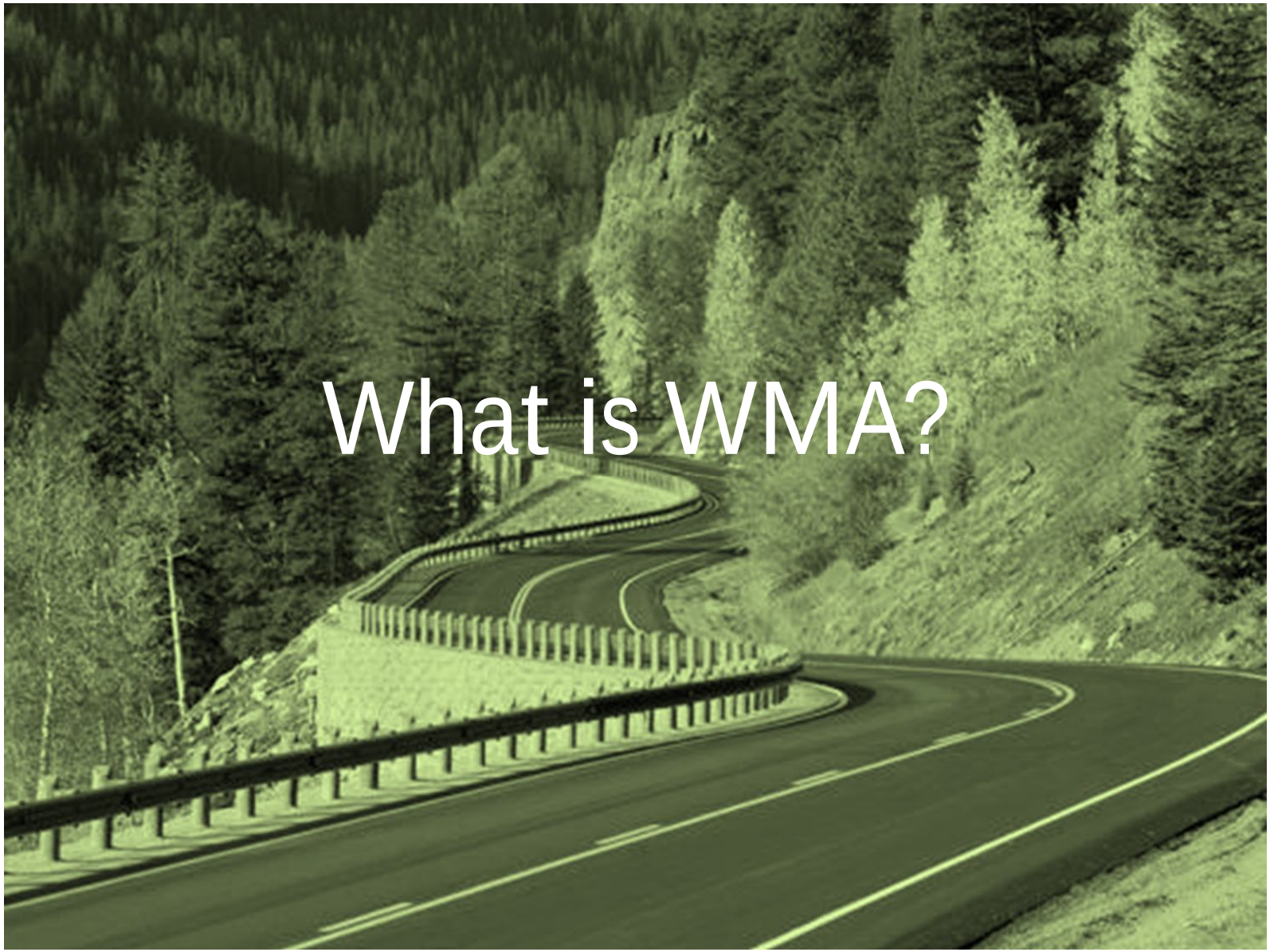

What is WMA?

FHWA Definition

- **Warm Mix Asphalt (WMA)** is the generic term for a variety of technologies that allow producers of ***Hot Mix Asphalt (*HMA)** pavement material to lower temperatures at which the material is mixed and placed on the road.

Warm Mix Asphalt (WMA)

Asphalt Binder

+

Aggregate

+

Recycled Asphalt Pavement or RAP (Optional)

+

Additives (Optional) ← Polymers, Shredded Rubber, etc.

