Addressing Extreme Events at WSDOT and Beyond



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Background and Experience

Assisted transportation agencies in assessing vulnerability and developing adaptation strategies as part of hydrologic and hydraulic analysis and design services

Examples:

- Evaluating flood risk under potential extreme events and land use scenarios that combine changes in the frequency and magnitude of peak stream flows with sea level rise

- Investigating effects of changes in precipitation, temperature regimes and design flows for the design of transportation infrastructure

Extreme Events and Climate Change at WSDOT

In October 2010, Federal Highways funded a pilot project which gave WSDOT a mechanism to understand how changes in our climate could effect WSDOT infrastructure and operations

General Overview of pilot project:

1) Identify Assets

2) Determine criticality of the asset

3) Identify potential climate threats

4) Share results of study with variety of offices within the agency to assist with making informed decisions

Goal: Preserve assets in a changing environment

- Apply an asset management approach
  - Be ready for severe weather events and long-term changes in site conditions
  - Inform long-term decisions
  - Build resilience where possible
- Conduct a statewide vulnerability assessment
  - Understand and communicate current science
  - Scope: Consider impacts on all WSDOT assets (Highways, Ferries, State-owned Rail and Airports)


Courtesy of WSDOT

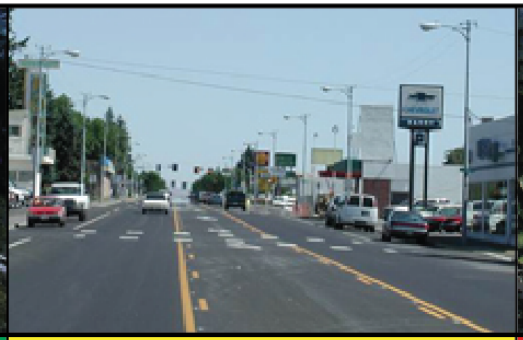
How critical is the asset?

WSDOT Methodology

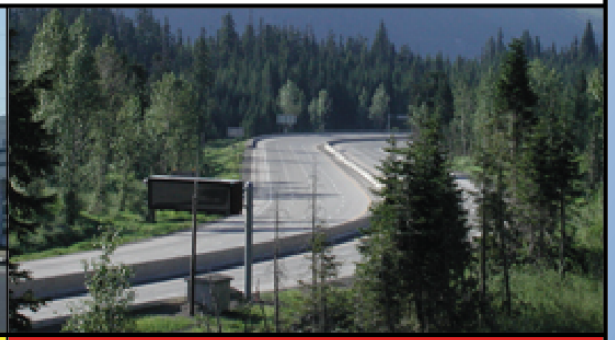
Very low to low				Moderate		Critical to Very Critical			
1	2	3	4	5	6	7	8	9	10
Criticality of asset									

Notice that along with the qualitative terms there is an associated scale of 1 to 10, this is to serve as a facilitation tool for some people who may find it useful to think in terms of a numerical scale - although the scoring by each individual is of course subjective. The scale is a generic scale of criticality where "1" is very low (least critical) and "10" is very critical.

Typically involves:
- non-NHS
- low AADT
- alternate routes available



Typically involves:
- some-NHS
- non-NHS
- low to medium AADT
- serves as an alternative for other state routes



Typically involves:
- Interstate
- Lifeline
- some NHS
- sole access
- no alternate routes

Courtesy of WSDOT

Record impact score

10 9 8 7 6 5 4 3 2 1

Complete catastrophic failure

Results in total loss or ruin of asset. Asset *may* be available for *limited* use after at least 60 days and would require major repair or rebuild over extended period of time. "Complete and/or catastrophic failure" typically involves:

- Immediate road closure;
- Disruptions to travel;
- Vehicles forced to re-route to other roads;
- Reduced commerce in affected areas;
- Reduces or eliminate.es access to some destinations;
- May sever some utilities located within right-of-way;
- May damage drainage conveyance or storage systems.

Temporary operational failure

Results in minor damage and/or disruption to asset. Asset would be available with either full or limited use within 60 days and may have immediate limited use still available.

"Temporary Operational Failure" typically involves:

- Temporary road closure, hours to weeks;
- Reduced access to destinations served by the asset;
- Stranded vehicles;
- Possible temporary utility failures.

Reduced capacity

Results in little or negligible impact to asset. Asset would be available with full use within 10 days and has immediate limited use still available. "Reduced capacity" typically involves:

- Less convenient travel;
- Occasional/ brief lane closures, but roads remain open;
- A few vehicles may move to alternate routes;

Courtesy of WSDOT

What are the Climate Threats?

- Discussed observed changes and extreme events with a variety of disciplines including: Maintenance, hydraulics, bridge, geotechnical, materials, environmental staff, etc

- Key Questions:
  - “What keeps you up at night?”
  - “What if it gets worse (given the scenario)?”
  - “How resilient is our existing system?

