BUILDING INNOVATION 2018

National Institute of BUILDING SCIENCES

CONFERENCE & EXPO

U.S. GLOBAL CHANGE RESEARCH PROGRAM

Adaptation Science Interagency Working Group (ASIWG)

Sub-Work Group: Federal Architects & Engineers on Buildings & Infrastructure Design (Climate Risks)

"Focusing on the Challenge and the Path Forward"

Presentation by --

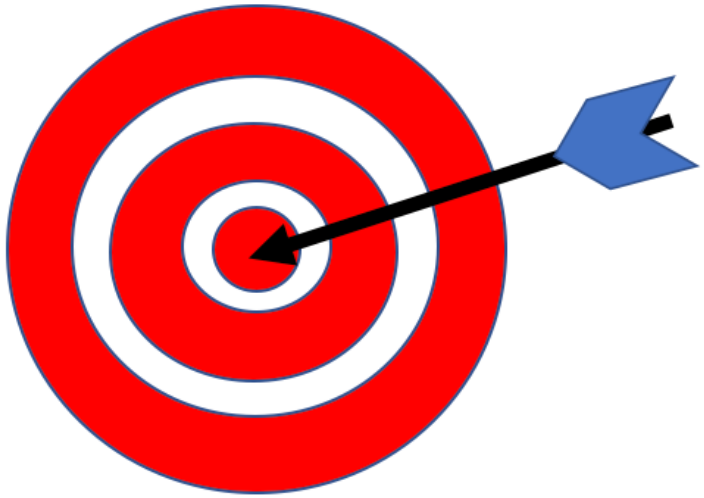
Sam Higuchi[1]

Chair, Sub-Work Group of Federal Architects & Engineers on
Buildings & Infrastructure Design (Climate Risks)
(Staff Engineer, NASA-HQ, Office of Strategic Infrastructure)

11 January 2018

National Institute of Building Sciences (NIBS)
6th Conference – "Building Innovation Conference & Expo: Sustain – Strengthen – Secure"
10:10 – 11:45 AM; Panel on: "Climate Resilience: Adaptive Design and Risk Management"
8-11 January 2018; Mandarin Oriental Hotel, 1330 Maryland Ave SW Washington DC
Contact Persons: Dr Richard Wright, ASCE

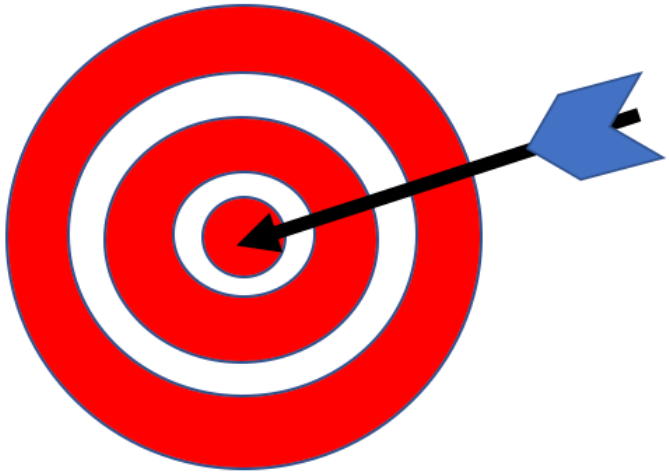
[1] *This presentation does not represent the official position of NASA or the United States government. This presentation reflects only the personal views of the presenter.*



Federal Agencies
SAFEGUARDING ASSETS

31 U.S.C. §3512

- **Funds**
- **Property**
- **Other Assets**



PROFESSIONAL LICENCES

- *Professional Architect*
- *Professional Engineer*

POWERS LEFT TO THE STATES: Police Powers

- **Public Safety**
- **Public Health**
- **Public Welfare**

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CLIMATE SCIENCE SPECIAL REPORT

1) *Temperature & Precipitation Changes*
2) *Drought, Floods & Wildfires*
3) *Extreme Storms*

Public Release: 3 Nov 2017
63 Key Findings

https://science2017.globalchange.gov/downloads/CSSR2017_FullReport.pdf

TABLE OF CONTENTS

BUILDING INNOVATION 2018
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15 USC §2938

(b) Availability of [U.S. Global Change Research Program and of Federal agencies and departments] Research Findings.

***

Agencies and departments … shall ensure that the research findings [of U.S. Global Change Research Program and of Federal agencies and departments] … are available to ---

(2) All Federal agencies and departments for use in … responding to … global change pursuant to … statutory responsibilities and obligations.

(c) Consistent with this subchapter, there is to be no delays in implementing Federal response actions designed to address the threats of global climate change.

AGENCIES ARE MANDATED BY STATUTE TO USE USGCRP RESEARCH FINDINGS: THIS INCLUDES CLIMATE DATA AND CLIMATE INFORMATION[1,2]

15 USC §2938

RESEARCH FINDINGS OF:		USE RESEARCH FINDINGS PURSUANT TO:			
		AGENCY (Authorization) STATUTES & LAWS:		OTHER FEDERAL STATUTES & LAWS (includes Sovereign Immunity Waivers):	
		Responsibilities	Obligations	Responsibilities	Obligations
1) U.S. Global Change Research Program (USGCRP):		X	X	X	X
2) USGCRP Member Agencies:	a) U.S. Department of Agriculture	X	X	X	X
	b) U.S. Department of Commence (includes NOAA)	X	X	X	X
	c) U.S. Department of Defense (includes USACE)	X	X	X	X
	d) U.S. Department of Energy	X	X	X	X
	e) U.S. Department of the Interior (includes USGS)	X	X	X	X
	f) U.S. Department of State	X	X	X	X
	g) U.S. andepartment of Transportation	X	X	X	X
	h) U.S. Environmental Protection Agency	X	X	X	X
	i) National Aeronautics & Space Administration	X	X	X	X

[1] USGCRP (May 2015) Principals decided to focus on CMIP5 scenarios RCP 8.5 and 4.5 for National Climate Assessment #4, and for the framing of impacts, vulnerability and adaptation research findings.

[2] Several USGCRP member agencies have created and maintained a climate data portal ("Downscaled CMIP3 & CMIP5 Climate and Hydrology Projects") relevant to the scope of architects & engineers involved with Federal buildings and infrastructure projects and assets.

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CHAPTER 7:

"KEY FINDINGS" - PRECIPITATION CHANGES IN THE UNITED STATES:

OBSERVATIONS

7-2 {25} ***Heavy precipitation events*** in most parts of the United States ***have increased in both intensity and frequency*** since 1901 (high confidence).

***

[L]argest increases occurring in the northeastern United States (high confidence).

***

[Organized clusters of thunderstorms] for warm season precipitation in [central U.S.] have increased in occurrence and … amounts since 1979 (medium confidence).

PROJECTIONS

7-3 {26} The ***frequency and intensity of heavy precipitation events are projected*** to continue ***to increase*** over the 21st century (high confidence).

Mesoscale convective systems in the central United States are expected to continue to increase in number and intensity in the future (medium confidence).

