



Recycling and Warm Mix Asphalt: The Trends

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National Asphalt Pavement Association

CAPA/NCDOT Asphalt Training Workshop

Raleigh, NC

February 21, 2012



Economic Drivers



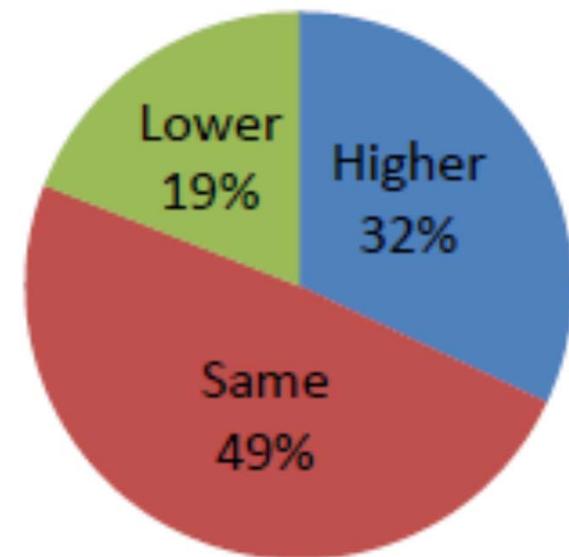
2012 Construction Outlook



Compared to 2011, do you expect available dollar volume of highway projects you compete for in 2012 to be:

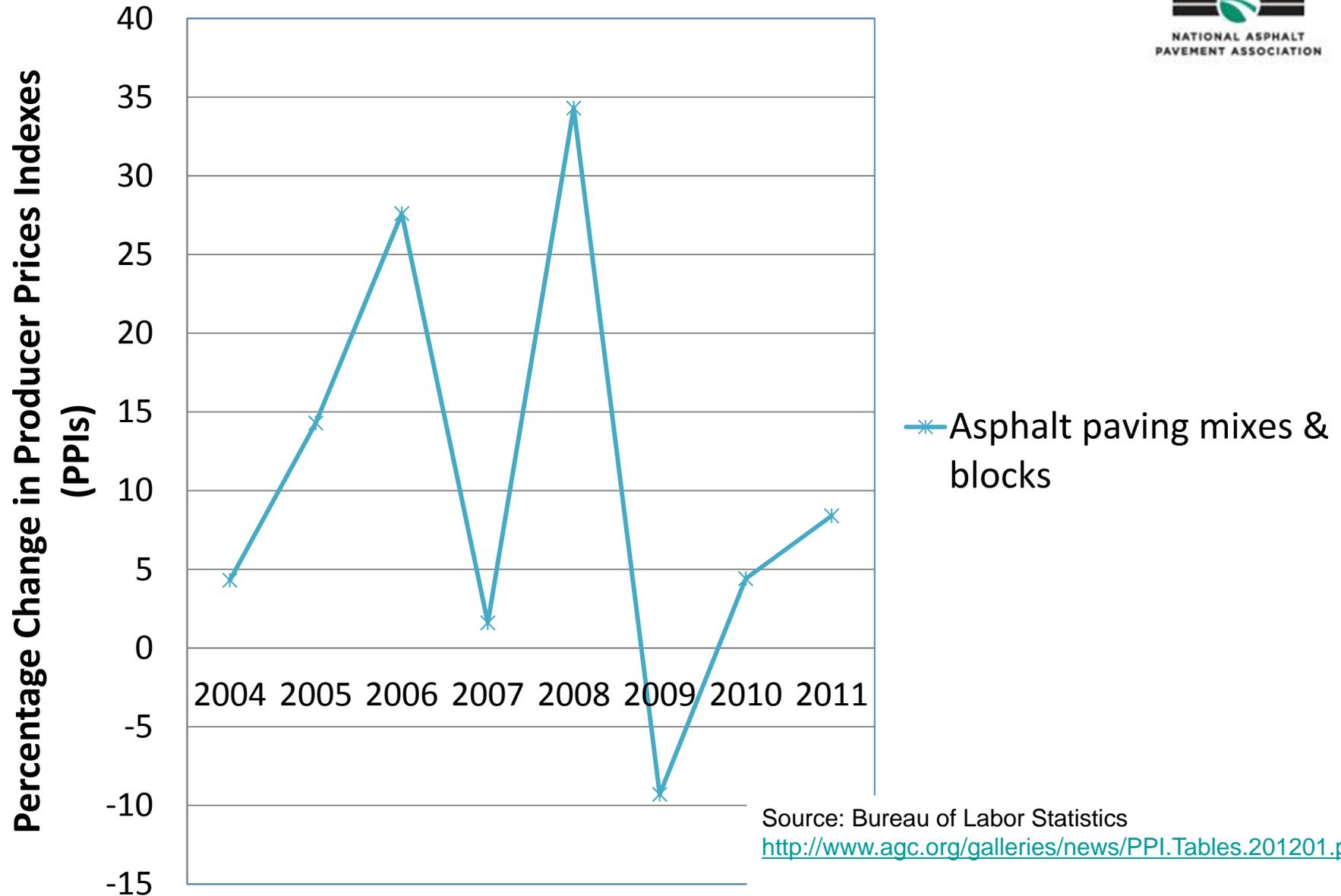
- A. Higher?
- B. Lower?
- C. About the same?

