. DEPARTMENT OF COMMERCE

-Cloud architecture
-Robust data security
-Advanced user authorization
-Configurable logic algorithms that optimize complex, multi-variable results
-Online dashboard interfaces
-APIs for data export/analytics



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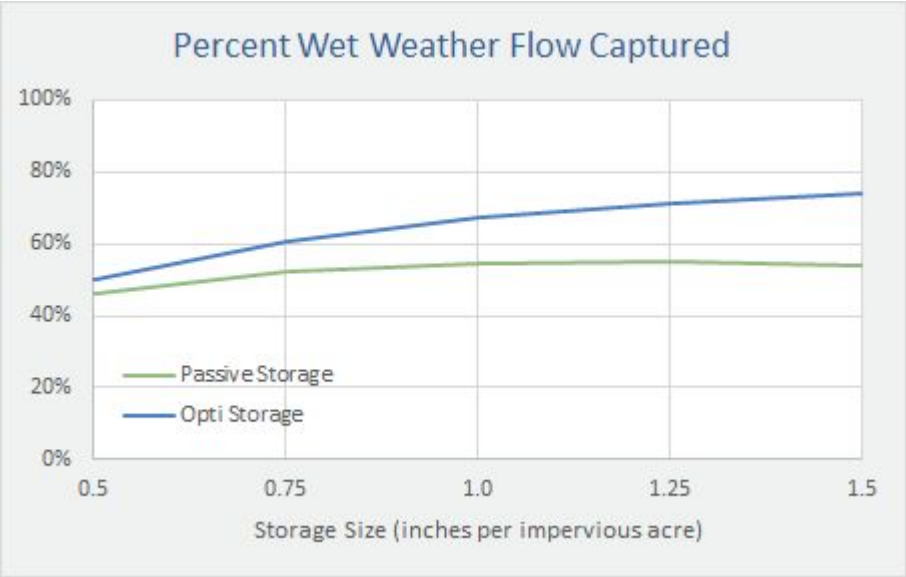
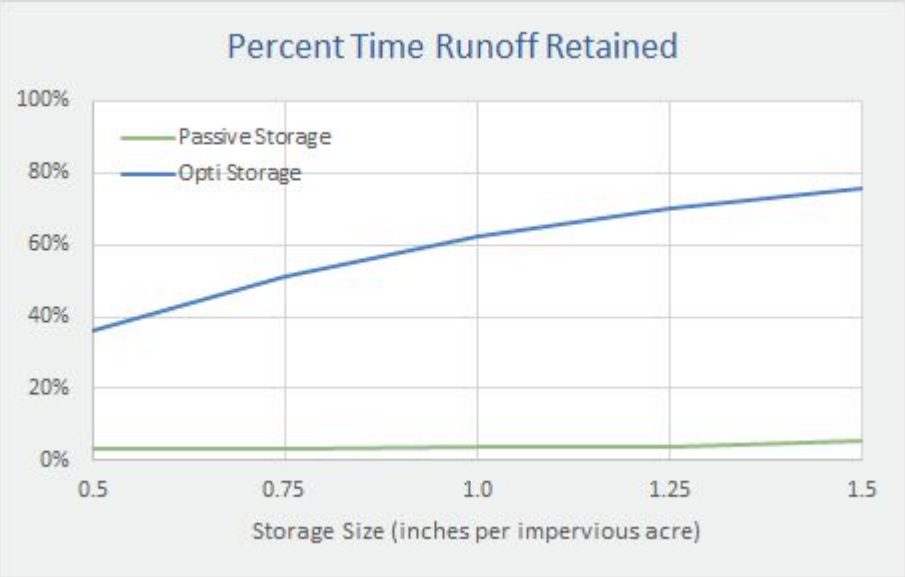
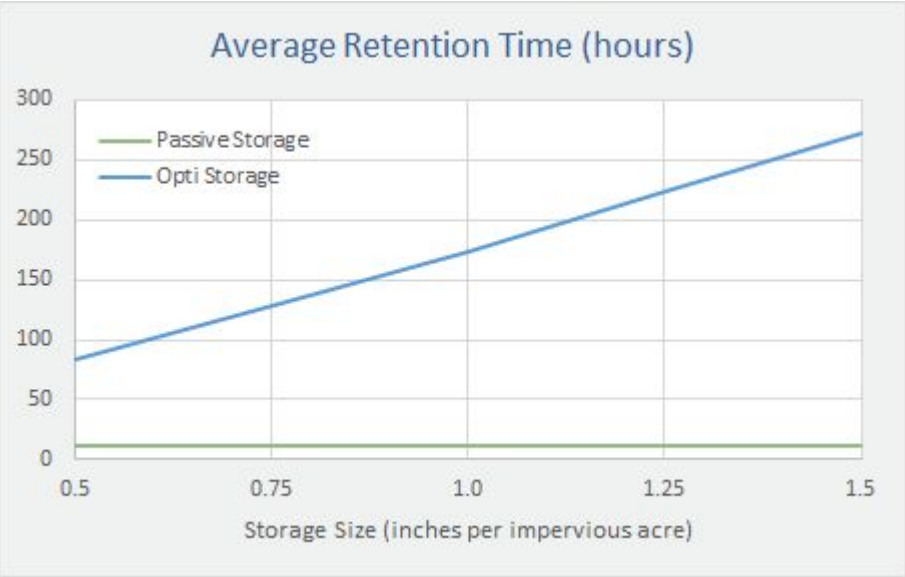
BMP Conversion: Dry to Wet Pond Modeling





