FHWA's Sustainable Pavements Program



Northwest Pavement Management Association Conference

Wednesday, 21 October 2015
Vancouver, WA

Steve Muench

Program Overview

US DOT Sustainability Policy Statement

"DOT will incorporate sustainability principles into our policies, operations, investments and research through innovative initiatives and actions such as:

- Infrastructure investments & grant programs
- Innovative financial tools & credit programs
- Rule- and policy-making
- Research, technology development, & application
- Public information
- Enforcement and monitoring"

-Signed by Secretary Anthony R. Foxx, June 2014

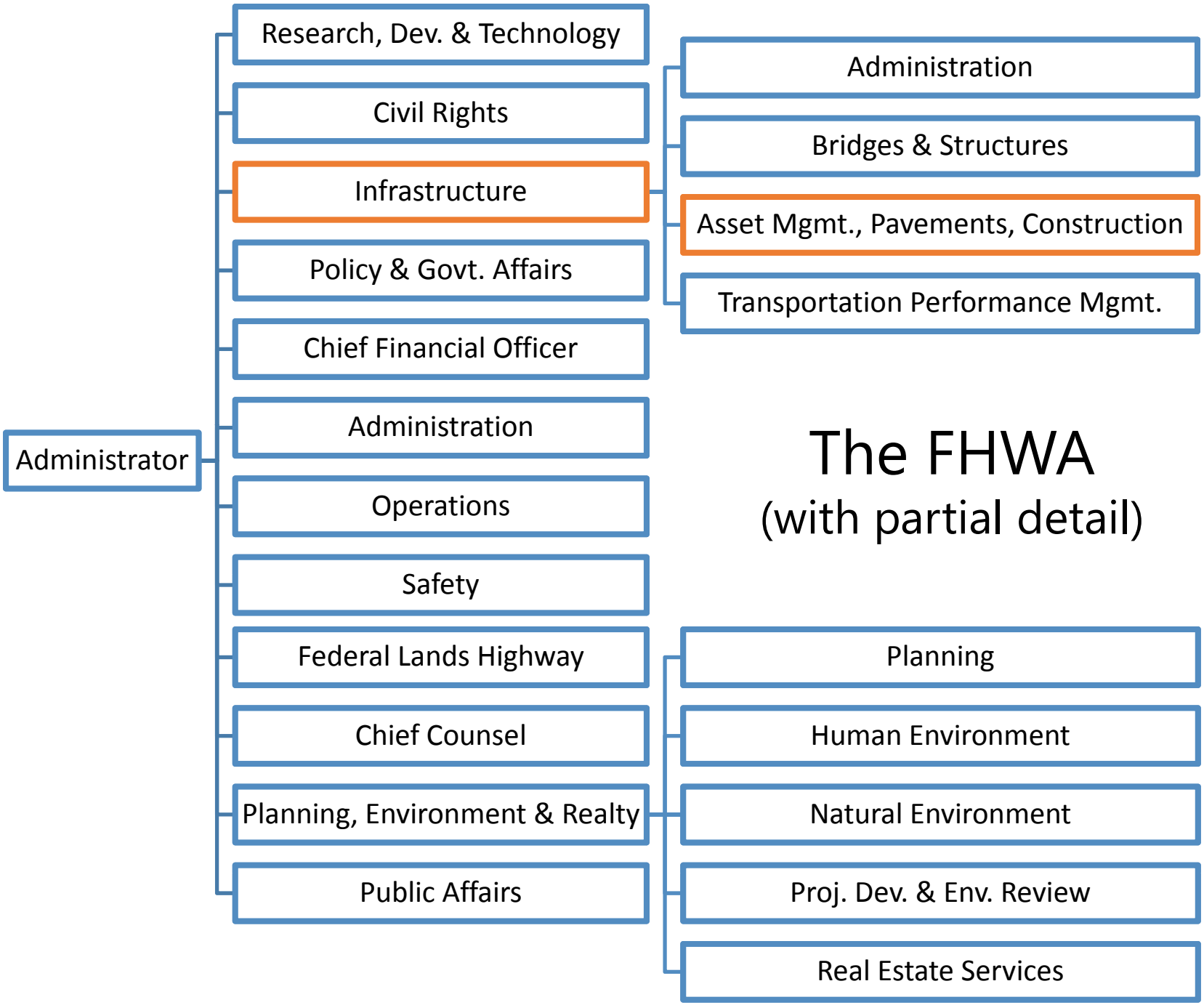
Sustainable Pavements Program

Purpose
Advance the knowledge and practice of sustainability related to pavements.

Scope
Asphalt, concrete, granular, and other materials in pavement systems including new and emerging materials.

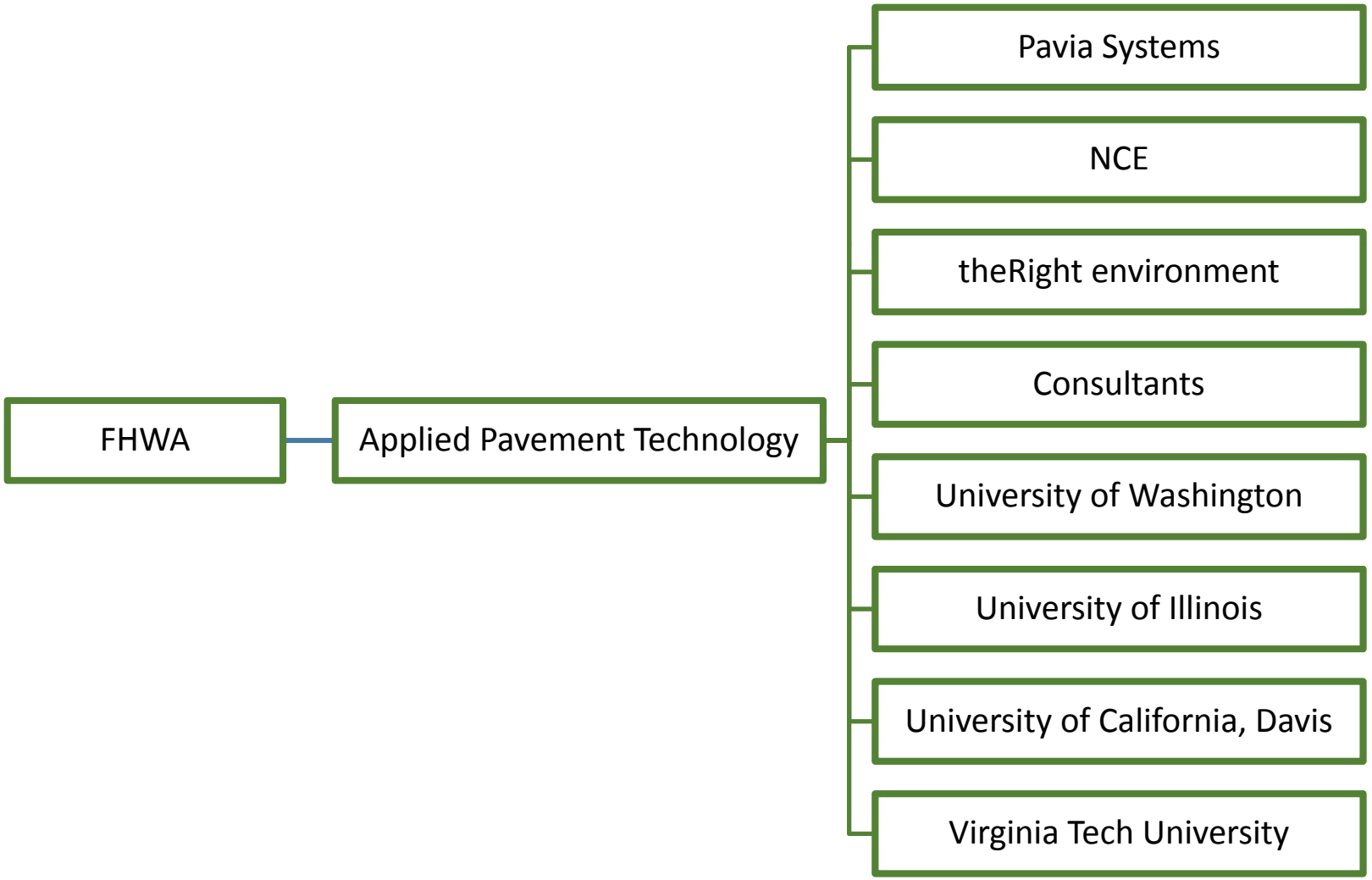
Outcome
Increase the awareness, visibility, and the body of knowledge of sustainability considerations in all the life cycle phases of pavement systems.