https://science2017.globalchange.gov/downloads/CSSR2017_FullReport.pdf

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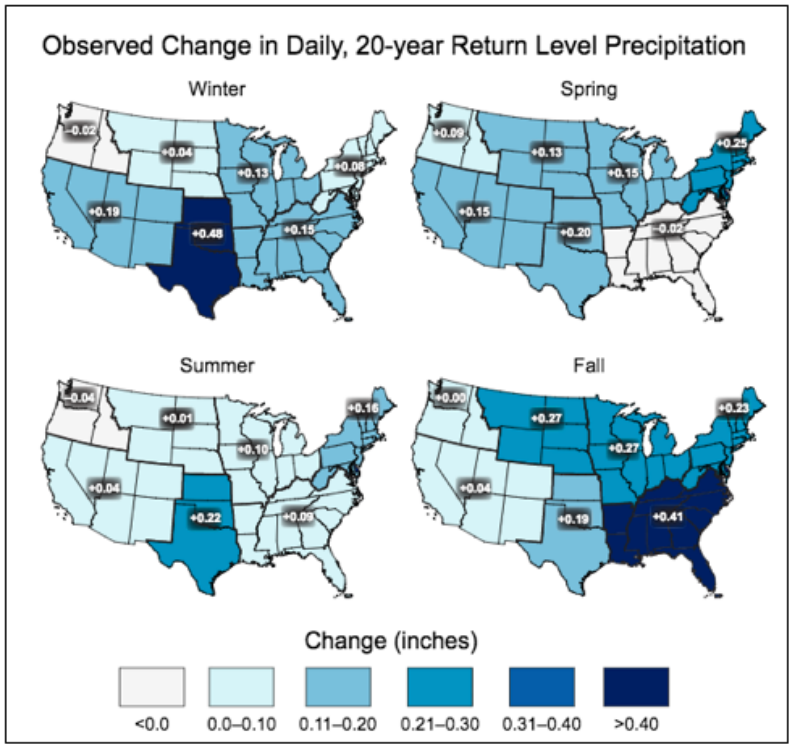
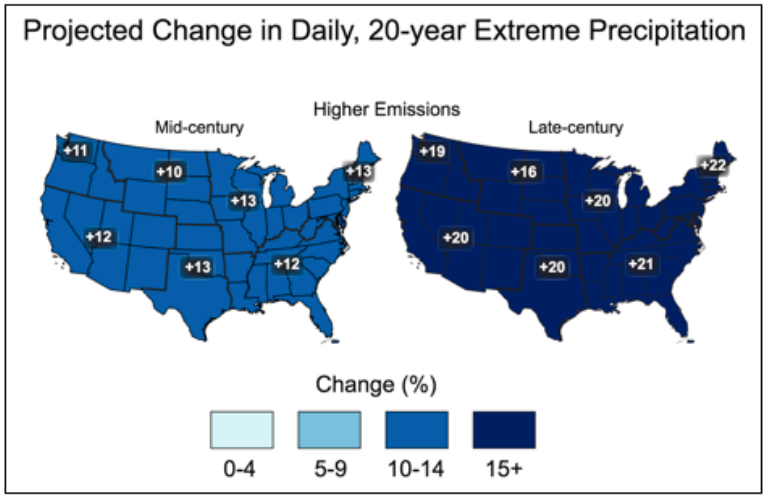
Observations and Projections

Observations
1948-2015



Projections
RCP 8.5
(LOCA data)



https://science2017.globalchange.gov/downloads/CSSR2017_FullReport.pdf

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Climate Risks

42 USC §17094 – Storm water runoff requirements for Federal development projects.

Any development or redevelopment project involving a Federal facility with a footprint that exceeds 5,000 square feet shall use site

- **planning,**
- **design,**
- **construction, and**
- **maintenance strategies**

for the property to maintain or restore, to the maximum extent technical feasible, the predevelopment hydrology of the property with regard to the

- **temperature,**
- **rate,**
- **volume, and**
- **duration of flow.**

42 USC §17094 – Storm water runoff requirements (Federal Facilities = 5,000 square feet)
Challenge – Precipitation Non-Stationarity

	Use Strategies for …			
To Maintain or Restore Hydrologic Property of …	**Planning**	**Design**	**Construction**	**Maintenance**
Temperature	X	X	X	X
Rate	X	X	X	X
Volume	X	X	X	X
Duration of Flow	X	X	X	X

Table 1. Guidelines for the selection of return period.		
No.	**Type of project or feature**	**Return period (yr)**
1	Urban drainage [low risk] (up to 100 ha)	5 to 10
2	Urban drainage [medium risk] (more than 100 ha)	25 to 50
3.	Road drainage	25 to 50
4	Principal spillways (dams)	25 to 100
5	Highway drainage	50 to 100
6	Levees [medium risk]	50 to 100
7	Urban drainage [high risk] (more than 1,000 ha)	50 to 100
8	Flood plain development	100
9	Bridge design (piers)	100 to 500
10	Levees [high risk]	200 to 1000
11	Emergency spillways (dams)	100 to 10,000 (PMP)
12	Freeboard hydrograph [for a class (c) dam]	10,000 (PMP)

http://ponce.tv/return_period.html

Table 1.1. Design Storm Selection Guidelines (AASHTO, 1999)

Roadway Classification	Exceedence Probability	Return Period
Rural Principal Arterial System	2%	50-year
Rural Minor Arterial System	4% - 2%	25-50-year
Rural Collector System, Major	4%	25-year
Rural Collector System, Minor	10%	10-year
Rural Local Road System	20% - 10%	5-10-year
Urban Principal Arterial System	4% - 2%	25-50-year
Urban Minor Arterial Street System	4%	25-year
Urban Collector Street System	10%	10-year
Urban Local Street System	20% - 10%	5-10-year

Note: Federal regulations require interstate highways to be provided with protection from the 2 percent flood event. AASHTO recommends that facilities such as underpasses, depressed roadways, etc., where no overflow relief is available should also be designed for the 2 percent flood event (AASHTO, 1999).

http://isddc.dot.gov/OLPFiles/FHWA/013248.pdf

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Precipitation Non-Stationarity

Was:

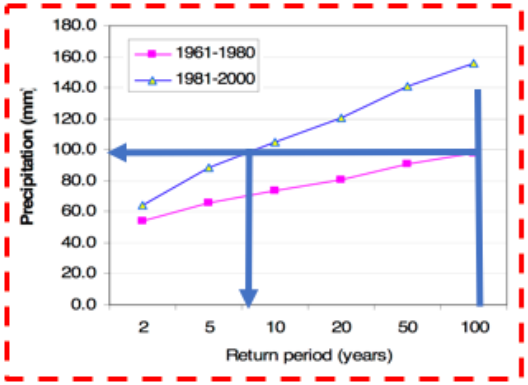
Average Return Interval (ARI) = 100-Years

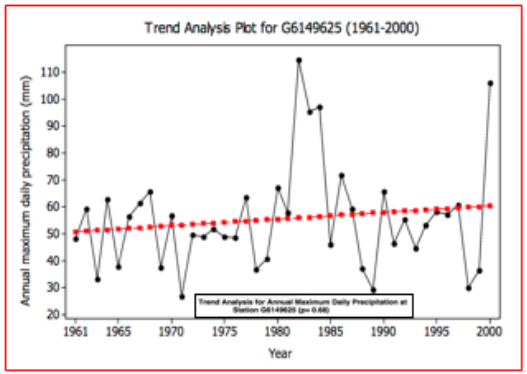
24-hour Extreme Precipitation Events

6-Years

Woodstock, Ontario, Canada
Meteorological Station G6149625
(near Niagara Falls/ Buffalo, NY)

URL: http://www.cspi.ca/sites/default/files/download/Final_MTO_Report_June2005rv.pdf

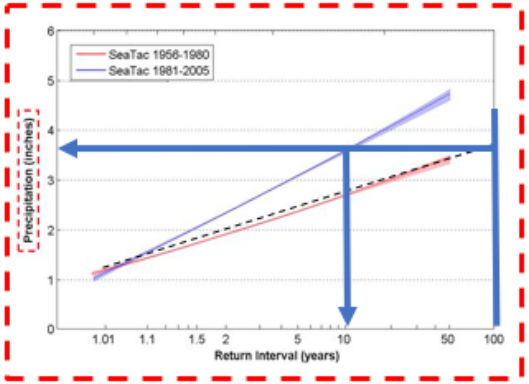


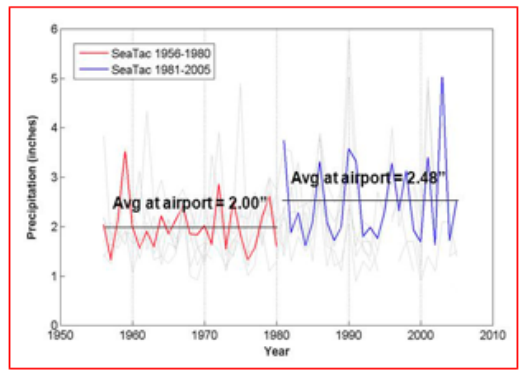


10-Years

SeaTac, WA
Station: 457473
(near Seattle, WA)

URL: http://www.stillwatersci.com/resources/2010stormwater_infrastructure_climate_change.pdf