= Warm Mix Asphalt (WMA)

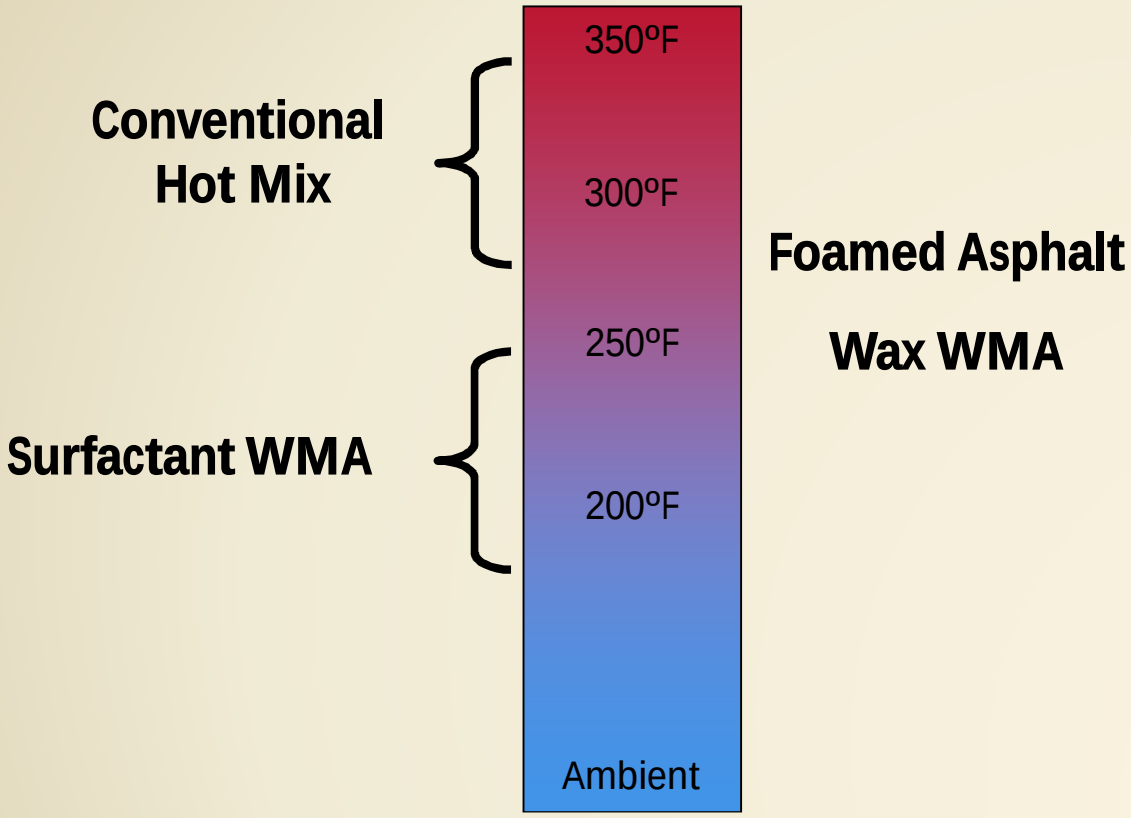
Produced at lower temperatures (30 to 100°F).

Why WMA?

**Advantages will only be realized by optimizing production operations and utilizing best practices

- Potential Advantages**
  - Energy Savings
  - Decreased Emissions
    - Visible and Non-Visible
  - Decreased Fumes
  - Decreased Binder Ageing
  - Extended Paving Season
  - Long Haul Distances
  - Compaction Aid
  - Increased RAP usage

WMA Technologies



WMA Technologies

WMA TECHNOLOGIES

- **Chemical additive**
  - reduction of internal friction between the asphalt binder, aggregate
  - Evotherm
- **Organic additive**
  - Sasobit, Sasoflex and Asphaltan B
- **Water-based additive**
  - Foaming process: water, which is added to the hot binder, turns into steam allowing the expansion of the binder. This allows the viscosity of the foamed binder to be significantly reduced.
  - WMA-Foam and the Double Barrel Green
- **Water-bearing additive**
  - induce foaming mechanisms in the asphalt binder using water bearing additives

How Does WMA Work?

- WMA technologies reduce the viscosity of the asphalt binder so that aggregates can be coated at lower temperatures.
- The key is the addition of additives (water-based, water-bearing, organic, chemical, or hybrids) to the asphalt mix.
- The additives allow the asphalt binder and aggregates to be mixed at lower temperatures.
- Reducing the viscosity also makes the mixture easier to manipulate and compact at lower temperature.

WMA Mix Design

- The procedure for selecting the aggregate gradation and optimum binder content for WMA is similar to that of HMA.
- Performance of the two mixture might be significantly different.
- Therefore, there is a need to evaluate rutting, fatigue cracking, and moisture susceptibility of WMA mixtures.
- Refer to ***NCHRP Report 691*** for more information.

WMA Mix Design

- Certain WMA additives may impact viscosity of the binder, gradation of the mixture (P200), or PG grade of the virgin binder
- Most designs can be built at HMA temperatures. Many suggest mixing & compaction temperatures should be ~250F.
- Chemical WMA designs have been built when volumetrics did not change when mixed & compacted from 190F to 240F to 310F.

WMA Mix Design

- SMA & OGFC mixtures have been designed without fibers when using low temperature WMA.
  - Rutgers & Clemson research
  - With lower temperatures, binder viscosity increases allowing reduced or eliminated drain-down
  - Balance between coating and drain-down

WMA Mix Design

- Virgin PG Grade may be adjusted when using WMA
  - Reduced binder oxidation
  - Higher recycle content may be allowed
- DOTs are changing specifications allowing more recycle or not requiring a binder grade dump when mix is produced below 275F.