A technical guidance and education program



The FHWA
(with partial detail)

Contractor Team



Major Program Activities

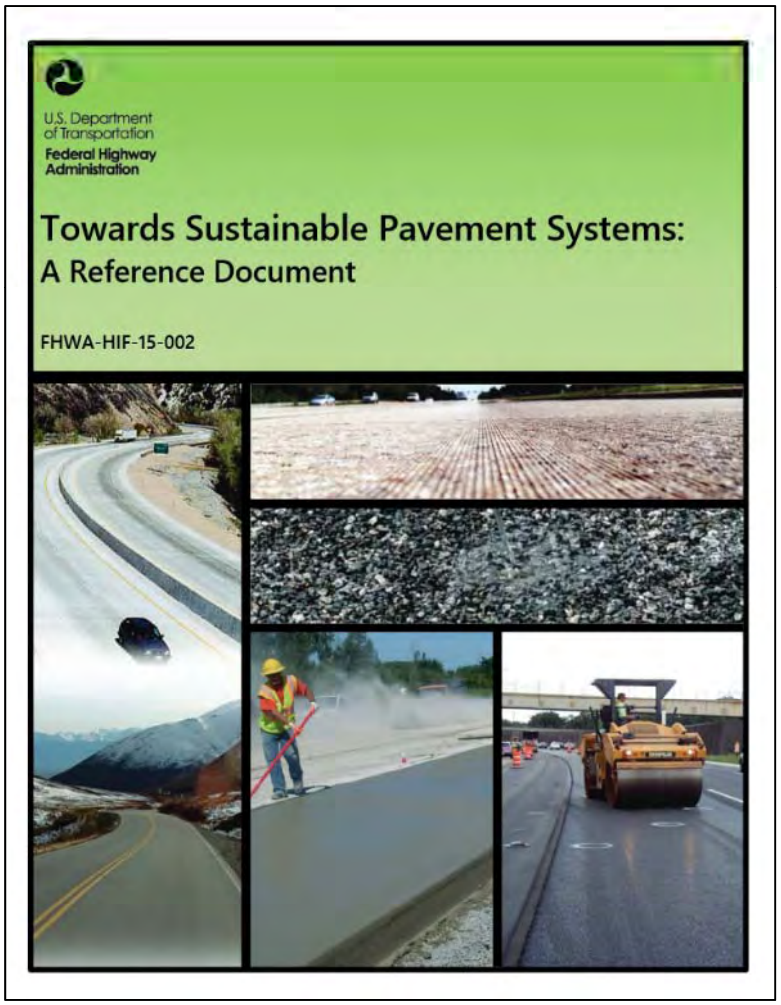
Major Program Activities

1. Stakeholder Engagement
   - Sustainable Pavements Technical Working Group (SPTWG) meetings
2. Technical Guidance
   - Reference document
   - LCA document (in review)
3. Deployment and Technology Transfer
   - Topical Technical Briefs (Techbriefs)
   - Outreach activities (webinars)
   - Sustainable pavements web page

Sustainable Pavement Technical Working Group (SPTWG)

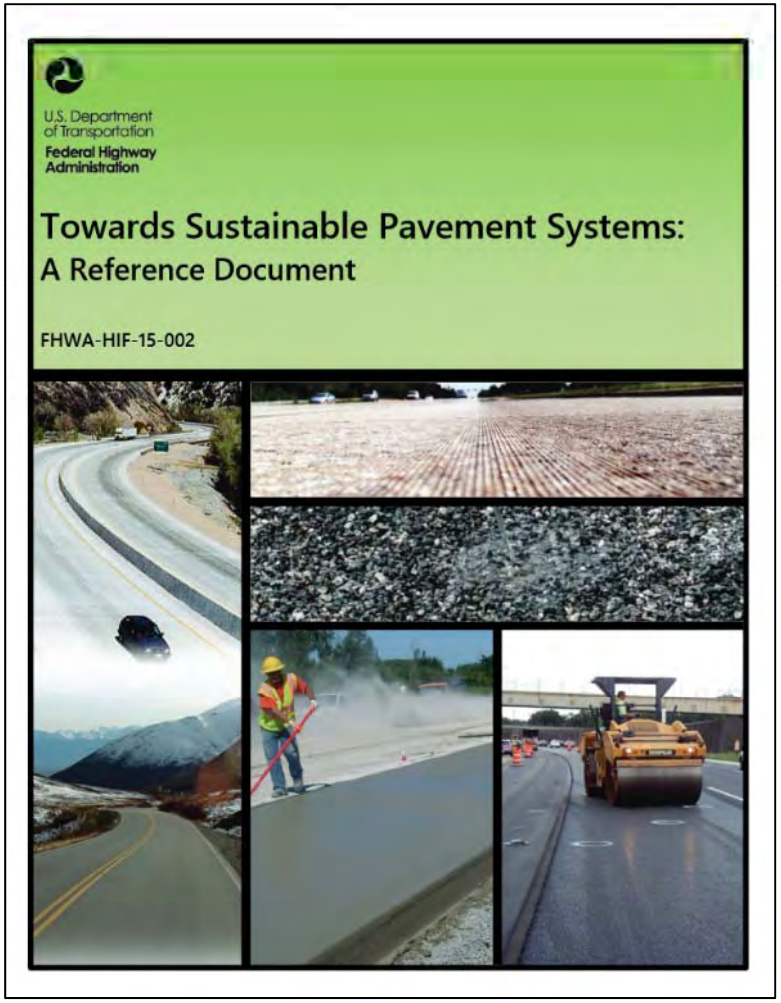
- Makeup
  - 20 members (DOTs, academia, industry)
  - 250+ “friends”
- Bi-annual meetings since 2011
- Function
  - Forum for information exchange
  - Review products from consultant

Reference Document



Title:	Towards Sustainable Pavement Systems: A Reference Document
Authors:	Lots. Really.
Published:	2014
What:	400+ page manual on everything to do with pavement sustainability
Find it:	https://www.fhwa.dot.gov/pavement/sustainability

