# Stormwater Management Under a Changing Climate

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## Climate Change and Urban Stormwater Guide

- **Goal of the Guide**
  - Develop a guide for stormwater control that advances adaptation planning in the stormwater community to potential changes in climate
- **Guide informed by literature review and simulation modeling**
- **Today's presentation**
  - Describe the simulation modeling approach
  - Share results and conclusions from the modeling

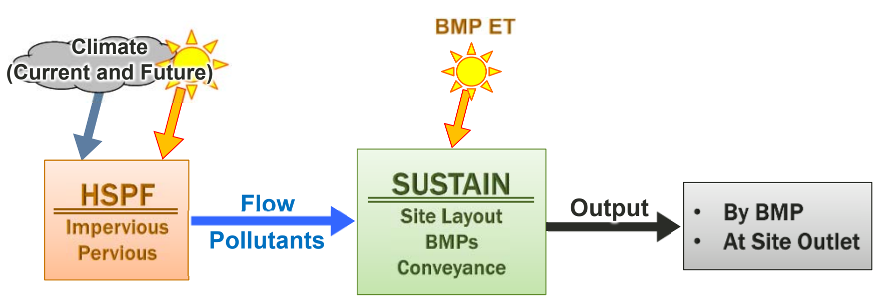
## Study Questions Informed by Modeling

1. How might climate change affect performance of conventional stormwater infrastructure and green infrastructure (GI) compared to current conditions?
2. How can conventional designs and green infrastructure designs be adapted so that a site under future climate conditions provides the same performance as the site under current conditions?
3. What do the results suggest regarding the adaptation of green and gray infrastructure?

## Continuous Simulation Modeling Approach

- **Site-scale focus**
  - Five development types
  - Five geographic regions
- **For each site**
  - Different stormwater management approaches (gray and green)
  - Current and future climate
- **Adaptation**
  - modify BMPs to achieve current performance using two approaches
- **Performance metrics**
  - Annual outflow volume (stormwater volume treatment), flow duration curve (channel erosion risk and flooding risk), pollutant mass export (water quality treatment)


## Modeling Approach – Framework

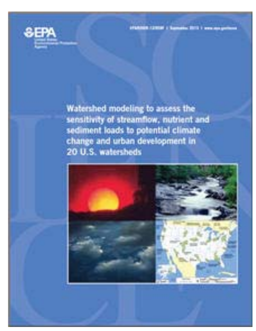


## Modeling Approach – Scenario Matrix

| Region | State | Development Type | Management Approach | | | Future Climate Scenarios |
|---|---|---|---|---|---|---|
| | | | Gray | Mixed | GI only | |
| Midwest | Minnesota | Residential | X | X | X | 6 |
| Southeast | Georgia | Ultra-urban | X | X | | 1 |
| Mid-Atlantic | Maryland | Mixed Use | X | X | | 4 |
| Arid Southwest | Arizona | Commercial | X | | X | 1 |
| Pacific Northwest | Oregon | Green Street | | | X | 1 |

## Modeling Approach – Climate Scenarios

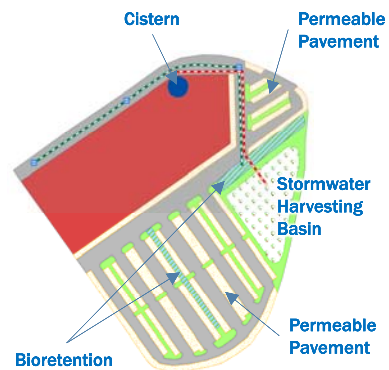
- **Global Climate Models (GCMs)**
  - Leverages climate scenarios and modeling for EPA "20 Watersheds" project
  - Variety of GCMs and spatial downscaling approaches (mid century predictions)
  - For 4 of 5 locations, selected one scenario with greatest increase in precipitation intensity
  - For 1 geographic location (Midwest), selected 3 scenarios representing a range




- **Percent Change Scenarios**
  - Applied percent change factors to entire precipitation record
  - Evapotranspiration also adjusted
  - Performed for 2 geographic regions (Midwest and Mid-Atlantic)

