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Stormwater: Too Simple?

Getting Closer to Advertised Level of Service

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Introduction

- Traditional approaches to solving stormwater problems are:
  - Increasingly cost prohibitive
  - Difficult to integrate all the missions (floodplain, storm drains, water quality, channel stability)
  - Often lacking precision in fixing the most urgent problems

- How can we address these issues?
  - Improve watershed characterization
  - Improve simulation of physical processes
  - Use of historic long-term precipitation data to drive models
  - Take a holistic approach to watershed management

Uncertainties in Watershed Attributes

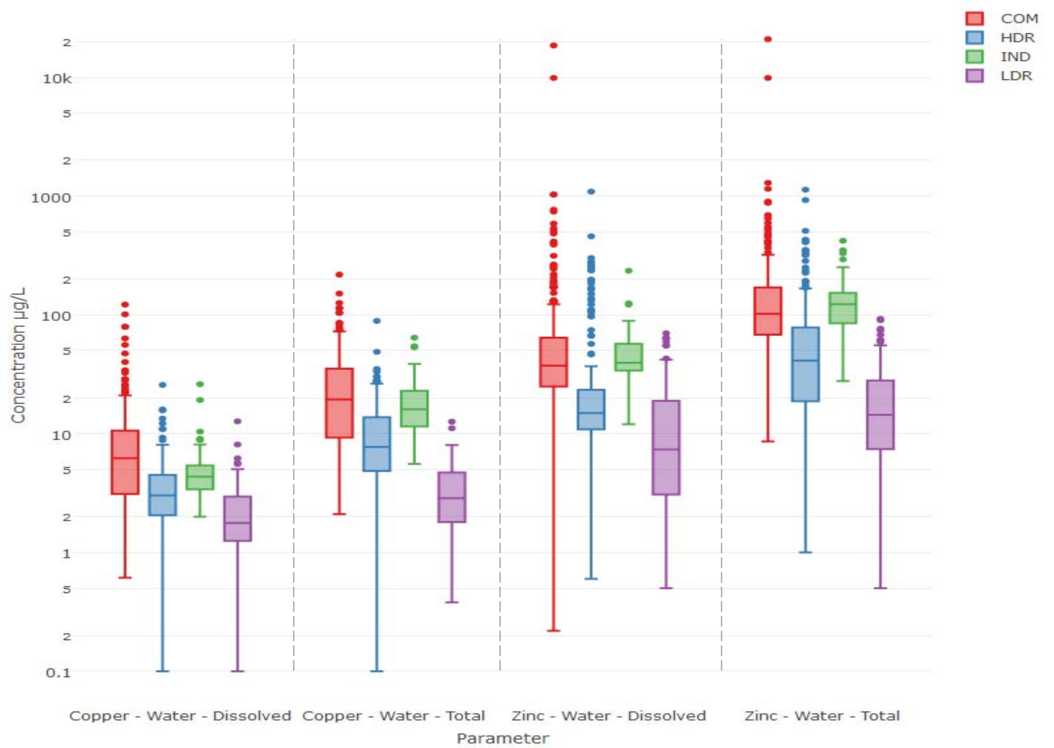
- Precipitation
  - Patterns, spatial variability, seasonal variability, future trends
- Evaporation
  - Cloud cover, wind speed, wet day versus dry day
- Land use
  - Pollutant loading from different surfaces
- Impervious cover
  - Characterization, pollutant loading
- Elevations
  - Accurate topographic data, field survey, LiDAR
- Drainage flow paths
  - Small scale flow paths, changes in flow paths at higher flows, uncertainty in drainage areas
- Soil characteristics
  - Infiltration parameters, soil variability
- Vegetation
  - Coverage, plant types, leaf area index, evapotranspiration

Uncertainties in Watershed Attributes

- With all these uncertainties, how can we best represent a watershed?
  - Calibration: make the model fit the data, but is the fit accurate?
  - Can create additional uncertainties:
    - Rainfall sensor clogged
    - Rating curves for flow rates (roughness values, discharge coefficients)
    - Bypass and/or changing drainage areas based on flow rates and wind speeds
- Alternatively, use available data to better characterize the watershed
  - Pollutant characterization by land use and BMP performance
  - Historical rainfall records
  - Adaptive management and resiliency