Reference Document



Outline

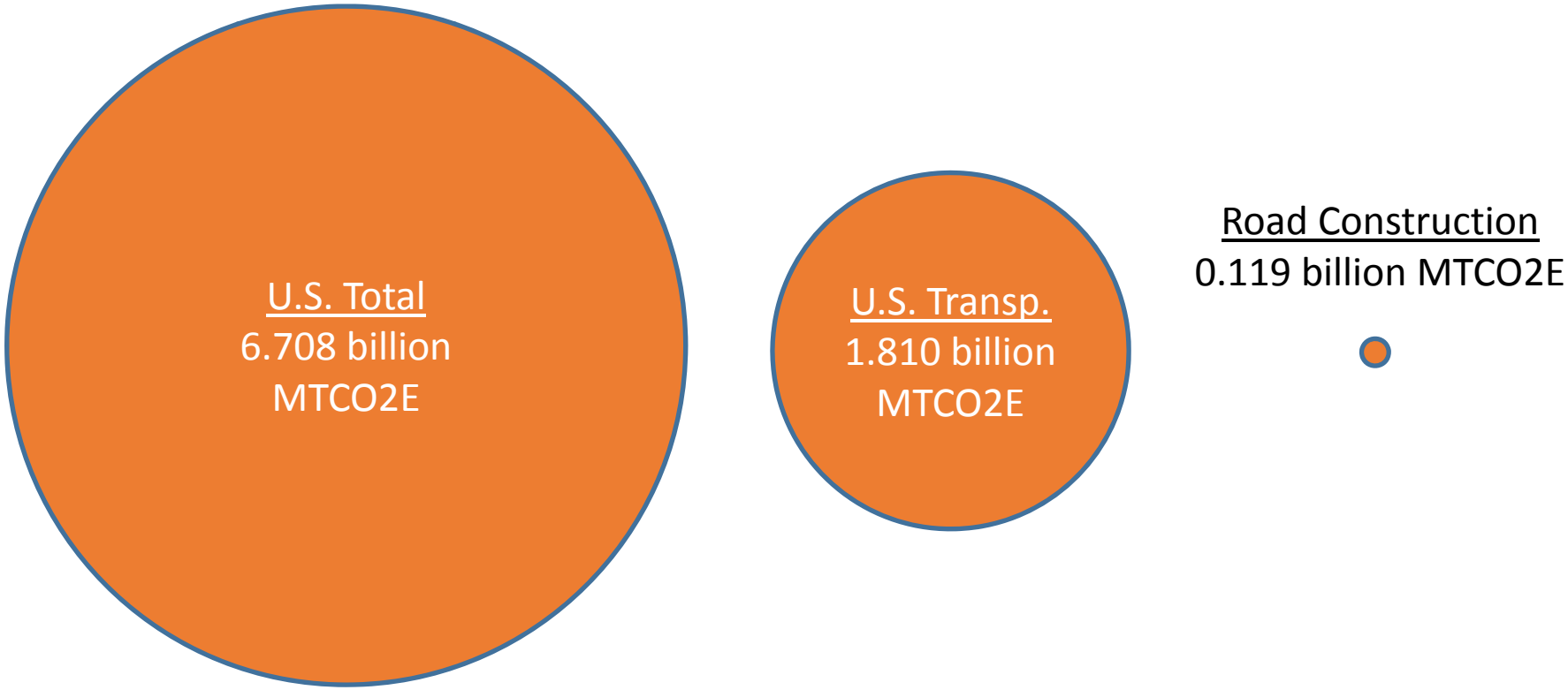
1. Introduction
2. Concepts of Sustainability
3. Materials Considerations
4. Pavement Design
5. Construction Considerations
6. Use-Phase Considerations
7. Maint./Preservation of Pavements
8. End of Life Considerations
9. Within Larger Systems
10. Assessing Pavement Sustainability
11. Concluding Remarks

Chapters 1 and 2

- Chapter 1: Introduction
  - What is Sustainability
  - Sustainability as it Pertains to Pavements
- Chapter 2: Concepts
  - Sustainability Definitions
  - Role of Pavements
  - Pavement Life Cycle
  - Measuring Sustainability
  - Trade-off Considerations

Greenhouse gas emissions in road construction (pavements) are kind of small.

- The U.S. emits 6.673 billion tonnes of CO2e in a year (2013)
  - 1.826 billion tonnes (27.2%) are from transportation
    - 0.106 billion tonnes (0.6% of transportation) are from road construction



Data from U.S. EPA from 2015 and other sources

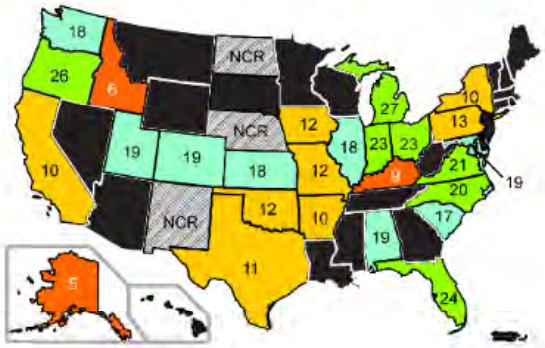
Chapter 3: Materials

- General Strategies:
  - Reduce amount of virgin materials
    - Recycled materials
    - Other co-products or waste materials
    - Improved mix design
    - Increased longevity
  - Reduce impact of materials production
    - Improve efficiency
    - Reduce emissions

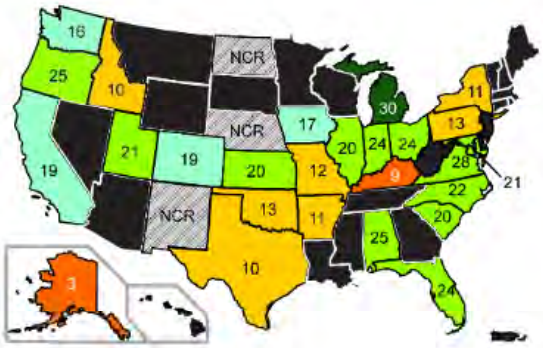
2013 RAP Statistics

Hansen, K.R. and Copeland, A. (2014). *Annual Asphalt Pavement Industry Survey on Recycled Materials and Warm-Mix Asphalt Useage: 2009-2013*. NAPA Information Series 138, FHWA and NAPA.

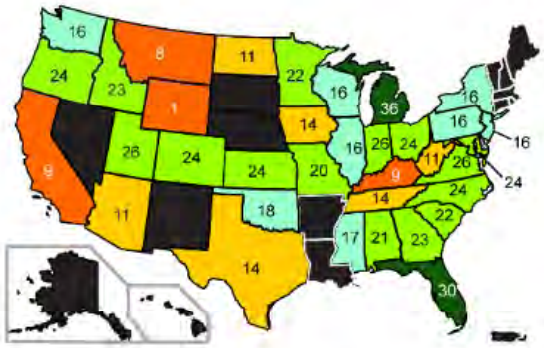
HMA/WMA produced:	350 million tons
RAP Accepted	76 million tons
Used in HMA/WMA	68 million tons
Use in Aggregate	4 million tons
Landfilled	0.1 million tons



