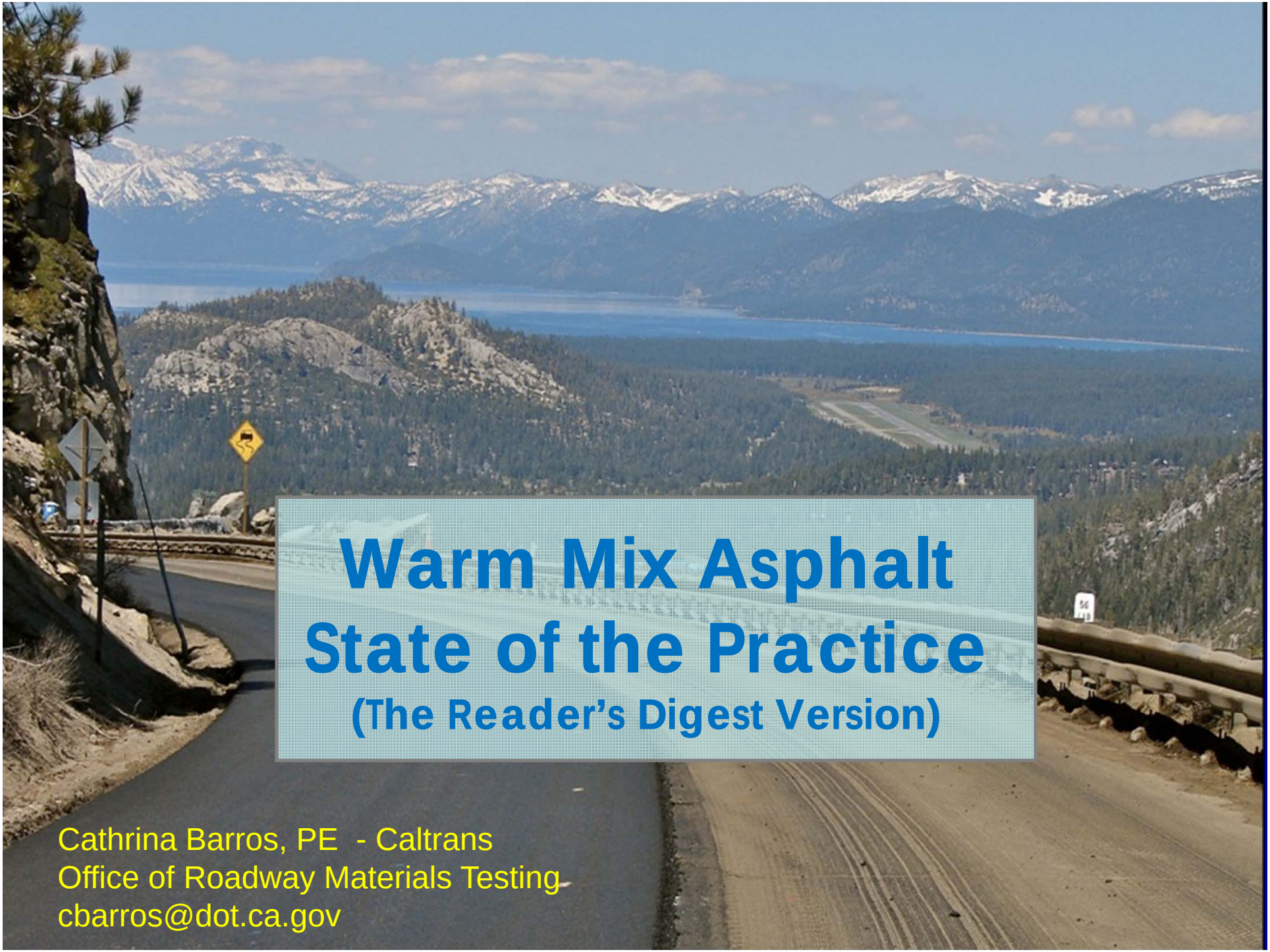

Warm Mix Asphalt State of the Practice

(The Reader's Digest Version)

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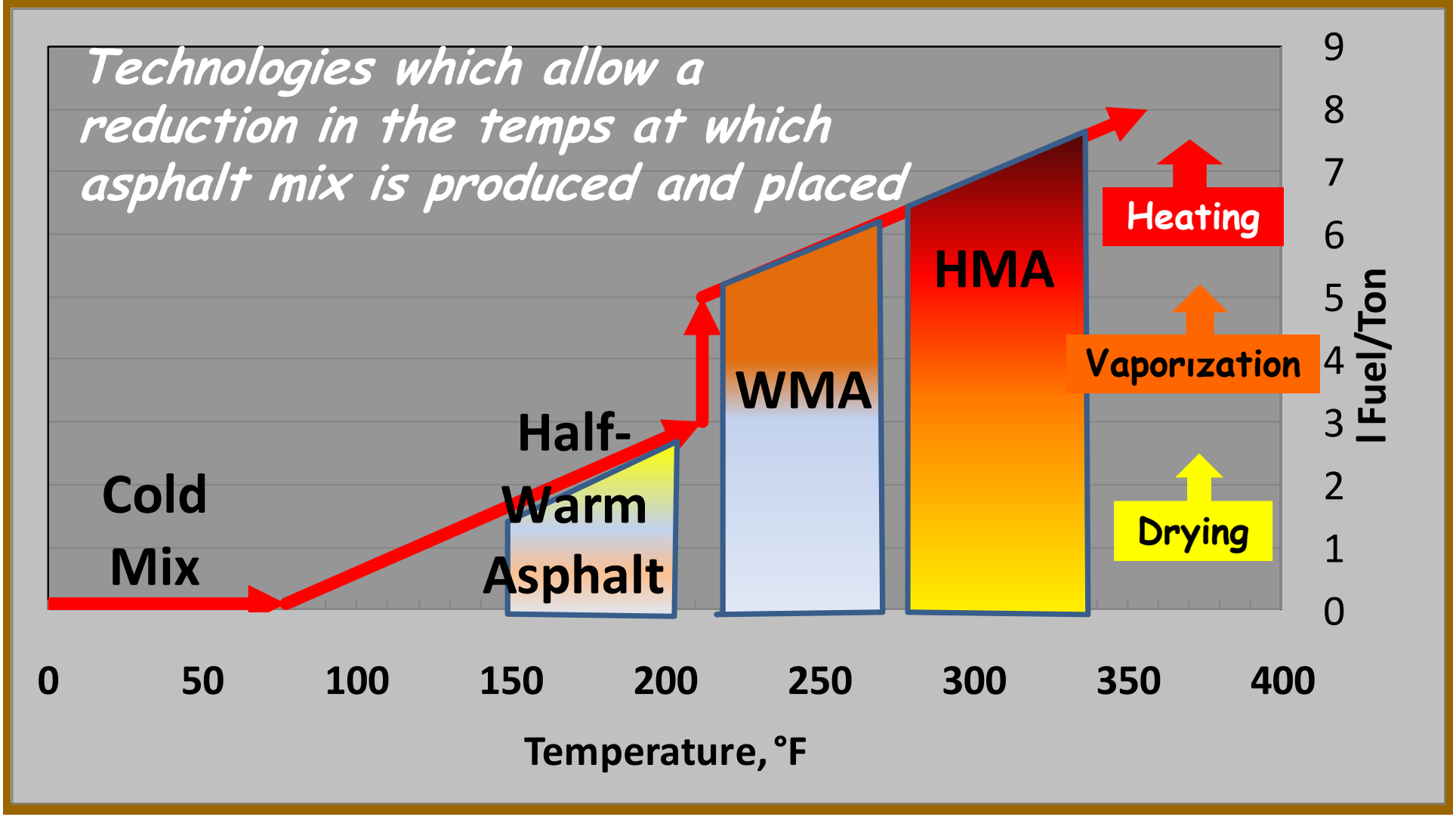
Acknowledgements

- Joe Peterson – Caltrans
- Matt Corrigan – FHWA
- Carl Monismith & Dave Jones – UC-Pavement Research Center
- Dave Newcomb – NAPA
- Adam Hand & Tony Limas -Granite Construction
- Rita Leahy – APACA
- Annette Smith – Advera
- John Shaw – Sasol
- Ray Hess – AkzoNobel
- Roger Sandberg – Maxam
- Kent Hansen – NAPA
- Scott Dmytrow – Telfer Oil Companies
- Brian Prowell – Advanced Materials Services, LLC

Presentation Overview

- What
- Why
- Technologies
- National Perspective
- Research
- Projects
- Resources

WMA – What?


Technologies which allow a reduction in the temps at which asphalt mix is produced and placed
Cold Mix
Half-Warm Asphalt
WMA
HMA
Heating
Vaporization
Drying
0
1
2
3
4
5
6
7
8
9
l Fuel/Ton
0
50
100
150
200
250
300
350
400
Temperature, °F

WMA- What?

