U.S. Department of Transportation
Federal Highway Administration

Office of Pavement Technology
Asphalt Pavement Program

Long-Life Asphalt Pavements for the 21st Century

Warm Mix Asphalt Projects & Specifications

North Central Asphalt User/Producer Group
NCAUPG

2009 NCAUPG Conference
February 5, 2009
Madison, WI

warmmixasphalt.com

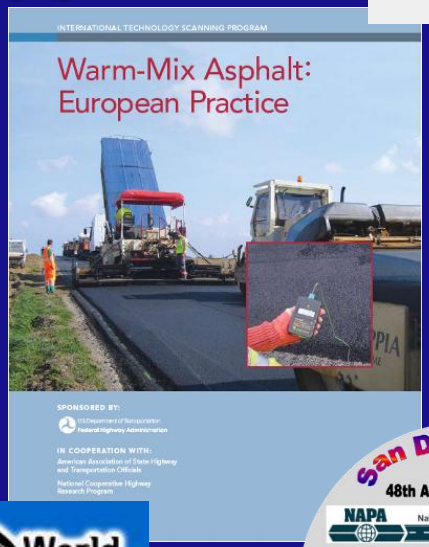
U.S. Department of Transportation
Federal Highway Administration

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 U.S., WMA pavements must have equal or better performance when compared to traditional HMA pavements

Brief U.S. History

- NAPA European Scan 2002
  - Germany and Norway
- NAPA Annual Meeting 2003
  - San Diego
- World of Asphalt 2004
  - Nashville
- WMA TWG 2005
- FHWA International Scan 2007
- International WMA Conference 2008



WMA European 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

U.S. Department of Transportation
Federal Highway Administration

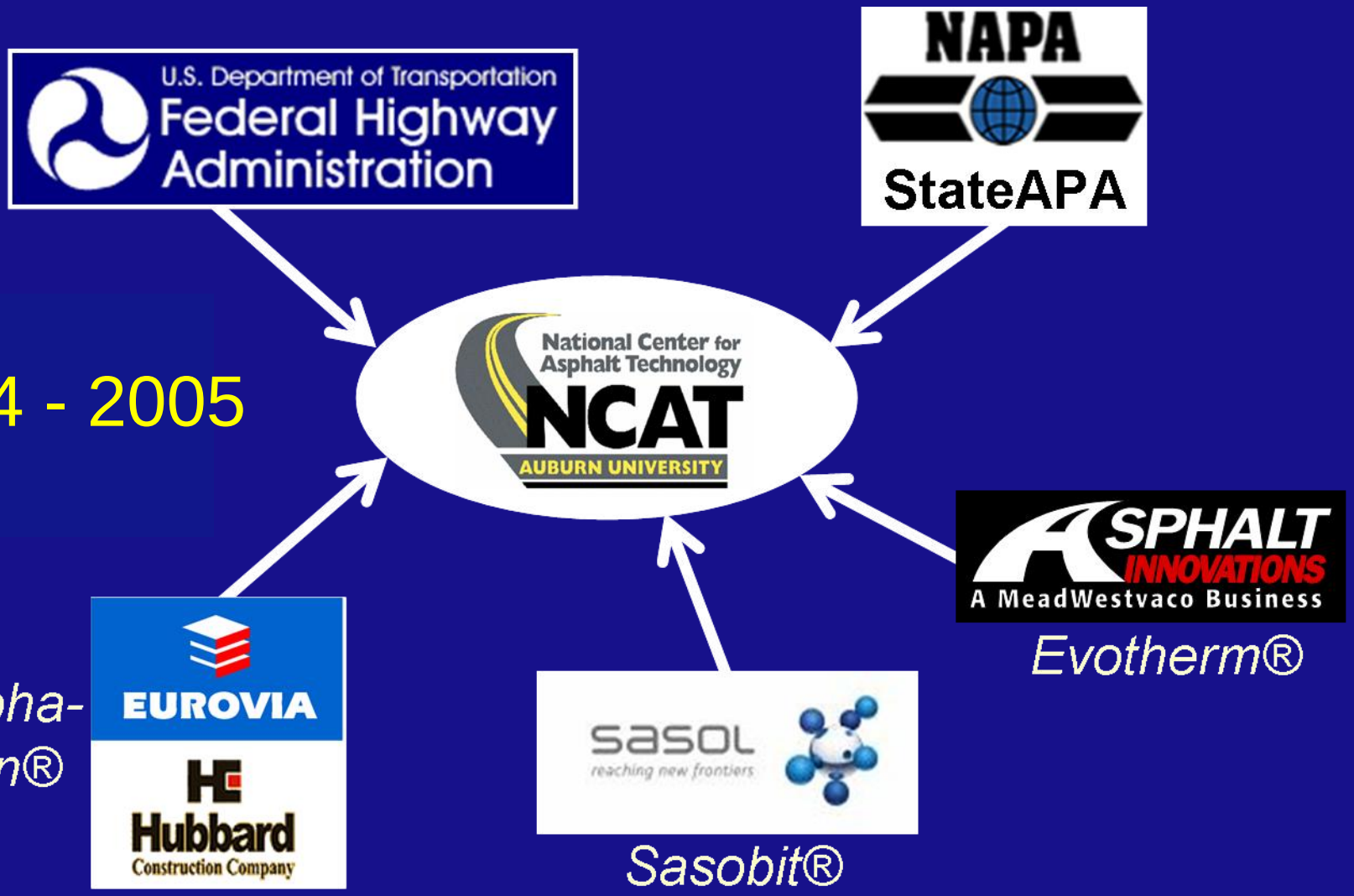
International WMA Conference

- NAPA, FHWA & AASHTO sponsored
- November 11-13, 2008 in Nashville, TN
- Features:
  - Processes
  - Mix Production & Placement
  - Energy consumption
  - Mix Design
  - Material Properties
  - Environmental Performance
  - Engineering
  - State of the Practice
  - Future Direction

