

Warm Mix Asphalt in Minnesota

A photograph of an asphalt plant. In the foreground, a white truck is being loaded with asphalt from a large black hopper. The hopper is part of a larger structure that has two large silos above it. The silos are white with a red and black stripe. Steam or smoke is rising from the hopper. In the background, there are more silos and industrial structures under a clear blue sky.

Tim Clyne
Mn/DOT

North Dakota Asphalt Conference

What is Warm Mix Asphalt (WMA)?

Technology that allows the reduction of mixing temperature by 20 to 100 F

★ **50 F typical**

Acts as a lubricator, not viscosity reducer

★ **Reduces surface tension of asphalt binder**

★ **Allows binder to flow and coat aggregates**

Environmental Benefits of WMA

Green Technology

- ★ **Lower greenhouse gas emissions (~30-90%)**
 - ★ **CO₂, NO_x, SO₂, VOC, etc.**
- ★ **Lower fuel consumption (~30%)**
- ★ **Reduced exposure of workers to fumes**
- ★ **Eliminates the need for fume evacuation equipment on plant and paver**

Operational Benefits of WMA

Construction Practices

- ★ Lower plant wear
- ★ Longer haul distances
- ★ Late season paving
- ★ Better compaction
- ★ Early site opening
- ★ More comfortable working conditions for plant and paving crews

Performance Benefits of WMA

Better Pavement Performance

- ★ Can use RAP and/or shingles with WMA
- ★ Reduced binder aging
- ★ Less susceptible to low temperature and fatigue cracking
- ★ Eliminates bump at joint when overlaying concrete
- ★ Rutting and stripping performance still being investigated

As good as or better than traditional HMA

WMA Technologies

Foaming Technologies

- ★ Water

- ★ Additive

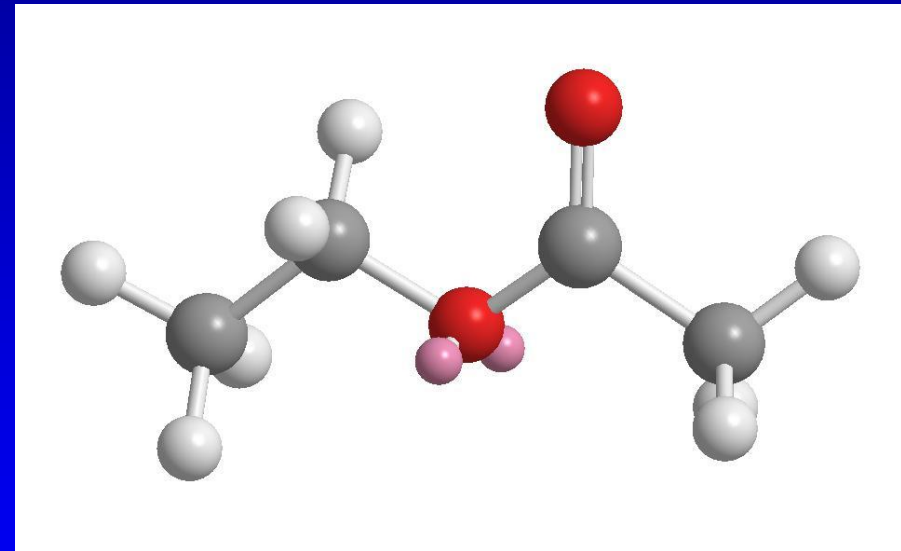
Organic Additives

- ★ Wax

Chemical Additives

- ★ Surfactants

- ★ Anti-strip agents



Technology Overview**

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

Courtesy: Matt Corrigan, Dave Newcomb

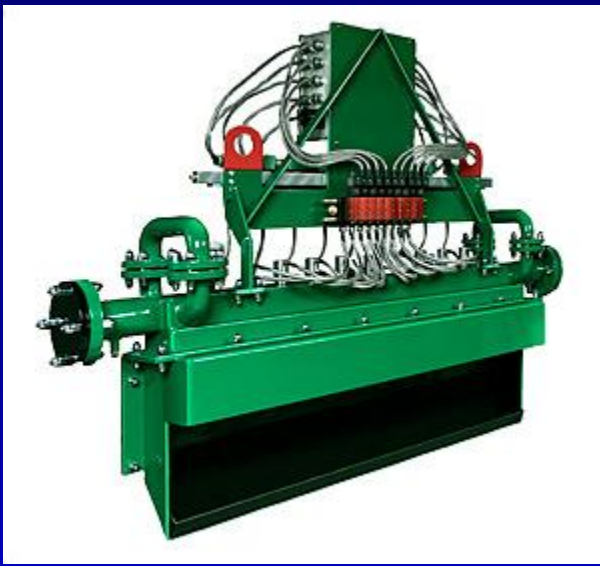
**FHWA does not endorse any particular proprietary product or technology.