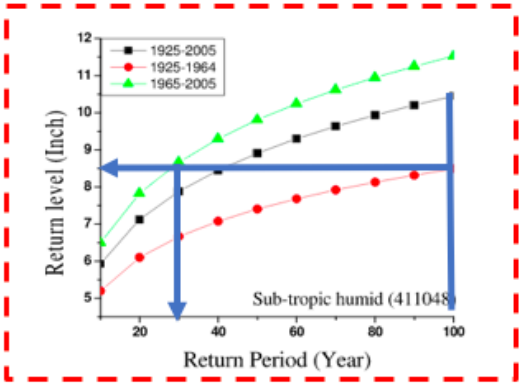


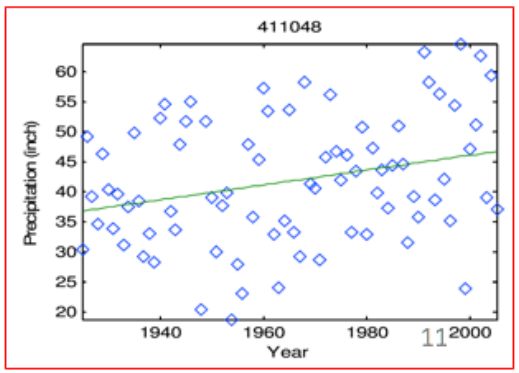


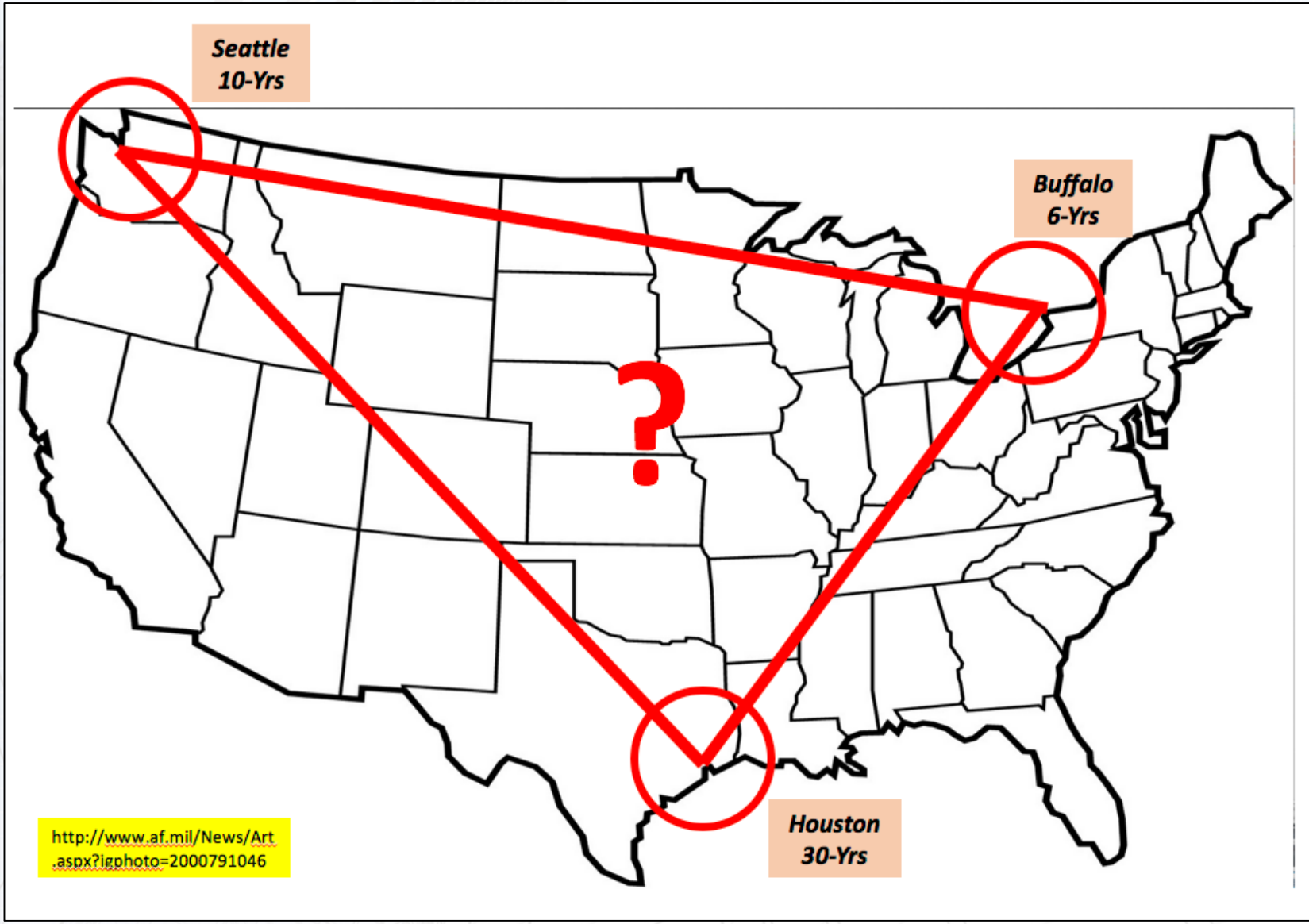
30-Years

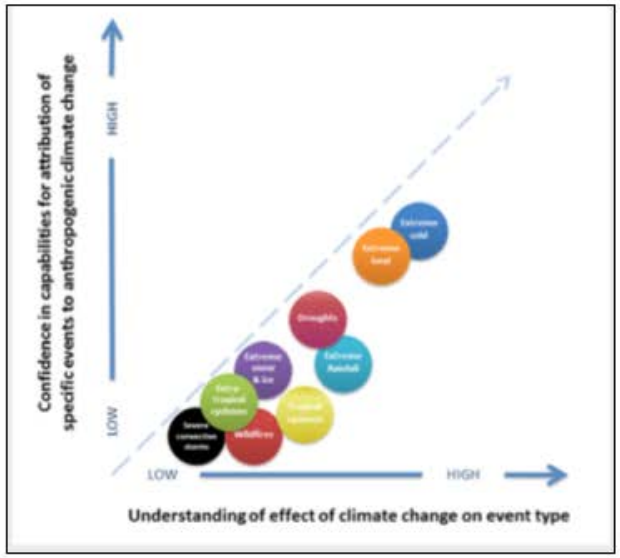
Brenham, TX
Station: 411048
(near Houston/ Galveston, TX)

URL: http://onlinelibrary.wiley.com/doi/10.1029/2009JD013398/epdf






Seattle
10-Yrs
Buffalo
6-Yrs
?
Houston
30-Yrs
http://www.af.mil/News/Art.aspx?igphoto=2000791046



Research Agenda:

1) Observational Record Analysis
2) Physical Mechanisms Understanding
3) Models to Simulate Event

Box 1. Current Scientific Confidence in Attribution Results Varies for Different Types of Extreme Event

● = high
◎ = medium
○ = low

	Capabilities of Climate Models to Simulate Event Class	Quality/ Length of the Observational Record	Understanding of Physical Mechanisms that Lead to Changes in Extremes as a Result of Climate Change
Extreme cold events	●	●	●
Extreme heat events	●	●	●
Drought	◎	◎	◎
Extreme rainfall	◎	◎	◎
Extreme snow	◎	○	◎
Tropical cyclones	○	○	◎
Extratropical cyclones	◎	○	○
Wildfire	○	◎	○
Severe convective storms	○	○	○

https://www.nap.edu/catalog/21852/attribution-of-extreme-weather-events-in-the-context-of-climate-change

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31 USC §3512

(c)(1) Each executive agency shall … ensure that --

*****

(B) All assets are safeguard against waste, loss, unauthorized use, and misappropriation*

- *Public Law 97-255 specifically states and lists & identifies: "funds, property and other assets" (= all assets)*
  - {for DOD 10 USC §383(b)(2)}

31 USC §3512 *Each executive agency is to ensure all assets* are safeguarded against loss.*			
	TYPE OF ASSET:**		
ENSURE AGAINST … :	**"FUNDS"**	**"PROPERTY"**	**"OTHER ASSETS"**
"… Loss"	**X**	**X**	**X**
"… Misappropriation"***	**X**	**X**	**X**
"… Waste"	**X**	**X**	**X**
"… Unauthorized Use"	**X**	**X**	**X**

* For example: buildings & infrastructure (or capital assets), and natural resources

** See Federal Accounting Standards Advisory Board concerning definition of "assets"; assets include: property plant and equipment, and heritage assets

*** See OMB Circular A-11 concerning "capital assets"; failure to use the appropriate "design life" (for example due to risks related to a changing climate) in justifying invest of a capital asset project to Congress