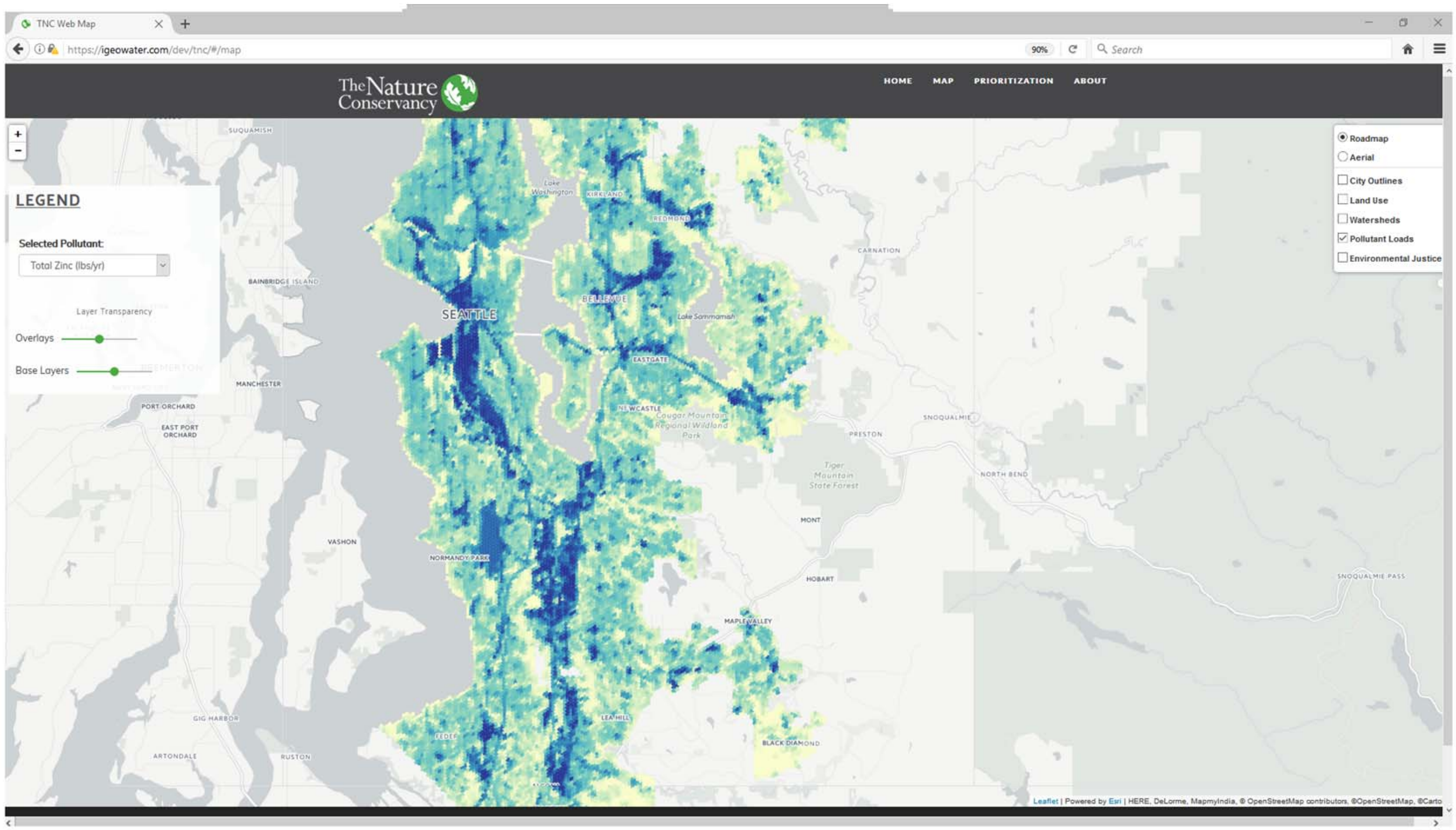
Land Use EMCs

- Event Mean Concentration (EMC) analysis can be used to represent pollutant loadings as well as treatment efficiency for stormwater control measures
- Metals analysis for four land use types
  - Local monitoring data for Phase 1 MS4 permit