warmmixasphalt.com

5

Initial U.S. Research Partners



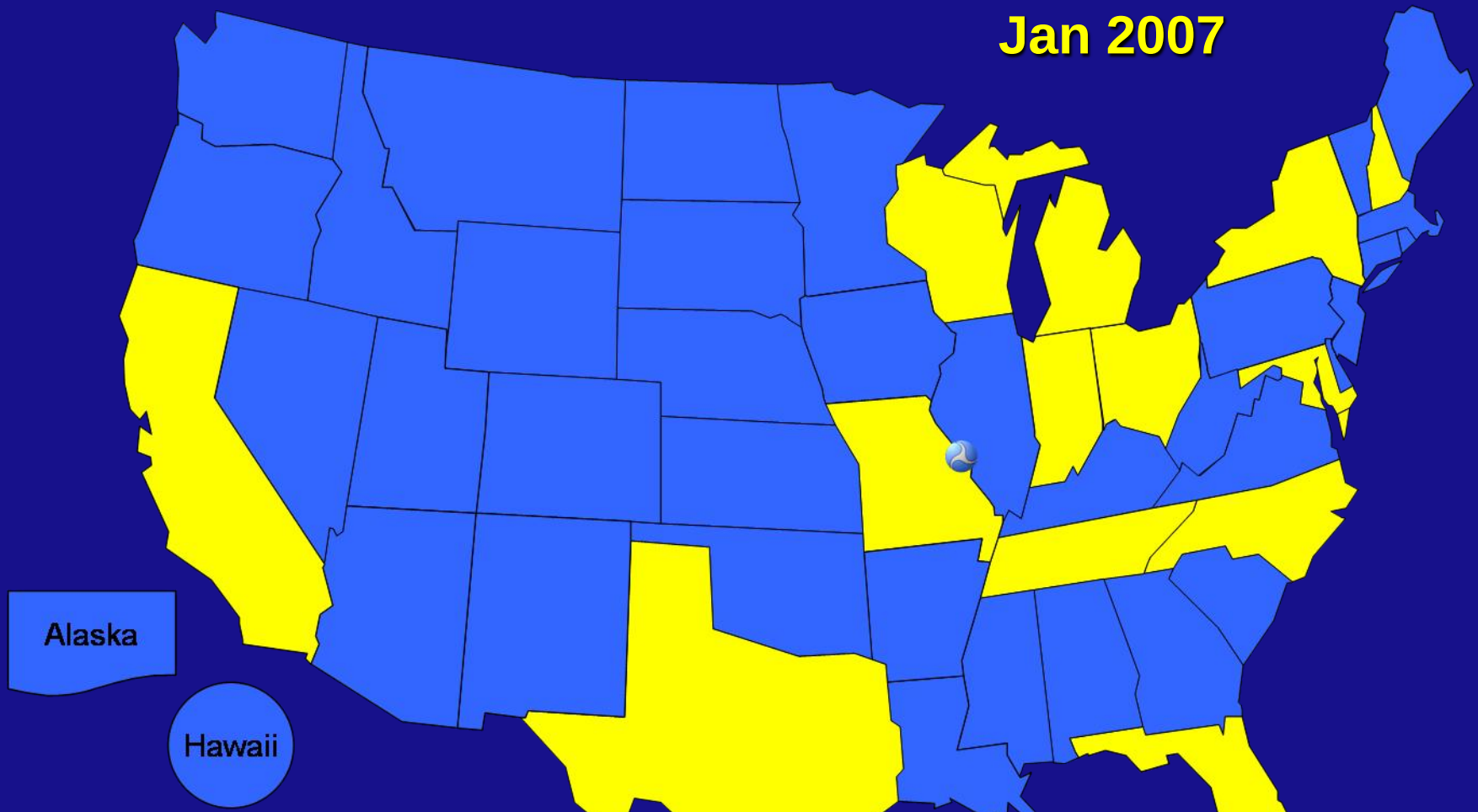
Technology Overview**

- WAM-Foam
- Low Emission Asphalt
- Aspha-Min
- Advera
- Sasobit
- REVIX
- Evotherm
- Cecabase RT
- Rediset WMX
- Ultrafoam GX
- Terex
- Stansteel
- Aquablack
- Double Barrel Green

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

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

WMA Trials and Demonstrations



U.S. Department of Transportation
Federal Highway Administration

WMA Trials and Demonstrations

Jan 2008

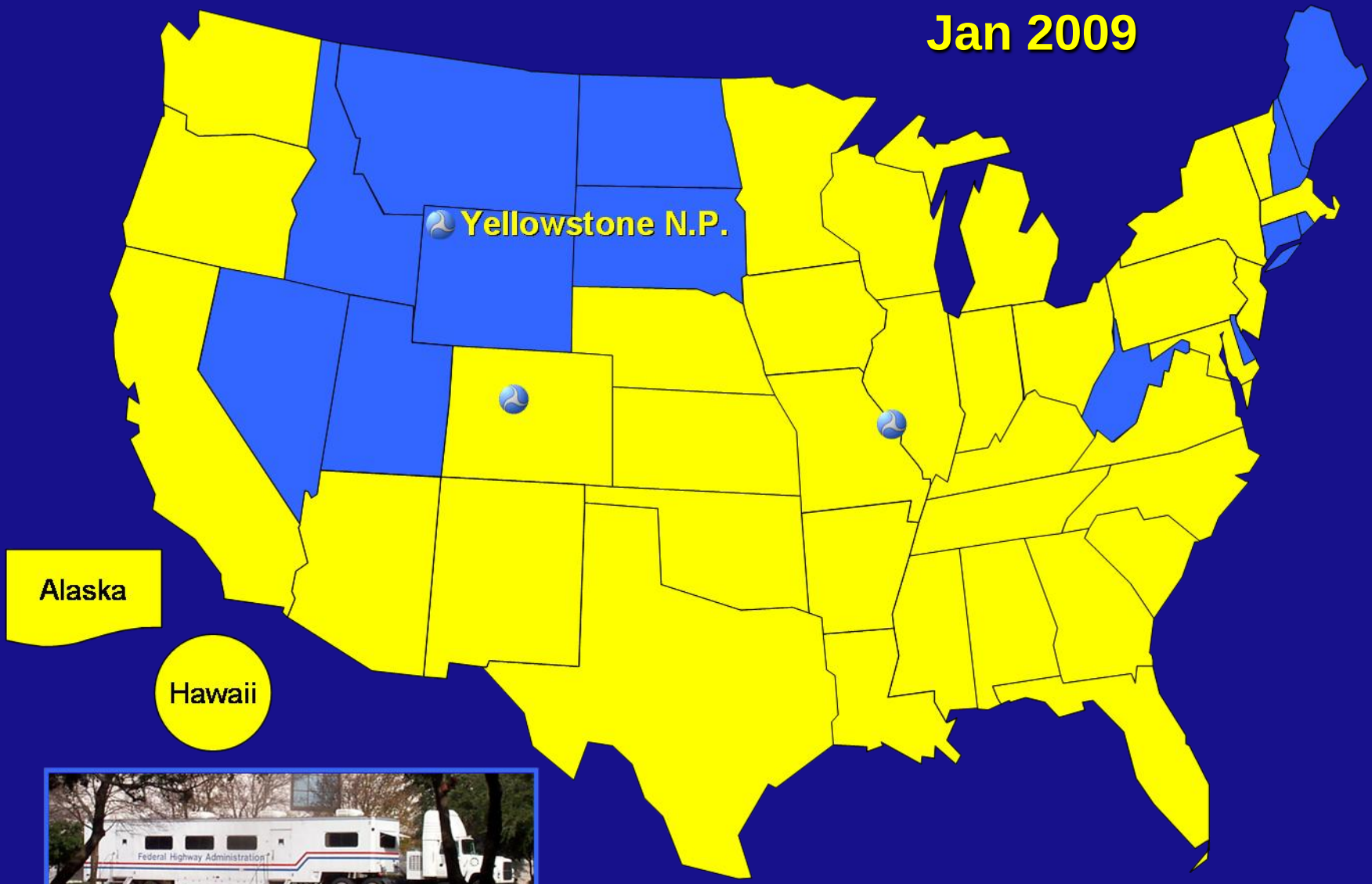
Yellowstone N.P.

