

Incorporating Climate and Extreme Weather Risk in Transportation Asset Management

Michael Meyer and Michael Flood
WSP Parsons Brinckerhoff

1. Define Scope

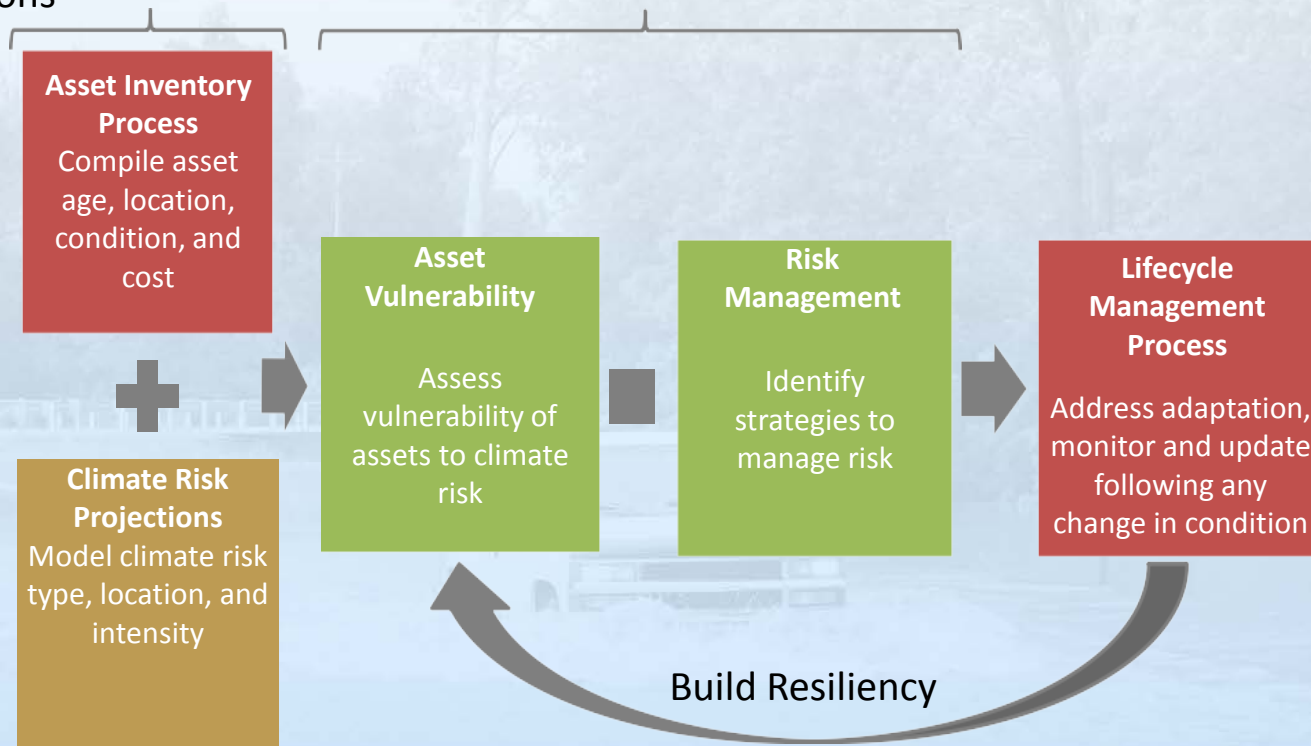
Gather asset data and climate risk modeling projections

2. Assess & Address Climate Risk

Evaluate climate risk impacts on safety, reliability, and lifecycle costs

3. Integrate into Decision-making

Incorporate risk management strategies into lifecycle management plans



Federal Rule

Undertake a risk management analysis for assets in the plan. As part of this process, ***state DOTs would identify and assess risks (e.g., extreme weather) that can affect asset condition or the effectiveness of the NHS as it relates to physical assets.***

Federal Rule

Address the risks to assets and to the highway system associated with current and future environmental conditions, ***including extreme weather events, climate change, and seismic activity, in order to provide information for decisions about how to minimize their impacts and increase asset and system resiliency.***