- Like HMA, but Cooler
  - Typically produced at 212-280°F
- Many WMA Technologies
- Technologies tend to provide better aggregate coating
- Produced with minor plant modifications
- Placed with conventional equipment

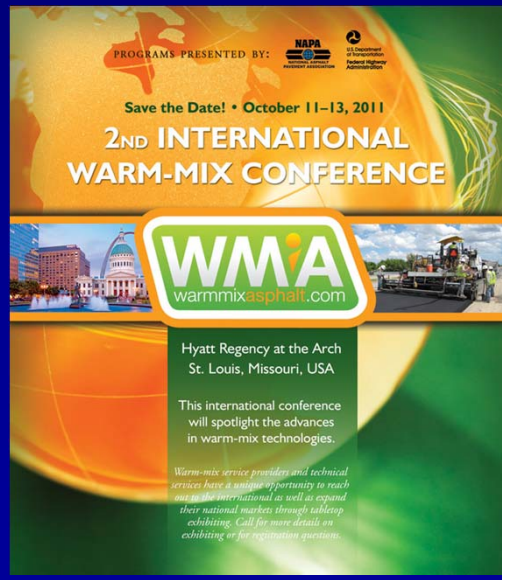
Brief History

- 1995 – 1999
  - European Experiments & Pavement Construction
- 2002
  - NAPA European Scan Tour (Denmark, Germany and Norway)
- 2004
  - WMA Demonstration at World of Asphalt
  - First field trials FL and NC
- 2005
  - National Technical Working Group (TWG) formed
  - Field trials in FL, IN, MD, NH, OH, TX and Canada
- 2006
  - Trials in CA, MI, NY, MO, SC, VA and WI

asphalt
connecting people

Brief History

- 2007
  - NCRHP 9-43 research initiated
  - 5 new WMA technologies in the US
- 2008
  - Documented WMA trials in 32 states
  - 13 WMA technologies marketed in the US
  - 1st International WMA Conference in TN
- 2010
  - Documented WMA trials in 45 US States and all 10 Canadian providences
  - Over 20 WMA technologies in the US
- 2011
  - 2nd International Conference in St Louis



WMA – Why?

- Reduce fumes, odors and emissions
- Improved workability
- Extended paving season
- Longer haul potential
- Ability to use higher RAP content
- Better working conditions!

Reduced Emissions

Warm Mix 270° F

Yellowstone Paving

Technologies

Technology Providers

Chemical

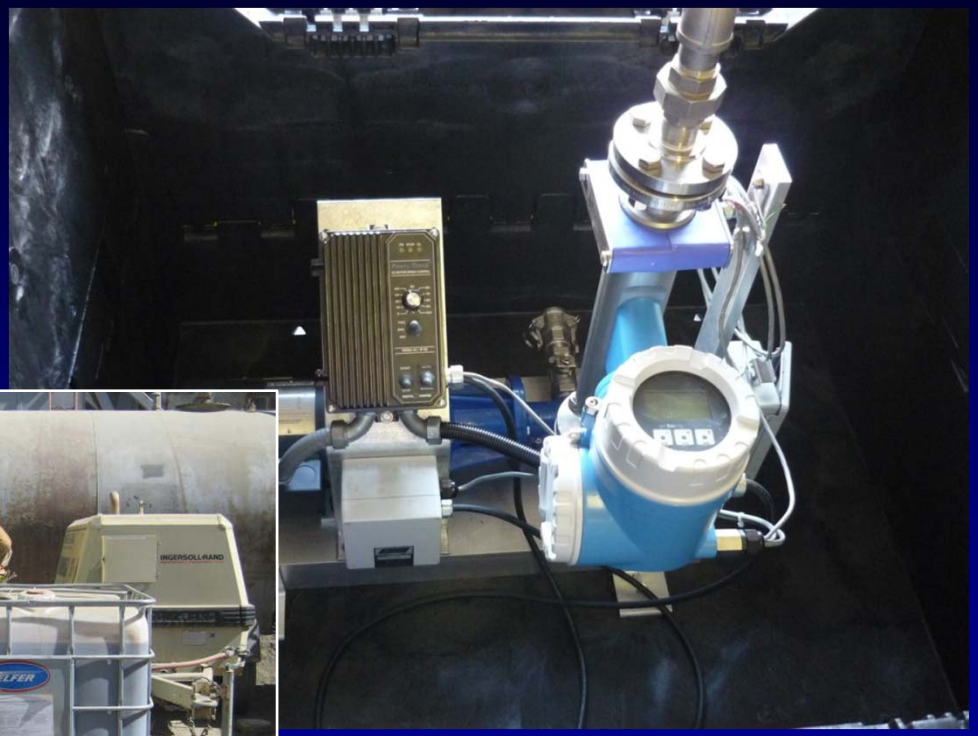
Cecabase® RT

Evotherm ™ (DAT/3G)

Hypertherm™/ QualiTherm

Rediset™ WMX

MeadWestvaco Evotherm DAT



- Added at ~5% of the AC content
- 85% water + 15% “chemical package”

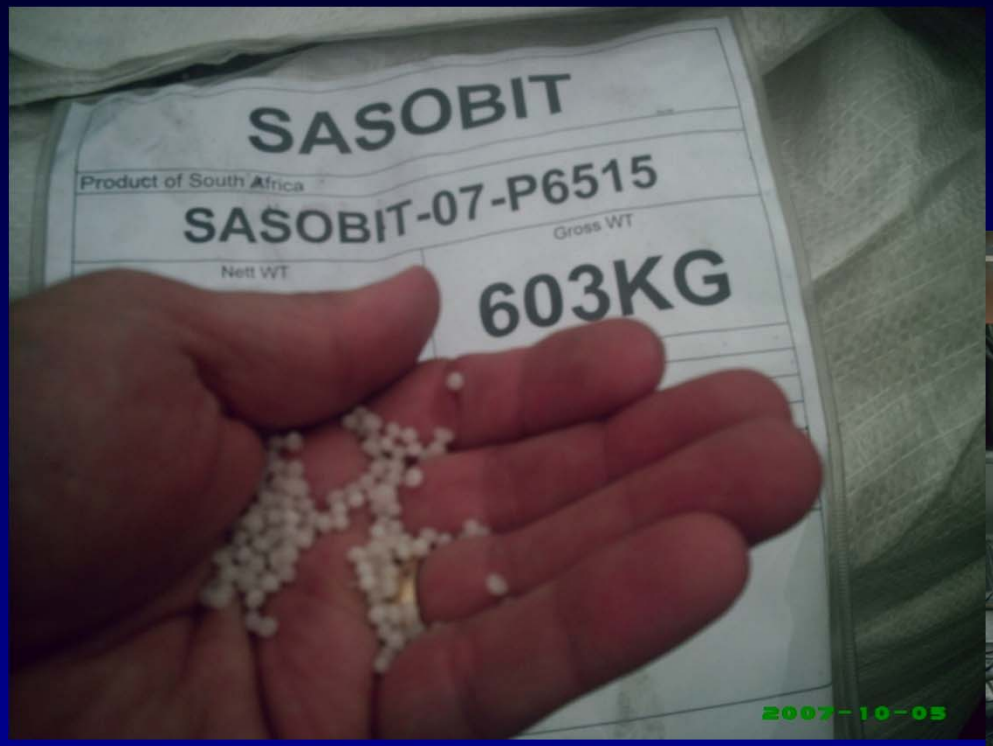
AkzoNobel - Rediset® WMX

- Solid Additive – Pastilles
- Built-in Anti-strip
- Added to the asphalt
- Also can be added to the mix at the hot-mix plant

Organic Additive

- Astech PER®
- Sasol – Sasobit®
- SonneWarmix™
- Thiopave™

Sasol – SASOBIT
(Organic paraffin wax)



- Added at 1 to 1.5% of AC Content
- Blend into binder or mix
- Improves rut resistance
- Non-Toxic; safe for crew

Mechanical Foaming

Accu-Shear™

AquaBlack™ WMA System

AquaFoam WMA System

Double Barrel® Green

Eco-Foam II

Green Machine Ultra Foam GX

LEA (Low Emission Asphalt)