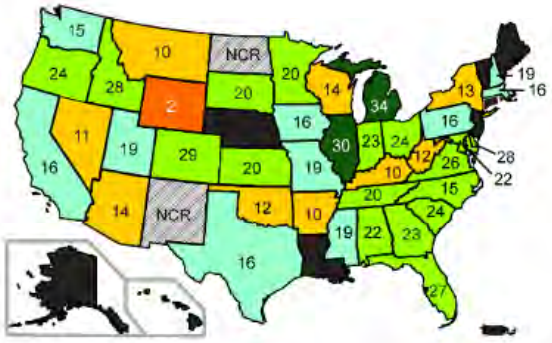
2009



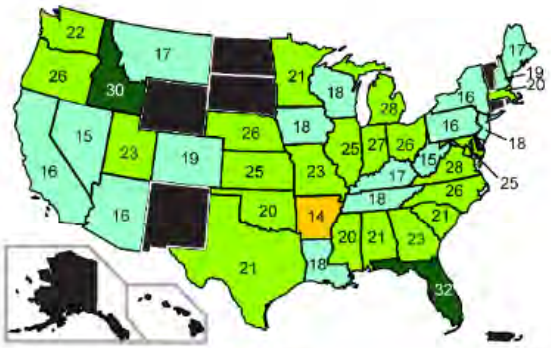
2010



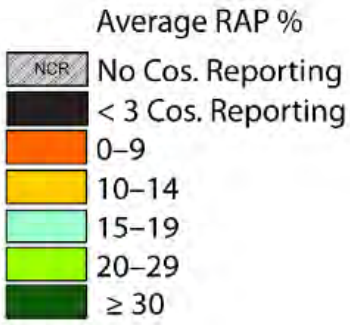
2011



2012



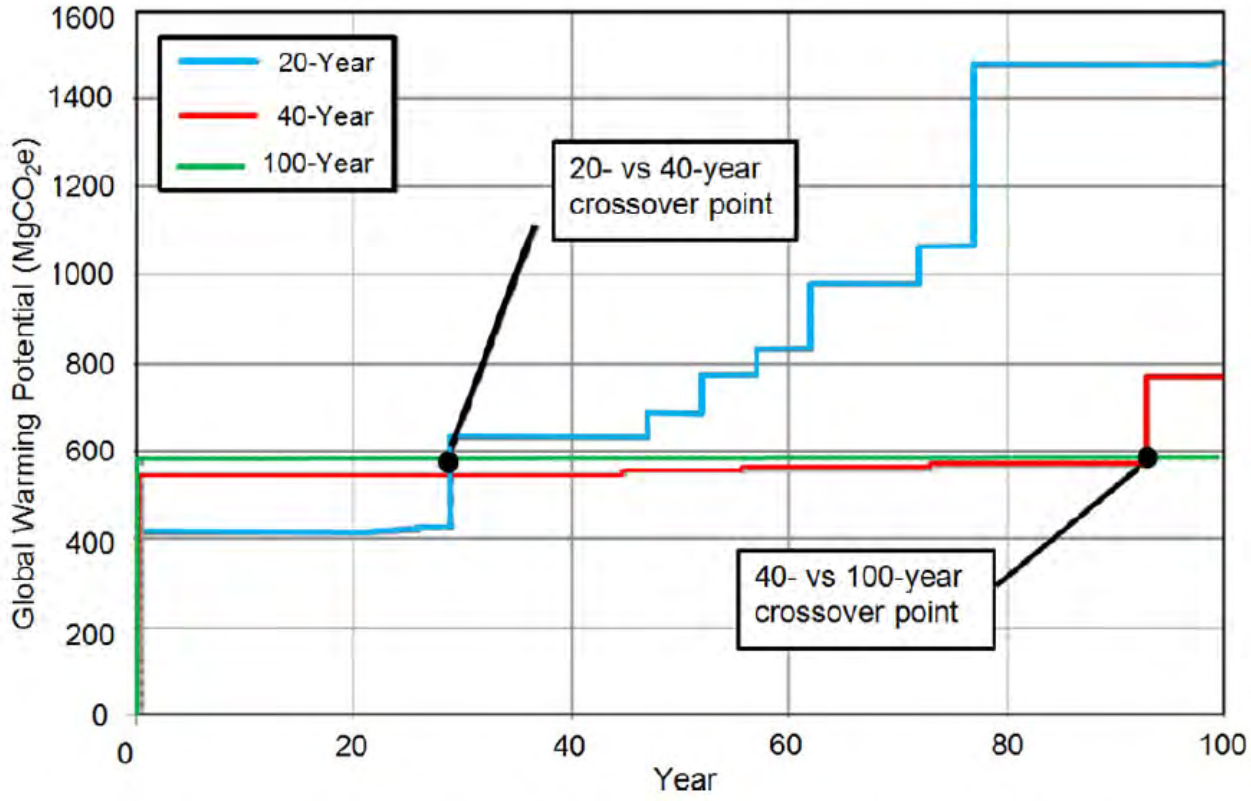
2013



Chapter 4: Design

- General Strategies
  - Use mechanistic-empirical methods
  - Optimize materials use in the structure
  - Consider LCCA, LCA, rating systems
  - Specialty designs
    - Noise-reducing surfaces
    - Permeable pavements for LID solutions

Payback time analysis for material production and construction of 3 different pavement design lives



Source

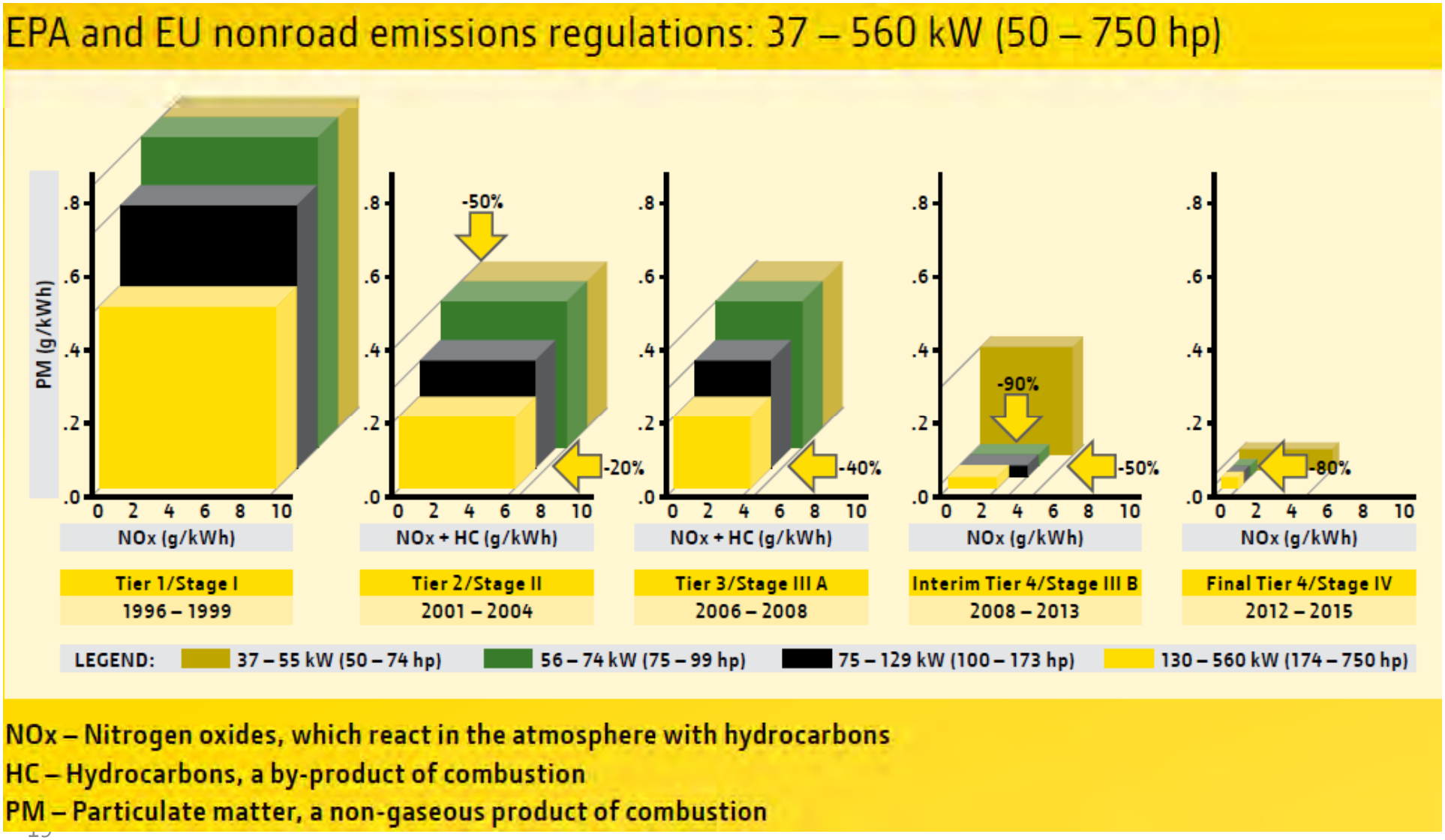
Santero, N., J. Harvey, and A. Horvath. 2011. "Environmental Policy for Longer life Pavements." *Transportation Research Part D: Transport and the Environment*. Vol. 16, Issue 2. Elsevier, Philadelphia, PA.