Evotherm is the industry's leading warm mix paving solution.

Comprehensive additive package

Optimized to deliver

- Mixing
- Coating
- Workability
- Compaction
- Adhesion

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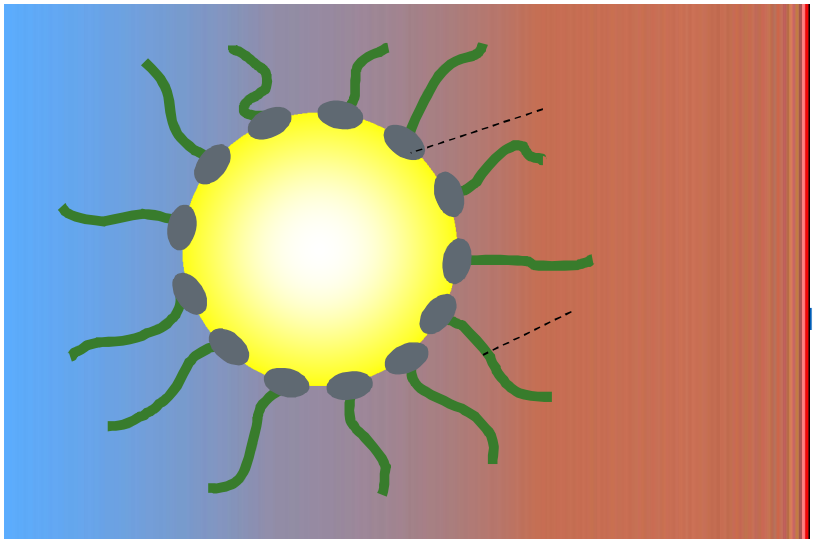
Evotherm uses natural chemicals derived from pine trees

Additives are comprised of specialty surfactants derived from pine trees

Specifically developed for use in asphalt applications

- Heat stable
- High flash point
- Low odor



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Chemical Additives

- May be added at the asphalt terminal or added at the plant
- Dosage rates depend on the selected additive

Evotherm Video

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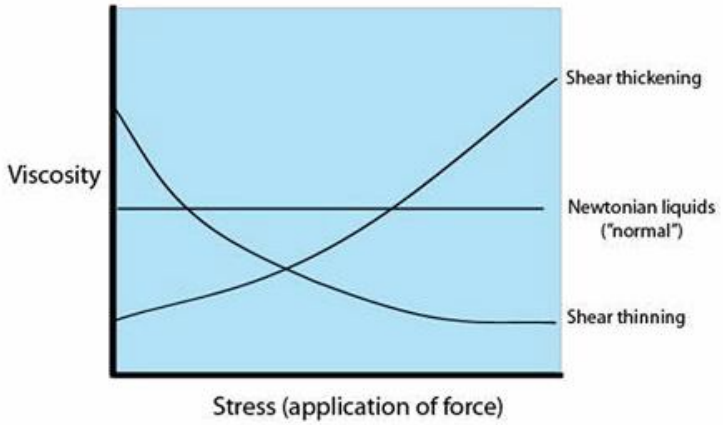
How surfactants work: washed cars & ketchup

Washed cars

- Additives improve asphalt's ability to wet (coat) aggregate at lower temperatures

Ketchup

- Additives reduce high-shear rheology of asphalt



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Surfactants reduce surface tension in water drops

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Magic Drop Test

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Ketchup demonstrates improved flow under high shear conditions

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The Evotherm Difference

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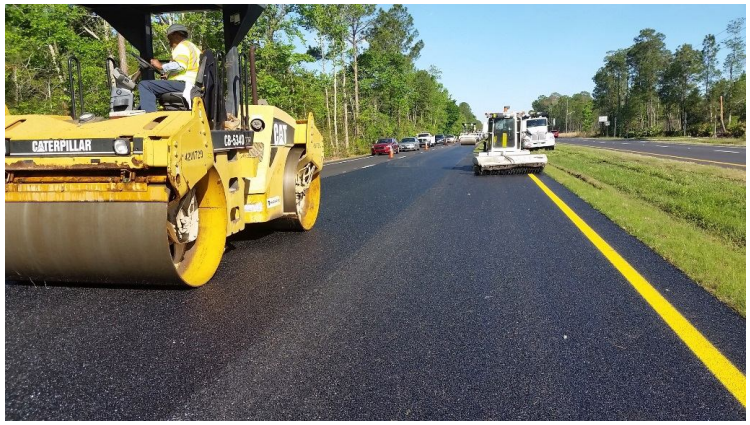
The Evotherm difference

Easy to use

Lowest temperatures

Proven performance



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The Evotherm difference

Easy to use

- Any mix plant
- No equipment to purchase or maintain
- Drop-in laboratory evaluations

Lowest temperatures

Proven performance

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The Evotherm difference

Easy to use

Lowest temperatures

- Reduced thermal segregation
- Lower emissions
- Energy savings
- Long hauls
- Extended paving season

Proven performance

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The Evotherm difference

Easy to use

Lowest temperatures

Proven performance

- Thousands of projects
- >250 million mix tons
- Projects in 50 states, more than 25 countries
- 30 million ESAL's on NCAT Test Track with less than 2 mm of rutting

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WMA Construction Differences?

