


Considering Climate Change in Wet Weather Planning

Regional Climate Services Workshop

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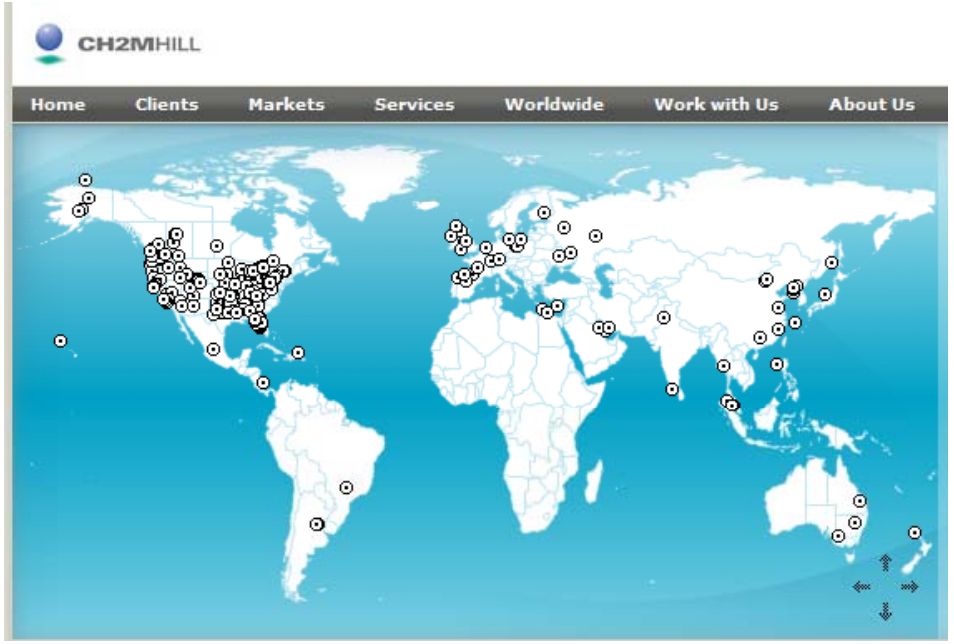
- Water resource planning
  - Water and waste treatment
- Greenhouse Gas Inventory
  - Carbon footprint
- Transportation engineering
  - Design, build
- Energy
  - Traditional, wind, solar
- Environmental
  - Green technology



Climate Change Impacts

Pep Talk - We Are At Critical Climate Juncture…

- Critical Alignment
  - Resources, technology, knowledge
  - Ability to assess, mitigate, or adapt to climate change-driven impacts
  - Local, regional, national, or global scales
- If not us, who?
- If not now, when?
- Small steps all count!

Is Something Important Happening With Respect to Extreme Climate Events?

- IPCC Special Report released on November 18, 2011
- Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX)
- Report addresses historical and projected
  - Temperature extremes
  - Precipitation amount & intensity
  - Drought frequency & intensity
  - Sea level changes & shore erosion
  - Cyclone intensity & frequency
- Focus on managing risks by integration of mitigation and adaption strategies

ipcc
INTERGOVERNMENTAL PANEL ON climate change
WMO UNEP

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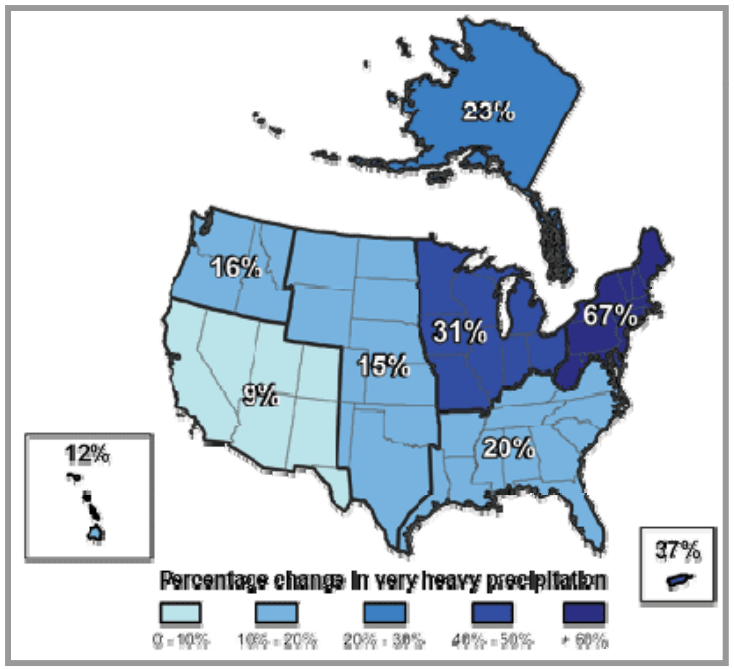
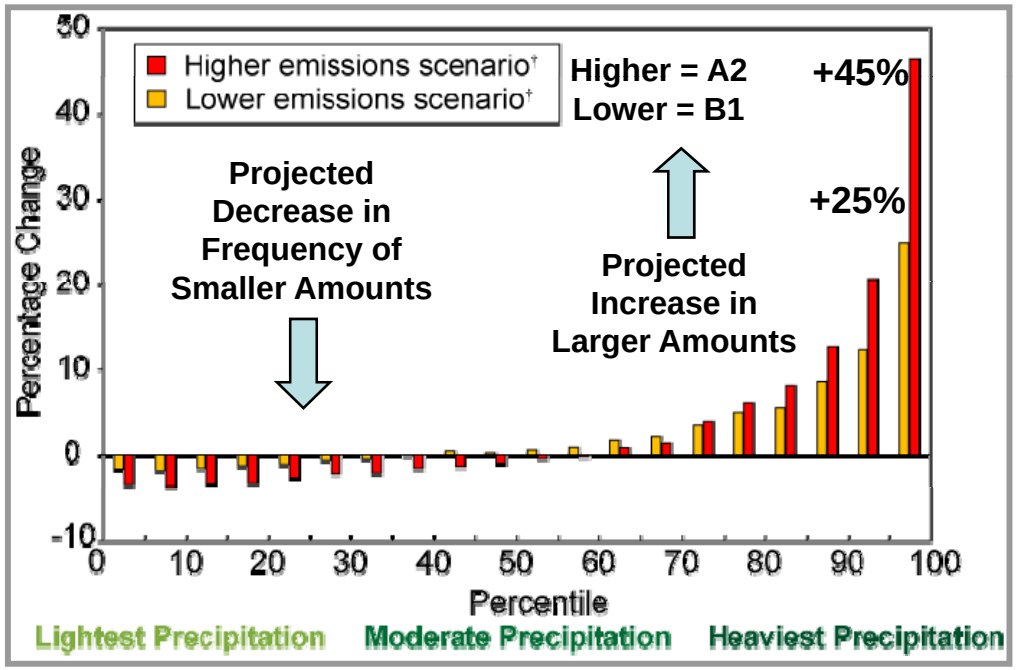
Climate Changes are Underway in the U.S. and are Projected to Grow - Precipitation