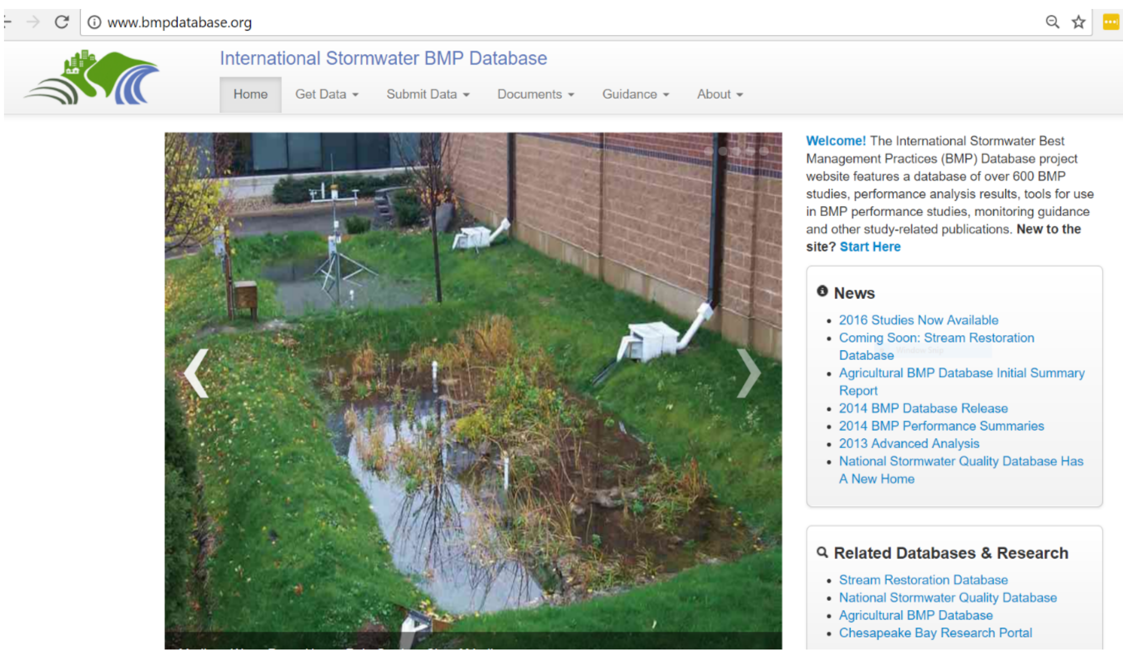
Land Use EMCs

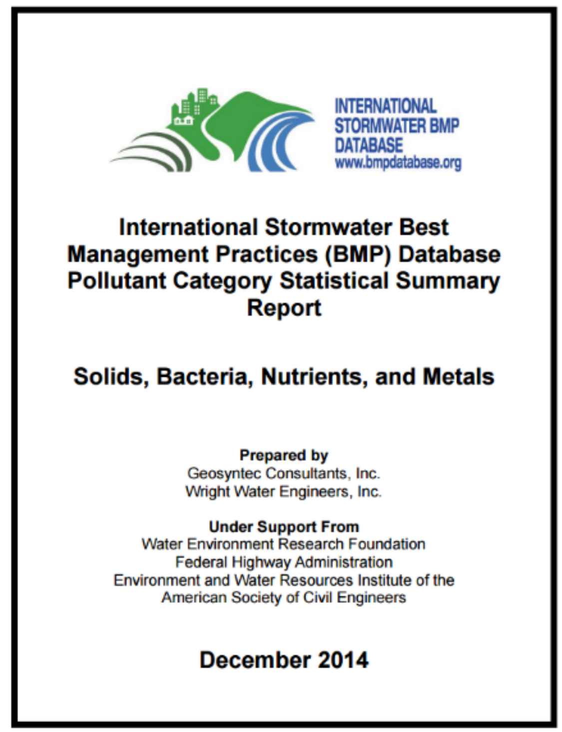
- Apply land use EMCs together with hydrology to identify areas of high pollutant loading
  - Assist with TMDL analysis
  - Identify priority areas and optimize treatment measures



Treatment Options

- With estimated pollutant loads, what stormwater treatment measures are most efficient at removal?
- International BMP Database provides data for range of BMP types, pollutants, climates, soils, etc.




INTERNATIONAL STORMWATER BMP DATABASE
www.bmpdatabase.org

International Stormwater Best Management Practices (BMP) Database Pollutant Category Statistical Summary Report

Solids, Bacteria, Nutrients, and Metals

Prepared by
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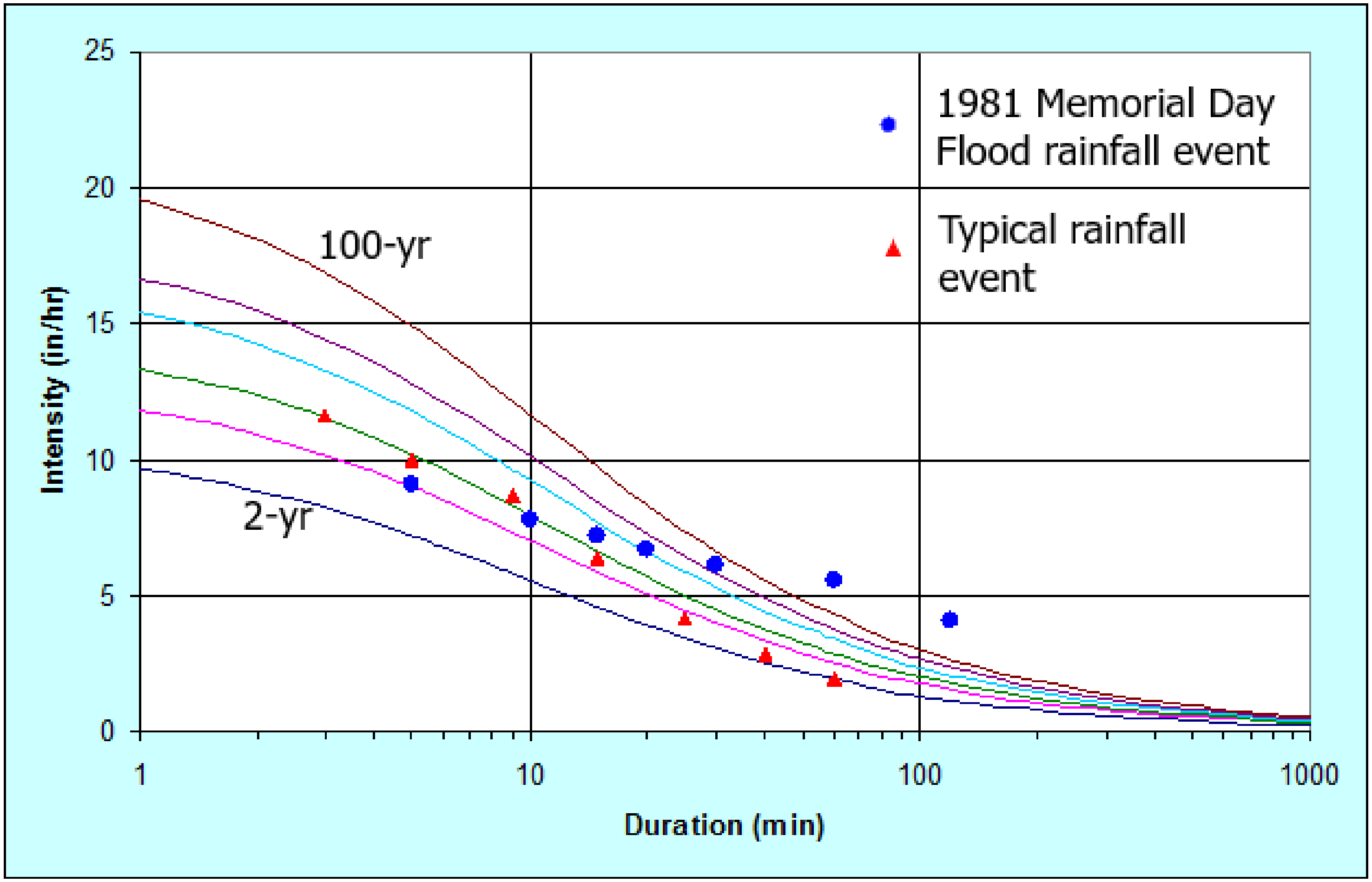
Design Storm or Continuous Simulation