- 50 years of hourly rainfall data from BWI
- Simulated passive dry pond and active retrofit to wet pond
- Various storage sizes
- 74 percent wet weather capture by volume
- 70 percent asset volume utilization during wet weather
- 270-hour average retention time of discharged water
- Complete runoff retention 76 percent of wet weather hours



BMP Enhancement: Wet Pond Retrofit

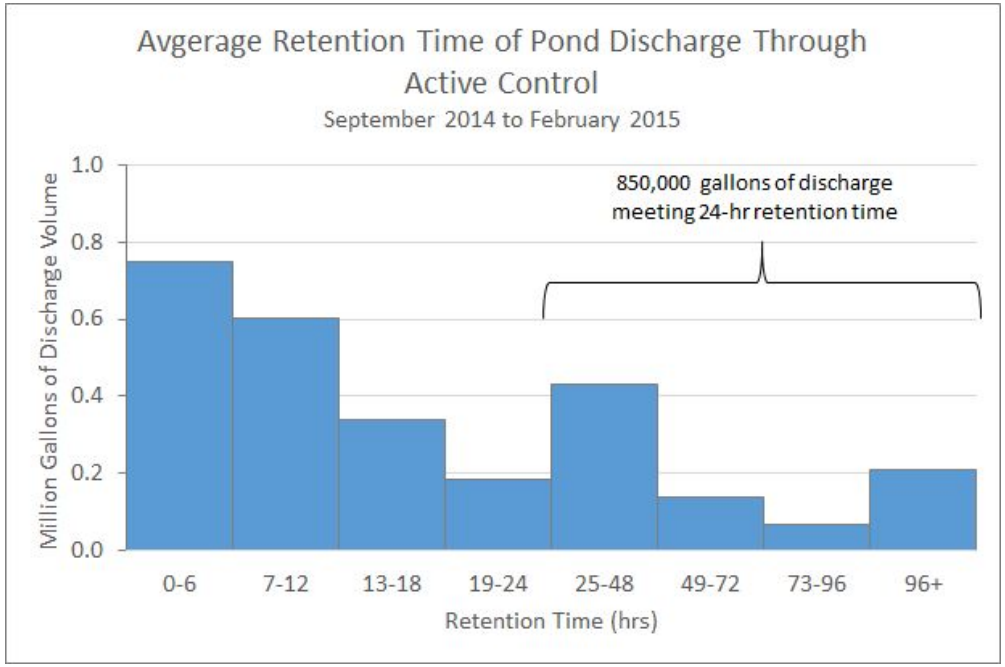
120 acre drainage area

Runoff from 0.2” in storm event or 0.12” of impervious storage

Very small existing pond

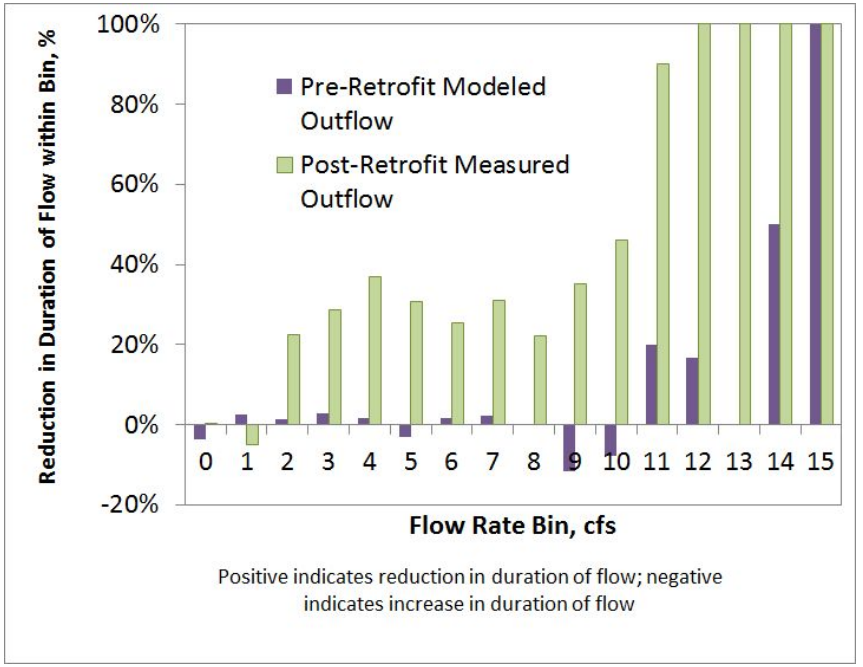
