FHWA Vulnerability Assessment Framework and INVEST Sustainability Tool

Southeast Florida Regional Climate Leadership Summit
December 6, 2012

Heather Holsinger
Sustainable Transport & Climate Change Team
Office of Planning, Environment & Realty
Federal Highway Administration
U.S. Department of Transportation
Climate Change and Extreme Weather Vulnerability Assessment Framework
Climate Change Adaptation at FHWA

- **Goal:** Systematic consideration of climate change vulnerability and risk in transportation decision making, at system and project level

- **Approach:** Develop and share information on tools and methodologies that state DOTs and MPOs can use to assess risk and prioritize actions

Photo: Flooding of the Hugh L. Carey Tunnel in NYC due to Hurricane Sandy. Source: MTA
FHWA’s Vulnerability Assessment Conceptual Model/Framework

- Draft framework developed in 2010
- Conducted pilot program 2010-2011
  - Help DOTs and MPOs more quickly advance existing adaptation assessment activities
  - Assist FHWA in test driving the framework

1. Develop inventory of assets
2. Gather climate data
3. Assess vulnerability of assets to projected climate change
4. Identify, analyze, and prioritize adaptation options
5. Monitor and revisit as resources allow
6. Within scope of Risk Assessment pilot (High likelihood, Low consequence, High likelihood, Low consequence)
7. Outside of scope of Risk Assessment pilot (High likelihood, High consequence, High likelihood, Low consequence, Low likelihood, High consequence)
Vulnerability Assessment Framework

- Define Project Scope
  - Objectives
  - Relevant Assets
  - Climate Variables

- Assess Vulnerability
  - Asset data, criticality, sensitivity
  - Climate Inputs
  - Vulnerabilities, risk

- Integrate Vulnerability Into Decision Making
Defining Project Scope - Objectives

• Articulate Objectives
  - What actions might be motivated by the assessment?
  - Who is your target audience?
  - What products are needed?
  - What level of detail is required?
Defining Project Scope – Choose Relevant Assets for Assessment

• Select and Characterize Relevant Assets
  ▪ Asset Type
  ▪ Existing vs. planned assets
  ▪ Ownership / Jurisdiction
  ▪ Consider Data availability

Assets to Consider:
- Bridges and tunnels
- Culverts
- Road segments
- Key evacuation routes
- Rail lines and rail yards
- Transit system facilities and vehicles
- Port and airport infrastructure
- Signals and traffic control centers
- Emergency operations systems
- Intelligent Transportation Systems (ITS)
- Signs and other roadside assets
- Pipelines
- Wetlands
- Floodplains
Defining Project Scope – Climate Variables

What are climate impacts of concern?

- Flooding
- Sea level rise and storm surge
- More intense precipitation events
- Snowpack changes
- Increase in hurricane intensity
- Increase in very hot days
- Permafrost thawing

NJ Pilot –
- Sea level rise, storm surge, temperature, precipitation, drought, and inland flooding.
- Worked with State Climatologist
- Hired a consultant to develop downscaled climate projections

Washington State DOT pilot -
- Sea level rise, precipitation change, temperature change, and fire risk
- Used climate projections mandated by the state government for use in adaptation studies, developed by the University of Washington Climate Impacts Group
Assessing Vulnerability

- **Assess Vulnerability**
  - Develop Climate Inputs
  - Collect and Integrate Data on Assets
  - Assess Asset Criticality
  - Develop Information on Asset Sensitivity to Climate
  - Identify and Rate Vulnerabilities
  - Incorporate Likelihood and
### Assessing Vulnerability – WSDOT Criticality Assessment

<table>
<thead>
<tr>
<th>Criticality of asset</th>
<th>Very low to low</th>
<th>Moderate</th>
<th>Critical to Very Critical</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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
Assessing Vulnerability – WSDOT Impact Ratings