Rainfall Analysis

- Real rainfall events don't follow design storms
  - Modern-era Austin's flood of record (prior to 2013)



Comparison

Design Storm (DS)

Advantages:

- Simplicity
- Inherently conservative
- Familiarity

Concerns:

- Addresses extreme hydrologic events
- Rainfall frequency may not always coincide with the runoff frequency
- Therefore, designs may not be cost-effective and are irrational in terms of their overall performance

Continuous Simulation (CS)

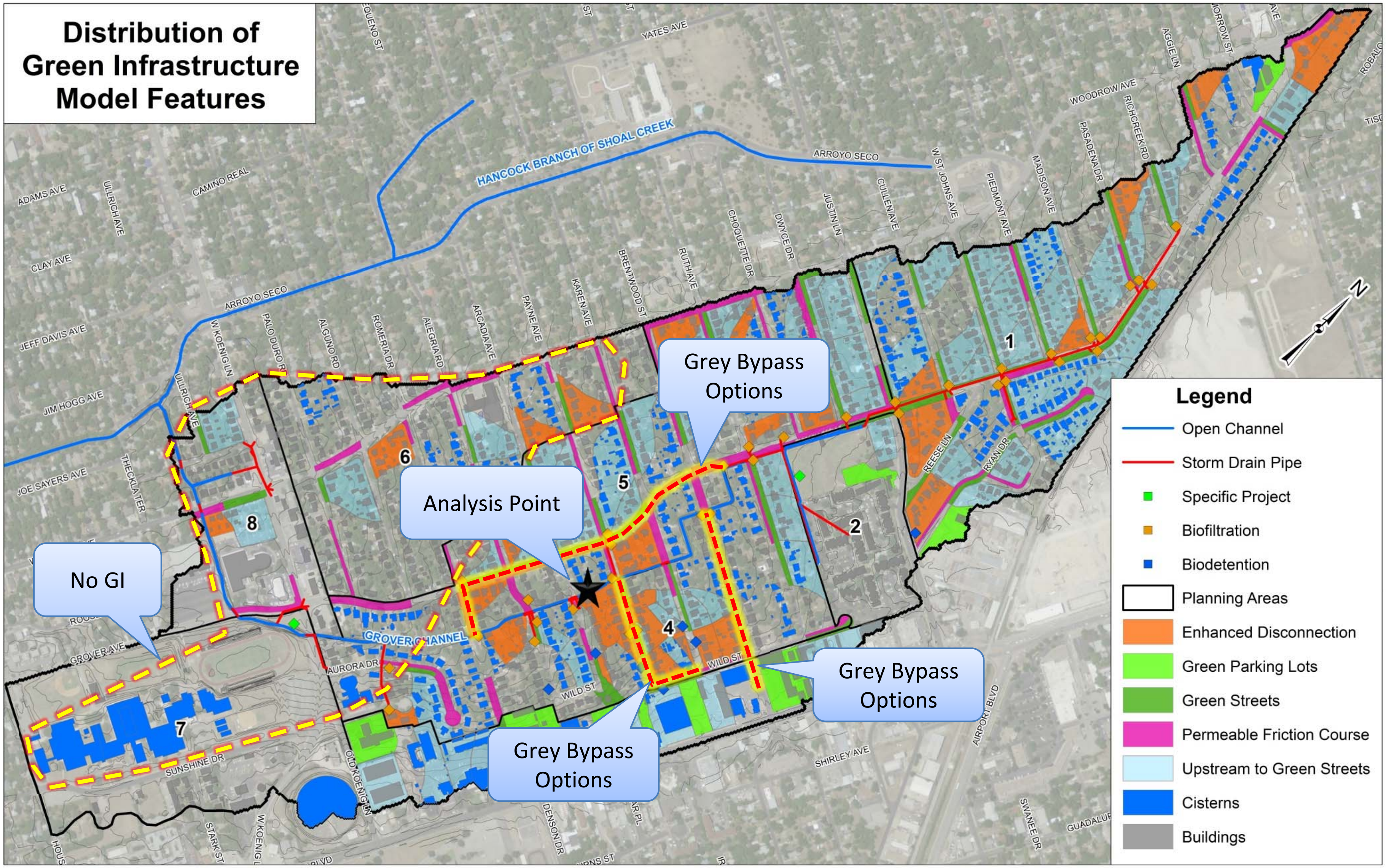
Advantages:

- Long-term performance (BMPs) under more frequent events
- Includes seasonal variability
- Realistic estimates for extreme event performance
- Performance-based designs may result in cost savings

Concerns:

- Lack of good data
- Complexity
- Perception of higher costs

Continuous Simulation Project Example

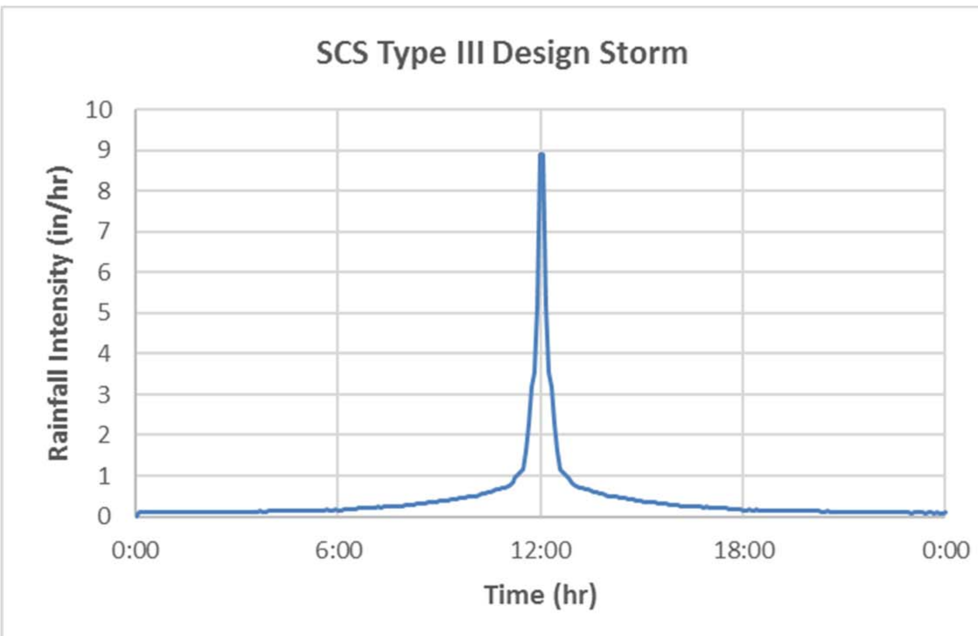


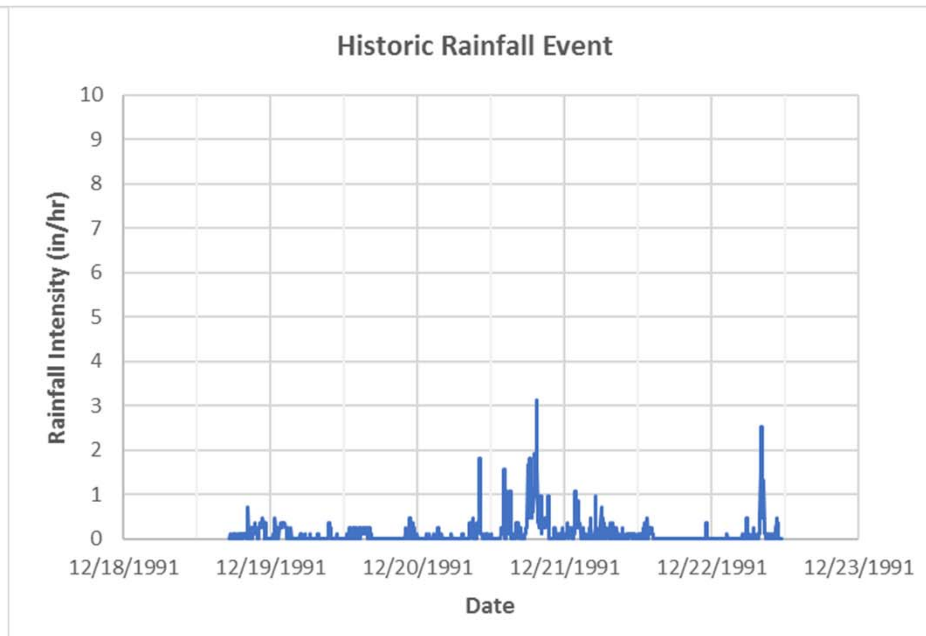
Project Objectives

- Flooding concerns
  - Reduce localized flooding with green infrastructure controls
  - Overland flooding issues resulted in 1D/2D modeling
  - Frequent localized flooding resulted in performance during smaller events to be the focus
- Reduce erosion potential
  - Long-term erosion/scour occurs primarily at bankfull conditions (~2-year event)
- Water quality benefits
- Water conservation implications
- Whole life-cycle cost reduction
  - $200M for traditional SW infrastructure improvements to meet the City's design storm (100-year)