Meeker Warm Mix

Terex ® WMA System

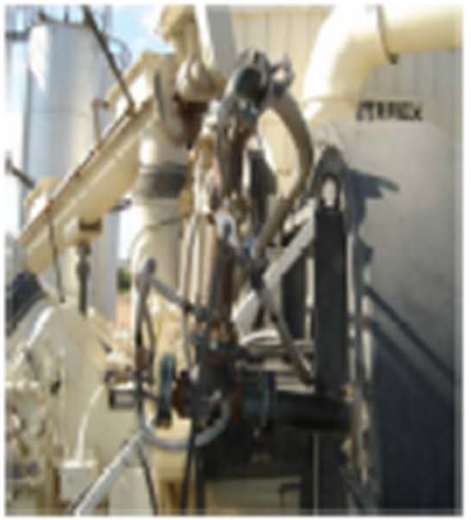
Tri-Mix Warm Mix Injection Systems

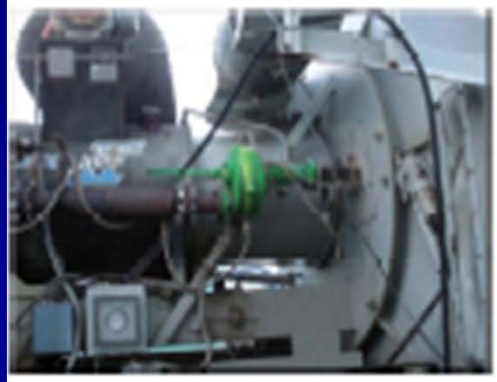
Ultrafoam GX2™ System

WAM Foam

Mechanical Foaming

Various WMA Foaming Systems

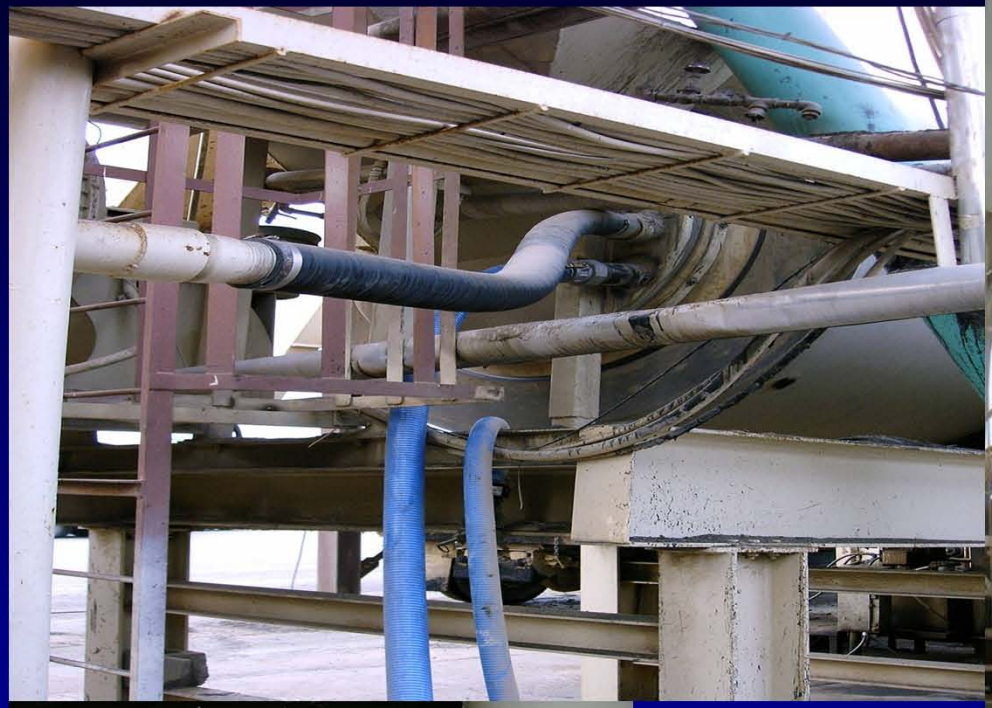




Chemical Foaming

- **Advera® WMA**
- **Aspha-min®**

PQ Corporation – Advera® WMA



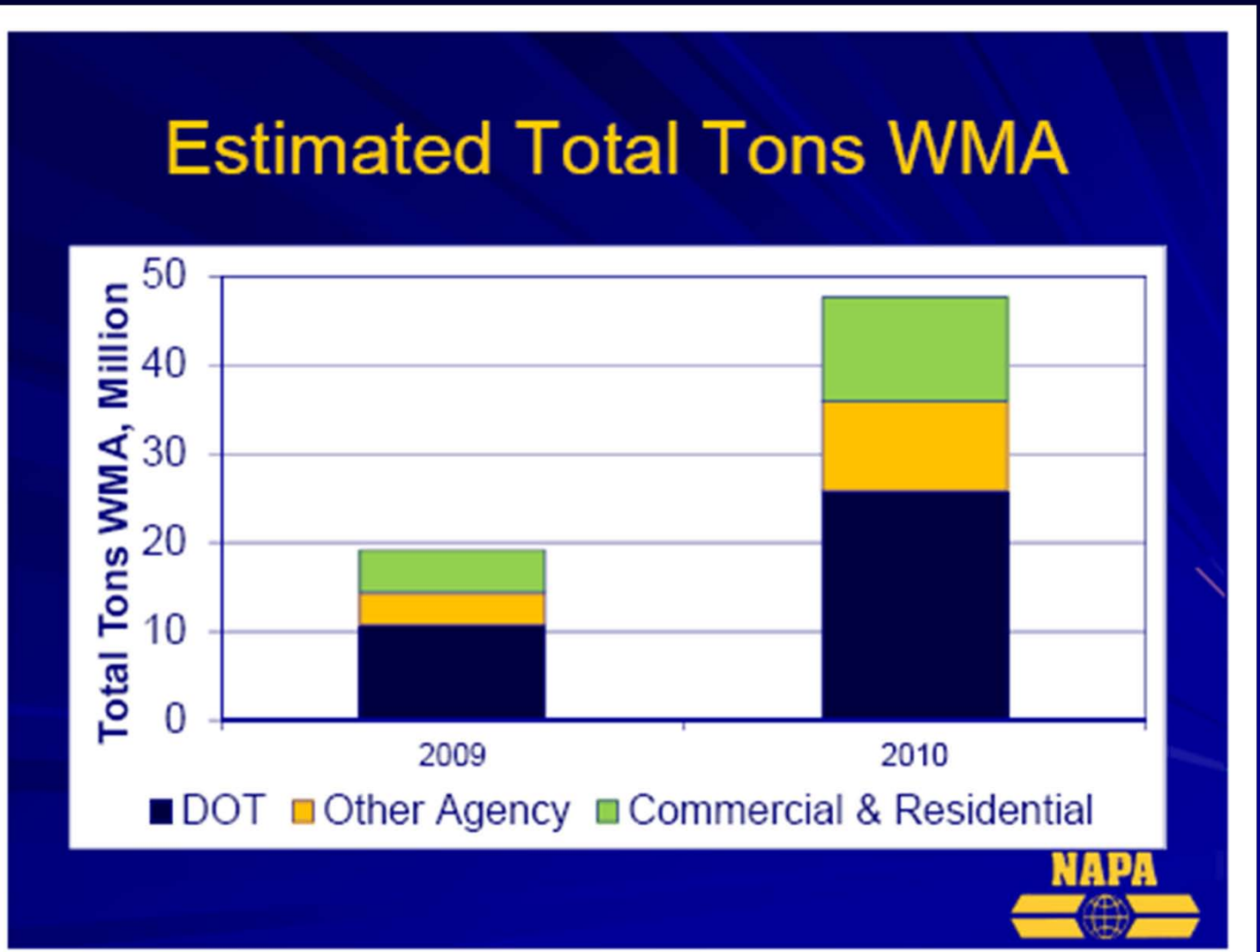
Dosage: 0.25% by weight of mix

National Perspective

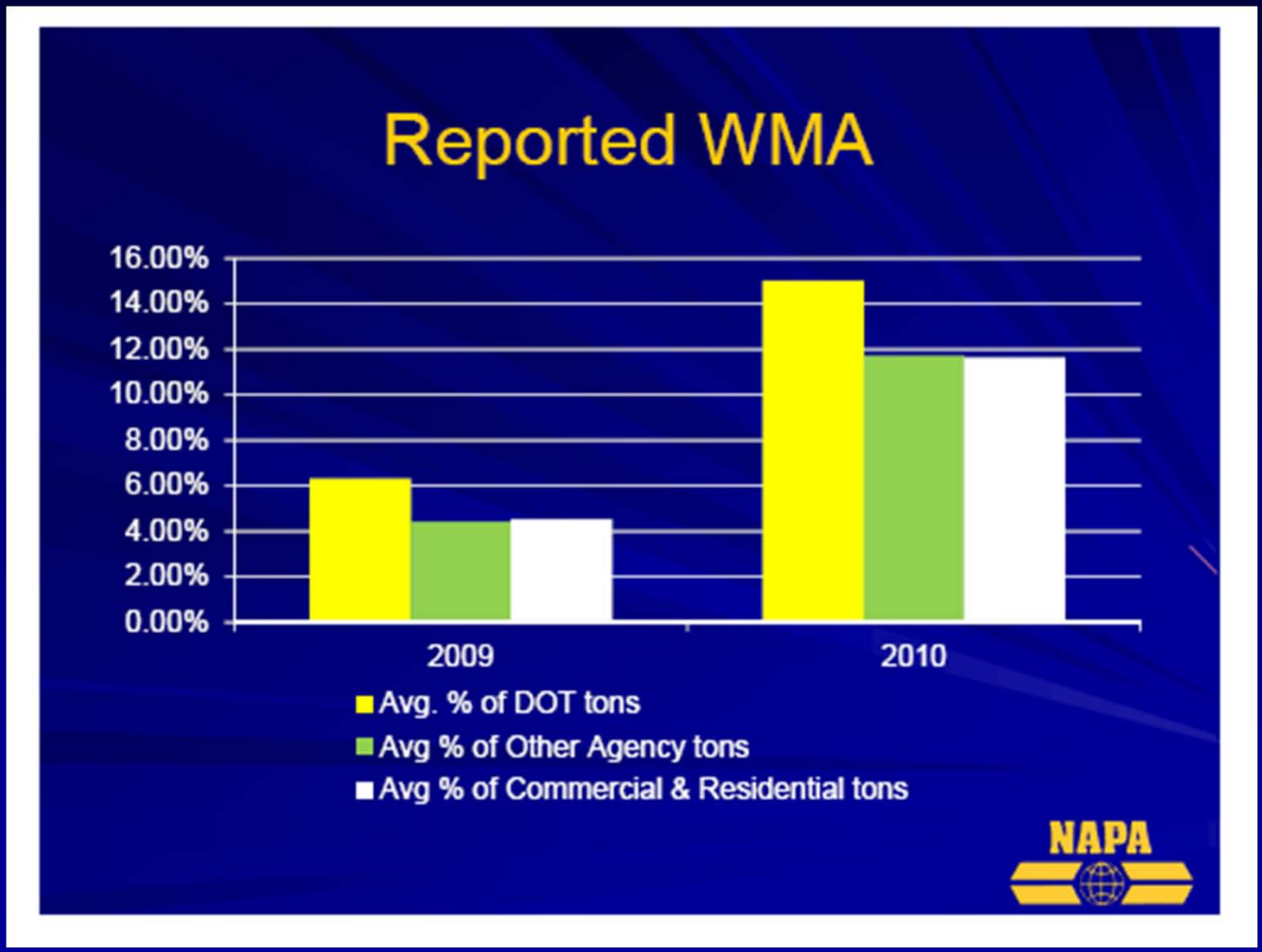
Progress in 6 Years

	2005	2011
Technology Providers	3	30+
States with Field Trials	7	46
States with WMA Specs	1	30