- Similar to HMA
  - Uses same equipment and practices
    - Some WMA need additional equipment
  - Little to no difference in the delivery, hauling, laydown, and placement of WMA from HMA
- Construction best practices are the same and the key to performance

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WMA Construction Suggestions

- Start hot & reduce after a few loads
  - This will help heat up equipment
    - Plant
    - Trucks
    - MTV / Pick up device
    - Paver
- In order to reduce temperature contractor may increase production and/or reduce burner
- Watch amps on drag slat, coaters, etc
- Be observant of coating – visual inspection
- Tarp trucks…

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WMA Construction Suggestions

- Reduction in stack emissions

Total Organic Material reduced

Drops Benzene Soluble Matter below detectible level

Better environment for workers

50F-70F cooler than traditional HMA

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WMA Construction Differences?

- Improved compaction
  - Time available to meet density is increased
  - Allows for longer haul
  - Improved workability in low air & pavement temperature
    - Numerous WisDOT project examples of success using WMA
  - Reduction in bumps from crack seal with thin lift overlays

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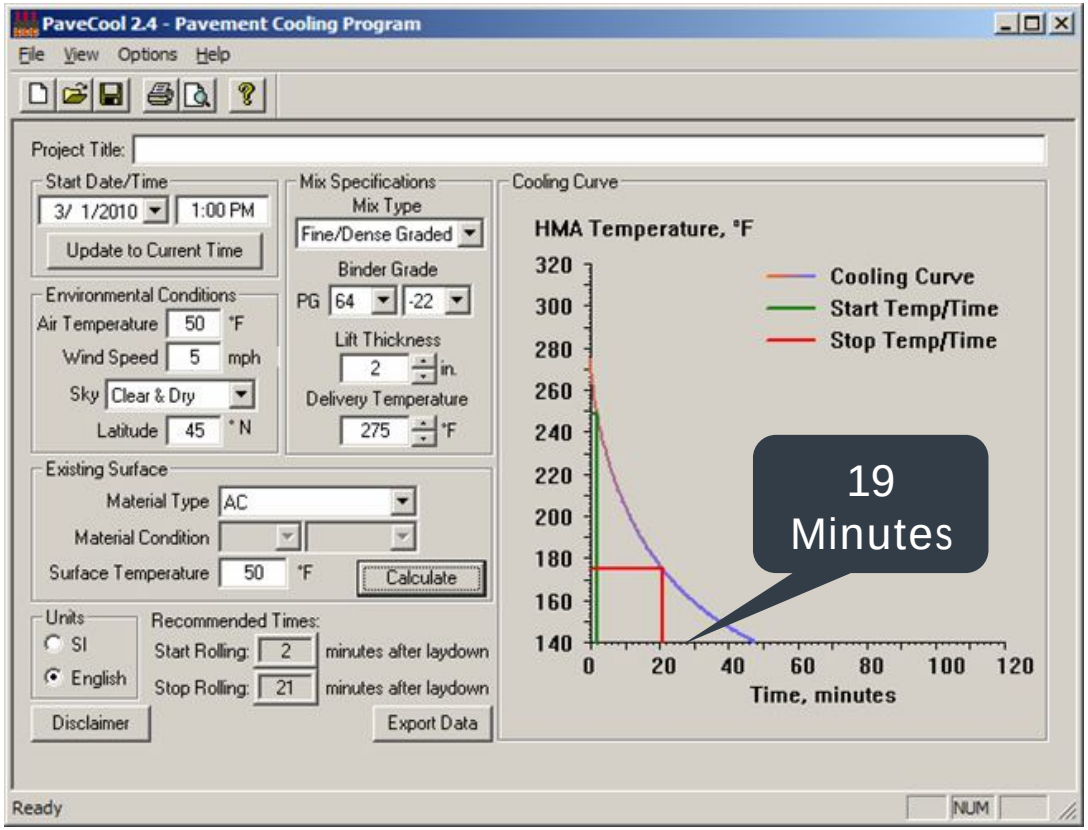
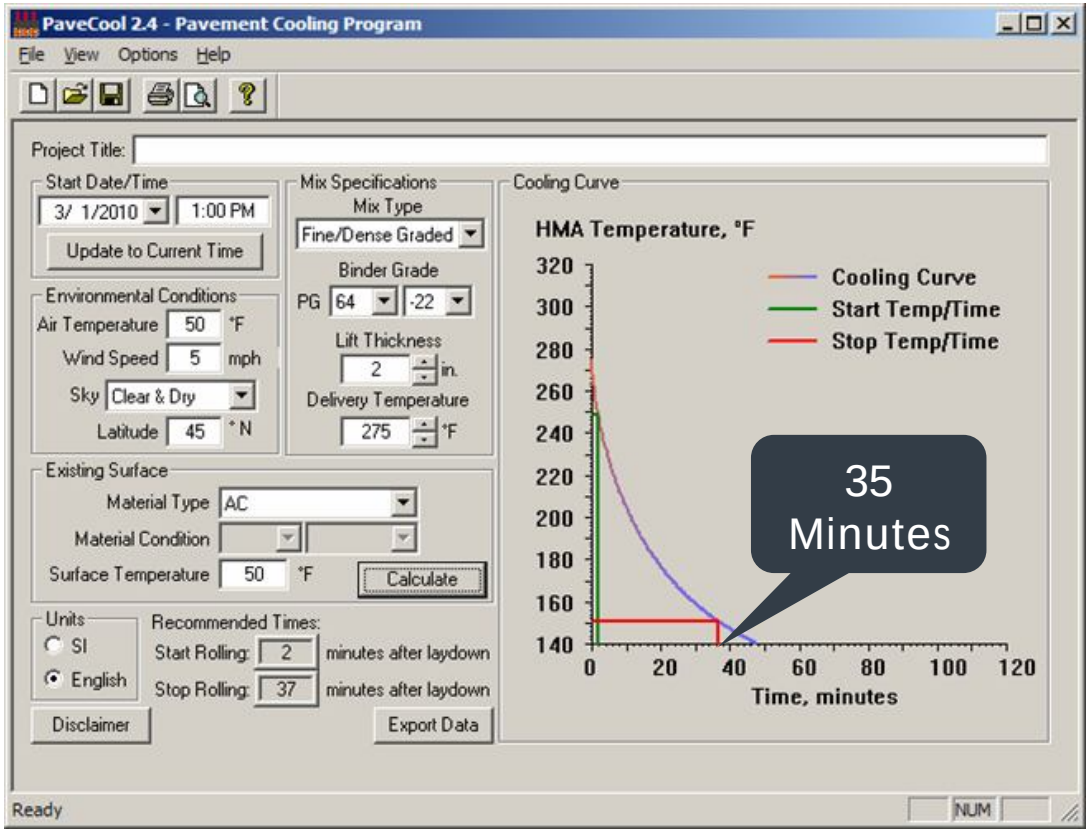
HMA at 50ºF