 U.S. Department of Transportation
Federal Highway Administration
 NATIONAL ASPHALT
PAVEMENT ASSOCIATION

DOT
materials

OVERVIEW OF WMA TECHNOLOGIES

Foam (water)



Astec Double Barrel Green



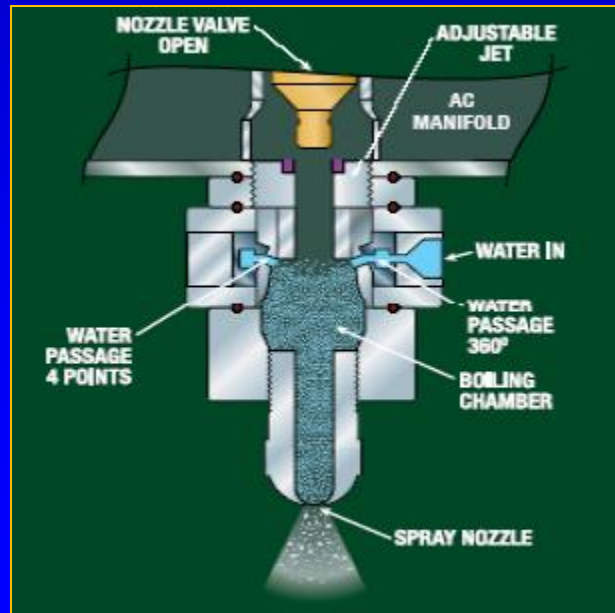
Gencor Ultrafoam GX



Maxam AQUABlack



Stansteel Accu-Shear



TEREX Warm Mix

Foam (additive)



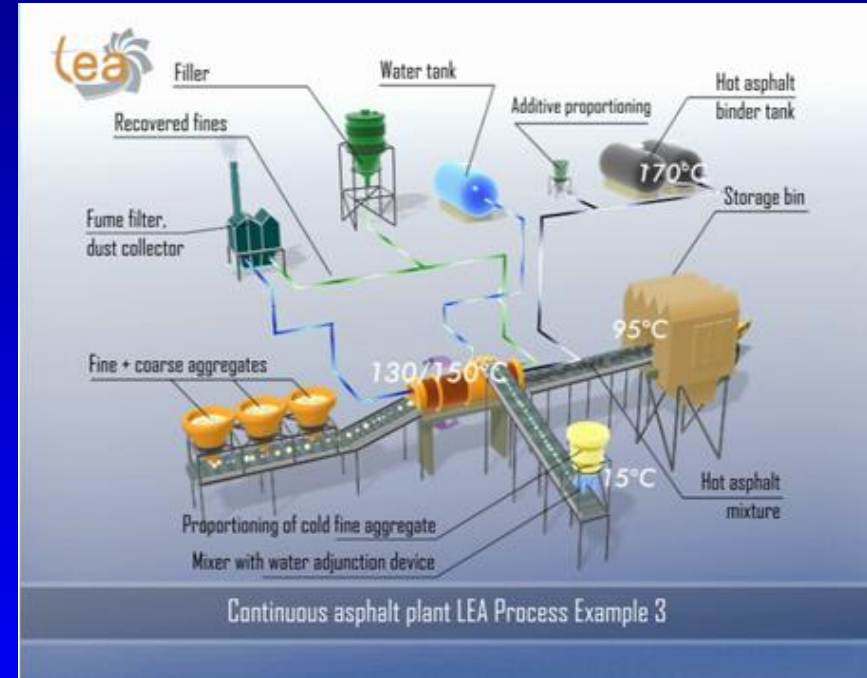
Aspha-Min



Readiset WMX



Advera



Low Emission Asphalt

Organic



Sasobit



2000 lb "Supersack"



