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Factoring the Impacts of Climate Change into Combined Sewer Overflow Mitigation

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Climate is changing

- Warming of the climate system is unequivocal as is evident from:
  - increases in global average air and ocean temperatures (~0.74^{o}C/century)
  - widespread melting of snow and ice
  - rising global average sea level (since 1961 ~ 1.8 mm/yr)

- Regionally variable changes have occurred in the amount, intensity, and form of precipitation during the last century
  - consistent with a “intensification” of the hydrologic cycle

- Trends expected to continue in the coming century; in northeast (UCS 2006)
  - temperature increase ~ 4-6°F by mid-century
  - precip increase ~ 10% by end of century
  - precip intensity increase ~ 8% by mid-century

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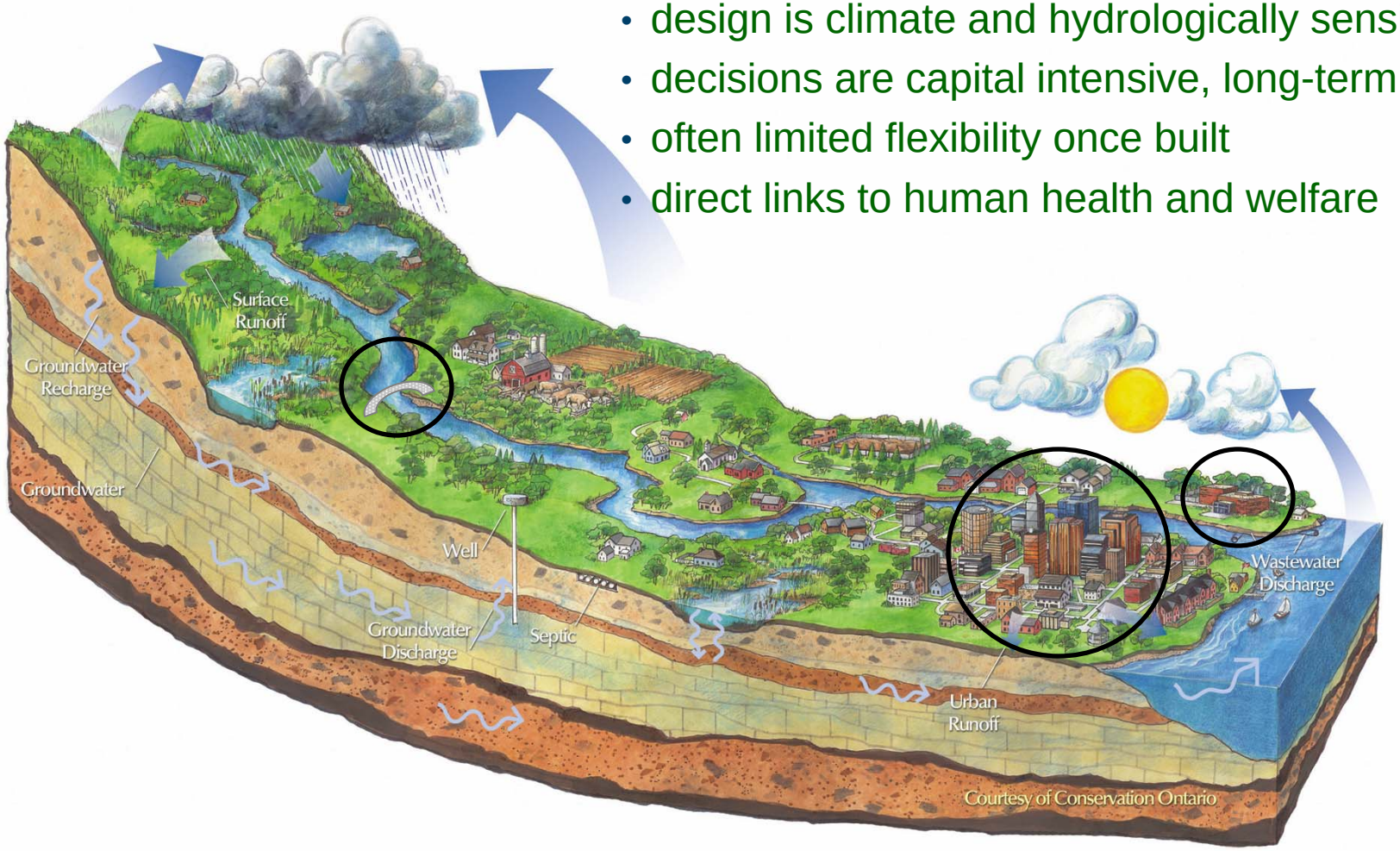
Water and watershed systems are highly vulnerable to these changes