2010 Tonnage
(from NAPA)

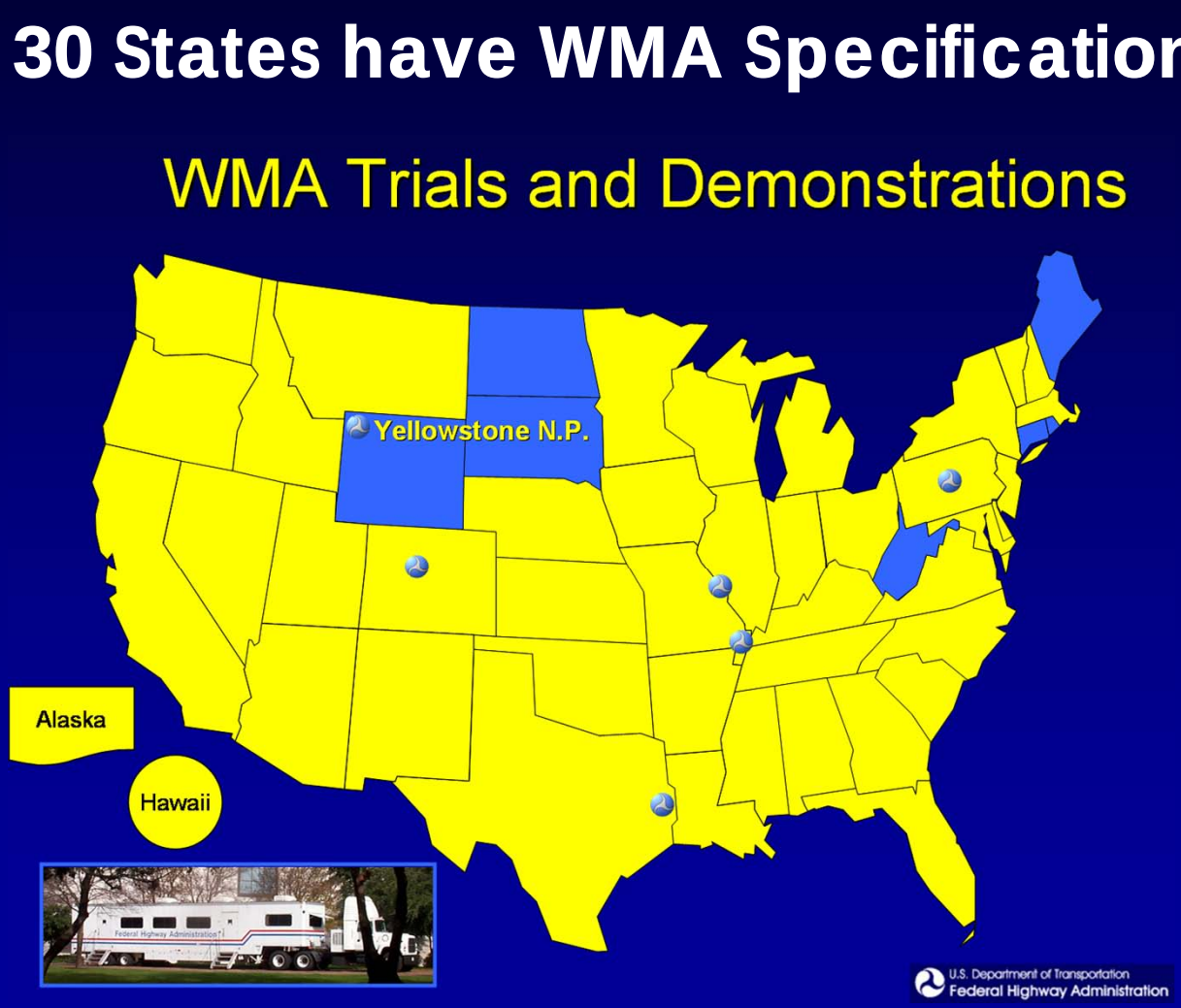


2010 Tonnage
(from NAPA)



State DOT Perspective

30 States have WMA Specifications



National Perspective

- **Warm-Mix Asphalt Part of FHWA's "Every Day Counts" Initiative**

EDC is designed to identify and deploy innovation aimed at shortening project delivery, enhancing the safety of our roadways, and protecting the environment.

ACCELERATING TECHNOLOGY DEPLOYMENT

National Perspective

- **By Dec 2011, 40 state DOT's and all Federal Lands Divisions will have a specification that allows WMA on federal aid projects**

- **By Dec 2012, at least 30 DOT's will have achieved set targets for WMA usage**

National Technical Working Group (TWG)

- FHWA & NAPA (Co-Sponsors)
- Matt Corrigan & Ron White (Co-Chairs)
- Representatives
  - ✓ State DOTs
  - ✓ State APA
  - ✓ AASHTO
  - ✓ NCAT
  - ✓ NIOSH
  - ✓ HMA Industry
  - ✓ Labor
  - ✓ Research Centers

TWG Deliverables

- WMA Guide Specs
- Best Practices Guide
- Testing Framework for Initial Pilot Projects
- Support for National Cooperative Highway Research Program (NCHRP) Research to Address Spec Challenges

Research

Ongoing National Research

- **NCHRP 9-43**
  - ***Mix Design Practices – completed ($500,000)***
- **NCHRP 9-47a**
  - ***Engineering Properties, Emissions & Field Performance - $900,000***
- **NCHRP 9-49**
  - ***Performance of WMA Technologies: Stage I Moisture Susceptibility - $450,000***
- **NCHRP 9-49A**
  - ***Performance of WMA Technologies: Stage II – Long Term Field Performance - $900,000***

TRB TRANSPORTATION RESEARCH BOARD OF THE NATIONAL ACADEMIES

Ongoing National Research

- **NCHRP 20-07 TASK 311**
  - ***Development of a Warm Mix Asphalt Technology Evaluation Program***
- **NCHRP 9-52 (2012)**
  - ***Short-Term Laboratory Conditioning of Asphalt Mixtures - $800,000***
- **NCHRP 9-53 (2012)**
  - ***Asphalt Foaming Characteristics for Warm Mix Asphalt Applications - $700,000***

TRB TRANSPORTATION RESEARCH BOARD OF THE NATIONAL ACADEMIES

NCHRP Project 9-43

- Appendix to AASHTO R35
- WMA Mix Design Workshop/Training Module (FREE!)

NCHRP Project 9-43

Special Mixture Design Considerations and 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. One of their main questions, particularly for agency mixture design technicians and engineers, is how WMA design differs from hot mix asphalt (HMA) design. "Mixture Design for Warm Mix Asphalt" is a Web-based training that presents the modifications to the current Superpave volumetric design procedure, as described in AASHTO R35, that are needed to complete a WMA mixture design. The training highlights key differences in WMA and HMA design procedures, and provides an opportunity to apply the AASHTO R35 standard practice to a WMA design modification.

NCHRP Project 9-43 (101)

ITEM	HMA AASHTO R35	WMA PROPOSED
WMA Process	N/A	Producer Selected
RAP Selection	AASHTO M323	Compaction Temperature
Mixing and Compaction Temperatures during mixture design	Viscosity Based	Coating and compactability evaluated at planned temperatures
Specimen Preparation	Standard	Process Specific
Mixture Evaluation for Rutting	None	Flow Number Test

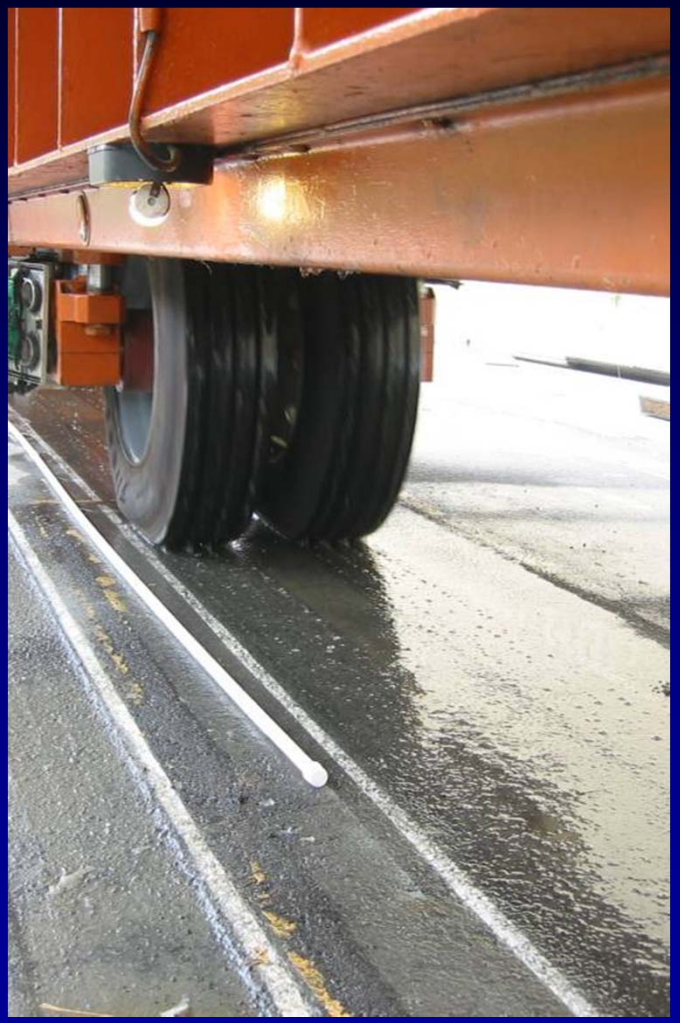
California Research

California Research Objectives

- Determine whether the addition of additives to reduce the production and construction temperatures of asphalt concrete influences performance
- Investigate additional benefits
  - Use in rubberized AC
  - Increased RAP content
  - Night paving
  - Late season paving
  - Long hauls
  - Overcome environmental constraints, etc
- Guide the implementation of WMA in California