Shell Thiopave

Chemical



Evothem



REVIX

WMA Technology Applications

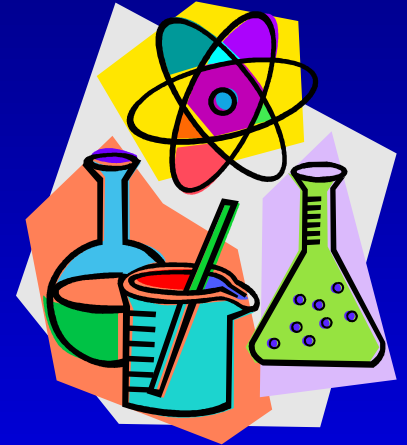
Asphalt terminal blend

Added to binder line at plant

Added to aggregate stream at
plant

Mineral filler feed line

Range from zero to moderate
plant modifications



WMA EXPERIENCE IN MINNESOTA

Oil Gravel

Cell 32 (1998) – Cold Mix Paving Practice

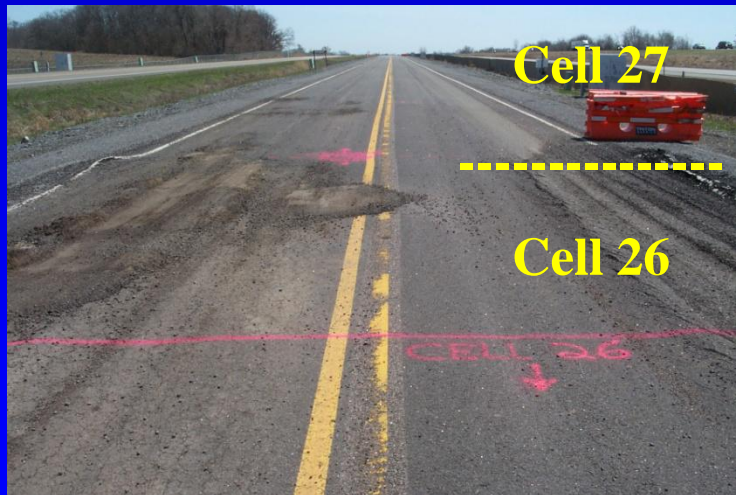
Cell 27 (1999) – Chip Seal / Large Stone Base

Cell 28 (1999) – Oil Gravel (luke warm mix) / Large Stone Base

Cell 26 (2000) – Oil Gravel (warm mix) / Reclaimed Base

Cell 27 (2000) – Oil Gravel (warm mix) / Large Stone Base

Several County Roads throughout Minnesota



- ★ Oil Gravel requires solid base
- ★ No Transverse Cracking or Rutting
- ★ Some Fatigue and Rough Ride

Olmsted & Goodhue Counties

First known true WMA jobs in MN (2007)

- ★ Revix (Evotherm 3G) technology

- ★ Olmsted CR 104

 - ★ 5 mile stretch

- ★ Goodhue CSAH11

 - ★ 537 tons placed in 4,200 feet of the EB lane



Crow Wing County

County Road 108 (2008)

- ★ **2913 tons WMA, 272 tons HMA**
- ★ **58-34 HMA vs. 58-28 WMA**
 - ★ **WMA is \$3-\$4 lower than HMA**
- ★ **Estimated 5 years of extended service life**
 - ★ **Life cycle cost analyses are favorable for WMA**
- ★ ***ASCE Cold Regions paper 2009***

County now allows alternate bids on several projects

- ★ **20,000 tons WMA in 2009 (CR 2)**

2008 MnROAD Construction

Warm Mix Asphalt						Control
15	16	17	18	19	23	24
3" WM	5" WM 58-34	5" WM 58-34	5" WM 58-34	5" WM 58-34	5" WM 58-34	3" 58-34
11.1" 64-22 1993 HMA	12" 100% recycle PCC	12" 50% RePCC 50% Class 5	12" 100% RAP	12" CI-5	12" Mesabi Ballast	4" Cl6sp
Clay	12" Cl3sp	12" Cl3sp	12" Cl3sp	12" Cl3sp	12" Cl3sp	Sand
58-34 Surface Binder	7" Select Gran	7" Select Gran	7" Select Gran	7" Select Gran	7" Select Gran	100' Fog Seal 2008
	Clay	Clay	Clay	Clay	Clay	100' Chip Seals 2009 2010 2011 2012

Mix Design Requirements

Wear and Non-Wear

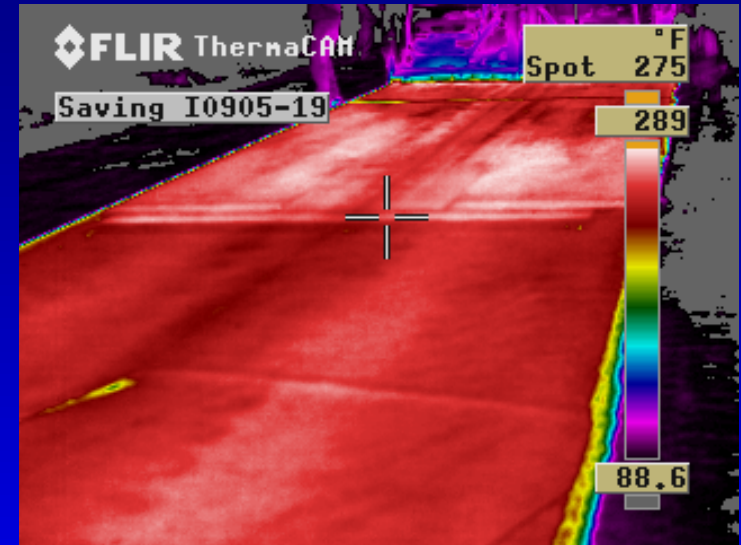
12.5 mm NMAS

Traffic Level 4

PG 58-34

20% RAP from MnROAD

No requirements for WMA technology



Next several slides courtesy of Chris Miller, Hardrives

REVIX™ Technology

Developed by Mathy Technology and Engineering
and Paragon Technical Services, Inc.

