FHWA Sustainable Pavements Program and Resilient Pavements

NCIT Sustainability & Resilience Workshop Webinar

7/23/2024

Disclaimer

Except for the statutes and regulations cited, the contents of this presentation do not have the force and effect of law and are not meant to bind the States or the public in any way. This presentation is intended only to provide information regarding existing requirements under the law or agency policies.

Unless otherwise noted, FHWA is the source for all images in this presentation.

Acronyms

- EPD Environmental Product Declaration
- GWP Global Warming Potential
- LCA Life Cycle Assessment
- LCCA Life Cycle Cost Analysis
- SPP Sustainable Pavements Program

Agenda

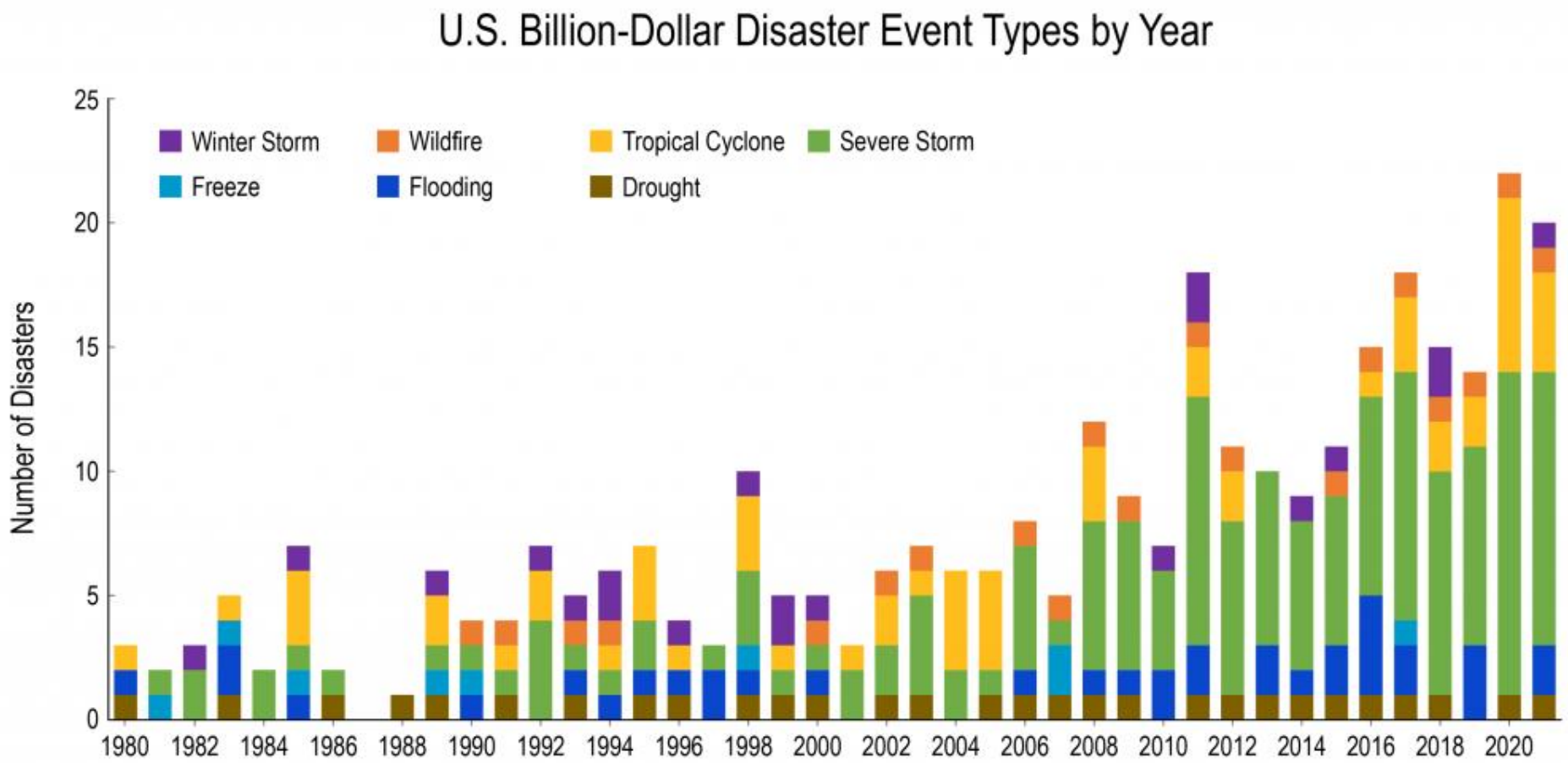
- Why?
- Sustainability
  - FHWA's SPP
  - Environmental Sustainability Quantification (LCA & EPD)
  - SPP Current Initiatives and Efforts
- Sustainability & Resiliency…What's the difference?
- Resilience
  - Motivation and Initiatives
- Resources

SUSTAINABLE PAVEMENTS PROGRAM

U.S. Department of Transportation
Federal Highway Administration

Sustainable and Resilient Pavements

Why?