Chapter 5: Construction

- General Strategies
  - Specifications that allow sustainability
  - Reduce negative impacts
    - Fuel consumption, emissions, noise, delay
  - Optimize/improve operations
  - Improve quality

Reductions Associated with Tiers 1-4 Diesel Engines

(graphic from John Deere)



Graphic from John Deere

Chapter 6: Use Phase

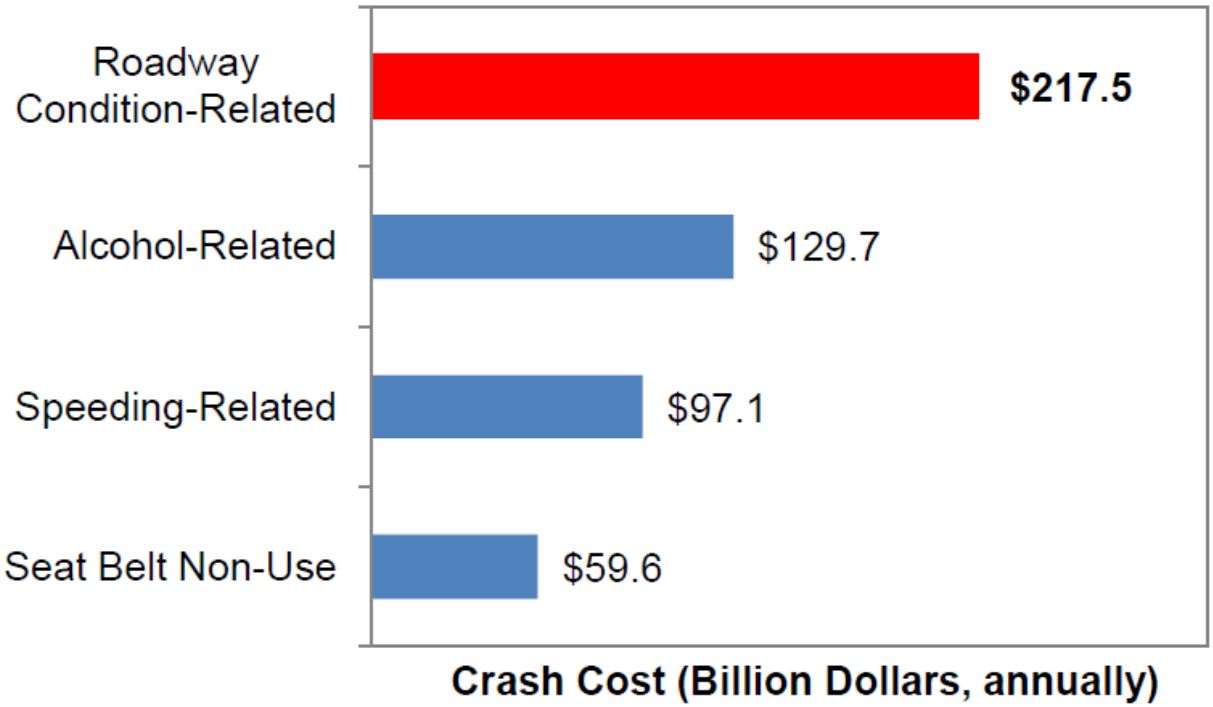
Pavement characteristics

- Deflection
- Macrotexture
- Roughness
- Permeability
- Albedo, heat capacity

Impacts

- Vehicle fuel consumption
- Vehicle emissions
- Noise
- Safety
- Stormwater runoff
- Temperature
- Human health
- Water quality
- Air quality

Annual Crash Costs by Crash Factor



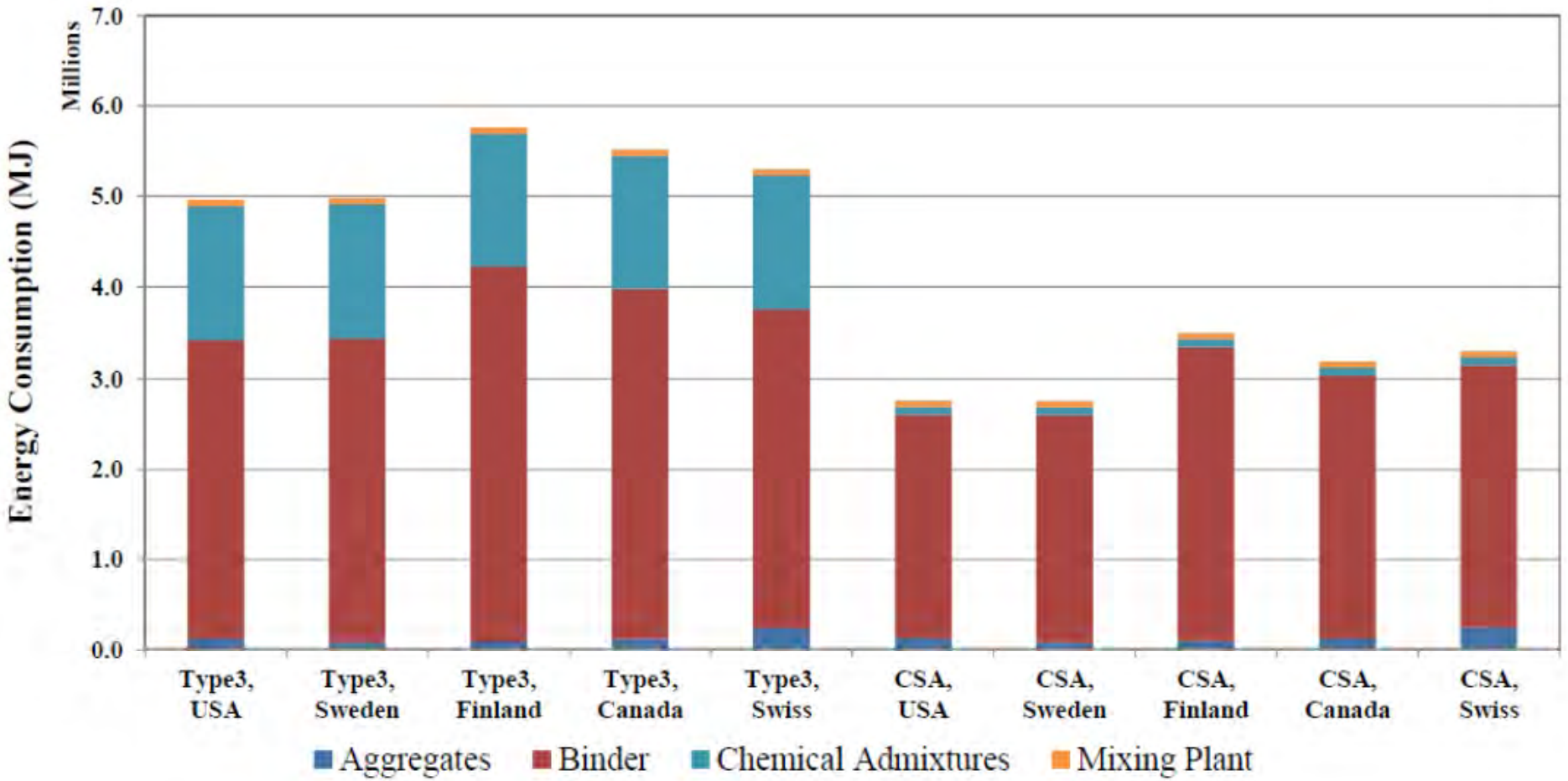
Source

Miller, T. R and E. Zaloshnja. 2009. *On a Crash Course: The Dangers and Health Costs of Deficient Roadways*. Pacific Institute for Research and Evaluation (PIRE), Calverton, MD.