North Carolina **Highway**

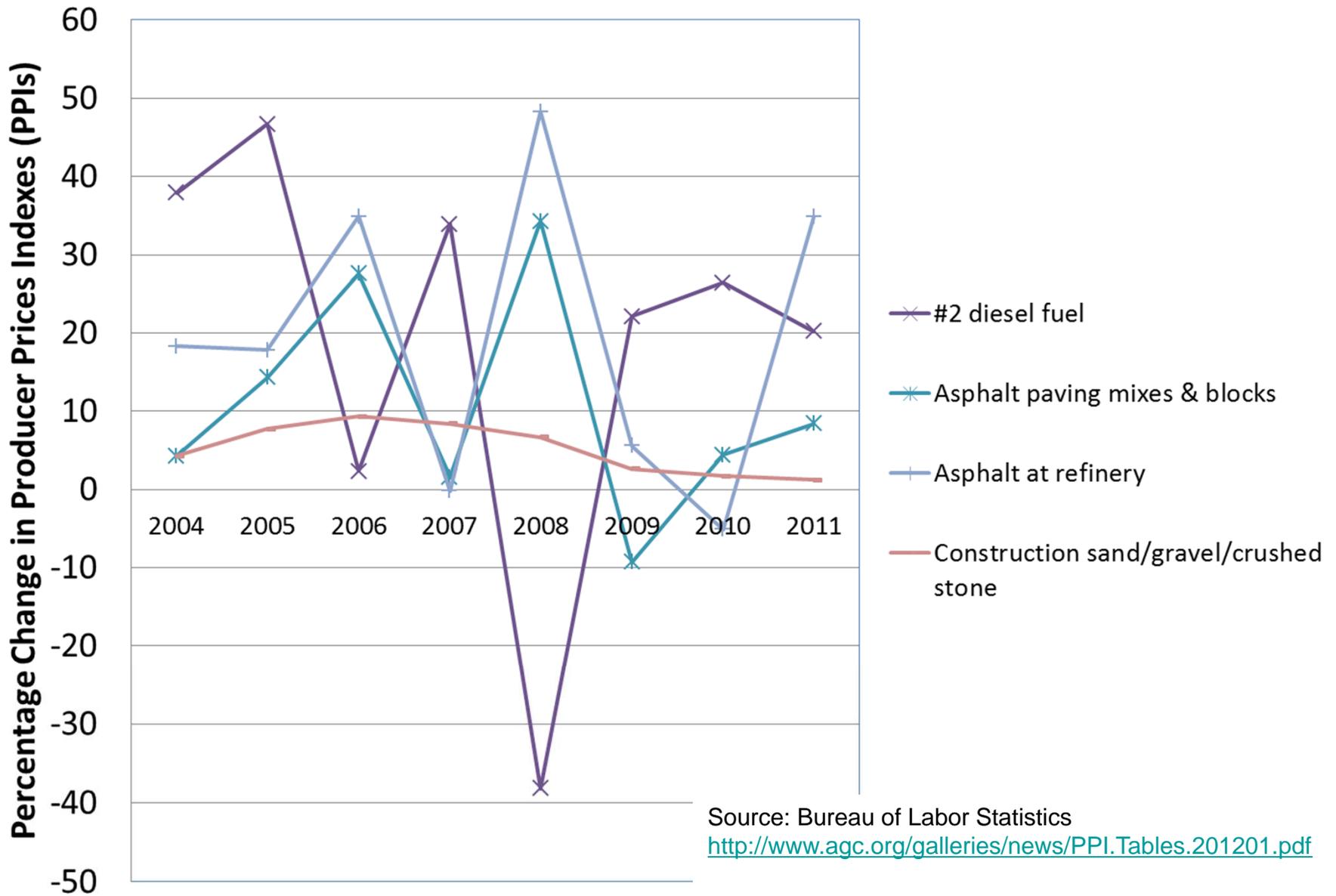


* National 2012 Construction Outlook Survey Results, AGC of America, <http://www.agc.org/galleries/news/National.pdf>, 2012