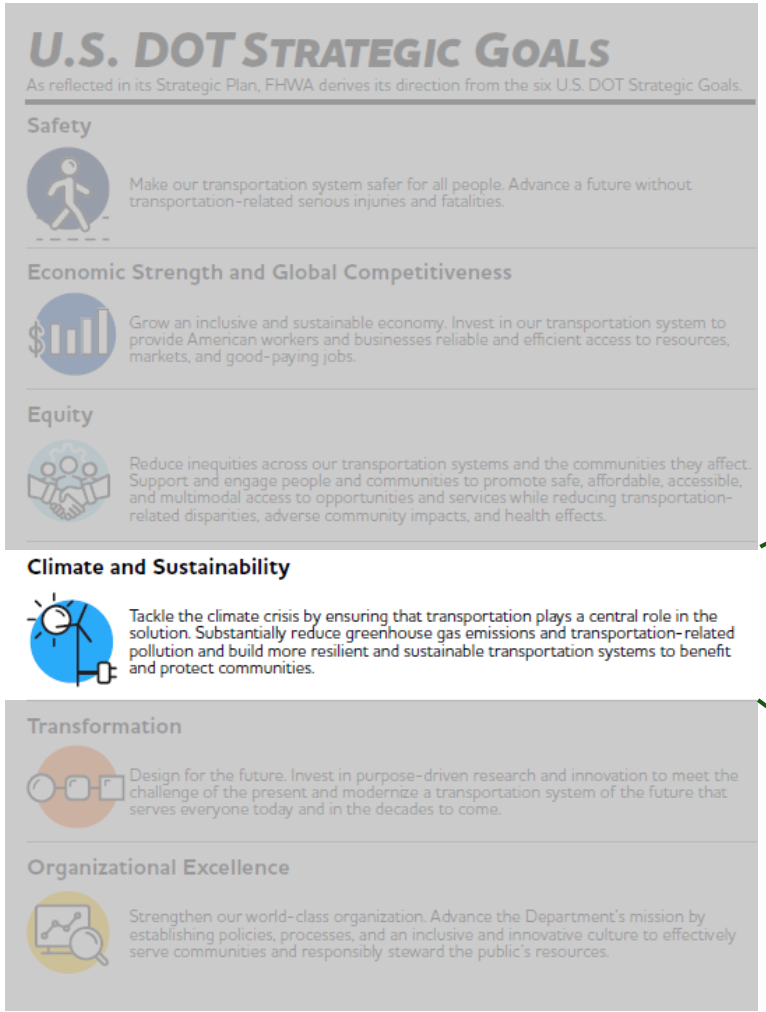


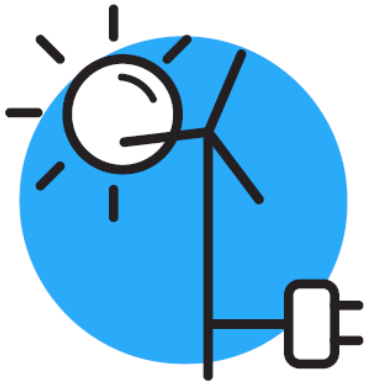
Source: globalchange.org

Why?

- **Extreme weather events** occurring with higher frequency and higher intensity.
- Agencies are focusing on **resilience** to deal with these changes.
- Focus also needed on mitigation to curb emissions that cause these weather events, thus the need for **Sustainability**.

United States Department of Transportation





Climate and Sustainability

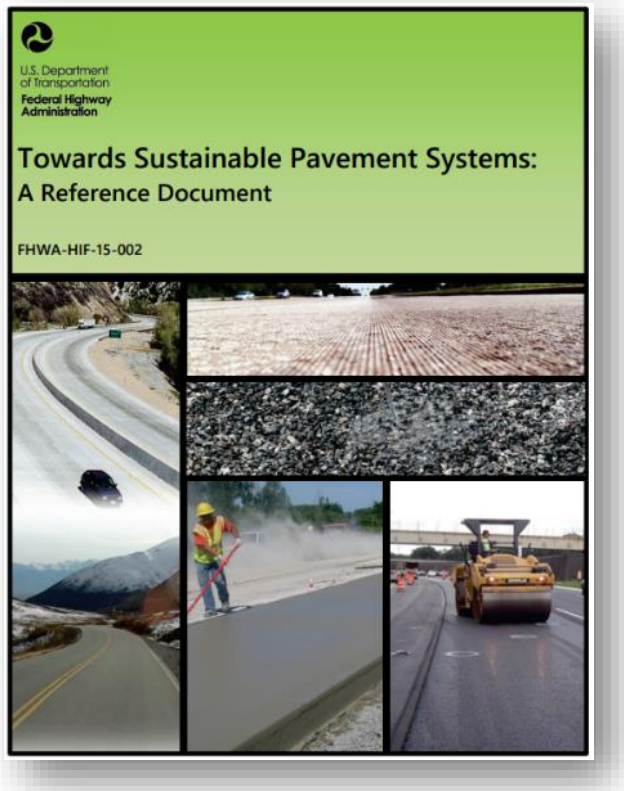
"…Substantially reduce greenhouse gas emissions and transportation-related pollution and build more **resilient** and **sustainable** transportation systems…"

Source: FHWA

FHWA's Pavements & Materials

Ensure that pavements are designed, constructed, preserved, and maintained to accommodate current and predicted traffic needs and consider ***economic, environmental, and social impacts and burdens*** *throughout the pavement's life cycle.*

Sustainable Pavements…



1. Achieve the engineering goals
2. Preserve and (ideally) restore surrounding ecosystems
3. Use financial, human, and environmental resources wisely
4. Meet basic human needs such as health, safety, equity, employment, comfort, and happiness