HMA has only 19 minutes of paving time until the minimum compaction temperature is reached.

WMA at 50ºF



WMA has 35 minutes until the minimum compaction temperature is reached.

> 80% Increase in compaction time

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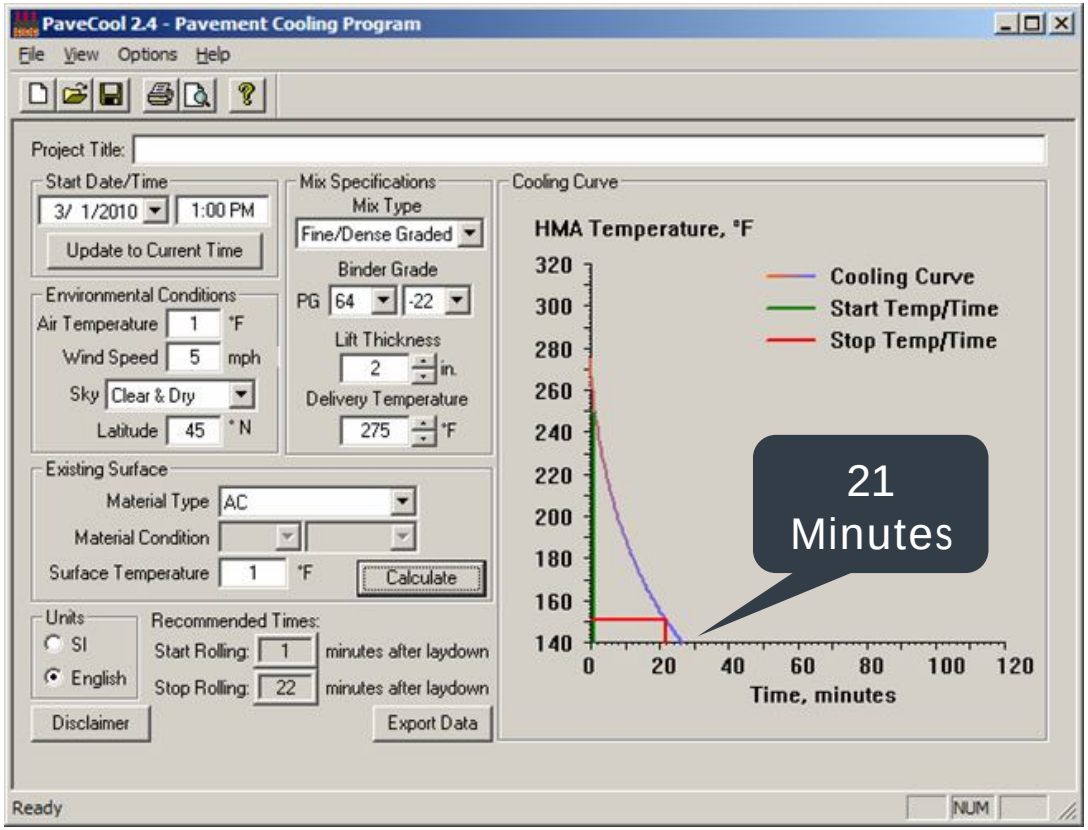
WMA at 1ºF



It would have to be 1°F outside for WMA to behave like HMA at 50 °F!

