

# **Warm Mix Asphalt: Best Practices**

**NAPA 53<sup>rd</sup> Annual Meeting**



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# Acknowledgements

- The authors thank:
  - The WMA technology providers
  - The many contractor and DOT personnel who provided information on projects
  - John Bartoszek, Bill Garret and Malcolm Swanson for their input on production
- The authors particularly thank Margaret Cervarich and Dave Newcomb for their tireless efforts in editing!



# Global Warming

2B · FRIDAY, MARCH 2, 2007 · USA TODAY

## \$110M worth of voluntary offsets bought in '06

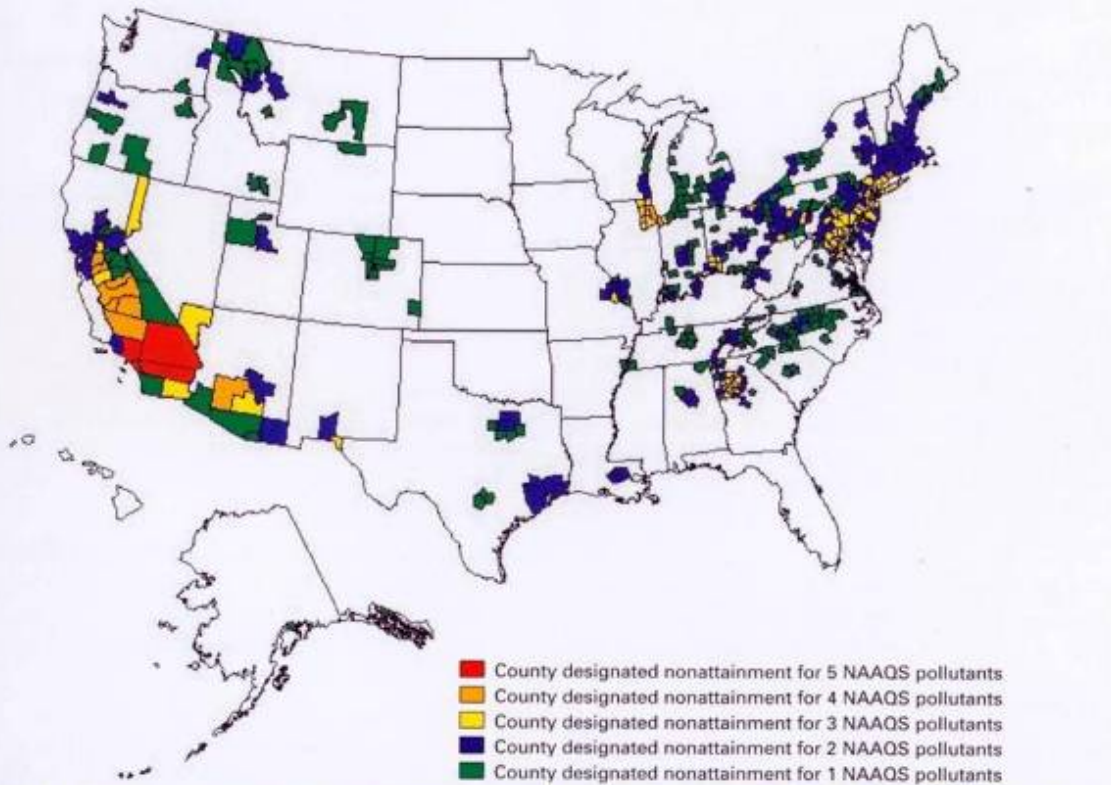
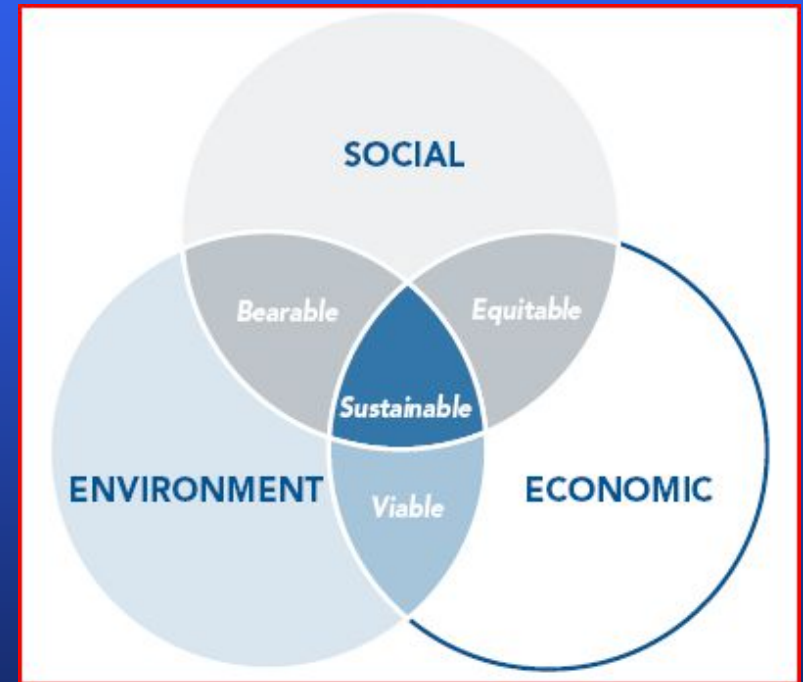
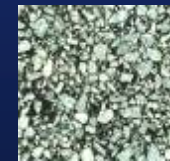