Observed Increases in Very Heavy (top 1%) of Daily Precipitation (1958 to 2007)



Projected Change in Precipitation Intensity (2080-2099)



Source: CCSP Unified Synthesis Product: Global Climate Impacts in the United States

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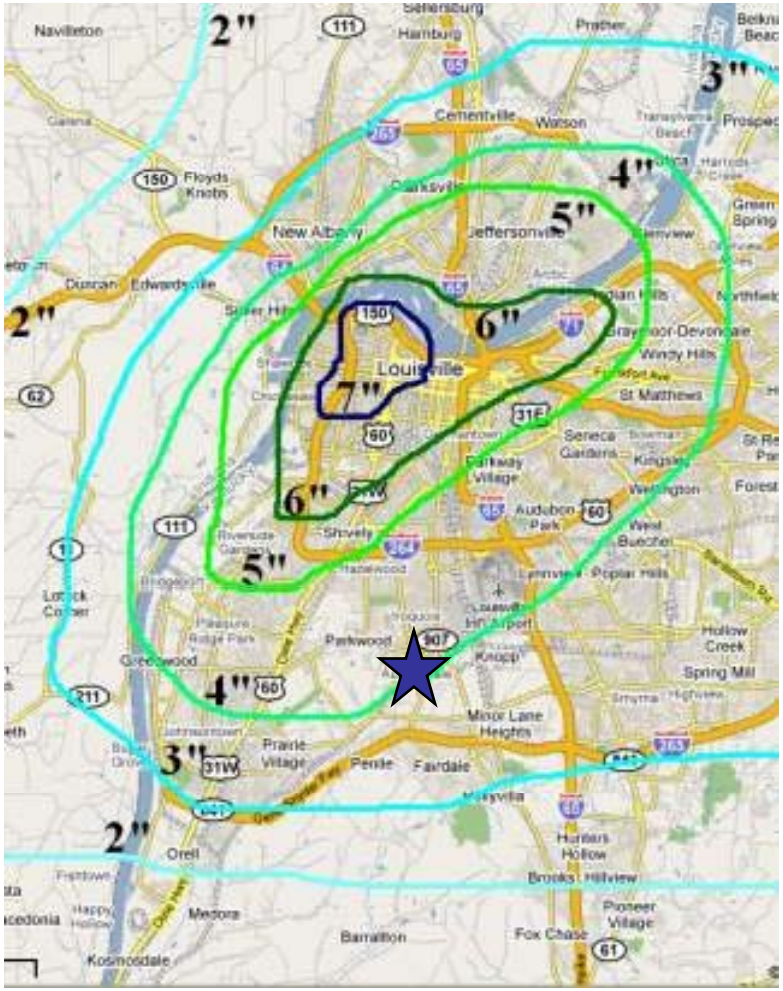
Example Extreme Rainfall Events

Louisville, KY Sept 2009:

- Five inches of rain fell in 90 minutes from 7:45am to 9:15am
- Rainfall rates up to 8.80”/hour
- NOAA Atlas 14 1-hour, 1000-yr return interval amount is 3.83”

Other recent extreme rainfall events:

- Chicago, IL – Two Events
  3.19 1-hr, 6.78 3-hr, 8.20 1-day; 7/23/11
  6.64” 1-day; 9/2008, TS Lowell
- Washington, DC
  11.3” 6-days, 6/2006
- Atlanta, GA
  13” in 1-day, 9/2009
- Providence, RI
  13.6” 30-days, 3/2010
- Nashville, TN
  13.6” 2-days, 5/2010



Source: NWS, Louisville, KY

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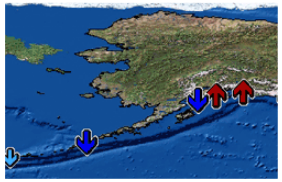
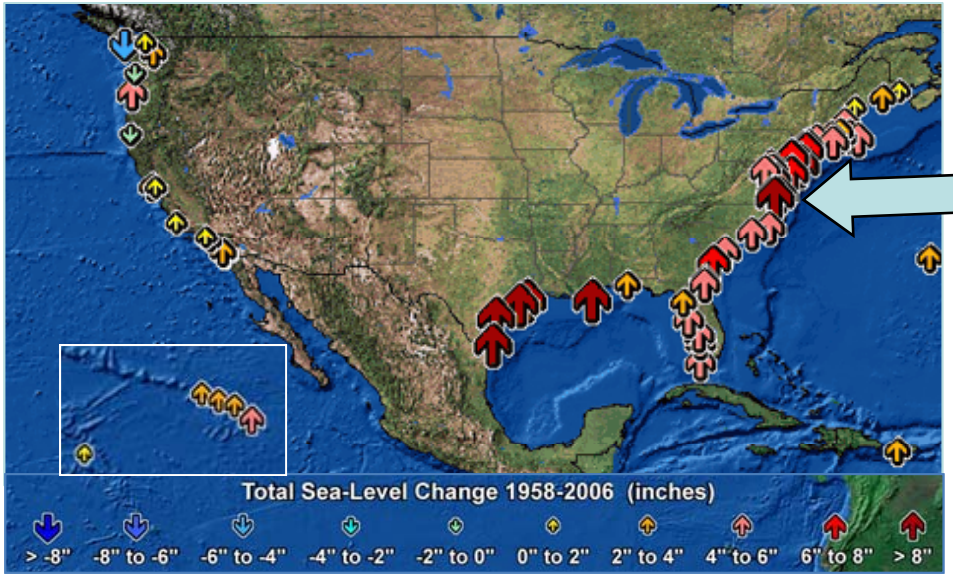
Climate Changes are Underway in the U.S. and are Projected to Grow