Change in Producer Price Indexes for Construction Materials



Change in Producer Price Indexes for Construction Materials



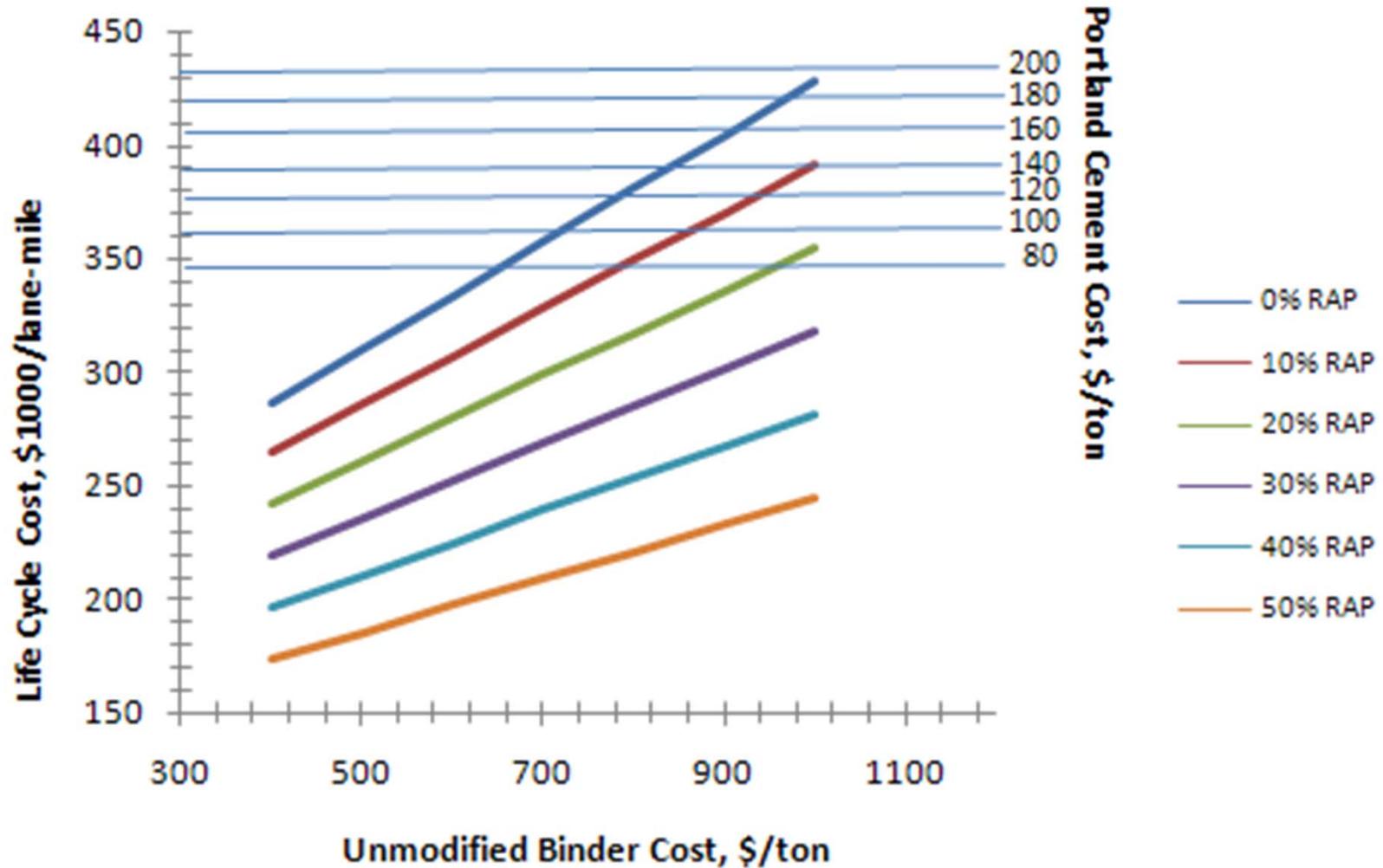
The Good News

The Asphalt Pavement Industry has solutions!



- Engineered Binders and Perpetual Pavements for Long-Life and Reduced Layer Thickness
- Recycled Materials for Binder Replacement
- Warm Mix Asphalt for Improved Performance and Reduced Fuel Usage
- Combining RAP and WMA – can be applied to most mixture types
- Performance Testing

Life Cycle Cost Using RAP 11" AC vs. 9" PCC





State-of-the-Practice



Tracking the Nation...

National Surveys



- **State DOTs – WMA, RAP, RAS**
 - AASHTO/FHWA Survey
 - Conducted by Jim Pappas, DeIDOT
 - Conducted every 2 years – 2007, 2009, 2011
- **Industry – WMA, RAP, RAS**
 - NAPA/FHWA Survey
 - Conducted by NAPA Staff
 - Conducted for 2009/2010, will be conducted for 2011
- **FHWA Division Offices – WMA**
 - Tracking WMA in State specifications & targets through 2012

The Use of RAP is Rising...

The Industry from 2009 to 2010



- The amount of RAP used in HMA/WMA increased by 10%.
 - Assuming 5% liquid asphalt in RAP, this represents over 3 million tons (19 million barrels) of asphalt binder conserved.
- The average percent RAP used in mixes has increased from about 16% to 18%.
- 96% of the contractors/branches reported using RAP and over 86% of these contractors reported excess RAP.

The Use of RAP is Rising...

The State DOTs



- In 2007...
 - Over 60% State DOTs **permitted** high RAP (> 25%) in the intermediate and surface layers.
 - About 25% actually **used** high RAP in the intermediate and surface layers.
 - The average asphalt mixture uses 12% RAP.
- As of 2011...
 - Over 85% State DOTs **permitted** high RAP (> 25%) in the intermediate and surface layers.
 - About 25% actually **used** high RAP in the intermediate and surface layers.
 - About half of the State DOTs (50%) use up to 20% RAP.
 - 18 States allow RAP with WMA

But There's Still Room to Grow...