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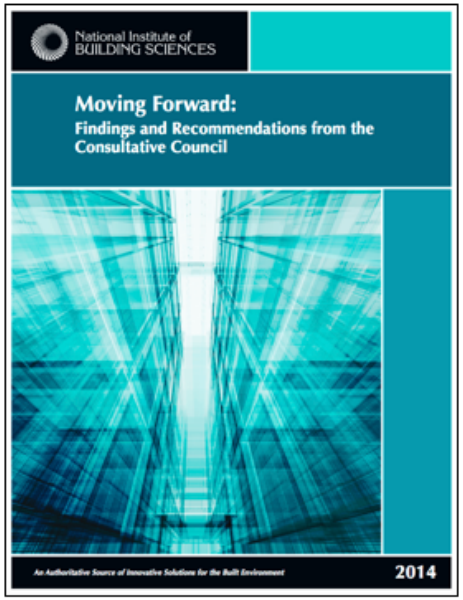
Engaging Stakeholders on Climate Risk Management through Statutory Chartered Entities

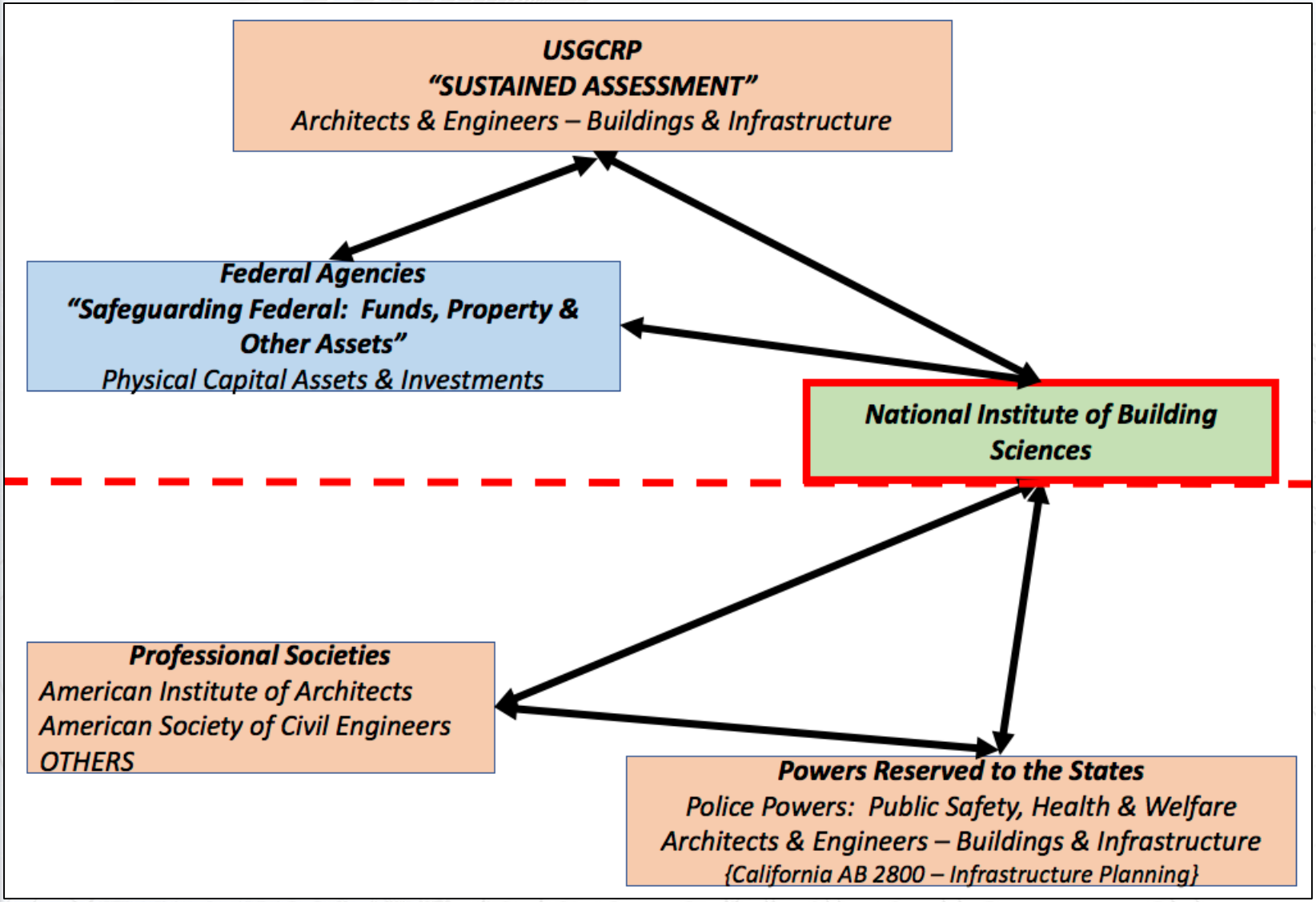
1) National Institute of Building Sciences (buildings & Infrastructure) 12 USC §1701j-2
2) National Academies of Science, Engineering & Medicine 36 USC §150301 et seq
3) National Academy of Public Administration (Federal-Tribes-State-Local) 36 USC §1501 et seq



"Establishing a long-term dialogue between climate scientists and building scientists ...."

The built environment will play a significant role when it comes to changes in climate. It is essential that the nation's communities have information that is actionable and easily understood in order to prepare buildings before and in response to events. Establishing a long-term dialogue between climate scientists and building scientists would help bridge the gap between the current uncertainty in climate and the design criteria required by the building industry. The structure of the Institute's Building Seismic Safety Council (BSSC), which brings together experts from a number of different fields, can serve as a model.[2] Such a dialogue would improve the relevance of climate modeling for use in the planning, design, operation, maintenance and renewal of the built and natural environment.

http://c.vmcdn.com/sites/www.nibs.org/resource/resmgr/CC/MovingForward-_Final.pdf


USGCRP
"SUSTAINED ASSESSMENT"
Architects & Engineers – Buildings & Infrastructure
Federal Agencies
"Safeguarding Federal: Funds, Property & Other Assets"
Physical Capital Assets & Investments
National Institute of Building Sciences
Professional Societies
American Institute of Architects
American Society of Civil Engineers
OTHERS
Powers Reserved to the States
Police Powers: Public Safety, Health & Welfare
Architects & Engineers – Buildings & Infrastructure
{California AB 2800 – Infrastructure Planning}

California AB 2800; Public Resources Code – Section 71155

A) Create "Climate Safe Infrastructure Working Group" - consisting of:

1) Engineers with expertise in infrastructure design
2) Scientists from Universities with expertise in climate change projections and impacts
3) Architects with experience in infrastructure design

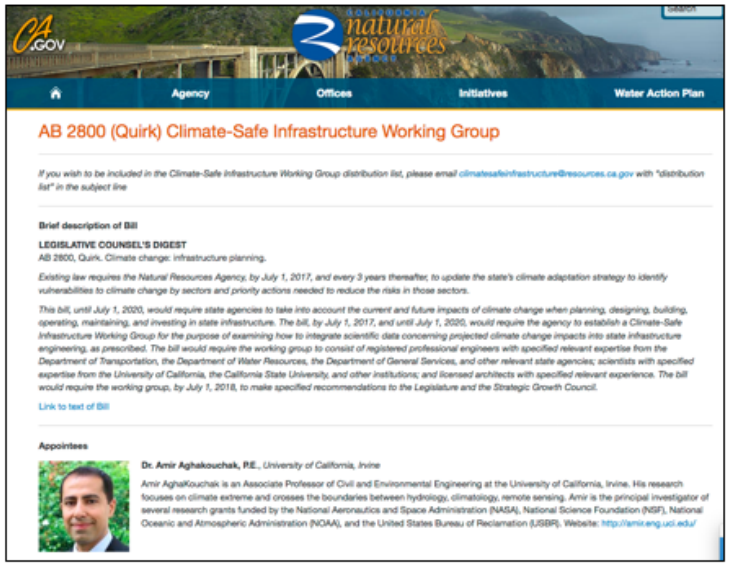
B) Establish by 1 July 2017, working group to work with other organizations that advance sustainability in infrastructure

C) Investigate the following issues:

1) Current informational and institutional barriers to integrating projected climate change impacts into infrastructure design
2) Critical information that engineers responsible for infrastructure design and construction need to address climate change impacts
3) How to select an appropriate engineering design for a range of future climate scenarios as related to:
   a) Infrastructure planning, and
   b) Investment

D) By 1 July 2018, make recommendations:

1) Integrate scientific knowledge of projected climate impacts into infrastructure design
2) Addressing critical gaps identified
3) Process to facilitate communications between climate scientists and infrastructure engineers



http://resources.ca.gov/climate/climate-safe-infrastructure-working-group/

California AB2800
"Climate-Safe Infrastructure Working Group"