- ★ **Chemical additive added at terminal or HMA plant**
- ★ **Requires no plant modification**
- ★ **Binder shipped from Mathy with WMA chemical package already added**

This technology is now marketed as Evotherm 3G



Mix Design

Existing SPWEB440 Mix Design

- ★ $\frac{3}{4}$ " 100% Crushed Stone
- ★ $\frac{1}{2}$ " Granite Chips
- ★ Washed Granite Sand
- ★ Crushed Millings from MnROAD

Replaced Standard Binder with WMA Binder

- ★ Lab compaction temperature 235° - 245° F

Ran points to find optimum AC content for
SPWEB440

Non-Wear MDR written from trial point data



WMA Production

Day 1 – 990 tons of SPNWB430C

- ★ No change in GMM from design
- ★ Drastic increase in Gmb (about 0.040)
- ★ Lower than expected Air Voids and VMA
- ★ Lower gyrating temperature gave equal results



WMA Production

Day 2 – 1996 tons of SPWEB440C

- ★ Aggregate proportion change as well as add AC% reduction
- ★ Air Voids on target
- ★ VMA drop of about 1.0



WMA Laydown

Business as usual – only cooler
Positive comments from the crew
Rolling Pattern Challenges



Laydown Temp (224 F)



Density Results

Non-Wear

- ★ All cores > 93.0%
- ★ Low air voids

Wear

- ★ Cores averaged 92%



WMA vs HMA



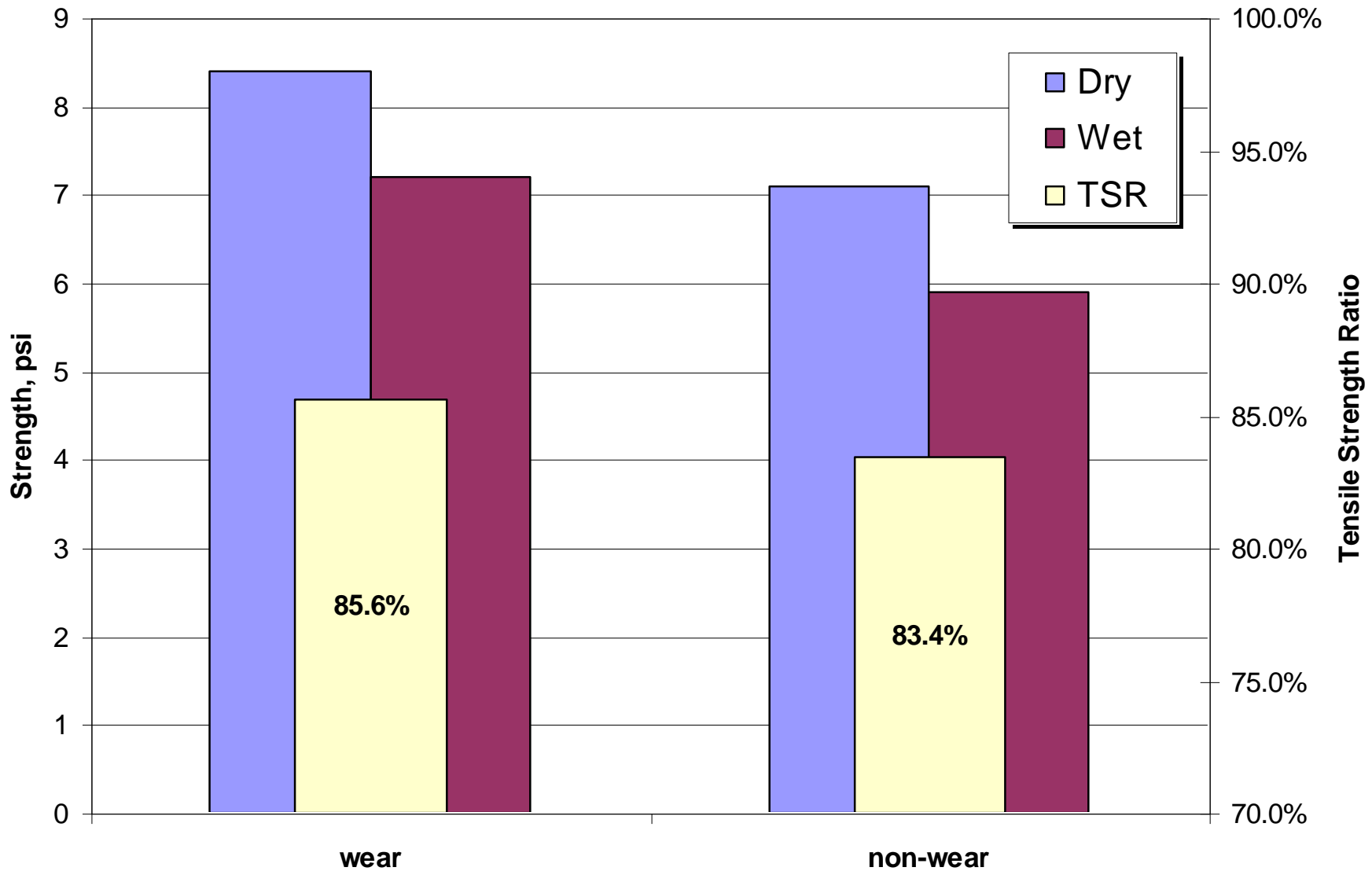
WMA vs. HMA



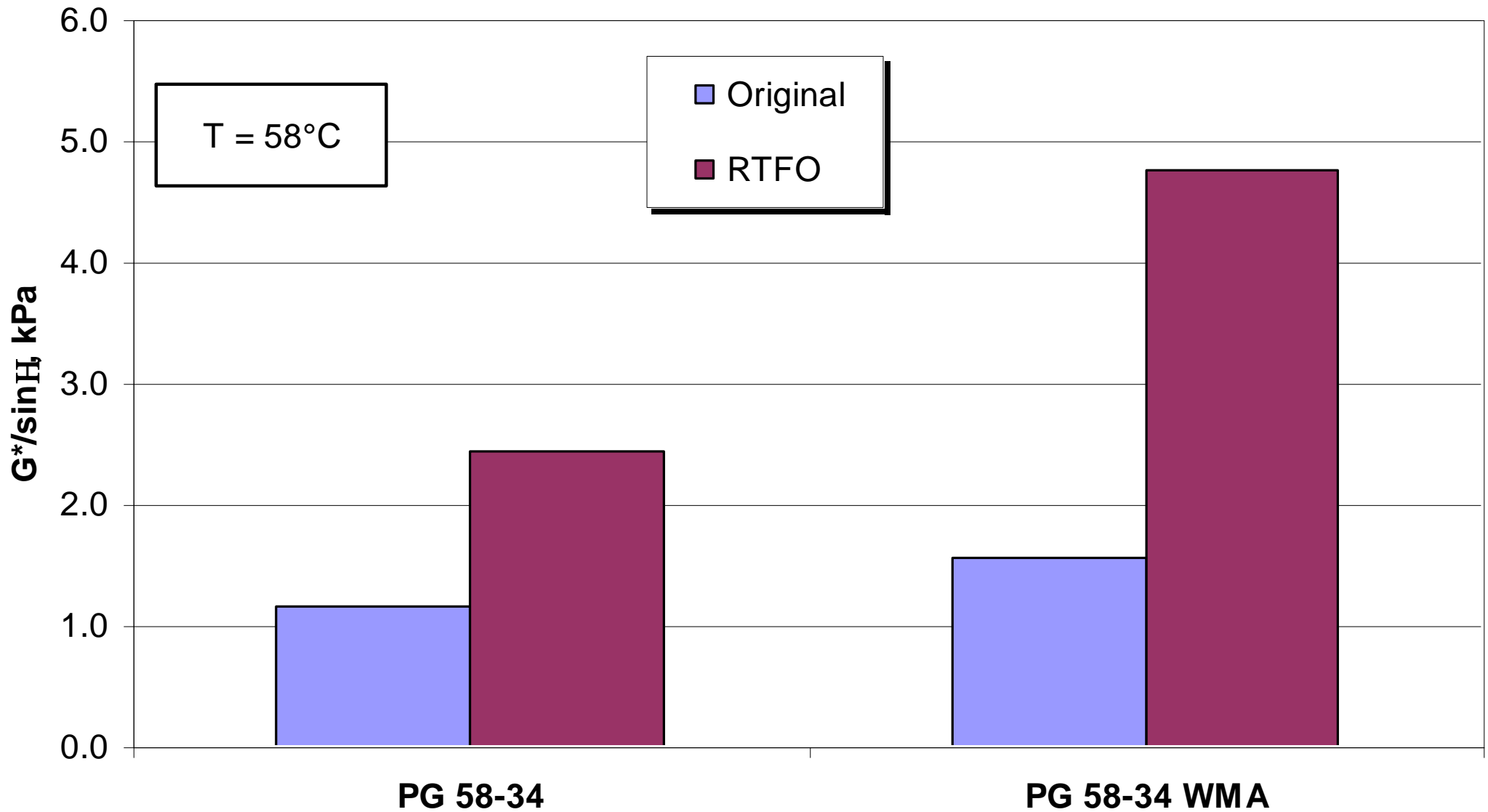
WMA vs. HMA



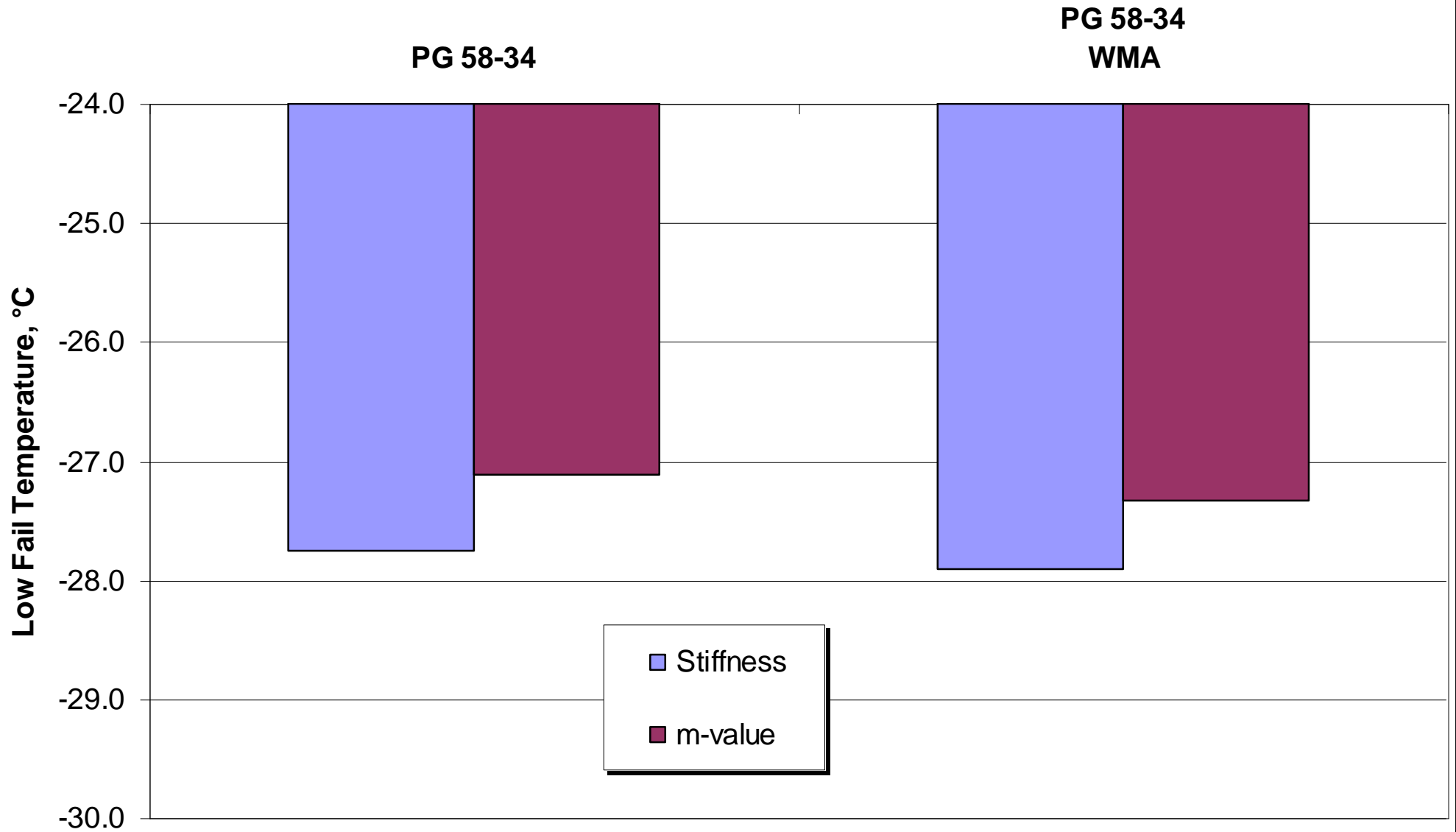
Stripping Potential



Binder DSR Testing



Binder BBR Testing



Lessons Learned

More lab work needed at mix design to determine compaction temperature range

Definite energy savings

Appears as though fumes/emissions were less

Equal density appears to be achievable with equal or less effort



Mn/DOT Trunk Highway 95

Late season paving (2009)

- ★ Contractor was delayed, needed to finish paving before winter
- ★ Supplemental Agreement – Mn/DOT paid extra \$0.60 per ton for WMA
- ★ Business as usual – good density, etc.



Bituminous Roadways



Maxam AquaBlack

- ★ Installed on 2 local plants
- ★ 15% of production was WMA



Mn/DOT District 7 and 3 Projects in 2010

First Mn/DOT projects requiring WMA

S-1 (2360) PLANT MIXED ASPHALT PAVEMENT – USE OF WARM MIX ASPHALT TECHNOLOGIES

The provisions of the attached 2360 Plant Mixed Asphalt Pavement (Gyratory Design) Specification is hereby modified as follows in order to use Warm Mix Asphalt (WMA)

All provisions for the production and placement of WMA will be the same as the conventional HMA mixtures as stipulated in 2360 Plant Mixed Asphalt Pavement (Gyratory Design) Specification except as noted below.