Water infrastructure is a particular concern

- design is climate and hydrologically sensitive
- decisions are capital intensive, long-term
- often limited flexibility once built
- direct links to human health and welfare



Climate change and CSOs

- CSOs and CSO mitigation are an important water quality issue in the northeast

- CSS performance is also highly climate sensitive:
  - more precipitation results in more runoff
  - more intense precipitation results in quicker runoff
  - changes in snowfall/snowmelt affect rates and timing of runoff

… changes can lead to changes in CSO frequency and severity

U.S. combined sewer systems

Questions to consider

What are the potential impacts of climate change on CSOs and CSO mitigation?

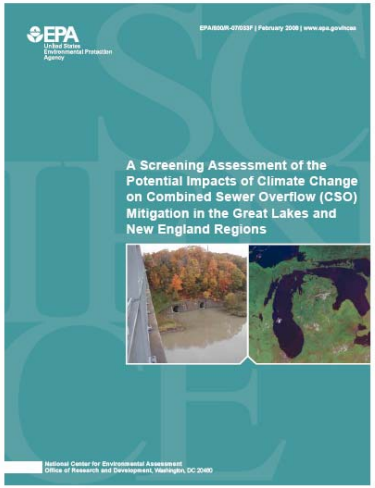
Will mitigation strategies based on current conditions be adequate to meet CSO goals in the future?

When are impacts likely to occur?

What can be done to manage any increase in risk?

What are the potential impacts?

- Impacts will vary in different locations and for different systems; but relatively little is known
- As a first step to understanding the problem, EPA conducted a screening-level assessment



"A screening-assessment of the potential impacts of climate change on CSO mitigation in the Great Lakes and New England regions"

Approach

- Assumed each CSO community will implement mitigation to meet the 4-event-per-year presumption standard based on historical precipitation

- Acquired historical and projected future daily precipitation data from VEMAP
  - future projections from 2 GCM models; Hadley and Canadian Center Models
  - data spatially interpolated to a 1° resolution grid

- Calculated the “benchmark” daily precipitation event (depth) that occurs 4 times per year at each VEMAP grid location
  - using historical climate
  - using future climate projections from each GCM model