FIGURE 3: Counties not attaining the National Ambient Air Quality Standards (NAAQS) of the Clean Air Act, April 2005.

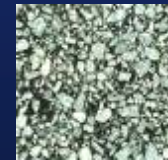


Sustainable Development



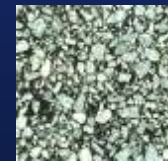
# Better Neighbors, Better Working Conditions

- NAPA has taken the lead in responding to a number of environmental, and health and safety issues:
  - Clean Air Act 1970 – Development of wet scrubbers and baghouses
  - Oil Embargo 1970's – Use of RAP
  - Concerns for paver operators – Engineering controls
  - Impact of asphalt plants on neighbors – Green Diamond Achievement Awards
- This trend continues with WMA



# Short History of WMA

- 1995-96 - First European experiments
- 1997-99 – First pavements constructed in Europe
- 2002 - NAPA Study Tour to Europe
- 2003 - Featured at NAPA's Annual Convention
- 2004
  - Demonstration at World of Asphalt
  - First U.S. field trials (Aspha-min) in FL and NC
- 2005-06
  - Numerous field trial, some “production” paving in MO
  - NCAT publishes research on Aspha-min, Sasobit, and Evotherm
- 2007
  - FHWA Scan
  - AASHTO/NCHRP research projects underway



Quality Improvement Series 125



## Warm-Mix Asphalt: Best Practices



# Purpose

- Present the state of the practice for WMA
  - Overview of technologies
  - Benefits
  - Best practices for production and laydown
  - Future needs