S-2.1 MIXTURE DESIGN

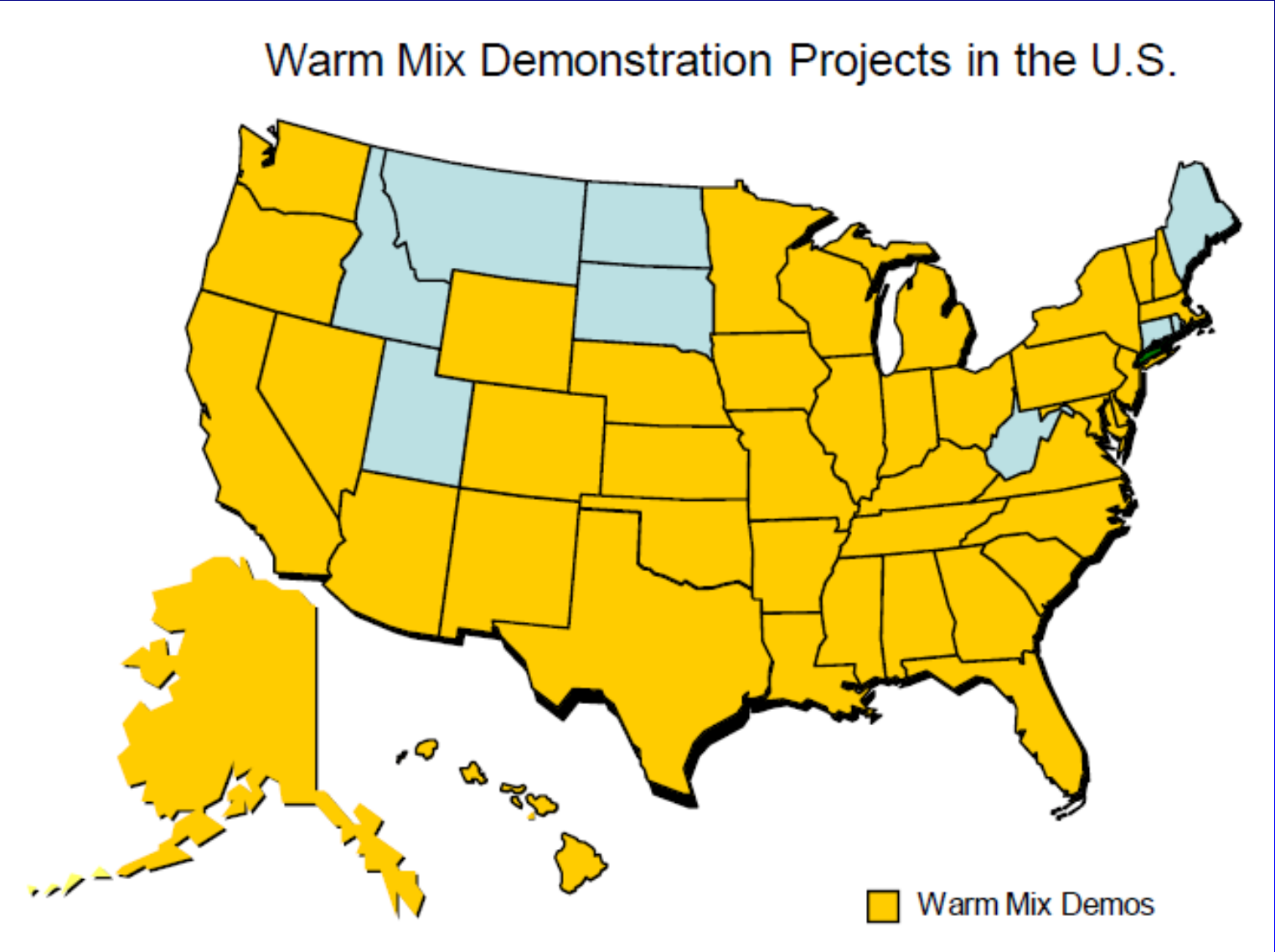
The contractor is responsible to use the same design used to produce the Hot Mix Asphalt, then modifying it to accommodate products or processes to meet the Warm mix criteria. This modification process will be limited to the same as described by the WMA Technical Working Group and found at <http://www.warmmixasphalt.com/WmaTechnologies.aspx>

Recycled Asphalt Shingles will not be allowed in any mixes on this project.

S-3.1 MIXTURE QUALITY MANAGEMENT

The Warm Mix Asphalt produced will not be allowed to exceed temperatures greater than 275 °F. Any WMA over that temperature will not be allowed to be used.