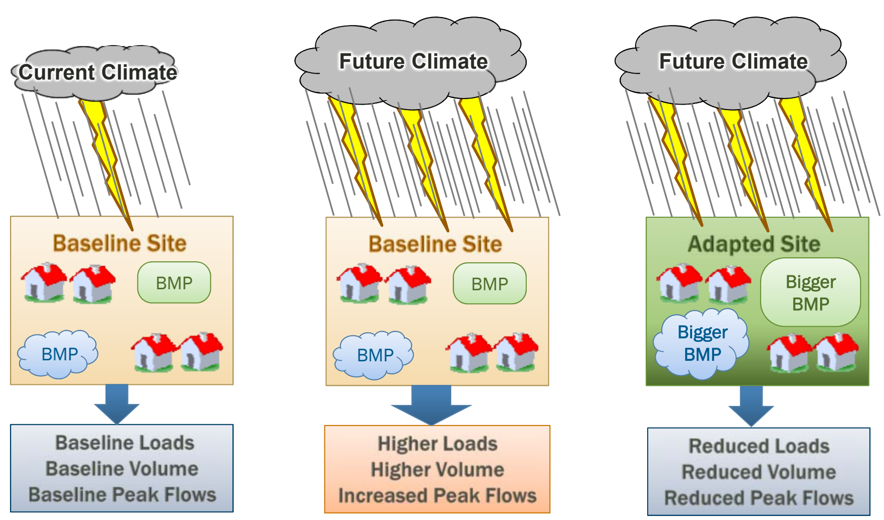
## Modeling Approach – Site Configurations

- Reviewed stormwater manuals/requirements for specific city/county in each region
- Selected appropriate BMPs and routing to meet criteria/requirements
- Scoping-level engineering design for BMPs (volume, depth, outlet structure, media properties, treatment, etc.)
- Developed cost estimates



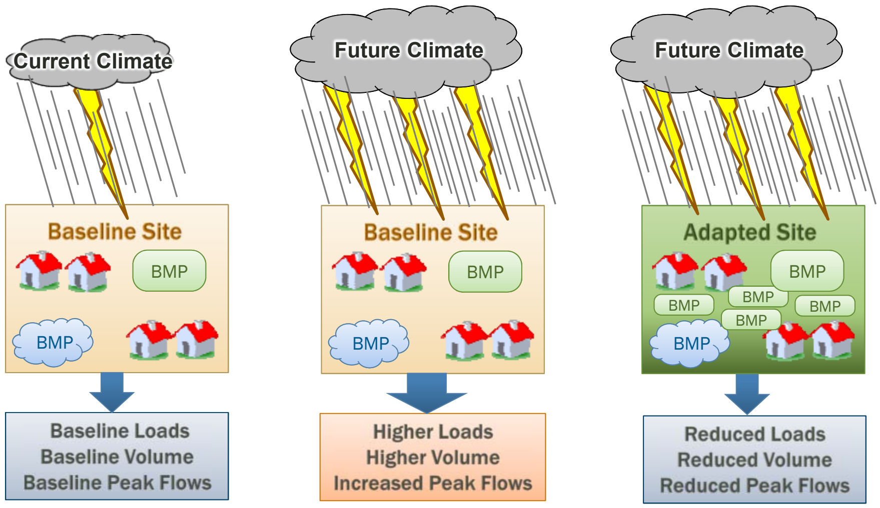

## Modeling Approach – Adaption to Future Climate

### Resize Existing BMPs (all geographic locations)



## Modeling Approach – Adaption to Future Climate

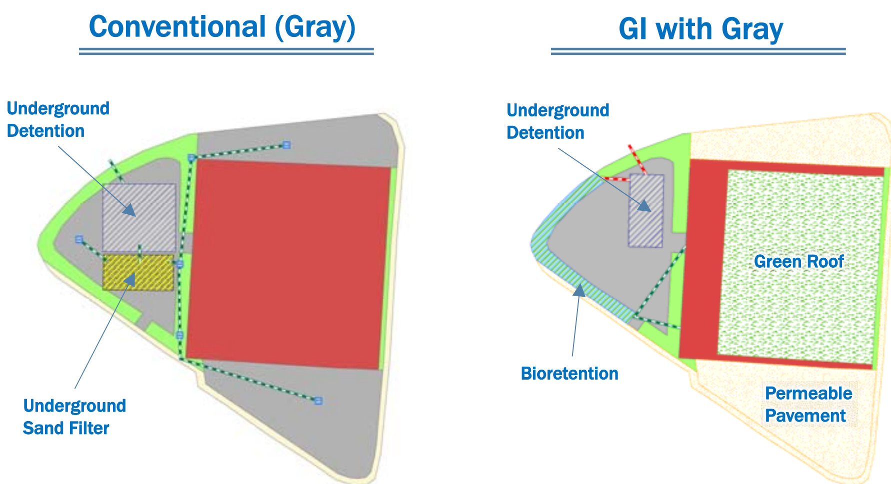
### Add Distributed GI BMPs (Midwest and Mid-Atlantic)