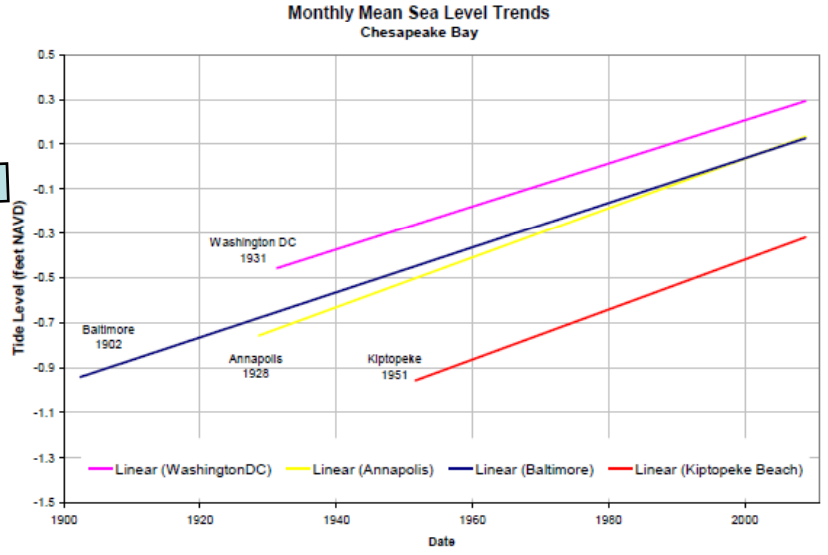


Observed U.S. Sea-Level Changes



Source: CCSP Unified Synthesis
Product: Global Climate Impacts in the United States

Observed Chesapeake Bay Sea-Level Changes



Source: NOAA Tides and Oceans, CO-OPS

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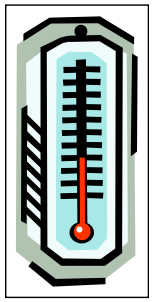
How does Climate Change Impact Management of Built and Natural Environments?



Temp Increase

Droughts and Floods

More Frequent Storm Events

Rising Sea Level

Ocean Acidification

Impacts on…

Source Water

- Regional drought
- Intake elevations
- WQ Issues
- Evaporation
- Groundwater depletion
- Seawater Intrusion

Stormwater

- Localized flooding
- Regional flooding
- Increased CSOs
- Other WQ issues
- Drainage system management

Water Treatment

- Siting elevations
- Sedimentation
- Additional treatment requirements
- WQ issues: algae

Wastewater

- Siting elevations
- Outfall elevations
- Temp-dependent processes
- Receiving WQ

Agriculture

- Evapotranspiration
- Crop yields
- Irrigation demands
- Growing season

Ecosystems

- Marine, freshwater ecosystem collapse
- Widespread species extinctions

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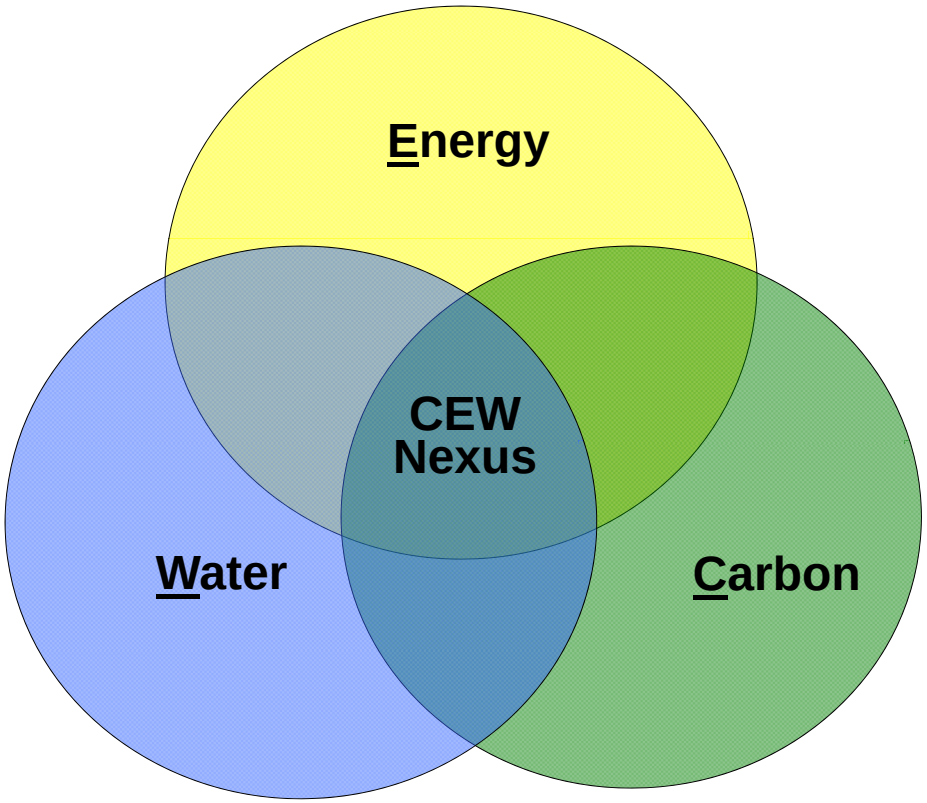
Stakeholder Needs

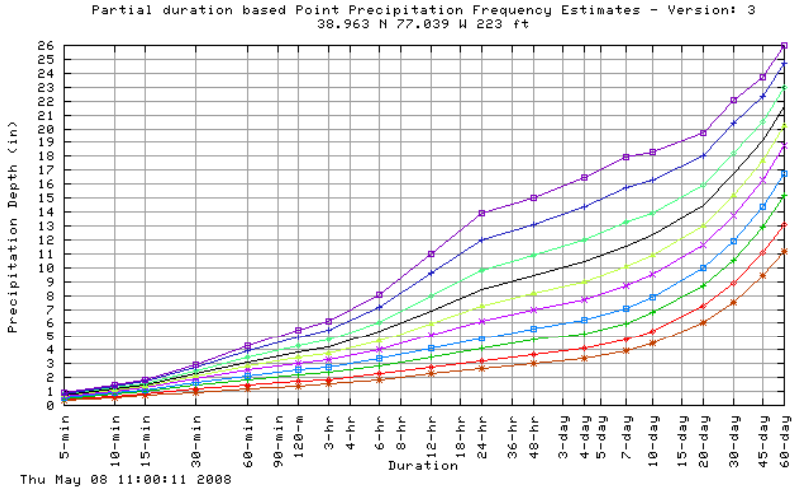
- Stakeholders are demanding sustainable solutions
- Tools to manage water, energy, and carbon under existing and future effects of climate change
- Understanding these linkages, the CEW Nexus, is the key to effective resource management