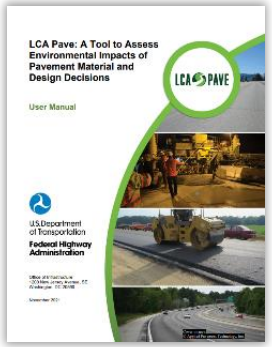
Balance of the Triple Bottom Line

INVEST
ECONOMIC • SOCIAL • ENVIRONMENTAL

REAL $ COST

Life-Cycle Cost Analysis
RealCost
USER MANUAL
LIFE-CYCLE COST ANALYSIS

LCA $ PAVE



EPD
ENVIRONMENTAL PRODUCT DECLARATION

Image Source: FHWA/APTech

Key Sustainability Takeaways

Sustainability is NOT only about the environmental impacts

If it doesn't meet the intended performance, it is not sustainable

You can't improve what you don't measure

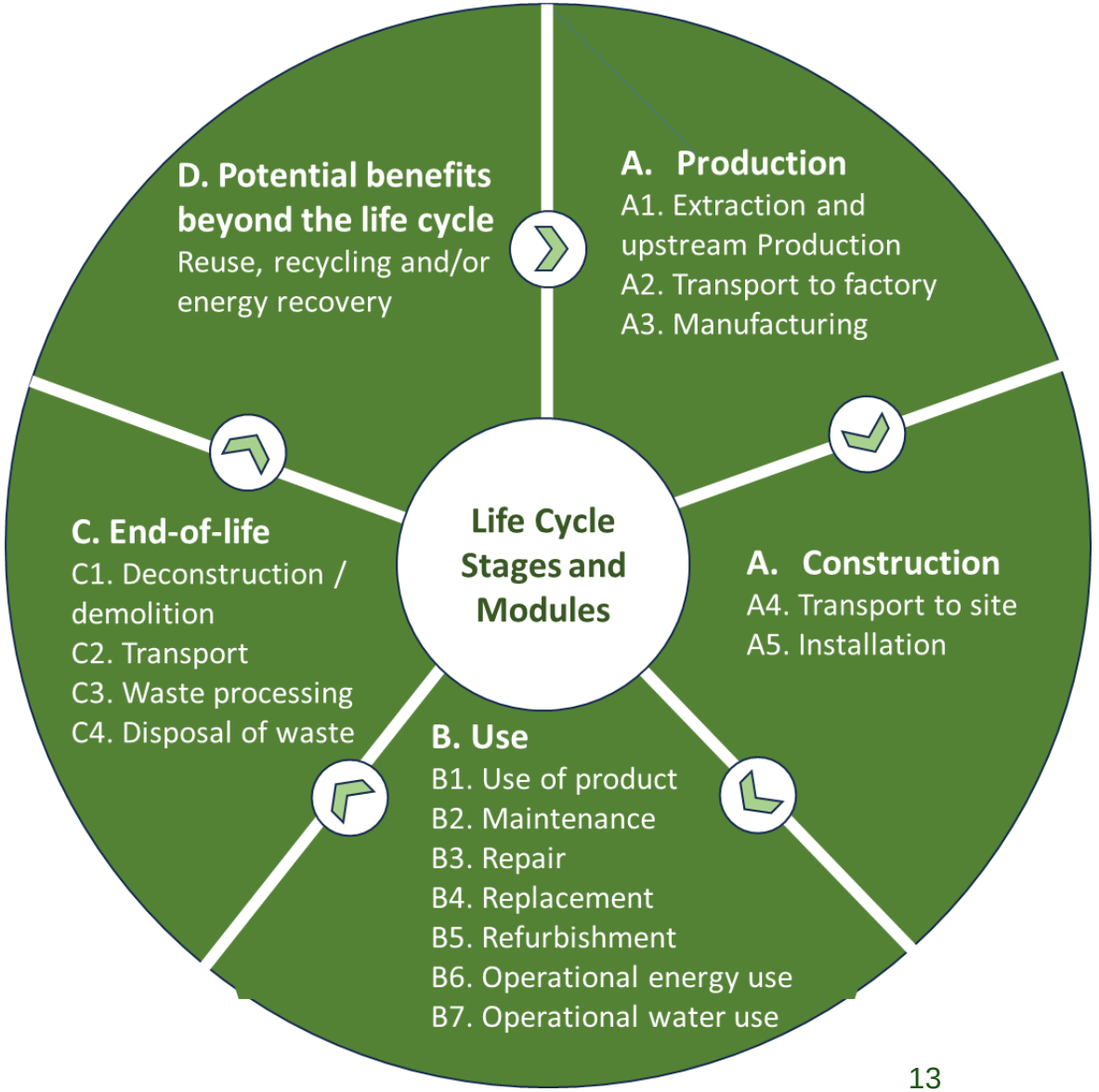
LCA ≠ LCCA

Sustainability is context sensitive

Sustainability is good engineering

What is Life Cycle Assessment (LCA)?

- A systematic analysis of the potential environmental impacts of products during their entire life cycle.
- LCCA is a financial accounting, LCA is an eco-accounting.
- ISO Standards 14040 and 14044.



What are Environmental Product Declarations (EPDs)?

- Communicate environmental impacts of a material or product
- Express the results of an LCA
- Developed with stakeholder input
- Follow industry standards described in the Product Category Rule

*Use of ISO specifications is not a Federal requirement.

Sustainable Pavements Program Current Initiatives

EO 14057
Specified goal of Net Zero Federal Procurement

CLIMATE CHALLENGE

25 States (+2 Local Agencies) Participating
35+ projects from 27 agencies
$7.1M

EPD
ENVIRONMENTAL PRODUCT DECLARATION

EDC-7
EPDs for Sustainable Project Delivery

IRA
INFLATION REDUCTION ACT

Inflation Reduction Act
(Pub. L. No. 117-169)
$2 Billion for FHWA
Low-carbon transportation materials grants

Executive Order 14057

Source: Council on Environmental Quality

- Sept 2021 Executive Order signed and Buy Clean Task Force created
- Sept 2022 Policy Statement on Buy Clean Initiative signed which leverages federal procurement to catalyze markets for **low-carbon construction materials to upgrade US transportation**, buildings and energy infrastructure
- Pollutant recommended: **GHG**
- Priority materials:
  - Asphalt
  - Concrete
  - Flat glass
  - Steel
- Reporting Tool recommended: **EPDs**

