pennsylvania
DEPARTMENT OF TRANSPORTATION

PENNDOT EXTREME WEATHER VULNERABILITY STUDY

Pennsylvania Climate Change Advisory Committee

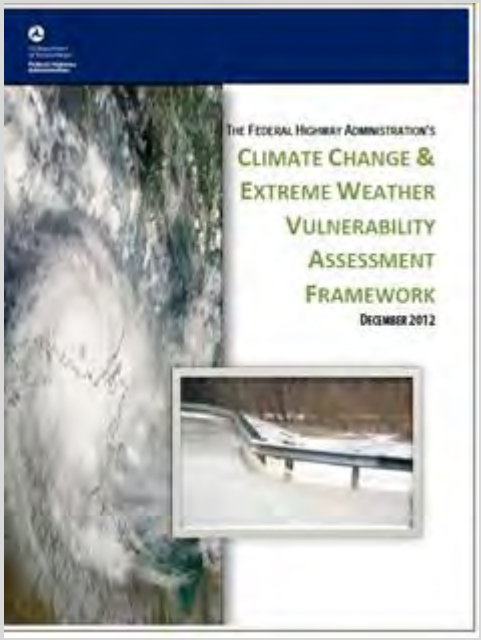
September 13, 2016

Presentation Outline

- Why Study Resiliency?
- Highlights of Project Study Tasks
- Summary of Study Goals
- Next Steps

Why Study Extreme Weather Impacts?

- To **better anticipate the consequences** and potential impacts of extreme weather events
- To **identify funding priorities** to improve transportation system resiliency
- To **identify potential adaptation strategies** to reduce risk

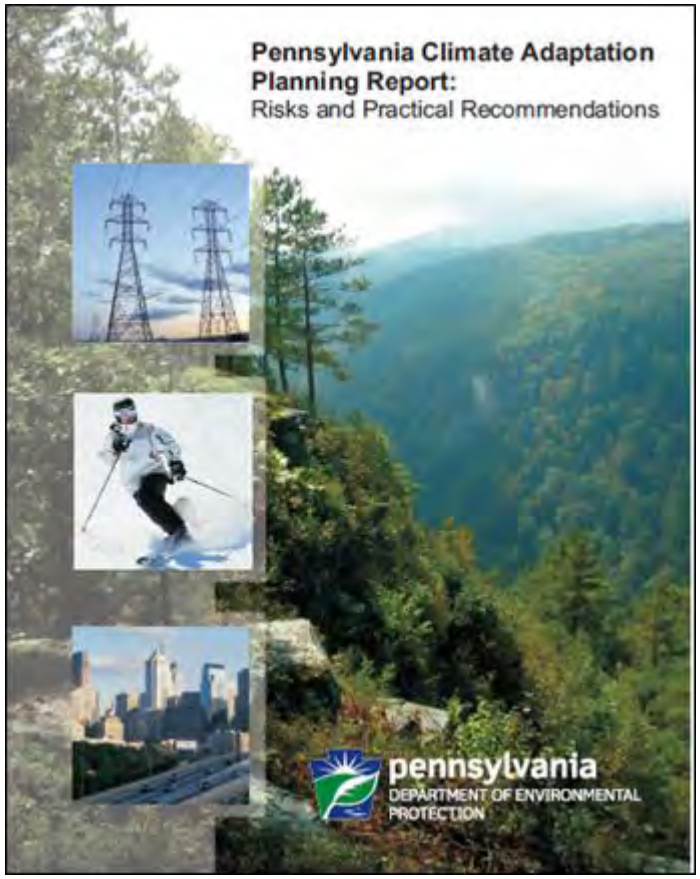


Emergency Funds Obligated:
$140 million spent on Federal Aid System since 2006

DEP Climate Adaptation Planning

- Prepared in 2010
- "Infrastructure Working Group"
- Identified vulnerabilities to climate variables that impact transportation
- Identified general adaptation strategies for each vulnerability

Sector	Vulnerabilities	Risk	Adaptation Strategy Recommendations
Transportation	Buckling of roadways and/or bridges due to concrete expansion and softening of bituminous pavements	State maintains over 40,000 miles of roadways and 25,000 bridges. Local system includes over 70,000 miles of roadway and 6,300 bridges over 20 feet in length and an unknown number of bridges less than 20 feet.	Review available research for potential materials that can withstand higher temperatures
Transportation	Higher temperatures may impact construction schedules due to impacts on materials and personnel.	Materials may not set or cure due to higher temperatures and workers are more susceptible to heat related injuries	Perform work activities during cooler portions of the day, i.e. work during the night time hours



Recent Emphasis in Federal Actions

FAST ACT

Section 1201 Metropolitan Transportation Planning:
System Resiliency added as a new planning factor

- Adds "***takes into consideration resiliency needs***" to the purposes of statewide and metropolitan planning

Council on Environmental Quality

Final Guidance on climate change considerations within National Environmental Policy Act (NEPA) reviews

- Provides a framework for agencies to consider the ***effects of climate change on a proposed action***.