NCHRP 25-25 (95) TAMP Sections

Asset inventory and conditions

Asset management objectives and measures

Performance gap assessment

Lifecycle cost considerations

Risk management analysis

Financial plan

Investment strategies

Investment asset management process enhancements

Mapping of Climate Change/Extreme Weather Factors and a TAMP

Section

Asset inventory and conditions	<ul style="list-style-type: none">• Summarize climate- and weather-related conditions that affected the system historically.• Identify expected changing climatic conditions.
--------------------------------	--

Section

Asset management objectives and measures	<ul style="list-style-type: none">• Define the objectives that relate to system resiliency, redundancy, evacuation and recovery.• Identify assets or network segments sensitive to climate- and weather-related disruptions.• Define levels of service and measures relating to climate- and weather-related system operations and conditions.• Define short term and long term condition targets for resiliency, redundancy, evacuation and recovery.
--	---

Section

Performance gap assessment

- Define short- and long-term planning horizons relating to climate/extreme weather factors.
- Illustrate the performance gap between existing performance levels and future performance levels with respect to system disruption.

Section

Lifecycle cost considerations

- In the context of lifecycle costs, discuss tradeoffs between minimizing asset vulnerabilities as part of the normal capital program versus waiting until an extreme weather event occurs.

Section

Risk management analysis

- Identify climate/extreme weather event risks to the system.
- Identify state assets that are at most risk.
- Include a risk register, including – likelihood of occurrence, consequences of occurrence, and mitigation activities.

Section

Financial plan	<ul style="list-style-type: none">• Incorporate into the TAMP financial plan a strategy for funding needed improvements to reduce system risks, whether as part of normal capital investment or as a stand-alone funding initiative.
----------------	--

Section

Investment strategies	<ul style="list-style-type: none">• Describe typical approaches to minimizing climate- and weather-related risks.
-----------------------	---

Section

Investment asset management process enhancements	<ul style="list-style-type: none">• Identify priorities for asset management improvement as it relates to climate- and weather-related considerations.• Incorporate lessons learned from system disruptions that occur over time.
--	--

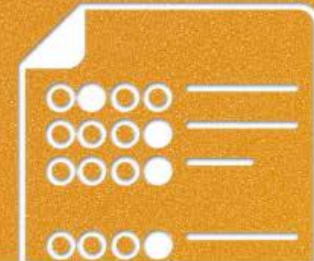
AASHTO TAMP Builder



Tools ▾ About ▾



Use this site to build a
MAP-21-compliant transportation
asset management plan.



The federal Moving Ahead for Progress in the 21st Century Act (MAP-21) requires state transportation agencies to develop risk-based transportation asset management plans (TAMPs). This site hosts electronic templates to assist agencies in preparing MAP-21-compliant TAMPs. The site also provides resources to customize templates in order to meet agency-specific objectives and requirements. More information about the website is available [here](#). To get started, follow one of the links below.



Build a Custom Outline

The custom TAMP outline builder allows you to easily modify the structure and contents of your TAMP outline by answering a few simple questions. Build a [custom](#) TAMP outline.



Download a Basic Outline

The Basic TAMP Outline reflects the minimum requirements established by MAP-21 and includes guidance and links to example TAMPs. Download a [basic](#) TAMP outline.



Download an Existing TAMP

Existing TAMPs are stored in an easily-searchable database. You can enter your specific search criteria and view all matching TAMPs. Download an [existing](#) TAMP.



Basic TAMP Outline

The Basic TAMP Outline should reflect the minimum requirements established by MAP-21. This outline contains the following sections:

1. Introduction
2. Inventory and Condition
3. Objectives and Measures
4. Performance Assessment
5. Lifecycle Management
6. Risk Management
7. Financial Plan
8. Investment Strategies
9. Process Improvements

The Basic TAMP Outline includes guidance and links to example TAMPs within each section to assist in TAMP development.