Advantages & Benefits

Advantages of Evotherm

1. Improved compaction
2. Liquid anti strip replacement & fiber removal
3. Reduced thermal segregation
4. Extended hauls and paving season
5. Increased RAP usage
6. Reduced fuel consumption and emissions
7. Longer binder life

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Improved Compaction

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Compaction aid:

Failing densities with PG64-22 HMA.

Achieved density with density bonus using Evotherm as a compaction aid.

Air temperature of 22°F with winds at 5 mph.

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Fiber replacement: SMA

THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

Rutgers University, Dr. Thomas Bennert

Evaluated HMA and Evotherm SMA mixtures with and without fibers

Less drain down

Higher fatigue resistance

Lower mixture stiffness

Lower permanent deformation resistance

Lower cost, Longer lasting roads with Evotherm

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Fiber replacement: OGFC

Clemson University, Dr. Brad Putman

Evaluated HMA and Evotherm OGFC mixtures with and without fibers

Less drain down

No moisture sensitivity

Lower cost,
Longer lasting roads
with Evotherm

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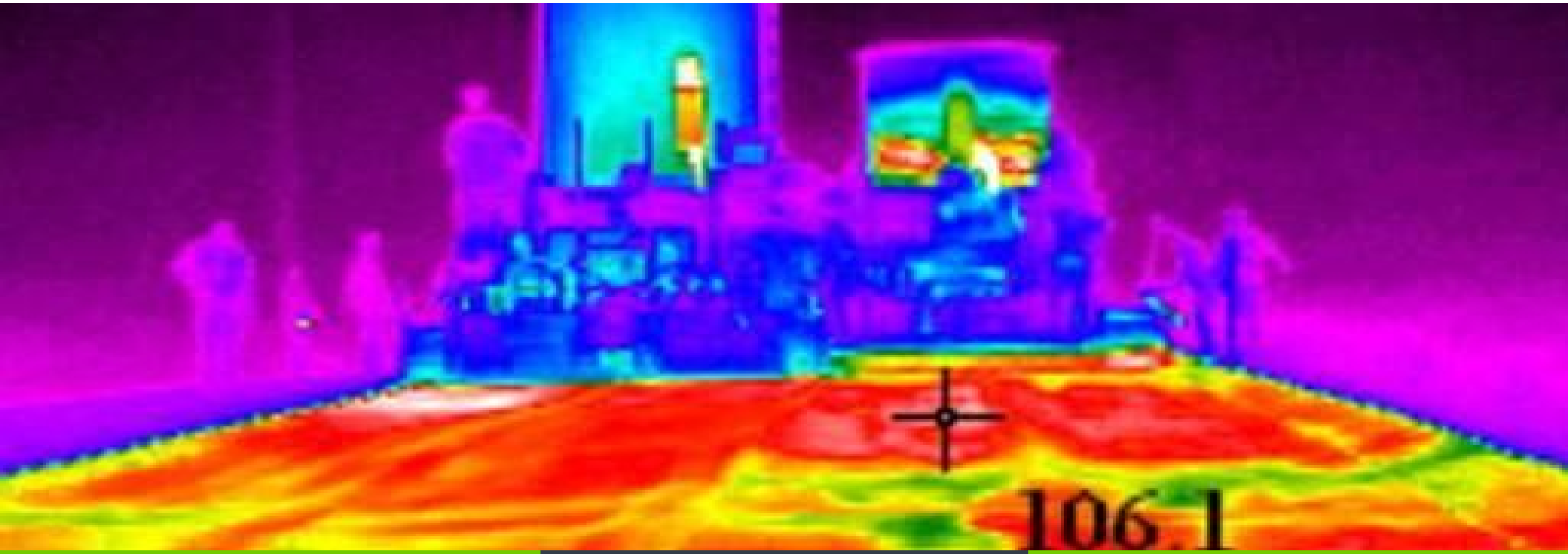

Reduced Thermal Segregation

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Thermal segregation

Associated with poor pavement performance

- Resists adequate compaction even after aggressive rolling
- Higher permeabilities due to lower density
- Lower shear strength
- Increased binder oxidation
- Reduced life of the road