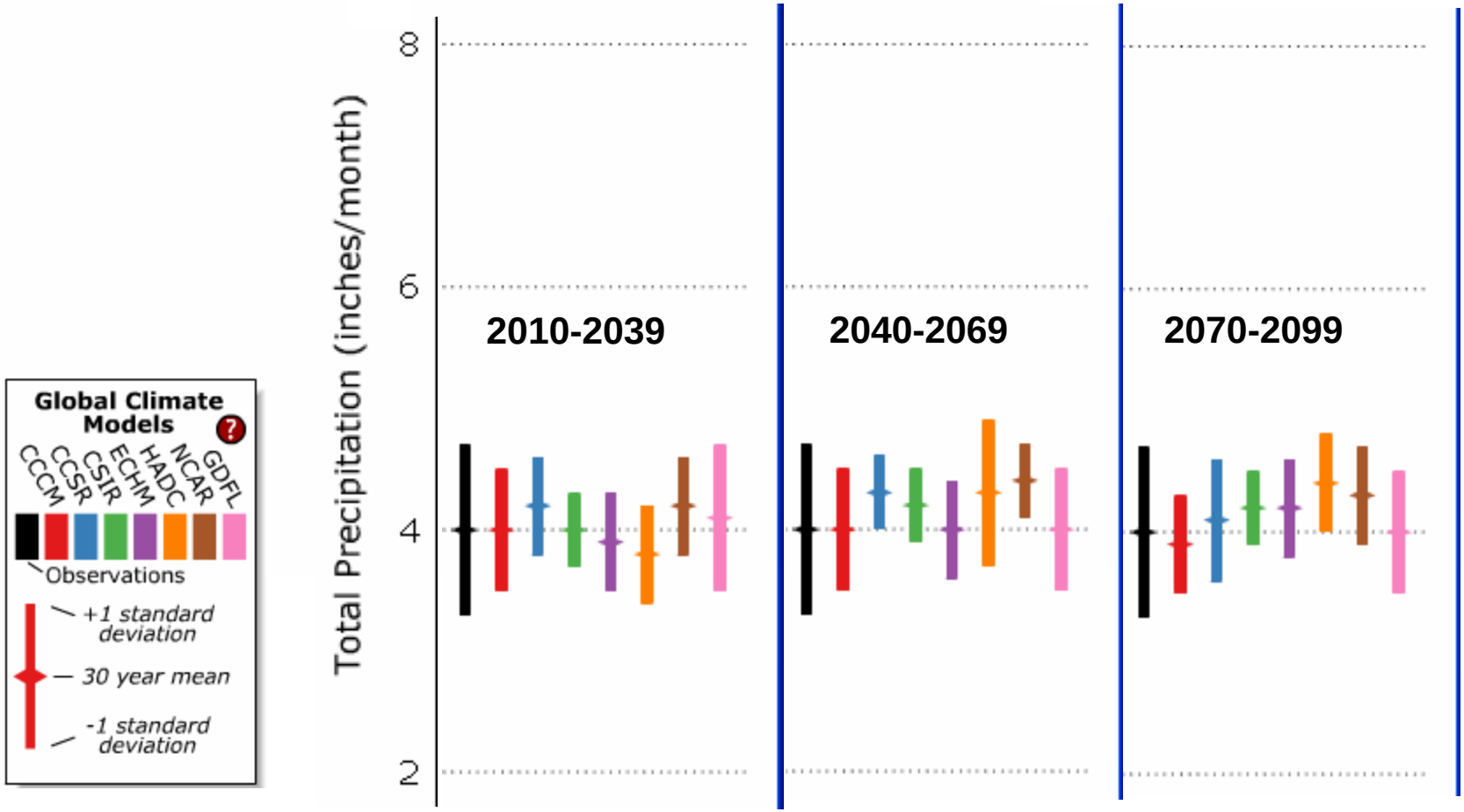
- Estimated potential future changes in CSO frequency based on future changes in the frequency of the 4-event-per-year benchmark precipitation event

- Estimated potential future changes in mitigation (system storage) to meet the 4-event standard as the percent change in magnitude of the benchmark event under future versus historical climates

Results – New England 2025-2050

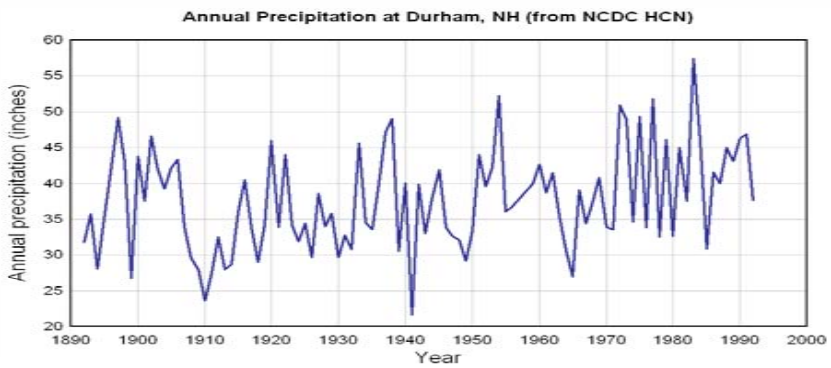
- Estimated regional average impacts on CSOs differ in direction
  - Canadian model
    - 24 % decrease in CSO frequency (~ 1 event/yr)
    - 3 to 6 % decrease in magnitude of benchmark event
  - Hadley Model
    - 14 % increase in CSO frequency (~ 1 event/2 yrs)
    - 3 % increase in magnitude of benchmark event
- Results are “inconclusive”, but do provide a plausible range
- Analysis may not capture longer term trends

Projected Precipitation – Massachusetts (from PSU CARA web site; IPCC 3rd Assess.)