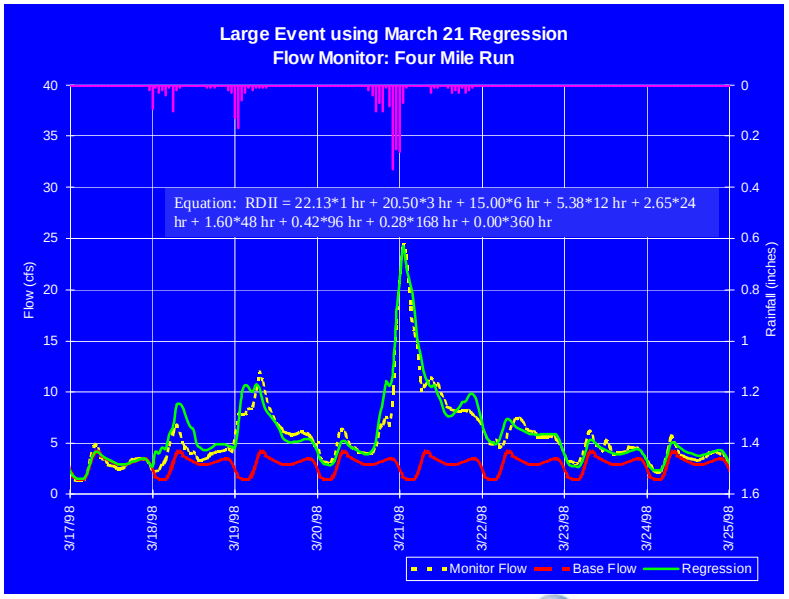


Why Factor Climate Change into Wet Weather Facilities Planning and Design?

- Collection systems, controls and treatment facilities are usually designed for selected peak design storms or representative continuous rainfall patterns based on analysis of the historical record.

- Climate change could alter design criteria resulting in significant over- or under-design of facilities, resulting either in unnecessary capital expense or non-compliance with permits.





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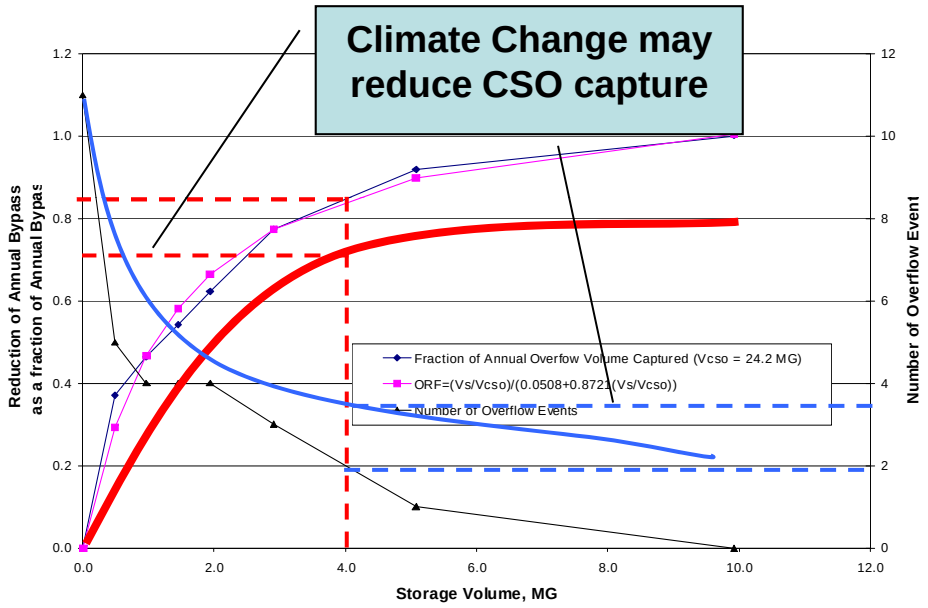
Questions Utility Managers Should be Asking:

- Will changing storm frequencies change design storm criteria for CSO/SSO and stormwater conveyance facilities?
- Consider:
  - Is a "10-year" storm expected to become a "2-year storm“?
  - Is 85% CSO capture expected to become 65% capture?
  - Will 4 discharges per year become 6, 8 or more?
  - Will receiving water quality standards be met within plan life cycles?
  - What are the liabilities for these changing criteria based on climate change?



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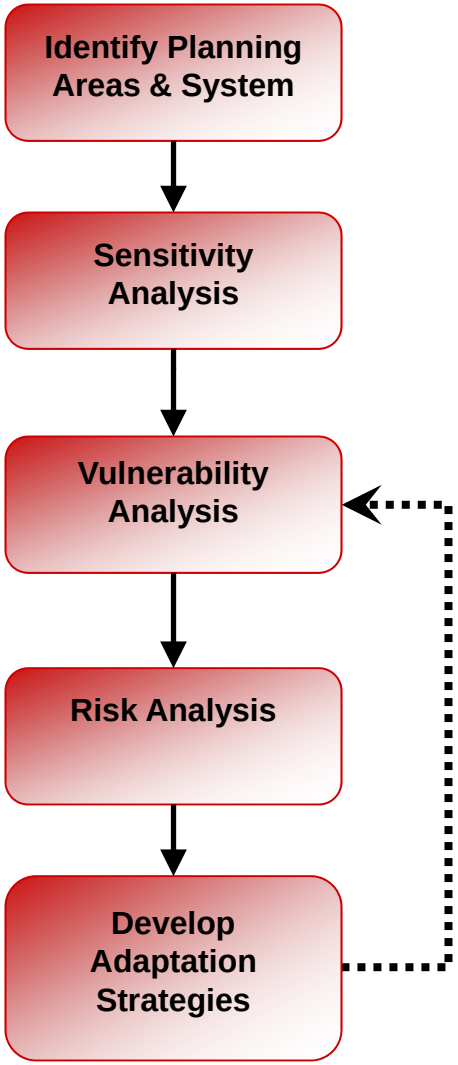
Questions Utility Managers Should be Asking:

- Will rising receiving waters impact system and facility siting, sizing, and performance?
  - Riverine for flooding
  - Estuarine
- Consider:
  - Is your outfall that is now not expected to be submerged going to be partially or fully submerged? More often?
  - What does that rising tail water condition do to your collection systems and facilities?
  - Will your facilities need to be flood-proofed or moved?