Workplan Summary

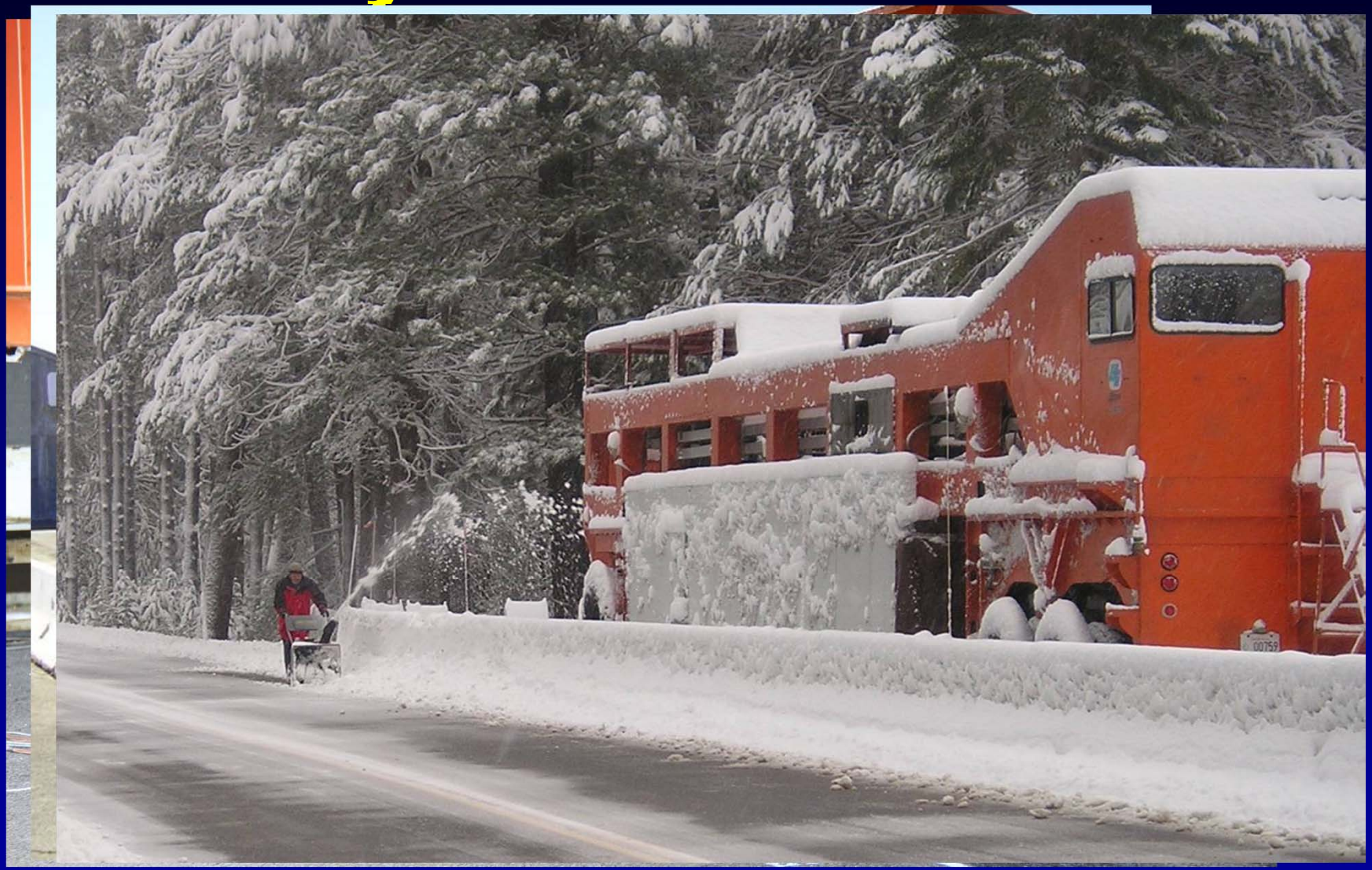
- Objectives met through:
  - Laboratory studies
  - Accelerated pavement testing
  - Field testing
- Phased approach followed
- Phase 1 & 2 DGAC *(complete)*
  - 3 most prominent technologies in 2007
    - Advera WMA®
    - Evotherm™
    - Sasobit®
  - Rutting and moisture sensitivity



Workplan Summary

- Phase 3, R-WMA-G
  - 7 technologies/each group
    - Advera® WMA.
    - Astec Double Barrel® Green.
    - Cecabase RT®.
    - Evotherm DAT™.
    - Gencor Ultrafoam GX™.
    - Rediset™ WMX.
    - Sasobit®
- Lab studies
  - Rutting & cracking performance
  - Moisture sensitivity
  - Other
    - Durability (OGFCs)
    - Aging
    - Emissions
    - Stability

Heavy Vehicle Simulator



Phase 1 & 2 Summary


July 2008
Research Report: UCPRC-RR-2008-11

Warm-Mix Asphalt Study:
Test Track Construction and First-Level Analysis of Phase 1 HVS and Laboratory Testing

Authors:
David Jones, Rongzong Wu, Bor-Wen Tsai, Qing Lu, and John T. Harvey

Partnered Pavement Research Program (PPRC) Contract Strategic Plan Element 4.18:
Warm-Mix Asphalt

PREPARED FOR:
California Department of Transportation
Division of Research and Innovation
Office of Roadway Research

PREPARED BY:
University of California
Pavement Research Center
UC Davis, UC Berkeley

UCPRC
UNIVERSITY OF CALIFORNIA | PAVEMENT RESEARCH CENTER

Caltrans

- Testing
  - 18 months of HVS testing
  - 12 months of lab testing
  - Months of data analysis
- Reports completed:
  - 1st Level Report: Construction & Phase 1 Study
  - 1st Level Report: Phase 2 Study & forensic investigation

HVS Phase 1 and 2 Findings

- Laboratory fatigue tests indicate WMA technologies assessed will not influence fatigue performance
- Moisture sensitivity testing indicates comparable performance between WMA technologies and control section
- A suite of lab tests were developed to correlate performance in the lab with HVS testing, which assists in evaluating upcoming WMA technologies

Phase 1 & 2 Conclusions

- No indication that the three warm-mix additives tested influence long-term rutting & fatigue performance or increase moisture sensitivity
- Construction quality/engineering remains a key concept
- Key issues
  - Beware wet aggregates
  - Beware initial "tenderness" because of less binder oxidation

Phase 3: RWMA-G Summary

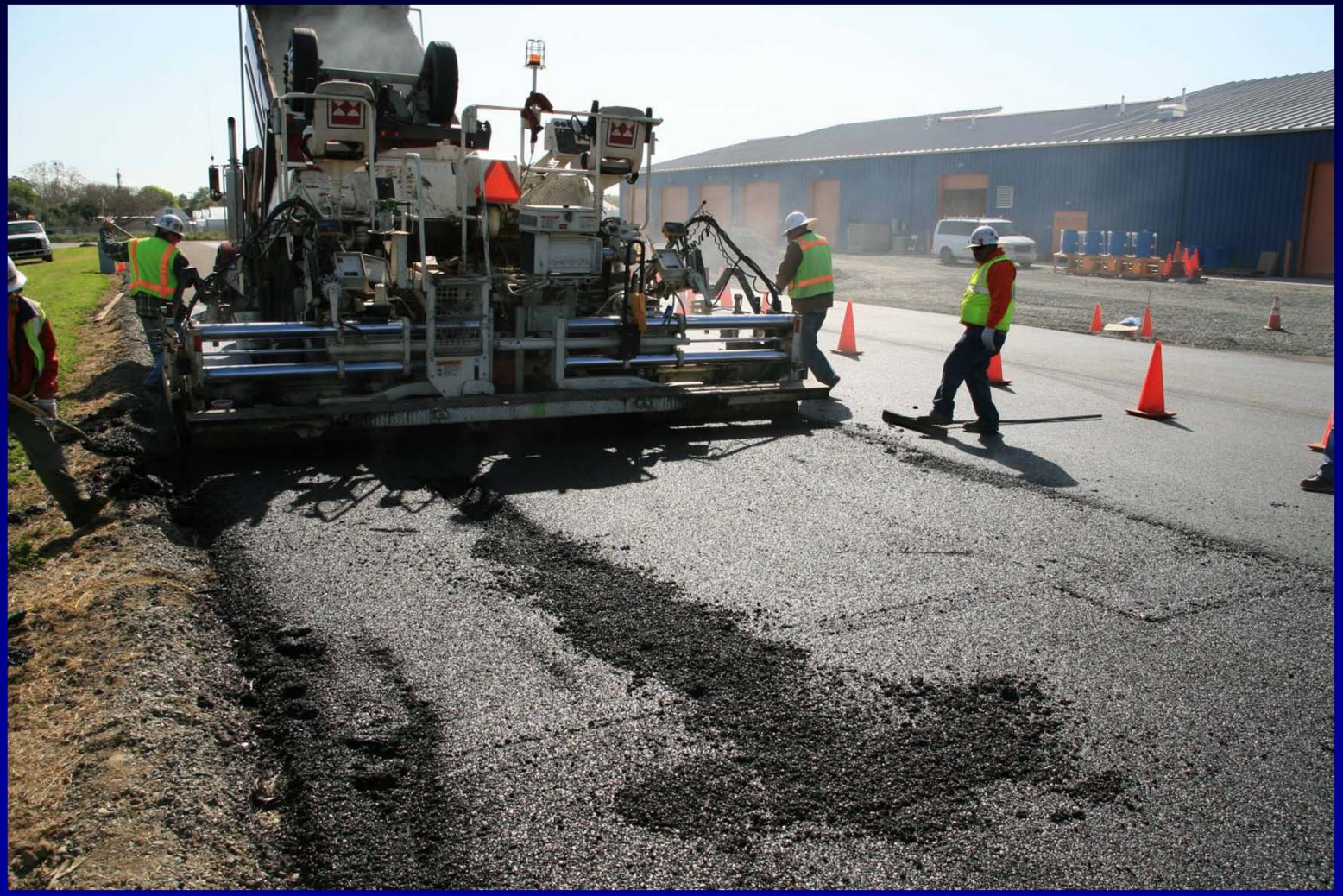
- Project 1
  - Technologies
    - Control
    - Cecabase
    - Evotherm
    - Gencor Ultrafoam GX
  - Binder content – 7.3%
  - Rubber content – 18%
  - Haul time – 60 mins
  - Paving air temp - 50˚ F-59˚ F