Chapter 7: Maintenance/Preservation

- General Strategies
  - Use sustainability metrics in current asset management systems
  - Understand life-cycle implications
  - More intensive use of maintenance

Energy Consumption for different components of concrete



Source

Wang, T., I. S. Lee, J. T. Harvey, A. Kendall, E. B. Lee, and C. Kim. 2012. *UCPRC Life Cycle Assessment Methodology and Initial Case Studies on Energy Consumption and GHG Emissions for Pavement Preservation Treatments with Different Rolling Resistance.* Research Report UCD-ITS-RR-12-36. Institute of Transportation Studies, University of California, Davis, CA.

Chapter 8: End of Life

- Avoid or delay end-of-life
  - Long-life pavements
  - Design, rehab., maint., preservation
- Increase recycling and reuse
  - Avoid landfilling old pavements
  - Use in-place reuse/recycling
  - Highest use of recycled materials
    - Use RAP in new HMA, not base course
  - Use more RAP/RCA in new pavements


HITACHI


HITACHI

Chapter 9: Sustainability within Larger Systems

How pavement systems interact with larger system sustainability goals

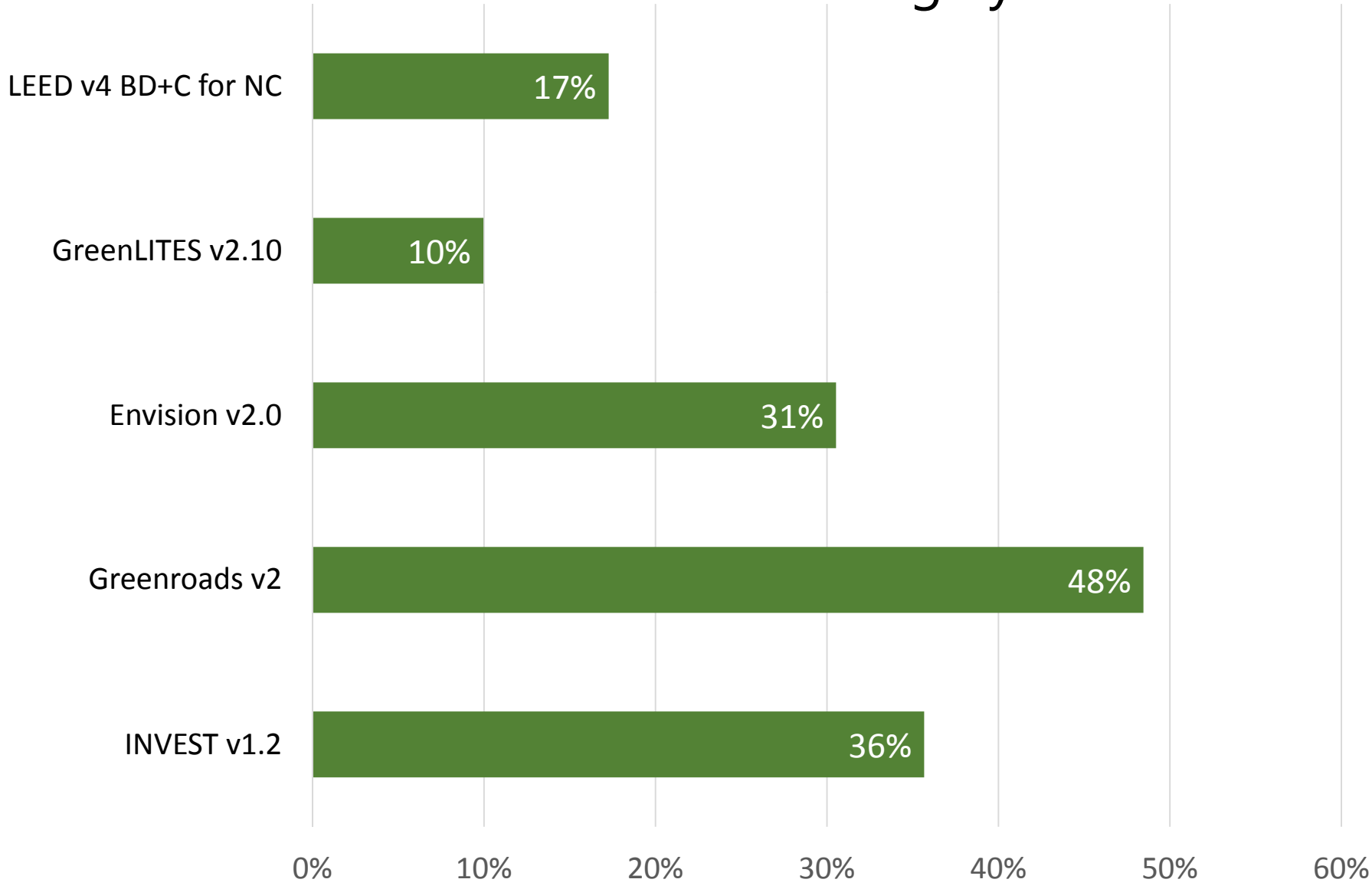
- Larger system goals and metrics
  - Sustainable Communities
  - Ecosystems
  - Aesthetics
  - Historical and cultural identity
  - Utility cuts
  - Worker & community health

Chapter 10: Assessment

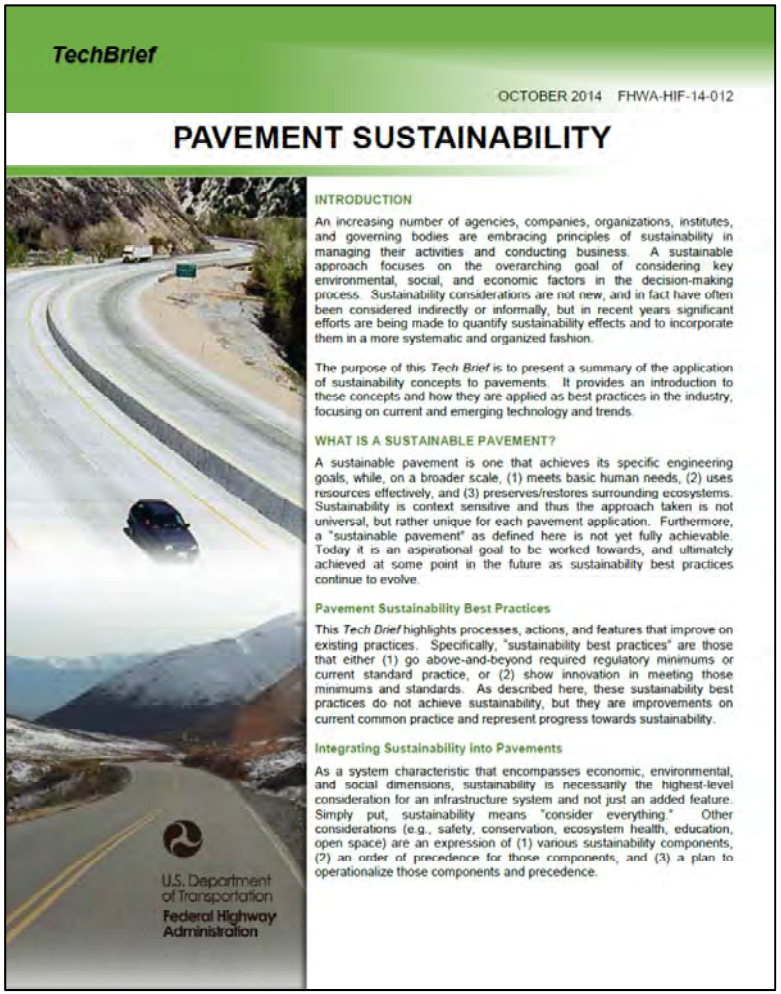
Ways to quantify sustainability

- Life Cycle Cost Analysis (LCCA)
- Life Cycle Assessment (LCA)
- Sustainability rating systems
  - INVEST
  - Greenroads
  - Envision
  - GreenLITES
  - LEED

