



U.S. Department  
of Transportation  
Federal Highway  
Administration



# EDC Summit

## Current State of the Technology



# The Innovations

Warm Mix Asphalt (WMA)



Precast Bridge Elements



Geosynthetic Reinforced Soil



Safety Edge



Adaptive Traffic Control Technology





# Our Visit Today

Part  
1:

What is the EDC  
Technology &  
Innovation?

Part  
2:

Current State of  
the Technology

Part  
3:

Barriers to  
Implementation

Part  
4:

State-based  
Technology  
Discussions





## Part 2:

### *Current State of the Technology*





# What is WMA?

- ✓ WMA encompasses a wide range of enabling technologies that enhance asphalt production and/or lay-down properties...





# Warm Mix Asphalt Technologies

What is available?





# Warm Mix Asphalt

## General Technology Categories:

- Materials Processing
- Organic Additives
  - wax, zeolites, other
- Chemical Additives
- Foaming Processes
  - water injection, zeolites
- Hybrid Systems  
(combination of technologies)





## \*\* Technology Overview

- Materials Processing
  - A different way of introducing materials in comparison to traditional HMA production
    - Multiple binder sources blended in line at the mixture production plant, or
    - Divert a portion of the aggregate structure away from the dryer process and introduce later in the mixing process

\*\*FHWA does not endorse any particular proprietary product or technology.





## \*\* Technology Overview

- Materials Processing
  - WAM-Foam
  - Low Emission Asphalt





## \*\* Technology Overview

- Mixture & Binder additives
  - Mix additives
    - Introduced by additive metering/dosage equipment installed at the plant
  - Binder additives
    - Introduced by additive metering/dosage equipment installed at the plant, or
    - Introduced by asphalt refiner/supplier and certified with type and dosage



## \*\* Technology Overview

- Mix or Binder additives (Chemical)

- Evotherm (ET, DAT, 3G)



- REVIX (Evotherm 3G)

Mathy Tech. & Eng. Services and  
Paragon Technical Services, Inc

- Cecabase RT



- Iterlow-T or HyperTherm





# \*\* Technology Overview

- Mix or Binder additives (wax)

- Sasobit



- Rediset WMX



- SonneWarmix





## \*\* Technology Overview

- Mix additives (zeolite: water bearing mineral filler)
  - Aspha-Min
  - Advera





# \*\* Technology Overview

- Water injection at the plant

- Ultrafoam GX



- Terex



- Double Barrel Green & Green Pac



- Stansteel



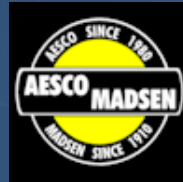
- Aquablack  
(continued)





# \*\* Technology Overview

- Water injection at the plant
  - ECOFOAM-II
  - Meeker WMA
  - AquaFoam
  - Tri-Mix





# Warm Mix Asphalt Implementation Status

## History and Deployment Resources







# Warm Mix Asphalt (WMA)

## Investigation and Implementation Premise

Although there are many factors driving the development and implementation of WMA technologies globally, in order for WMA to succeed in the US, *WMA pavements must have equal or better performance when compared to traditional HMA pavements.*



“The collective efforts from highway agencies and industry partners to advance warm mix asphalt technologies as a standard practice has been tremendous.”



-Peter Stephanos, Director,  
Office of Pavement Technology, FHWA

“[We] support the development and implementation of warm-mix asphalt ... this will inevitably become the standard practice for asphalt mixture production.”



- Global Asphalt Pavement Alliance



“WMA is the future of flexible pavements in the U.S. ... lowering our production and paving temperatures promises improved energy consumption, operations, and quality.”

-Mike Acott, President, NAPA

“WMA technology provides an important tool to the pavement engineer ... designers and contractors alike now have a great opportunity to learn more about this promising practice which is revolutionizing the paving industry in North America.”

-Pete Grass, President, Asphalt Institute





# Deployment Status

- ▶ WMA projects have been completed in over 40 states
- ▶ At least 10 State Agencies have adopted permissive specifications

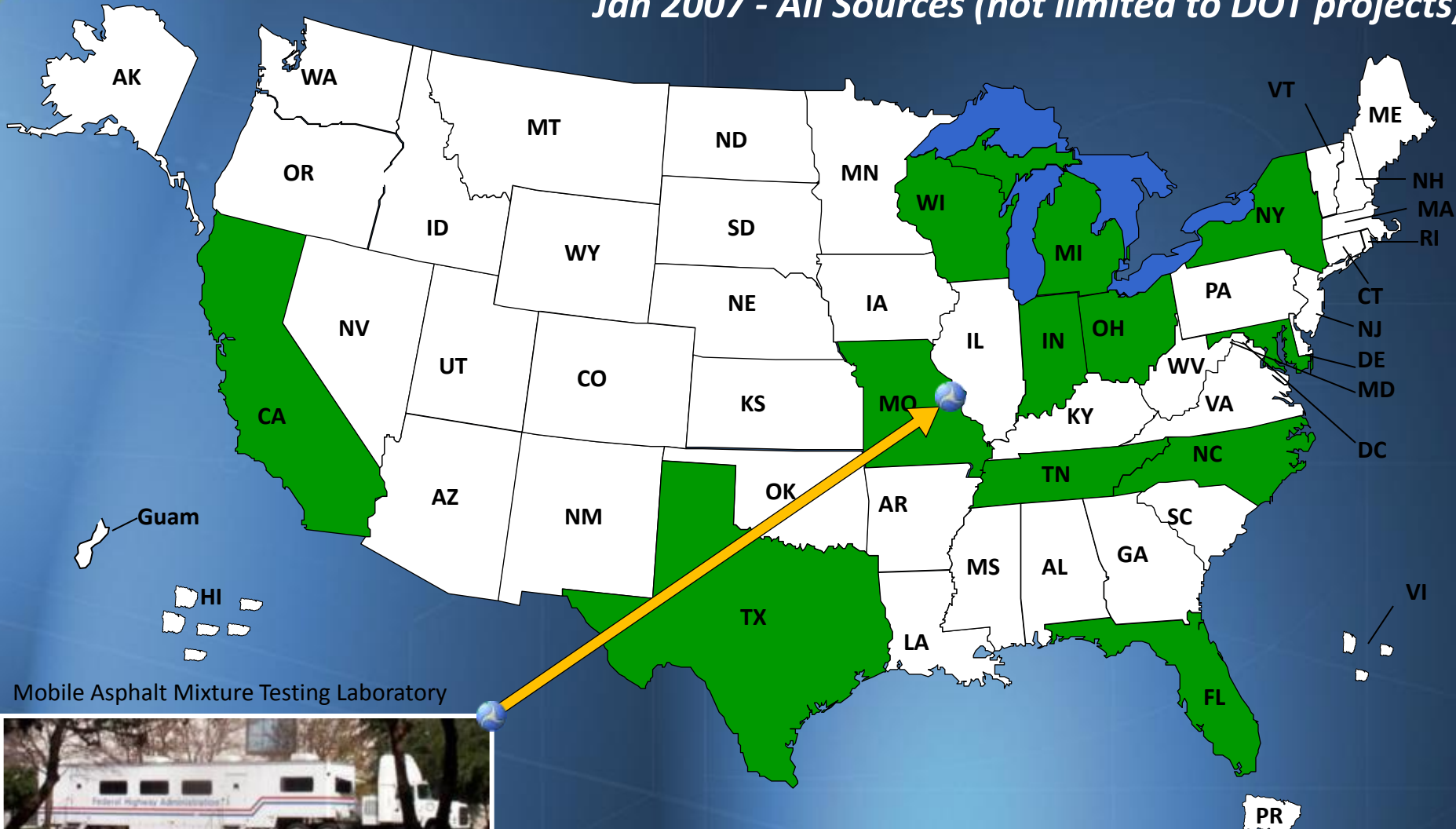
Photo: Maine DOT WMA Demo...