Adaptation Planning Framework

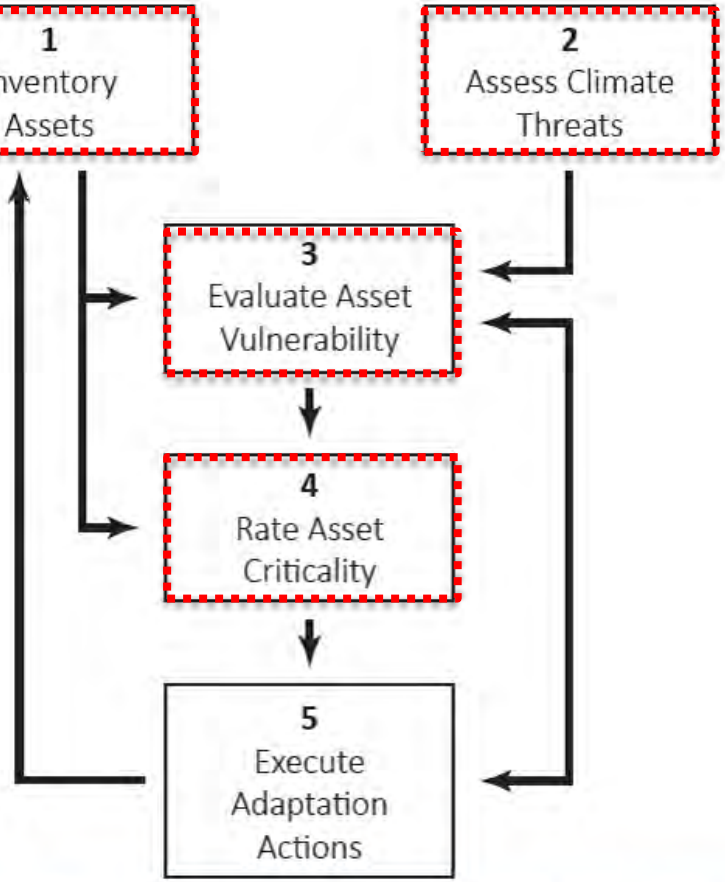
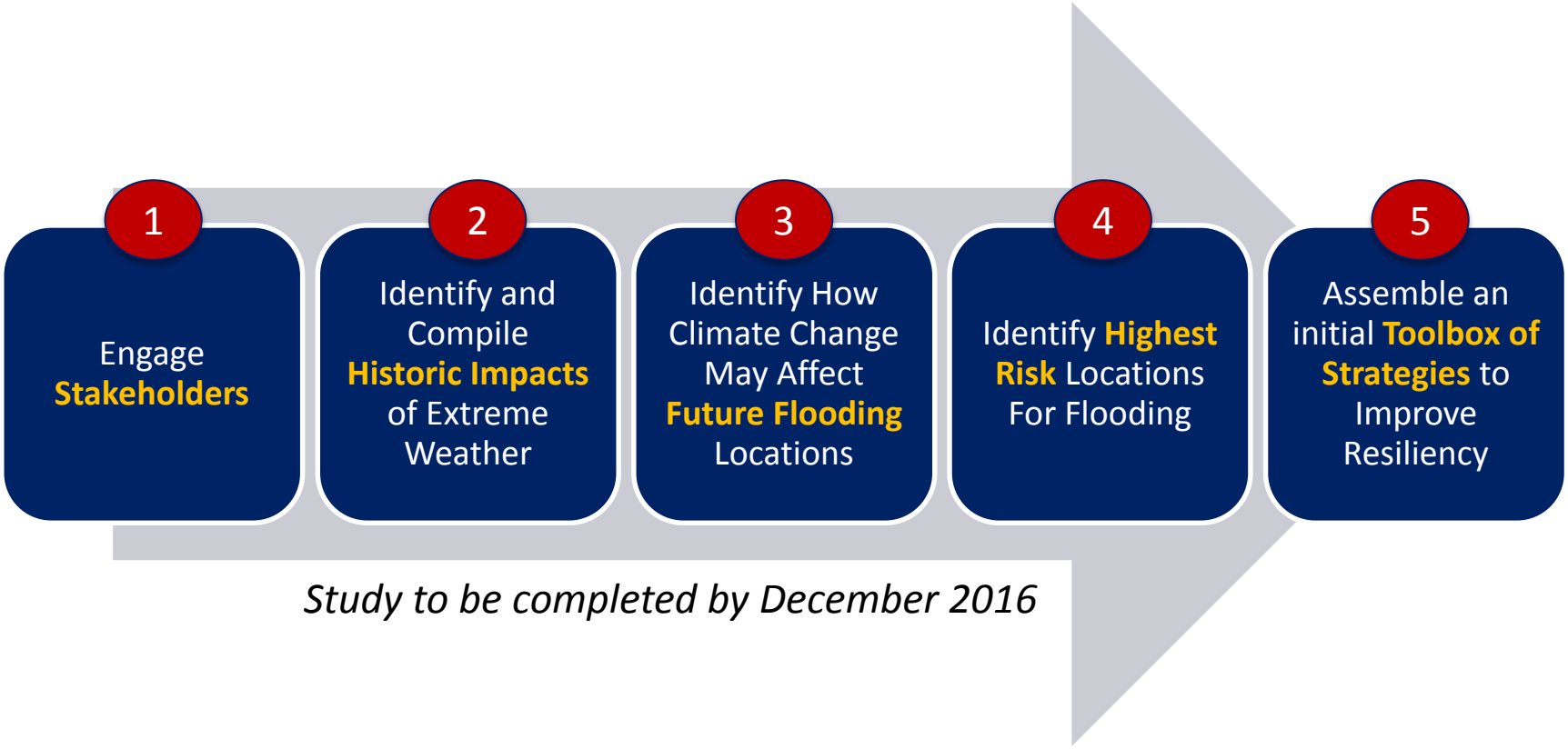


Figure 1: Five-step Common Framework for Climate Adaptation Planning for Transportation Systems.

PennDOT Study Tasks

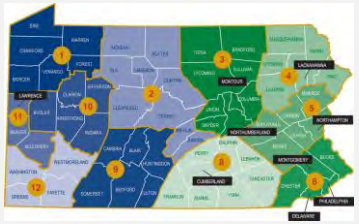


Study to be completed by December 2016

Stakeholder Outreach

Outreach Methods:

- **Meetings at PennDOT District Offices** (highlighted agencies below)
- **Webinar Outreach**
- **Future Coordination with other groups and agencies**



PennDOT	PEMA	MPO/RPO	DEP	Turnpike
County OEM	PSP	Transit	Homeland Security	Dept Health
	DCNR	DCED	PSU	

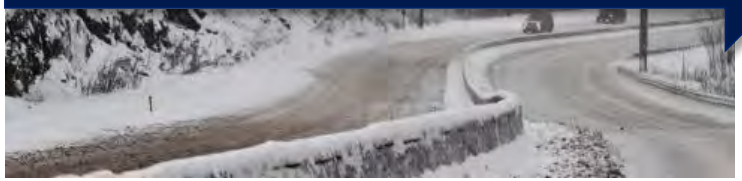
Themes on Weather Impacts

Flooding

- Flooding has caused roadway damage and traffic impacts throughout the state
- Districts are **primarily reactive** to repeated flash flooding
- Most significant **issues have resulted from tropical storms or deficiencies in local drainage systems**

Themes on Weather Impacts

Snow



- Major area of focus but hard to predict
- Processes and procedures in place
- Snow drifting issue in some areas

Heat

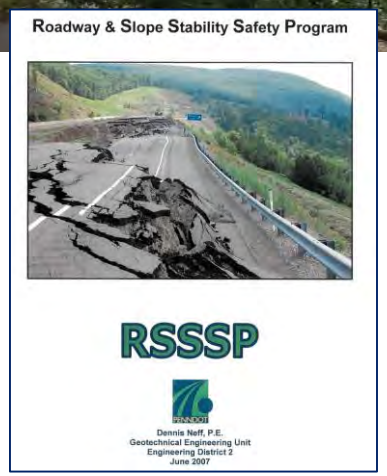
- Pavement joint buckling
- Practices in place to address
- Not a major issue for most Districts