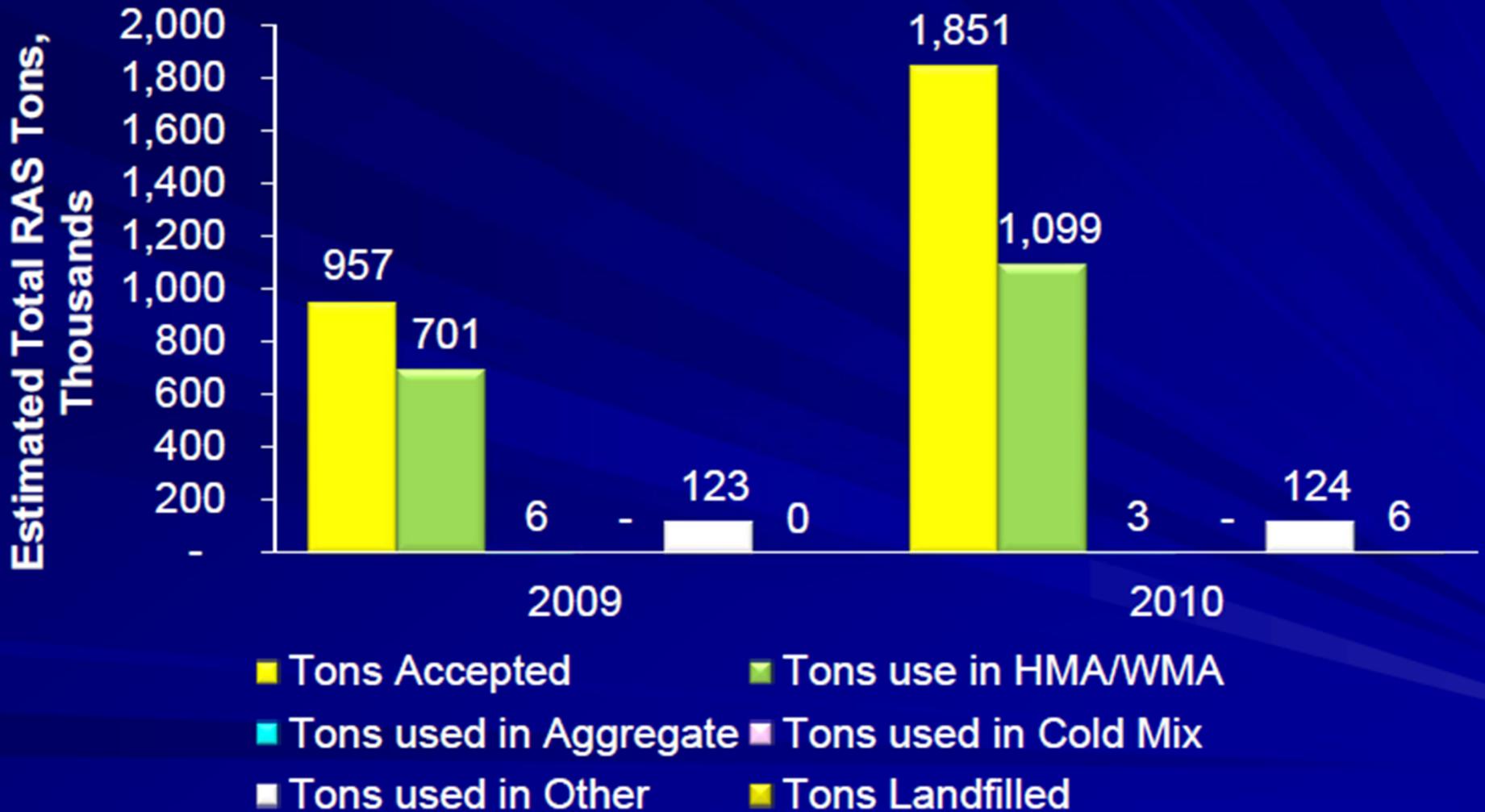


- Our comfort level with RAP is less than 20% by weight of mix.
- Still 5 to 10% RAP that can be used under existing specs. We can go further!
- Based on research*, Indiana found they could increase specification to allow up to 20% RAP with no binder grade change.
 - Cost savings of about \$1.25 per ton of asphalt mixture.
 - Based on the amount of asphalt mixtures produced in 2010, this can result in savings of \$125 million.

*McDaniel, et al. *Investigation of Low- and High-Temperature Properties of Plant-Produced RAP Mixtures*. Publication No. FHWA-HRT-11-058, Federal Highway Administration, Washington, DC, 2011.

<http://www.fhwa.dot.gov/publications/research/infrastructure/pavements/11058/11058.pdf>