Results of Extensive Field Monitoring
Accurate and Precise Performance Metrics

Water Quality



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

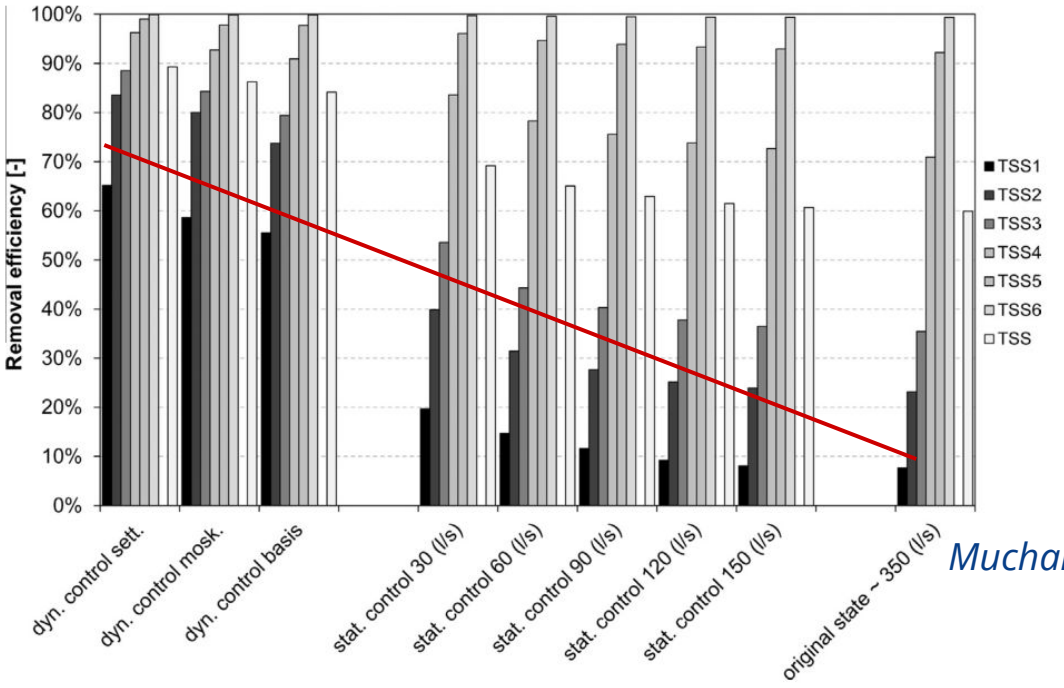
Stream Restoration



Quantitative and Verifiable Reporting Data

Increased control → Increased retention time → Increased WQ benefit

increased removal of smallest particle fraction with increased active control



Muchalla et al. 2014

Dry pond to wet pond retrofit (no active control) increased retention time and improved TSS and ammonia-nitrogen removal efficiencies

