

# Wastewater Infrastructure Climate Change Adaptation

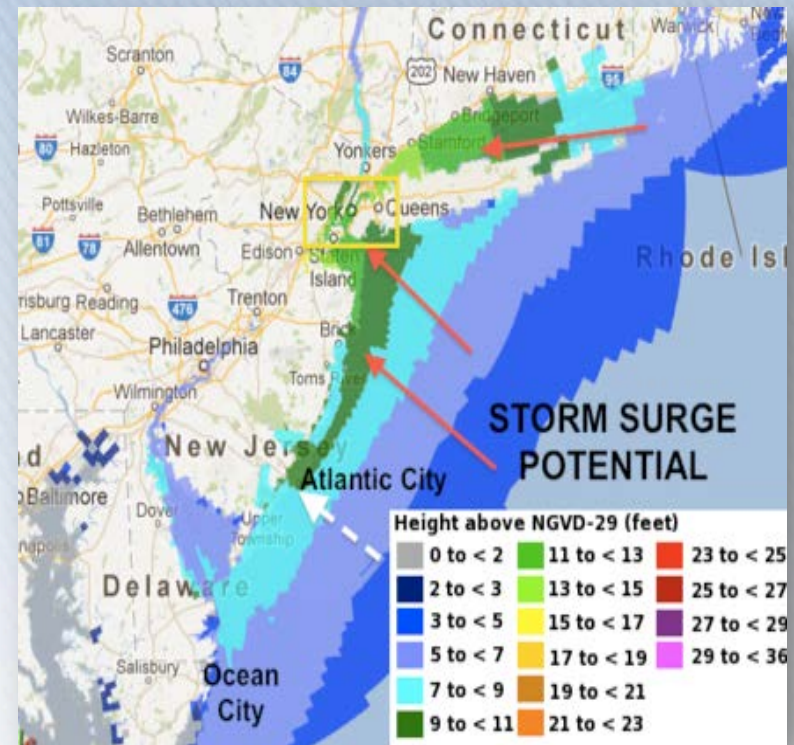
**NEWEA Spring Convention  
June 9, 2015**

Presented by:  
John W. Braccio, PE

**WRIGHT-PIERCE**   
Engineering a Better Environment

# Climate Change Issue?

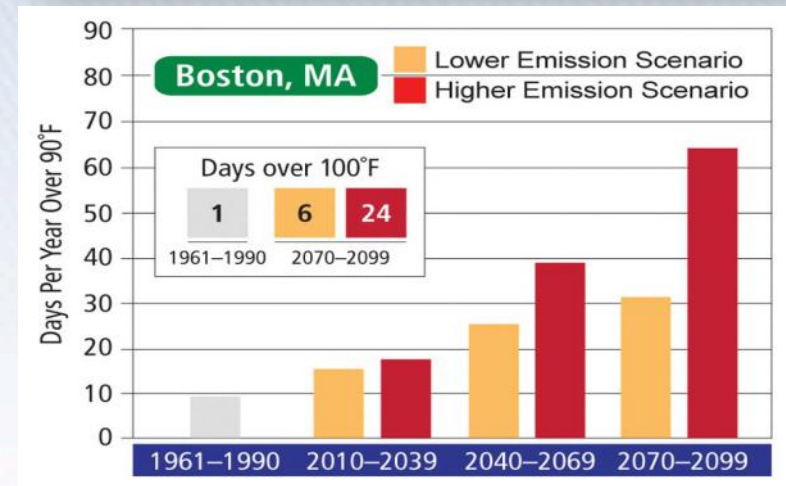
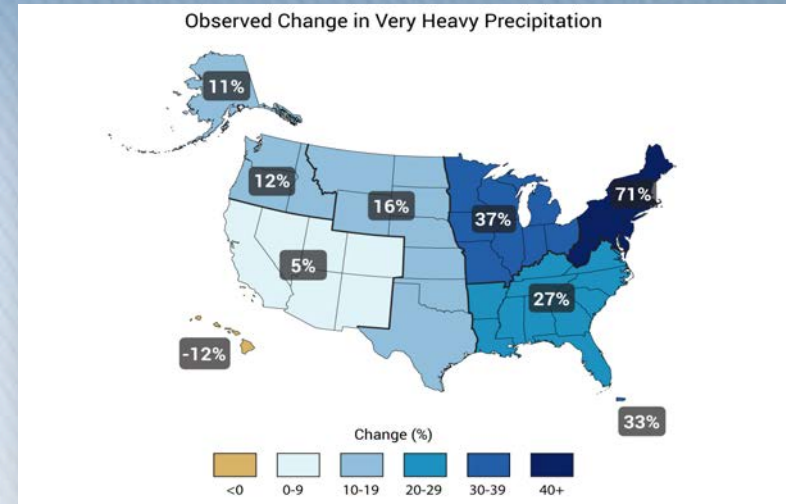
- ongoing debate about causes & future trends
- the data is the data.
- obligation for reliable wastewater infrastructure