<table>
<thead>
<tr>
<th>Impact</th>
<th>Complete Failure</th>
<th>Temporary Operational Failure</th>
<th>Reduced Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Complete Failure</td>
<td>Temporary Operational Failure</td>
<td>Reduced Capacity</td>
</tr>
<tr>
<td>9</td>
<td>Complete Failure</td>
<td>Temporary Operational Failure</td>
<td>Reduced Capacity</td>
</tr>
<tr>
<td>8</td>
<td>Complete Failure</td>
<td>Temporary Operational Failure</td>
<td>Reduced Capacity</td>
</tr>
<tr>
<td>7</td>
<td>Complete Failure</td>
<td>Temporary Operational Failure</td>
<td>Reduced Capacity</td>
</tr>
<tr>
<td>6</td>
<td>Complete Failure</td>
<td>Temporary Operational Failure</td>
<td>Reduced Capacity</td>
</tr>
<tr>
<td>5</td>
<td>Complete Failure</td>
<td>Temporary Operational Failure</td>
<td>Reduced Capacity</td>
</tr>
<tr>
<td>4</td>
<td>Complete Failure</td>
<td>Temporary Operational Failure</td>
<td>Reduced Capacity</td>
</tr>
<tr>
<td>3</td>
<td>Complete Failure</td>
<td>Temporary Operational Failure</td>
<td>Reduced Capacity</td>
</tr>
<tr>
<td>2</td>
<td>Complete Failure</td>
<td>Temporary Operational Failure</td>
<td>Reduced Capacity</td>
</tr>
<tr>
<td>1</td>
<td>Complete Failure</td>
<td>Temporary Operational Failure</td>
<td>Reduced Capacity</td>
</tr>
</tbody>
</table>

**Complete 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 an extended period of time.

“Complete and/or catastrophic failure” typically involves:
- Immediate road closure
- Travel disruptions
- Vehicles forced to reroute to other roads
- Reduced commerce in affected areas
- Reduced or eliminated access to some destinations

May sever some utilities. 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.

“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
- Some vehicles may move to alternate routes.
Assessing Vulnerability – NJ Assessment Results

- 2100 Coastal area inundation:
  - 48 miles roadway (43 on major roads)
  - 3 miles NJ Transit tracks
  - 31 total rail miles impacted
  - Ocean city municipal airport

Aerial photo of Atlantic City following Hurricane Sandy. Source: Michael Reynolds/European Pressphoto Agency

SLR 1 Meter, 2100, Coastal Study Area (Roadways). Source NJTPA
Integrate Results into Decision Making

• **WSDOT**  
Pilot results incorporated into project level environmental guidance

• **Oahu MPO**  
Pilot findings used in developing legislation on incorporating adaptation into statewide planning
FHWA is soliciting descriptions of proposed pilot projects from transportation agencies in two areas:

- assessments of transportation vulnerability to climate change and extreme weather events
- options for improving resiliency of transportation facilities or systems to climate changes and/or extreme weather events.
2013-2014 Pilot Program (cont.)

Timeline

• November 2012: Call for Pilots Released
  • Informational webinars on December 6\textsuperscript{th} and December 18\textsuperscript{th} (register on FHWA website)

• January 22, 2013: Proposed project descriptions due to FHWA Division Offices

• February 19, 2012: FHWA HQ announces selected pilot projects

Pilots of vulnerability / risk assessment conceptual model (2011, 2013)

Gulf Coast Study: Impacts of Climate Variability and Change on Transportation Systems and Infrastructure (U.S. DOT)
  - Phase 1 – Gulf-wide (2008) [SAP 4.7]
  - Phase 2 – Mobile, AL (ongoing)

Regional Climate Change Effects: Useful Information for Transportation Agencies [Climate Effects Typology] (2010)

Potential Impacts of Global Sea Level Rise on Transportation Infrastructure: Mid-Atlantic Focus (2008) (U.S. DOT)

Adaptation Funding Eligibility Memo (2012)
Primary Phase 2 Tasks

- Task 1: Identify critical transportation assets in Mobile (complete)
- Task 2: Identify climate impacts, assess infrastructure sensitivity (complete)
- Task 3: Assess vulnerability of critical assets (2012-2013)
- Task 4: Develop risk management tools for transportation agencies to conduct similar analyses (2012-2013)

Available from the FHWA website
FHWA Funding for Adaptation Work

• FHWA released a memo on using Federal-aid and Federal Lands funding for adaptation activities to address
  ▪ Extreme weather events
  ▪ Climate change impacts

• Three sections: Memo, Qs & As, Funding category-specific information

• Clarifies eligibility for various activities
  ▪ Planning (e.g., vulnerability assessments)
  ▪ Design (e.g., designing to handle potential impacts)
  ▪ Construction, etc.