  - $22M (construction) + $35M (50-year life O&M) for green infrastructure + limited grey achieved significant improvements (~25-year)

Rainfall Comparison

- 100-year design storm
  - Depth = 10.2 inches
  - Peak intensity = 8.9 in/hr
  - Duration = 24 hours
- Historic rainfall event, ~50-year return period based on rainfall
  - Depth = 10.6 inches
  - Peak intensity = 3.1 in/hr
  - Duration = 100 hours (4 days)



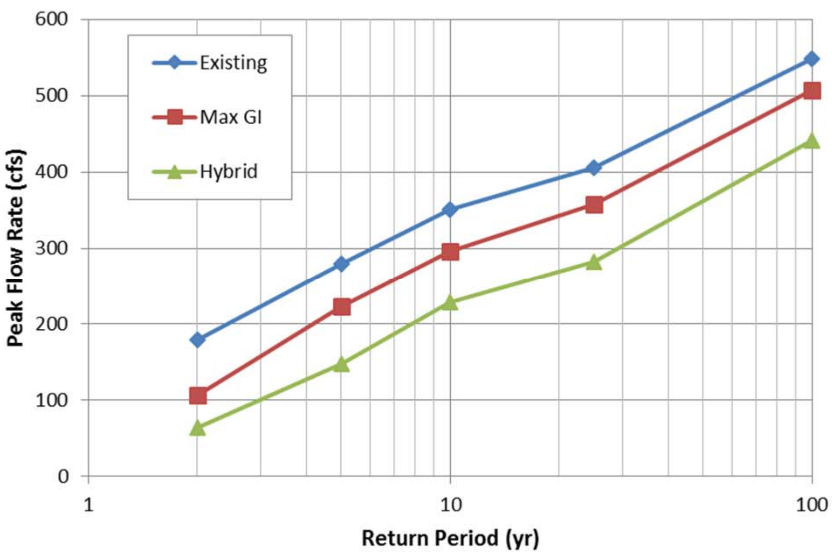


DS vs CS Comparison Results

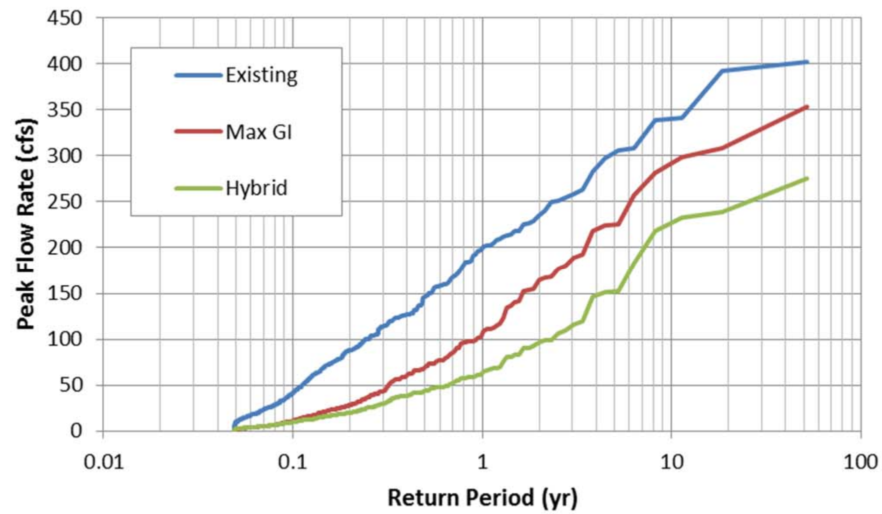
- CS suggests higher peak flows for more frequent events (<5-year return period) and lower peaks for less frequent events
- Less confidence for larger return periods (for both CS and DS)

Return Period (yr)	DS Peak Flow (cfs)		
	Existing	Max GI	Hybrid
1	N/A	N/A	N/A
2	179	107	64
5	280	223	147
10	351	296	229
25	405	358	283