- WSDOT’s experts ranked all WSDOT assets

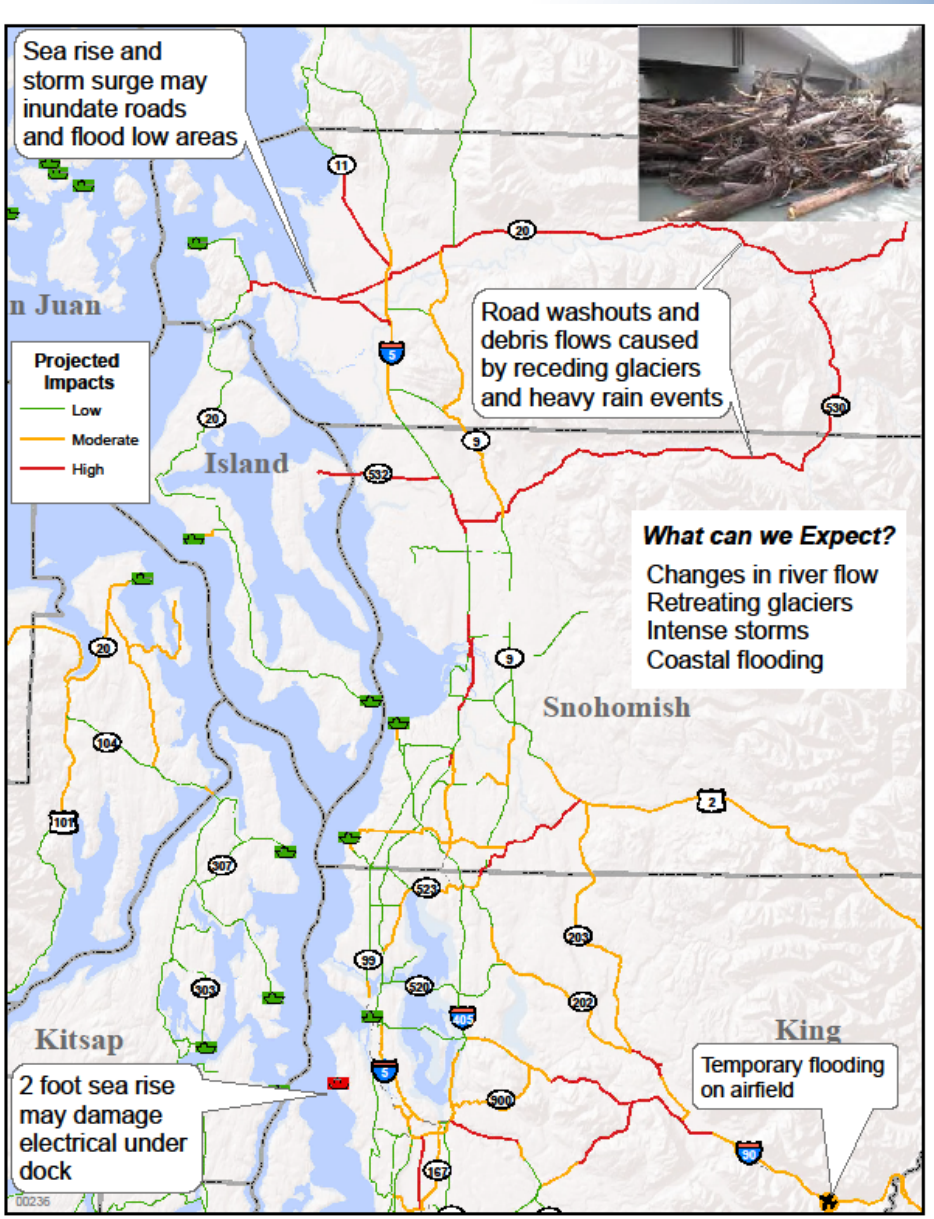
Workshops: How might climate impact assets?

Primary climate drivers		*Can lead to impacts on...*
Temperature	→	Expansion joints, pavement, rail tracks, construction periods, habitat projects, electrical equipment
Precipitation	→	Flooding of surface roads & tunnels, road washout, pump capacity, drainage
Hydrologic shifts	→	Soil instability, water supply, bridge and road support structures
Sea level rise, storm surge	→	Coastal erosion, coastal and upriver flooding, bridge footings, drainage, roadside stability, salt / corrosion