1. Introduction
2. Inventory and Condition
3. Objectives and Measures
4. Performance Assessment
5. Lifecycle Management
6. Risk Management
7. Financial Plan
8. Investment Strategies
9. Process Improvements

Introduction

1. In considering asset management critical risks, how have the agency's assets been affected by extreme weather-related events in the past?
2. Have forecasts been made on how extreme weather events might change in the future? (e.g., more heavy precipitation for longer durations, warmer winters, etc.)

Inventory and Condition

1. What types of extreme weather events have had the greatest impact on the agency's assets? Heavy precipitation? Extreme temperatures? Strong winds? Are there data trends that indicate these impacts?
2. What are the possible impacts of future extreme weather events on the agency's assets, both in terms of the possible greater intensity of such events or the likelihood of increased asset failures with deteriorating asset conditions in light extreme weather events?
3. Are certain types of assets more vulnerable to extreme weather events than others?

Objectives and Measures

1. Which objectives are most susceptible to extreme weather-related risks? Has consideration been given to reducing extreme weather risks in achieving these objectives?
2. Have you considered performance measures that relate to asset risks and potential damage related to extreme weather events?

Performance Assessment

1. Which performance measures will be most affected by the influence of extreme weather?
2. How are these performance measures linked to other sections of the TAMP, and thus possibly cause a cascading effect of extreme weather impacts on the success of the TAMP?
3. How are the potential impacts of extreme weather events considered in agency decision-making and program adjustments?

Lifecycle Management

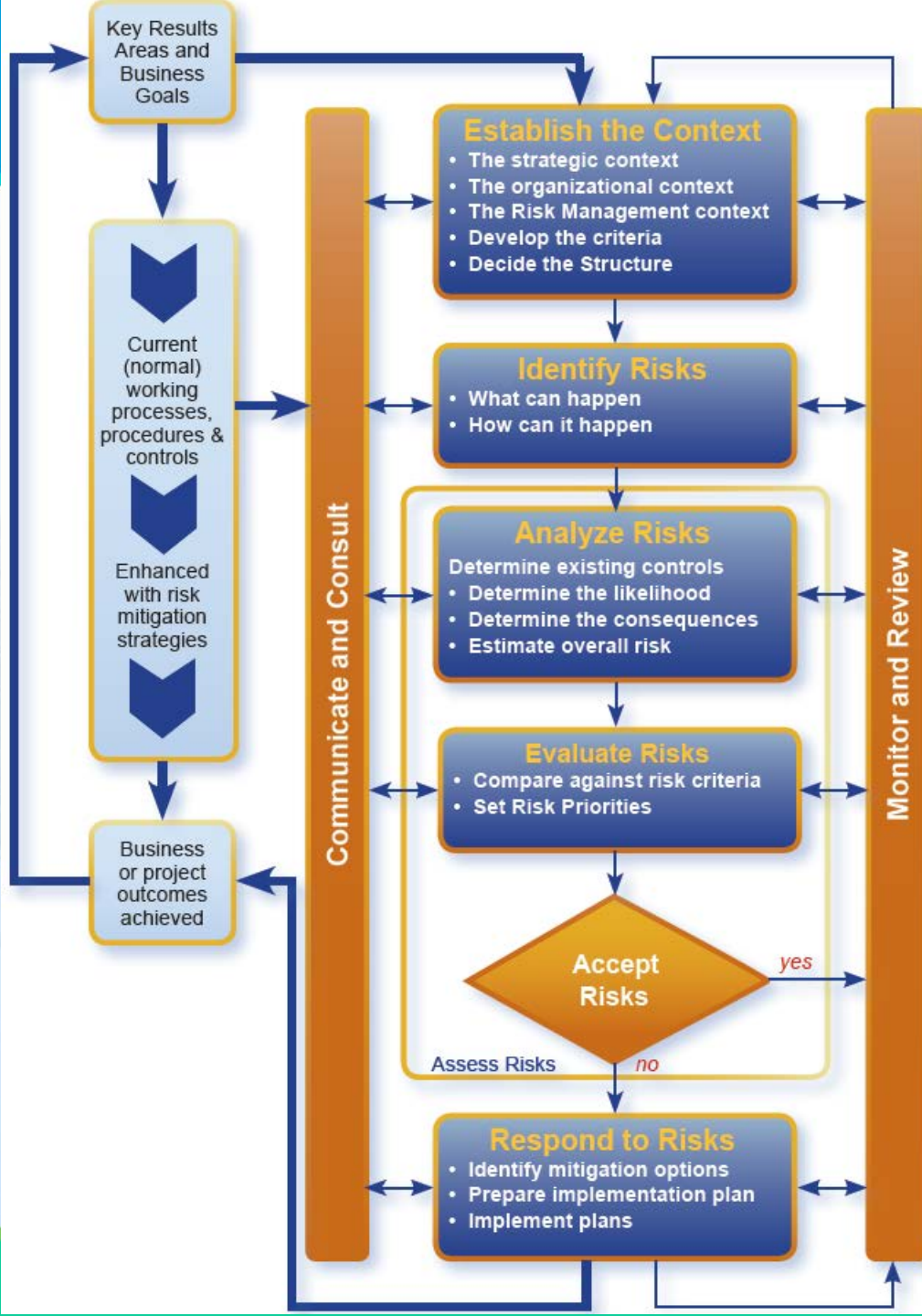
1. How have extreme weather-related impacts been considered in the lifecycle management of the agency's assets? (for example, have maintenance programs been adjusted to account for extreme weather considerations)
2. How have extreme weather-related risks to assets been identified and included in the agency's strategy to minimize damage due to extreme weather events?