# Climate Change Impacts

- increased precipitation
- temperature changes
- increased storm intensities
- Sea Level Rise (SLR)
- combination of Storm Surge and SLR



# Vulnerability Examples – Storm Intensity & Flooding

- extreme rain events
  - flooded WPCFs & PSs
- extreme wind & ice storm events
  - loss of power to WPCFs & PSs
- Hurricane Irene – August 2011
  - VT – 17 WPCFs
  - NY – 52 WPCFs





# Vulnerability Examples – Sea Level Rise & Storm Surge

- Hurricane Sandy - October 2012
- 11 BG overflows
- DC to RI
- 1/3 untreated
- \$3B damages
- 17 facilities in NE



# Adaptation Planning for Climate Change

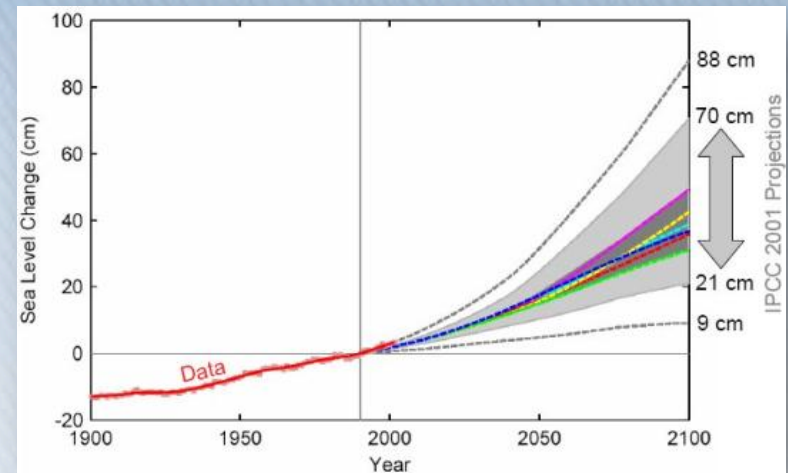
- wastewater facilities plans
  - capital improvements
- enhanced O&M procedures
  - ensure reliability
  - wet weather SOPs
- asset management plan
  - long-term prioritized CIP & budgeting plans





# Overall Process

1. Determine flood/SLR/storm surge scenarios
2. Identify vulnerable assets
3. Determine economic, health & environmental impacts
4. Evaluate alternatives & costs
  - maintain asset operational with temporary provisions
  - repair asset
  - capital improvements to avoid future impact
5. Rank & prioritize alternatives
  - Cost-benefit analysis



# Step 1.

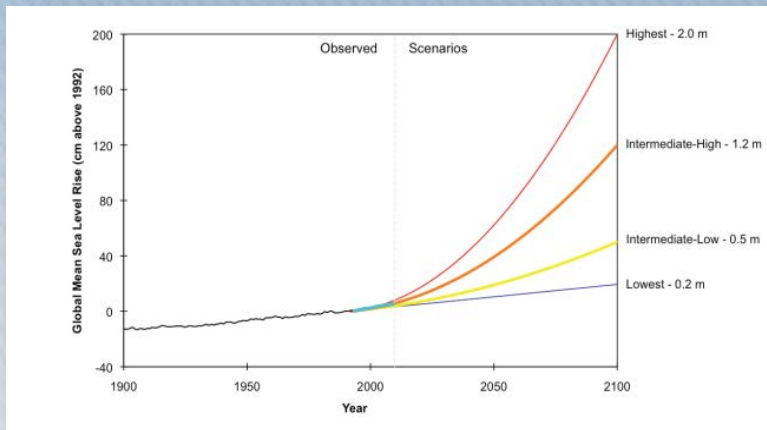
## Select study criteria

- consider multiple scenarios
- storm surge/flooding projections & frequency
- other contributing flooding issues
- determine planning horizon
- consider process and stakeholders