# WMA Trials & Demonstration *Projects*

Jan 2007 - All Sources (not limited to DOT projects)





# WMA Trials & Demonstration *Projects*

*Jan 2010 - All Sources (not limited to DOT projects)*

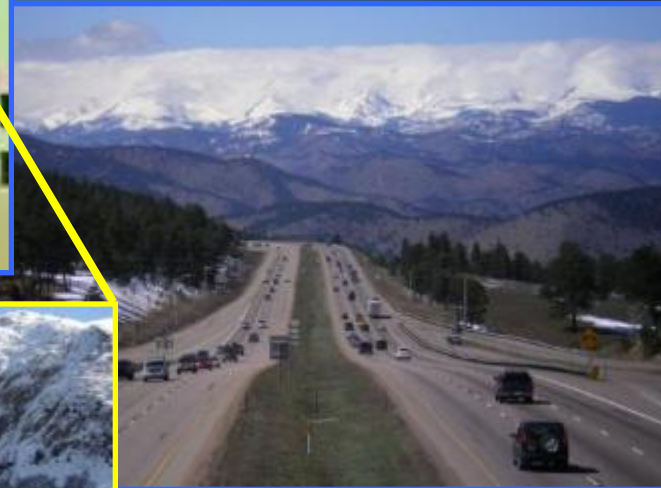


Mobile Asphalt Mixture Testing Laboratory





# Interstate 70, Dillon, CO





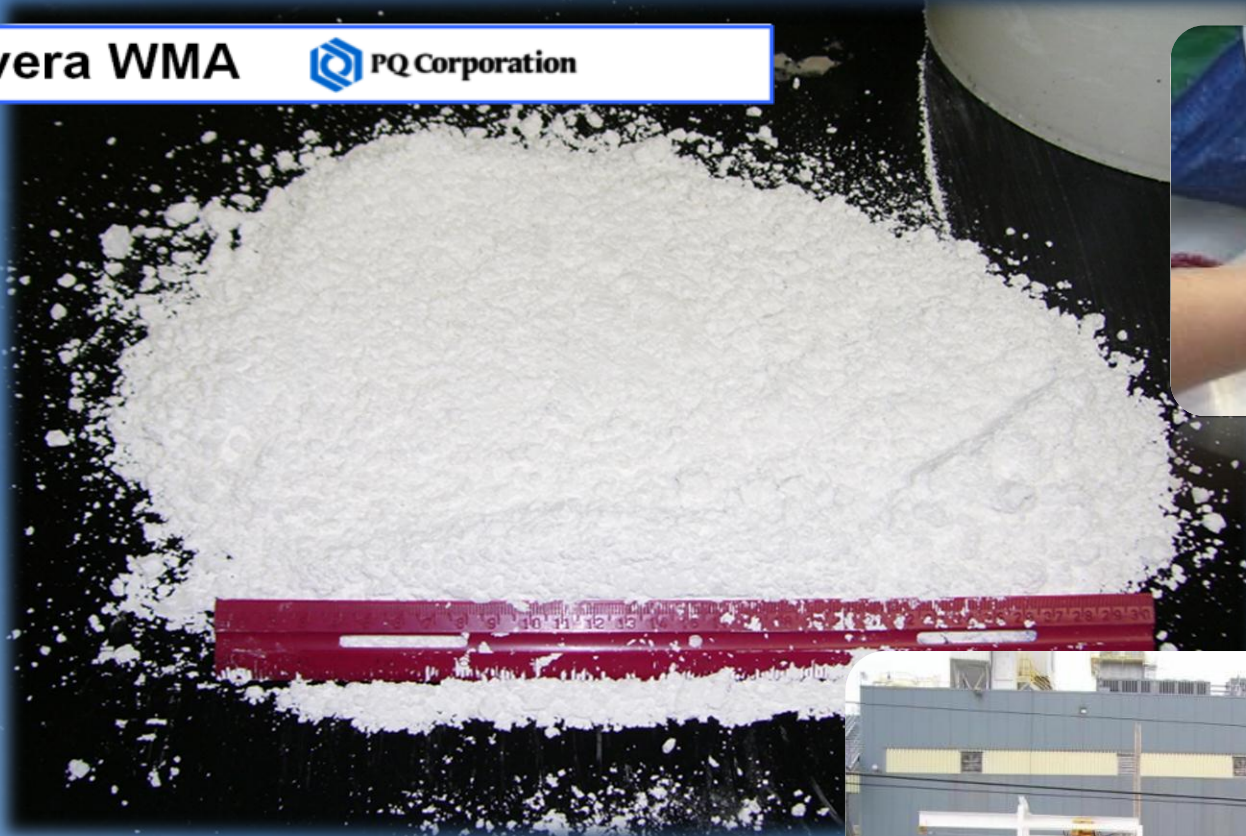
# Interstate 70, Dillon, CO Technologies Used

- Sasobit  (wax)
- Advera  (zeolite)
- Evotherm ET  (emulsion)
- HMA Control Section