Alaska

Hawaii

U.S. Department of Transportation
Federal Highway Administration

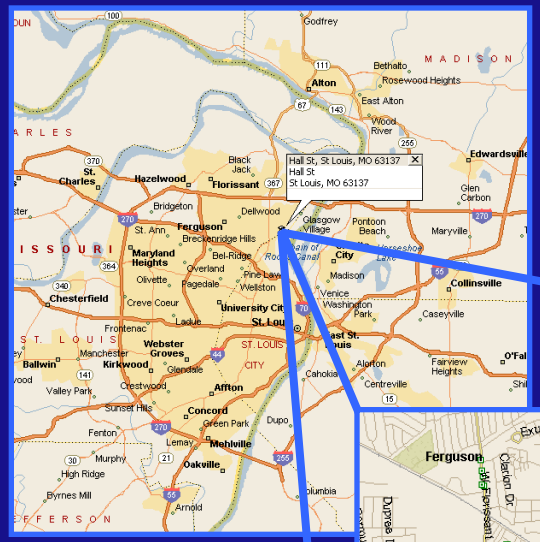
WMA Trials and Demonstrations



U.S. Department of Transportation
Federal Highway Administration

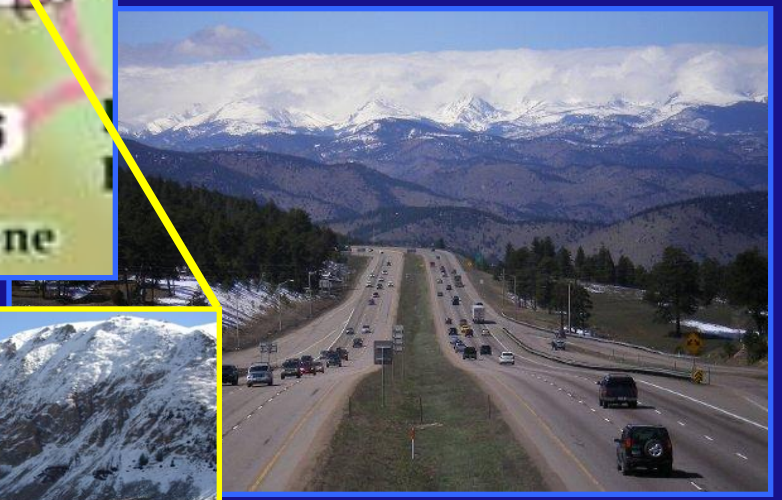
Mobile Asphalt Testing Laboratory (MATL)