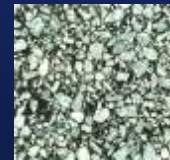
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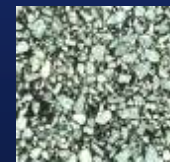
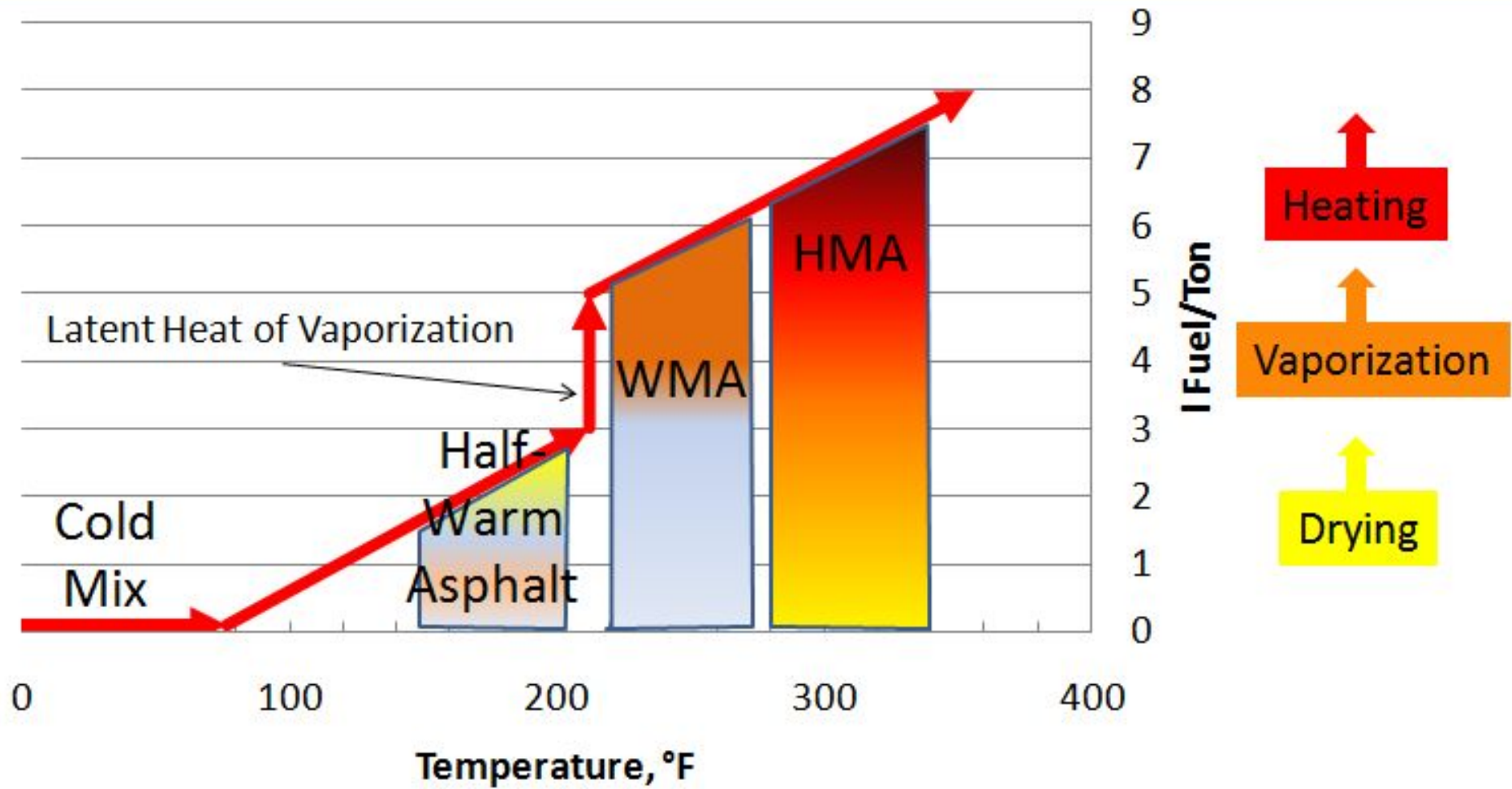
# Chapter 2

## Overview of Technologies

Provides:

- Contact information
- Technology description
  - Plant modifications
  - Mix design modifications
- Experience/Usage





# Technologies and Temperature Reduction

WMA Technology	Process Type	Decreases Production Temperatures by 30 to 50 F° (17 to 28 C°)	Decreases Production Temperatures by More Than 50 F° (28 C°)
Double Barrel <sup>®</sup> Green	Foaming	XX <sup>1</sup>	X <sup>2</sup>
Evotherm <sup>™</sup>	Chemical Additive	XX	XX
(LEA) Low Energy Asphalt	Foaming		XX
Rediset <sup>™</sup> WMX	Chemical Additive	XX	X
REVIX <sup>™</sup>	Chemical Additive	X	XX
Sasobit	Organic Additive	XX	X
Synthetic Zeolite	Foaming	XX	X
WAM-Foam	Foaming		XX