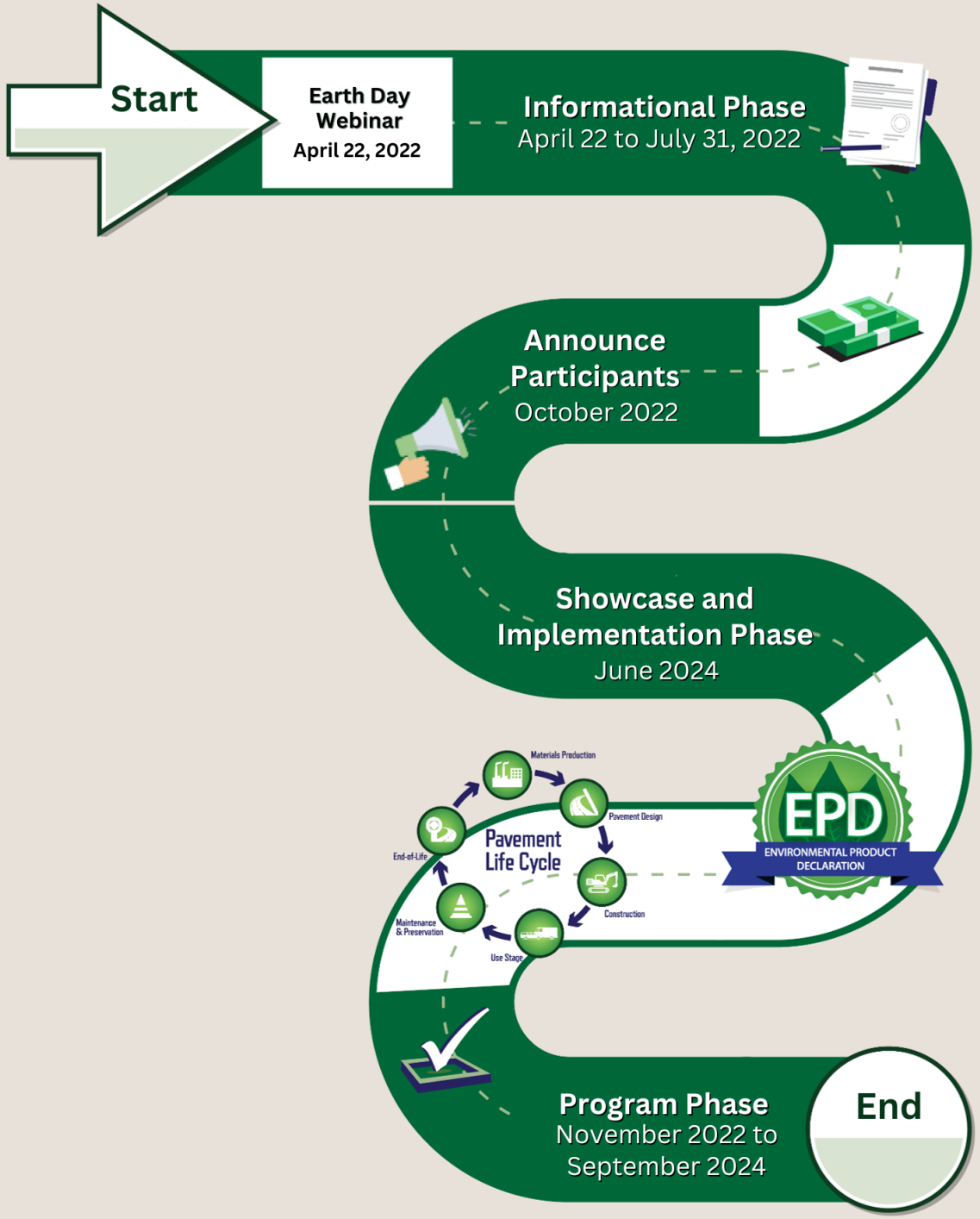
Source: Fact Sheet: Biden-Harris Administration Announces New Buy Clean Actions

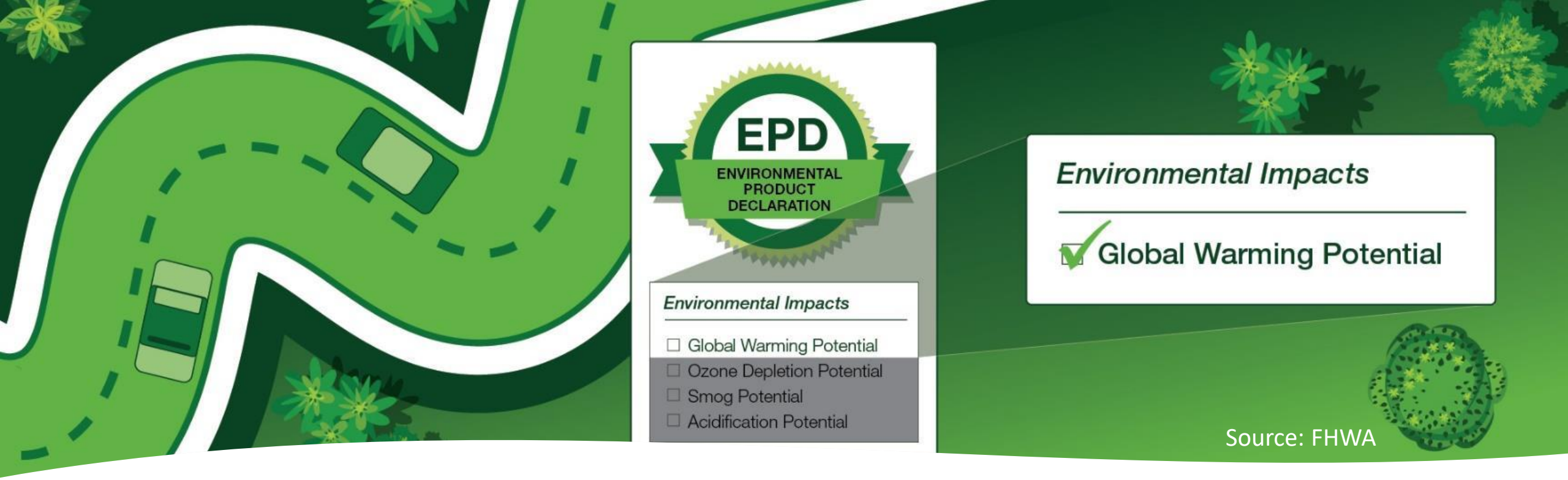
Climate Challenge Program

State DOTs and other public agencies **explore the use of LCA and EPDs** as a standard practice to inform pavement material and design selection for enhancing sustainable pavement practices and quantify the emissions and impacts of those practices.