# Interstate 70, Dillon, CO Technologies Used

Advera WMA





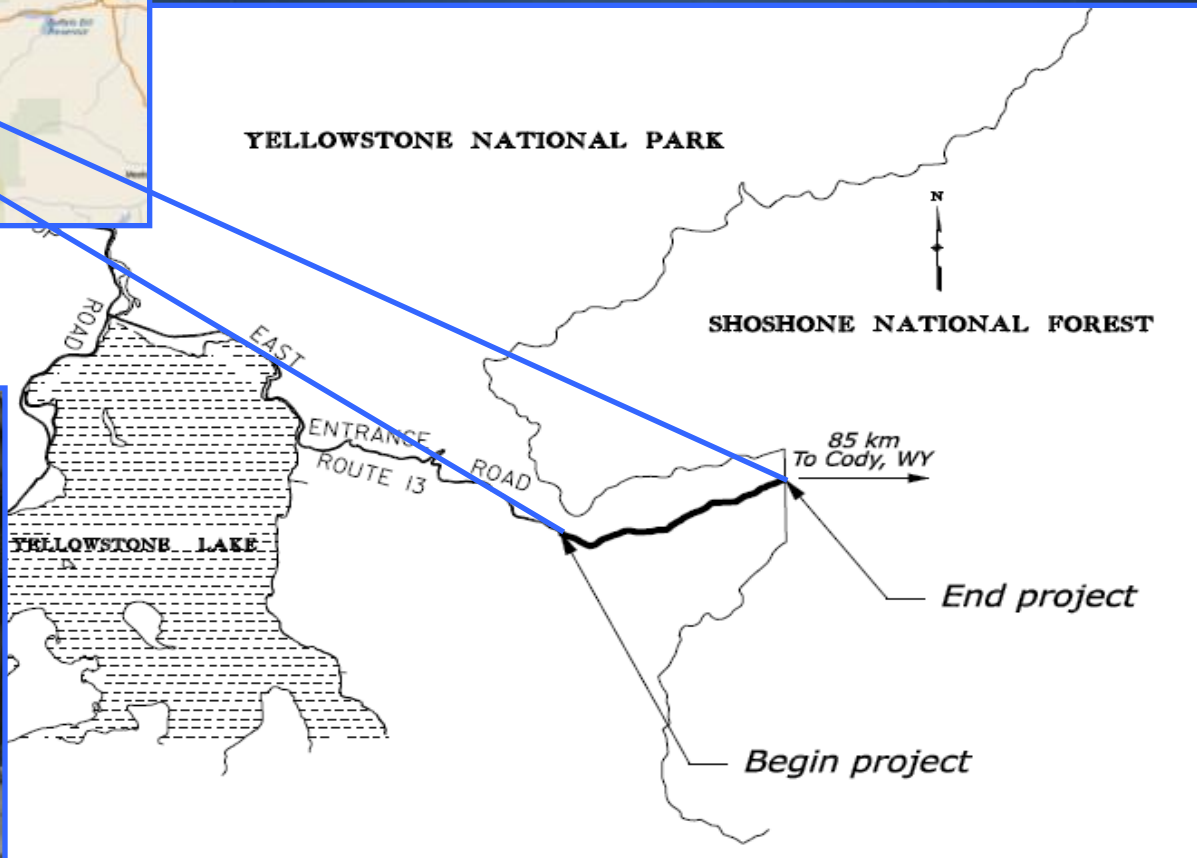
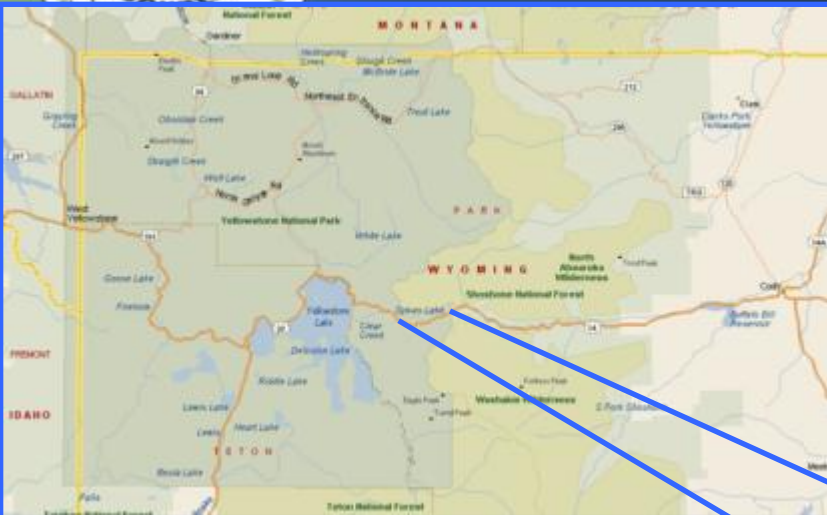


# Interstate 70, Dillon, CO Technologies Used





# East Entrance, Yellowstone, WY





# East Entrance, Yellowstone N.P. Technologies Used

- Sasobit



(wax)

- Advera

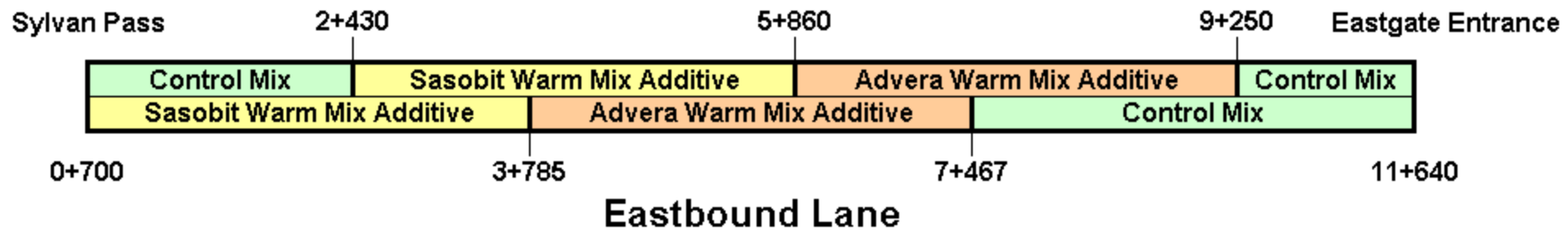
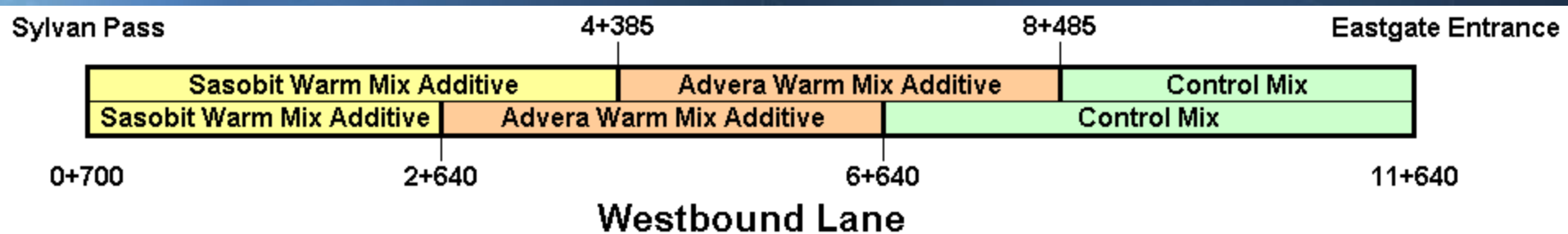