Courtesy of WSDOT

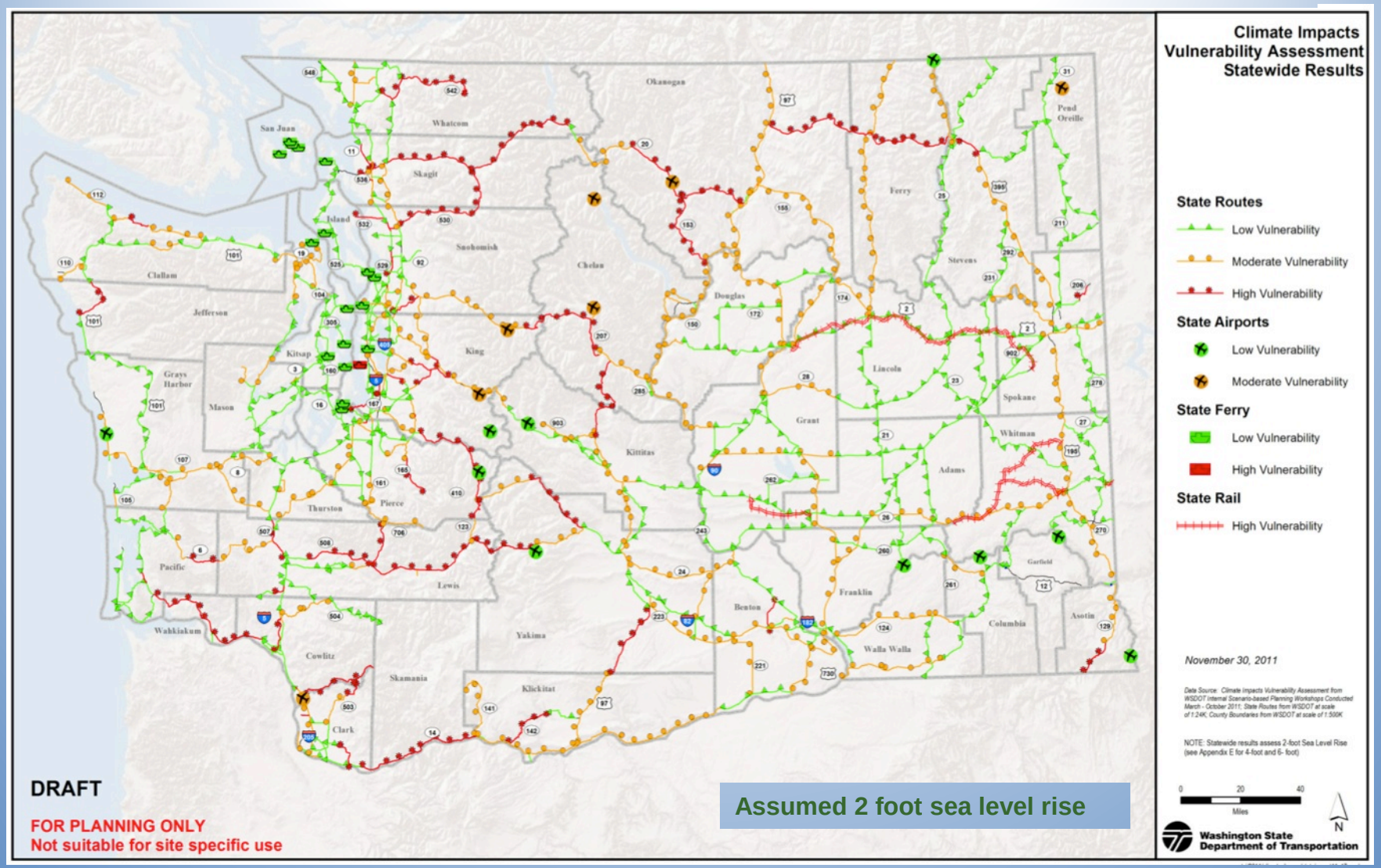
What did WSDOT find?

- Intensifies known threats
- Reinforces value of WSDOT current maintenance and retrofit programs
- Some surprises
- Unique and effective way to capture knowledge of field staff