CLIMATE CHALLENGE

https://highways.dot.gov/climatechallenge





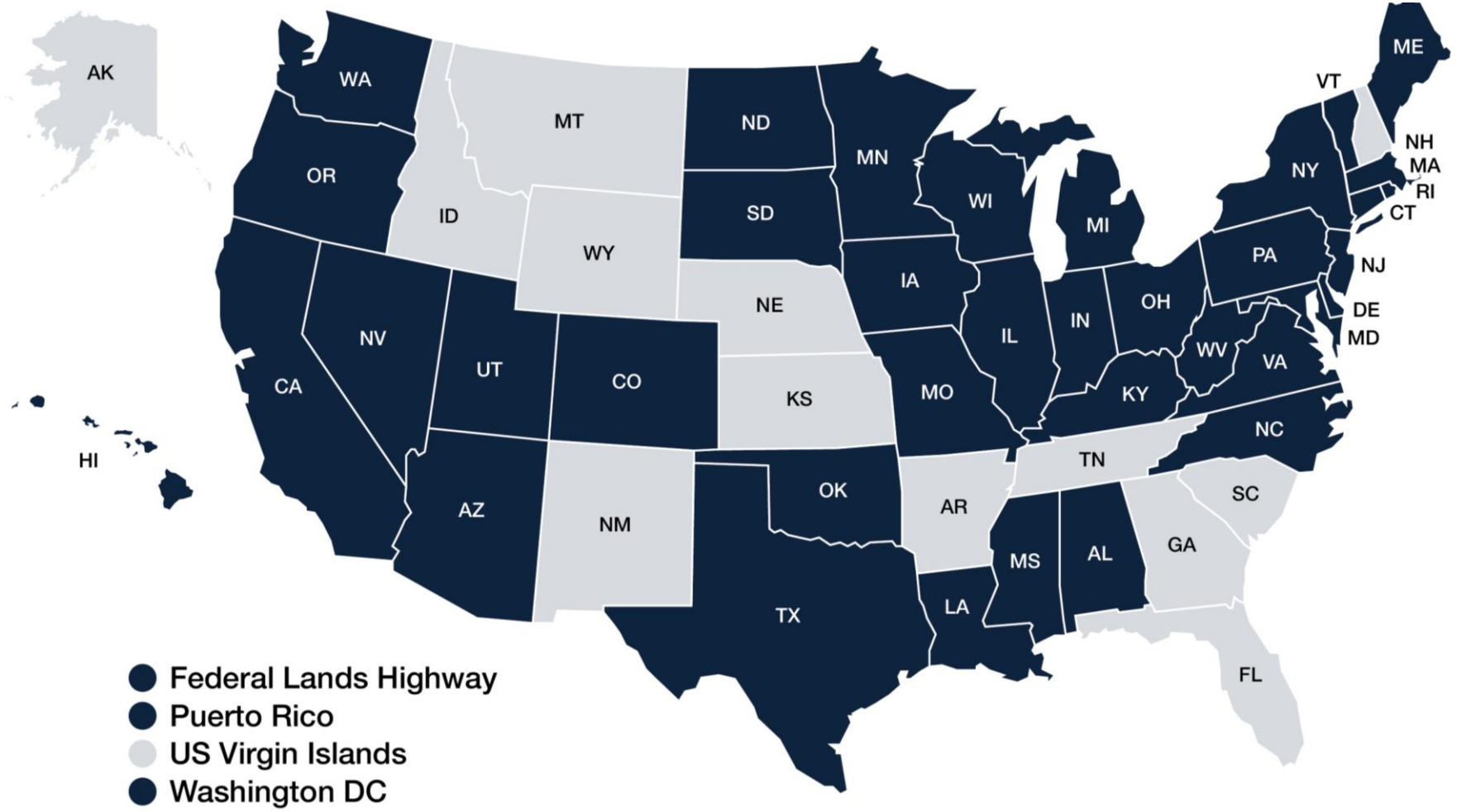
EDC-7 EPDs for Sustainable Project Delivery Innovation

Collection of EPDs

- Contract and specifications language
- Selection of appropriate materials and bid items
- Database, tools, and best practices
- Educates on uses throughout the project delivery process

Climate Challenge & EDC Participants

39 States, 2 local agencies & Federal Lands



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U.S. Department of Transportation
Federal Highway Administration

LOW CARBON
TRANSPORTATION
MATERIALS

Inflation Reduction Act Section 60506 Overview

IRA (Pub. L. No. 117-169, Aug. 16, 2022)
FHWA's IRA Program Website

What is the LCTM Program?

- **$2B** Grant program for eligible projects that include **materials and products determined to have "substantially lower levels of embodied greenhouse gas emissions,"** as described by the Environmental Protection Agency (EPA).
- Eligible materials are concrete (and cement), glass, asphalt mix, and steel
- Funds are available to use on Title 23 construction projects, including:
  - Federal-aid highways
  - Tribal transportation facilities
  - Federal lands transportation facilitates
  - Federal lands access transportation facilities

State DOTs via Request for Applications (RFA)

- RFA closed: June 10, 2024
- Up to $1.2B for State DOTs
- Anticipated award: September 2024

Coming Soon

Non-State DOTs via Notice of Funding Opportunity (NOFO)

- Will be available on Grants.gov
- Anticipated $800M for non-State DOTs

NOTE: All funds must be obligated by September 30, 2026, and are available for expenditure through September 30, 2031.