(zeolite)

- HMA Control Section



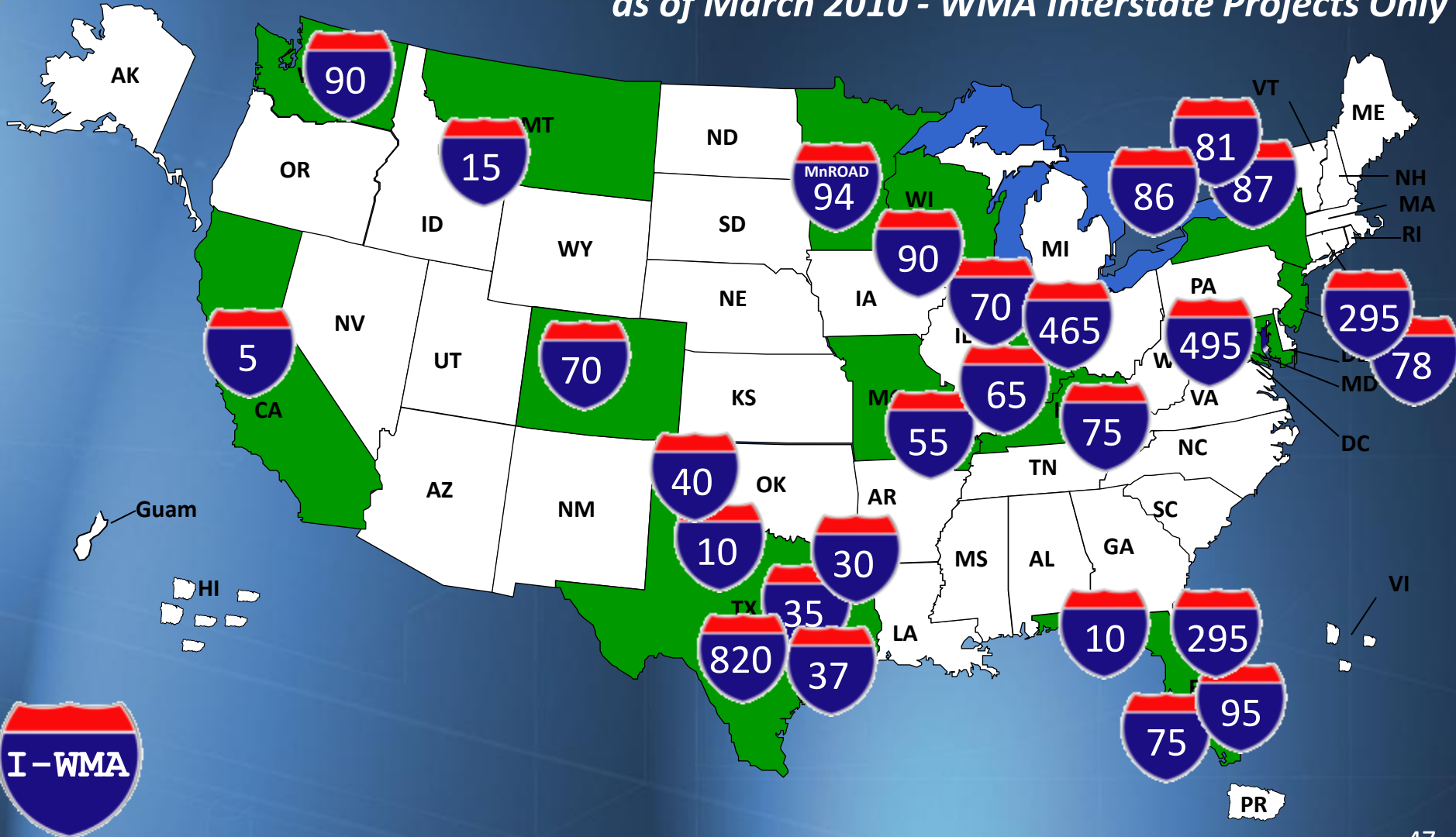
# East Entrance, Yellowstone, WY







# Interstate Highway WMA Usage as of March 2010 - WMA Interstate Projects Only





# Documented WMA Projects

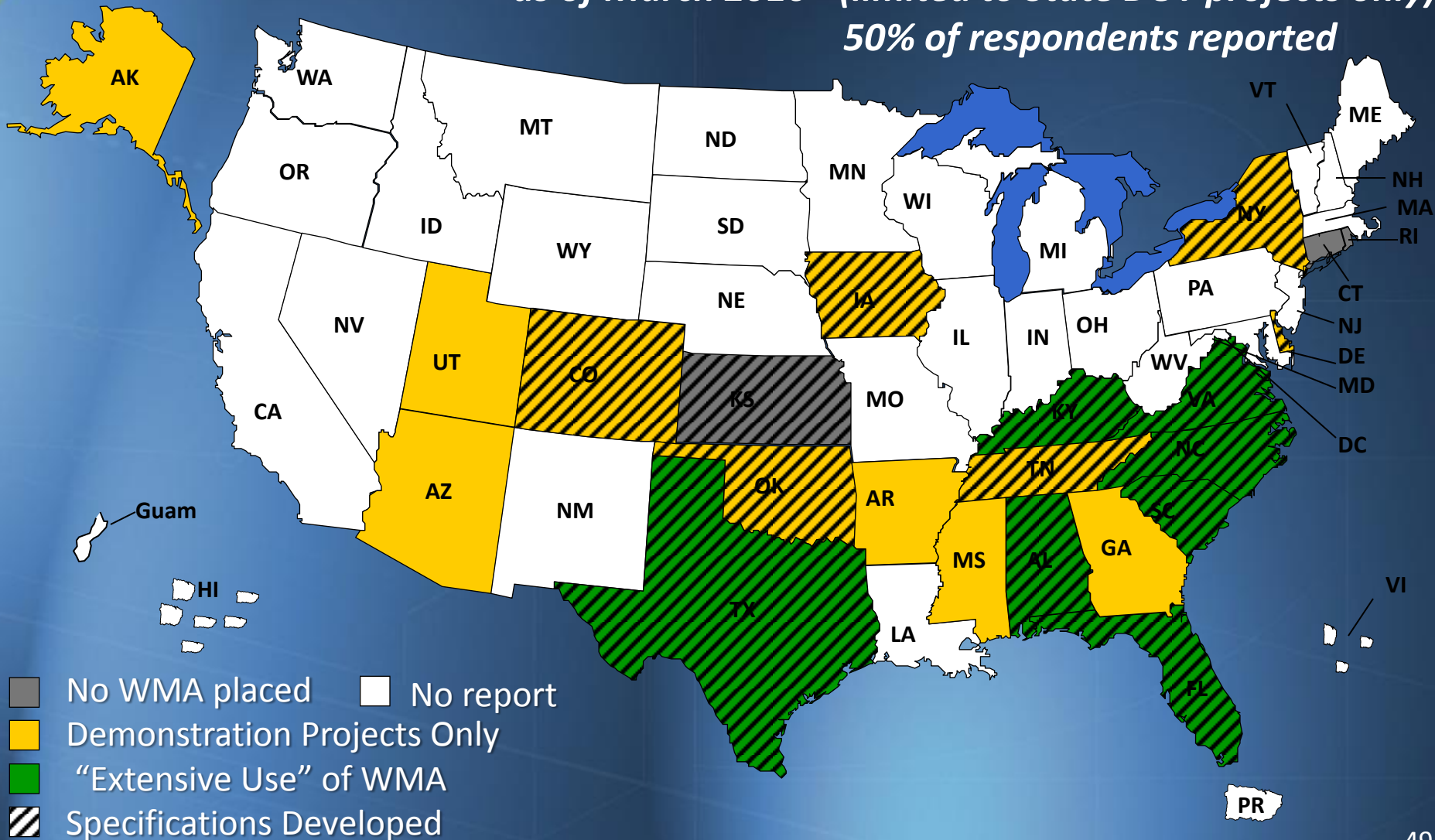
Climatic Region	State (Number of WMA Projects*)	Reported Performance Problems
Dry, No Freeze	CA(2), TX(4)	No performance problems reported
Dry, Freeze	CO(3), NV(2), WA(1), WY(2)	No performance problems reported
Wet, No Freeze	AL (3), AR(1), CA(8), FL(3), GA(1), MS(2), NC(2), SC(3), TN(1), TX(10), VA(2), WA(6)	Nashville, TN HMA and at least one WMA may be showing signs of moisture damage.
Wet, Freeze	AK (3), IL(1), IN(1), MD(3), MA(1), MI(1), MN(1), MO(5), NE(1), NY(46), OH(4), PA(3), TN(8), VT(1), VA(1), WI(6)	Kimbolton, OH sections are raveling, which may be a sign of moisture damage. No other problems reported



# DOT WMA *Projects & Specifications*

*as of March 2010 - (limited to State DOT projects only)*

