Assessing how to prioritize stormwater infrastructure projects under a changing climate

City of Takoma Park, MD

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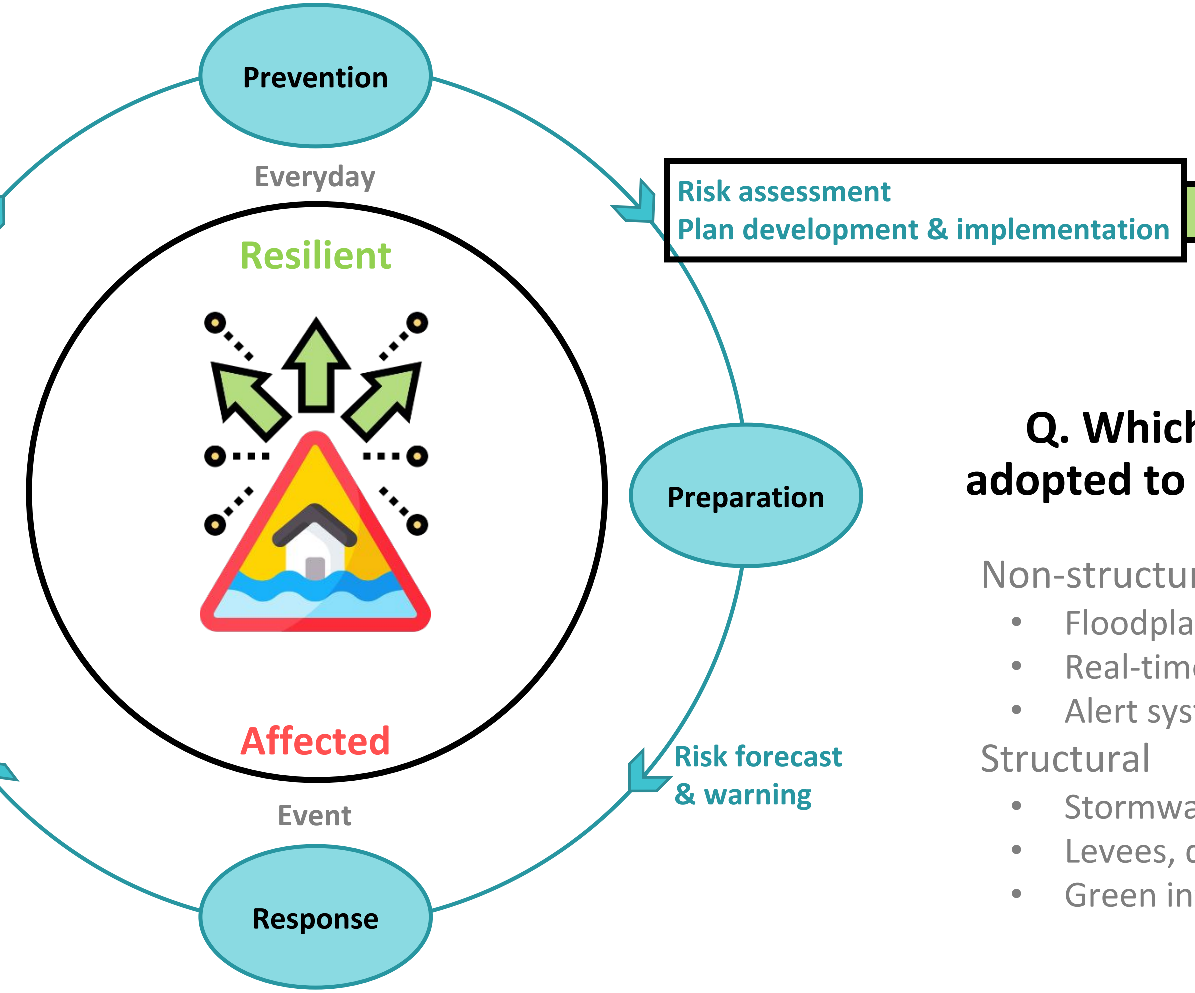
Flood Resilience in Metropolitan Areas



Q. Which approaches could be adopted to support flood resilience?

Non-structural
- Floodplain management
- Real-time flood forecast
- Alert system

Structural
- Stormwater systems
- Levees, dams, and detention basins
- Green infrastructure