Tornado / Earthquake

- Has impacted roads and bridges
- More protocols needed

Themes on Weather Impacts

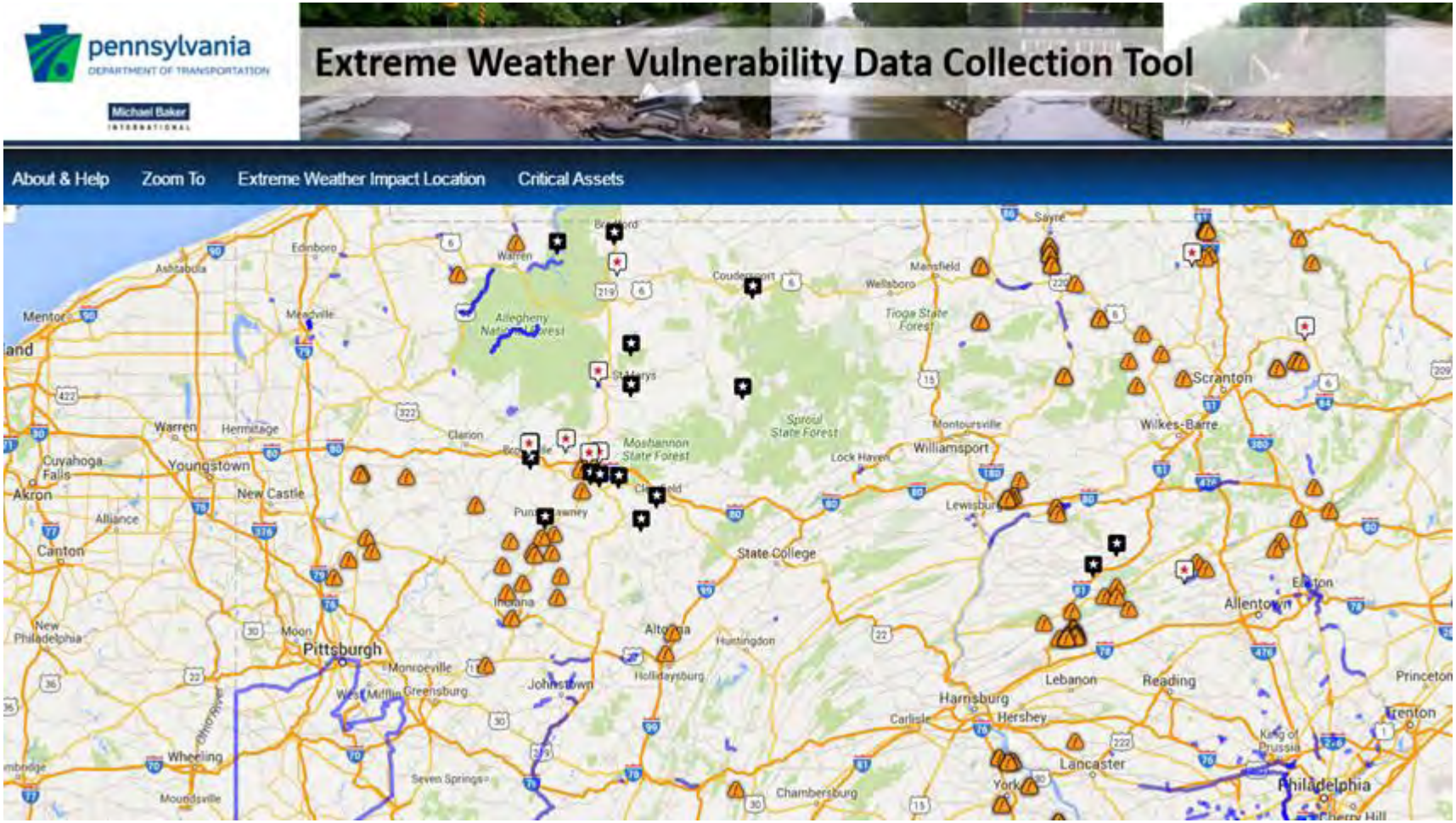
Other Impacts of Weather



- **Secondary impacts from weather have often caused most impacts on traffic and road closures**
- Trees down from wind and storms
- Utilities

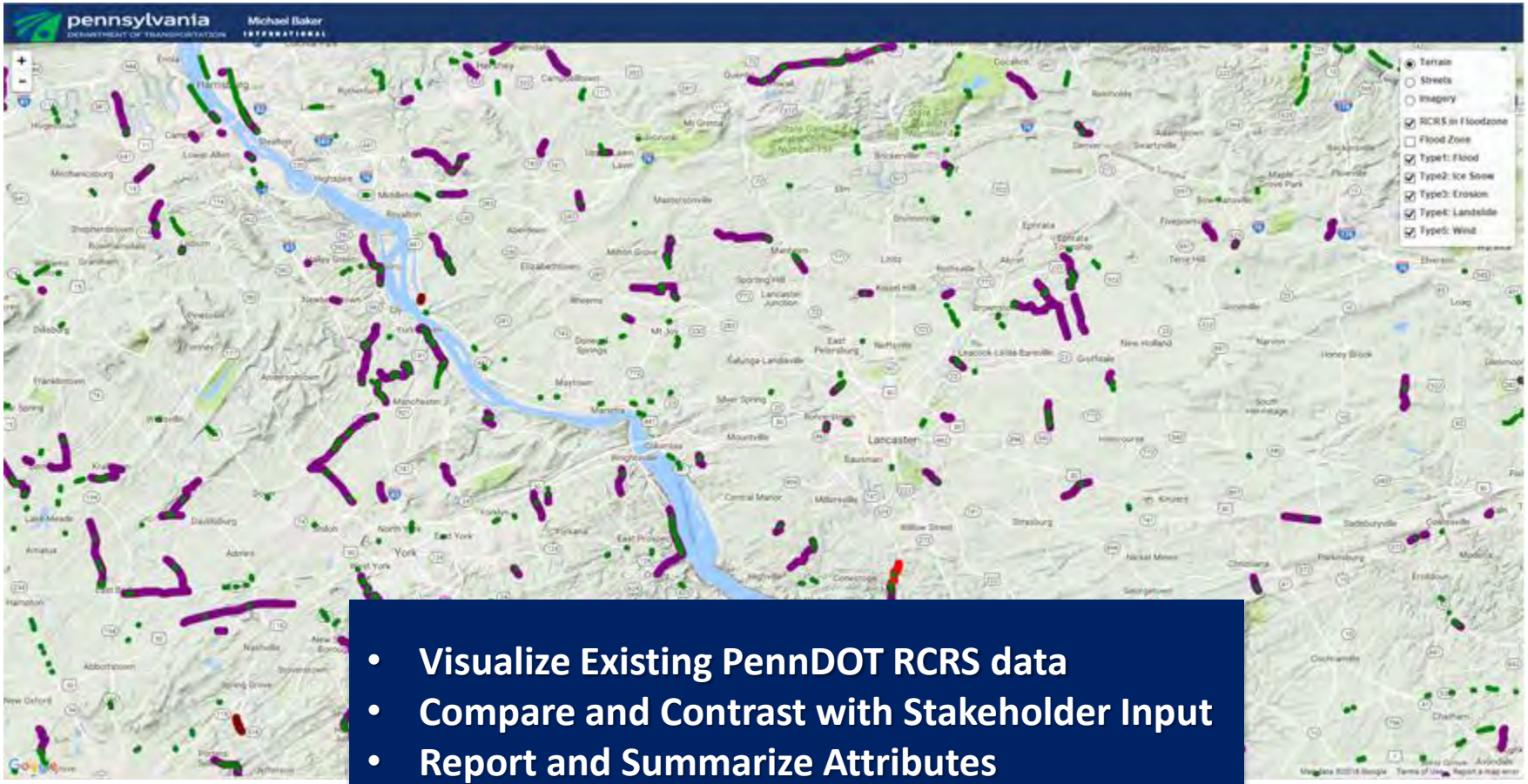
- Coal and acid mine drainage have degraded metal pipes under many roads
- Land/rock slides a major issue in mountainous areas of state
- Retaining wall failures