Courtesy of WSDOT

Statewide Results



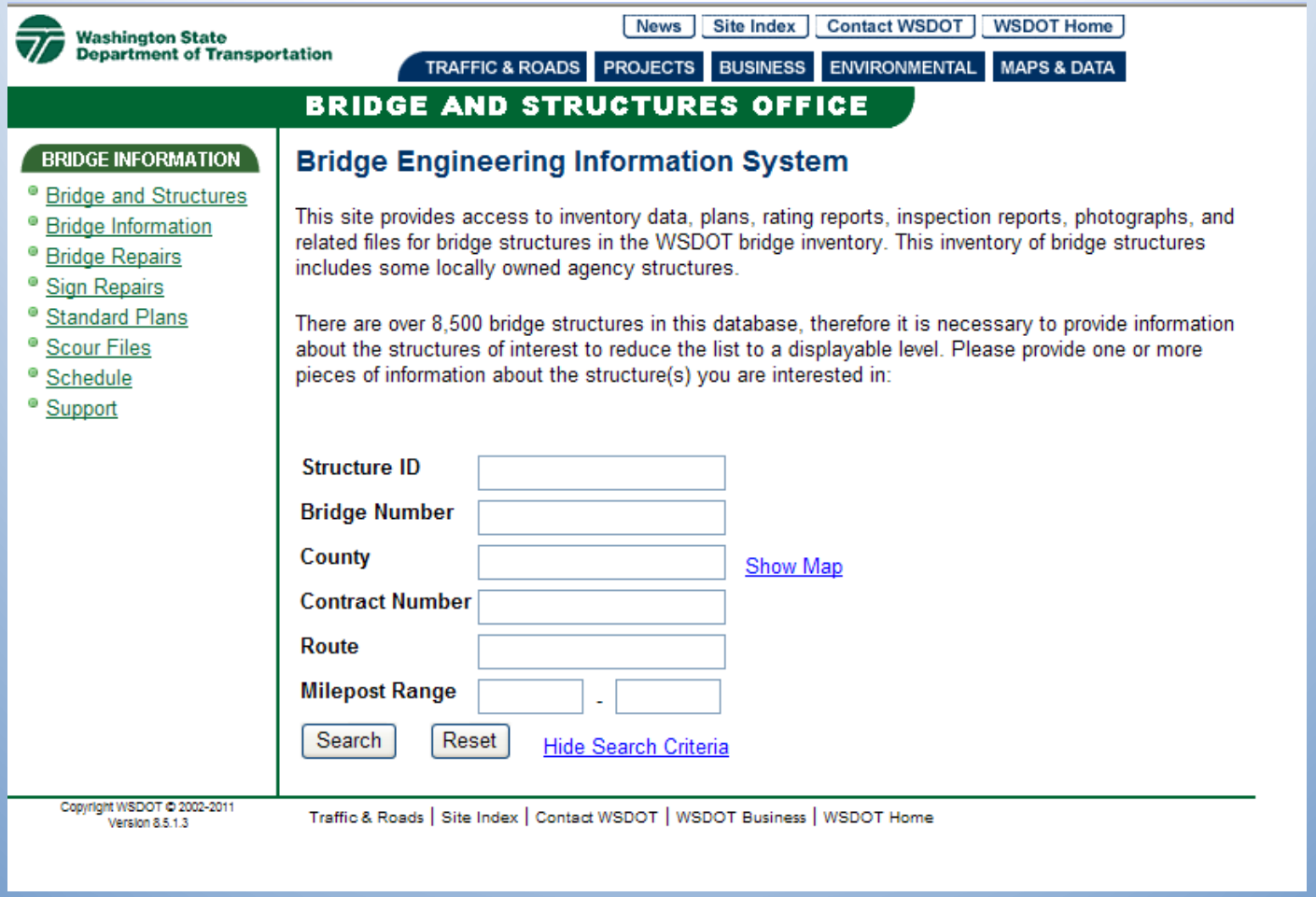
Courtesy of WSDOT

Using Vulnerability Information to Inform Decisions

Takeaways

- There is not a consistent way for how to use vulnerability information in design
- Typically happens on a project-by-project basis
- Trade off between other agency strategic goals (e.g. is designing for an extreme event practical design?)
- Not all sites or extreme events are the same. Need to understand your site and cost of “failure”
- Not adequate data (intensity data) for design at local scale (e.g. highway drainage, storm drains, etc)

Bridge Engineering Information System (BEISt)



Mud Bay Bridge (101/508E)

Washington State Department of Transportation

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BRIDGE AND STRUCTURES OFFICE

BRIDGE INFORMATION

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- Bridge Repairs
- Sign Repairs
- Standard Plans
- Scour Files
- Schedule
- Support

STRUCTURE DATA

- Current Bridge
- Plans
- Scour POA
- Contracts
- Inspection Photos
- Inspection Files
- Correspondence
- Inspection Reports
- Repairs
- Maintenance
- WS SI&A (English)
- WS SI&A (Metric)

MUD BAY

Hide current Bridge Information

Bridge Number	**101/508E**	Structure Type	**CS**
Structure Identifier	**0005677A**	Operating Rating Tons	**56**
Location	**1.3 S JCT SR 8**	Inventory Rating Tons	**34**
Route	**00101**	Min Over Deck	**99' 99"**
Mile Post	**362.83**	Min Under Bridge	**0"**
Feature Intersected	**MUD BAY**	Sufficiency Rating	**80.42**
Facilities Carried	**US 101**	Year Built	**1958**
Region	**OL**	Year Rebuilt	
Owner	**Washington State**	SD/FO	**N/A**