Percentage of Points Directly Relevant to Pavements for Various Rating Systems



Deployment: TechBriefs



TechBrief

OCTOBER 2014 FHWA-HIF-14-012

PAVEMENT SUSTAINABILITY

INTRODUCTION

An increasing number of agencies, companies, organizations, institutes, and governing bodies are embracing principles of sustainability in managing their activities and conducting business. A sustainable approach focuses on the overarching goal of considering key environmental, social, and economic factors in the decision-making process. Sustainability considerations are not new, and in fact have often been considered indirectly or informally, but in recent years significant efforts are being made to quantify sustainability effects and to incorporate them in a more systematic and organized fashion.

The purpose of this *Tech Brief* is to present a summary of the application of sustainability concepts to pavements. It provides an introduction to these concepts and how they are applied as best practices in the industry, focusing on current and emerging technology and trends.

WHAT IS A SUSTAINABLE PAVEMENT?

A sustainable pavement is one that achieves its specific engineering goals, while, on a broader scale, (1) meets basic human needs, (2) uses resources effectively, and (3) preserves/restores surrounding ecosystems. Sustainability is context sensitive and thus the approach taken is not universal, but rather unique for each pavement application. Furthermore, a "sustainable pavement" as defined here is not yet fully achievable. Today it is an aspirational goal to be worked towards, and ultimately achieved at some point in the future as sustainability best practices continue to evolve.

Pavement Sustainability Best Practices

This *Tech Brief* highlights processes, actions, and features that improve on existing practices. Specifically, "sustainability best practices" are those that either (1) go above-and-beyond required regulatory minimums or current standard practice, or (2) show innovation in meeting those minimums and standards. As described here, these sustainability best practices do not achieve sustainability, but they are improvements on current common practice and represent progress towards sustainability.

Integrating Sustainability into Pavements

As a system characteristic that encompasses economic, environmental, and social dimensions, sustainability is necessarily the highest-level consideration for an infrastructure system and not just an added feature. Simply put, sustainability means "consider everything." Other considerations (e.g., safety, conservation, ecosystem health, education, open space) are an expression of (1) various sustainability components, (2) an order of precedence for those components, and (3) a plan to operationalize those components and precedence.

U.S. Department of Transportation
Federal Highway Administration

Title: Pavement Sustainability

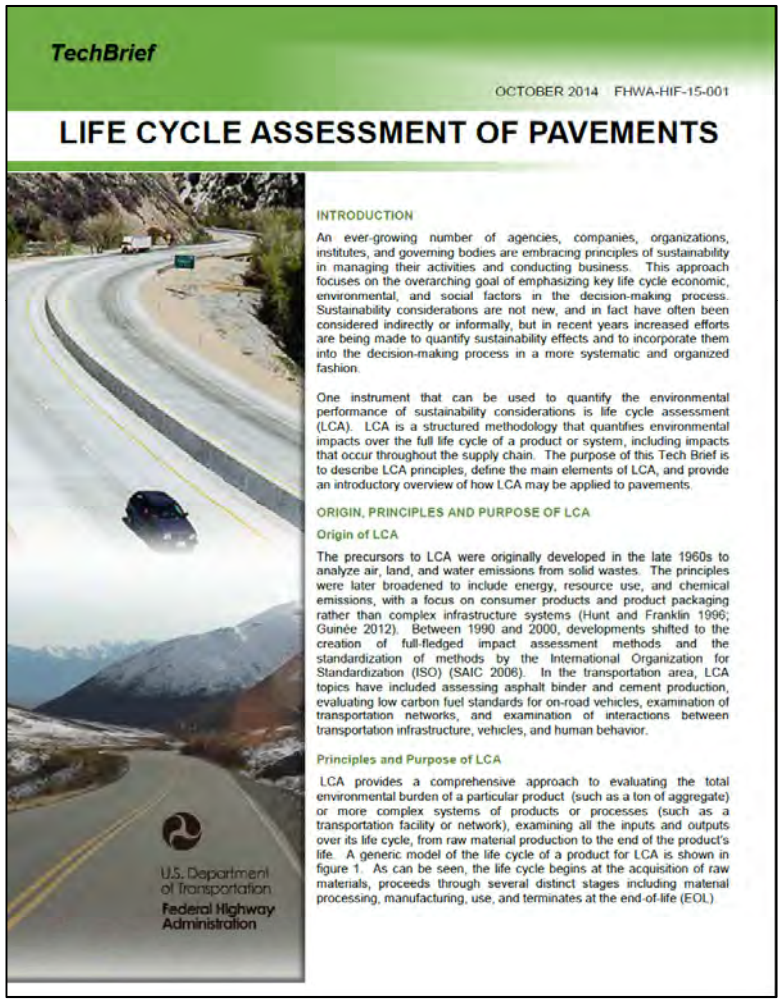
Authors: Muench and Van Dam

Published: October 2014

What: Short version of the 400 page Reference Manual

Find it: https://www.fhwa.dot.gov/pavement/sustainability

Deployment: TechBriefs



TechBrief

OCTOBER 2014 FHWA-HIF-15-001

LIFE CYCLE ASSESSMENT OF PAVEMENTS

U.S. Department of Transportation
Federal Highway Administration

INTRODUCTION

An ever-growing number of agencies, companies, organizations, institutes, and governing bodies are embracing principles of sustainability in managing their activities and conducting business. This approach focuses on the overarching goal of emphasizing key life cycle economic, environmental, and social factors in the decision-making process. Sustainability considerations are not new, and in fact have often been considered indirectly or informally, but in recent years increased efforts are being made to quantify sustainability effects and to incorporate them into the decision-making process in a more systematic and organized fashion.

One instrument that can be used to quantify the environmental performance of sustainability considerations is life cycle assessment (LCA). LCA is a structured methodology that quantifies environmental impacts over the full life cycle of a product or system, including impacts that occur throughout the supply chain. The purpose of this Tech Brief is to describe LCA principles, define the main elements of LCA, and provide an introductory overview of how LCA may be applied to pavements.

ORIGIN, PRINCIPLES AND PURPOSE OF LCA

Origin of LCA

The precursors to LCA were originally developed in the late 1960s to analyze air, land, and water emissions from solid wastes. The principles were later broadened to include energy, resource use, and chemical emissions, with a focus on consumer products and product packaging rather than complex infrastructure systems (Hunt and Franklin 1996; Guinée 2012). Between 1990 and 2000, developments shifted to the creation of full-fledged impact assessment methods and the standardization of methods by the International Organization for Standardization (ISO) (SAIC 2006). In the transportation area, LCA topics have included assessing asphalt binder and cement production, evaluating low carbon fuel standards for on-road vehicles, examination of transportation networks, and examination of interactions between transportation infrastructure, vehicles, and human behavior.