*50% of respondents reported*







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# WARM MIX ASPHALT - FLORIDA DOT “IMPLEMENTATION IN PRACTICE”



# Florida's path to implementation....

- WMA Trial Projects

Year	Highway Class	WMA Technology	Comments
2006	Turnpike	Aspha-min	Control HMA Section, OGFC
2007	Major Arterial	Evotherm DAT	Control HMA Section
2007	State Route	Water Injection	Control HMA Section, High RAP
2008	Interstate 10	Water Injection	



# Florida Trial Project Summary

- Two lane road
  - 3 to <math>10^6</math> ESAL's
  - Logging traffic
- 4.9 miles of control HMA/high RAP
- 9.6 miles of WMA/high RAP
- Superpave -12.5 fine mix
  - PG58-28
  - 45% fractionated RAP
  - 1.5" structural layer



# *Water injection WMA Process*



First large production of Water-Injection WMA (besides trials)  
Design called for up to 45% RAP  
QC manager indicated between 40%-45% RAP used



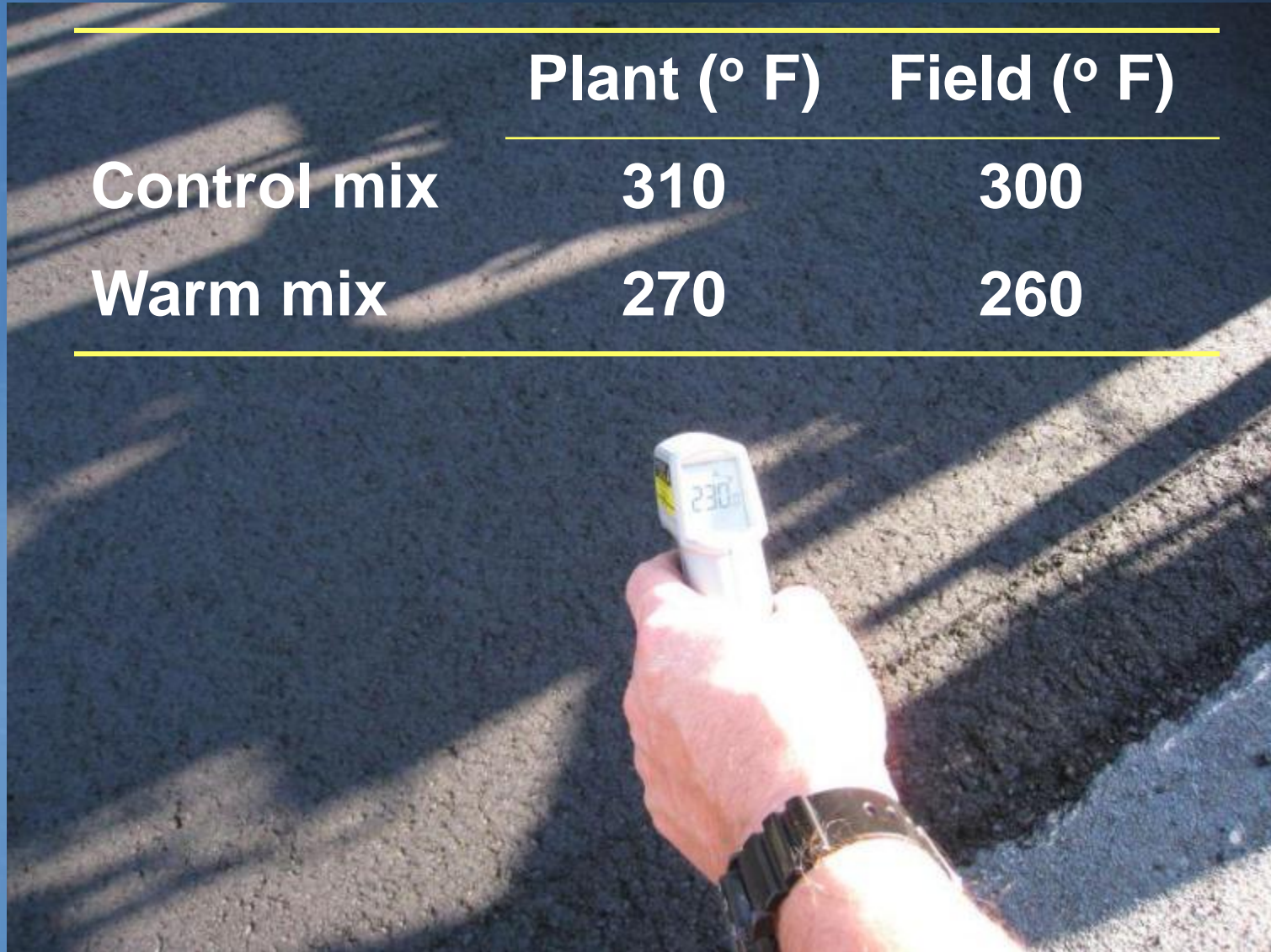
Water added at  
2% by weight of  
binder.