Hall Street, St. Louis, MO



U.S. Department of Transportation
Federal Highway Administration

Interstate 70, Dillon, CO

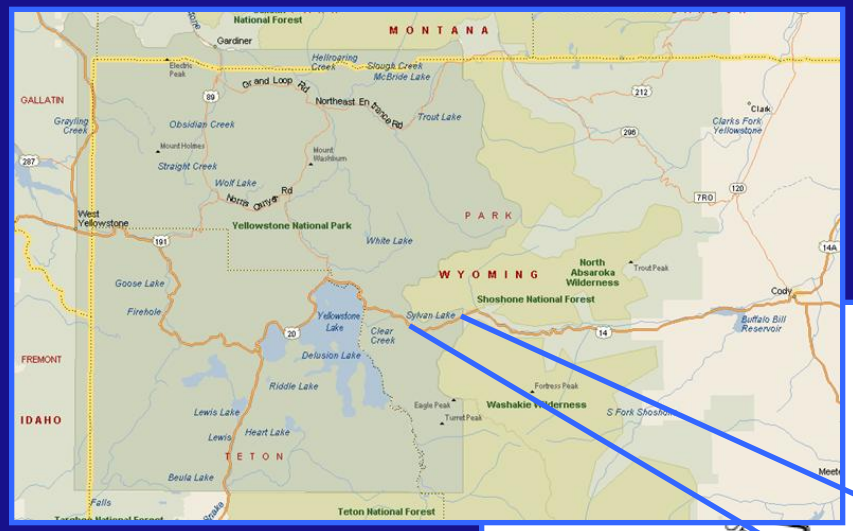


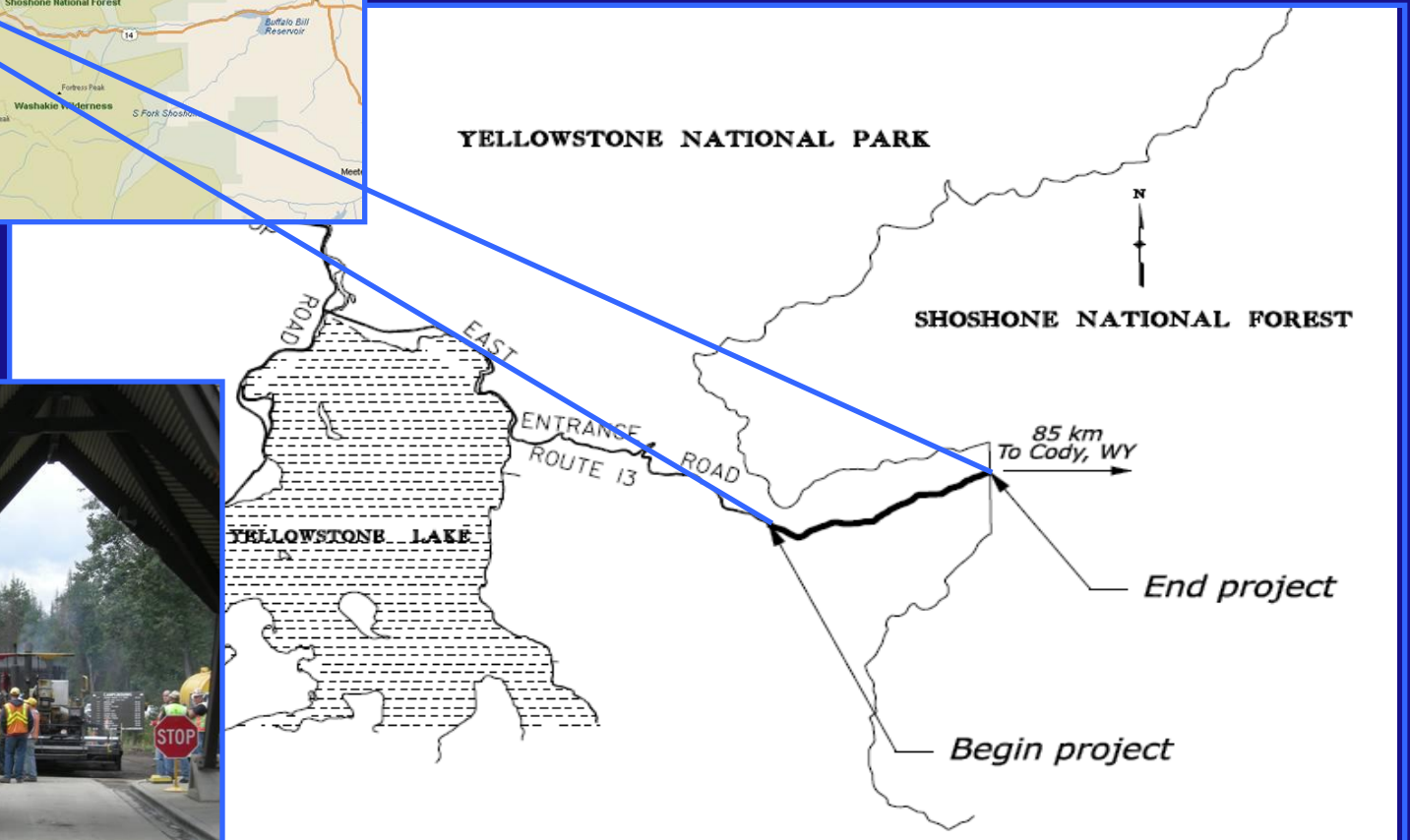
70 miles West of Denver, CO

Elevation 8,800 – 11,100 Feet

U.S. Department of Transportation
Federal Highway Administration

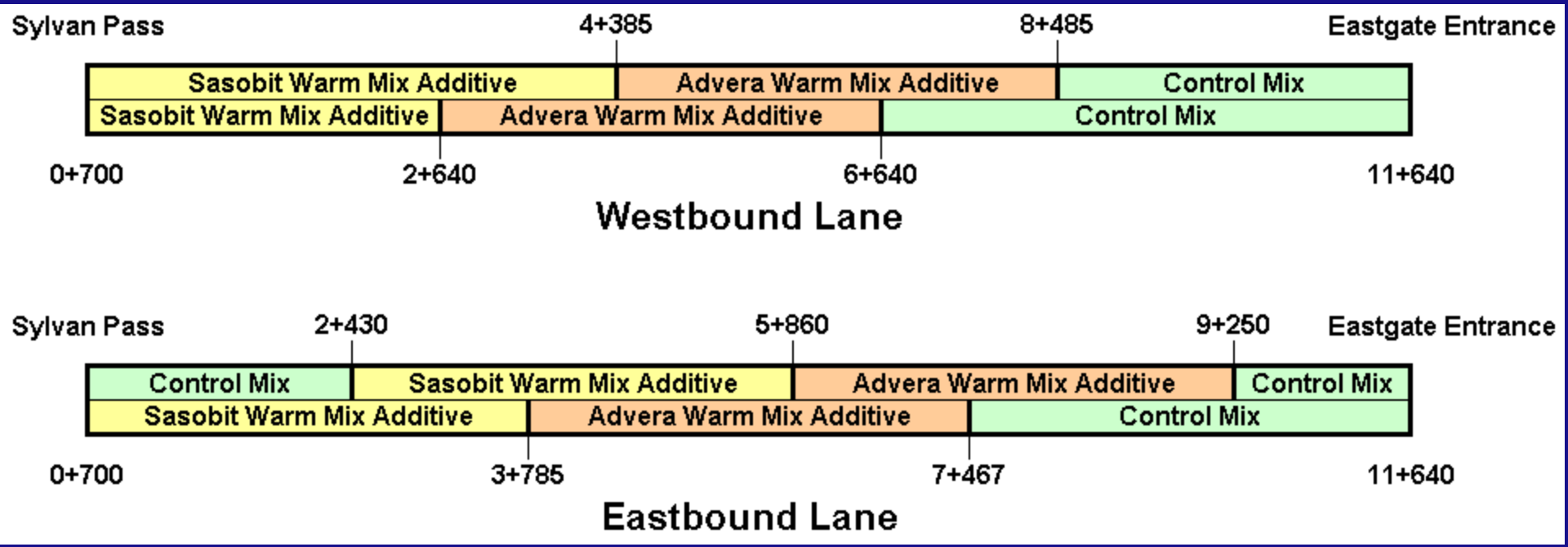
East Entrance, Yellowstone, WY





U.S. Department of Transportation
Federal Highway Administration

East Entrance, Yellowstone, WY



MAMTL Trailer WMA Projects

Warm Mix Asphalt Projects				
Location	**Mix Design**	**Lab Compaction Level , Gyrations**	**Base Binder Grade**	**Technologies**
Hall St., St. Louis, MO	12.5mm Superpave	100	PG 70-22	Aspha-Min Evotherm Sasobit
I-70, Dillon, CO, West of Eisenhower Tunnel	9.5mm Superpave	75	PG 58-28	Advera Evotherm Sasobit
East Entrance Road, Yellowstone National Park, WY	19mm Hveem	75	PG 58-34	Advera Sasobit