Compile Historic Impact Data



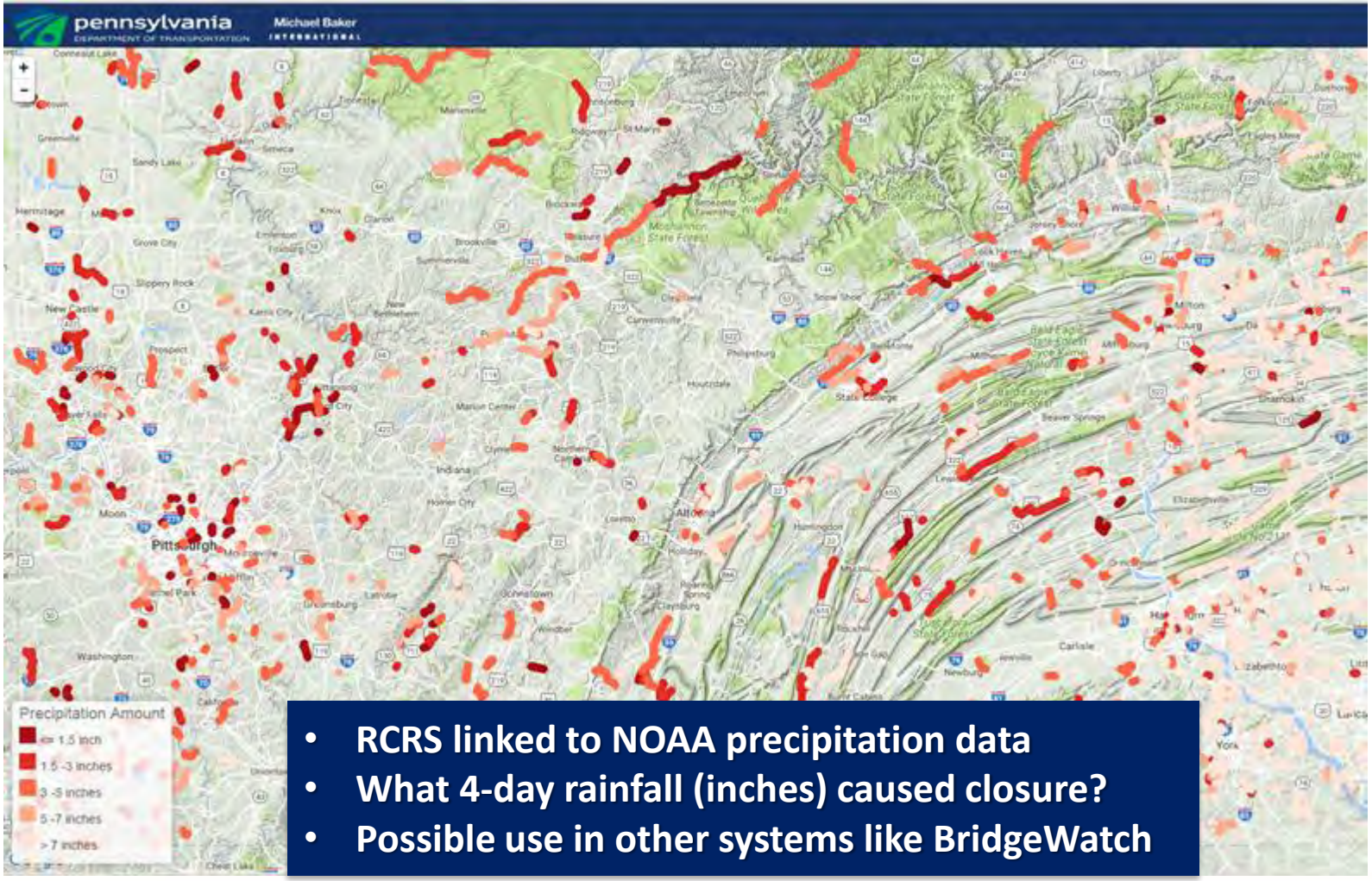
Assessment of PennDOT Data

(RCRS – Road Conditions Reporting System)



- Visualize Existing PennDOT RCRS data
- Compare and Contrast with Stakeholder Input
- Report and Summarize Attributes

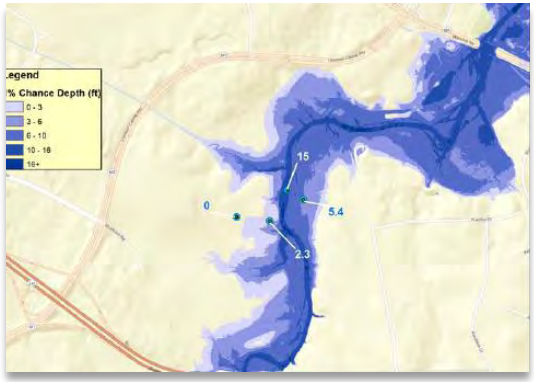
RCRS Linkage to Rainfall Data

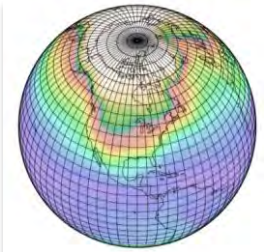


Forecast Climate Impact on Flooding

- Conduct **planning level analyses to assess changes to FEMA floodplain maps** based on climate change
- Work with PSU to **assess global climate model outputs**
- Utilize stream gauge, forecast impervious area, and digital elevation data.
- Assess **inundation of PennDOT roads and bridges** based on increased stream depths

