Ohio DOT Infrastructure Resiliency Plan

July 26, 2017
Overview – Ohio DOT
Infrastructure Resiliency Plan

Motivation
Related Initiatives
Climate Effects Expected in Ohio
Special Topics
Determining Asset Vulnerability
Recommendations
Motivation for the Resiliency Plan

To conduct systems-level vulnerability and risk assessment of the ODOT’s infrastructure that will likely be impacted by climate change effects. Time frame – 2100.
Related Initiatives in Ohio

• Ohio River Basin Climate Change Project
  - US Army Corps of Engineers, NOAA/NWS, USGS, EPA

• Sustaining Scioto-Columbus, OH region, focus on water supply and quality

• >20 Similar Efforts by Other State DOTs
Intergovernmental Panel on Climate Change

- Climate Projections

(a) A1

(b) A2

(c) B1

(d) B2
Likely Climate Change Effects

From: TRB Special Report 290

- Increases in very hot days and heat waves – very likely (>90%)
- Rising sea levels – virtually certain (>99%)
- Increases in Arctic temperature – virtually certain (>99%)
- Increases in intense precipitation events – very likely (>90%)
- Increases in hurricane intensity -- likely (>66%)
Projected Changes in Ohio Climate – US Army Corps of Engineers (ORBCC)

<table>
<thead>
<tr>
<th>Gradual</th>
<th>Event-Driven</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increasing Average Temperatures</td>
<td>x</td>
</tr>
<tr>
<td>Increased Drought Duration</td>
<td>x</td>
</tr>
<tr>
<td>Reduced Lake Erie Water Levels</td>
<td>x</td>
</tr>
<tr>
<td>Increased Frequency of Heavy Precipitation Events</td>
<td>x</td>
</tr>
</tbody>
</table>

Projected Average Annual Temperature Increase, Ohio (F)

IPCC Scenario A1B (Mid GHG Emissions)

<table>
<thead>
<tr>
<th></th>
<th>Low</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>+50 Years</td>
<td>2.5</td>
<td>5.0</td>
</tr>
<tr>
<td>+100 Years</td>
<td>4.5</td>
<td>7.0</td>
</tr>
</tbody>
</table>
Impacts of Warmer Temps – Some “+”s and “–”s

Warmer Winters =
- reductions in snow and ice removal costs;
- reduced environmental impacts from the use of salt and chemicals on roads and bridges;
- extend the construction season;
- improve the mobility and safety of passenger and freight travel through reduced winter hazards.

Hotter Summers =
- Limit on construction activities and the hours road crews can work due to health and safety concerns for highway workers.
- Load restrictions on roads.
- Pavement damage and buckling will disrupt vehicle movements.
- Extreme heat could disrupt vehicle operations because of overheating and increased risk of tire blowouts in heavily loaded vehicles.
1. Impacts of Extreme Heat on Pavements
2. Impacts on Air Quality
3. Lake Erie Water Levels
4. Potential Opening of the Northwest Passage
Special Topic #1: Impacts to Pavements – Key Findings

1. Pavement modeling generally suggests pavement impacts will be minimal and that there are many ways to adapt pavements to climate change effects, if necessary.

2. ODOT-maintained highways are not typically constructed on expandable clay soils within the pavement structure profile.

3. However, secondary roads maintained by counties or other jurisdictions may be vulnerable to projected drought-inundation cycles due to lower design standards.
Special Topic #2” Impacts to Air Quality

Ohio currently has 3 Ozone Non-Attainment Areas:
  Cincinnati-Hamilton
  Cleveland-Akron-Lorain
  Columbus

Anticipated tightening of Ozone standard to 70ppm.

Likely increase in the degree and extent of Non-Attainment.
Special Topic #3” Lake Erie Water Levels

Low water levels contributed to this structural damage at Port Wing, Wisconsin.
Special Topic #4” Northwest Passage

Average Monthly Arctic Sea Ice Extent
July 1979 - 2013

Year

Extent (million square kilometers)


National Snow and Ice Data Center
Special Topic #4” Northwest Passage

Possible passage to Lake Erie
Main Northwest Passage Way
Precipitation Projections for the Midwest, 2041-2070 Relative to 1971-2000, National Climate Assessment
Projected Climate Effect – Increasing Variability of Precipitation & Stream Flows
FHWA Vulnerability Model - Three Components

- Exposure Indicator 1
- Exposure Indicator 2
- Sensitivity Indicator 1
- Sensitivity Indicator 2
- Adaptive Capacity Indicator 1
- Adaptive Capacity Indicator 2