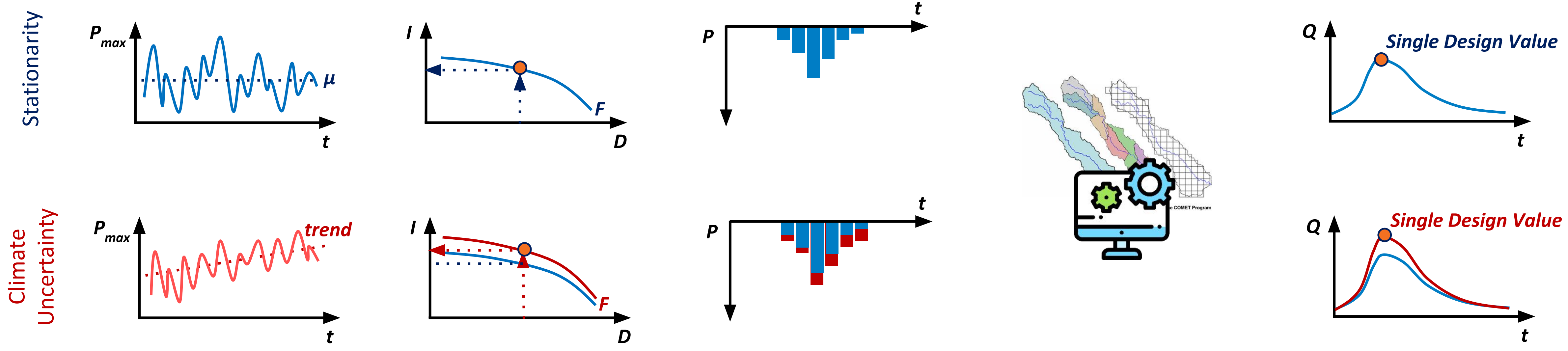
<u>Design</u>

10 Sep 2020
Takoma Park, MD

10 Sep 2020
Prince George’s County, MD

Infrastructure Design

Frequency analysis (retrospective) > Intensity-Duration-Frequency (IDF) > Design Storm > Hydrologic & Hydraulic Modeling > Infrastructure design



Concerns:

Current infrastructure under- or over-designed ⍰ level of protection

Future associated to uncertainty

Future Climate and Decision Making

Global Climate Models

- Numeric simulations of Earth’s complex physical, chemical, and biological process
- Characterization of future climate, including precipitation changes

Uncertainties

- Data processing methods,
- Translation of outputs to hydrologic model
- Natural climate variability

Adaptive Method

- Flexible plan prepared to commit to short-term actions and guide future actions
- Allow updates as the knowledge improves (e.g., newer data, advances in climate models, more recent projections)

Objective

To understand how future projections of climate change will affect Takoma Park's stormwater infrastructure functioning, a GIS, climate change, and hydrologic modeling analysis was conducted to assess areas that are undersized and need to be updated in the stormwater infrastructure system.

Analysis:

Stormwater infrastructure weaknesses based on the changes projected for different planning horizon, i.e., 2020, 2040, 2060, 2080, and 2100.

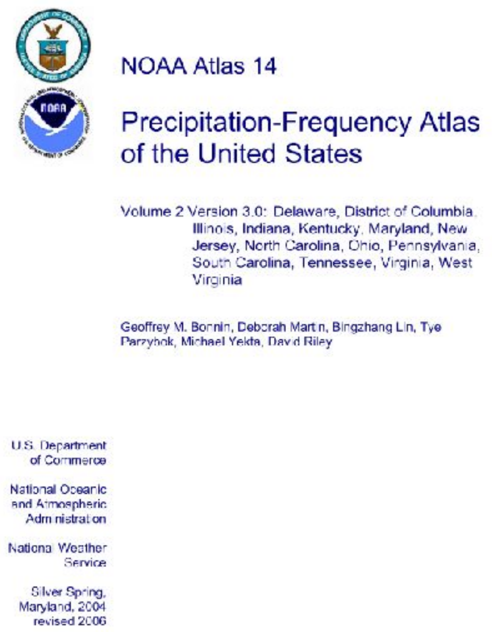
Outcome:

Areas within the stormwater infrastructure that are undersized were categorized by low, medium and high priority depending on whether they are in areas that would cause property damage or traffic disruption.