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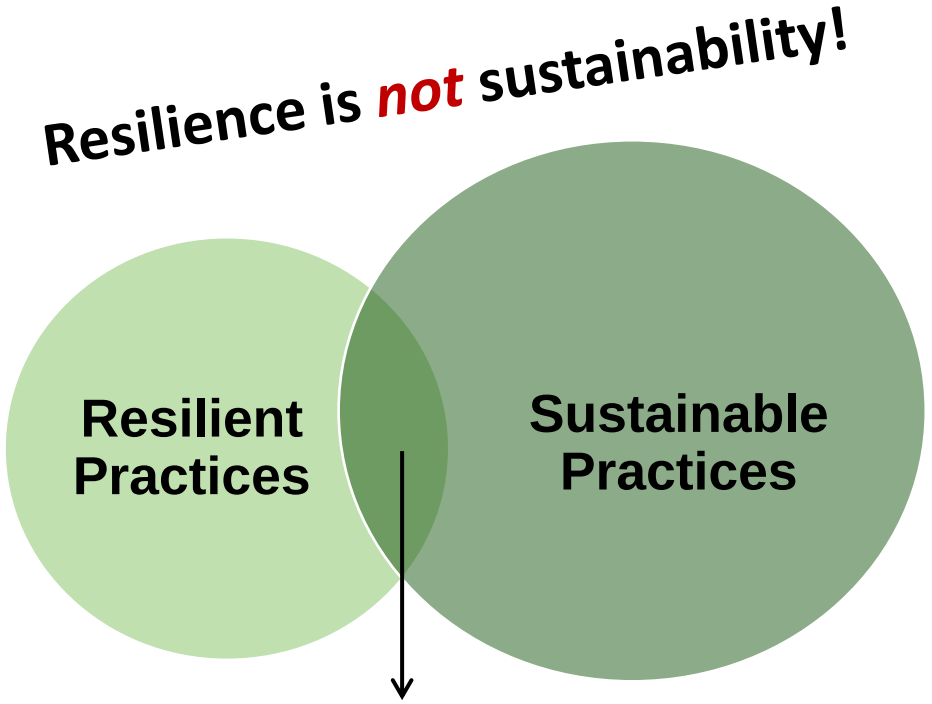
Sustainability & Resilience…

What's the Difference?

Considering Sustainability & Resilience in Design

Resilient Pavement Practices

- Over-designing for catastrophic events
- Use of climate adaptable materials in unsustainable circumstances
- Incorporation of vulnerability assessments



Resilient & Sustainable Pavement Practices

- Use of porous pavements
- Design and management that incorporates future climate conditions

Sustainable Pavement Practices

- Use of recycled materials
- Integration of pavement preservation and management
- Addressing social impacts such as equity and safety
- Incorporating LCCA and LCA

FHWA building-block approach to Sustainable Transportation Infrastructure

"Stick"

"Carrot"

Encouragement

LOW CARBON TRANSPORTATION MATERIALS

Policy & Mandates

Incentivize & Pilot

Educate & Promote

BUY CLEAN

CLIMATE CHALLENGE

EPD ENVIRONMENTAL PRODUCT DECLARATION

However…

While resilient solutions may or may not be sustainable…

- ***resilient systems contributes to sustainability***
- ***sustainable systems addresses need for resilience***

Resilience and Sustainability in a Changing World

While we need resilience to withstand the extreme weather events, we need sustainability to mitigate the climate crisis.

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Pavement Resilience

Motivation and State of Practice

Pavement Climate Resilience

1. Ability to anticipate, prepare for, and adapt to changing conditions while maintaining expected pavement performance.
    1. Gradual changes in frequency and intensity of climate stressors
2. Withstand, respond to, and recover rapidly from disruptions
    1. Extreme events that are very disruptive/destructive
    2. Rapid assessment and repair practices

For the full definition, see sec. 11103 of the Bipartisan Infrastructure Law (BIL), enacted as the Infrastructure Investment and Jobs Act, Pub. L. 117-58 (Nov. 15, 2021). See also FHWA policy on Using BIL Resources to Build a Better America (Dec. 16, 2021).

Source: Adapted from FHWA Order 5520

Pavement Impacts from Climate

- Environmental factors contribute to pavement performance:
  - Contributed to 36 percent of total damage for flexible pavements
  - Contributed to 24 percent of total damage for rigid pavements
- Changes in climate:
  - Are characterized by changes in frequency and intensity of:
    - Temperature
    - Precipitation
    - Drought, floods, and wildfires
    - Arctic change
    - Sea level rise
    - Extreme weather events
  - Expose ***vulnerabilities*** in pavements that have associated ***risks***
    - Produce pavement performance implications (see indicators)

Sources:
FHWA-HRT-16-078
FHWA-HIF-23-006

Key pavement indicators to monitor for climate impacts:

Asphalt Pavement Indicators	Concrete Pavement Indicators
Rutting of asphalt surface	Blow-ups (JPCP)
Low temperature (transverse) cracking	Slab cracking
Block cracking	Punch-outs (CRCP)
Raveling	Joint spalling
Fatigue cracking and potholes	Freeze-thaw durability
Rutting of subgrade and unbound base	Faulting, pumping, and corner breaks
Stripping	Slab warping
	Punch-outs (CRCP)

Source: FHWA-HIF-15-015

CRCP = continuously reinforced concrete pavement;
JPCP = jointed plain concrete pavement.

Pavement Climate Vulnerability & Risk

- Pavement climate vulnerabilities are ***context-specific***
  - For example, consider temperature change:

Category	Climate Stressor	Pavement Vulnerabilities
Temperature	Higher average temperature	1. Increased maximum pavement temperature 2. Increased rate of age hardening of asphalt binder 3. Increased concrete temperature-related curling and associated stresses 4. Increased concrete moisture-related warping if accompanied by lower relative humidity.
	Higher extreme maximum temperature	In addition to what is listed above: 1. Concrete pavement blow-ups due to excessive slab expansion. 2. More construction scheduling limits due to high temperature working hour restrictions
	Warmer extreme minimum temperature	1. Shallower frost depth 2. Reduced risk of frost heave 3. Warmer minimum pavement temperature
	More freeze-thaw events in some locations	1. Increased thermal cycling 2. Increased need for deicing

Source: FHWA-HIF-23-006

- Addressing vulnerability requires measuring and adapting for climate risk
- "…Risk is often represented as probability or likelihood of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur." FHWA-HEP-17-082

FHWA Resilience Motivation:

- Strategic Goal: Climate and Sustainability
  - Infrastructure Resilience:
    - **CSR2:** Enhance Data collection and analysis methods to assess the risks posed by climate change to the transportation system and identify vulnerable infrastructure assets
    - **CSR3:** Research and advance the adoption of adaptable resilient materials and structures
  - Climate Justice and Environmental Justice
    - **CSJ4:** Establish data collection and analysis methods to assess the risks posed by climate change to vulnerable communities and the transportation systems nearby

Source: FHWA

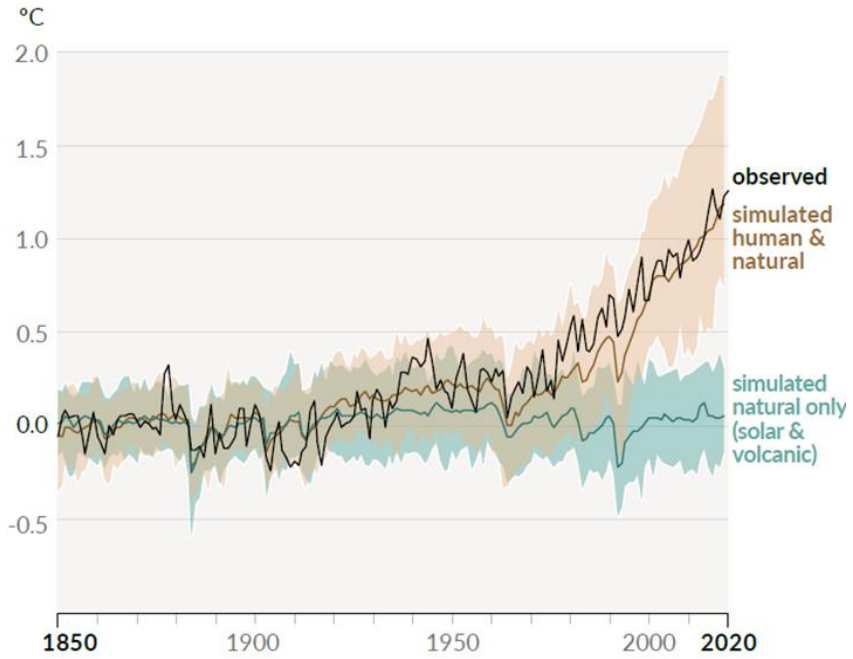
FHWA Resilience Motivation:

- Conducting research to *deploy strategies* for improving pavement resilience [CSR2, CSR3, CSJ4]
  - Example: Impact of Increasing temperature on flexible pavement infrastructure
    - Requires quantification in pavement design and management

- Climatic data are used explicitly in some cases.
  - **These methods assume climate *stationarity.***

- Stationary Assumption:
  - Observed data = future climate

- Non-stationary Assumption:
  - Observed data ≠ future climate



Source: *IPCC AR6 WG1*

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Ongoing Initiatives and Resources

Goal: Build & Disseminate Current Knowledge

Impacts of Wildfires on Pavements

- Project objectives:
  - Determine the state of knowledge of wildfire impacts on pavements and other assets.
  - Define direct and indirect impacts.
  - Identify research gaps and needs.
- Project deliverables:
  - Determine the state of knowledge.
  - Identify how State DOTs deal with this issue:
    - Conduct detailed interviews.
    - Gather information on their experiences, observations, and challenges.

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Assessing Flooded Pavements Project

- Project objectives:
  - Develop methods to assess flooded pavements.
  - Assess the capacity to carry traffic during/after flooding.
  - Evaluate emergency or heavy equipment.
  - Evaluate normal traffic.
  - Determine the tradeoff between the user costs of road closure (and detours) versus the costs of increased road damage.
  - Develop a decision support tool.

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National Oceanic and Atmospheric Administration Project: Effects of Sea Level Rise

- Joint project with the National Centers for Coastal Ocean Science.
- Project goal details:
  - Facilitate informed adaptation planning and coastal management decisions through a multidisciplinary research program that results in integrated models and tools of dynamic physical and biological processes capable of evaluating vulnerability and resilience under multiple SLR, inundation, and management scenarios.

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NOAA Project (Continued)

Two focus areas:

- Coastal resilience.
- Surface transportation resilience:
  - Quantify the vulnerability of surface transportation systems to SLR and inundation.
  - Quantify the social, economic, and/or ecological benefits.
  - Predict the effects of SLR and inundation on surface transportation infrastructure under varying risk mitigation and management strategies.

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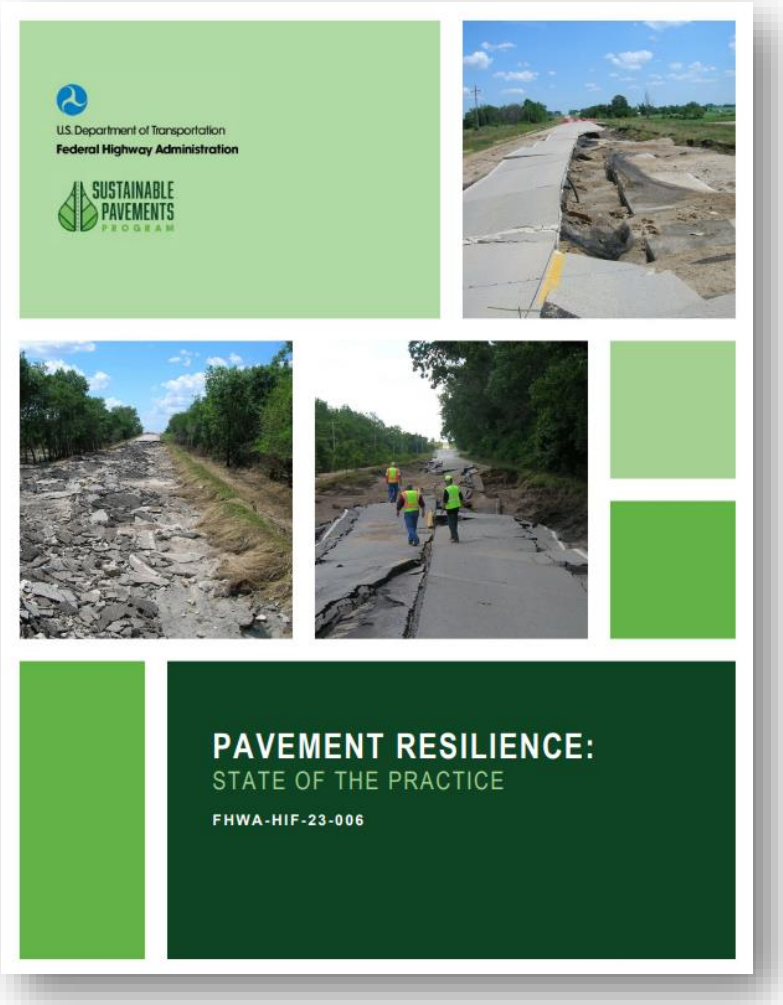
Pavement Resiliency: State of Practice