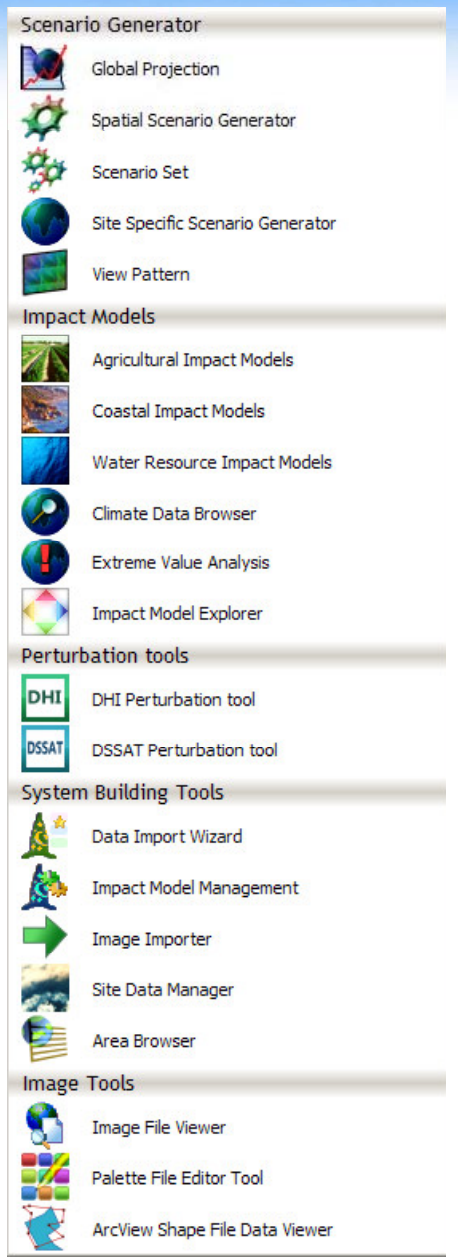
Climate Change
Vulnerability & Risk Assessment

1. **Identify Planning Area, System, and Components:**
   - Establish context or “fenceline” for evaluating risk
   - Review historical climate information
2. **Sensitivity Analysis:**
   - How sensitive is the “system” to climate change?
3. **Vulnerability Analysis:**
   - How much climate change can the system accommodate? Reservoir resilience?
4. **Risk Analysis:**
   - What is the importance of the impact (consequence) and probability of occurrence (probability)?
   - Risk = (consequence * probability)
5. **Develop / Implement / Monitor Adaptation Strategies:**
   - Mechanisms to reduce risk
   - Monitor system performance



SimCLIM Technology

- SimCLIM developed by CLIMsystems, NZ:
  - SimCLIM is a PC-based application
  - Seamlessly integrates observed data, SRES emission scenarios, and general circulation model (GCM) results to create temperature, precipitation, and sea level rise scenarios –
  - CMIP3, CMIP5, BCSD (Maurer, Wood), monthly / daily GCMs
  - Generates daily time series of baseline and future temperature, precipitation, rainfall return frequencies and amounts
  - Results exported into applications; REF-ET, Excel, and ArcGIS formats
- CH2M HILL / CLIMsystems North America Strategic Alliance Partners



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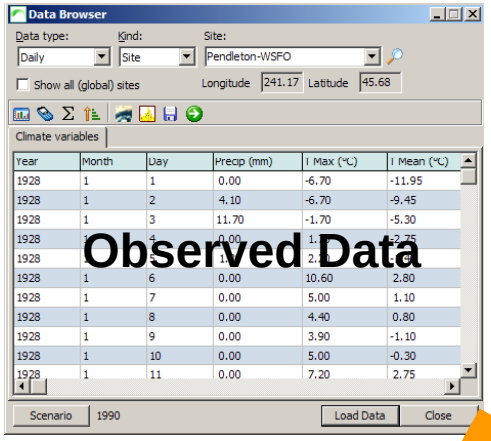
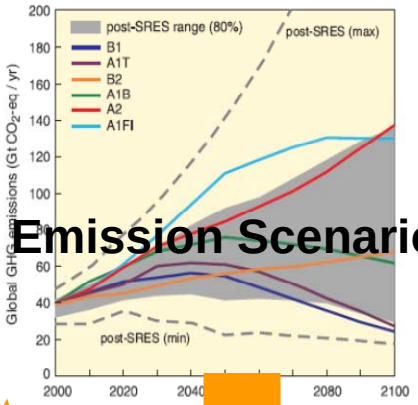
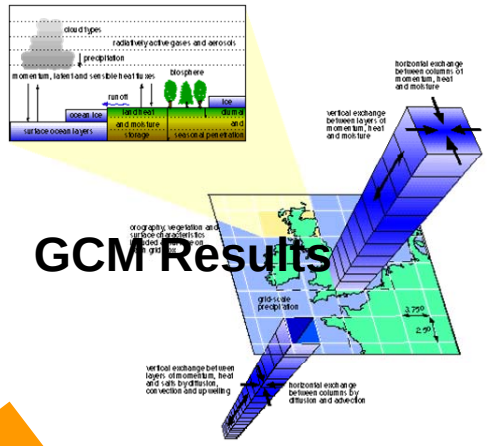
SimCLIM Input and Output