<sup>1</sup>Frequently observed; <sup>2</sup>Observed

# New Technologies

Double Barrel® Green



Rediset™ WMX

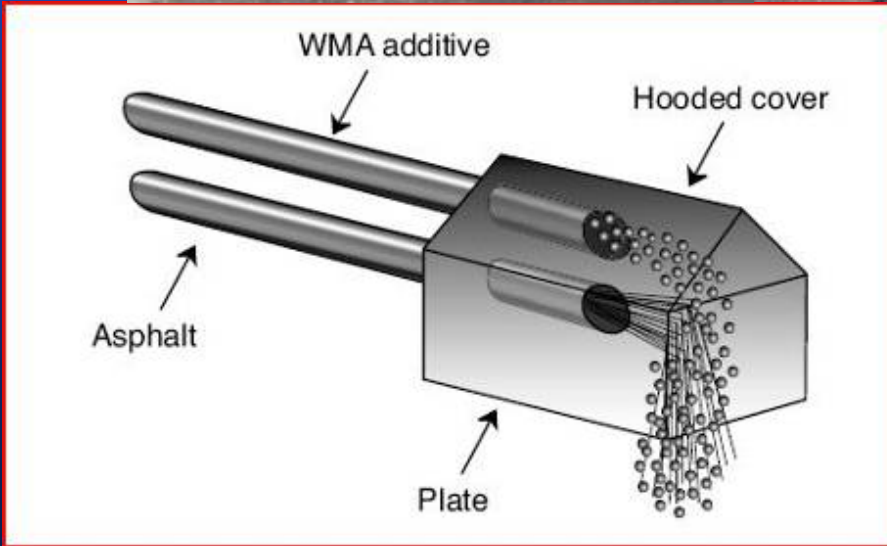


REVIX™



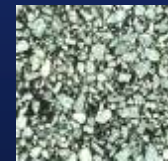
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# Plant Modifications



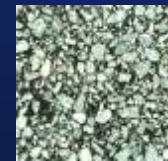
# Experience and Usage

- New WMA technologies are being introduced
- There is more research/experience with some, than with others
- Provides information from projects regarding:
  - Binder grades,
  - Aggregate type,
  - Mix type,
  - RAP content, and
  - Tonnage
- Designed to be updated



# Chapter 3 - Benefits

- Paving Benefits
  - Compaction aid
  - Cold-weather paving
  - Longer haul distances
  - Use of higher percentages of RAP
  - Less restriction, potentially more production in non-attainment areas
  - Specific pavement rehabilitations
- Reduced Fuel Usage
- Reduced Emissions
- Improved Working Conditions

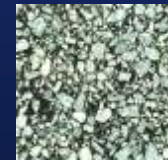


# Cold-weather Paving



PG 82-22, January 12, 2008  
Avg. Density: 93.9% cores  
93.7% nuclear gauge

- The greater the differential between the mix and ambient temperatures, the faster the mix cools
- WMA cools slower
- WMA allows compaction at lower temperatures

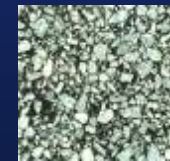


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# Longer Haul Distances



Placing WMA at Ohio University's Accelerated Pavement Load Facility after hauling for over one hour



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# Paving over Crack Sealant

HMA



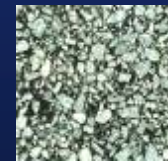
WMA after six months



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# Fuel Savings

- Theoretical calculations show 50 °F reduction in temperature = 11% savings
- Reported fuel savings typically 30 to 35%
  - Larger savings may be driven by heat losses from plant during mixing
- Processes where a portion of the aggregate is not heated above the boiling point of water have shown savings of 34 to 47%



# Reduced Emissions

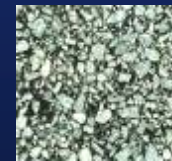
HMA at 330 °F



WMA at 255 °F



Reduced or eliminated fugitive emissions!