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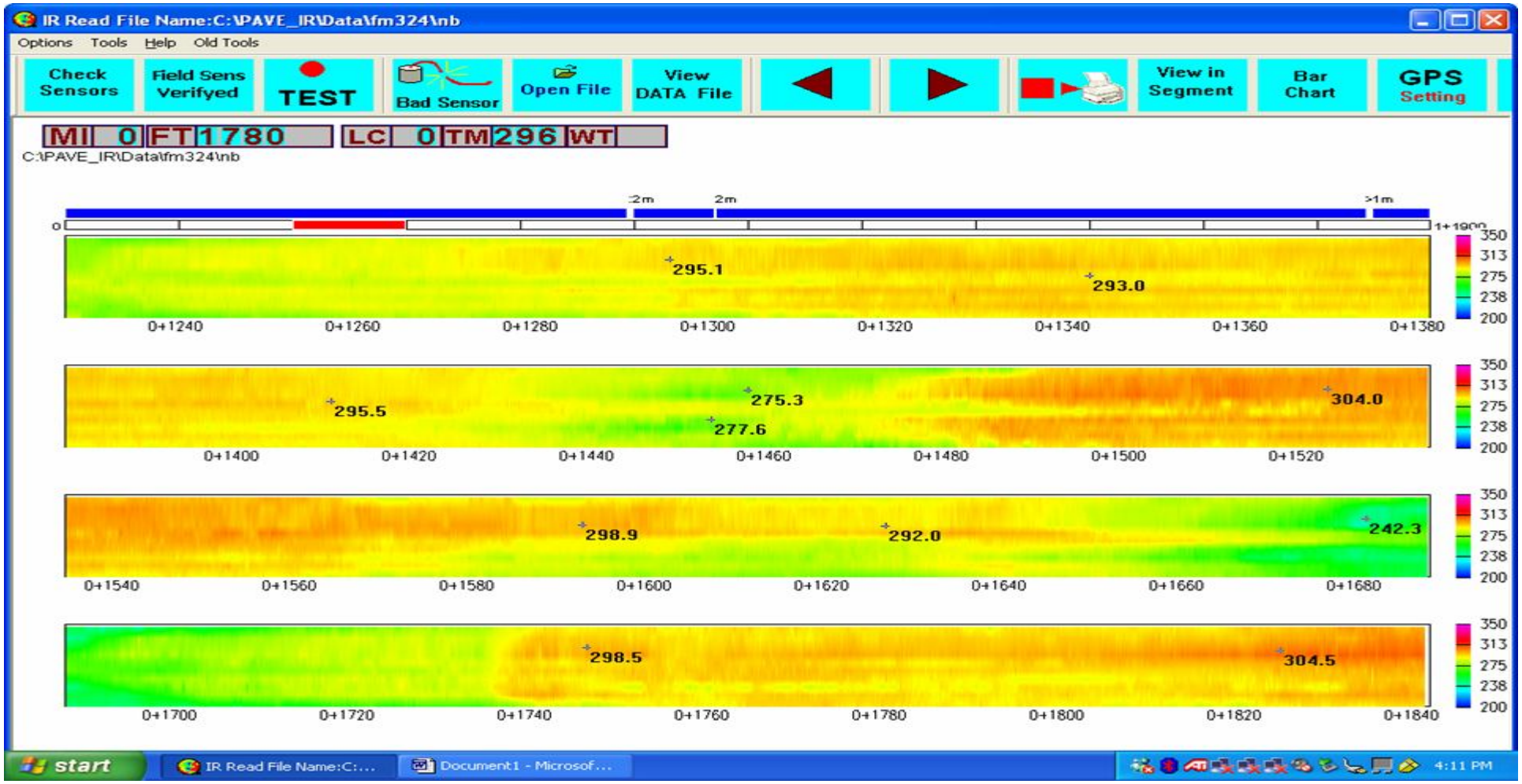