Return Period (yr)	CS Peak Flow (cfs)		
	Existing	Max GI	Hybrid
1	199	105	63
2	235	165	96
5	304	225	152
10	340	291	227
25	395	317	246



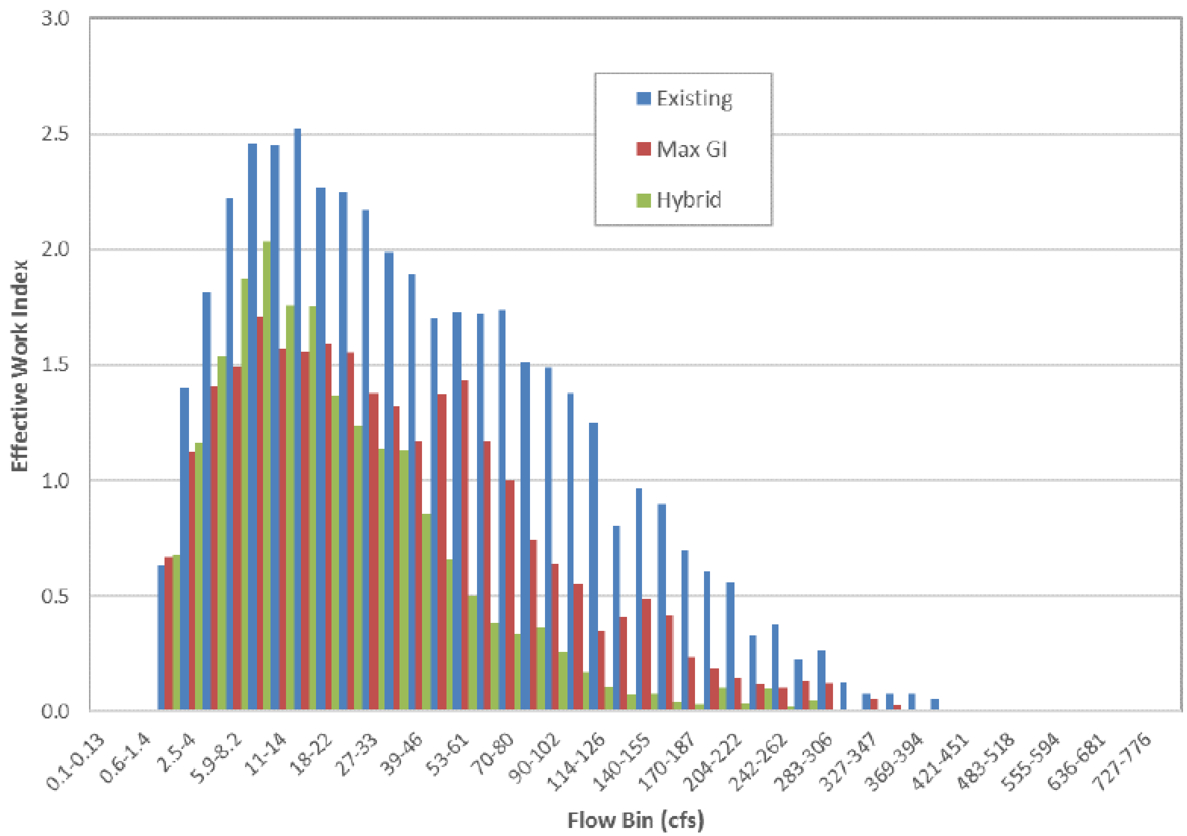
Design Storms



Continuous Simulation

More Accurate Performance Predictions

- Erosion potential: most erosion occurs at more frequent events
  - Higher effective work = higher erosion potential