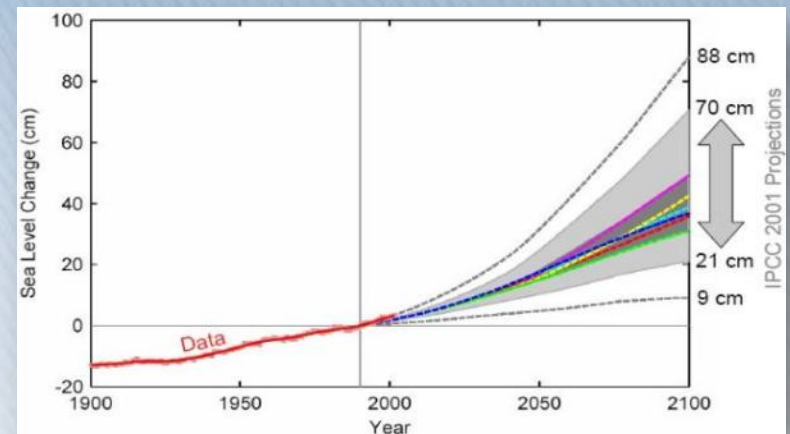




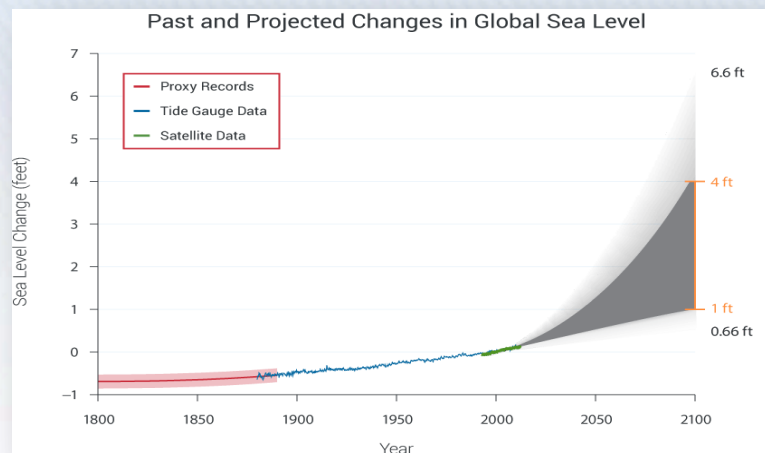
# What should we use for base SLR elevations?