Appointees include:

Name	Affiliation
Dr. Amir Aghakouchak, P.E.	University of California, Irvine
Bruce Swanger, P.E.	California Department of Transportation
Chester Widom, FAIA	California Department of General Services: Division of State Architect
Dr. Chris Liban, P.E., ENV SP	Los Angeles County Metropolitan Transportation Authority; City of Los Angeles; National Council for Environmental Policy and Technology, USEPA
Dr. Dan Cayan	University of California, San Diego: Scripps Institution of Oceanography
Dr. David Groves	RAND Water and Climate Resilience; Pardee Rand Graduate School
Dr. Deb Niemeier, P.E, NAE	University of California, Davis
James Deane AIA, CDT, LEED AP, PMP	California High Speed Rail Authority; Parsons Brinckerhoff
John Andrew, P.E.	California Department of Water Resources
Dr. Kristin Heinemeier, P.E.	University of California, Davis: Energy Efficiency Center
Dr. Kyle Meng	University of California, Santa Barbara: Bren School of Environmental Science and Management
Martha Brook, P.E.	California Energy Commission
Nancy Ander, P.E.	California Department of General Services
Dr. Noah Diffenbaugh	Stanford University: Stanford Woods Institute for the Environment

https://yubanet.com/california/secretary-laird-announces-establishment-of-climate-safe-infrastructure-working-group/

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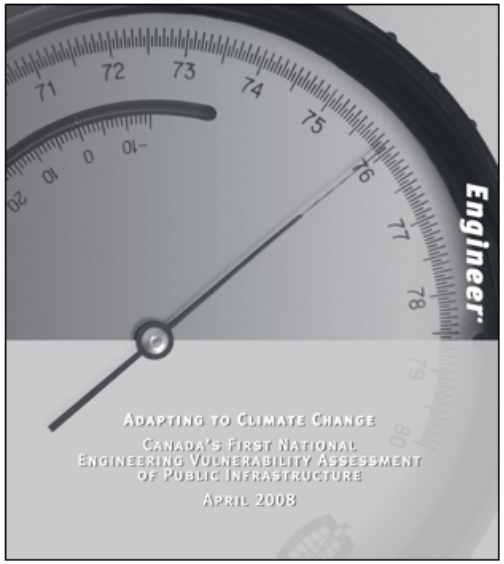
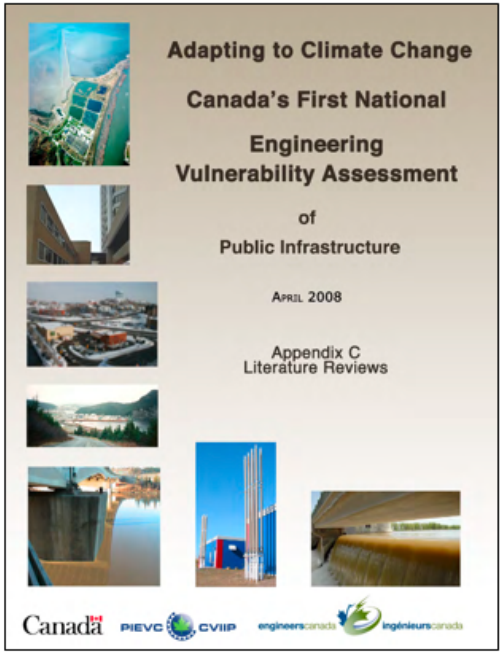
CANADA

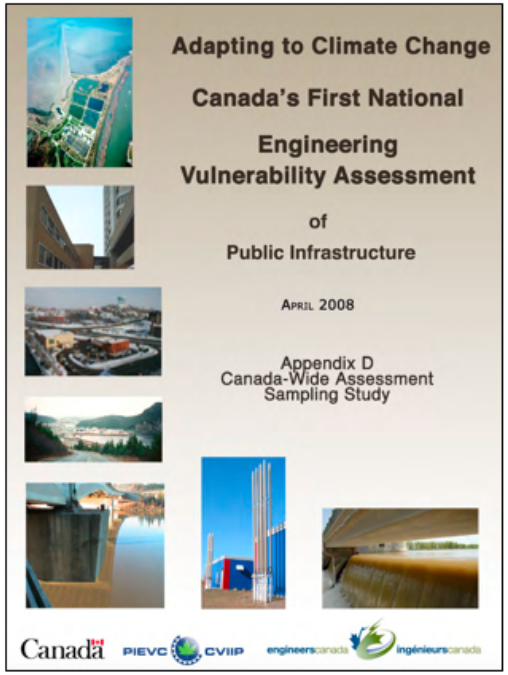
1st National Engineering Vulnerability Assessment of Infrastructure 2008



https://pievc.ca/sites/default/files/adapting_to_climate_change_report_final.pdf

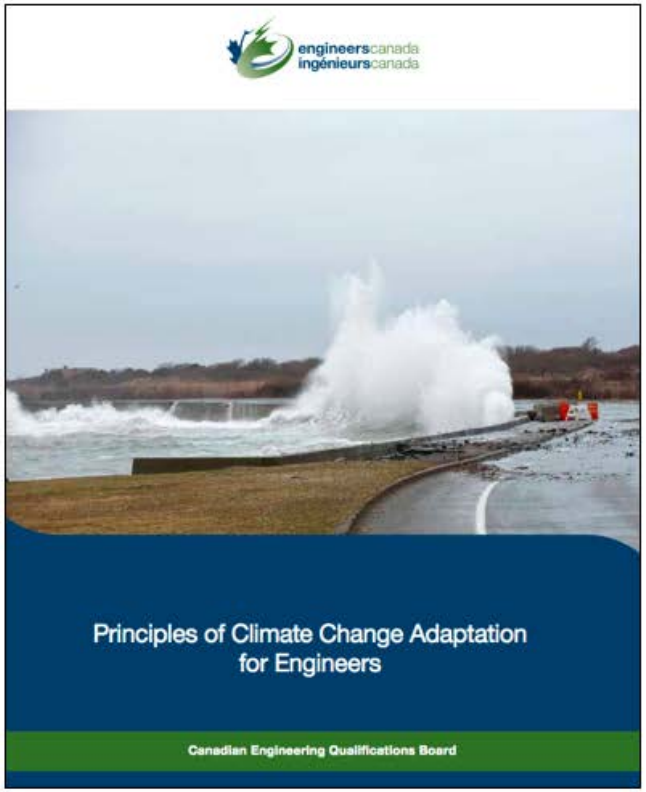


https://pievc.ca/sites/default/files/appendix_c_literature_reviews.pdf



https://pievc.ca/sites/default/files/appendix_d_final_report_canada_wide_assessment_sampling_strategy.pdf

Transportation Infrastructure – Climate Change Issues
Buildings Infrastructure – Climate Change Issues
Water Resources Infrastructure – Climate Change Issues
Stormwater & Wastewater Infrastructure – Climate Change Issues



CANADA

Canadian Engineering Qualifications Board
October 2014

Professional Judgment

Guideline Element # 1: Integrate Adaptation into Practice
Guideline Element # 2: Review Adequacy of Current Standards
Guideline Element # 3: Exercise Professional Judgement

Integrating Climate Information

Guideline Element # 4: Interpret Climate Information
Guideline Element # 5: Work with Specialists and Stakeholders
Guideline Element # 6: Use Effective Language

Practice Guidance

Guideline Element # 7: Plan for Service Life
Guideline Element # 8: Use Risk Assessment for Uncertainty
Guideline Element # 9: Monitor Legal Liabilities

https://engineerscanada.ca/sites/default/files/01_national_guideline_climate_change_adaptation.pdf

Environmental Engineers: … address global issues, such as … :

1) *Climate change and*
2) *environmental sustainability*

OCCUPATIONAL OUTLOOK HANDBOOK

Occupational Outlook Handbook > Architecture and Engineering >

Environmental Engineers

Summary | **What They Do** | Work Environment | How to Become One | Pay | Job Outlook

What Environmental Engineers Do

Environmental engineers use the principles of engineering, soil science, biology, and chemistry to develop solutions to environmental problems. They work to improve recycling, waste disposal, public health, and water and air pollution control. They also address global issues, such as unsafe drinking water, climate change, and environmental sustainability.

https://www.bls.gov/ooh/architecture-and-engineering/environmental-engineers.htm#tab-2