# Temperature Targets

	Plant (° F)	Field (° F)
Control mix	310	300
Warm mix	270	260





# *Were challenges encountered?*

- State Material Office results:
  - Original binder (PG64-22) did not meet viscosity requirements
  - WMA mix had high AC content & low air voids
  - Tensile Strength Ratio (TSR) results were low
    - HMA control – 61%
    - WMA – 58%
- Overcoming challenges:
  - Specified softer binder (PG 58-28)
  - Performed performance testing for rutting
    - HMA control - 4.1 mm
    - WMA - 2.7 mm





# Florida QC Test Results



- Average for project
- Gradation good for both mixtures.
- AC slightly high (0.2%) for warm mix and slightly low (0.3%) for control mix.
- Air voids: 3.0 for warm mix, 3.9 for control mix
- Density: 93.7% for warm and control mixes.







# What did we learn?

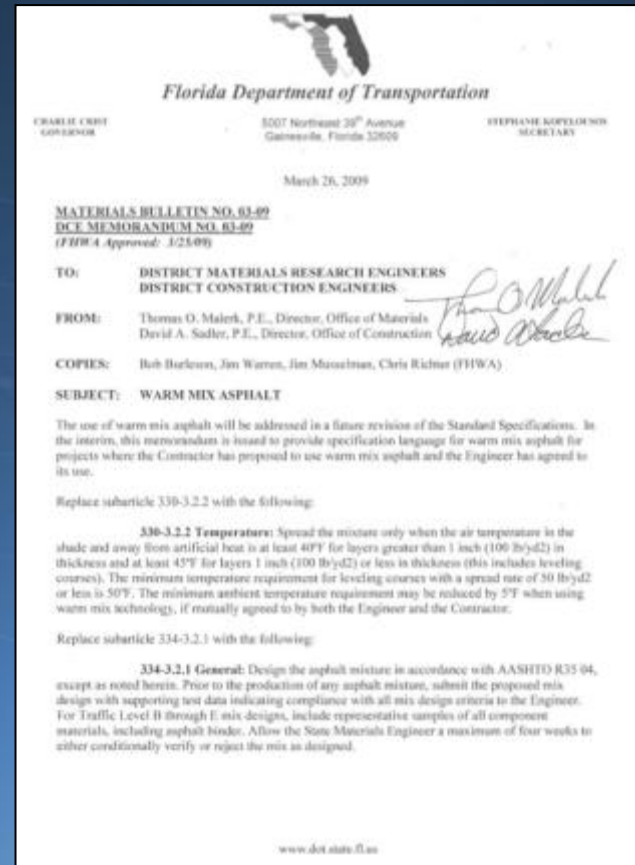
- Best Practices Learned
  - Stockpile management
  - Plant processing
  - Warm-mix technologies may facilitate high RAP
  - Avoid production of mixtures at various temperatures (i.e. warm mix versus hot mix)
- Workability was similar to normal mix
  - Workers reported it handled just like normal mix.
- *"There have been no construction or performance problems noted to date."*
  - *Jim Musselman, FDOT Materials Engineer*



# Continuing on the path to implementation....



- Issued interim memo in 2009 to allow WMA.



<http://www.dot.state.fl.us/statematerialsoffice/administration/resources/library/materialsbulletins/topics/2009/mb03-09.pdf>



# The path to implementation.

- Changed Standard Specifications - January 2010

*Warm mix technologies (additives, foaming techniques, etc.) listed on the Department's website may be used in the production of the mix.*

<http://www.dot.state.fl.us/Specificationsoffice/implemented/URLinSpecs/files/WarmMixAsphalt.pdf>

- Approved products/process list
- Requirements (all 3 must be met):
  1. Be a recognized process with successful project(s) constructed nationally or internationally.
  2. Partner with a contractor and FDOT District Office and construct a demonstration section on a FDOT project.
  3. Meet all FDOT construction specifications during construction of the demonstration section.



# Where is FL now?



- 400,000 tons of WMA has been placed in Florida
- About 95% of that was placed between 2009 – 2010.





# National Research Initiatives

- NCHRP 9-43 “*Mix Design Practices for Warm Mix Asphalt*” \$500,000
- NCHRP 9-47A “*Engineering Properties, Emissions, and Field Performance*” \$900,000
- NCHRP 9-49 “*Long Term Field Performance of Warm Mix Asphalt Technologies*”
  - Phase I, Moisture Susceptibility - \$450,000
  - Phase II, Long-Term Performance - \$900,000





# National Research Initiatives

- NCHRP 9-43 *“Mix Design Practices for Warm Mix Asphalt”* \$500,000
- Deployment Products:
  - WMA specific mix design procedures  
“Special Mixture Design Considerations and Methods for Warm Mix Asphalt (WMA) “
  - Proposed Appendix to AASHTO R 35 “Superpave Volumetric Design for Hot Mix Asphalt (HMA)”
  - Commentary on R 35 Appendix recommendations
  - Half day training module



# National Research Initiatives

- NCHRP 9-47A *“Engineering Properties, Emissions, and Field Performance”* \$900,000
- First comprehensive independent benchmarking of emission reductions and fuel savings
  - Utilizing U.S. standardized testing protocols
- Benchmarking short term field performance of existing WMA construction projects.