Risk Management

1. How are extreme weather-related impacts considered in the agency-wide risk management strategy?
2. How has the risk of recurring damage and cost of future repair due to extreme weather events been considered in the risk management strategy?
3. How do risk-based asset inspections take into account potential extreme weather impacts?
4. How are extreme weather-related risks taken into account in maintenance planning and practices?

5. Have emergency response plans for extreme weather events available and have they been developed collaboratively with emergency response agencies?
6. What monitoring strategies and reporting processes related to extreme weather risks are in place to inform the agency's risk management strategy? Are extreme weather risk monitoring and response strategies captured in the agency's risk register?

Minnesota DOT



Condition of ITS Assets

Category Average	Percent Useful Life
Closed Circuit Video Camera (CCTV)	157%
Microwave Vehicle Radar Detector (MVRD)	37%
Road and Weather information Station (RWIS)	146%
Travel Time Indicator (TTI)	46%
Variable Message Sign (VMS)	69%
Emergency Call Boxes	222%
Automated Traffic Recorders (ATR)	184%
Ramp Meters	115%
Weigh-In-Motion Sensors (WIM)	169%
Network Equipment	105%
Average Percent Useful Life for all ITS Devices	143%

Colorado Risk Consideration

Likelihood
Safety
Mobility
Asset Damage
Financial
Funding
Insurance
Political
Regulatory

Project Risks

3a	10	Flooding (resulting in long-term impacts – damage to assets, requiring replacement)	4	5	5	5	5	√	√	√	√	24.0
3b	12	Burn area – post-fire debris flows, blocked culverts – loss of service	5	4	4	4	2	√	√	√	√	21.0
3c	11	Scour Critical Bridges are vulnerable to a storm event of sufficient size resulting in road loss	4	5	5	4	3	√			√	18.7
3d	10	Rockfall incident with loss of function/mobility (several days) or fatality	4	5	4	3	3	√	√	√	√	18.0
3e	11	Landslide – loss of road and mobility	4	4	4	4	2	√	√		√	16.1
3e2	9	Hazardous materials (need more of an event description) – spill, e.g., Hwy 6	5	3	2	4	2	√	√		√	15.8
3f	9	Retaining walls (failing and impacting traffic)	4	4	3	4	2	√	√		√	15.0
3g	9	Subsurface utilities impacts by others in ROW (and below roadways)	4	3	3	4	2	√		√	√	13.8
3h	11	Crash with fire occurs inside a tunnel resulting in a loss of service	3	4	4	4	3	√	√	√	√	13.5
3i	9	Overhead bridges are in danger of being hit – over height vehicles	5	3	3	2	1	√			√	12.4
3i2	10	ITS or traffic control failure – resulting in safety impact	5	4	2	1	1	√			√	11.0
3j	10	Avalanche causing delay	5	3	3	1	1	√			√	11.0
3j2	9	Bridge failure – structural, other than hits, scour, resulting in loss of service	2	5	5	4	4	√	√	√	√	10.8
3k	10	Avalanche requiring maintenance but no/minimal delay	5	3	2	1	1	√			√	9.6