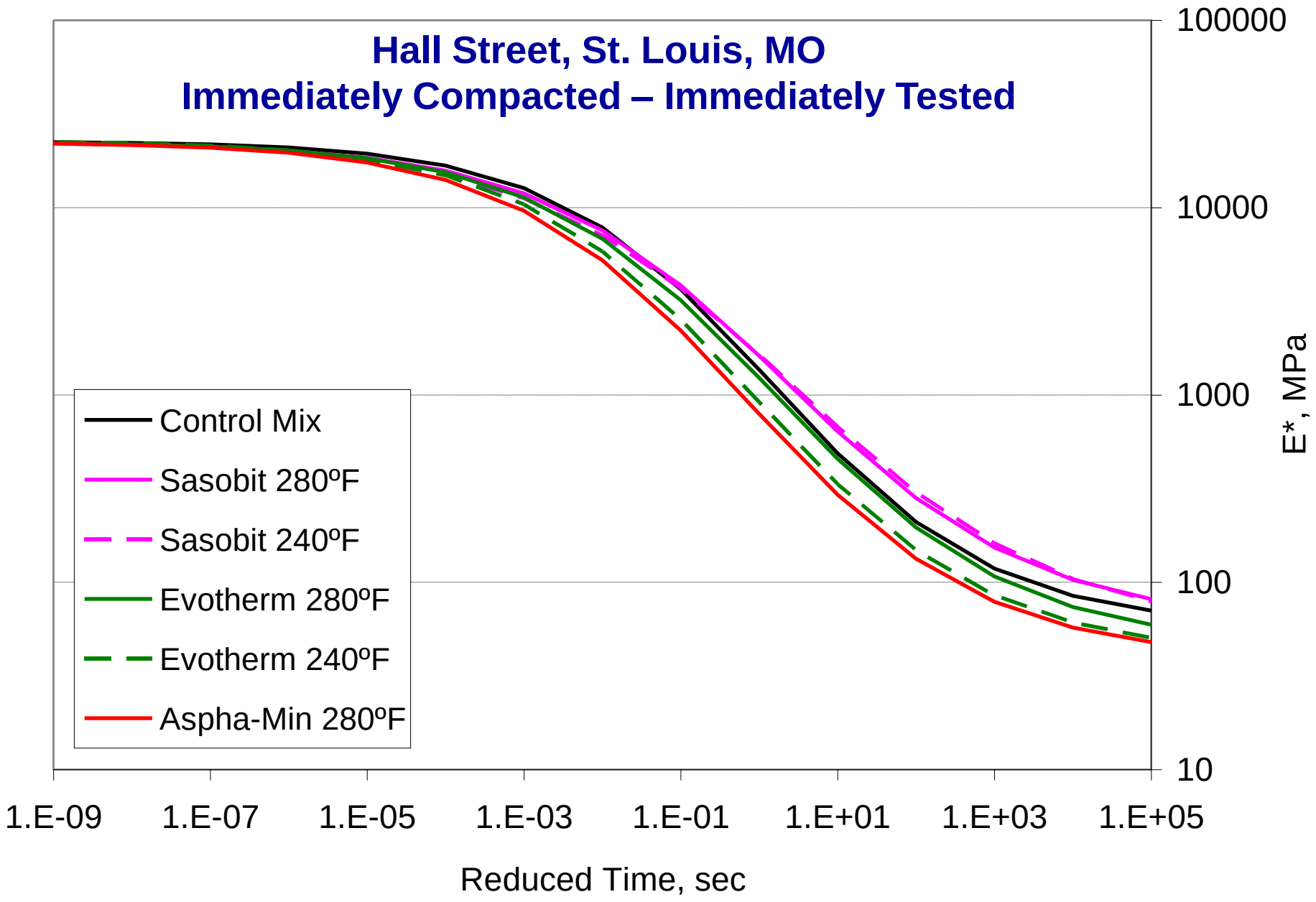
Mobile Asphalt Mixture Testing Laboratory (MAMTL)

Asphalt Mixture Performance Tester

Dynamic Modulus (E*)

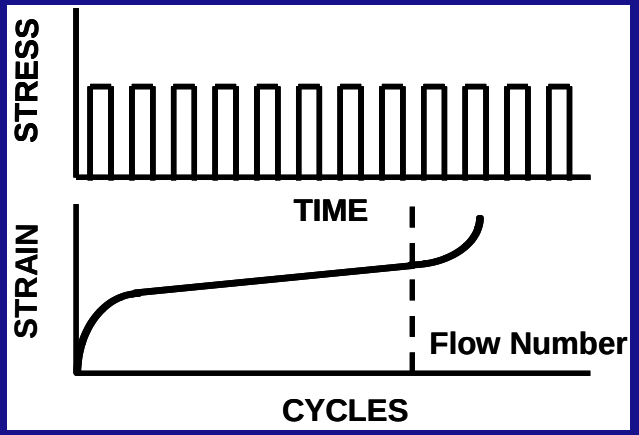
- Test Temperatures
  - **4.4º C** (40º F)
  - **21.1º C** (70º F)
  - **37.8º C** (100º F)
  - **54.4º C** (130º F)
- Frequencies
  - **0.1, 0.5, 1, 5, 10, 25 Hz**

IPC Global
AMPT Device



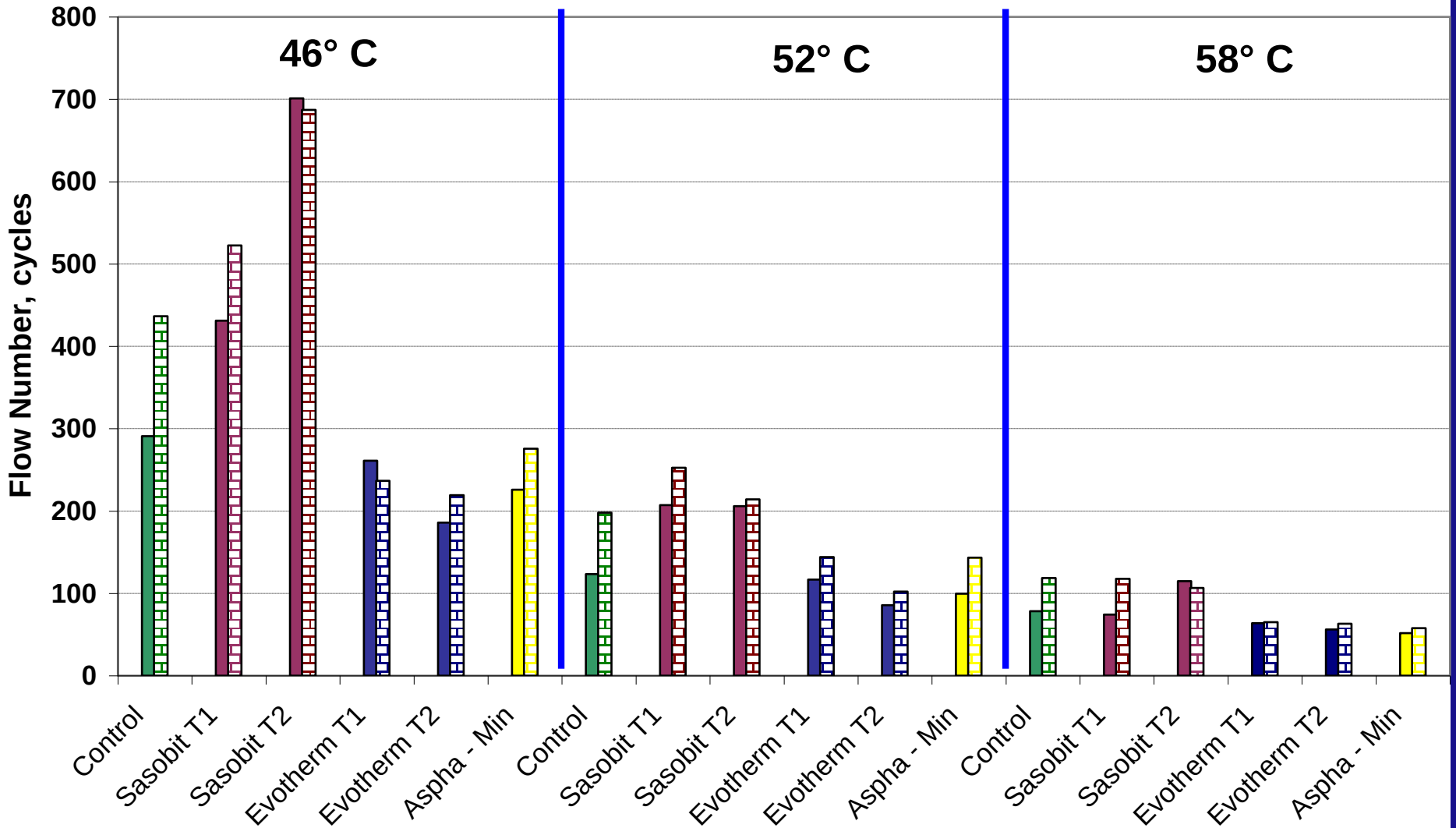
Flow Number, Fn

- Loading
  - Axial load applied for 0.1 second with 0.9 second rest period
- Test Temperatures
  - LTTPBind, Version 3.1 Software
  - Site pavement temperature at 50% Reliability
    - Pavement Temperature
    - Pavement Temperature + 6 C
    - Pavement Temperature - 6 C