# Resources

## WMA





# Available Resources

1. Every Day Counts Website & Sharepoint Site (internal)
2. Division Office Pavement & Materials Engineer
3. WMA Core Team



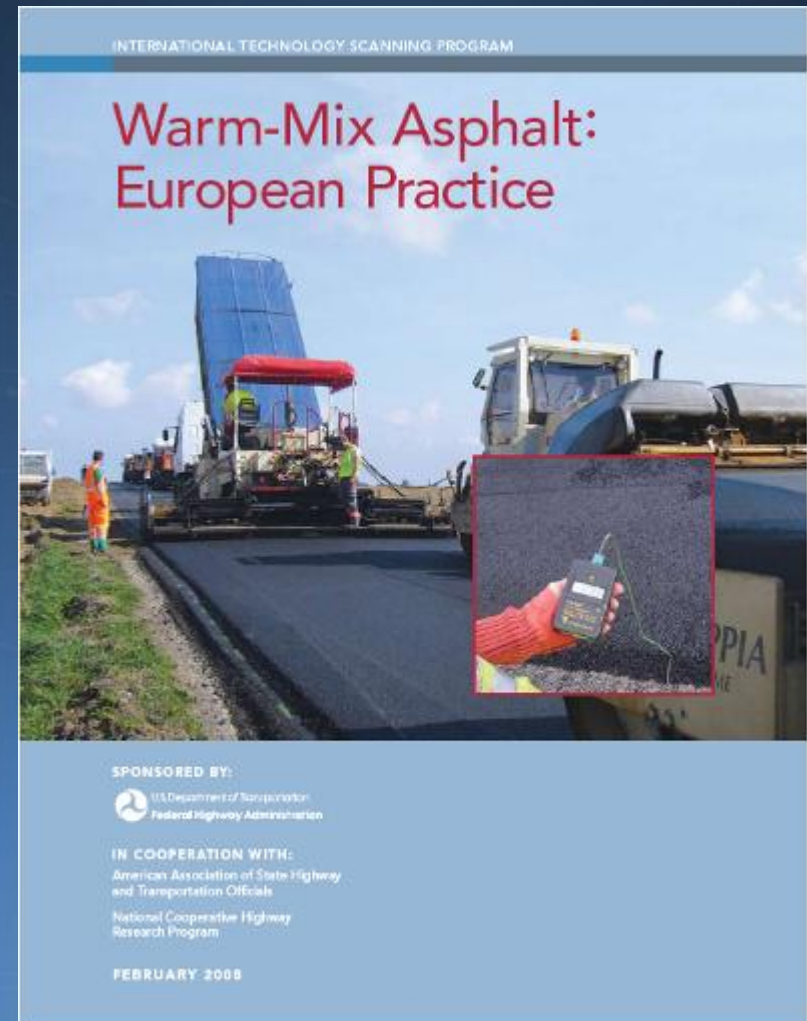
# <http://www.fhwa.dot.gov/everydaycounts>

The screenshot shows a Windows Internet Explorer browser window displaying the homepage of the Every Day Counts initiative. The browser's address bar shows the URL <http://www.fhwa.dot.gov/everydaycounts/>. The website header includes the FHWA logo and navigation links: [Home](#), [About EDC](#), [Shortening Project Delivery](#), [Accelerating Technology](#), [Contact Us](#), and [EDC Forum](#). The main content area features a large image of a road construction site with a paving machine. To the right of the image is the text: "The Every Day Counts Initiative" followed by a paragraph: "EDC is designed to identify and deploy innovation aimed at shortening project delivery, enhancing the safety of our roadways, and protecting the environment." Below this is a section titled "Warm-Mix Asphalt" with a sub-paragraph: "Warm Mix Asphalt technologies create benefits such as of reduced emissions, easier compaction, and improved working conditions." and a "Read More >>" link. The footer contains three columns: "Shortening Project Delivery" with a description and a list of methods (Design-build, Construction Manager/General Contractor, Shortening Project Delivery Toolkit); "Accelerating Technology/Innovation" with a description and a list of technologies (Adaptive Signal Control, Geosynthetic Reinforced Soil Integrated Bridge System, Prefabricated Bridge); and "EDC Innovation Box" with a description and a "Download Brochure" link. The browser's status bar at the bottom shows "Done", "Trusted sites", and "100%" zoom.



# WMA International Scan Tour

- Joint Program w/  
FHWA, AASHTO,  
NCHRP and Industry
- Publication  
FHWA-PL-08-007
- Scan Final Report  
– .pdf available at  
<http://international.fhwa.dot.gov/pubs/pl08007/index.cfm>