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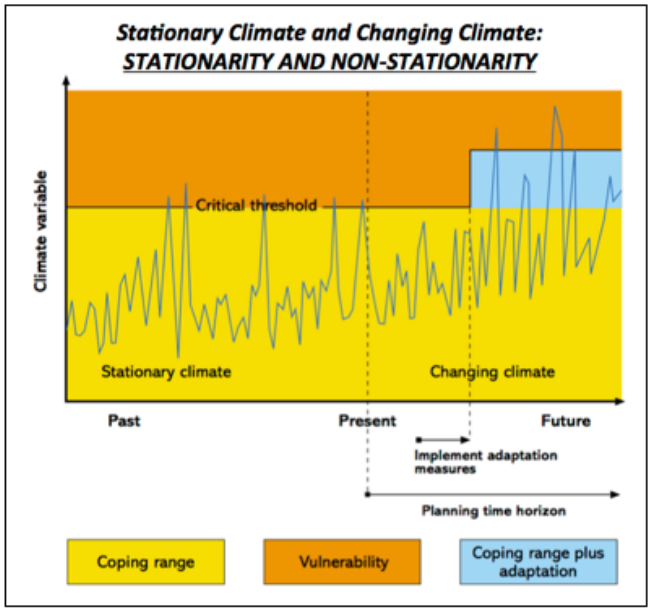
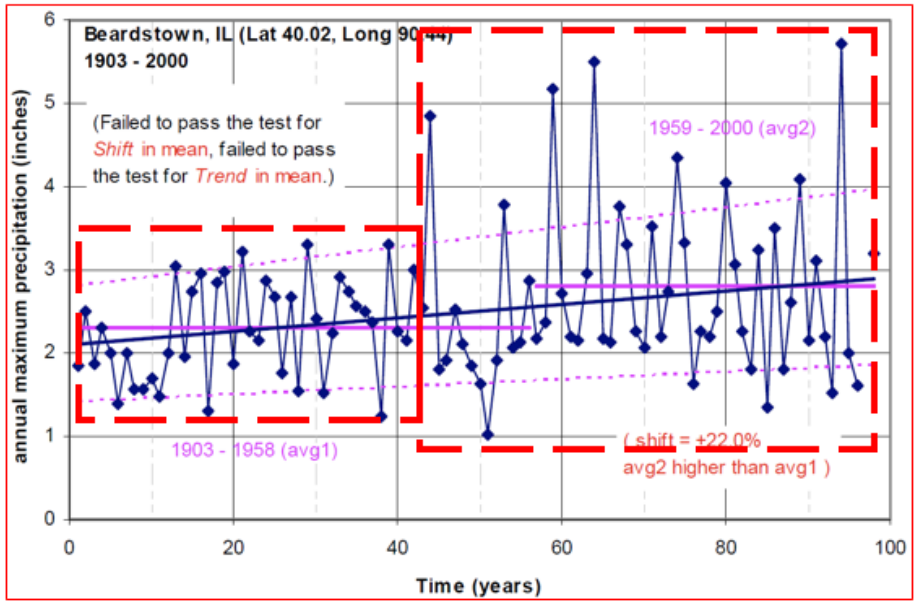
NON-STATIONARITY

Concept



http://www.ukcip.org.uk/wp-content/PDFs/UKCIP-Risk-framework.pdf

Observational Data



http://www.nws.noaa.gov/oh/hdsc/PF_documents/Atlas14_Volume2.p

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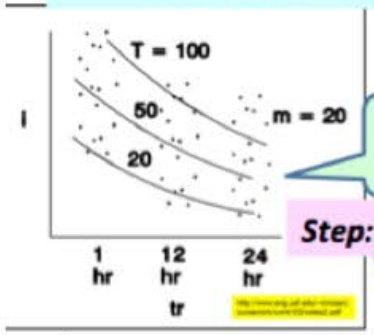
"OLD SCHOOL" – ASSUMPTION OF "STATIONARITY": *Science and Engineering*

Storm Water Management: pipe culvert design *(Historical Data)*

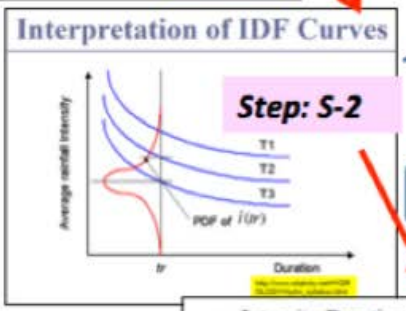


Science

"Location Specific Observations"

Step: S-1

"Data Distribution Curve"



Step: S-2

"Historical Data"

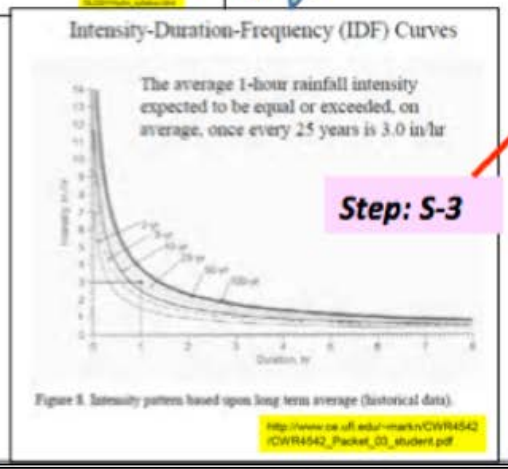


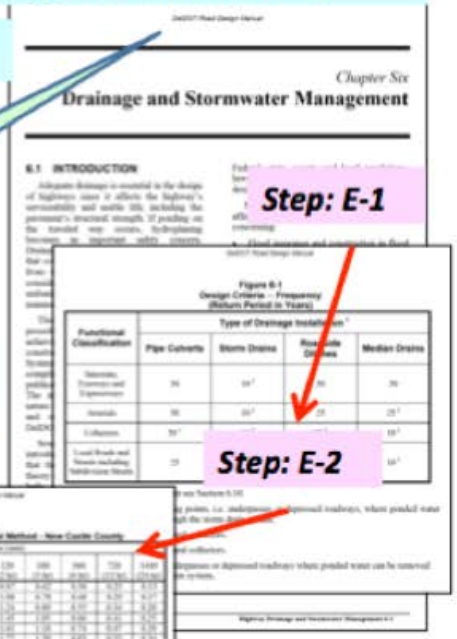
Figure 8. Intensity pattern based upon long term average (historical data).

http://www.ce.ufl.edu/~mark/n/CWR4542/CWR4542_Packet_03_student.pdf

Step: S-3

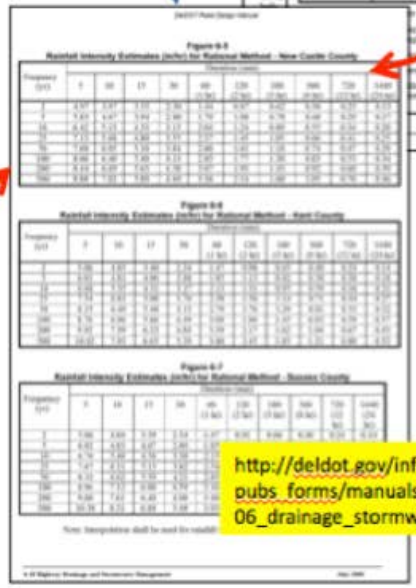
Engineering

"Design Manual"



Step: E-1

"Location Specific"



Step: E-2

http://deldot.gov/information/pubs_forms/manuals/road_design/pdf/06_drainage_stormwater_mgmt.pdf

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Chapter Six

Drainage and Stormwater Management

6.1 INTRODUCTION

Adequate drainage is essential in the design of highways since it affects the highway's serviceability and usable life, including the pavement's structural strength. If ponding on the traveled way becomes an import... Drainage design involv... that collect, transport ... from the highway. ... consider the stormwate... embankment through ... manmade ditches.

This chapter deals ... procedures and guidan... achieving cost-effec... construction within ... System. The informati... compiled from variou... publications, textbooks. The information prov... nature with the inclusi... and references speci... DelDOT projects.

Source documents ... introduction to each s... that the designer is f... theory and methods of ... both hydrology a... information provided ... supplemented with h... access to the referenced ...

The regulatory en... drainage design is ... continues to grow in ... responsible for the pl... drainage facilities must ...

Federal, state, county and local regulations, laws, and ordinances that may impact the design of storm drain systems.

Many federal laws have implications that affect drainage design. These include laws ...