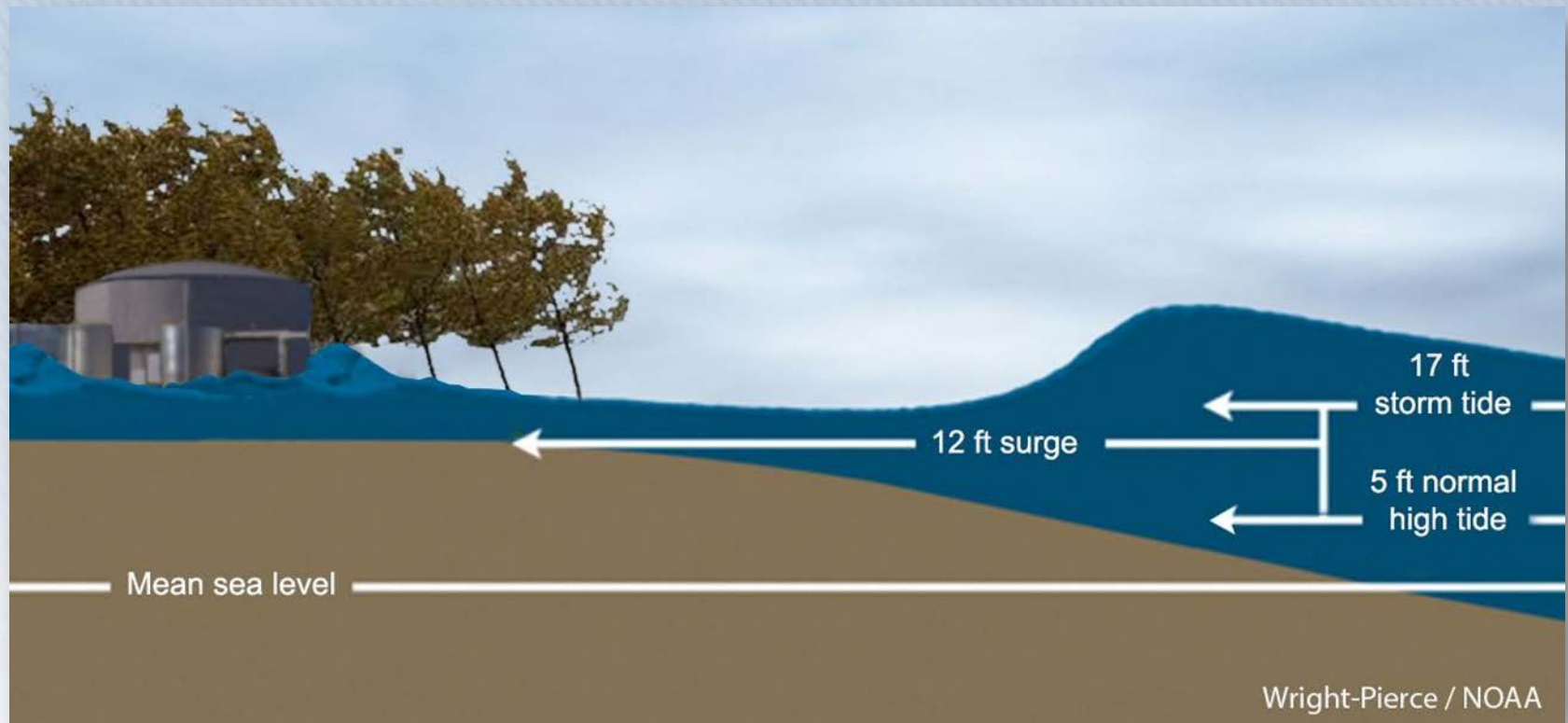
U.S. Global Change Research Program (USGCRP)



Intergovernmental Panel on Climate Change (ICCP)



# What is Storm Surge?





# Access to Storm Surge & Flooding Data

- National Weather Service (NWS) SLOSH model
  - inundation for different hurricane wind categories at high tide
- FEMA – Flood Insurance Flood Mapping (FIRM)
  - Special Flood Hazard Areas (SFHA)
  - 100-year storm elevations
  - regulated floodways
- variety of other sources (USGCRP, IPCC,)



FEMA



# Step 2.

## Identify Vulnerable Assets

- typically infrastructure in low-lying areas
- sewers
- pump stations
- WPCF's
- CSO facilities
- other facilities?





# Impacts to Sewers

- inflow via manhole covers
- inflow into combined sewers at catch basins
- backup through CSO discharge points
- inflow via roof drain leaders
- discharge from sump pumps
- damage from coastal erosion



# Impacts to Pump Stations

- flow entering hatches
- flow entering doors
- water in control panels
- inundation of generators
- electrical/control conduits
- accessibility?





# Impacts to WPCFs

- overtopping tank walls
- flow through doors
- inundation of generators
- water intrusion into electrical/ control conduits
- outfalls (increased head on discharge)
- temperature?
- accessibility?