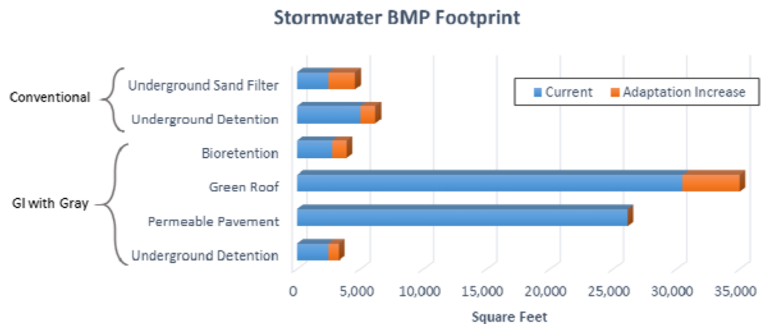

## Site Example – Southeast (Atlanta, GA)

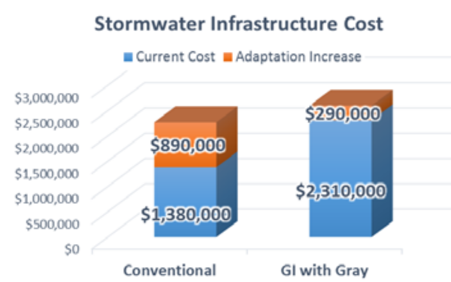
- Ultra-urban, 2 acres, 90% impervious (building and parking with some landscaping)
- Stormwater requirements
  - Retain runoff from 1$^{st}$ inch of rainfall ~or~ 80% TSS removal
  - Detain runoff from 1-yr 24-hr storm, release over 24 hours
  - Match pre-development peaks for 2-yr through 100-yr 24-hr events
- Future climate scenario
  - 7% increase in annual rainfall
  - 90$^{th}$ percentile event increases from 1.03 in to 1.15 in
  - Average 20% increase in large storm event depth