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# Best Practices for Producing WMA

- Reduce stockpile moisture content
- Tune burner to ensure complete combustion
- Drying aggregate while maintaining baghouse temperatures



# Reduce Stockpile Moisture

- Saves fuel – 2% decrease = savings of 0.48 gal/ton
- Drier aggregate in = drier aggregate out, reducing potential for moisture damage

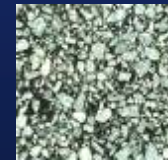


# Tune Burner – Prevent Fuel Contamination

- Can be difficult to adjust burner with lower production temperatures combined with lower production rates (trial sections)
- WMA more sensitive to contamination than HMA



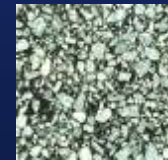
Note brown color of mix. Project had high VOCs and CO



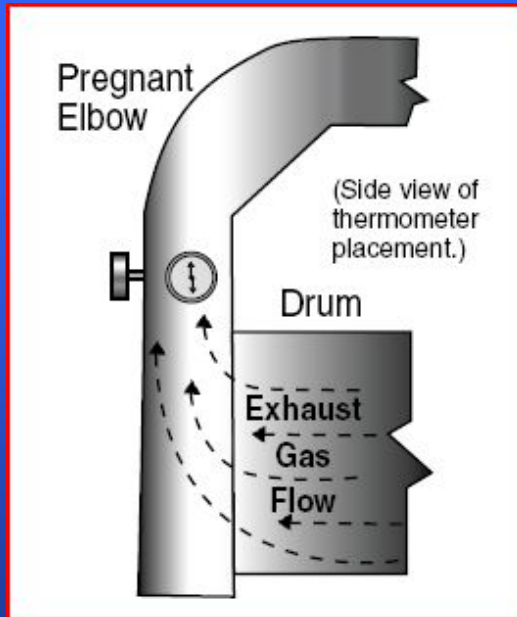
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# Why Incomplete Combustion?

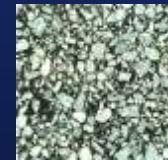
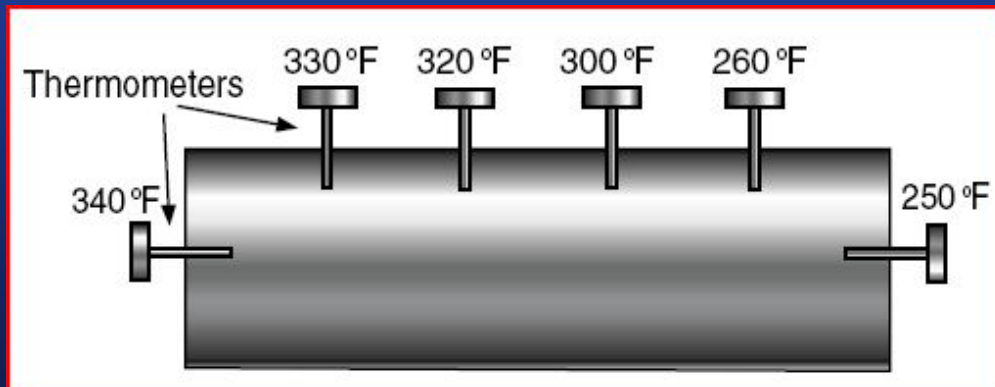
- Incomplete atomization of fuel
  - Nozzles worn
  - Air passages plugged with yard dust
  - Fuel not adequately pre-heated
- Both projects where contamination suspected used reclaimed motor oil as fuel
  - Manufacturers generally recommend preheating to obtain maximum viscosity of 90 Saybolt Seconds Universal (SSU)
  - Astec recommends preheating to viscosity of 70 SSU
  - #2 Oil viscosity 40 SSU



# Indications of Moisture in Aggregate

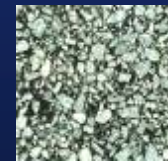


- Difference in exhaust temperatures across breach exceeds 60 °F
- Mix temperature drop more than 20 °F from discharge to load out