Analysis for 3 sample Counties: Lycoming, Delaware, Allegheny





CLIMA

- **Compare to historic data**

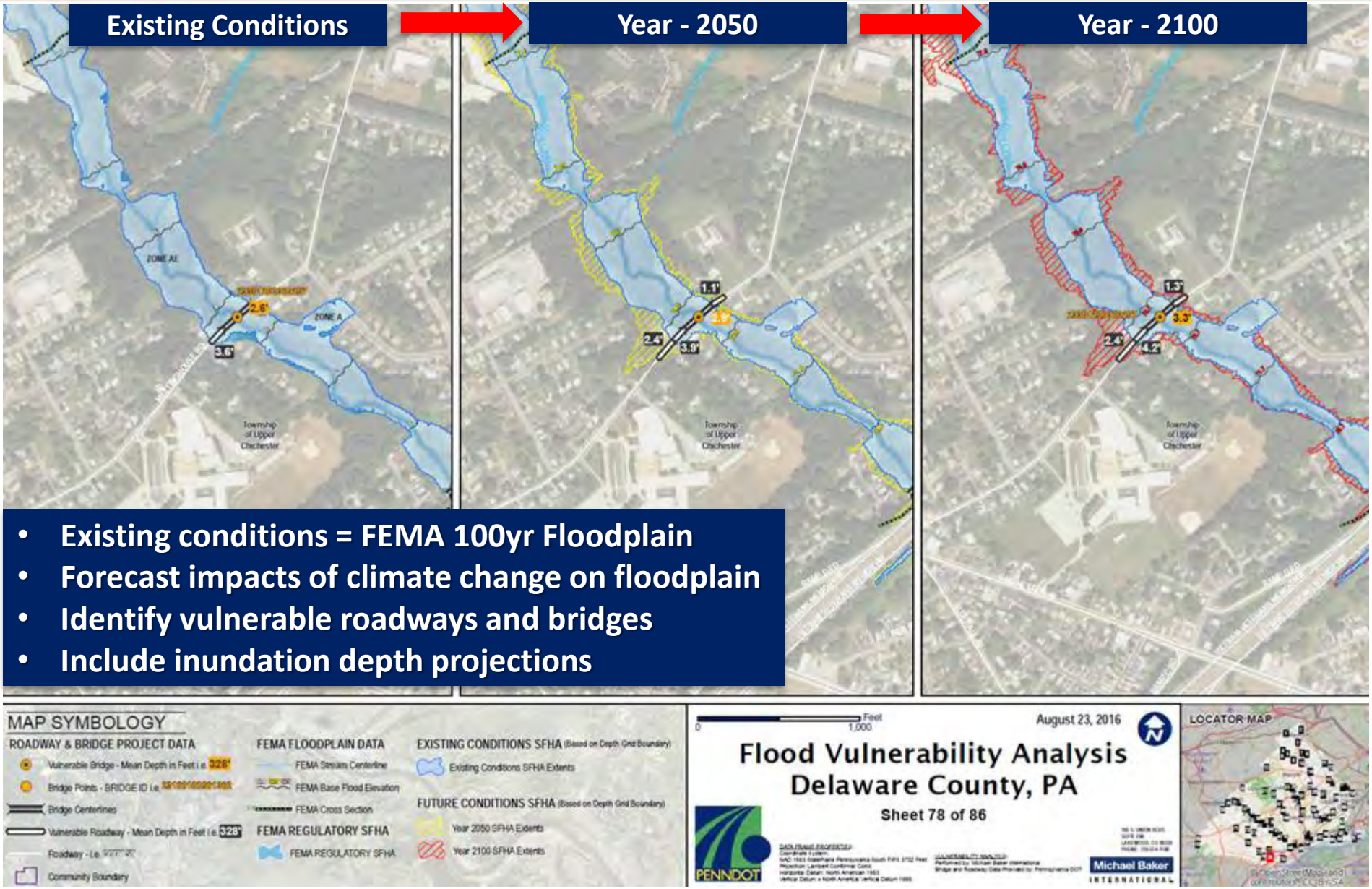
Pennsylvania Climate Impacts Assessment Update

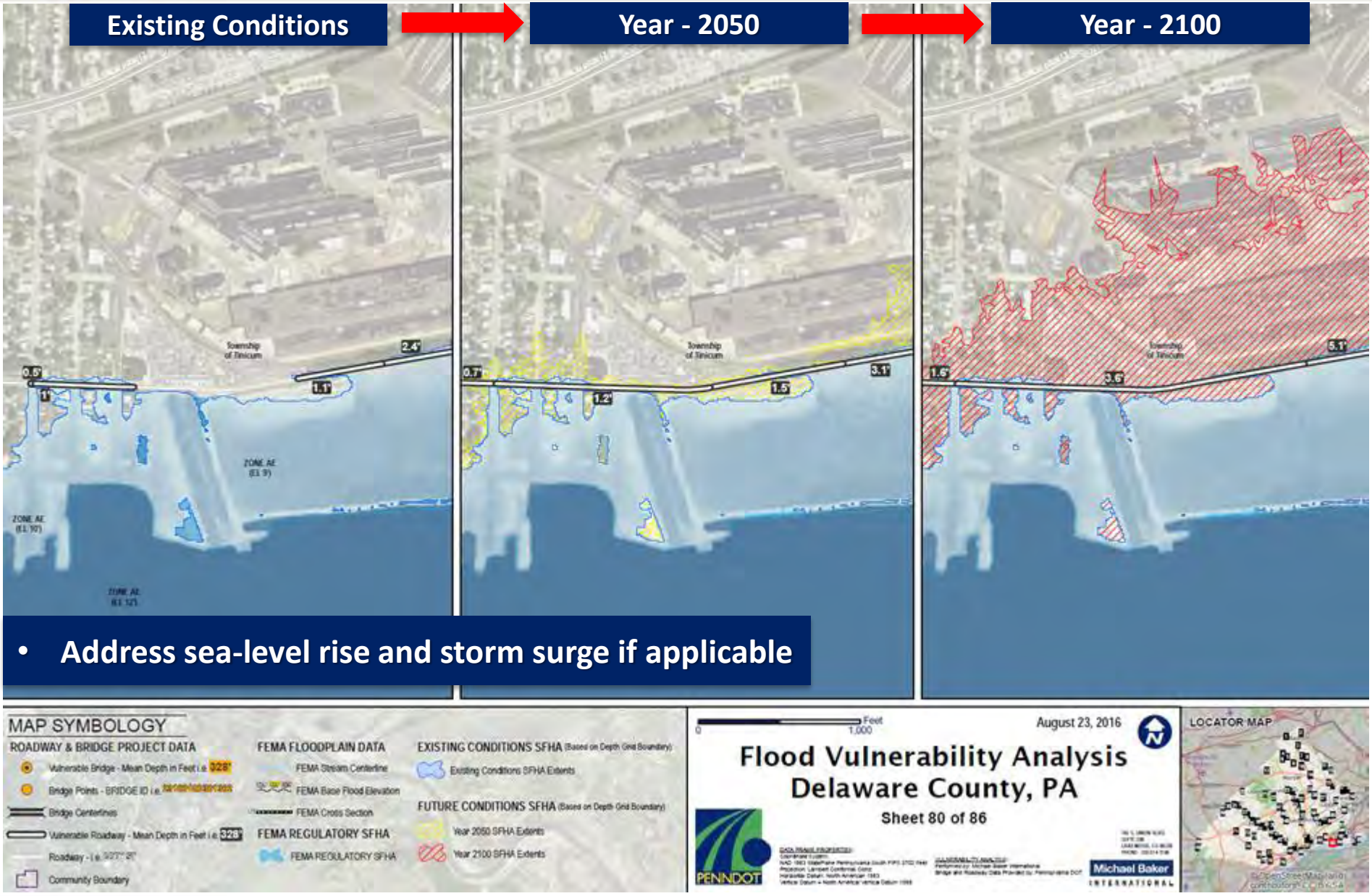
May 2015

Level of Analysis Comparison

- Maryland used HAZUS model to estimate depth grids
- PennDOT used regression equations, incorporated projected daily rainfall
- More cost effective approach