Phase 3: RWMA-G Summary

- Project 2
  - Technologies
    - Control
    - Advera
    - Astec DBG
    - Rediset
    - Sasobit
  - Binder content – 8.3%
  - Rubber content – 19%
  - Haul time – 120 mins
  - Paving air temp - 50˚ F-59˚ F

Phase 3 – Control

Phase 3 – Control



Phase 3 - WMA

Phase 3 - WMA

Phase 3 Summary

- Testing
  - 9 months of HVS testing
  - 9 months of lab testing
  - Additional APT to assess aging effect
- Reports completed:
  - 1st Level Report: Phase 3 Study
  - 1st Level Report: Construction emissions
  - 1st Level Report: Lab mix, lab compact study

Ph 3 Observations & Conclusions

- WMA mixes had significantly less smoke and odor
- WMA mixes were notably more workable
- Compaction generally poor
  - Set production temperatures based on required compaction temperature

Ph 3 Observations & Conclusions

- **WMA generally had equal or better performance**
  - **Lower performance on 2 (subgrade moisture)**
  - **Comparative performance on 1 (incorrect binder content)**
  - **Lab performance dependent on air void content**
- **Key Issues**
  - **Beware temperature limits**
  - **Final conclusions after completion of lab testing and aging effects study**
  - **Emissions dependent on technology**

CA Approval Process

- Supplier to submit comprehensive report that includes:
  - Laboratory testing data
  - 3 field trials
    - 10,000 AADT, 15% truck traffic
    - Follow-up site assessment in 12 months
- Approved product list on CT website:

  www.dot.ca.gov/hq/esc/approved_products_list

Projects

"The coldest winter I ever spent was a summer in San Francisco..."

Photo taken August 2010
Central Federal Lands WMA job near SF

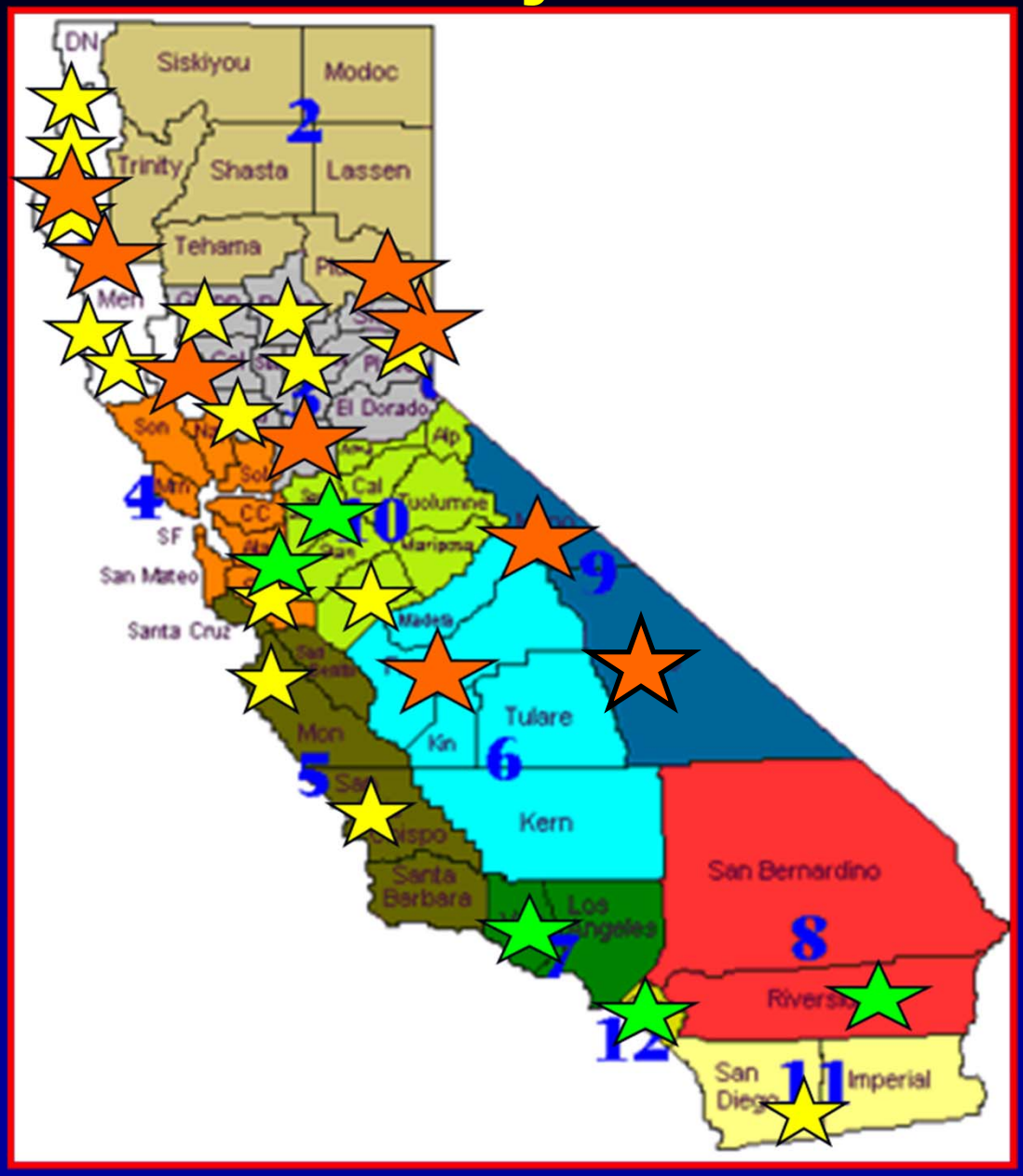
Caltrans – 12 districts with distinctly different & varying needs