Current Hydrologic Engineering Design Reference

National Oceanic and Atmospheric Administration (NOAA) Atlas 14

- Primary source of IDF curves in the United States
- Maryland is in Volume 2, which used observed from in-situ stations available until 2000


NOAA Atlas 14

Precipitation-Frequency Atlas of the United States

Volume 2 Version 3.0: Delaware, District of Columbia, Illinois, Indiana, Kentucky, Maryland, New Jersey, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Virginia, West Virginia

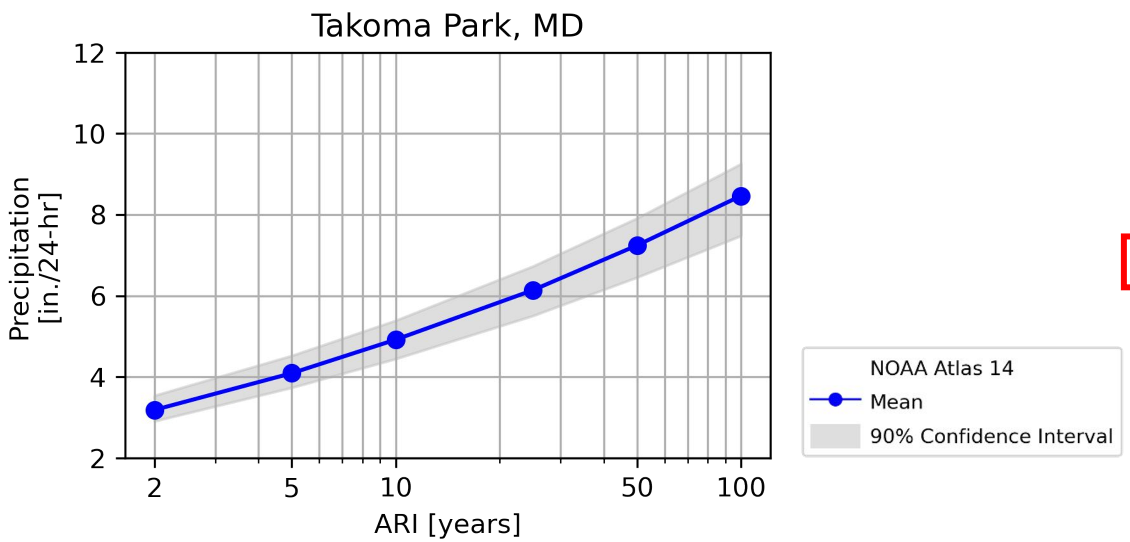
Geoffrey M. Bonnin, Deborah Martin, Bingzhang Lin, Tye Parzybok, Michael Yekta, David Riley

U.S. Department of Commerce

National Oceanic and Atmospheric Administration

National Weather Service

Silver Spring, Maryland, 2004 revised 2006



ARI [years]	**Precipitation** [in./24-hr]
10	4.9
25	6.1
50	7.2
100	8.5

ARI = Average Recurrence Interval or Return Period

Example: Probability of occurrence of 10-yr ARI in any given year is 1/10 = 0.1 = 10%