Estimated Total RAS



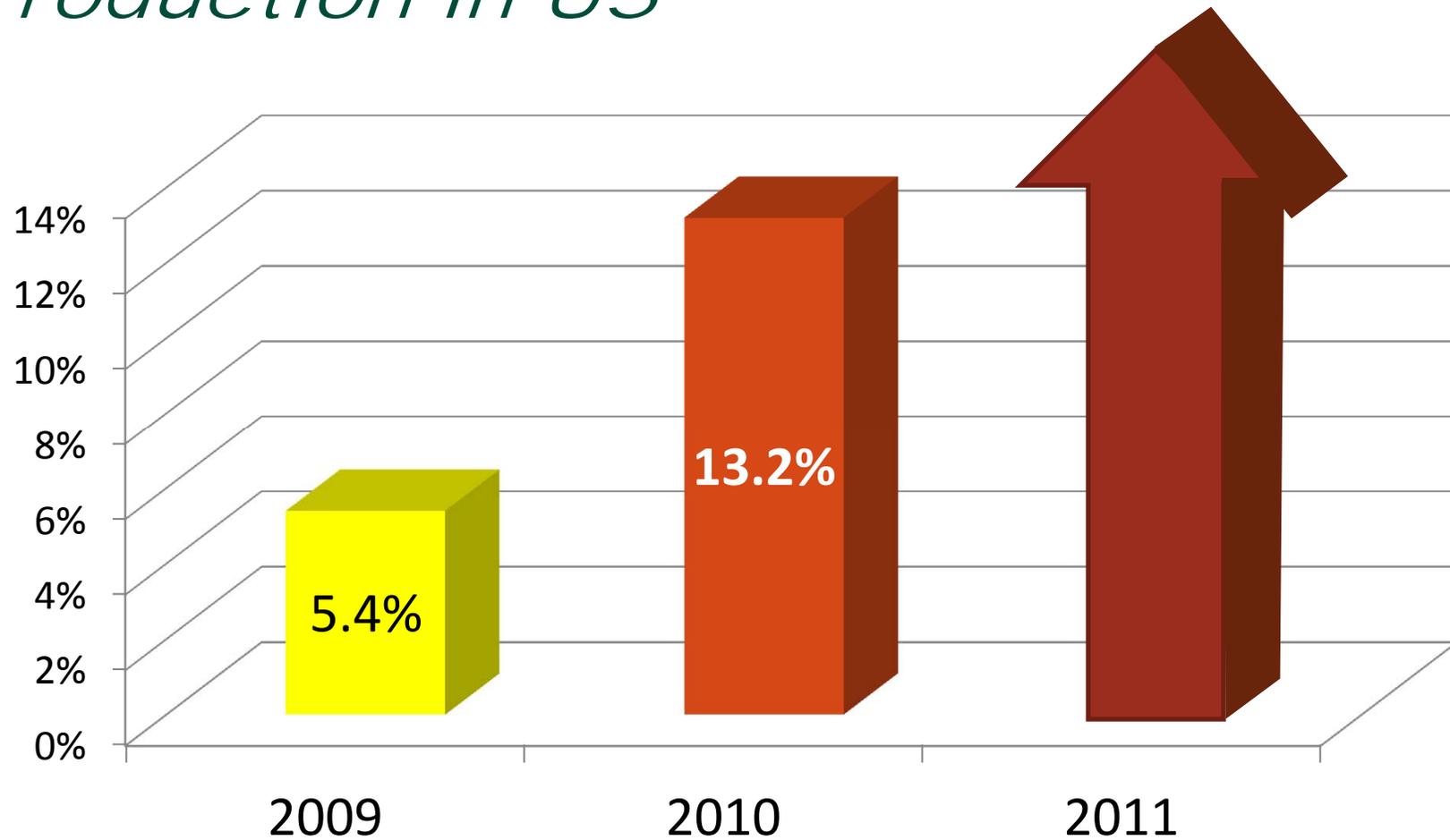
Reclaimed Asphalt Shingles



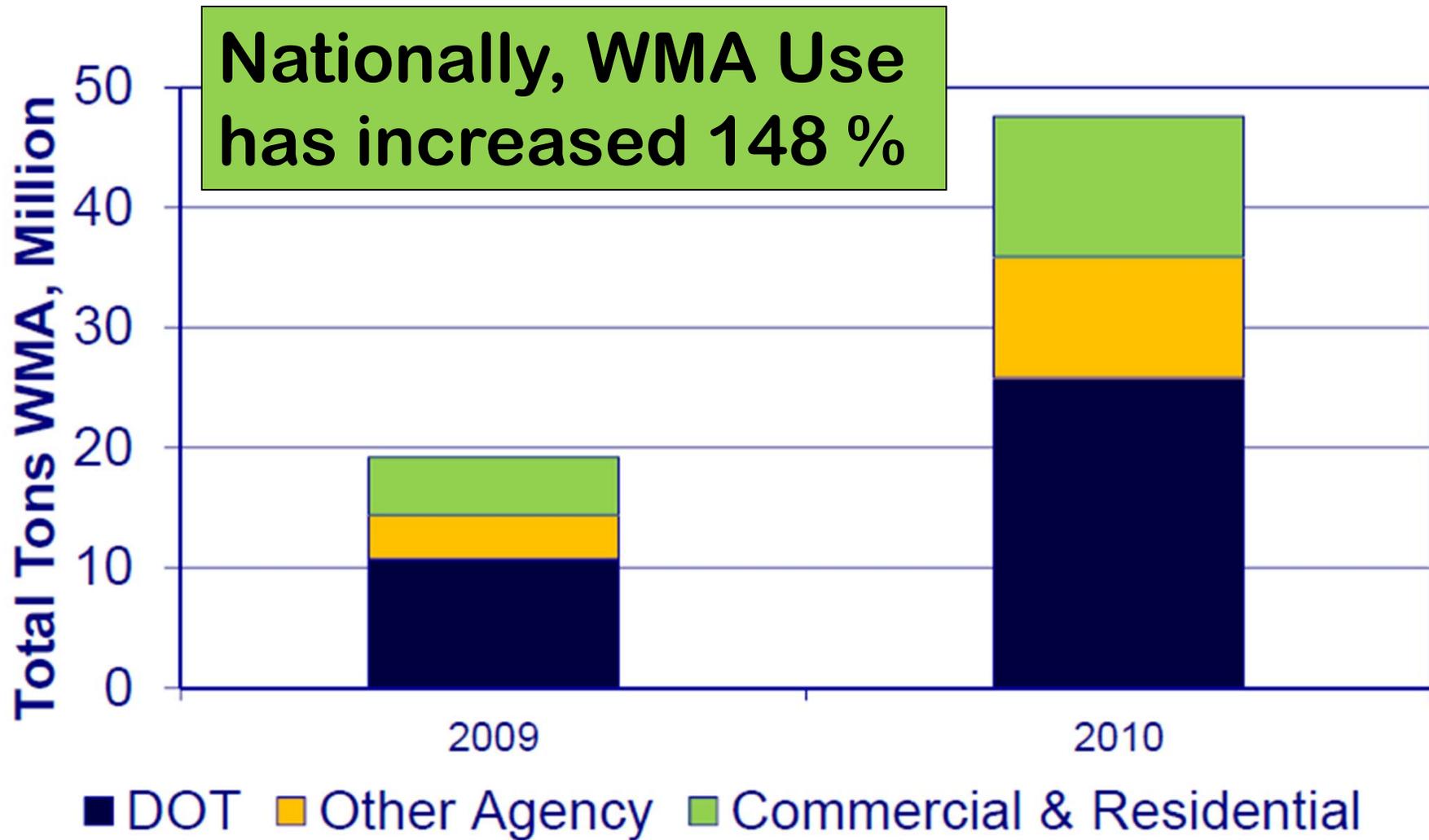
- Half (25) of State DOTs already allow or are considering allowing RAS.
- About half (12) of those State DOTs report actually using RAS.
- Industry results indicated RAS use has increased by 57% from 2009 to 2010.

WMA Usage

Percentage of Total Asphalt Production in US



Total Tons WMA (Estimated)



FHWA's Every Day Counts Performance Metrics



1. By December 2011, 40 State DOTs and all Federal Lands Divisions will have a specification &/or contractual language that allows WMA on Federal-aid or Federal Lands projects.

COMPLETE: 41 States + all FLHD

2. By December 2012, at least 30 State DOTs will have achieved set targets for WMA usage.

In 2010 it is estimated WMA...



- Saved over 30 million gallons of fuel during production
- Reduced CO₂e by 800,000 tons
 - Equivalent to taking 150,000 vehicles off the road!