Location of WMA Projects

★ 2006 - 2010

★ 2010 - 2011

★ Local Agency



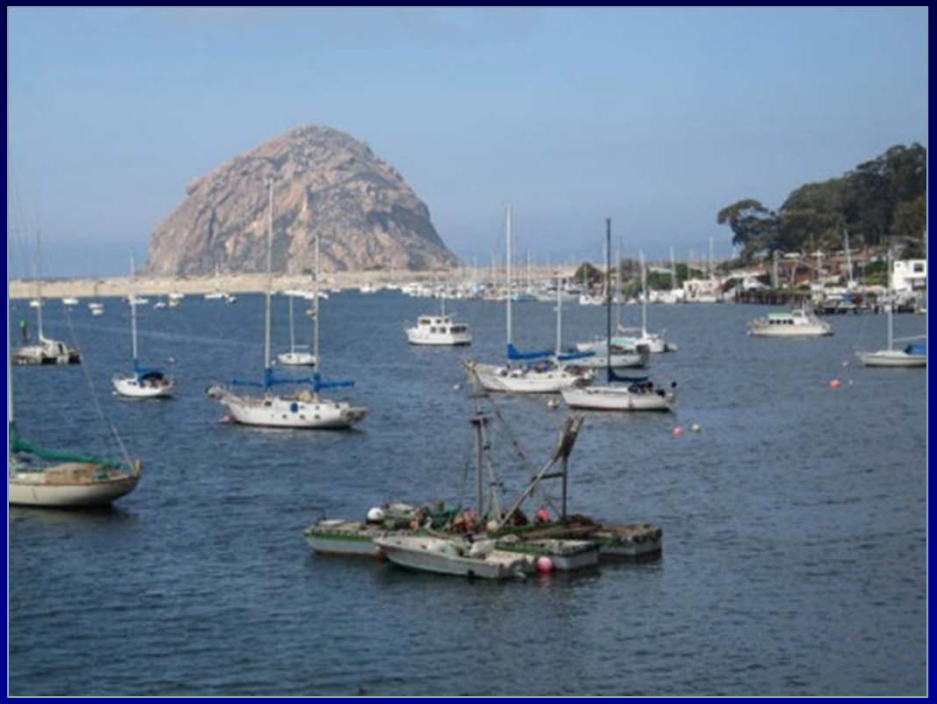
2006 – 2010: 14 projects

70,000 tons

2010-11: 24 projects

OGFC, RHMA, DGAC over 1 million tons

CA 1in Morro Bay – May 2008

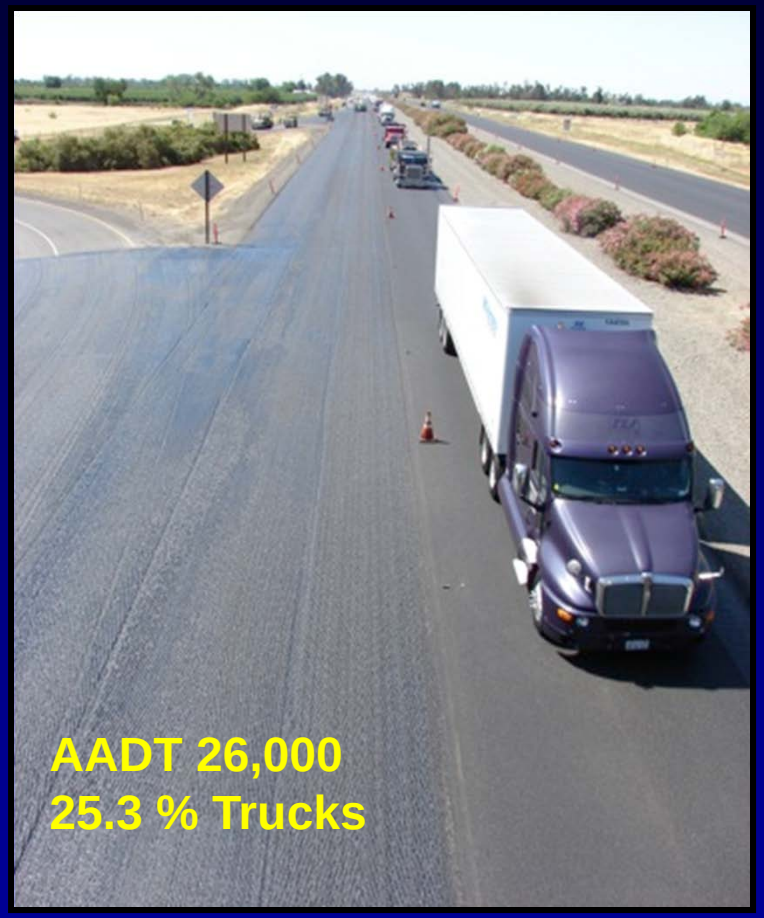


Project Information

- 1.2” (30mm) OGFC PG 58-34 PM
- 2000 ton control section and 3 WMA test sections (Evotherm, Advera & Sasobit)
- Ambient temperature between 50 ºF and 60 ºF
- Mixing temps 260 ºF to 290 ºF (vs. 320 ºF)
- Final compaction by 220ºF (vs. 250 ºF)

Morro Bay: 2008 - 2011

Interstate 5 in Orland, CA



Project Information

- 1.2” (30mm) RHMA-O PG 64-16
- 3,000 tons of Control (320ºF)
- 12,000 tons Evotherm WMA (285ºF to 305ºF)
- Ambient temperature between 60 ºF and 70 ºF
- Mix workable down to 230ºF

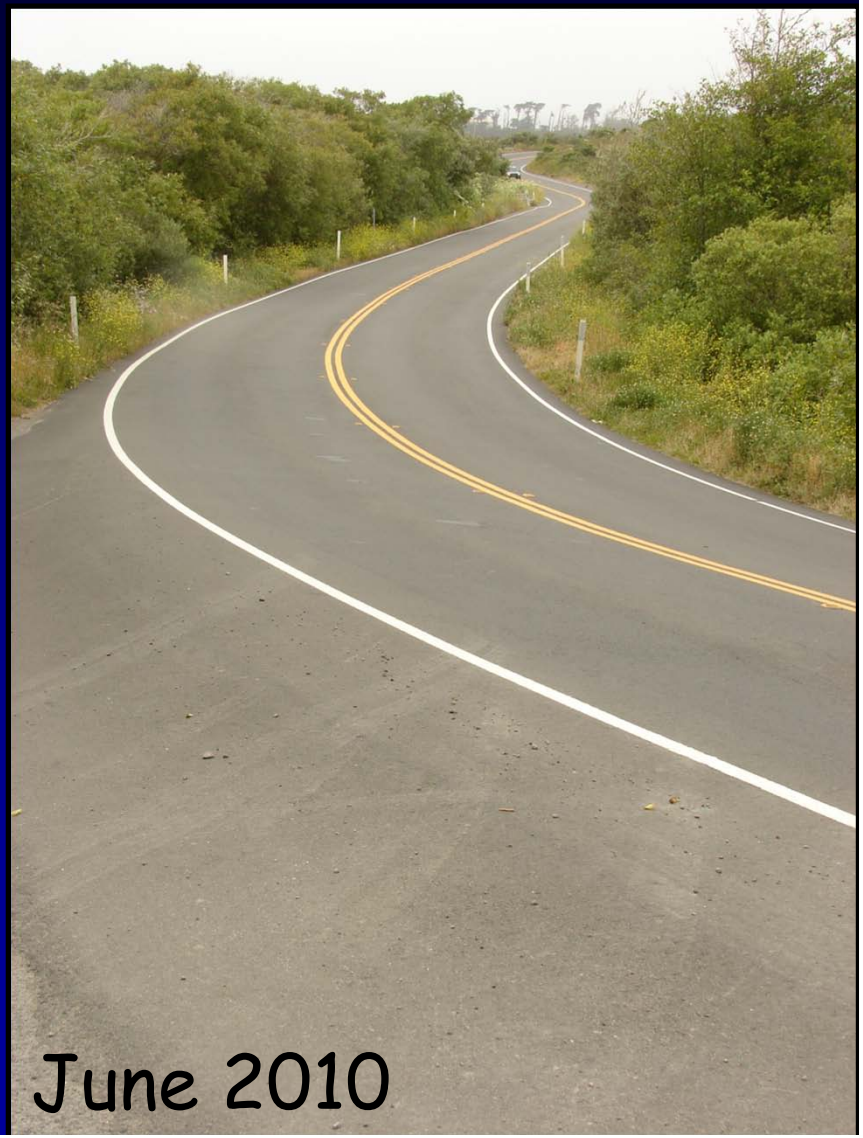
Orland: May 2011

CA 1 Point Arena – Sept 2008

- 0.10’ OGFC w/ PG 58-34 PM
- Mix production temperature: 320ºF to 290ºF (vs. 320 ºF)
- Breakdown temperature: 240 ºF to 210 ºF (vs. 240 ºF)
- 3 – 4 hour haul time
- Air temp 55ºF and “misty”
- MTV required


June 2010


April 2009


June 2010

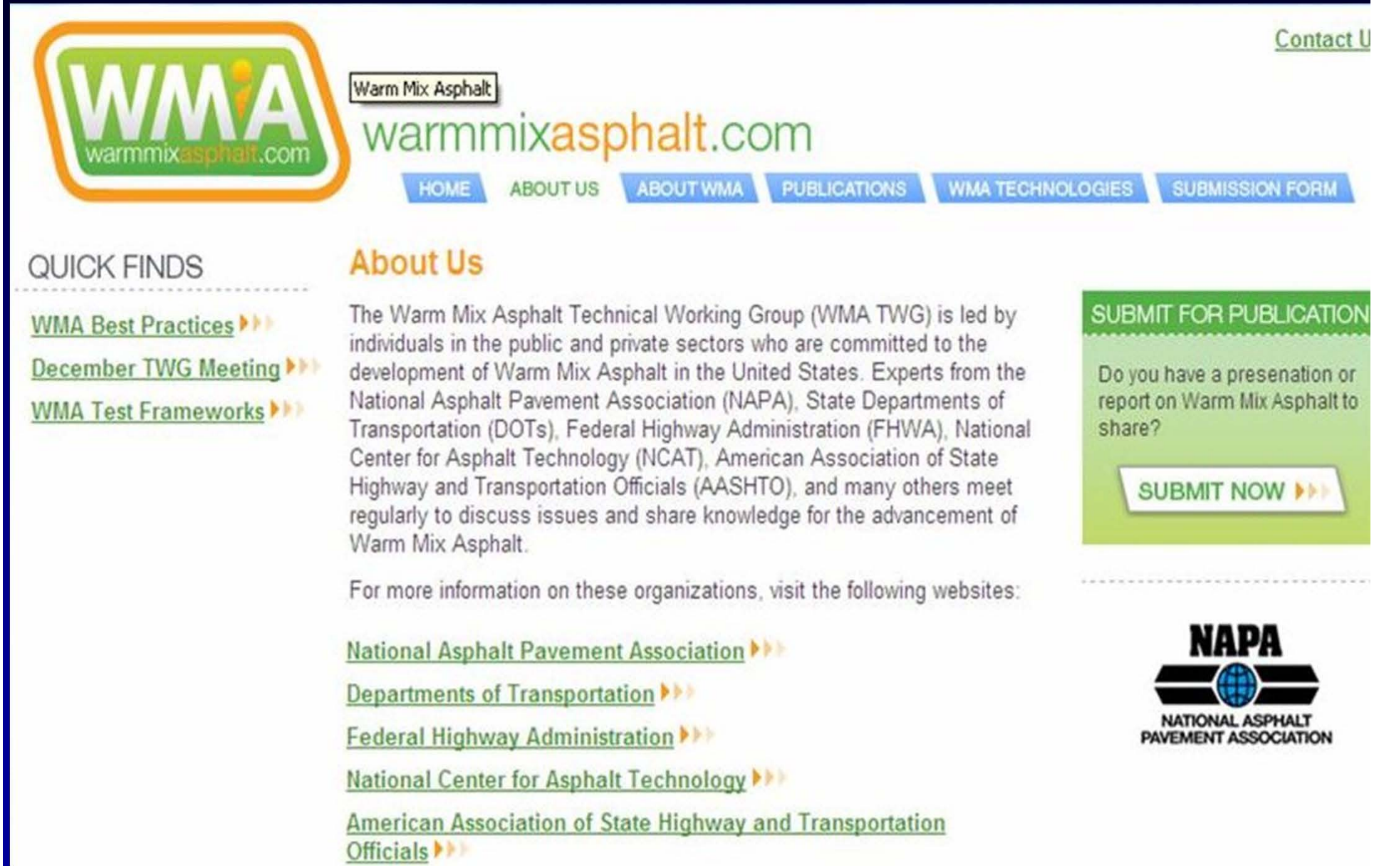
I-5 Slab Replacements (2011)