- **TSS: from 39 to 90%**
- **NH_3-N: from 10 to 84%**

Carpenter et al. 2014
Gaborit et al. 2012

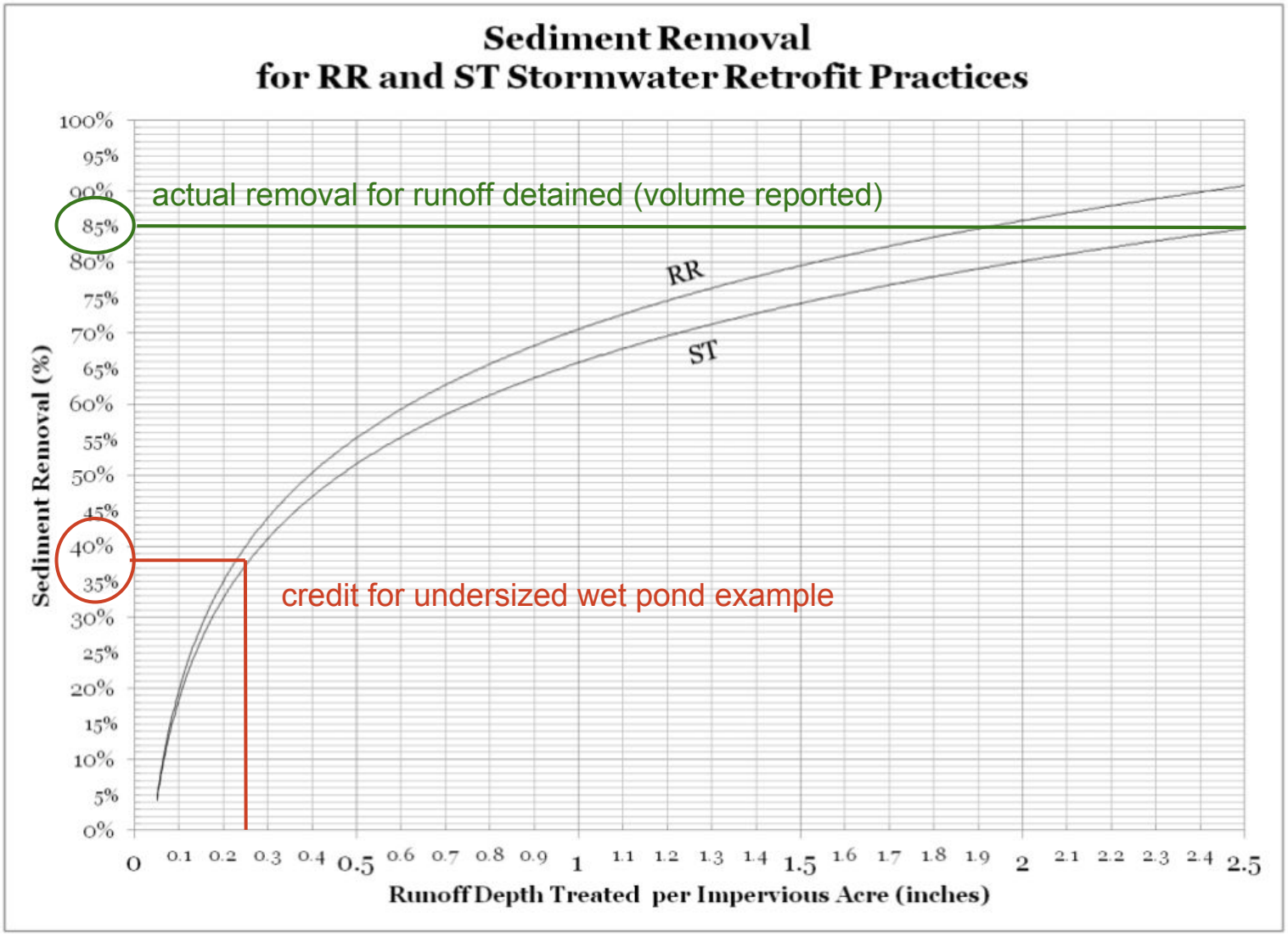
48-60% better removal efficiency of small particles in pond with active, rainfall-driven control

Muchalla et al. 2014

Smaller particles have higher associated phosphorus concentrations than larger particles

Moquecho and Pitt 2005

Credit Calculation: possibilities with quantification of volume treated



CMAC Facility Types

Conversion Types
- Dry Pond to Wet Pond
- Wet Pond to Wet Extended Detention Pond

Enhancements
- Wet Extended Detention Ponds
- Bioretention
- Wetlands
- Demand Dependant Cisterns to Fully Utilized Cistern
- Infiltration Facility

Benefits
- Increased residence time
- Increased volume retained
- Restore pre-development hydrology
- And additional benefits

References

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