# Best Practices for Baghouse

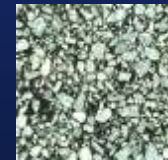
- Preheat for 15 to 20 minutes to remove condensation
- Monitor pressure drop across bags, pressure drop greater than 4-5 inches may indicate caking
- Inspect baghouse fines return lines



# Drying Aggregate while Maintaining Baghouse Temperatures

Action	Benefit	Consequence or Detriment
Reduce slope of drum. An alternative may be to install a donut in the drum to retard the aggregate flow.	Increases aggregate dwell time which will allow more complete drying at lower temperature.	Maybe expensive to make change. Will increase electrical consumption of the motor used to turn the drum due to additional weight in the drum. May decrease temperature of exhaust gases to baghouse.
Remove a portion of the flights to increase heat penetration.	Increase baghouse temperature.	Reduces heat transfer efficiency. May cause baghouse to overheat when producing HMA with a high percentage of RAP.
Increase combustion air (induced or forced) for a given burner setting	Increases hot exhaust gases above that needed to dry aggregate. Additional gases increase baghouse temperature.	Significantly increases fuel consumption.
Add a minimum of 10 to 15 percent RAP to mix.	Virgin aggregate must be superheated to dry RAP. Superheating improves drying of virgin aggregate and increases baghouse temperature.	None.

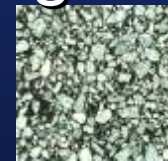
Keep Baghouse above 220 °F for low sulfur fuels and above 240 – 250 °F for high sulfur fuels to prevent corrosion



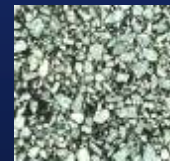
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# Combining WMA and RAP

- A win-win or Green-Green solution!
- Adding 10 to 15% RAP
  - Reduces veil, increasing heat penetration, increasing baghouse temperature
  - Superheated virgin aggregate more likely to dry
  - Lower WMA temps reduce oxidation of virgin binder – good for RAP in terms of cracking
  - Aged RAP binder helps offset softer virgin binder in terms of rutting

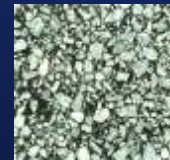


# Chapter 5: Summary and Research Needs



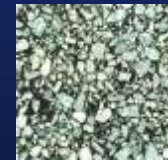
# Research Needs

- Mix Design
- Long-term Performance
- Product Approval System
- Quantification of Benefits
- RAP and WMA
- Production Equipment



# Performance of WMA from U.S. Scan Tour

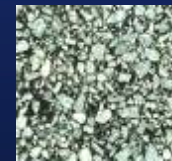
- Consensus of European Countries that WMA should provide equal or better performance than HMA
  - Norway – performance mixed, problems not attributed to WMA
  - Germany – performance same or better, developed guidelines to allow use of waxes and zeolite
  - France – toll road operator, district, and city of Paris pleased with performance to date