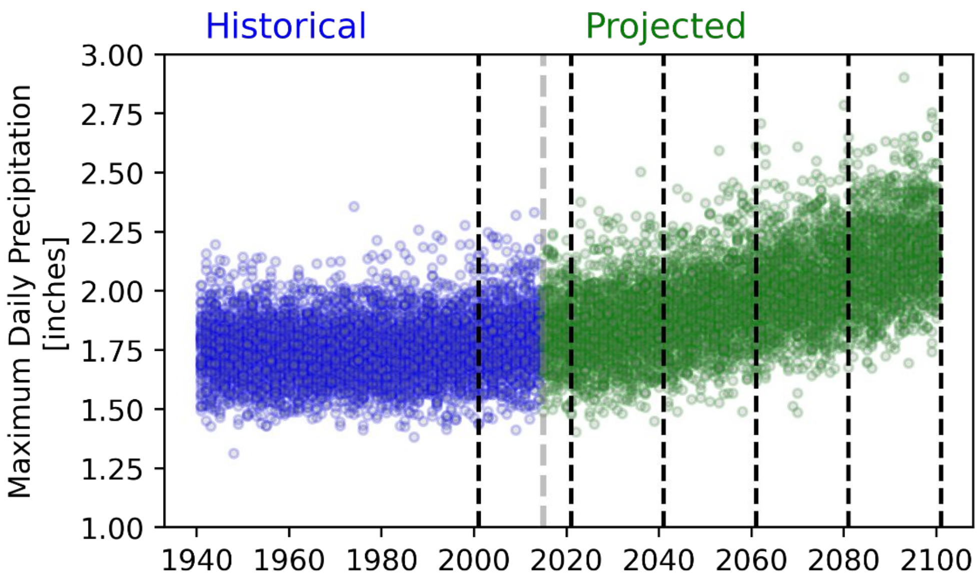
Climate Model Data and Data Processing

Coupled Model Intercomparison Project Phase 6 (CMIP6)

- Most recent protocols for designing and distributing global climate model simulations

Community Earth System Model Version 2 Large Ensemble (CESM2-LE)

- 70 simulations
- 1850-2014 – Historic
- 2015-2100 – Shared Socioeconomic Pathway (SSP) 3-7.0



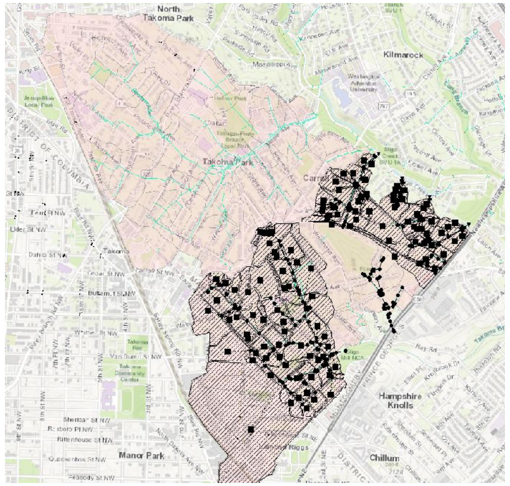
Data Processing

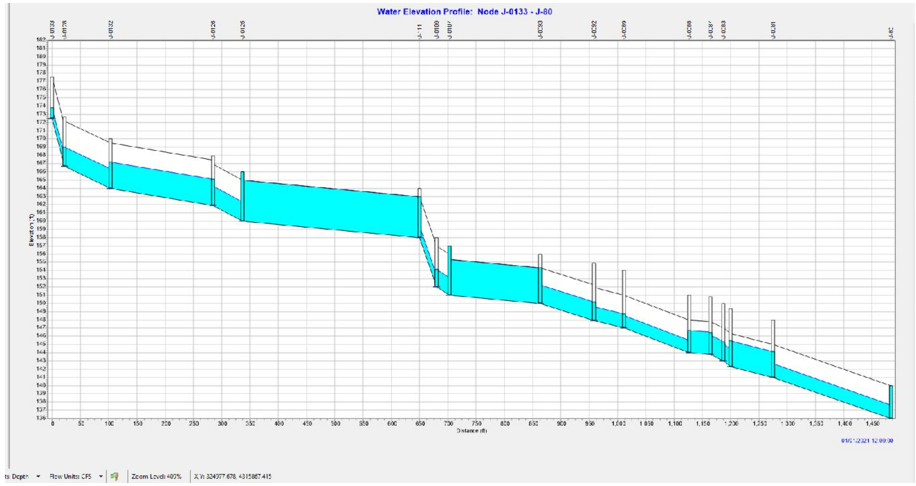
- Reference Period matching NOAA Atlas 14 (1941-2000)
- Projected Periods with 20 years (2001-2020, …, 2081-2100)
- Relative Change between Reference and Projected
- Incorporate change in NOAA Atlas 14