• Memo available at: http://www.fhwa.dot.gov/federalaid/120924.cfm
What is a Sustainable Highway System?

- Integral part of sustainable development
- Satisfies functional requirements
  - Fulfills transportation goals and needs
- Addresses development and economic growth
- Avoids, minimizes, reduces impacts
  - Environment
  - Consumption of resources
Sustainability and FHWA

- Stress implementation of sustainable practices: sustainability = action
- Deliver the Federal Aid and Federal Lands Highway Programs in a more sustainable way
- Make wise investment decisions w/limited resources
- Encourage changes in professional practice
- Include sustainability throughout the decision making process
- Go beyond compliance
- Seek Balanced solutions – Not just a GREEN Initiative
Sustainable Highways Initiative

- Promote coordination within FHWA and with other FHWA initiatives
- Strengthen engagement with DOTs and MPOs
- Case Studies to highlight sustainable practices
- Website to serve as portal to access information on activities and available resources: www.sustainablehighways.dot.gov
- Develop tools: INVEST
What is INVEST?

**INVEST - Infrastructure Voluntary Evaluation Sustainability Tool**

A web-based self-evaluation tool for assessing sustainability over the life cycle of a transportation project or program — from system and project planning through design and construction, to operations and maintenance.
Built for the Real World

- Voluntary - use it how and where you want
- Private - data belongs to you
- Free - no licenses, no limits
- Tangible & Practical - relates to things you do everyday
Supporting the Entire Lifecycle

- System Planning & Processes
- Project Development
- Operations & Maintenance
INVEST Goals

- Encourage implementation of sustainable practices
- Help agencies assess their level of sustainability implementation and identify areas for internal improvement
  - Assess single or multiple projects
  - Prospective vs. retrospective
  - Planning or O&M programs and processes
- Provide a framework for communicating with stakeholders and decision makers about sustainability
- Establish a method for identifying sustainable best practices in highway systems, projects, programs
Evolution of INVEST

**Beta Test Version**
- Released Fall 2010
- Over 700 comments from AASHTO, EPA, SMEs, others

**Pilot Test Version**
- Released Fall 2011
- Over 1200 comments from pilot test participants, SMEs, FTA, others

**Version 1.0**
- Released October 2012
Pilot Testing of INVEST

- Testing done on the Project Development (PD), System Planning (SP) and Operations & Maintenance (OM) criteria from July 2011 – February 2012
- Objectives were to obtain input on:
  - further refinements to the criteria
  - scoring and achievement levels
  - making the tool easier to use
- Process varied across pilot test agencies
Rte 156th W. Corridor Realignment

INVEST Role: Project Development

- Environmental document submitted
- Reviewed against current design + standard practices → scored Gold
- Team identified key ideas to incorporate more sustainable features that would get them to Platinum
- Evaluation will influence decisions on this project
- Will evaluate again in design and construction
Western Federal Lands

Glacier National Park - National Scenic Parkway  
*INVEST Role: Project Development*

- 70 years of traffic, weather, avalanches & rockslides
- Aggressive 20-year seasonal rehab program keeps road open but work moving ahead
- Reusing all existing stonework, re-seeding disturbed roadsides
- INVEST helped validate context sensitivity but also improve their documentation & communications
Maintaining a State-Wide Highway System

*INVEST Role: Operations & Maintenance*

- Traffic monitoring & coordination across 6K+ center-line miles of highways
- Key goals: preserve infrastructure, optimize mobility, improve safety, strengthen the economy
- Budget pressures driving need for more sustainable practices
- Used INVEST to ID inexpensive ways to promote sustainability, like better data about pavement conditions
North Central Texas Council of Governments (NCTCOG)

Large Multi-Modal Transportation Plan

*INVEST Role: System Planning & Processes*

- Rapid regional growth: 6.5M to 10M
- Projected funding shortfall of $45B
- Need to increase mobility, cut some improvements & reprioritize others
- Influence travel behavior & demand, improve transportation / land use links
- Extend life of existing assets, increase spending on O&M
- Used INVEST to validate assumptions, ID improvements in asset management and infrastructure resiliency
Lessons Learned from Pilots