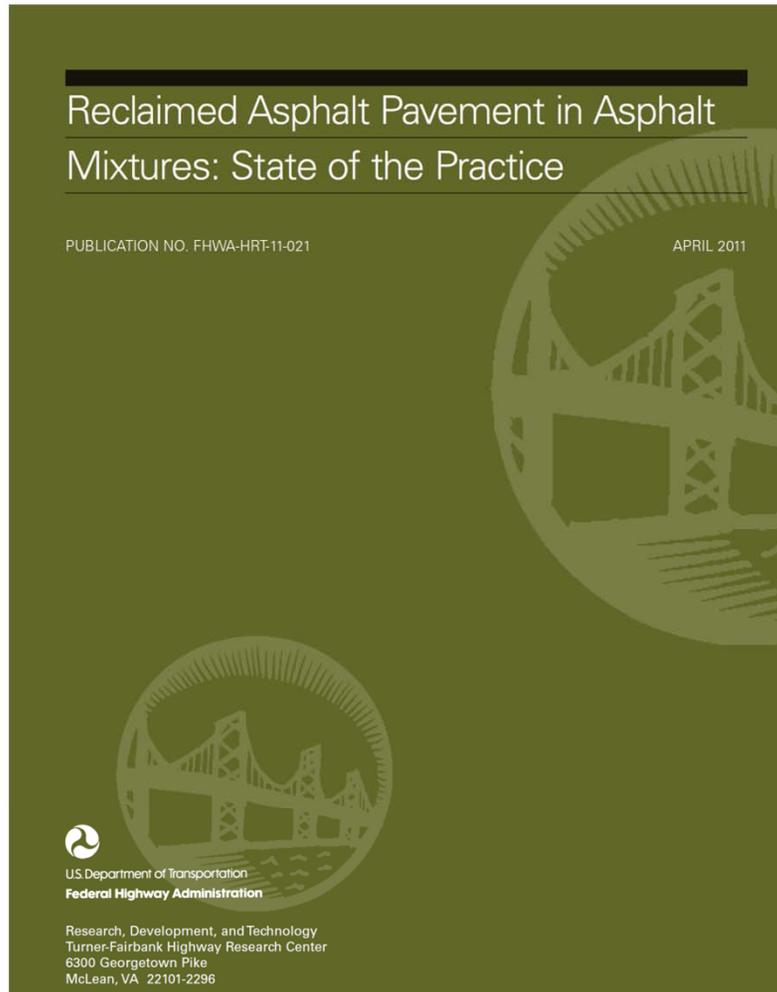
North Carolina Snapshot Industry Survey & CAPA Results



- Use 100% of available RAP in asphalt mixtures.
- On average, asphalt mixtures contain 23% RAP. DOT mixes contain 20% RAP.
- In 2009, 17% of companies reported using RAS. In 2010, 50% of companies reported using RAS.
- 80 to 90% of companies use WMA

Resources

RAP Publications from FHWA



INFOBRIEF

High Reclaimed Asphalt Pavement Use

FHWA Publication No.: FHWA-HRT-11-057

FHWA Contact: Audrey Copeland, HRDI-10, (202) 493-3097, audrey.copeland@dot.gov

RAP Defined

Existing asphalt materials are commonly removed during resurfacing, rehabilitation, and reconstruction operations. Once removed and processed, the pavement materials become reclaimed asphalt pavement (RAP), which contains valuable asphalt binder and aggregate. RAP is a valuable, high-quality material that can replace more expensive virgin aggregates and binders. The most economical use of RAP is in the intermediate and surface layers of flexible pavements where the less expensive binder from RAP can replace a portion of the more expensive virgin binder. While RAP has been used for decades, there is a current interest in using higher RAP contents. High RAP content mixtures have greater than 25 percent RAP by weight of the mix.

RAP Use Today

The RAP ETG, in partnership with the American Association of State Highway and Transportation Officials (AASHTO), conducts a RAP use survey every 2 years. The survey was conducted in 2007, 2009, and 2011. In 2007, the typical hot mix asphalt (HMA) mixture contained about 12 percent RAP. From 2007 to 2009, about 27 States increased the amount of RAP permitted in asphalt mixtures, and, as of 2009, 23 States have experience with high RAP mixtures. The results of the 2007 and 2009 surveys are summarized in the *Public Roads* article "Reclaiming Roads."⁽¹⁾ As of 2011, the majority of State highway agencies (more than 40) allow more than 30 percent RAP; however, only 11 report actually using 25 percent RAP or more.⁽²⁾

Providing Technical Information

Designing High RAP Mixes

The RAP ETG developed and disseminated technical information for high RAP use. In the first major effort, the Federal Highway Administration partnered with AASHTO and the National Asphalt Pavement Association to create *Designing HMA Mixtures with High RAP Content: A Practical Guide*, which provides guidance for designing high RAP mixtures.⁽³⁾ As a follow-up and in conjunction with the Transportation Research Board, the RAP ETG conducted the webinar *Design and Production of High Reclaimed Asphalt Pavement Mixes*.⁽⁴⁾

Management and Production Best Practices

There are two best practices reports available.^(5,6) In addition, presentations by three RAP ETG members are available, which provide a historical