- Use of watershed models like HEC-HMS or Win TR-20
- Rainfall data from global models used to estimate flood discharges
- More time consuming, costly


Existing Conditions
Year - 2050
Year - 2100
ZONE AE
ZONE A
2.6'
3.6'
1.1'
2.4'
3.9'
1.5'
3.3'
2.4'
4.2'
Township of Upper Chichester
Township of Upper Chichester
Township of Upper Chichester
• Existing conditions = FEMA 100yr Floodplain
• Forecast impacts of climate change on floodplain
• Identify vulnerable roadways and bridges
• Include inundation depth projections
MAP SYMBOLOGY
ROADWAY & BRIDGE PROJECT DATA
Vulnerable Bridge - Mean Depth in Feet i.e. 3'2.8'
Bridge Points - BRIDGE ID i.e.
Bridge Centerlines
Vulnerable Roadway - Mean Depth in Feet i.e. 3'2.8'
Roadway - i.e.
Community Boundary
FEMA FLOODPLAIN DATA
FEMA Stream Centerline
FEMA Base Flood Elevation
FEMA Cross Section
FEMA REGULATORY SFHA
FEMA REGULATORY SFHA
EXISTING CONDITIONS SFHA (Based on Depth Grid Boundary)
Existing Conditions SFHA Extents
FUTURE CONDITIONS SFHA (Based on Depth Grid Boundary)
Year 2050 SFHA Extents
Year 2100 SFHA Extents
0
Feet
1,000
August 23, 2016
Flood Vulnerability Analysis
Delaware County, PA
Sheet 78 of 86
PENNDOT
Michael Baker
INTERNATIONAL
LOCATOR MAP


Existing Conditions
Year - 2050
Year - 2100
Township of Tinicum
2.4'
1.1'
0.5'
1'
ZONE AE
(EL 9')
ZONE AE
(EL 10')
ZONE AE
(EL 12')
0.7'
1.2'
1.5'
3.1'
1.6'
3.6'
5.1'
• Address sea-level rise and storm surge if applicable
MAP SYMBOLOGY
ROADWAY & BRIDGE PROJECT DATA
Vulnerable Bridge - Mean Depth in Feet i.e. 3'28"
Bridge Points - BRIDGE ID i.e.
Bridge Centerlines
Vulnerable Roadway - Mean Depth in Feet i.e. 3'28"
Roadway - i.e.
Community Boundary
FEMA FLOODPLAIN DATA
FEMA Stream Centerline
FEMA Base Flood Elevation
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Feet
0
1,000
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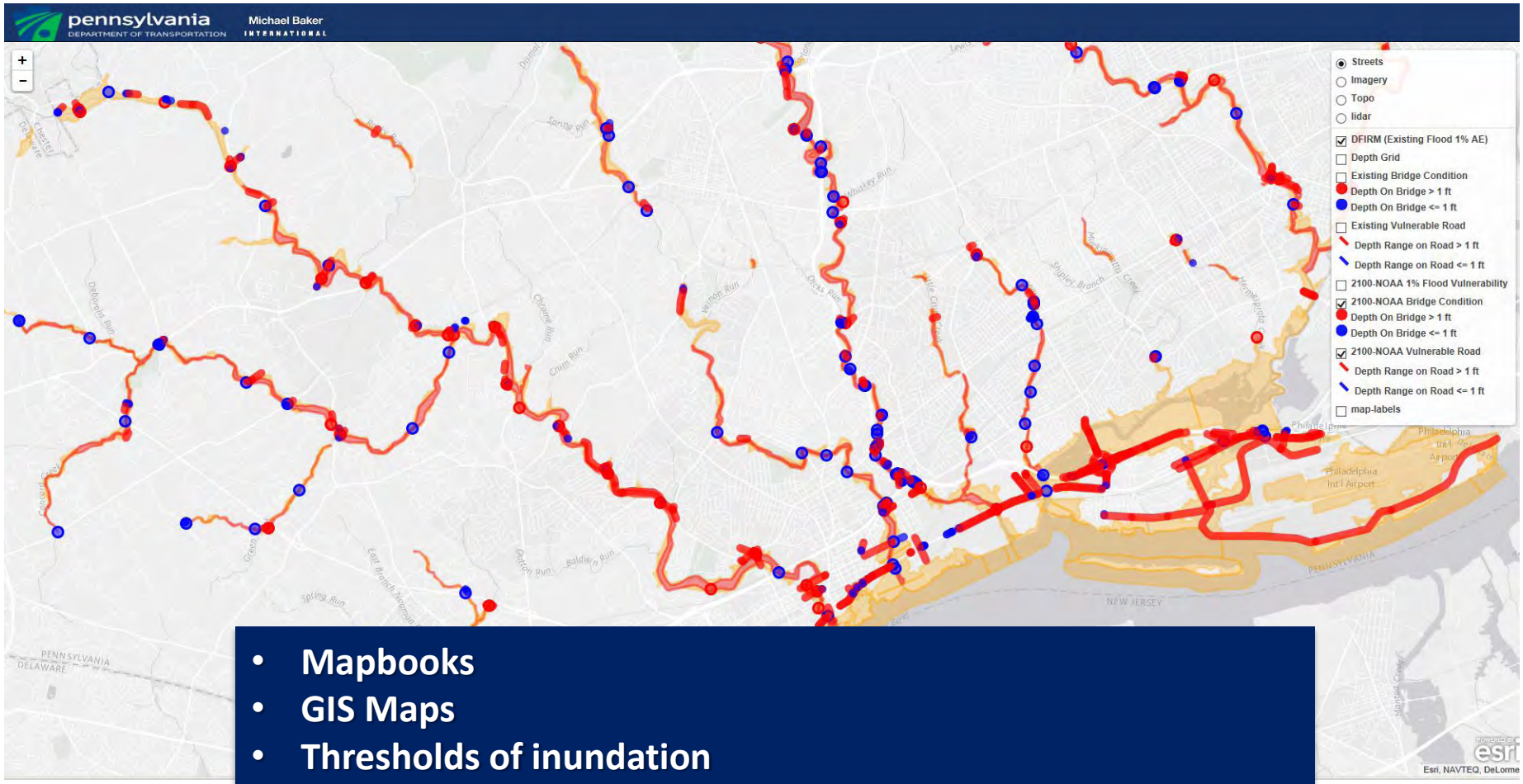
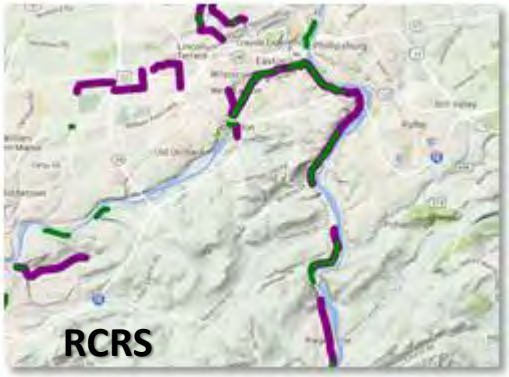
Summarizing Analysis Results