Photo taken April 2010 by WSA Superintendent  
Janine Burke



# Determine Vulnerable Assets

- confirm elevations of existing facilities
  - Record Drawings/As Built
  - LiDAR Mapping (USGS)
  - pay attention to the datum!
    - ◆ NGVD 29
    - ◆ NAVD 88
    - ◆ local datum?
  - conversion can be tricky
- compare to flood & surge elevations





# Step 3.

## Evaluate Impacts:

- non-compliance/ environmental impacts
  - water quality impacts
  - petroleum & other hazards
- public health/safety
- catastrophic damages
  - costly
  - cleanup
  - electrical, controls, motors
  - equipment & building systems
  - consider repetitive losses



# Environmental Impacts associated with Sea Level Rise & Storm Surge

- Hurricane Sandy resulted in over 11 billion gallons of CSO's, SSO's and discharge from flooded wastewater facilities
- For context, that's more than ten times the total annual CSO volume for the state of Maine



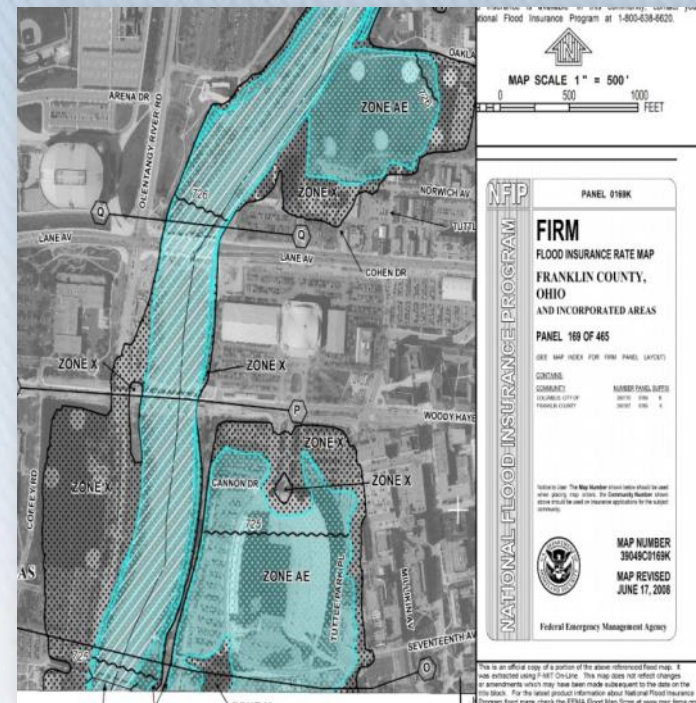


# Step 4.

## Evaluate Alternatives & Costs

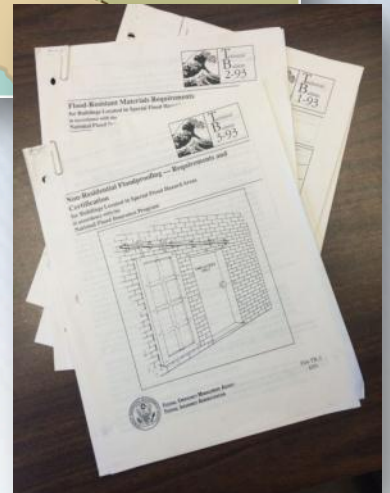
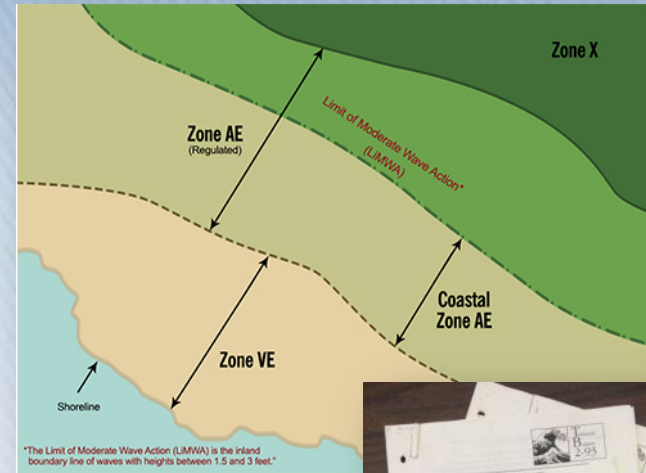
### Adaptation Scenarios:

- facilities operational during 100 year event
- safely accessible during 100 year event
- pending TR-16 Standards for Climate Change Adaptation?
- Challenge: The benchmark for what constitutes a 100 year event is in flux