# AASHTO Guide Specification for Highway Construction 2008

## DIVISION 400 FLEXIBLE PAVEMENTS

### SECTION 401 HOT MIX ASPHALT (HMA) PAVEMENTS

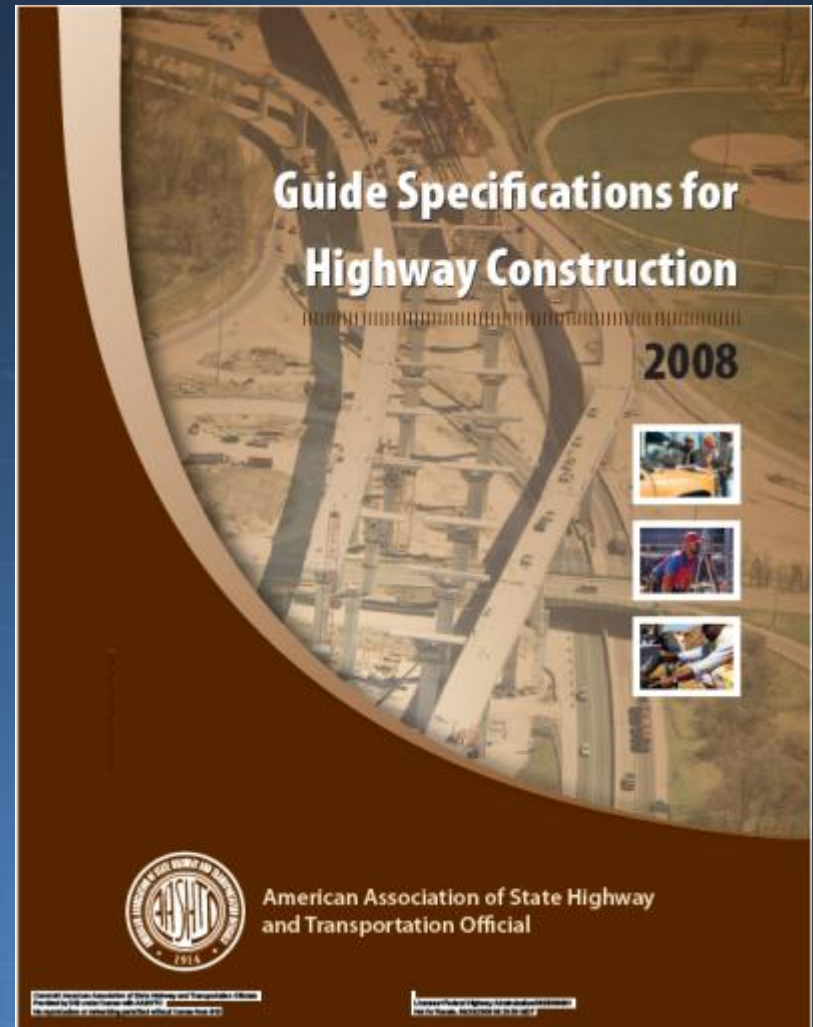
401.01 Description

401.02 Material

401.03 Construction

401.04 Measurement

401.05 Payment





# Warm Mix Asphalt (WMA) Guide Specification for Highway Construction

## DIVISION 400 - Asphalt Pavements and Surface Treatments

### SECTION 4XX - WARM MIX ASPHALT (WMA) PAVEMENTS

#### 4XX.01 Description

#### 4XX.02 Material

#### 4XX.03 Construction

#### 4XX.04 Measurement

#### 4XX.05 Payment

### Warm Mix Asphalt (WMA) Guide Specification for Highway Construction

#### Division 400 - Asphalt Pavements and Surface Treatments

##### SECTION 4XX - WARM MIX ASPHALT (WMA) PAVEMENT

Warm mix asphalt (WMA) is the generic term used to describe the reduction in production, paving, and compaction temperatures achieved through the application of one of several WMA technologies.

Some modifications to HMA plants may be necessary to accommodate the WMA technologies as noted in Section 4XX.03 Construction.

Production and paving temperatures may need to be increased for higher reclaimed asphalt pavement (RAP) content, increased haul distances, decreased ambient temperatures, or other WMA project specific conditions.

All provisions for the production and placement of conventional HMA mixtures as stipulated in [applicable agency specification] are in force except as noted below.

##### 4XX.01 Description

Construct one or more courses of plant produced warm mix asphalt (WMA) pavement on a prepared foundation, using virgin aggregate or a combination of virgin and/or reclaimed aggregate material (RAM) and prescribed manufactured WMA additives and/or WMA plant process modifications. Use of RAP materials, consisting of cold milled, crushed, or processed bituminous asphalt mixture, and reclaimed asphalt shingles (RAS) are permitted at the current [agency specific] percentages, provided that the mixture meets all the requirements of these specifications.

##### 4XX.02 Material

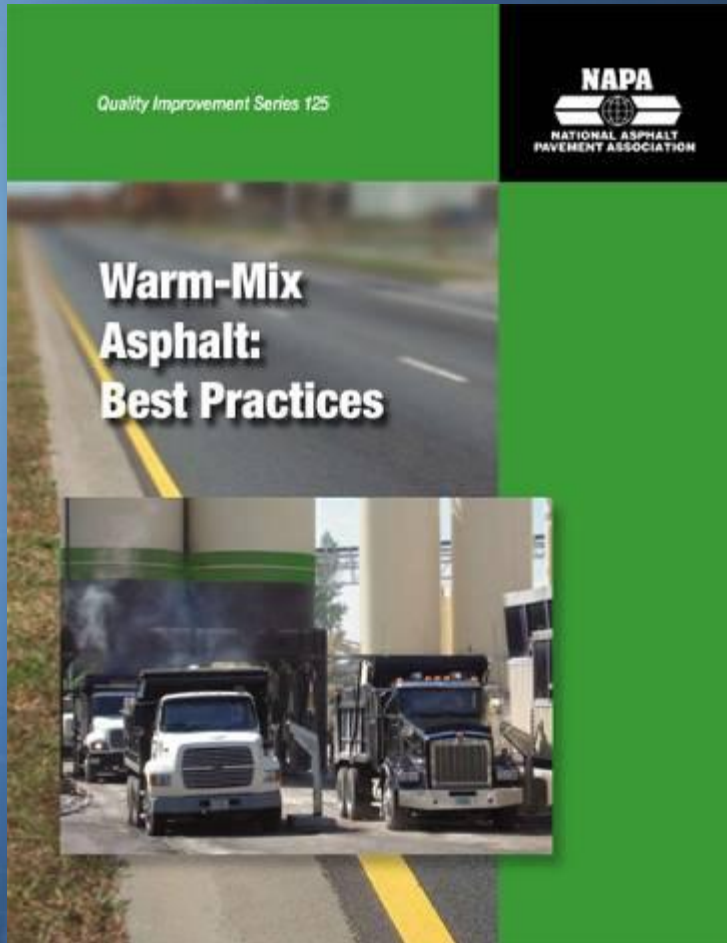
WMA may be produced by one or a combination of several technologies involving HMA plant foaming processes and equipment, mineral additives, or chemicals that allow the reduction of mix production temperatures to within 185°F to 275°F. (Note: The upper temperature range is appropriate for modified asphalt binders and WMA mixtures which include higher percentages of reclaimed asphalt pavement.)

Provide materials as specified in:

Aggregate	Subsection XXXX
Liquid Antistrips	Subsection XXXX
Asphalt Binder	Subsection XXXX
HMA Additives	Subsection XXXX
Lime for Asphalt Mixtures	Subsection XXXX
Mineral Filler	Subsection XXXX
Reclaimed Asphalt Pavement	Subsection XXXX
Reclaimed Aggregate Material	Subsection XXXX
Reclaimed Asphalt Shingles	Subsection XXXX



# Warm-Mix Asphalt: Best Practices



- Stockpile Moisture Management
- Burner Adjustments and Efficiency
- Aggregate Drying and Baghouse Temperatures
- Drum Slope and Flighting
- Combustion Air
- RAP usage
- *Placement Changes*

The following **references** detail specifics related to **plant modifications and operational changes** in order to **maximize the benefits of WMA** production:

- Quality Improvement Series 125 (QIP 125),  
*“Warm Mix Asphalt: Best Practices”*
- Quality Improvement Series 126 (QIP 126),  
*“Energy Conservation in Hot Mix Asphalt Production”*
- Environmental Council 101 (EC-101),  
*“Best Management Practices to Minimize Emissions During HMA Construction”*
- *“The Fundamentals of the Maintenance System in Asphalt Facility”* (IS-52)





# Memorable Message

- **I.C. = I.P.**  
Improved Compaction = Improved Performance
- **F.E.W. key benefits**
  - Fuel
  - Emissions
  - Worker Comfort