IPC Global AMPT Device

Immediate and Delayed Test Specimens



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 U.S., WMA pavements must have equal or better performance when compared to traditional HMA pavements

WMA Technical Working Group (TWG)

- FHWA / NAPA sponsored
- Co-Chairs
  - Matthew Corrigan, FHWA
  - Ron White, Industry
- Represented
  - State DOT
  - State APA
  - NCAT
  - AASHTO
  - Labor
  - NIOSH
  - Hot Mix Asphalt Industry

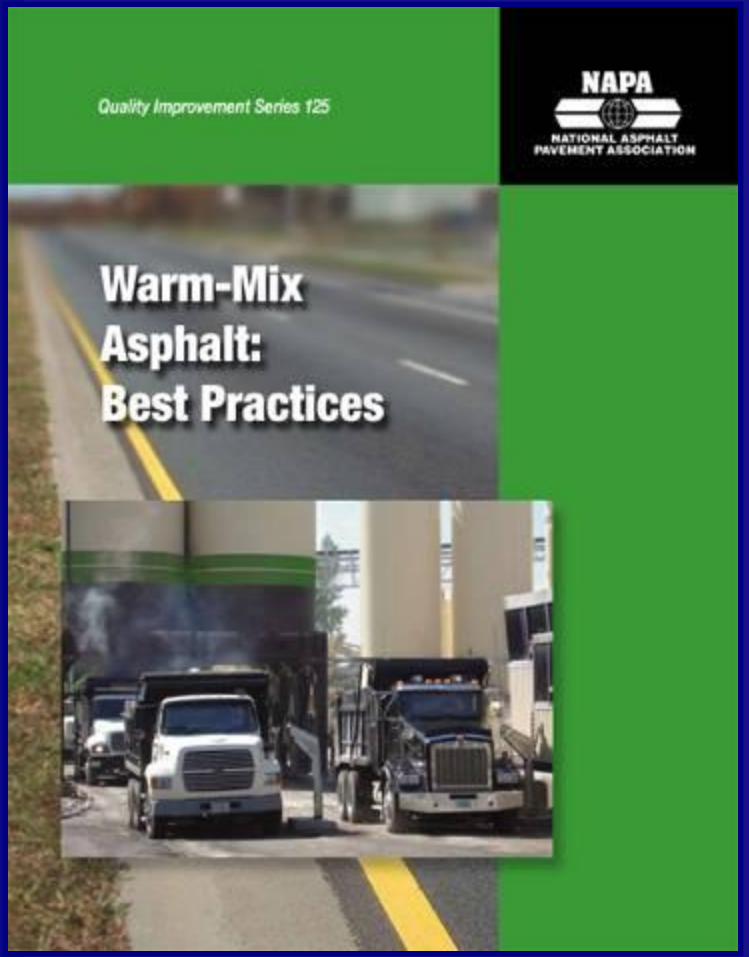
WMA TWG Accomplishments

- www.warmmixasphalt.com
- Material Testing Framework
- Emission Testing Framework
- WMA Best Practices Document
- Research Needs Identified
  - Developed three (3) research statements
  - Submitted through AASHTO to NCHRP
    - All projects highly ranked by SCOR
    - Total $1.4 million
- WMA Guide Spec for Highway Construction

warmmixasphalt.com

Warm Mix Asphalt: Best Practices

- Quality Improvement Series (QIP) 125
  - Stockpile Moisture Management
  - Burner Adjustments and Efficiency
  - Aggregate Drying and Baghouse Temperatures
  - Drum Slope and Flighting
  - Combustion Air
  - RAP usage
  - Placement Changes