WMA Projects in the U.S. (Dec 2009)



Courtesy: Dave Newcomb

Outstanding Issues

Early Rutting

- ★ No known problems have occurred
- ★ Binder grade bump may be needed

Moisture Damage

Long Term Performance



Research In Progress

NCHRP 09-43, Mix Design Practices for Warm Mix Asphalt

NCHRP 09-47A, Properties and Performance of Warm Mix Asphalt Technologies

NCHRP 09-49, Performance of WMA Technologies: Stage I - Moisture Susceptibility

Mn/DOT 2010 Bituminous Specification

Previously WMA was handled on a case-by-case basis

★ 2009 Position Memo

★ www.dot.state.mn.us/materials/bituminous.html

Table 2360.6-C5
Mixture Temperature Control^(C)

Air Temperature °F [°C]	Compacted Mat Thickness, inches ^(A)			
	1 inch [25 mm]	1-1/2 inch [40 mm]	2 inch [50 mm]	≥3 inch [75 mm]
+32-40 [0-5]	--	265 ^(B) [129]	255 [124]	250 [121]
+ 41-50 [6-10]	270 ^(B) [130]	260 [127]	250 [121]	245 [118]
+ 51-60 [11-15]	260 ^(B) [127]	255 [124]	245 [118]	240 [115]
+ 61-70 [16-21]	250 ^(B) [121]	245 [118]	240 [115]	235 [113]
+ 71-80 [22-27]	245 [118]	240 [115]	235 [113]	235 [113]
+ 81-90 [28-32]	235 [113]	230 [110]	230 [110]	230 [110]
91+ [+ 33]	230 [110]	230 [110]	230 [110]	225 [107]

(A) Based on approved or specified compacted lift thickness.

(B) A minimum of one pneumatic-tire roller shall be used for intermediate rolling unless otherwise directed by the Engineer. The Engineer may specify or modify in writing (with concurrence from the Department Bituminous Engineer) a minimum laydown temperature.

(C) Not applicable if a WMA additive or process is used.

SUMMARY

Production and Paving Best Practices

Work to minimize aggregate moisture

Make sure the burner is tuned for the temperature

Keep baghouse temperature above condensation point

Consider superheating aggregate ahead of RAP

Follow normal placement practices

WMA Investigation and Implementation

FHWA working in partnership with AASHTO and Industry to establish clear targets for implementation

WMA Technical Working Group (TWG)

FHWA Expert Task Groups

First projects requiring WMA

- ★ **Binder, Mixture, and Models**

Regional User-Producer Groups

- ★ **Share data and information**

Move out of demonstration phase

Training and Education

Online Resources

www.warmmixasphalt.com

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

www.hotmix.org

www.asphaltisbest.com



Publications

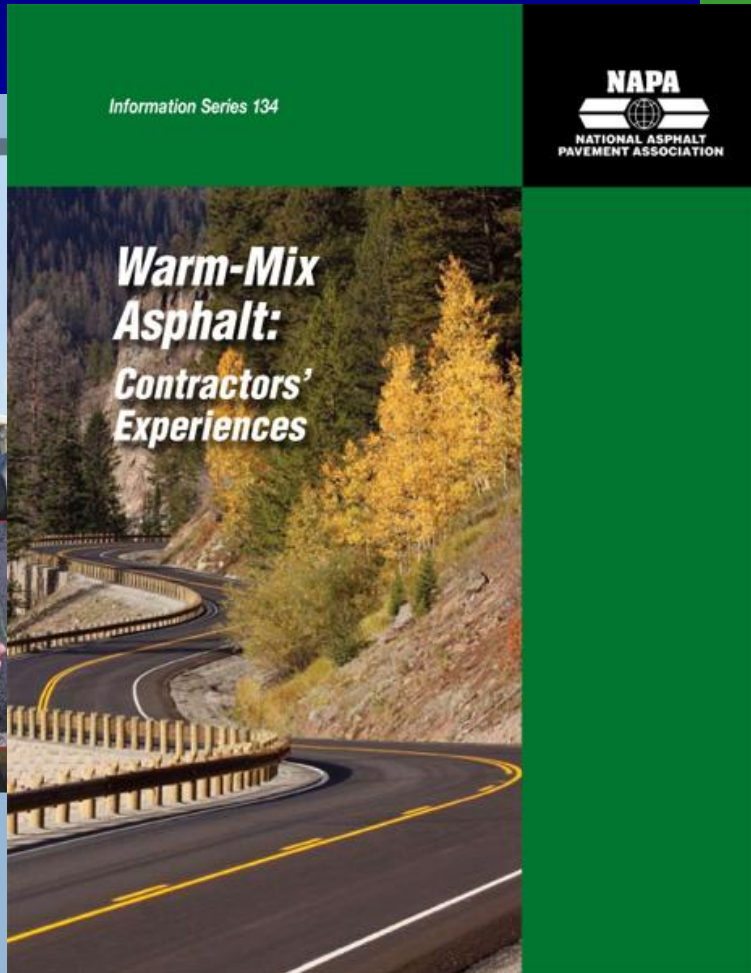


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FEBRUARY 2008



Conclusions

WMA should meet all Superpave requirements

Warm mix is the future of asphalt mixtures

Technology providers coming forward

Industry and agencies must work together to make it happen

Advantages far outweigh concerns



Thank You!

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