Score

$$\text{Risk Score} = P_s \times O_s \times [(S_s + M_s + D_s + F_s)/4]$$

Where:

P_s = Likelihood Value;

O_s = Other Considerations Value = $1 + (0.05 \times [\text{Number of Other Considerations Checked}])$;

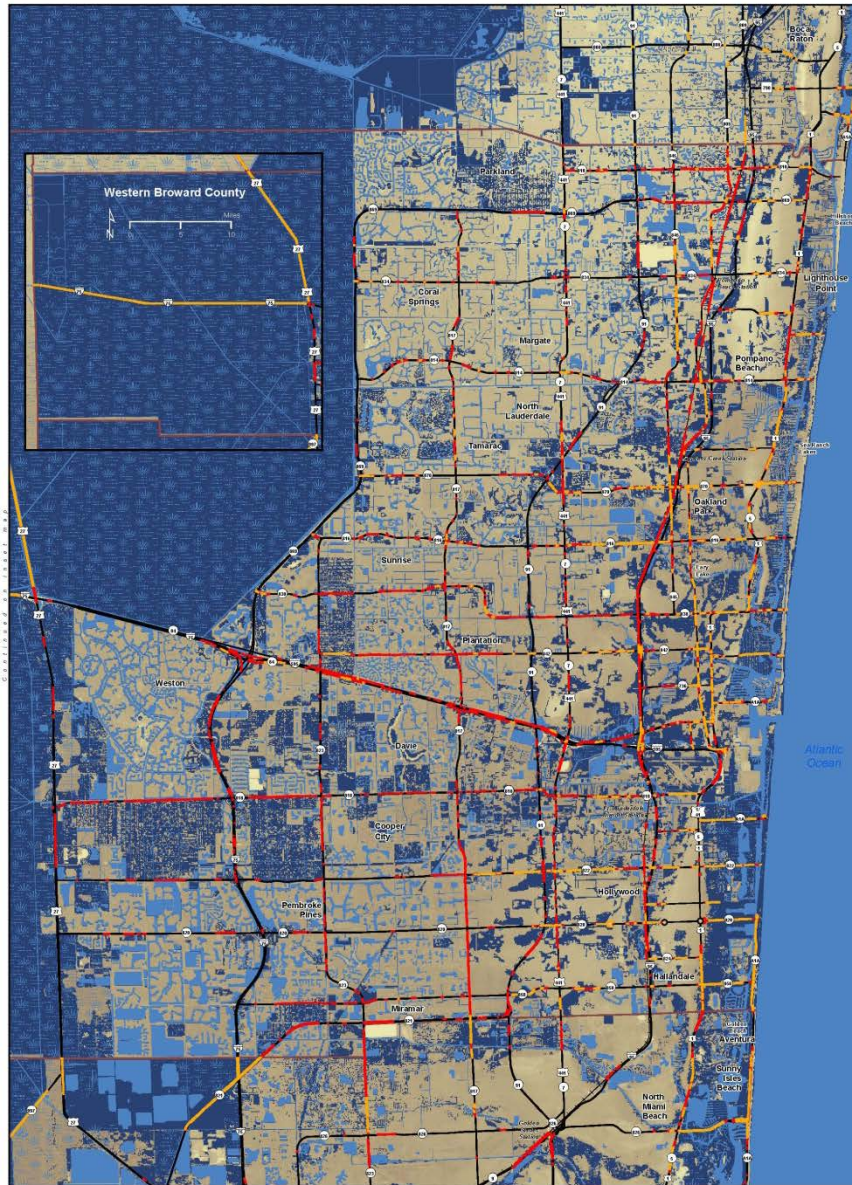
S_s = Safety Value;