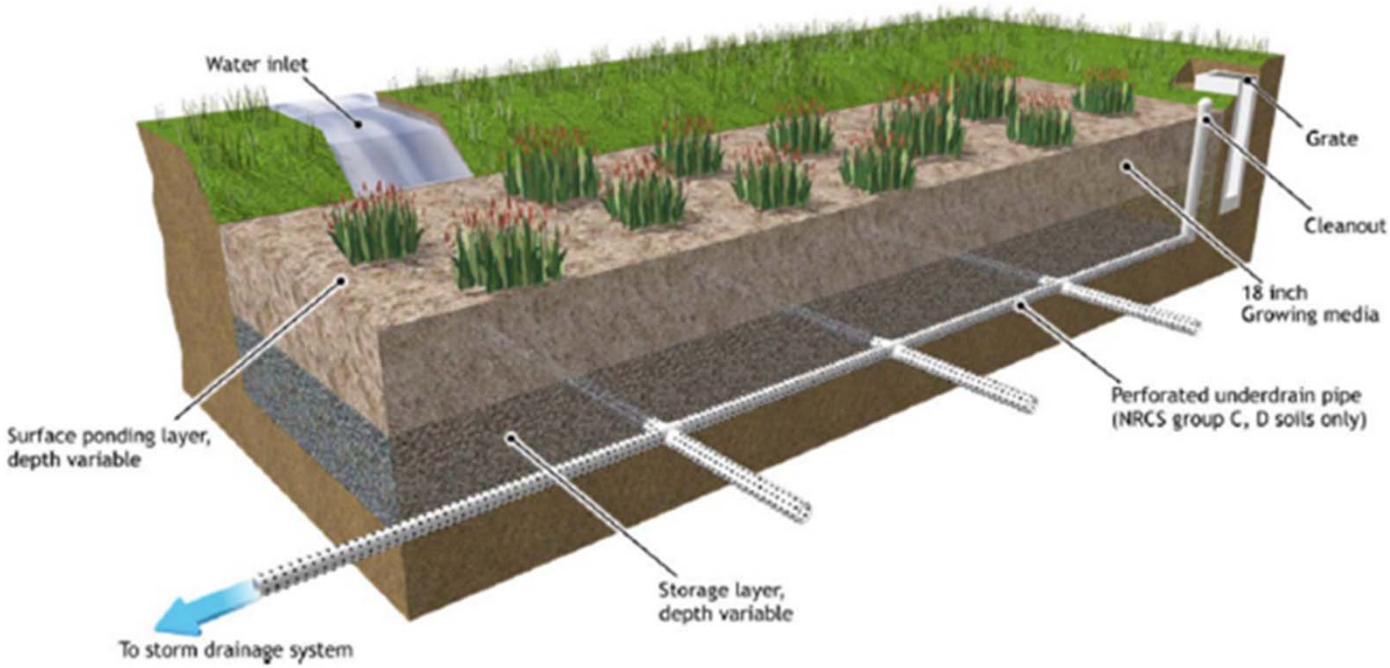


Future Uncertainty

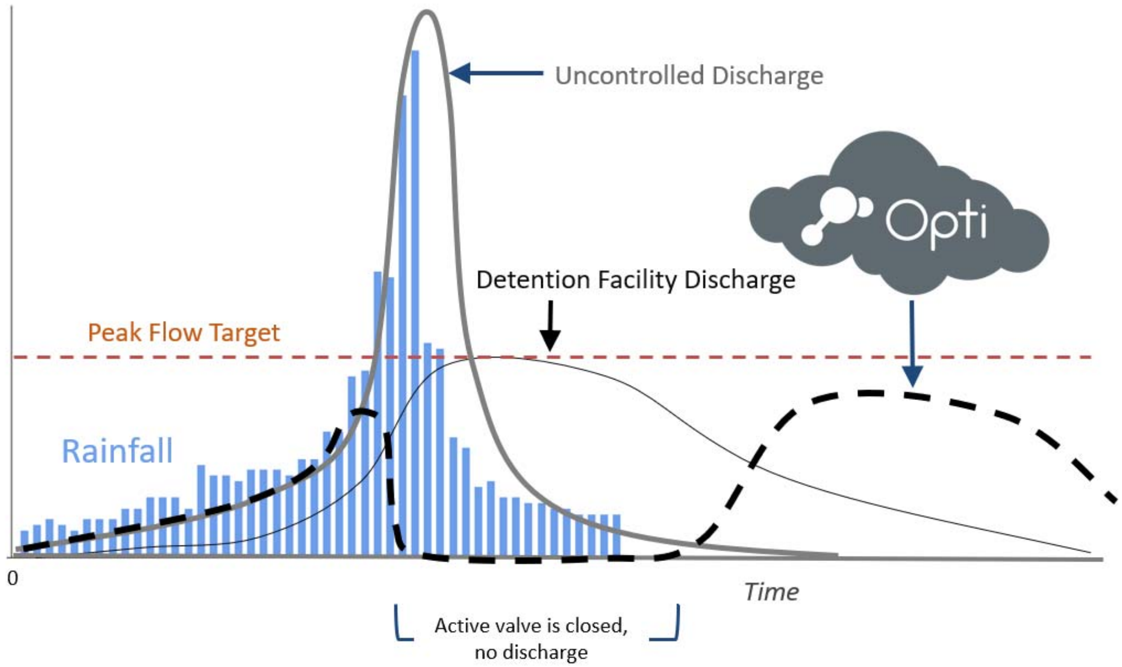
Design for Resiliency and Adaptive Management

Addressing Future Uncertainty

- How to further account for future uncertainties
  - Design in resiliency features



Continuous Monitoring and Adaptive Control



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Summary

- Uncertainty in watershed attributes likely far outweighs uncertainty in future rainfall predictions
- We can address these uncertainties by improving:
  - Watershed characterization
    - Land use EMCs, accurate topographic data, etc.
    - Site-specific data collection
  - Simulation of physical processes
    - Design storm versus continuous simulation
    - Continuous simulation for better assessment of BMP effectiveness
  - Holistic approach to watershed management
    - Multiple project objectives/goals

Questions or Discussion?

Thank you!

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Precipitation Observations

- Future scenarios focus on changing precipitation patterns (intensity, depths, seasonality)
- Observed rainfall trends are changing although percent change varies by location and often within scatter of available data