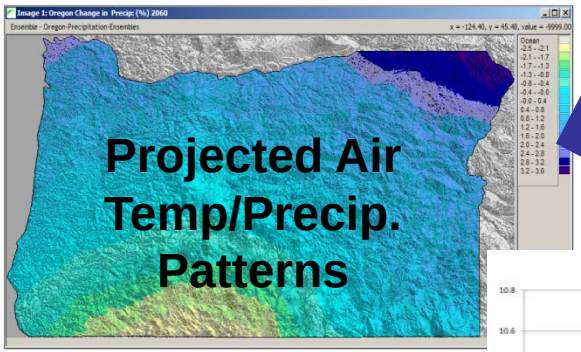
Observed Data



Emission Scenarios



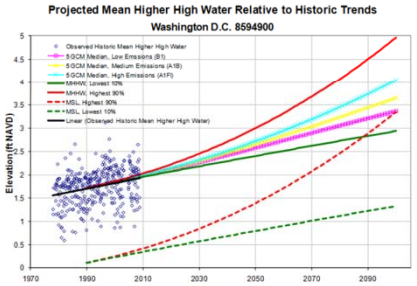
GCM Results

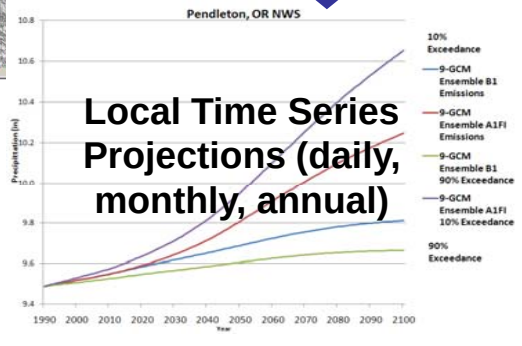


Projected Air Temp/Precip. Patterns

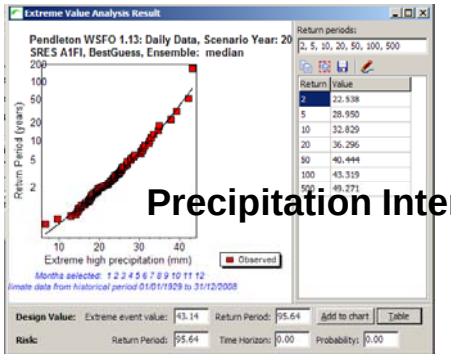
SimCLIM

Sea Level Rise





Local Time Series Projections (daily, monthly, annual)



Precipitation Intensity

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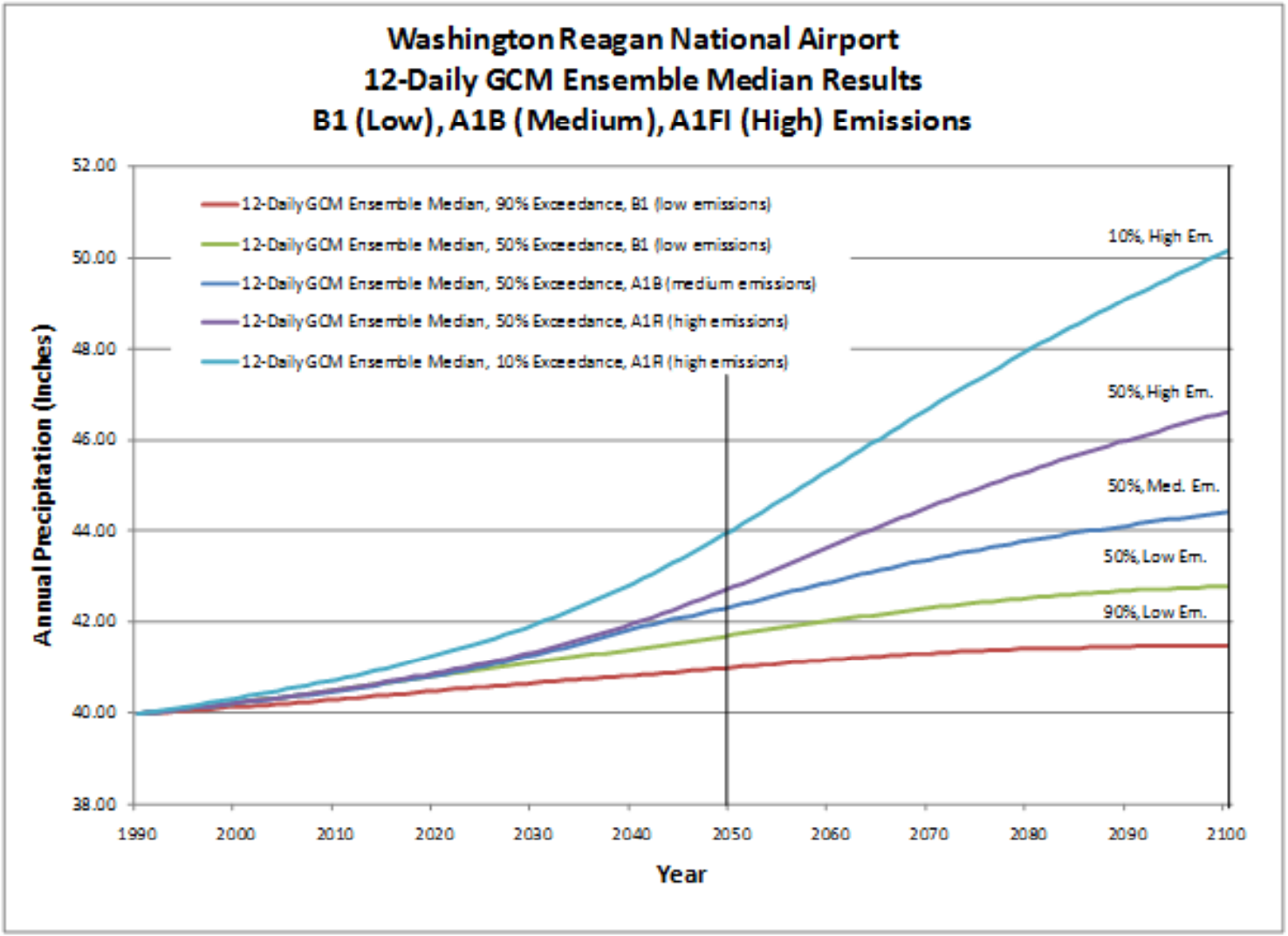
Projected Annual Precipitation for CC Scenarios

(Reagan National Airport, DC)