Stormwater Modeling

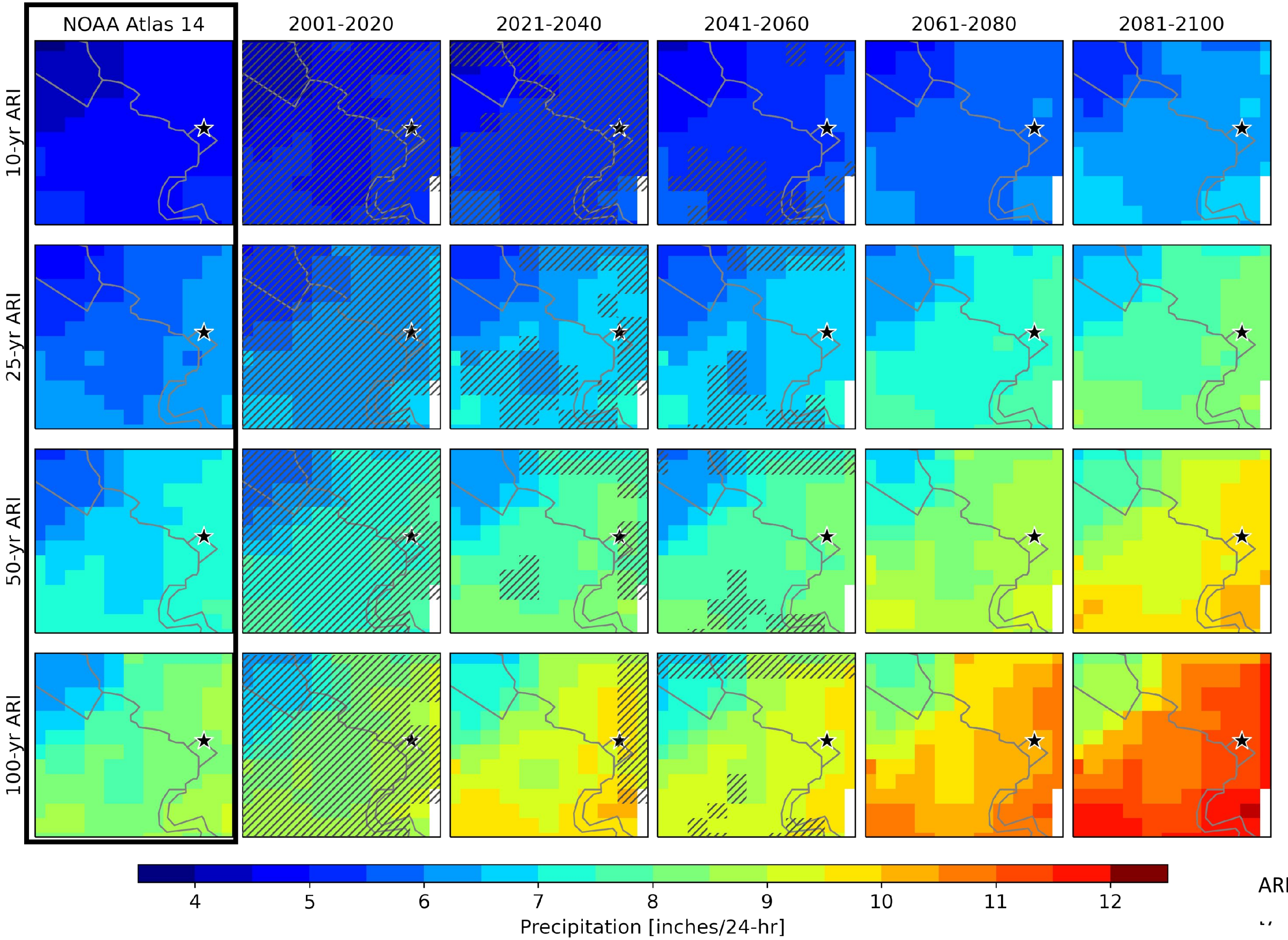
Storm Water Management Model (SWMM)

- Simulate rainfall-runoff process and drainage network hydraulics
- Model calibration using observed data from low-cost sensor
- Storm water system verification for design storm (10-year ARI in 24 hours)
- Prioritization based on overflow duration:
  - **Low** below 30 min
  - **Medium** 30-60 min
  - **High** above 1 hours