M_s = Mobility Value;

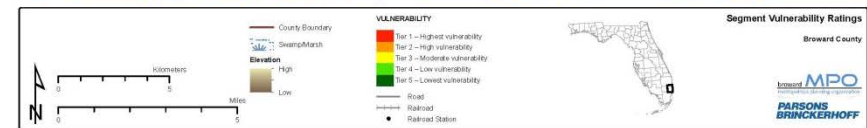
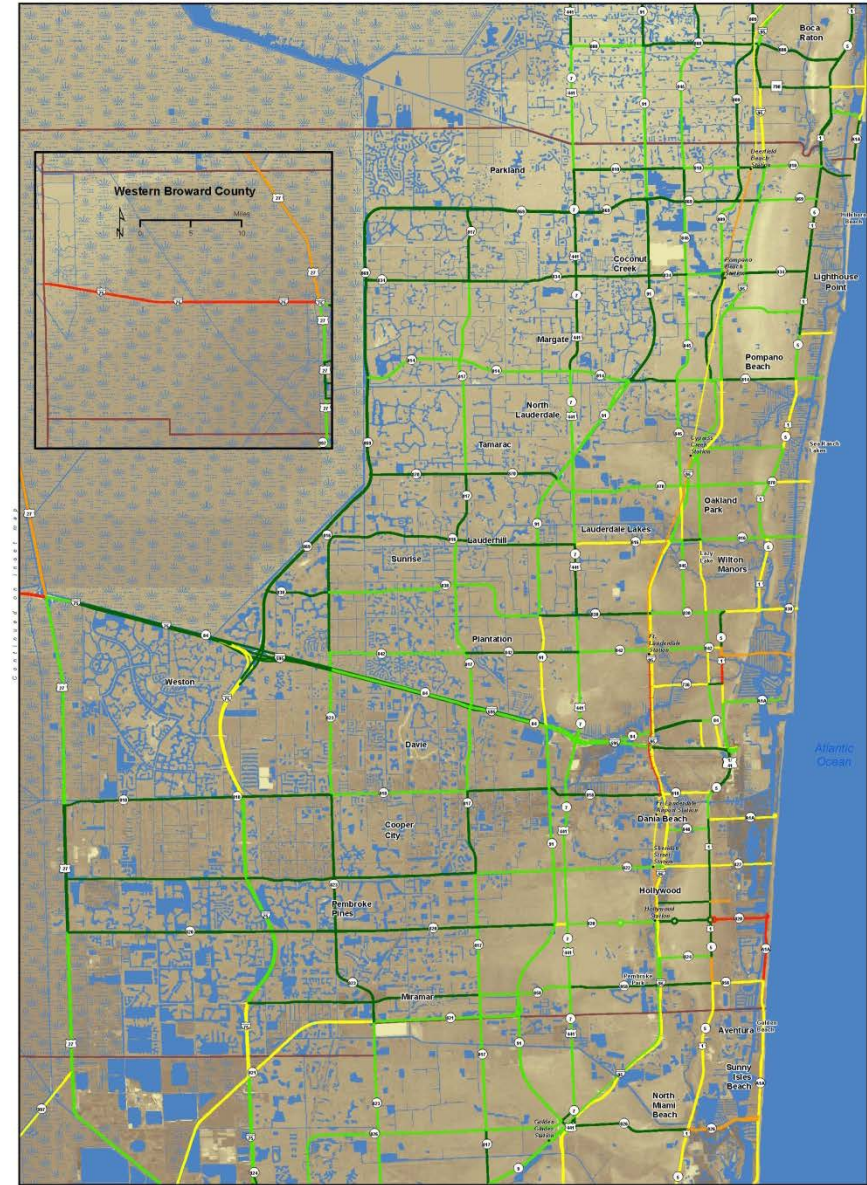
D_s = Damage (Asset) Value; and

F_s = Financial Value.