- Overall pilot agencies were supportive and enthusiastic about INVEST
- Programmatic application most useful
- Pilot agencies suggested many good technical and contextual changes to the criteria and web interface
- Pilot agencies would like to see:
  - More information and a guide for using the tool
  - Additional examples of sustainable practices, case studies, etc.
Changes for INVEST 1.0

- Significant changes to the criteria in all three modules
- More flexibility in selecting relevant PD criteria to address project concerns/context
  - urban vs. rural
  - large vs. small
- More opportunities for partial credit (i.e., gradation in point scale within criteria)
- Putting more emphasis on the process of using the tool and learning (not the score!)
Welcome!

INVEST, the FHWA Sustainable Highways Self-Evaluation Tool

INVEST (Infrastructure Voluntary Evaluation Sustainability Tool) was developed by FHWA as a practical, web-based, collection of voluntary best practices, called criteria, designed to help transportation agencies integrate sustainability into their programs (policies, processes, procedures and practices) and projects. While the use of INVEST is voluntary, it can be used by transportation agencies, such as DOTs, MPOs, Council of Governments, public works departments, and their consultants and partners, to evaluate and aid the integration of sustainability into their programs and projects.

What do you want to do?

Learn
A guided tour through the INVEST website to learn about sustainable highways and integrating sustainability best practices into projects and programs.

Browse
Scoring in System Planning

System Planning Criteria by Sustainability Principle

- SP-1: Integrated Planning: Economic Development and Land Use
- SP-2: Integrated Planning: Natural Environment
- SP-3: Integrated Planning: Social
- SP-4: Integrated Planning: Bonus
- SP-5: Access & Affordability
- SP-6: Safety Planning
- SP-7: Multimodal Transportation and Public Health
- SP-8: Freight and Goods Movement
- SP-9: Travel Demand Management
- SP-10: Air Quality
- SP-11: Energy and Fuels
- SP-12: Financial Sustainability
- SP-13: Analysis Methods
- SP-14: Transportation Systems Management & Operations
- SP-15: Linking Asset Management and Planning
- SP-16: Infrastructure Resiliency
- SP-17: Linking Planning and NEPA

Criterion Details

**SP-1 Integrated Planning: Economic Development and Land Use**

**Goal**
Integrate statewide and metropolitan Long Range Transportation Plans (LRTP) with statewide, regional, and/or local land use plans and economic development forecasts and goals. Proactively encourage and facilitate sustainability through the coordination of transportation, land use, and economic development planning.

**Sustainability Linkage**
Integrating transportation planning with economic development and land use supports the economic triple bottom line principle by creating opportunities to improve access and mobility, and increase the social, environmental, and economic returns on both public and private investments in transportation projects and programs.

**Scoring Requirements**

**Background**
This criterion recognizes that each state and MPO has different land use and economic development regulatory, policy, and institutional frameworks, plans, and goals, and allows for flexibility in the activities and types of plans agencies use to measure integration. The intent of this criterion is to encourage agencies to integrate sustainability into...
How INVEST Measures Sustainability

System Planning Scorecard

Program or Process: Test 1 edit

View full scorecard to save or print from your browser.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP-01 Integrated Planning: Economic Development and Land Use</td>
<td>4/15</td>
</tr>
<tr>
<td>SP-02 Integrated Planning: Natural Environment</td>
<td>8/15</td>
</tr>
<tr>
<td>SP-03 Integrated Planning: Social</td>
<td>5/15</td>
</tr>
</tbody>
</table>

Score

75
Your Rating: Bronze

96 points needed for Silver
120 points needed for Gold
144 points needed for Platinum
### Version 1 Project Development Criteria