Open Close Posted Code **A**

Inspections Performed

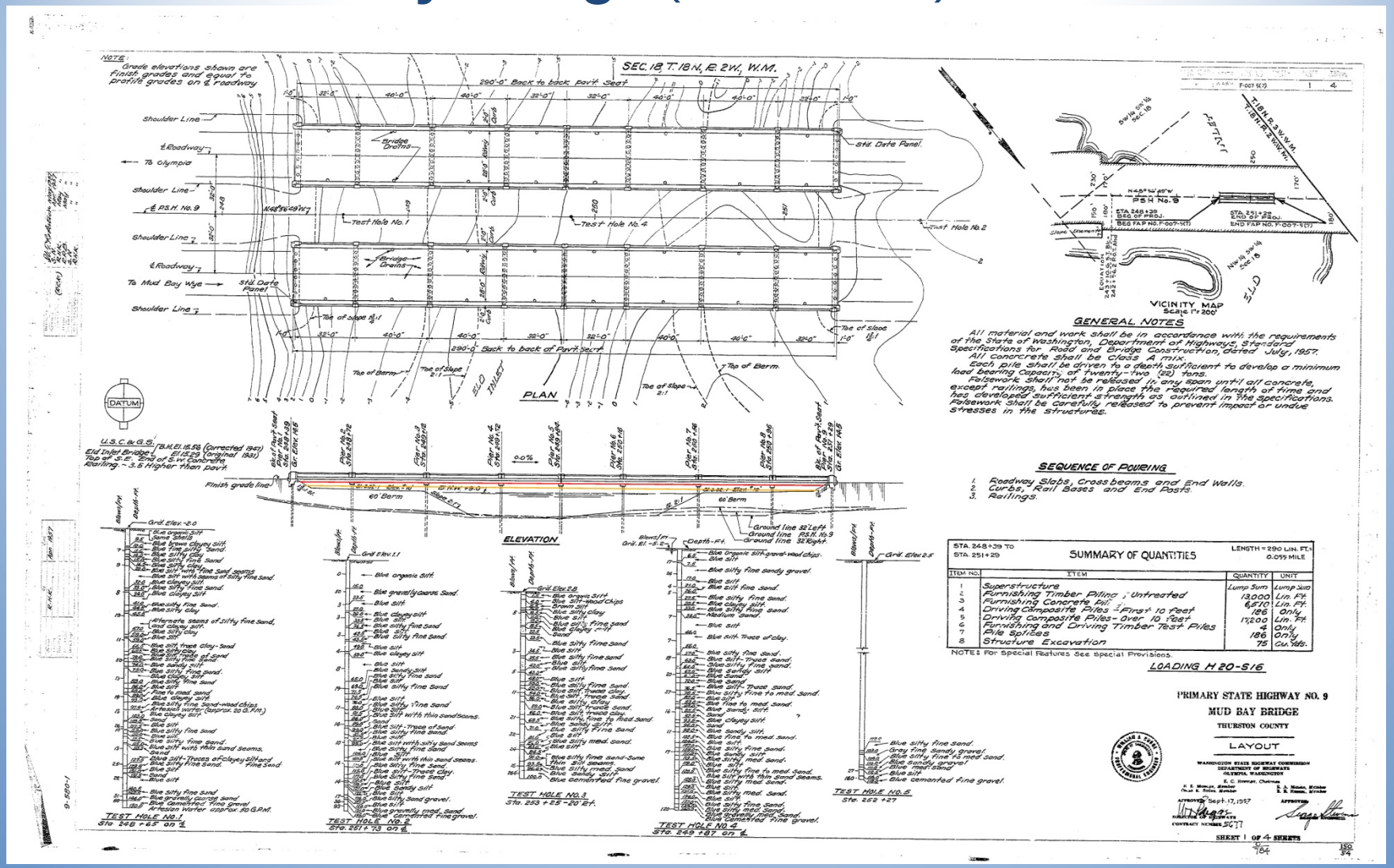
Hide Current Inspections Performed

Report Type	Inspn Date	Inspn Freq	Insp Type
Routine	2010-05-12	24	
Equipment	2010-05-12	72	