Figure 6-1
Design Criteria — Frequency
(Return Period in Years)

Functional Classification	Type of Drainage Installation [1]			
	Pipe Culverts	Storm Drains	Roadside Ditches	Median Drains
Interstate, Freeways and Expressways	50	10 [2]	50	50
Arterials	50	10 [2]	25	25 [2]
Collectors	50 [3]	10 [2]	25 [4]	10 [2]
Local Roads and Streets including Subdivision Streets	25	10 [5]	10	10 [5]

[1] For Stormwater Management see Section 6.10.

[2] Use a 50-yr frequency at sag points, i.e. underpasses or depressed roadways, where ponded wate... can be removed only through the storm drain system.

[3] Use a 25-yr frequency for rural collectors.

[4] Use a 10-yr frequency for rural collectors.

[5] Use a 25-yr frequency at underpasses or depressed roadways where ponded water can be removed only through the storm drain system.

https://www.deldot.gov/Publications/manuals/road_design/pdfs/06_drainage_stormwater_mgmt.pdf

Figure 6-5
Rainfall Intensity Estimates (in/hr) for Rational Method - New Castle County

Frequency (yr)	Duration (min)									
	5	10	15	30	60 (1 hr)	120 (2 hr)	180 (3 hr)	360 (6 hr)	720 (12 hr)	1440 (24 hr)
2	4.97	3.97	3.33	2.30	1.44	0.87	0.62	0.38	0.23	0.13
5	5.83	4.67	3.94	2.80	1.79	1.08	0.78	0.48	0.29	0.17
10	6.42	5.13	4.33	3.13	2.04	1.24	0.89	0.55	0.34	0.20
25	7.13	5.68	4.80	3.55	2.37	1.45	1.05	0.66	0.41	0.25
50	7.60	6.05	5.10	3.84	2.60	1.61	1.18	0.74	0.47	0.29
100	8.06	6.40	5.40	4.13	2.85	1.77	1.30	0.83	0.53	0.34
200	8.44	6.69	5.63	4.38	3.07	1.93	1.43	0.92	0.60	0.39
500	8.88	7.02	5.89	4.69	3.36	2.14	1.60	1.05	0.70	0.46

Figure 6-6
Rainfall Intensity Estimates (in/hr) for Rational Method - Kent County

Frequency (yr)	Duration (min)									
	5	10	15	30	60 (1 hr)	120 (2 hr)	180 (3 hr)	360 (6 hr)	720 (12 hr)	1440 (24 hr)
2	5.06	4.05	3.40	2.34	1.47	0.90	0.65	0.40	0.24	0.14
5	6.01	4.81	4.06	2.88	1.85	1.13	0.82	0.50	0.30	0.18
10	6.68	5.35	4.51	3.27	2.13	1.31	0.95	0.59	0.36	0.21
25	7.54	6.01	5.08	3.76	2.50	1.56	1.14	0.71	0.44	0.27
50	8.15	6.49	5.48	4.13	2.79	1.76	1.29	0.81	0.51	0.32
100	8.76	6.96	5.86	4.49	3.09	1.96	1.45	0.92	0.59	0.37
200	9.92	7.39	6.22	4.84	3.39	2.17	1.62	1.04	0.67	0.43
500	10.02	7.93	6.65	5.29	3.80	2.45	1.85	1.21	0.80	0.52

Figure 6-7
Rainfall Intensity Estimates (in/hr) for Rational Method - Sussex County

Frequency (yr)	Duration (min)									
	5	10	15	30	60 (1 hr)	120 (2 hr)	180 (3 hr)	360 (6 hr)	720 (12 hr)	1440 (24 hr)
2	5.06	4.04	3.39	2.34	1.47	0.91	0.66	0.40	0.24	0.14
5	6.02	4.83	4.07	2.89	1.85	1.16	0.84	0.52	0.30	0.19
10	6.76	5.40	4.56	3.30	2.15	1.35	0.99	0.61	0.36	0.22
25	7.67	6.11	5.15	3.82	2.54	1.61	1.19	0.74	0.45	0.28
50	8.32	6.62	5.59	4.21	2.85	1.83	1.35	0.85	0.52	0.33
100	8.96	7.12	6.00	4.59	3.16	2.05	1.53	0.97	0.61	0.38
200	9.60	7.61	6.40	4.98	3.49	2.28	1.71	1.10	0.70	0.45
500	10.38	8.21	6.88	5.48	3.93	2.59	1.97	1.28	0.84	0.54

Note: Interpolation shall be used for rainfall for intermediate durations.

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http://saturn500f.com/sonny-carter-training-facilityneutral-buoyancy-laboratory

Unique facility to practice EVAs *(space walks)*

NASA-JSC Sonny Carter Training Facility: Neutral Buoyancy Laboratory –

Exposure to Storm Surges: Blue: 100-year flood

http://planhouston.org/sites/default/files/plans/EllingtonAirportMasterPlan.pdf

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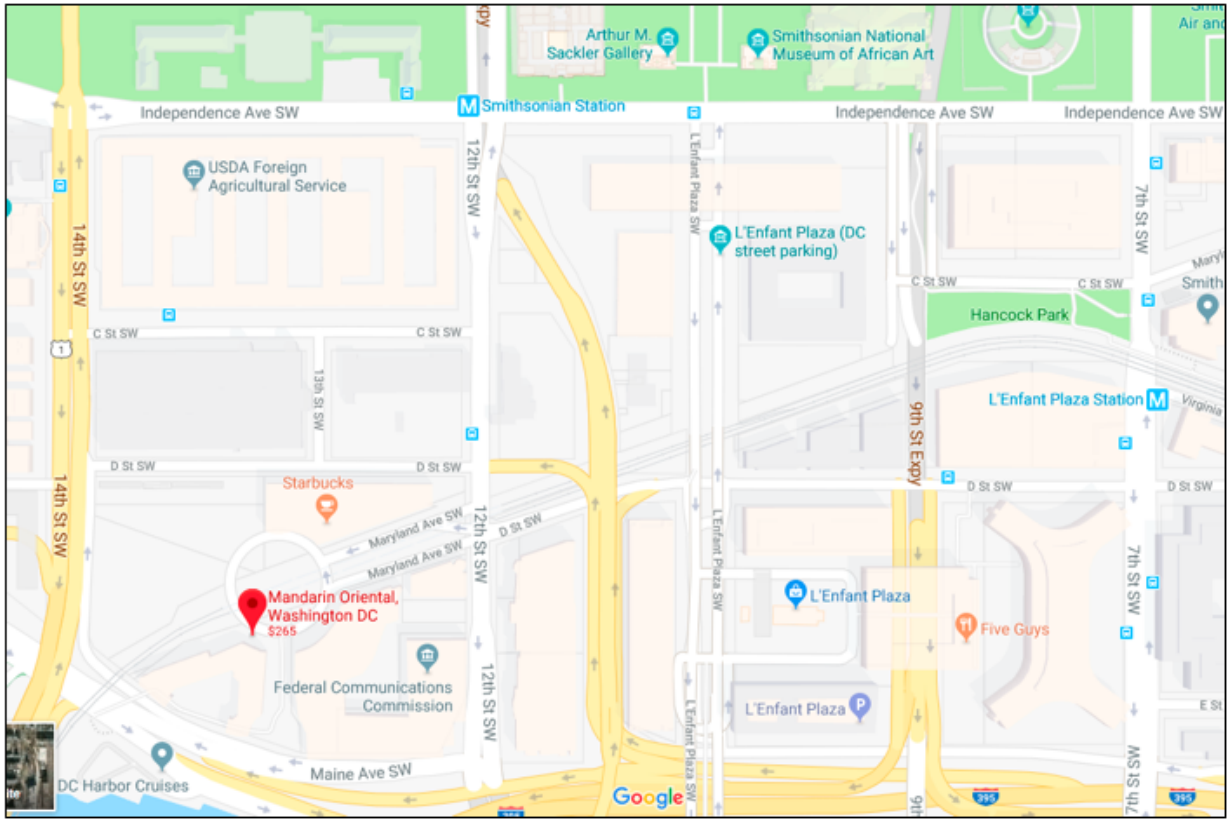
MetroRail Station
Smithsonian



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INTERAGENCY FORUM ON CLIMATE RISKS, IMPACTS & ADAPTATION

CLIMATE RISK MANAGEMENT: Best Available Science and Best Management Practices

Presentation by --
Sam Higuchi[1] *{for Dr. Tom Fish}*
Co-Chair, Interagency Forum on Climate Risks, Impacts & Adaptation
(NASA-HQ, Office of Strategic Infrastructure)
{National Coordinator, Cooperative Ecosystem Studies Units (CESU), U.S. Department of the Interior}