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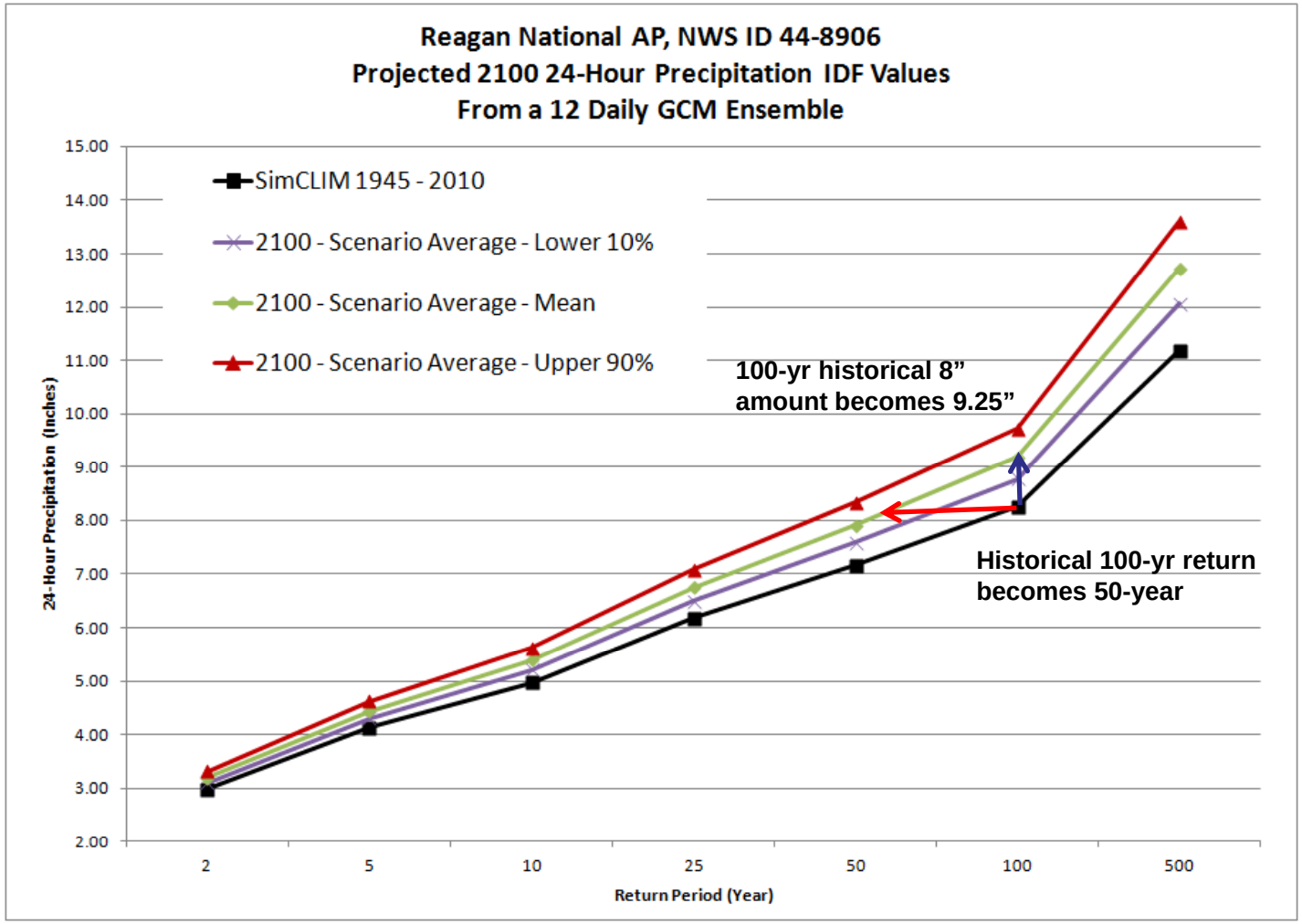
Projected Changes in Precipitation Intensity Duration, Frequency (IDF) for Washington Reagan National Airport for Year 2100



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Sea Level Rise Risk Assessment

- Provide the City of Alexandria with a range of potential sea level rise (SLR) conditions based on appropriate climate change scenarios
- Analyze historical records for trends and uses the GCM-derived SLR projections to quantitatively determine specific SLR in Chesapeake Bay and the Potomac River near Alexandria
- Incorporate subsidence, historical trends, and AOGCM sea level rise projections

Rates of SLR (ft/century) for the Chesapeake and Delaware Bays Region.
Data from tide gages and data record shown in parenthesis.
Source: The Maryland Commission Climate Change