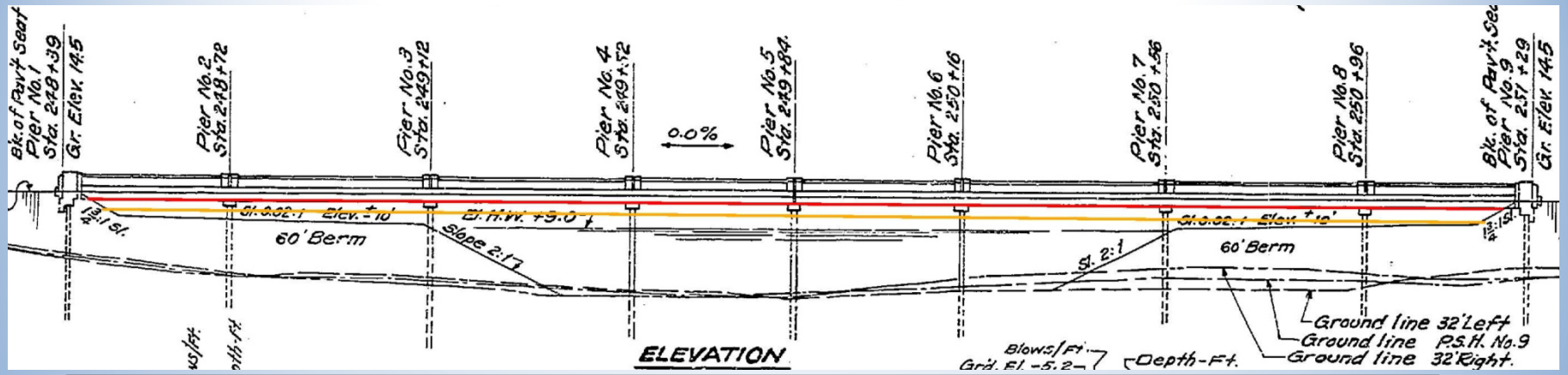
MUD BAY Image

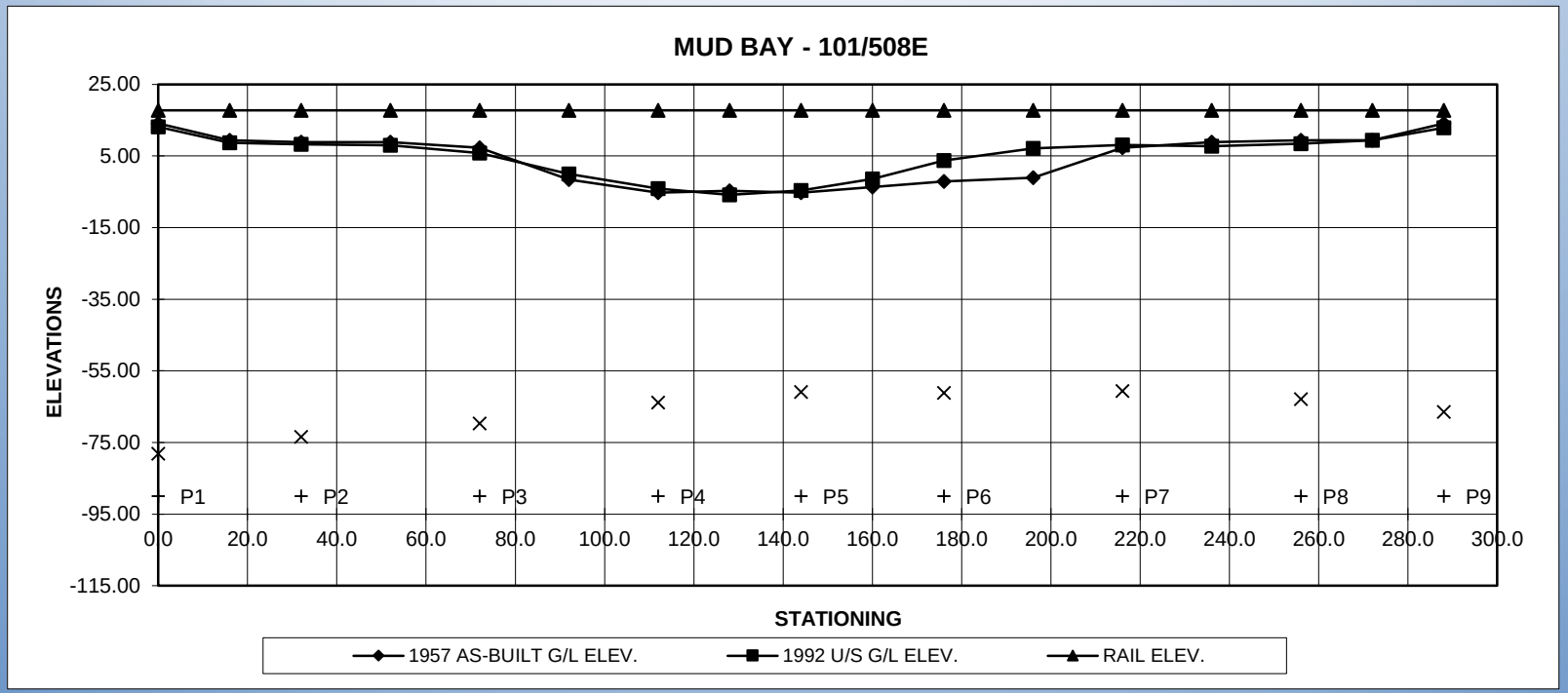
Hide Current Bridge Image

Mud Bay Bridge (101/508E) As-Built

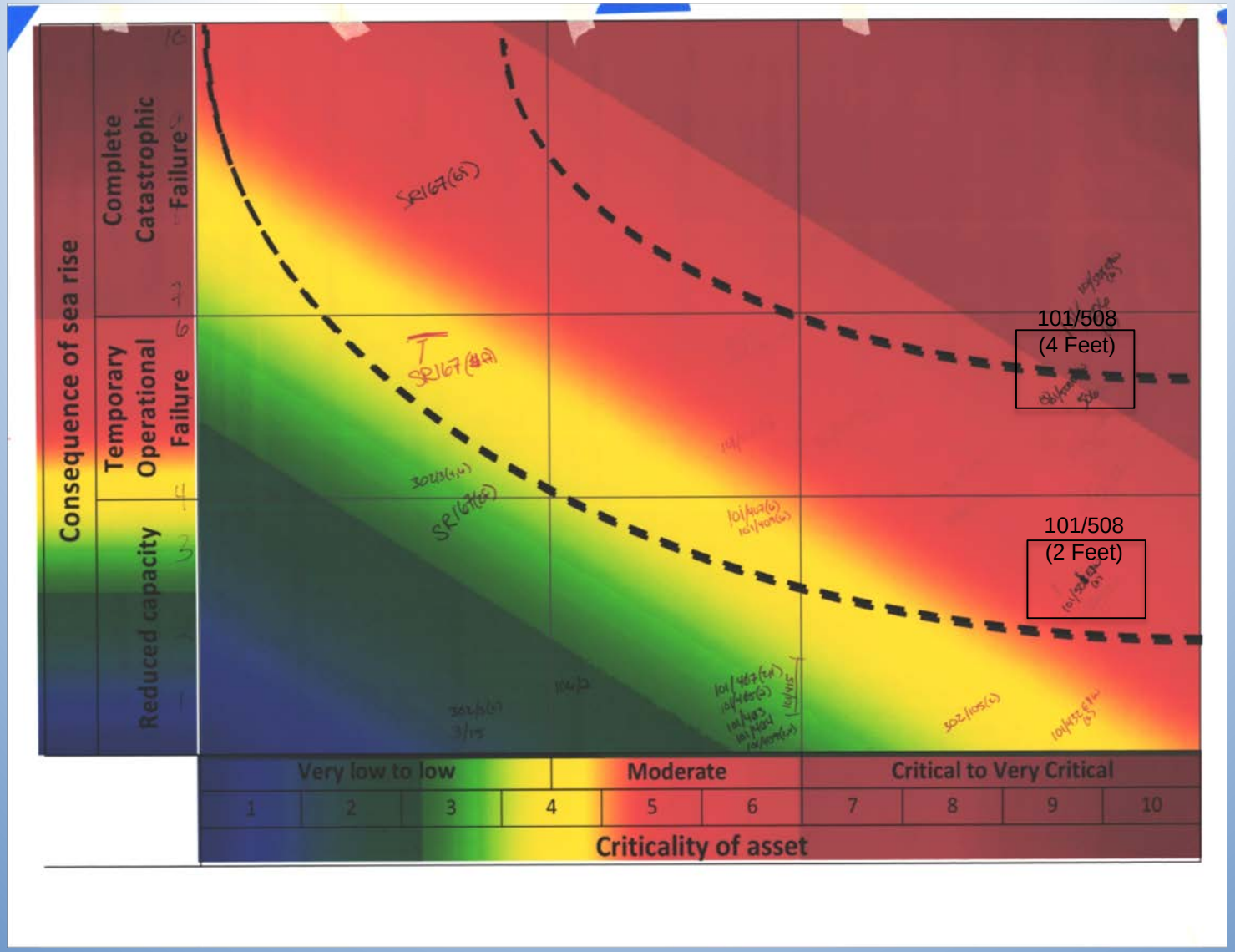


Mud Bay Bridge (101/508E) As-Builts





Mud Bay Bridge (101/508E)



SR 4 – Pete's Creek Culvert

Extreme Event Impacts on Highway Infrastructure Engineering Vulnerability Assessment