Normalize and Weight

- Exposure Score
- Sensitivity Score
- Adaptive Capacity Score

Weight

Vulnerability Score
Vulnerability to Flooding – Bridges and Culverts

Previous Flooding Issues
Percent Forest
Percent Not Wetlands or Lakes
Percent Urban
Stream Flow Increase
Rain Fall Increase

Channel Condition Rating
Waterway Adequacy Rating
Scour Rating
Substructure Rating

Future AADT
Truck AADT
Detour Length
Strategic Transportation System
Distance to Critical Facilities

Normalize, Weight, and Average

Exposure Score
Sensitivity Score
Adaptive Capacity Score

Weight and Average

Vulnerability Score
# 10 Most Vulnerable Bridges from Vulnerability Modeling

## Most Vulnerable Assets

<table>
<thead>
<tr>
<th>Asset ID</th>
<th>Bridge Location Description</th>
<th>Score (Rank#)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4822</td>
<td>NB I 75 (RILEY CREEK)</td>
<td>2.64 (1)</td>
</tr>
<tr>
<td>4823</td>
<td>SB I 75 (RILEY CREEK)</td>
<td>2.64 (2)</td>
</tr>
<tr>
<td>2228</td>
<td>I.R.475 00475 (OTTAWA RIVER)</td>
<td>2.62 (3)</td>
</tr>
<tr>
<td>2228</td>
<td>I.R.475 00475 (OTTAWA RIVER)</td>
<td>2.62 (3)</td>
</tr>
<tr>
<td>4056</td>
<td>US 62 3.09 MI W OF SR 165 (BR MAHONING RIVER)</td>
<td>2.5 (4)</td>
</tr>
<tr>
<td>2144</td>
<td>US 224 0.70 MI E OF SR 625 (MILL CREEK)</td>
<td>2.48 (5)</td>
</tr>
<tr>
<td>2132</td>
<td>US 62 0.47 MI W OF SR 289 (SR 289 MAH R &amp; CSX&amp;NS RR)</td>
<td>2.45 (6)</td>
</tr>
<tr>
<td>2143</td>
<td>US 224 0.80 MI E OF SR 625 (MILL CREEK)</td>
<td>2.44 (7)</td>
</tr>
<tr>
<td>785</td>
<td>US 62 4.13 MI E OF SR 173 (OVR SR183 RR CRK&amp;GASKILL)</td>
<td>2.43 (8)</td>
</tr>
<tr>
<td>786</td>
<td>US 62 4.13 MI E OF SR 173 (OVR SR183 RR CRK&amp;GASKILL)</td>
<td>2.42 (9)</td>
</tr>
<tr>
<td>751</td>
<td>SR 619 2.24 MI W OF SR 183 (LITTLE BEECH CREEK)</td>
<td>2.42 (10)</td>
</tr>
</tbody>
</table>

number of assets: 5608
with valid scores: 5444
shown here: top 10

8-31-2016
Vulnerability to Flooding – Highways

- Previous Flooding Issues
- Length at Risk of Erosion
- Percent Not Wetlands or Lakes
- Percent Urban
- Stream Flow Increase
- Rain Fall Increase
- Pavement Condition Rating
- AADT
- Truck AADT
- Stategic Transporation System
- Distance to Critical Facilities

Normalize, Weight, and Average

Exposure Score
Sensitivity Score
Adaptive Capacity Score

Weight and Average

Vulnerability Score
Most Vulnerable Highway Segments

Most Vulnerable Assets

number of assets: 5608
with valid scores: 5444
shown here: top 10
### Most Vulnerable Highway Segments