11 January 2018

National Institute of Building Sciences (NIBS)
6th Conference – "Building Innovation Conference & Expo: Sustain – Strengthen – Secure"
10:10 – 11:45 AM; Panel on: "Climate Resilience: Adaptive Design and Risk Management"
8-11 January 2018; Mandarin Oriental Hotel, Washington DC
Contact Persons: Dr Richard Wright, ASCE

[1] *This presentation does not represent the official position of NASA or the United States government. This presentation reflects only the personal views of the presenter.*

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INTERAGENCY FORUM

11th Year (Established 2007)

Interagency Forum

On Climate Risks, Impacts, and Adaptation

The Forum's scope includes but is not limited to aspects of the following:

A Federal Agency is mandated to

31 U.S.C. §3512

Safeguard: Funds, Property, and Other Assets

Exposure to "Material Weakness" requirements; with statutory related "Disclosure" to Congress, and to taxpayers and the public, unless a specific statutory exemption applies

Further, an Agency is mandated to

31 U.S.C. §1115

Manage High Risk Management Challenges, Identified by GAO* or IG

* "Limiting the Federal Government's Fiscal Exposure by better managing climate change risks" URL: *http://www.gao.gov/highrisk/limiting_federal_government_fiscal_exposure/why_did_study*

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"Knowledge Networks" = Interagency Forum

CONNECTING PRODUCERS & USERS OF CLIMATE SCIENCE: PROVEN INSTITUTIONAL ARRANGEMENTS & MECHANISMS*

* L DILLING & M C LEMOS (2011) "CREATING USABLE SCIENCE: OPPORTUNITIES AND CONSTRAINTS FOR CLIMATE KNOWLEDGE USE AND THEIR IMPLICATIONS FOR SCIENCE POLICY"; GLOBAL ENVIRONMENTAL; CHANGE, PAGES 680-689

Institutional Arrangements & Mechanisms	**Description**	**Remarks: *NASA's Approach***
1) Information Brokers	Broker is an intermediary between the user and the scientists	*NASA's contractor consultant is currently SAIC*
2) Collaborative Group Processes	Many groups with a vested the outcome and where decision making is highly distributed	*NASA "Oversight Steering Group": Directorate level stakeholders that coordinate efforts*
3) Embedded Capacity	Local climate scientists available to provide information and advice	*NASA Climate Adaptation Science Investigators (CASI) are NASA climate scientists at NASA Centers doing local applied research*
4) Boundary Organizations	Functions between the world of research and use of science to tailor information and produce value-added products; translation and customization of climate information to specific users	*NASA "Core Team" on Climate Risks & Adaptation: implementation team that designs workshops and information products*
5) Knowledge Networks	Comprised of policy makers, scientists, government agencies, and non-government organizations that communicate and share information across areas of practice	*Interagency Forum on Climate Change Impacts & Adaptations: (NASA, USACE, and others) NASA is Forum Co-Chair and uses the Forum to spin-in best practices.*

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FORUM SEEKS OUT:

- ***BEST AVAILABLE SCIENCE***
- ***BEST AMANGEMENT PRACTICES***
- ***LESSONS LEARNED***

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U.S. Department of Agriculture (including U.S. Forest Service, Natural Resources Conservation Service)	U.S. Environmental Protection Agency
U.S. Department of Justice	U.S. Department of Transportation (including Federal Aviation Administration)
Government Accountability Office	U.S. Department of State (including U.S. Agency for International Development)
U.S. Army (including U.S. Army War College, Army Environmental Policy Institute)	General Services Administration
U.S. Navy	U.S. Air Force
U.S. Department of Commerce (including National Oceanic and Atmospheric Administration)	National Academies (including National Academy of Sciences, National Research Council)
U.S. Department of Energy	Office of Secretary of Defense
U.S. Global Change Research Program	National Institutes of Health

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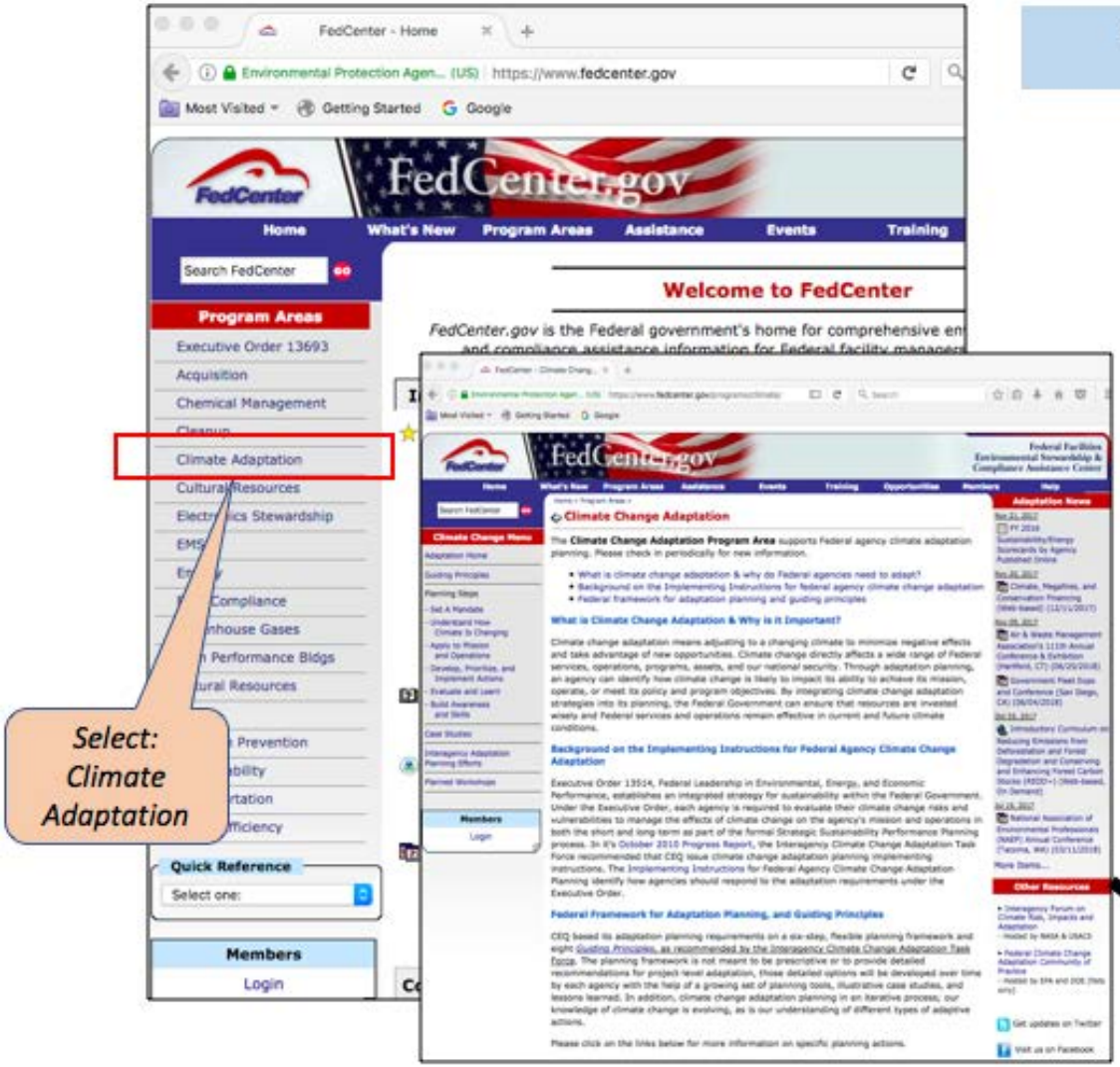

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Other Resources

- Interagency Forum on Climate Risk, Impacts and Adaptation
  - Hosted by NASA & USACE

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*(Past) **SPECIAL EVENTS***

- *2nd International Technical Workshop on Climate Risks*
- *Special Training Event: Climate Change - Installation Adaptation & Resilience*
- *Special Training Event: Climate Risks Management*
- *Special Training Event: Climate Adaptation and Infrastructure Engineering*
- *Climate and Energy: Extreme Weather & Climate Events*
- *Special Session: Climate Change and Adaptation*

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