25

AASHTO Guide Specification for Highway Construction 2008

DIVISION 400 FLEXIBLE PAVEMENTS

SECTION 401 HOT MIX ASPHALT (HMA) PAVEMENTS

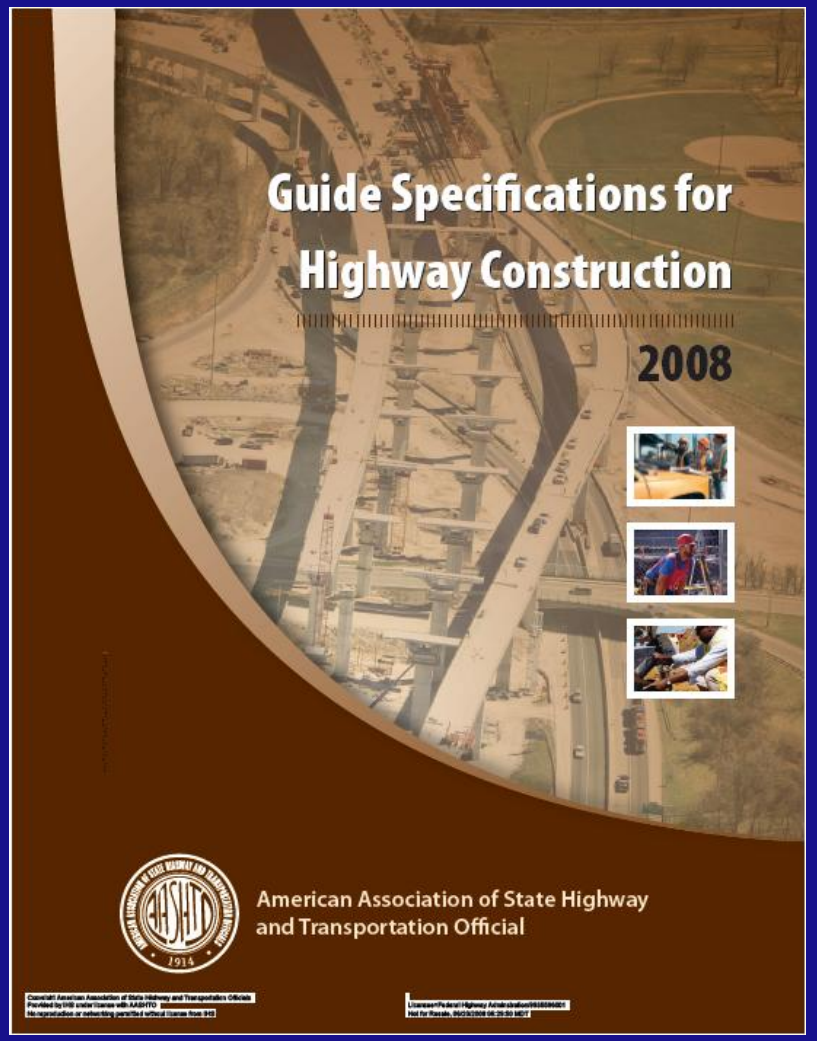
401.01 Description

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

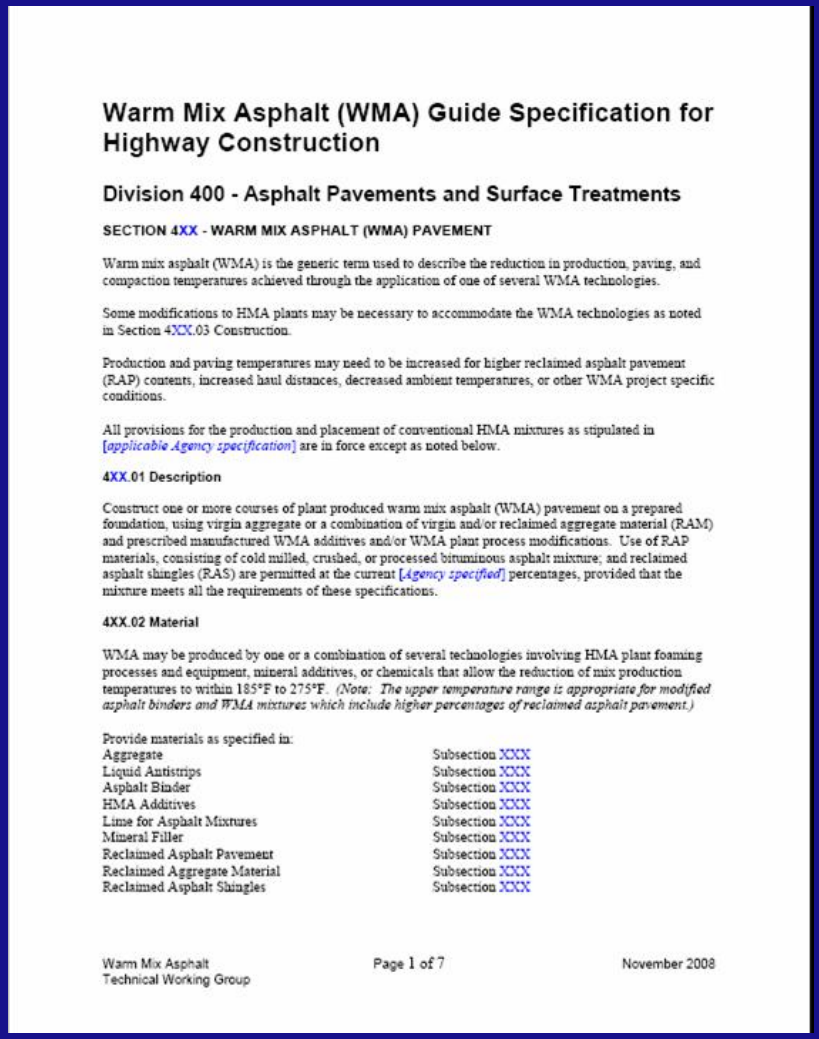
4XX.01 Description

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) contents, 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 specified]* 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 XXX
Liquid Antistrips	Subsection XXX
Asphalt Binder	Subsection XXX
HMA Additives	Subsection XXX
Lime for Asphalt Mixtures	Subsection XXX
Mineral Filler	Subsection XXX
Reclaimed Asphalt Pavement	Subsection XXX
Reclaimed Aggregate Material	Subsection XXX
Reclaimed Asphalt Shingles	Subsection XXX

U.S. Department of Transportation Federal Highway Administration

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,” and
- Environmental Council 101 (EC-101), “Best Management Practices to Minimize Emissions During HMA Construction”)

Ongoing National Research

TRB TRANSPORTATION RESEARCH BOARD OF THE NATIONAL ACADEMIES

- NCHRP 9-43 “Mix Design Practices for Warm Mix Asphalt” $500,000
- NCHRP 9-47 “Engineering Properties, Emissions, and Field Performance” $900,000

Proposed National Research

TRB TRANSPORTATION RESEARCH BOARD OF THE NATIONAL ACADEMIES

- D-06 “Long Term Field Performance of Warm Mix Asphalt Technologies” $1,200,000
- D-08 “Moisture Sensitivity of Warm Mix Asphalt Technologies” $600,000
- D-05 “Development of a New Protocol for Determination of Moisture Susceptibility of Asphalt Mixtures” $300,000

Future National Research?

TRB TRANSPORTATION RESEARCH BOARD OF THE NATIONAL ACADEMIES

- Short Term Ageing of WMA Binders During Production
- Differences between Field Produced WMA and HMA Volumetric Properties
- More to come …??

Future National Research?

Photo courtesy of Texas A&M University

Additional Research

Binder ETG Research Projects

- Laboratory Evaluation: Wax Additives in Warm-Mix Asphalt Binder

- Evaluate the effect of wax additives on physical properties and characteristics of asphalt binders and their subsequent performance in mixtures.

Binder ETG Research Projects

- Asphalt – One (1)
  - Lion Oil PG64-22 Eldorado, AR Refinery
- Wax Additives – Nine (9)
  - Non-Paraffin Wax Additives
- Aggregates
  - Vulcan Barin Quarry Granite, Columbus, GA
- Mix Design
  - 12.5mm Dense Graded SuperPave Gyratory
    - ~5.5% Binder
    - ~7.0% Air Voids

34

Binder ETG Research Projects

- Fourier Transform Infra-Red Spectroscopy
- Gel Permeation Chromatography
- Glass Transition (Tg)
- Branching
- Physical Hardening (32 days saturation at -12°C) Bending Beam Rheometry
  - Testing at 1,2,4,8,16 and 32 Days
- Multi-Step Creep Recovery (MSCR)
- Binder Stress Sweep Fatigue
- Additional testing … etc.