# Atlanta, GA – BMP Configurations

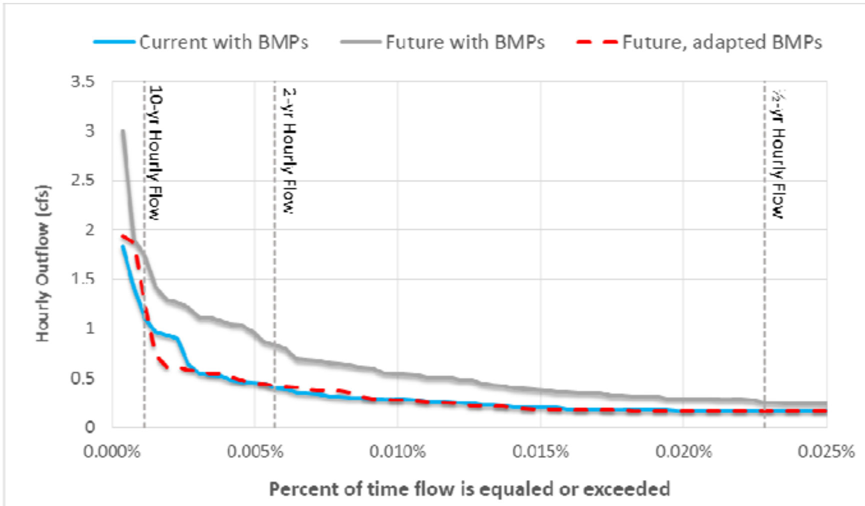



# Atlanta, GA – Adaptation to Achieve Current Performance

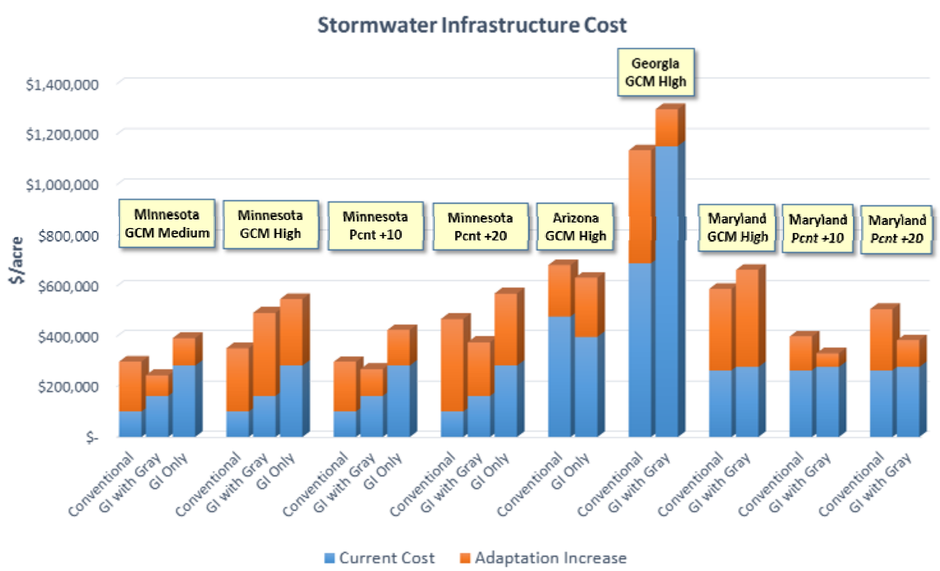


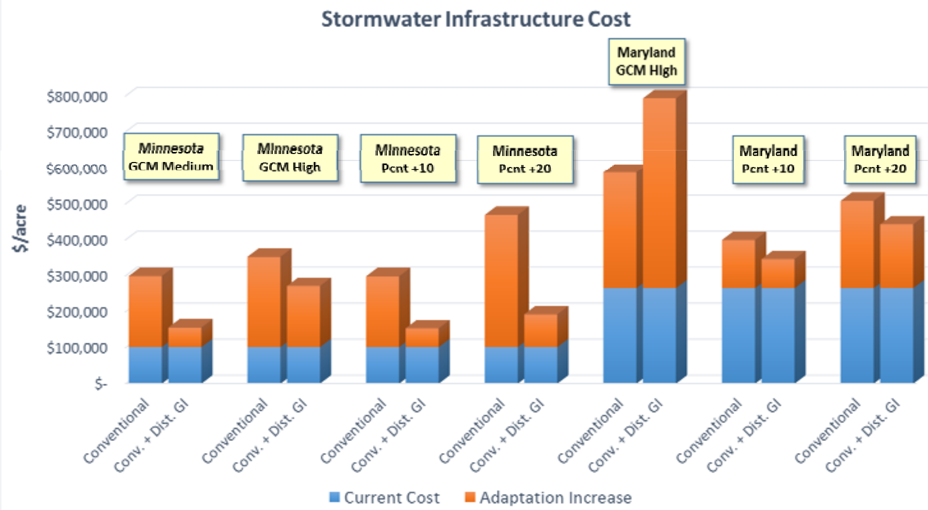
## Atlanta, GA – Bankfull/Flooding Event Performance




## Adaptation Cost – Resize Practices



## Adaptation Cost – Add Distributed GI




## Modeling Conclusions

- Percent increases in volume/loads for future climate with high intensity change generally range from 1.5% to 26.7% at four of the five sites
- Highest peak flows increase from 42% to 91% at four of the five sites
- Under future climate,
  - BMP mass/volume removal may increase or decrease
  - BMP percent removal rates typically decrease
  - Site export typically increases

## Modeling Conclusions continued

- Control of large flooding events was the limiting or co-limiting factor in 80% of the adaptation scenarios
- Gray infrastructure with detention storage more effective for mitigating extreme event volume increase
- GI has greater flexibility for addressing multiple objectives
- Stormwater management that combines gray and green approaches tends to have better cost resiliency

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