Current and Projected Precipitation



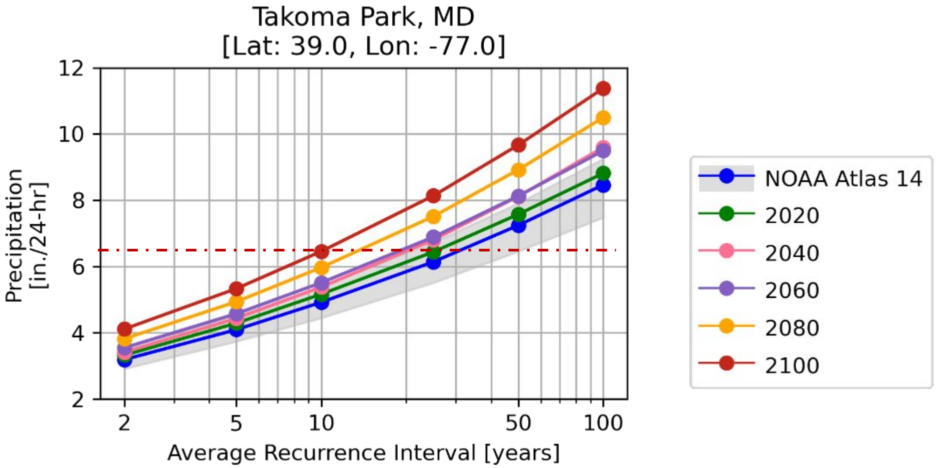
ARI = Average Recurrence Interval
rs]
Projected Precipitation inside 90% Confidence Interval of NOAA Atlas 14

Incorporating Changes in Engineering Design

Percentage Increase of Precipitation in 24 hours

	Average Recurrence Interval (ARI)					
Period	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
2001-2020	4%	5%	5%	5%	5%	5%
2021-2040	7%	8%	9%	11%	12%	13%
2041-2060	11%	12%	12%	12%	12%	12%
2061-2080	20%	21%	21%	22%	23%	24%
2081-2100	29%	30%	31%	32%	33%	34%

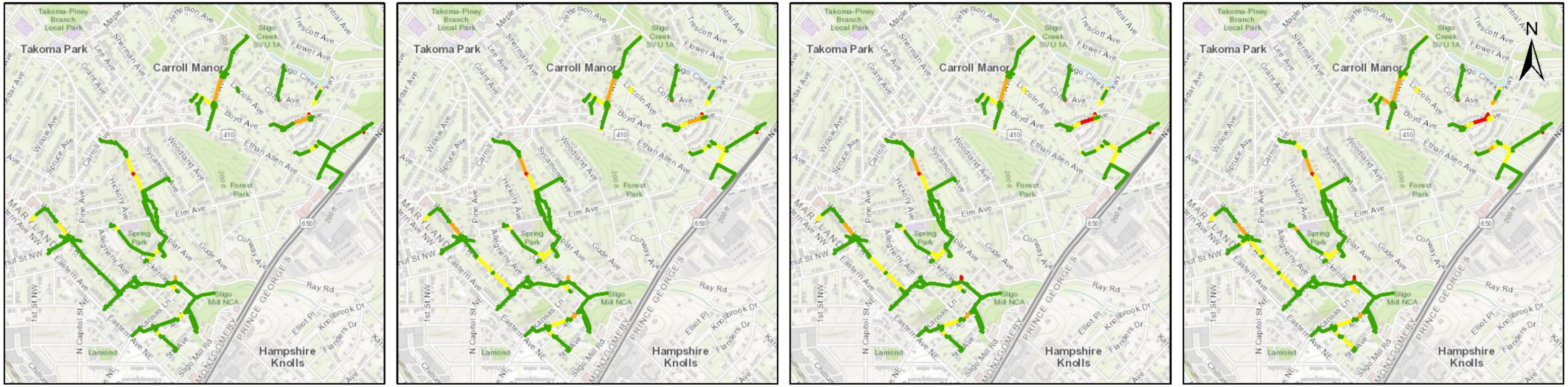
Projected IDF Curves



Stormwater Infrastructure Analysis

10-yr Average Recurrence Interval Precipitation in 24 hours

Current Standard NOAA Atlas 14	2020	2060	2100



- Satisfactory
- Low Priority (0 min < t overflow < 30 min)
- Medium Priority (30 min ≤ t overflow < 1 hour)
- High Priority (1 hour ≤ t overflow)

Community Outcomes

Extreme Precipitation

- Projected increase between 7-13% in 2040 and 29-34% by 2100

Current Infrastructure Design

- Infrastructure in flood prone areas should be verified using updated design storms considering current changes, and assessed for future conditions to identify retrofitting needs

New Infrastructure Projects

- Should incorporate changes in IDF curves based on expected life cycle, and verify for worst case scenarios

Thank you!

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