- 9” DGAC, PG 64-10
- 3 Lifts
- 8 hours, night paving
- Mix Temp: 255ºF

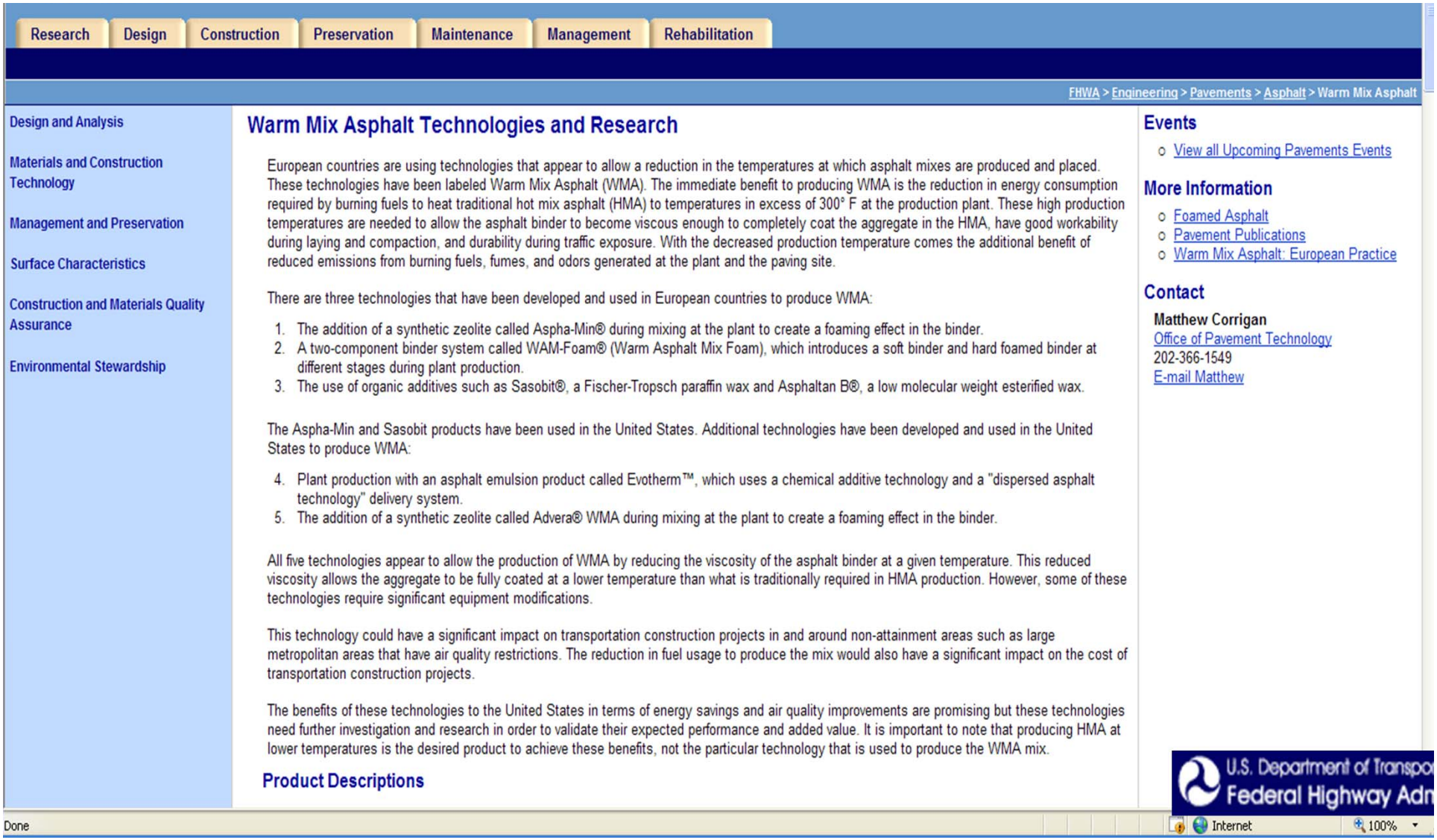

TROXLER
Dens: 145.6 PCF
%MR: 92.25%
100-%MR: 7.75%
%VOID: 7.75%
4640-B
159 C
ON
OFF
YES
NO/CE
7
8
9
STORE
THICK
4
5
6
TIME
1
2
3
SHIFT
STD
0
START/
ENTER
FINGER TIGHTEN ONLY
THIN LAYER DENSITY GAUGE

Resources

www.warmmixasphalt.com



http://www.fhwa.dot.gov/pavement/asphalt/wma.cfm



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Dedicated to providing knowledge, the Pavement Research Center uses innovative research and sound engineering principles to improve pavement structures, materials, and technologies.

NEWS

- *APT2012*, the 4th International Conference on Accelerated Pavement Testing, will be held in Davis, California, in September 2012. Information is available here.
- Lifecycle Analysis Framework Kick-off Workshop held at UCPRC, May 2010. More information is available here.

Summer 2010 UCPRC Activities

SHRP 2 R21 Composite Pavement Systems. In 2008, UCPRC started work on the federal Strategic Highway Research Program (SHRP 2) R21 Project on Composite Pavement Systems. One of three major participants in the study, UCPRC is focusing on the use of hot-mix asphalt (HMA) surfaces over portland cement concrete (PCC) in new pavement construction. UCPRC activities have included performing agency surveys, modeling performance, designing and installing instrumentation, and constructing test sections.

Heavy Vehicle Simulator (HVS) testing currently underway at the UCPRC's UC Davis facility will yield data on the rutting performance of two HMA types, PG64-28PM and RHMA-G, that are candidates for use as the surface layer on composite pavements. After the HVS rutting performance tests end, the composite pavement sections will undergo further testing to examine HMA and PCC cracking performance.

The HMA/PCC portion of this SHRP 2 project has several aims: to determine HMA and PCC behavior and identify their critical material and performance parameters; to develop and validate mechanistic-empirical performance models and

Internet 120%

WMA European Scan Tour

- Joint Program w/ FHWA, AASHTO, NCHRP & Industry
- FHWA-PL-08-007

NAPA Publications

PS-30

Warm-Mix Asphalt: The Future of Asphalt

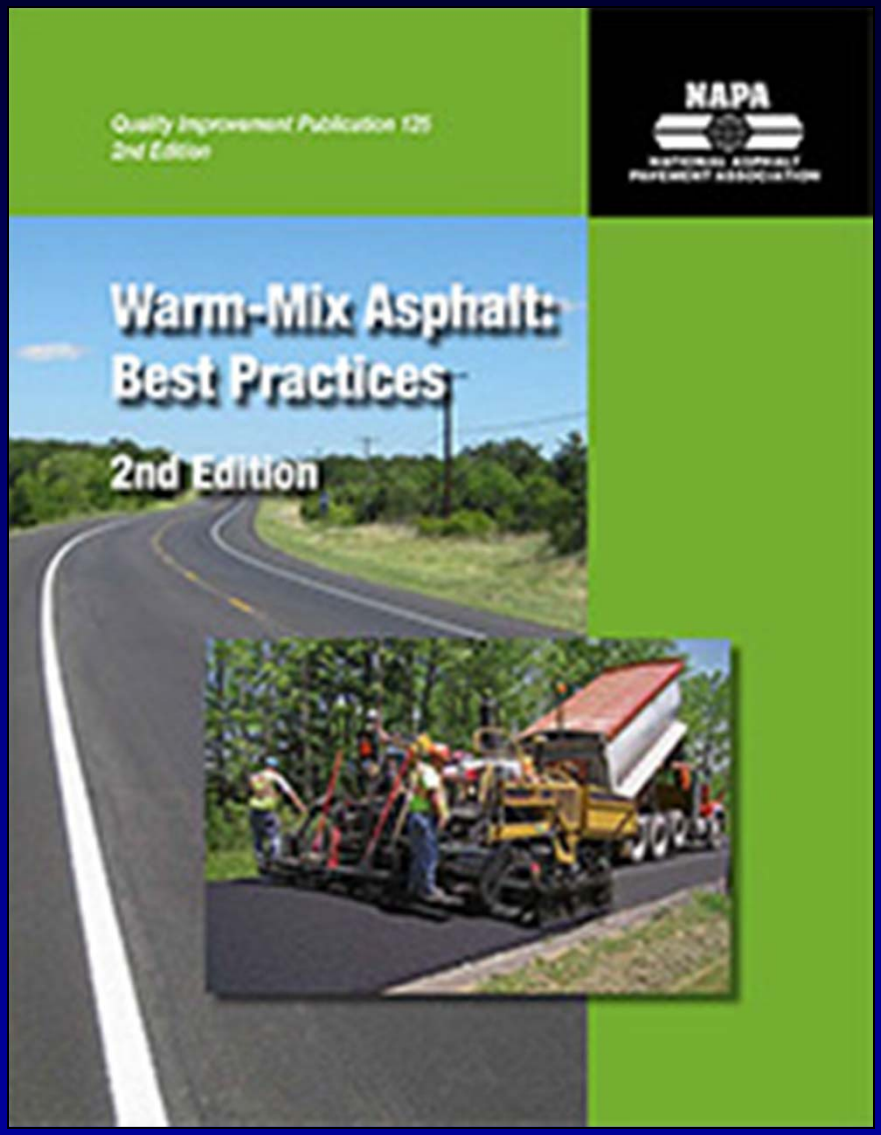
QIP 125

Warm Mix Asphalt: Best Practices

IS-134

Warm-Mix Asphalt: Contractors' Experiences

Newest NAPA Publication!



Top 5 List re: WMA

5. WMA Information is everywhere!

4. Different technologies have different advantages and disadvantages. (See number 5)

3. Warm mixes can improve workability and compaction. (See number 4)

Top 5 List re: WMA

2. Pro… …res
   doe… …e

1. Wa… …ood
   eng…
   pra…


Questions?