# FEMA Guidelines

- flood-proof non-residential structures
- flood doors
- berms/levees
- elevate electrical components
- flood damage resistant materials
- resist hydrostatic pressure and uplift
- raise facilities above 100-year flood elevations





# Other Regulatory Constraints

local level:

- shoreland zoning
- municipal site plan review

state level:

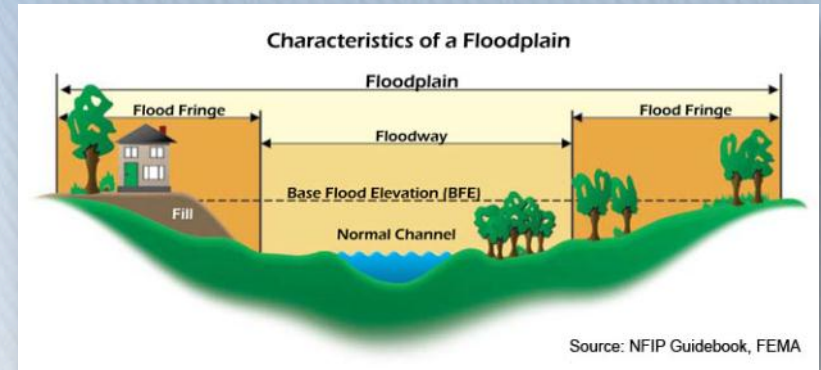
- Natural Resource Protection Act

# federal Level

- NEPA

# EO 13690

- **2' – “non-critical” facilities**
- **3' – “critical” facilities**



# Adaptation Alternatives for Sewers

- watertight manhole covers
- sewer replacement/lining
- separation of combined sewers
- backflow prevention at CSO discharge points
- separate roof drain leaders
- separate sump pumps
- assess potential for damage from coastal erosion
  - re-route sewers





# Adaptation Alternatives for Pump Stations

- construct berms/levees
- raise facilities
- install watertight doors/hatches
- raise or otherwise protect electrical components
- address accessibility?



# Adaptation Alternatives for WPCF's

- construct berms/levees
- raise facilities
- increase height of tank walls
- install watertight doors/hatches
- raise or otherwise protect electrical components
- provide pumping capability for effluent discharge/outfall
- address accessibility?





# Step 6.

## Rank and Prioritize Alternatives

- Cost-Benefit Analysis:
  - capital costs for repair, upgrade or replacement
  - O&M costs
  - remaining life of asset
  - compare impacts to costs for alternative
  - probability of risk scenarios
- impact to user fees
- rank & prioritize alternatives



# Examples of Adaptation Components

## Old Orchard Beach, ME – West Grand Pump Station

- flood doors
- generator enclosure
- sewer improvements





# Examples of Adaptation Components

## Ogunquit, ME - WPCF

- existing berm and sheet pile barrier
- range of options
- regulatory constraints



# Examples of Adaptation Components

Portland, ME -

- Back Cove South CSO
- 3.5 MG CSO tank
- design for inundation





# Examples of Adaptation Components

## Mattabassett WPCF

- effluent pump station
- outfall tide valves



# Examples of Mitigation Components

## Portland, CT – Indian Hill Pump Station

- inaccessible during flooding
- relocated up-gradient
- deep sewer, adverse to grade





# Examples of Mitigation Components

## Glastonbury, CT - WPCF

- flood control levee
- stormwater pumping station



# Examples of Mitigation Components

## Norwalk, CT – Sammis St Pump Station

- flooded by Sandy
- redesigned for resilience
- coordination with residents





# Examples of Mitigation Components

## Fairfield, CT POTW

- starting evaluation
- flooded by Sandy
- impact of storm tides on outfall hydraulics



# Examples of Mitigation Components:

## Stamford, CT - WPCF

- flood protection berms
- stormwater pump stations
- provided a high level of protection during Sandy





# Take Home Message

- many wastewater utilities will be subject to climate change impacts
- develop long-term adaptation plans:
  1. identify climate change scenarios
  2. identify assets at risk
  3. identify impacts
  4. evaluate interim and long term adaptation alternatives
  5. develop cost-benefit and prioritized ranking of alternatives





# Questions & Discussion

**Thank you!**