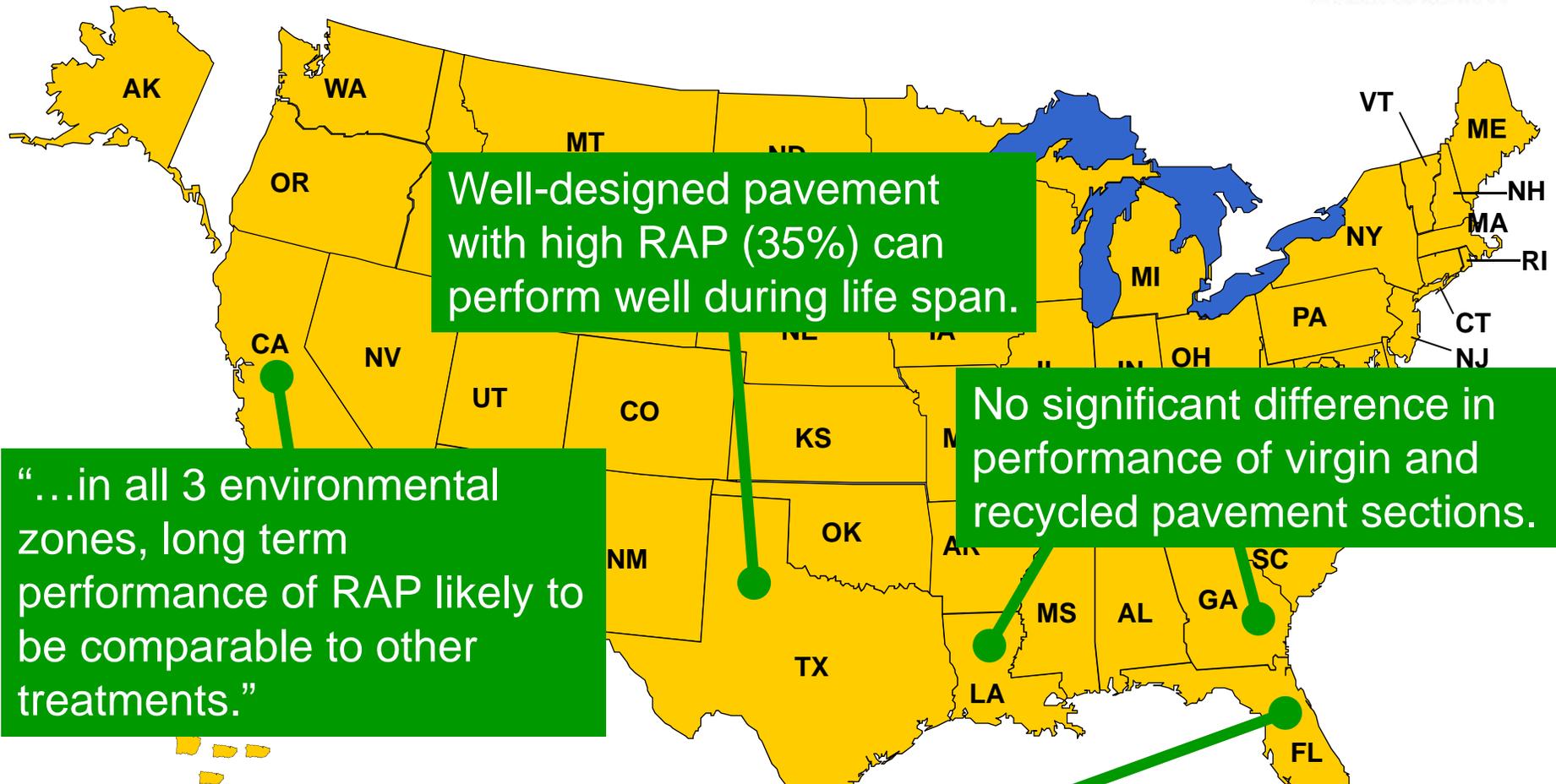
U.S. Department of Transportation
Federal Highway Administration
<http://www.fhwa.dot.gov/research/>

Research, Development, and Technology Turner-Fairbank Highway Research Center 6300 Georgetown Pike, McLean, VA 22101-2296

<http://www.fhwa.dot.gov/publications/research/infrastructure/pavements/11021/11021.pdf>

<http://www.fhwa.dot.gov/publications/research/infrastructure/pavements/11057/11057.pdf>

Long-Term Performance of RAP in HMA



Well-designed pavement with high RAP (35%) can perform well during life span.

“...in all 3 environmental zones, long term performance of RAP likely to be comparable to other treatments.”

No significant difference in performance of virgin and recycled pavement sections.

Average age of virgin mixes is 11 years. For 30–50% RAP content, the average age ranges from 10–13 years.

TECHBRIEF



Statistical Analysis of Performance of Recycled Hot Mix Asphalt Overlays in Flexible Pavement Rehabilitation

FHWA Publication No.: FHWA-HRT-11-051

FHWA Contact: Larry Wiser, HRDI-30, (202) 493-3079,
larry.wiser@dot.gov

This document is a technical summary of the Federal Highway Administration report, *Impact of Design Features on Pavement Response and Performance in Rehabilitated Flexible and Rigid Pavements* (FHWA-HRT-10-066).

Introduction

The growing need for materials to rehabilitate the highway infrastructure in the United States and for sustainable and environmentally friendly alternatives have substantially increased the demand for recycling materials. The most common material recycling application in pavements is reclaimed asphalt pavement (RAP). RAP includes any removed or reprocessed pavement material that contains asphalt and aggregates. The largest source of RAP is milled material retrieved from existing pavements or from full-depth removal. RAP can be combined with virgin aggregates, new binder, and/or recycling agents to produce a recycled hot mix, which is the most frequent use of RAP. The incorporation of RAP in recycled hot mixes is not a new concept. A survey of 12 State transportation departments indicates that in 1996 33 percent of pavement removed was used as RAP in hot mix asphalt (HMA) production.⁽¹⁾ This percentage is likely to have increased since the time of the survey with the effort of Federal and State transportation departments promoting RAP use and with advancements in pavement recycling technology.⁽²⁾

Several studies have evaluated properties and performance of mixes with RAP in the laboratory that have been documented in literature.⁽³⁾ When designed properly, RAP mixes have demonstrated a quality comparable to virgin HMAs. However, despite all the information available and the success rate of RAP mix projects, the perception that recycled materials are of inferior quality still persists. The objective of this TechBrief is to provide a summary of statistical analysis results of data collected during the Long-Term Pavement Performance (LTPP) program in which performance of recycled HMA was compared to virgin mix in flexible pavement overlays.

LTPP SPS-5 Experiment

The LTPP Specific Pavement Study (SPS)-5 experiment was designed to provide quality data for developing improved design

The Long-Term Pavement Performance (LTPP) program is a 20-year study of in-service pavements across North America. Its goal is to extend the life of highway pavements through various designs of new and rehabilitated pavement structures, using different materials and under different loads, environments, subgrade soil, and maintenance practices. LTPP was established under the Strategic Highway Research Program and is now managed by the Federal Highway Administration.