Emergency protection being placed at the west abutment of Bitter Creek Bridge shortly before the bridge was washed out (September, 2011).

NHC participates in the development of national and international downscaled projections of climate and hydrology

Several NHC professionals are familiar users of U.S.-wide datasets of downscaled climate and hydrology.

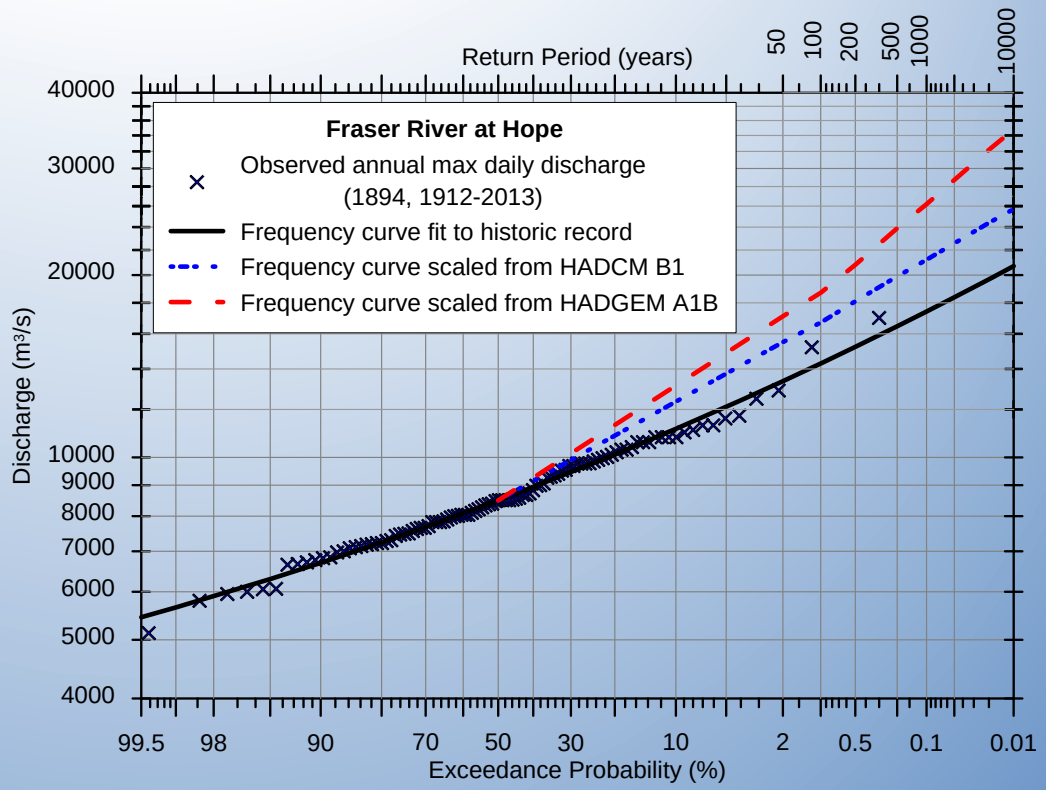
Some examples:

- NASA's high resolution (800 m) statistically-downscaled climate projections
- USGS's statistically- and dynamically-downscaled climate projections
- NARCCAP's dynamically-downscaled climate projections
- U. Idaho's statistically-downscaled climate projections
- USBR (and others) hydrologic projections
- EPA's hydrologic projections

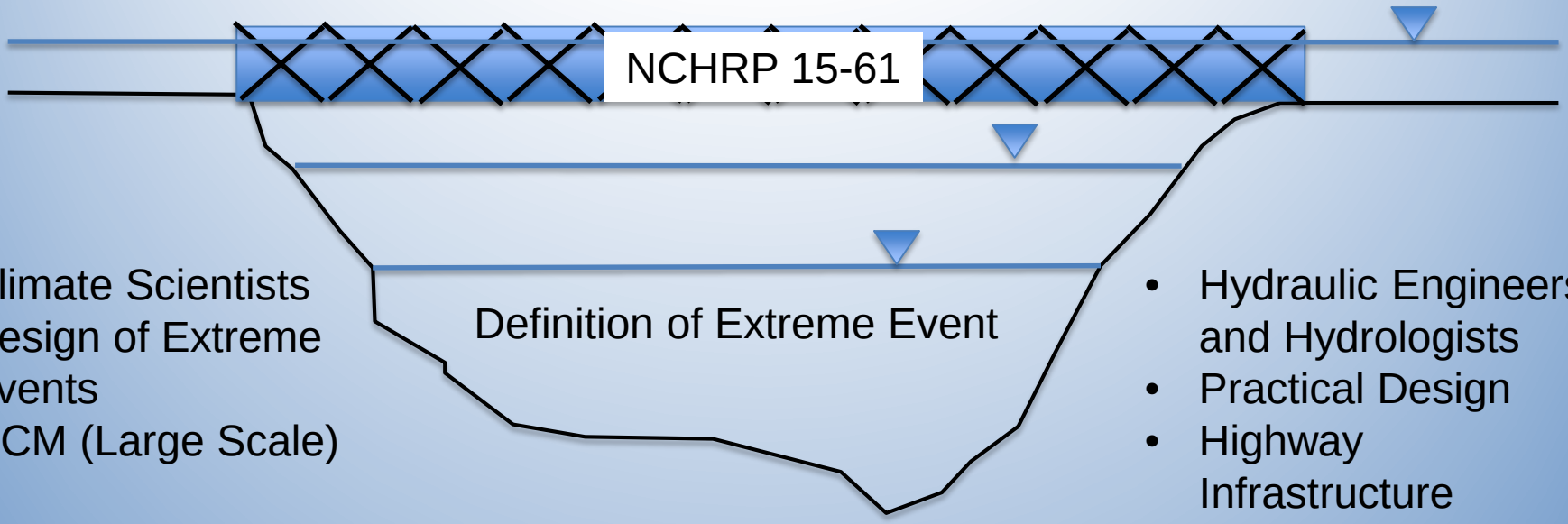
NHC also has experience generating downscaled projections of climate and hydrology for specific watersheds, using state of the art hydrologic models.

Climate Change Impacts on Flood Hazard Assessment for Fraser River at Hope (B.C.)

Evaluate future flood frequency using extreme value analysis of projected streamflows corresponding to 3 different climate scenarios



Bridging the Gap



- Climate Scientists
- Design of Extreme Events
- GCM (Large Scale)

- Hydraulic Engineers and Hydrologists
- Practical Design
- Highway Infrastructure (Typically small scale)

Questions?

For more information:
http://www.nhcweb.com/services/climate-change.asp

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