<table>
<thead>
<tr>
<th>PD-1</th>
<th>Economic Analyses</th>
<th>PD-10</th>
<th>Pedestrian Access</th>
</tr>
</thead>
<tbody>
<tr>
<td>PD-2</td>
<td>Lifecycle Cost Analysis</td>
<td>PD-11</td>
<td>Bicycle Access</td>
</tr>
<tr>
<td>PD-3</td>
<td>Context Sensitive Project</td>
<td>PD-12</td>
<td>Transit &amp; HOV Access</td>
</tr>
<tr>
<td></td>
<td>Development</td>
<td>PD-13</td>
<td>Freight Mobility</td>
</tr>
<tr>
<td>PD-4</td>
<td>Highway and Traffic Safety</td>
<td>PD-14</td>
<td>ITS for System Operations</td>
</tr>
<tr>
<td>PD-5</td>
<td>Educational Outreach</td>
<td>PD-15</td>
<td>Historical, Archaeological,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>and Cultural Preservation</td>
</tr>
<tr>
<td>PD-6</td>
<td>Tracking Environmental</td>
<td>PD-16</td>
<td>Scenic, Natural, or</td>
</tr>
<tr>
<td></td>
<td>Commitments</td>
<td></td>
<td>Recreational Qualities</td>
</tr>
<tr>
<td>PD-7</td>
<td>Habitat Restoration</td>
<td>PD-17</td>
<td>Energy Efficiency</td>
</tr>
<tr>
<td>PD-8</td>
<td>Stormwater</td>
<td>PD-18</td>
<td>Site Vegetation</td>
</tr>
<tr>
<td>PD-9</td>
<td>Ecological Connectivity</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PD-19</td>
<td>Reduce and Reuse Materials</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>-------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PD-20</td>
<td>Recycle Materials</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PD-21</td>
<td>Earthwork Balance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PD-22</td>
<td>Long-Life Pavement Design</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PD-23</td>
<td>Reduced Energy and Emissions in Pavement Materials</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PD-24</td>
<td>Contractor Warranty</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PD-25</td>
<td>Construction Environmental Training</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PD-26</td>
<td>Construction Equipment Emission Reduction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PD-27</td>
<td>Construction Noise Mitigation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PD-28</td>
<td>Construction Quality Control Plan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PD-29</td>
<td>Construction Waste Management</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Multiple Scorecards to Fit Your Project

Larger Project

Smaller Project

- Rural/Extended
- Urban/Extended
- Rural/Basic
- Urban/Basic
- Paving
- Custom

Rural

Urban
<table>
<thead>
<tr>
<th>OM-1</th>
<th>Internal Sustainability Plan</th>
<th>OM-8</th>
<th>Bridge Management System</th>
</tr>
</thead>
<tbody>
<tr>
<td>OM-2</td>
<td>Electrical Energy Efficiency and Use</td>
<td>OM-9</td>
<td>Maintenance Management System</td>
</tr>
<tr>
<td>OM-3</td>
<td>Vehicle Fuel Efficiency and Use</td>
<td>OM-10</td>
<td>Highway Infrastructure Preservation and Maintenance</td>
</tr>
<tr>
<td>OM-4</td>
<td>Reuse and Recycle</td>
<td>OM-11</td>
<td>Traffic Control Infrastructure Maintenance</td>
</tr>
<tr>
<td>OM-5</td>
<td>Safety Management</td>
<td>OM-12</td>
<td>Road Weather Management Program</td>
</tr>
<tr>
<td>OM-6</td>
<td>Environmental Commitments Tracking System</td>
<td>OM-13</td>
<td>Transportation Management and Operations</td>
</tr>
<tr>
<td>OM-7</td>
<td>Pavement Management System</td>
<td>OM-14</td>
<td>Work Zone Traffic Control</td>
</tr>
</tbody>
</table>
Next Steps

- INVEST 1.0 was released on October 10th
  - Link to the recorded event @ www.sustainablehighways.org
- Initiation of Deployment Program (PY13)
  - Request for deployment sites released soon
- INVEST Toolkits
- Monitor performance/impact of INVEST 1.0
- INVEST 1.X, 2.0…beyond
Try INVEST at www.sustainablehighways.org

Contacts:
Mike Culp (michael.culp @dot.gov)
Connie Hill (connie.hill@dot.gov)
Tina Hodges (tina.hodges@dot.gov), or
Heather Holsinger (heather.holsinger@dot.gov)
Robert Hyman (robert.hyman@dot.gov)
Thank you

www.fhwa.dot.gov/hep/climate_change