U.S. Department of Transportation
Federal Highway Administration

Research, Development, and
Technology

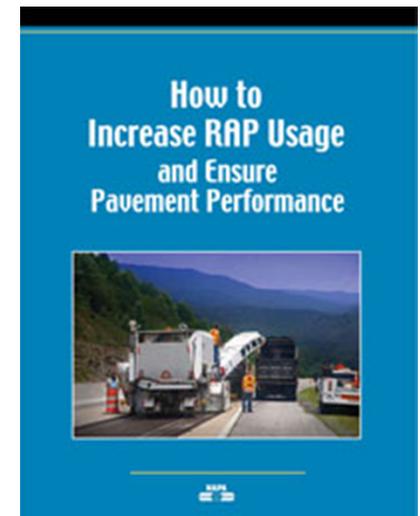
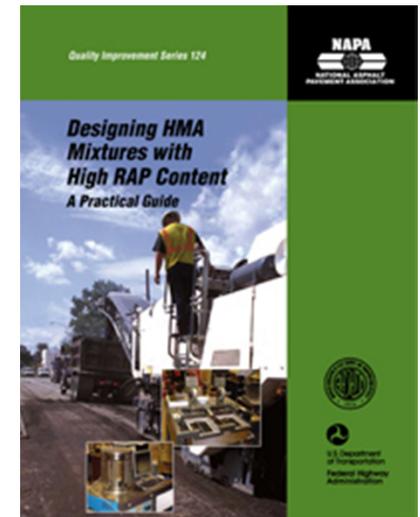
Turner-Fairbank Highway
Research Center
6300 Georgetown Pike
McLean, VA 22101-2296

<http://www.fhwa.dot.gov/research/through/programs/infrastructure/pavements/ltppl/>

*“In summary, the performance data from LTPP SPS-5 shows that RAP and virgin HMA mixes used in overlays of flexible pavements showed approximately the same performance across a range of climates, traffic, and existing pavement conditions over a period of up to 17 years. **This finding should give agencies confidence in specifying RAP mixtures for overlays when economic and other conditions warrant.**”*

RAP/RAS Publications

- Designing HMA Mixtures with High RAP Content: A Practical Guide, Publication QIP-124
- How to Increase RAP Usage and Ensure Pavement Performance, NAPA Publication PS 34
- Uses of Waste Shingles in HMA: State-of-the-Practice, Special Report 179
- Guidelines for the Use of Reclaimed Asphalt Shingles in Asphalt Pavements, Information Series 136



RAP Webinars



- TRB Webinar "Design and Production of High Reclaimed Asphalt Pavement Mixes"
<http://www.morerap.us/RAP%20Resources/webinar.html>
- Best Practices for RAP Management
 - Find the recording at www.moreRAP.us



WMA Publications



<http://store.asphaltpavement.org/index.php?productID=552>

New WMA Resource



<http://www.ct.gov/dot/AASHTO-R35>



The banner features the "CT.gov" logo on the left, which includes a red barn and the text "STATE OF CONNECTICUT". To the right is the "CONNECTICUT DEPARTMENT OF TRANSPORTATION" logo, which includes a circular seal with the text "CONNECTICUT DEPARTMENT OF TRANSPORTATION" and "ROADS TO THE FUTURE". The text "Video On-Demand" is centered on the right side of the banner.

**Special Mixture Design
Considerations and Methods for
Warm Mix Asphalt (WMA)**

*An Appendix to AASHTO R35
Standard Practice for Superpave
Volumetric Design for Hot-Mix
Asphalt (HMA)*



A portrait of Ramon Bonaquist, a man with glasses wearing a light green polo shirt, speaking into a lapel microphone against a blue background.

Ramon Bonaquist, Ph.D., P.E.

Special Mixture Design Considerations
and Methods for WMA

NHI 13117 Web-based





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Course Description

Special Mixture Design Considerations and Methods for Warm Mix Asphalt - WEB-BASED

PROGRAM AREA: Pavements and Materials
COURSE NUMBER: FHWA-NHI-131137

| CALENDAR YEAR | LENGTH | CEU | FEE |
|---------------|---------|---------|---------------------|
| 2011 | 2 Hours | 0 Units | \$0 Per Participant |
| 2012 | 2 Hours | 0 Units | \$0 Per Participant |

TRAINING LEVEL: Basic

CLASS SIZE: Minimum:1; Maximum:1

DESCRIPTION:

Highway transportation agencies are exploring the use of warm mix asphalt (WMA) for pavement projects. Because of the potential environmental and engineering benefits that WMA provides, agency and industry personnel want to learn the proper design considerations for a quality WMA mixture design. Mixture design technicians and engineers are particularly interested in design differences between WMA and HMA.

The Special Mixture Design Considerations and Methods for Warm Mix Asphalt course explains the key differences between WMA and HMA design procedures. Participants in this course compare important elements of the mixtures and review the effects of those elements on the final WMA product. Learners also have an opportunity to apply AASHTO R35 standard practice to a WMA design modification, converting an HMA mixture design to WMA.



The National Trend...



- The nation is comfortable using up to 20% RAP, but there's room to use up to 30%.
- The use of RAS and interest in rubber is increasing.
- The use of WMA in the industry has increased by almost 150%!
- AASHTO is accounting for these changes in specifications.



Thank you for your hard work and effort to produce quality pavements, improve transportation infrastructure, and our economy.

For more information:

Web: www.asphaltpavement.org

Email: audrey@asphaltpavement.org

Industry Survey Summary



| | 2009 | 2010 |
|----------------------|---------|---------|
| HMA/WMA Tons | 358 MT | 360 MT |
| RAP used in HMA/WMA | 56 MT | 62 MT |
| Total RAP Recycled | 64 MT | 72 MT |
| Total RAS to HMA/WMA | 0.70 MT | 1.10 MT |
| Total WMA Tons | 19.2 MT | 47.6 MT |

Source: Hansen, K. and D. Newcomb. NAPA Asphalt Mix Production Survey on Reclaimed Asphalt Pavement, Reclaimed Asphalt Shingles, and Warm Mix Asphalt Usage: 2009-2010, Information Series 138, http://www.asphaltpavement.org/images/stories/is-138_rap_ras_wma_survey_2009_2010.pdf, 2011.