When are impacts likely to occur?

- Climate change is expected to accelerate in the coming century but will occur over time along with significant, short-term random variation
  - no single event will signal the arrival of “climate change”



- Managers/planners will thus need to grapple with impacts prospectively rather than as a reaction to observed events

What can be done?

- Climate models currently demonstrate limited skill at *predicting* future precipitation at the local and regional scales needed by water managers (in part due to uncertainty about future emissions)

- Given this uncertainty, useful to think about adaptation in the context of risk management

- Models are very effective for understanding system behavior
  - we can use this understanding start identifying the ranges of potential impacts, and to develop strategies for reducing exposure to risk

A few alternatives…

- Develop institutional capacity for flexibility and rapid response, then wait and watch

- Take advantage of current “no-regrets” opportunities to increase resilience to future climate change
  - leverage current efforts to address other concerns (stormwater management, LID)
  - look for “economies of scale”

- Better constrain/define the problem through improved knowledge
  - research and assessment (partnerships)
  - development of decision support tools

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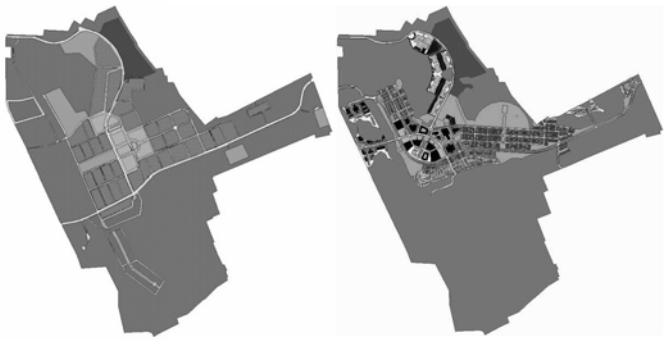
Smart growth as a “no-regrets” opportunity

- Communities throughout the nation are adopting smart growth principles to facilitate growth while protecting their economy, quality of life, public health, and natural environments.
- These same smart growth principles can also enhance neighborhood resilience to future climate change
- An EPA study is assessing the potential benefits of sustainable neighborhood design in the context of adapting to climate change

Approach

- Used the SG Water model to simulate the potential stormwater and water quality impacts of two alternative site plans for the redevelopment of South Weymouth Naval Air Station (SWNAS)
  - conventional design
  - sustainable design
    (more compact, mixed use configuration)



Conventional Sustainable

- Assessed the sensitivity of each design to:
  - more intense precipitation events; scenarios created by adjusting historical precipitation data to reflect historical trend
  - increased/decreased annual precipitation; scenarios created by adjusting historical precipitation data by +/- 20%

Results – South Weymouth Naval Air Station Site

		Propsed Conventional Design	Proposed Smart Growth Design	Percent Change w/ Smart Growth (Relative to Conventional)
Stormwater Runoff (ft3/ac/yr)	Historic Rainfall	37690	26742	-29%
	Future Rainfall*	43285	32085	-26%
Suspended Solids (lbs/ac/yr)	Historic Rainfall	146	109	-26%
	Future Rainfall*	170	131	-23%
Phosphorus (lbs/ac/yr)	Historic Rainfall	0.65	0.44	-33%
	Future Rainfall*	0.71	0.49	-31%
Nitrogen (lbs/ac/yr)	Historic Rainfall	3.74	2.83	-24%
	Future Rainfall*	4.26	3.34	-22%

* future scenarios assume increased intensity of top 5% magnitude events; extrapolation of historical trend for 90 years

Closing comments

- Investments in water infrastructure tend to be long-term, capital-intensive, and irreversible in the short- to medium-term; today's decisions could thus influence the ability of facilities to accommodate changes in climate for decades into the future

- The potential impacts of climate change vary significantly among regions and individual systems; each facility also has a unique set of attributes, existing challenges, and constraints that must be considered in determining what reasonable and appropriate actions should be taken

- We know more than enough to start identifying the potential impacts of climate change, and to begin developing strategies to adapt

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