35

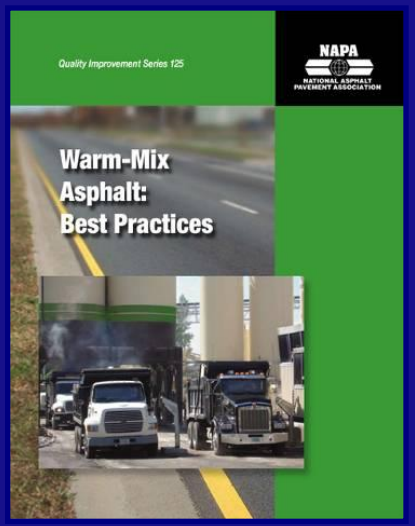
Future WMA Specifications

- Emphasis on Performance
  - Asphalt Mixture Performance Tester (AMPT)
    - Flow Number (Fn), mixture rutting
    - Dynamic Modulus (E*), mixture stiffness
    - Cyclic Tension – Compression, fatigue cracking
  - IDT Creep and Strength
    - fatigue and thermal cracking
  - Hamburg wheel tracking
  - Asphalt Pavement Analyzer
  - Moisture Susceptibility Testing

How to get WMA into projects?

- Continued Progress
  - Ongoing national research projects
  - Ongoing questions by industry
  - Short performance history
  - Multiple technologies and more on the way …
- Must prove WMA quality and performance
  - Hamburg / Asphalt Pavement Analyzer
  - Tensile strength / TSR

How to get WMA into projects?



- Not a cure for poor practice
- Production optimization
  - Stockpile moisture management
  - Burner size and efficiency
  - Drum slope, dwell time, and flighting
  - Etc.
- Cannot request waiver of existing HMA performance requirements
  - Need to find a way to make technologies pass existing testing requirements

Too many activities at one time?

- WMA + high RAP
- WMA + shingles
- WMA + rubber
- WMA + asphalt binder extenders
- WMA + asphalt binder alternatives
- WMA + other additives (compatibility?)
- WMA - one asphalt roller compactor

Experimental Features

- FHWA policy prohibits the use of a patented or proprietary material, specification, or process …:
- …competitive bidding with equally suitable unpatented items
- …used for research or for a special type of construction on relatively short sections of road for experimental purposes
- http://www.fhwa.dot.gov/construction/cqit/propriet.cfm

Experimental Features

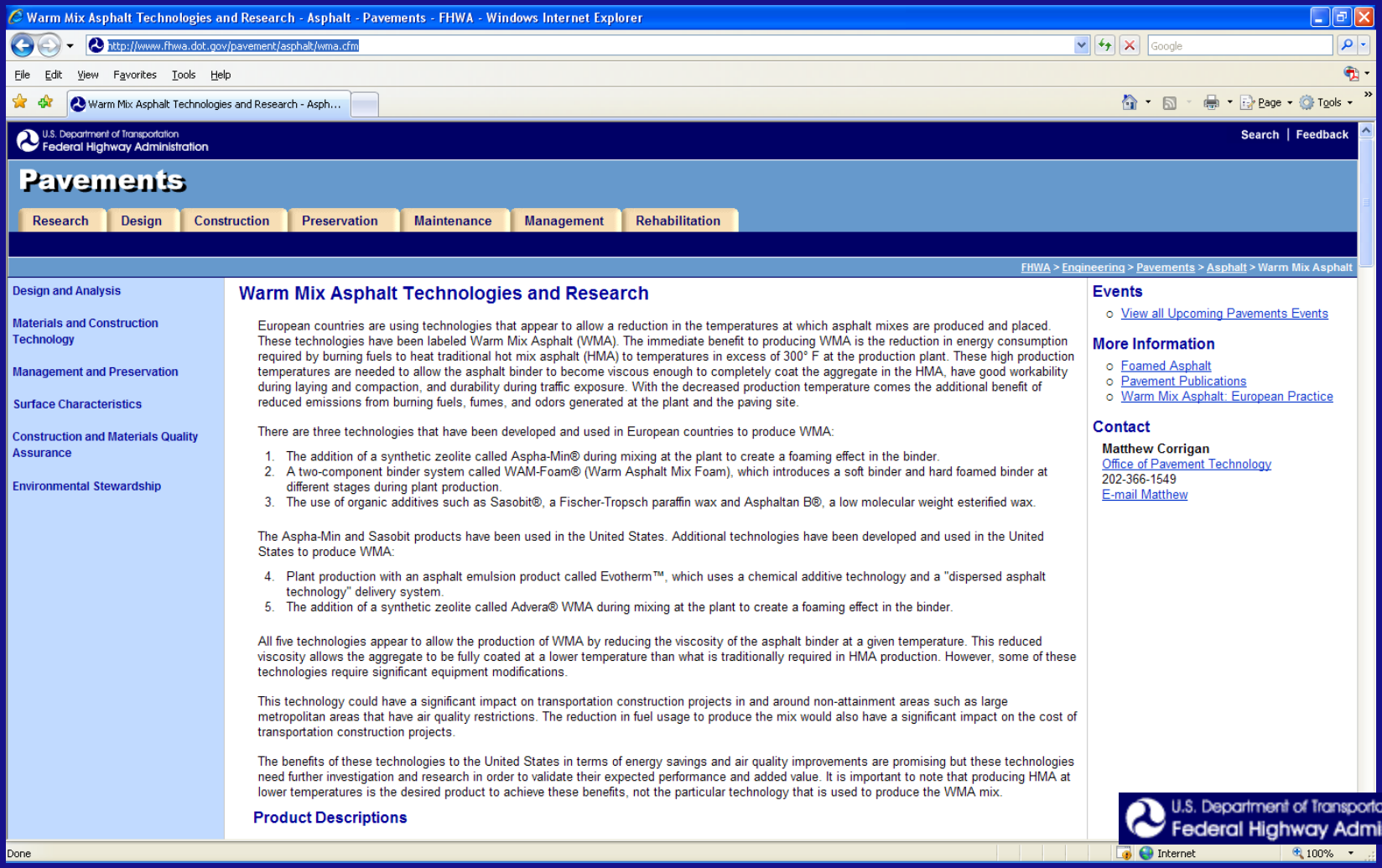
- *Experimental Feature - a material, process, method, equipment item, traffic operational device, or other feature that: (1) has not been sufficiently tested under actual service conditions to merit acceptance without reservation in normal highway construction, or (2) has been accepted but needs to be compared with alternative acceptable features for determining their relative merits and cost effectiveness.*

Experimental Features

- *Construction Projects Incorporating Experimental Features*
- *Federal-Aid Policy Guide*
  - G6042.4 - Construction Projects Incorporating Experimental Features
- Justification, Work Plan, Evaluation Criteria, Control Section, Cost Data
- Annual Reporting Requirements
- *http://www.fhwa.dot.gov/programadmin/contracts/expermnt.cfm*

Written Summary of WMA @

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



Office of Pavement Technology
Asphalt Pavement Program

Matthew Corrigan, P.E.

Mobile Asphalt Laboratory Program Manager
Warm Mix Asphalt Program Manager

Office of Pavement Technology
HIPT-10, Room E73-465
1200 New Jersey Ave. S.E.
Washington, DC 20590

matthew.corrigan@fhwa.dot.gov
www.fhwa.dot.gov/pavement