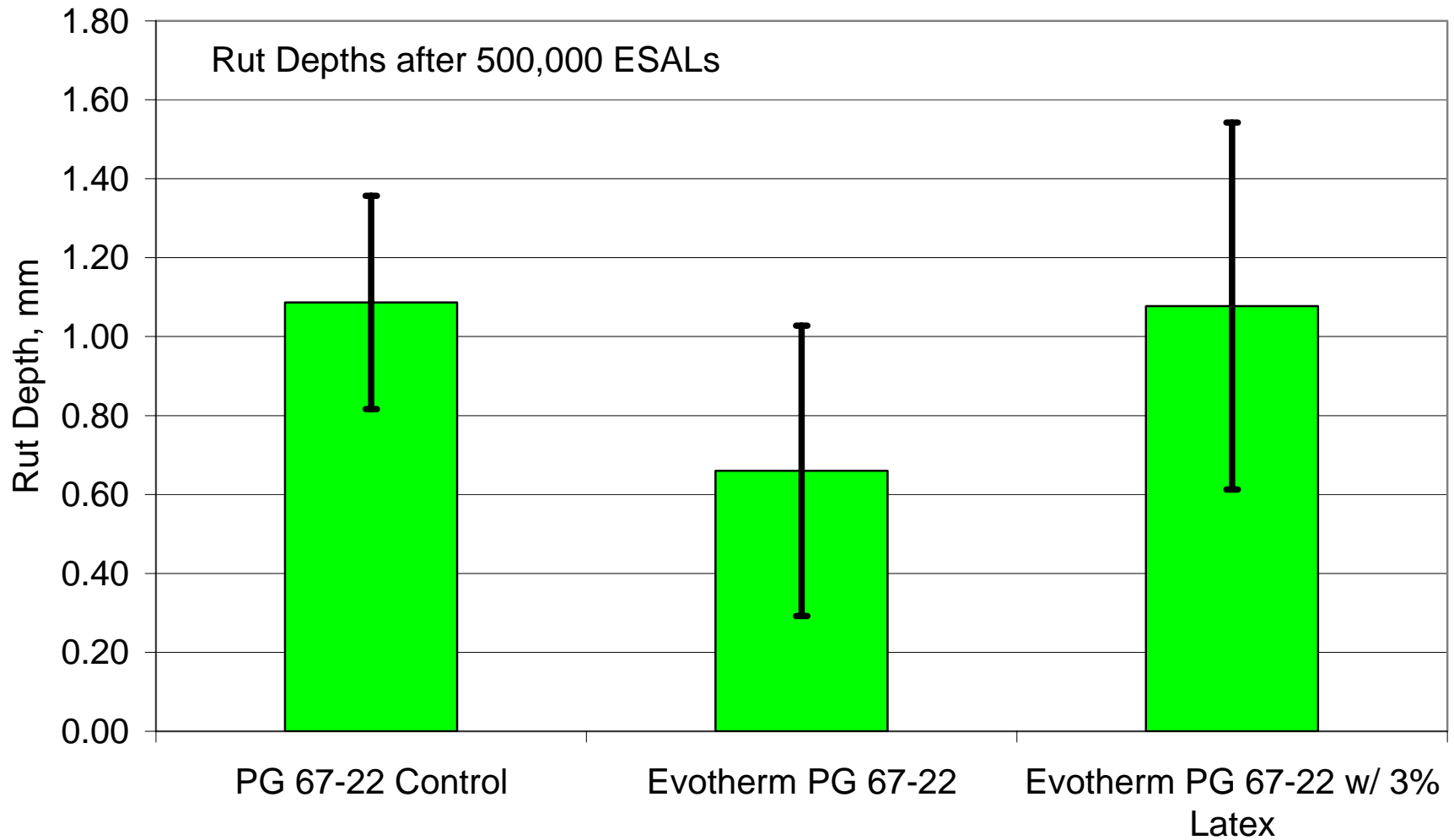
# Evotherm Test Sections

## NCAT Test Track - November 2005

	<b>N2</b>	<b>N1</b>	<b>E9</b>
	<div style="text-align: center;"> <math>\longleftrightarrow</math> <b>9.5 mm NMAS</b> <math>\longrightarrow</math> </div>		
<b>1"</b>	HMA Control PG 67-22	Evotherm PG 67-22 + 3% Latex	Evotherm PG 67-22
<b>2"</b>	<b>19.0 mm NMAS w/ Evotherm PG 67-22</b>		<b><math>N_{\text{design}} = 80</math> for all mixes</b>
<b>2"</b>			



# Evotherm Field Rut Depths - NCAT Test Track

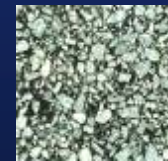


# Highway 115, Charlotte – after 26 months



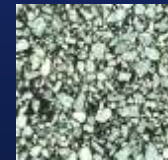
# Product Approval

- As interest grows, how do we sort good products from bad?
  - Initial laboratory screening
  - Well documented field trials
  - National or regional certification
  - France and Germany both have well developed systems
  - Needed for all new products



# Why Warm Mix?

- Warm Mix can address a variety of needs
  - Improved compaction
  - Fuel Savings
  - Environmental
  - Working conditions
- Significant research already completed
- Future looks warm!



# Thanks!

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