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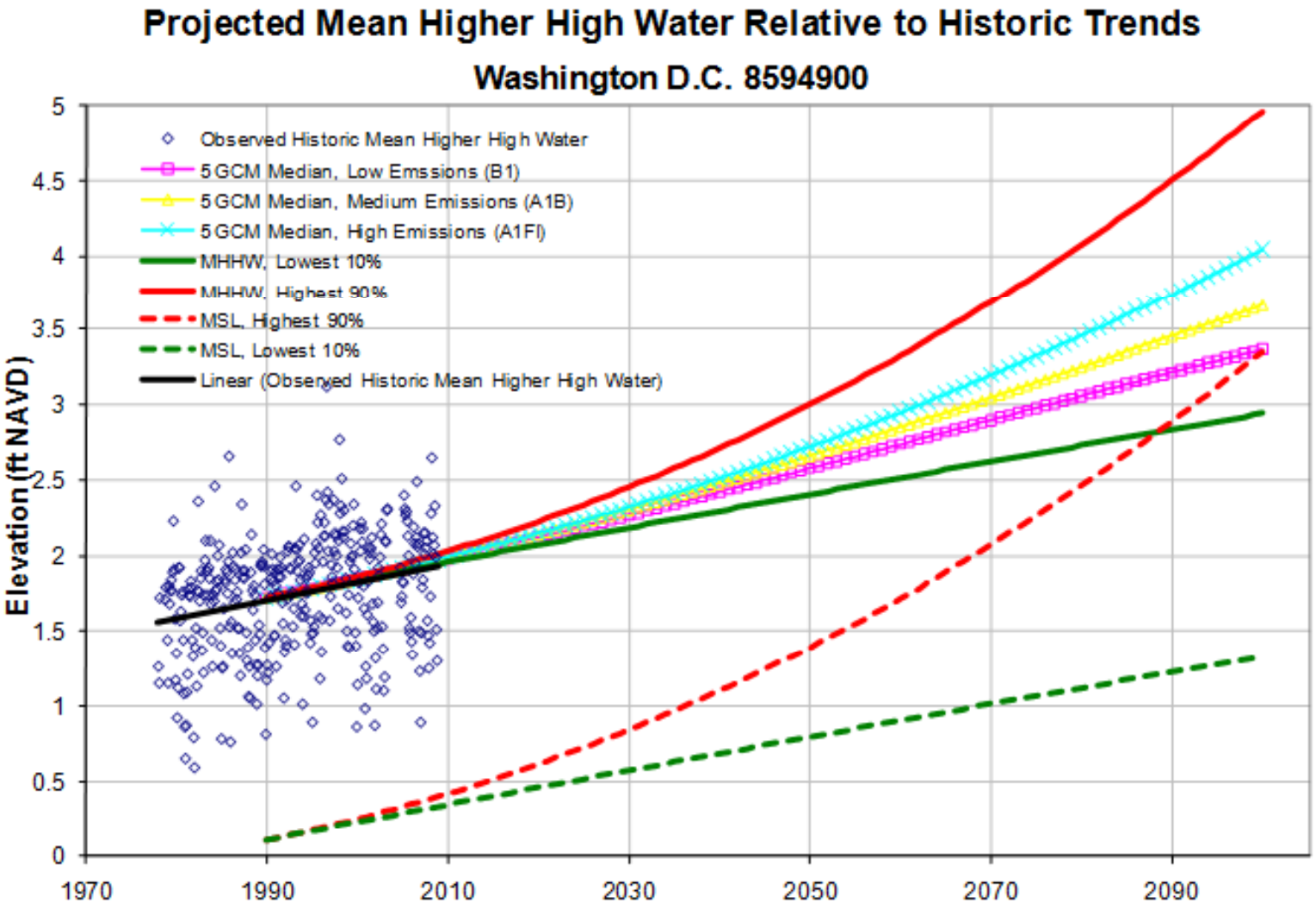
SimCLIM-Derived Projection of Mean Higher High Water Levels (1990-2100) Relative to Observed Historic Values and Trend (1978-2008)



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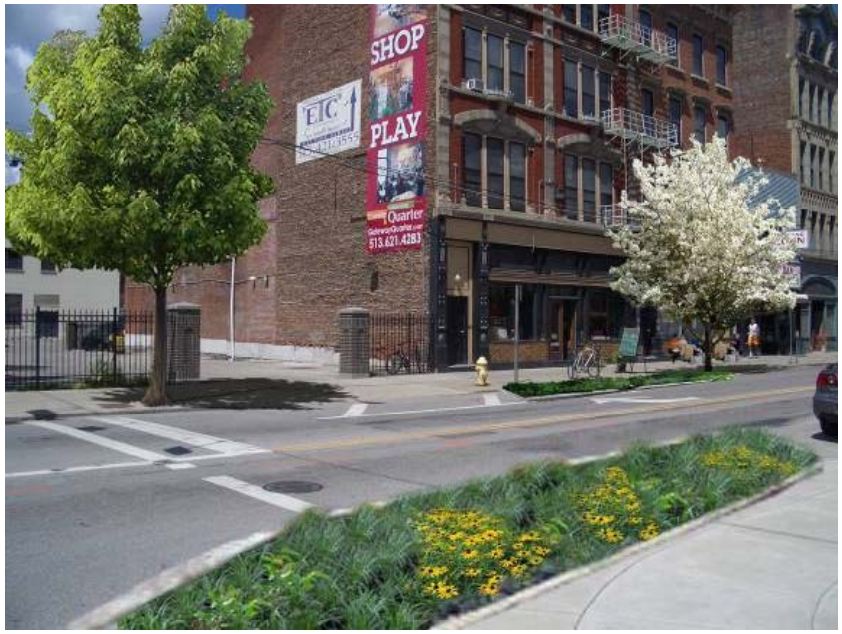
Adaptation Strategies



- Build Resiliency into Systems
  - System modification
  - Capacity expansion
  - Flood proofing
  - Relocating facilities
- Grey vs. Green:
  - Large capital projects build long-term resiliency into systems
  - Green infrastructure alternatives that reduce stormwater runoff and the sizes of tunnels, interceptors and storm sewers (the plumbing), can be implemented over the long term to adapt to changes.

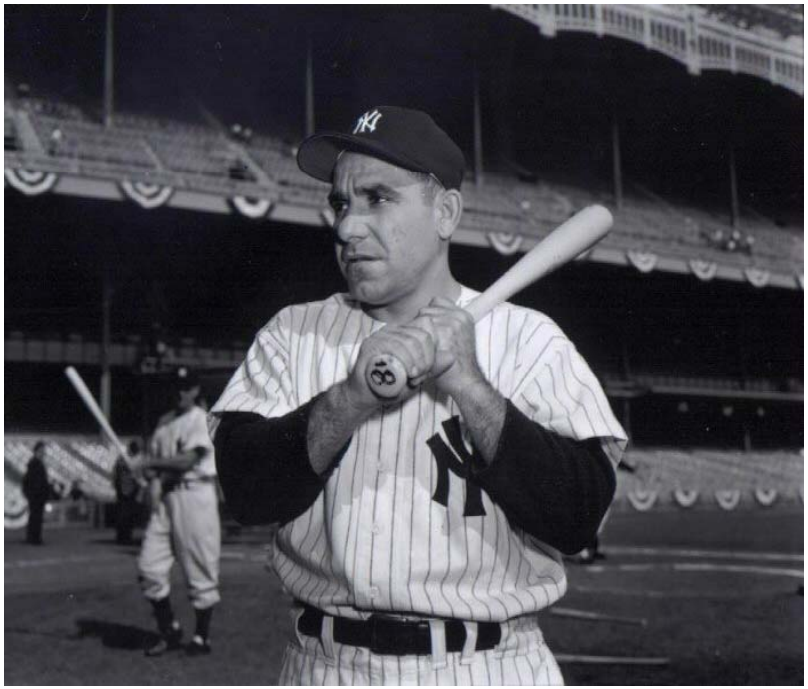
Yogi Berra On Climate

Climate Stationarity

"The future ain't what it used to be."

Future Climate

"I wish I had an answer to that because I'm tired of answering that question."



Yogi Berra

Thank You!

Questions?

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