- Mapbooks
- GIS Maps
- Thresholds of inundation
- Compare and contrast with historic flooding results

Initial Assessment of Risks

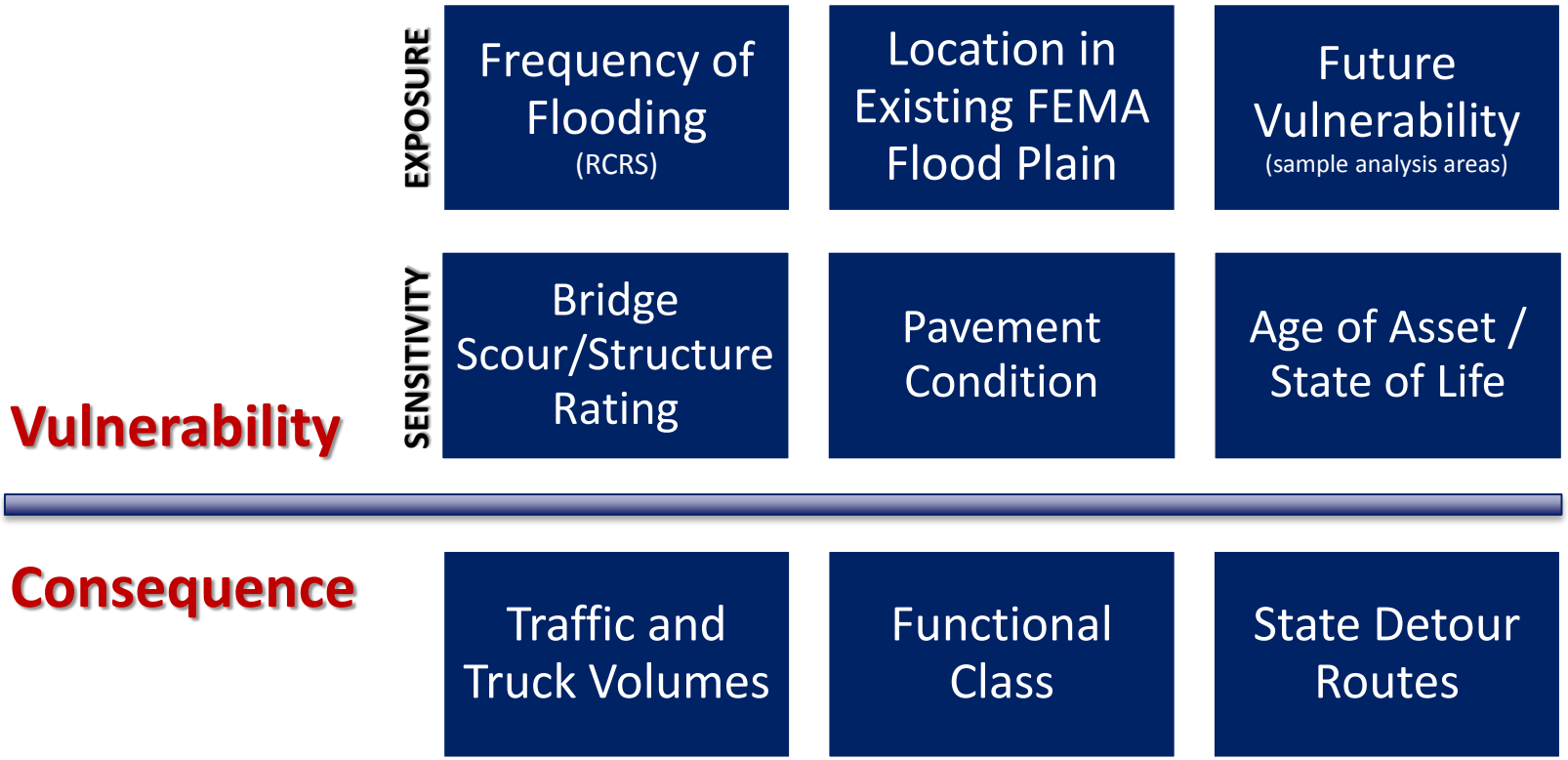
- Understand **potential consequences and costs** of extreme weather impacts on specific locations
- Help PennDOT determine **priority locations for more detailed further study** (may be watershed driven)
- Support for **planning and programming of projects** (potential integration into DOT/MPO/RPO project prioritization process)



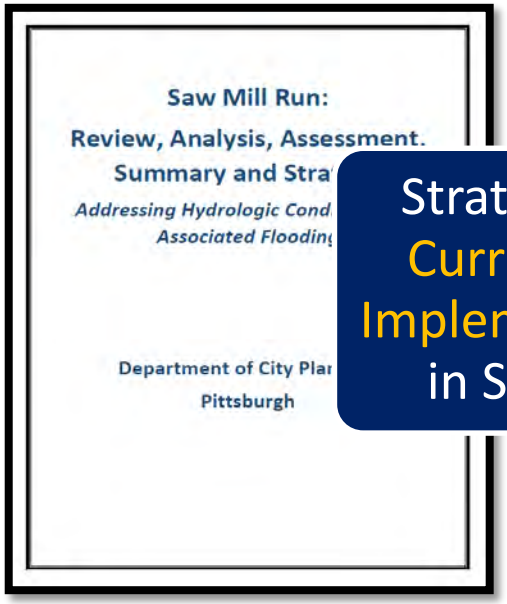
Vulnerable Rating \ Consequence Rating	1	2	3	4	5
1	2	3	4	5	6
2	3	4	5	6	7
3	4	5	6	7	8
4	5	6	7	8	9
5	6	7	8	9	10

RISK = Vulnerability Rating + Consequence Rating

Quantify Vulnerability & Consequence



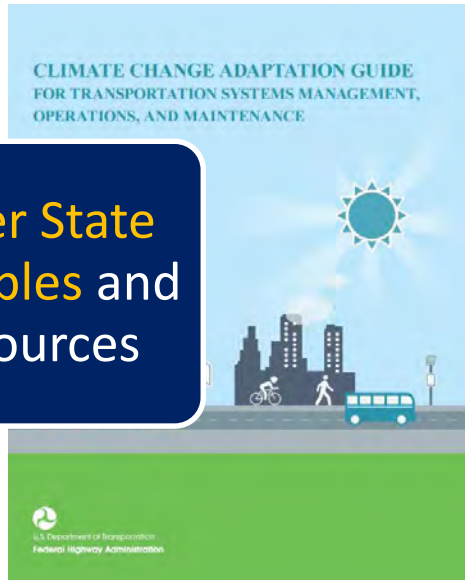
Strategy Toolbox



Strategies Currently Implemented in State

Ideas and Insights from Stakeholders

Other State Examples and Resources



Strategy Toolbox

Future phases of study may evaluate strategies in more detail

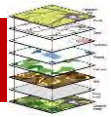
Strategy Ideas for PennDOT & Planning Partners

