Integrating Climate Resiliency into Engineering Design

Becky Lupes
Sustainable Transport and Climate Change Team
Federal Highway Administration
September 25, 2015
Importance of Resilience for FHWA and State DOTs

- Climate change and extreme weather events disrupting transportation systems
- Past events don’t necessarily reflect future conditions
- FHWA Order 5520: Transportation System Preparedness and Resilience to Climate Change and Extreme Weather Events (December 2014)

Hurricane Katrina flooding around New Orleans. Source: Komonews.com
Approach: Engineering Assessments

There is limited guidance on how to incorporate climate change projections into transportation engineering design.

1. Develop engineering analysis on a diverse set of transportation assets through projects around the country and working with different agencies,

2. Explain and document specific findings.

3. Use results to formulate recommended practices.
11-Step Engineering Assessment “Process”

1. Describe the site context
2. Describe the existing or proposed facility
3. Identify environmental factors that may impact infrastructure components
4. Decide on climate scenarios and determine magnitude of changes
5. Assess performance of the existing or proposed facility
6. Develop adaptation option(s)
7. Assess performance of the adaptation options
8. Conduct an economic analysis
9. Evaluate additional decision-making considerations
10. Select a course of action
11. Plan and conduct ongoing activities

- Determine scope of the analysis
- Figure out what might harm the facility
- Develop solutions to make more resilient
- Make a decision, and monitor
Gulf Coast 2 Project – Mobile Alabama

I-10 – Mileposts 24 to 25
MassDOT: Central Artery Study

Tip O’Neill Tunnel Portal

Probability of flooding in 2030 from Boston Harbor Flood Risk Model Results, 2030 High Emissions Scenario.


Flood Depth in 1,000 year (0.1%) Storm

<table>
<thead>
<tr>
<th></th>
<th>2013 Depth (ft)</th>
<th>2013 to 2030 Depth (ft)</th>
<th>2030 to 2070/2100 Depth (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.4</td>
<td>1.4</td>
<td>4.5</td>
</tr>
</tbody>
</table>
Silver Creek Culvert

Upstream Cross-Section of Design Option 1 for culvert 5648. Source: MnDOT pilot final report

| Table 4: Projected Life-Cycle Costs for Culvert 5648 Adaptation Options WITH Social Costs, Medium Scenario |
|--------------------------------------------------|--------------------------------------------------|--------------------------------------------------|--------------------------------------------------|--------------------------------------------------|--------------------------------------------------|--------------------------------------------------|
| | Period 1 | Period 2 | Period 3 | Initial Construction | Total Damage/Repair Costs by 2100 | Total Life Cycle Costs by 2100 |
| | 2025-2055 | 2056-2085 | 2086-2100 | | | |
| Base Case: Replace in-Kind | $120,262 | $52,703 | $16,693 | $643,069 | $189,658 | $832,727 |
| Option 1: Two-Cell Culvert | $18,226 | $7,851 | $2,487 | $697,413 | $28,564 | $725,977 |
| Option 2: 52-Foot Bridge | $69,148 | $31,269 | $9,904 | $1,023,476 | $110,321 | $1,133,797 |
| Option 3: 57-Foot Bridge | $25,839 | $11,130 | $3,525 | $1,095,934 | $40,494 | $1,136,428 |
Assessments Underway

- Hurricane Sandy Follow-up and Vulnerability Assessment and Adaptation Analysis (Spring 2016)
- Transportation Engineering Approaches to Climate Resilience (TEACR) (2016)
Bringing it all together: Reference Document on Resiliency in Engineering

Research/Guidance

Gulf Coast 2 Study
Engineering-focused Pilots
Hurricane Sandy Project
Engineering Assessments Study
Guidance (HEC-25 & 17)

Synthesis Document

Engineering Approaches for Climate and Extreme Weather Resilience (2016)
Thank You!

For more information:  
http://www.fhwa.dot.gov/environment/climate_change/adaptation

First International Conference on Surface Transportation System Resilience to Climate Change and Extreme Weather Events  
Recording available for viewing until September 2016

Sustainable Transportation and Climate Change Team Resilience Contacts:  
• Mike Culp, Team Leader, Michael.Culp@dot.gov  
• Tina Hodges, Tina.Hodges@dot.gov  
• Heather Holsinger, Heather.Holsinger@dot.gov  
• Rob Hyman, Robert.Hyman@dot.gov  
• Rob Kafalenos, Robert.Kafalenos@dot.gov  
• Becky Lupes, Rebecca.Lupes@dot.gov

Office of Infrastructure Contact:s  
• Joe Krolak, Principal Hydraulics Engineer, joseph.krolak@dot.gov  
• Brian Beucler, Senior Hydraulics Engineer, Brian.Beucler@dot.gov  
• Gina Ahlstrom, Pavement Engineer: Gina.Ahlstrom@dot.gov