- Two national peer exchange meetings:
  - Identify strategies and barriers for designing, constructing, and maintaining more resilient pavements
- Pavement Resiliency Document:
  - Based on peer exchanges
  - Approaches and strategies
  - Gaps and Research Needs

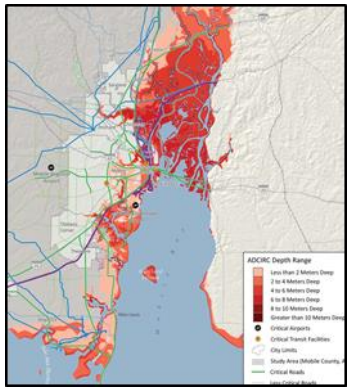


Ongoing & Upcoming Dissemination Items

- FHWA Resilient Pavements Website
  - Showcase FHWA pavement resilience knowledge, projects, and outreach opportunities
- Dissemination of Available Knowledge on Infrastructure Resilience
  - A series of technical webinars, workshops, and a TechBrief
- Pavement Resilience Knowledge Series
  - A series of primer documents delivering entry-level pavement resilience concepts for stakeholders
- FHWA Cooperative Agreement: Advancing Sustainability and Resilience in Pavements

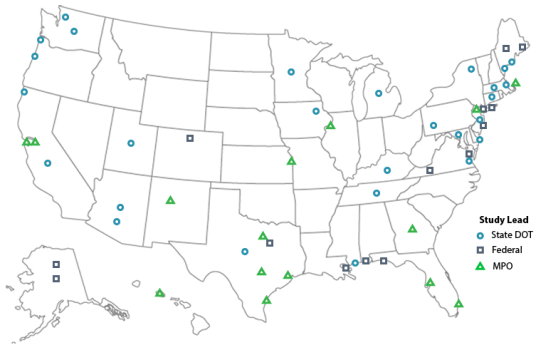
FHWA Resilience Resources

Gulf Coast 2 Study



(FHWA 2019)

Resilience Pilots with State DOTs and MPOs



(FHWA 2021c) MPOs = metropolitan planning organizations.

Hurricane Sandy Project

(FHWA 2017c)

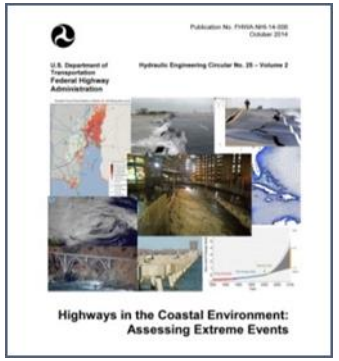
Engineering Assessments

(FHWA 2017d)

Vulnerability and Adaptation Framework

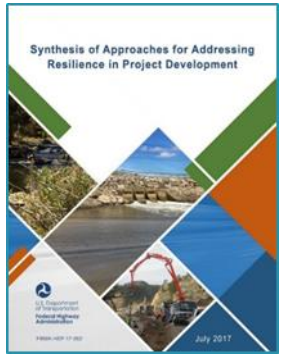
(FHWA 2019)

Engineering Guidance (HEC-25 & 17)



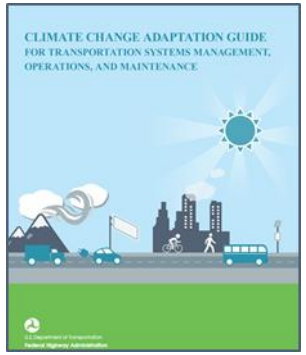
(FHWA 2014a)

Project Development



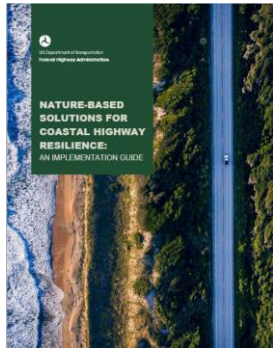
(FHWA 2015)

Operations and Maintenance



(FHWA 2017a)

Nature-Based Solutions



(Buckingham and Torossian 2021)

All photos source: FHWA.

Resources

- FHWA SPP dedicated website to EPDs: https://www.fhwa.dot.gov/pavement/sustainability/epds/

- IRA Low-Carbon Transportation Materials website: https://www.fhwa.dot.gov/lowcarbon/
- Introduction | Sustainable Pavements Program Cooperative Center (ucdavis.edu)

Resources

- http://www.fhwa.dot.gov/pavement/sustainability

Education	Research	Deployment
Pavement LCA Framework	LCA fit in transportation decision-making	LCAPave Tools
Webinars	EPDs in Green Public Procurement	Pilot projects with State DOTs
Tech briefs, studies	LCA of recycled plastics in pavements	Climate Challenge
Technical articles	LCA of ground tire rubber in pavements	EDC 7- EPD for Sustainable Project Delivery

Thank you

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http://www.fhwa.dot.gov/pavement/sustainability

https://highways.dot.gov/research/infrastructure/resilient-pavements