Principles and Purpose of LCA

LCA provides a comprehensive approach to evaluating the total environmental burden of a particular product (such as a ton of aggregate) or more complex systems of products or processes (such as a transportation facility or network), examining all the inputs and outputs over its life cycle, from raw material production to the end of the product's life. A generic model of the life cycle of a product for LCA is shown in figure 1. As can be seen, the life cycle begins at the acquisition of raw materials, proceeds through several distinct stages including material processing, manufacturing, use, and terminates at the end-of-life (EOL)

Title: Life Cycle Assessment of Pavements

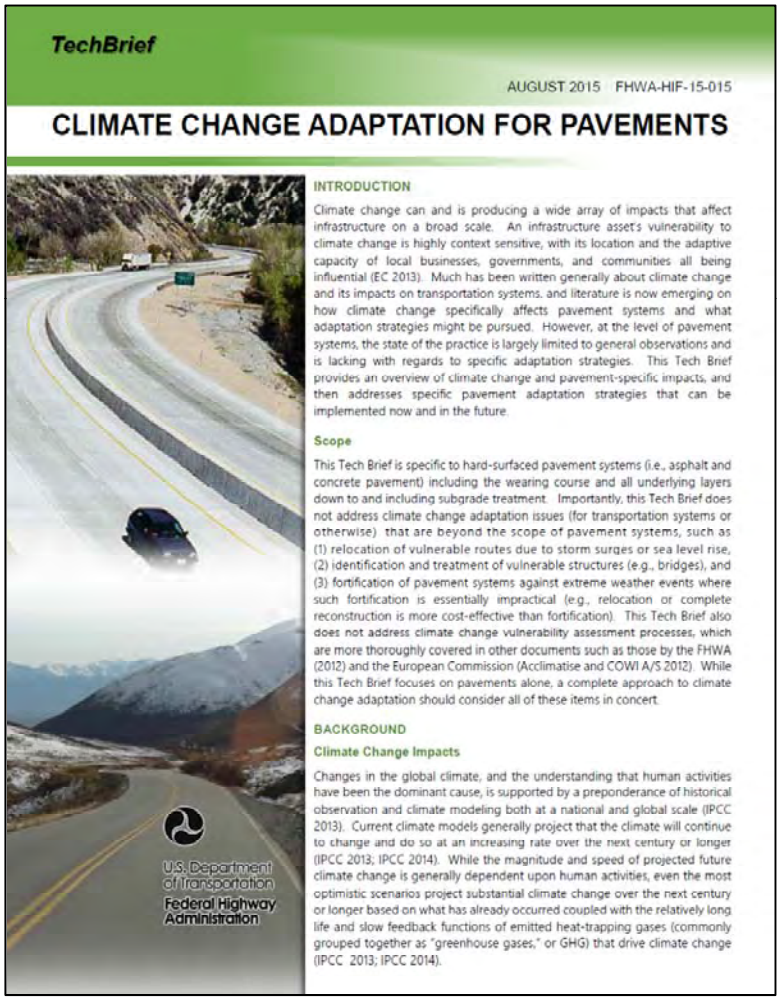
Authors: Harvey, Meijer, Kendall

Published: October 2014

What: Overview of life cycle assessment as it is done for pavements

Find it: https://www.fhwa.dot.gov/pavement/sustainability

Deployment: TechBriefs



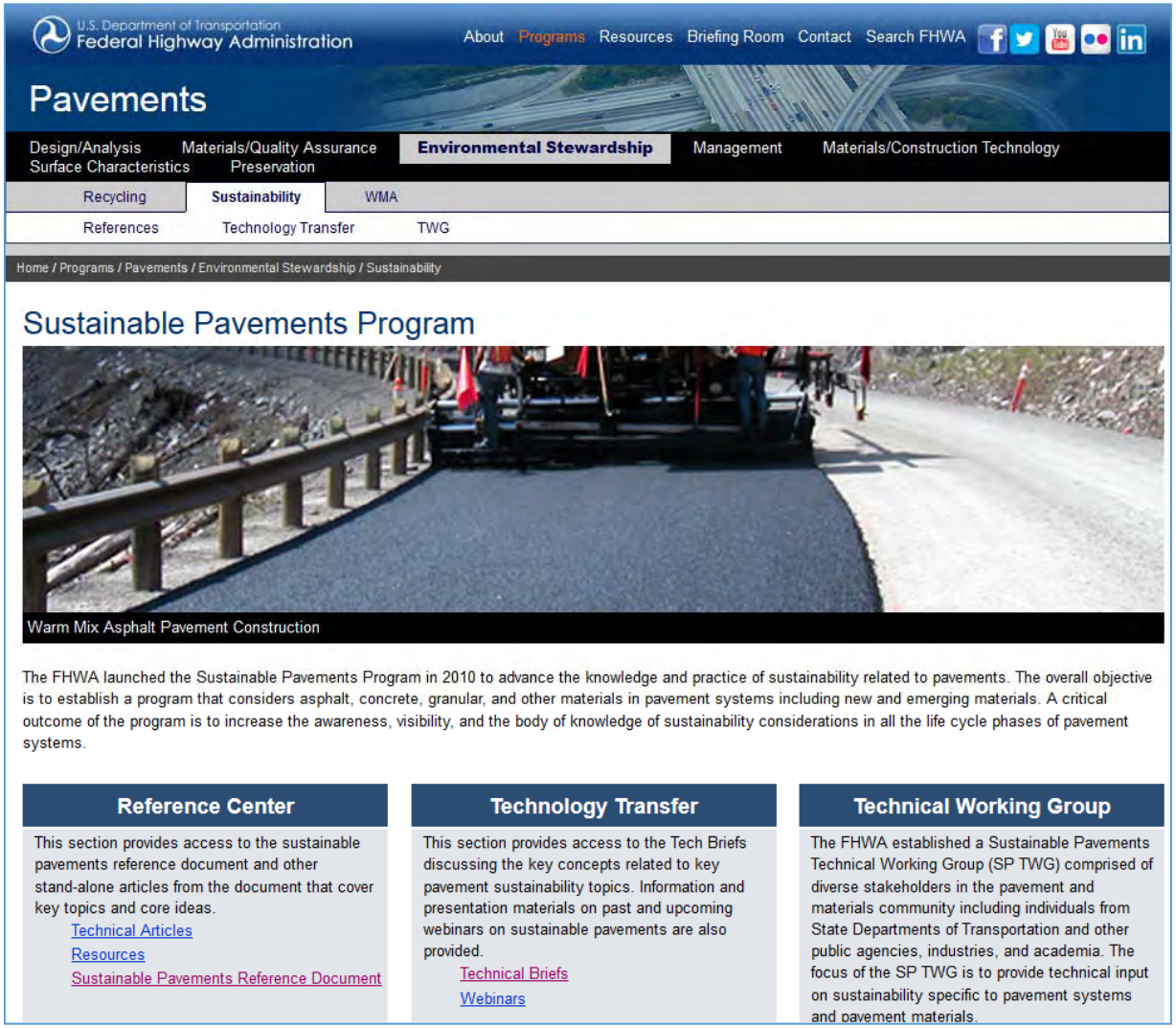
Title:	Climate Change Adaptation for Pavements
Authors:	Muench and Van Dam
Published:	August 2015
What:	Overview of potential climate change adaptation efforts for pavements
Find it:	https://www.fhwa.dot.gov/pavement/sustainability

Deployment: Webinars

- 5 webinars
  - 2 hours each

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

Deployment: Web Page



www.fhwa.dot.gov/pavement/sustainability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