<table>
<thead>
<tr>
<th>Asset ID</th>
<th>Rank</th>
<th>Highway Segment Vulnerability</th>
<th>Location Description</th>
<th>Map Image</th>
</tr>
</thead>
<tbody>
<tr>
<td>115</td>
<td>1</td>
<td>2.75</td>
<td>Highway 33, St. Mary's, OH</td>
<td><img src="image1.png" alt="Map of Highway 33, St. Mary's, OH" /></td>
</tr>
<tr>
<td>102</td>
<td>2</td>
<td>2.74</td>
<td>Highway 33, St. Mary's, OH</td>
<td><img src="image2.png" alt="Map of Highway 33, St. Mary's, OH" /></td>
</tr>
<tr>
<td>106</td>
<td>3</td>
<td>2.55</td>
<td>Highway 7, Martins Ferry, OH</td>
<td><img src="image3.png" alt="Map of Highway 7, Martins Ferry, OH" /></td>
</tr>
<tr>
<td>121</td>
<td>4</td>
<td>2.55</td>
<td>Highway 7, Martins Ferry, OH</td>
<td><img src="image4.png" alt="Map of Highway 7, Martins Ferry, OH" /></td>
</tr>
<tr>
<td>Asset ID</td>
<td>Rank</td>
<td>Highway Segment Vulnerability</td>
<td>Location Description</td>
<td>Map Image</td>
</tr>
<tr>
<td>----------</td>
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<td>-------------------------------</td>
<td>----------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>50</td>
<td>5</td>
<td>2.54</td>
<td>Highway 50 (Appalachian Hwy), east of Athens</td>
<td><img src="image1.png" alt="Map Image" /></td>
</tr>
<tr>
<td>45</td>
<td>6</td>
<td>2.52</td>
<td>Highway 50 (Appalachian Hwy), east of Athens</td>
<td><img src="image2.png" alt="Map Image" /></td>
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<tr>
<td>21</td>
<td>7</td>
<td>2.5</td>
<td>Highway 50 (Appalachian Hwy), east of Athens</td>
<td><img src="image3.png" alt="Map Image" /></td>
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<tr>
<td>312</td>
<td>8</td>
<td>2.49</td>
<td>Highway 33, Long Street, north of Scioto River</td>
<td><img src="image4.png" alt="Map Image" /></td>
</tr>
<tr>
<td>79</td>
<td>9</td>
<td>2.48</td>
<td>Highway 50 (Appalachian Hwy), east of Athens</td>
<td><img src="image5.png" alt="Map Image" /></td>
</tr>
<tr>
<td>605</td>
<td>10</td>
<td>2.48</td>
<td>I-280, southeast of Toledo</td>
<td><img src="image6.png" alt="Map Image" /></td>
</tr>
</tbody>
</table>
“ODOT seems relatively well equipped and prepared to respond to the threats posed by extreme weather as they might affect the ODOT system.”

1. Follow-up with districts which expressed a potential for improvement in each of the topic areas surveyed, in order to understand what can and should be done in light of this information.

2. Implementation of formal “after action” reviews as an essential component of the Incident Command Structure (ICS).
Recommendations

- Designate a specialist within ODOT to manage a divisional cross-cutting effort to maintain the Department’s focus on vulnerability to climate change impacts to core infrastructure
  - logical lead is within Office of Planning.
- Annual Tasks of the Resiliency Lead (selected items):
  - Issues, data collection and analysis that need to be monitored on an ongoing basis, as part of input to ODOT’s transportation planning function.
  - What climate stressors will affect the proposed facility either directly or through effects on the surrounding ecology?
  - Integration of Vulnerability Assessment into Project Scoping/Design
Recommendations

- Develop Strategies for Protecting the Function of Identified Vulnerable Assets

<table>
<thead>
<tr>
<th>Planning</th>
<th>![Compass]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental Analysis</td>
<td>![Thermometer]</td>
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<tr>
<td>Design Standards</td>
<td>![Rule]</td>
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<tr>
<td>Infrastructure Retrofit/Maintenance</td>
<td>![Hammer]</td>
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<tr>
<td>Operations</td>
<td>![Storm Cloud]</td>
</tr>
<tr>
<td>Public Outreach/Communications</td>
<td>![Phone]</td>
</tr>
</tbody>
</table>
Recommendations

• Ongoing refinement of VAST model for the 3 asset types (highways, bridges, culverts):
  – Initial refinement of scales and weights in VAST model based on input from Districts.
  – Annual inspection visit to the top ranked vulnerable assets in each asset class. Revise VAST model as necessary to conform to best data/knowledge from USGS and from field inspections.
  – Update list of critical facilities, re-run VAST to determine whether there is a different prioritization of assets.
**Recommendations**

- **Interagency Coordination:**
  - Coordinate with ODOT Emergency Transportation Operations
  - Follow-up with districts which expressed a potential for improvement in each of the topic areas surveyed, in order to understand what can and should be done in light of this information.
  - Implementation of formal “after action” reviews as an essential component of the continuous improvement philosophy under the Incident Command Structure (ICS) / Continuity of Operations / Continuity Program Management Cycle ([https://www.fema.gov/continuity-operations](https://www.fema.gov/continuity-operations))
  - Coordinate with ODOT Asset Management,
  - Develop advisory team of ODOT and extra-ODOT, including climate scientists from USGS/NWS.
Project Contacts

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