Future Flooding



Vulnerability



Financial Plan

1. How have agency funds been spent in responding to extreme weather events and their aftermath?
2. Which assets have had the greatest amount of funding allocated to reconstruction for recovery from extreme weather events?
3. Are funds allocated to extreme weather risk monitoring/mitigation and/or programs to improve asset resiliency?

Investment Strategies

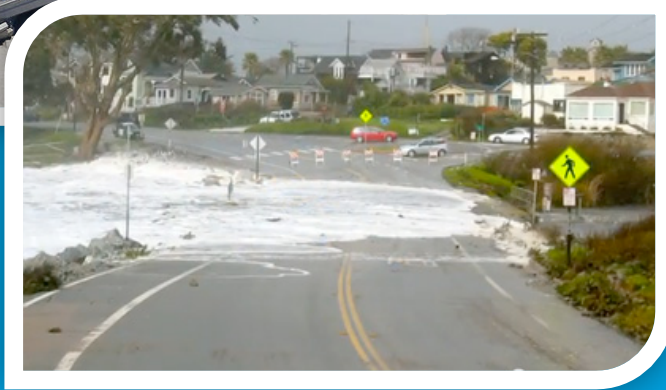
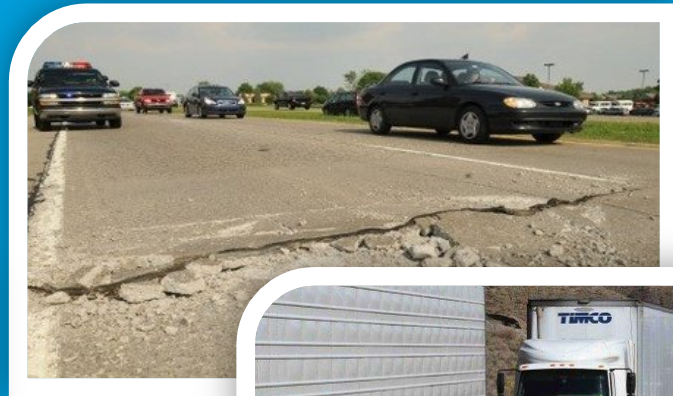
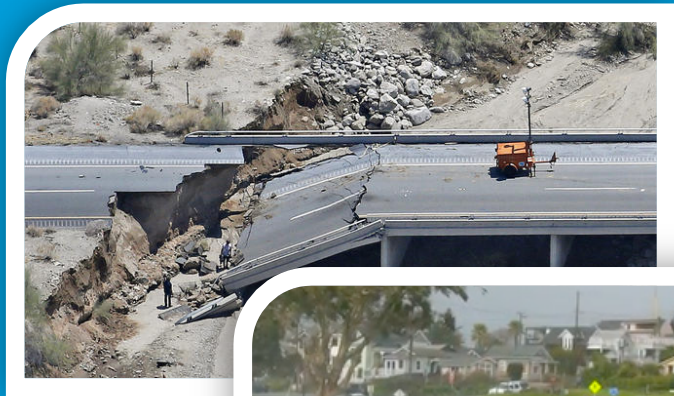
1. What are the short- and long-term financial needs associated with recovery from extreme weather events? How have these needs been reflected in the investment scenarios? And in the budget?
2. What types of strategies for mitigating the potential impact of extreme weather events have been considered as part of the investment strategies?

Process Improvements

1. Have changes been made in the TAM process to incorporate consideration for extreme weather events?
2. What data or information are needed to make such adjustments?

Michigan DOT

- Integrate climate resiliency goals and strategies into Michigan State Long Range Transportation Plan
- Incorporate climate risk scores for extreme heat into Road Quality Forecast System (RQFS) and Remaining Service Life (RSL) strategies. Begin monitoring performance relative to standard reconstruction and rehabilitation timeframes.
- Incorporate risk scores into Bridge Management System (BMS). Associate climate risk score for each bridge in the National Bridge Inventory, Pontis Bridge Inspection, and Structure Inventory and Appraisal reporting systems.



Thank You



**PARSONS
BRINCKERHOFF**