PLANNING, COORDINATION AND TRAINING

- Integrate resiliency and vulnerability information into PennDOT and MPO project prioritization process
- Improve coordination between state, local and property owners to address stormwater systems on non-PennDOT roadways
- Improve coordination between agencies (PEMA, PSP, ACOE, District, County EMA, Municipalities, DEP, Utilities)
- Develop metrics to evaluate and monitor extreme weather impacts
  Establish working groups to evaluate resiliency progress

Strategy Ideas for PennDOT & Planning Partners

DATA ANALYSES AND INFORMATION SHARING



- **Summarize and share RCRS data** for planning and emergency response preparation (enhance RCRS detail for weather impacts)
- Improve **integration of resiliency planning** efforts (PennDOT, MPO/RPO, Hazard Mitigation plans)
- Improve efforts to **track and understand past maintenance dollar spending** over time related to extreme weather
- Build on PennDOT's study to **identify and evaluate extreme weather vulnerabilities** within local regions

Strategy Ideas for PennDOT & Planning Partners

MAINTENANCE AND INSPECTIONS

- Improve maintenance procedures and armoring of stream banks to prepare for increased flooding events in future
- Continue to expand and improve methods and procedures for pre and post flood inspections of roadways, bridges, and streams
- Plan for increasing redundancy at roadway locations that may be impacted by storms (ensure secondary roads are maintained and available for use)
- Conduct stormwater management studies using a watershed approach including municipalities, PennDOT and DEP

Strategy Ideas for PennDOT & Planning Partners

DESIGN

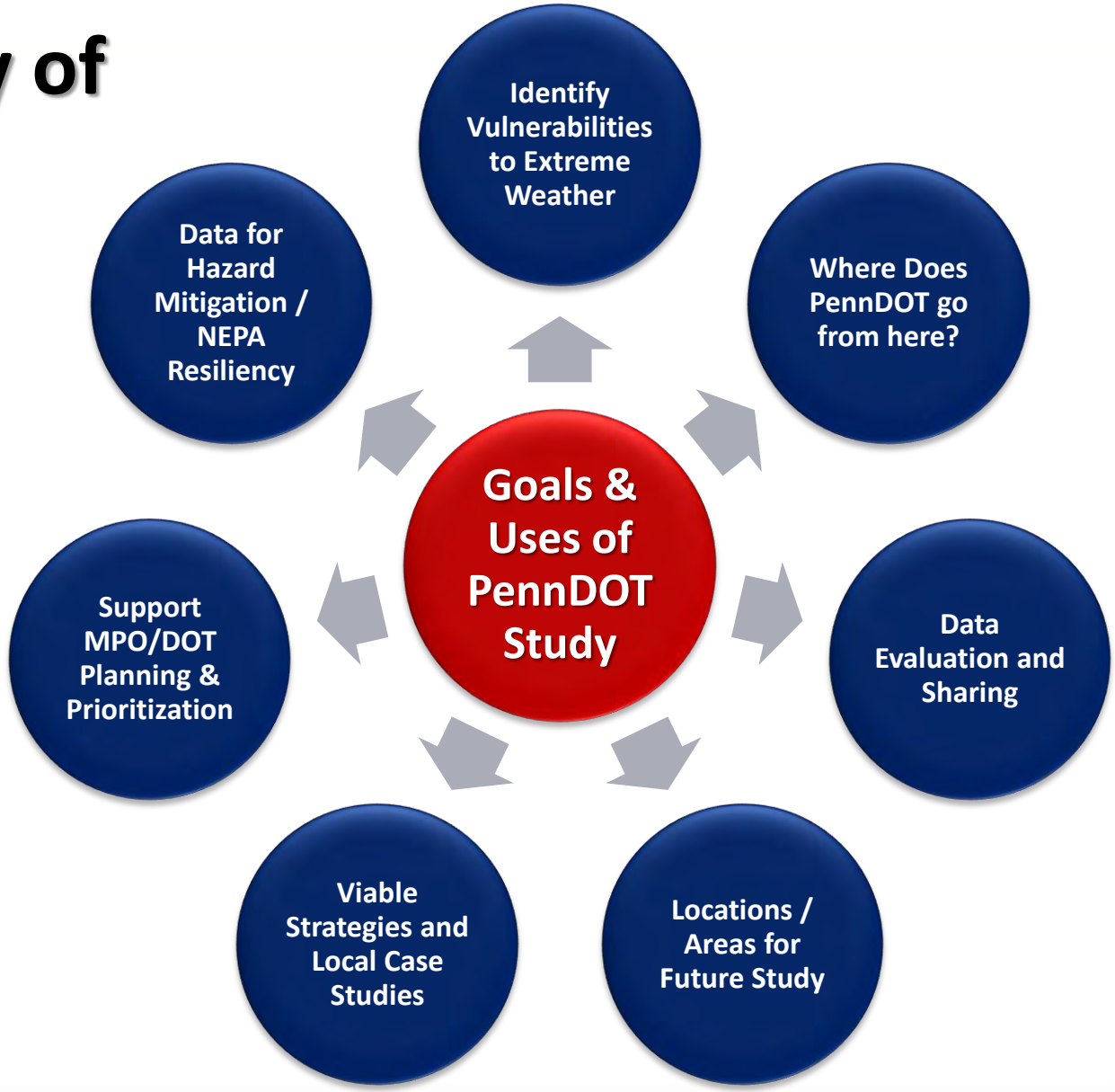
- Identify updates to PennDOT design manuals based on national research and other university studies
- Program projects to improve stormwater capacity, reduce impermeability and ensure adequate maintenance of infrastructure
- Work with municipalities to identify the impacts of development on stormwater management.
- Identify facilities requiring design upgrade in advance of funding requests

Strategy Ideas for PennDOT & Planning Partners

EQUIPMENT, MATERIALS AND TECHNOLOGY

- Identify and integrate technology like web cameras to better monitor storm impacts and flood stages
- Continue efforts to ensure equipment needs are coordinated across PennDOT Districts. Develop plans in case more equipment needed.
- Evaluate District equipment purchases to address weather events including drill rigs, portable bridges, swing gates, pumps
- Integration of automated warning systems to establish road closures and alternative routes

Summary of Study Goals



Project Schedule / Coordination

- Draft Documents - December 2016
  - Draft Report
  - Executive Summary
  - GIS Data Files and Mapping
- Finalize Document (Early 2016)
- Plan Communication and Outreach
  - Steering Committee and Executive Office Meetings
  - Webinar (all stakeholders)

Project Contact

PennDOT Contact

Douglas E. Zimmerman
Assistant for Strategic Management
PennDOT | Office of Planning
400 North Street | 8th Floor
Harrisburg Pa. 17120
Phone: 717-787-0782
dozimmerma@pa.gov I www.penndot.gov