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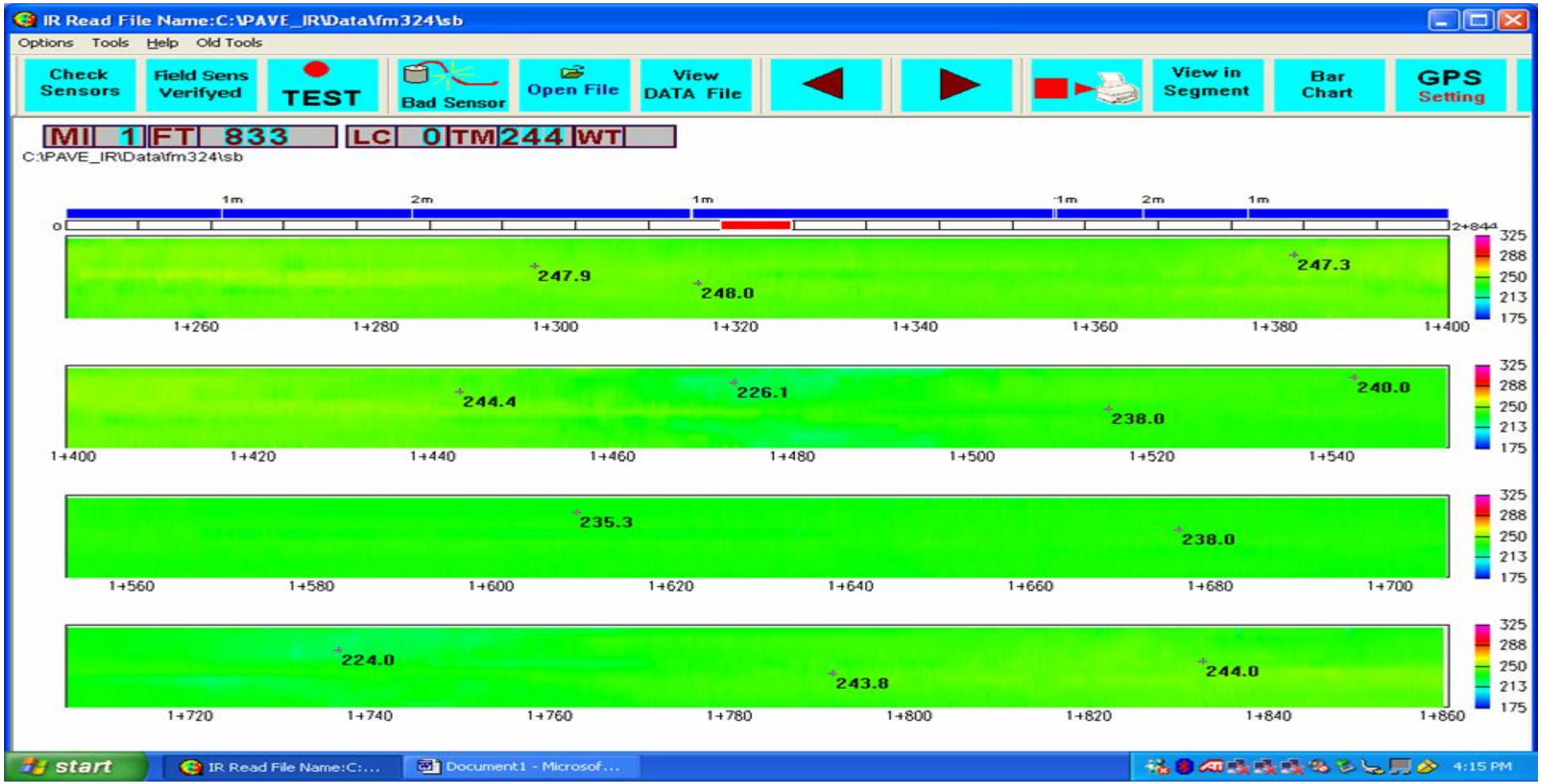

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Extended Hauls and Paving Season

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Benefits of using WMA

Late Season

- Finishing jobs
- Squeezing in extra jobs
- Emergency paving

Early Start

- Getting a jump on the competition
- Continuing large projects

Longer Day

- Starting earlier in the day
- Minimizing crew wait times
- Increasing production

Longer Haul

- Expanding market reach
- Additional bid opportunities
- Handles unexpected wait times

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Century Asphalt: no vibrations

Logistical nightmare

- Bridge deck of I-35 in downtown San Antonio, Texas
- Milling, then chip seal, then overlay
- All night paving
- Plenty of freeway intersections and ramps
- Type D mix with PG64-22, 16 percent RAP, 4 percent RAS
- No vibratory rollers allowed on bridges
- **Long truck wait times!**

Evotherm

- 70ºF drop in production temperature
- Excellent workability even with truck delays
- Rollers ran right behind the screed
- 93.5 to 94 densities

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Early start: California

- US 50 Echo Summit (near south Lake Tahoe) @ 7,382 ft
- Cold mornings with lows in the 20s
- 1½—2 hour haul (from Truckee on the north shore)
- Mix temperatures behind the screed of 210°F
- Achieved density with less effort (no falling rocks)

Don Garcia, CC Meyers, Telfer Oil, Caltrans

PG64-28, 15% RAP

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Extended season: New York City

Initial work in December 2008

- Temperature of 22°F
- Steady six mph winds
- All measurements met target of less than eight percent air voids

Full adoption for extended season

- Began in November 2011
- Evotherm with 40-50 percent RAP
- Extended paving to January 2012
- Hurricane Sandy response paving Winter 2013

New York City DOT

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Increased Usage of RAP

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Increased RAP in Missouri

	Evotherm **35%** RAP	HMA 20% RAP
Penetration	28	29
Viscosity	23,500	25,900
Ductility	42	38
DSR @ 64 C	7.56	7.35
MSCR	32	26
DSR @ 70 C	3.49	3.48

I-44 in Eureka, Mo. near St. Louis

12.5 mm Superpave mix with PG70-22 binder

Increased RAP content by 75 percent while maintaining binder properties

Excellent field workability

RAP savings of $3 per mix ton!

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Increased recycled content: Chicago

PG 58-22

37 percent RAP

5 percent RAS

- ✓ Using high amounts of RAP and RAS even in cold temperatures like 25ºF
- ✓ Reduced equipment wear and tear by lowering the production temperature to 325ºF from 365ºF (winter production temps)
- ✓ Better workability
- ✓ **SAVINGS** from lower asphalt content

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Reduced Fuel Consumption & Emissions

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Lower emissions

Hot mix

Evotherm

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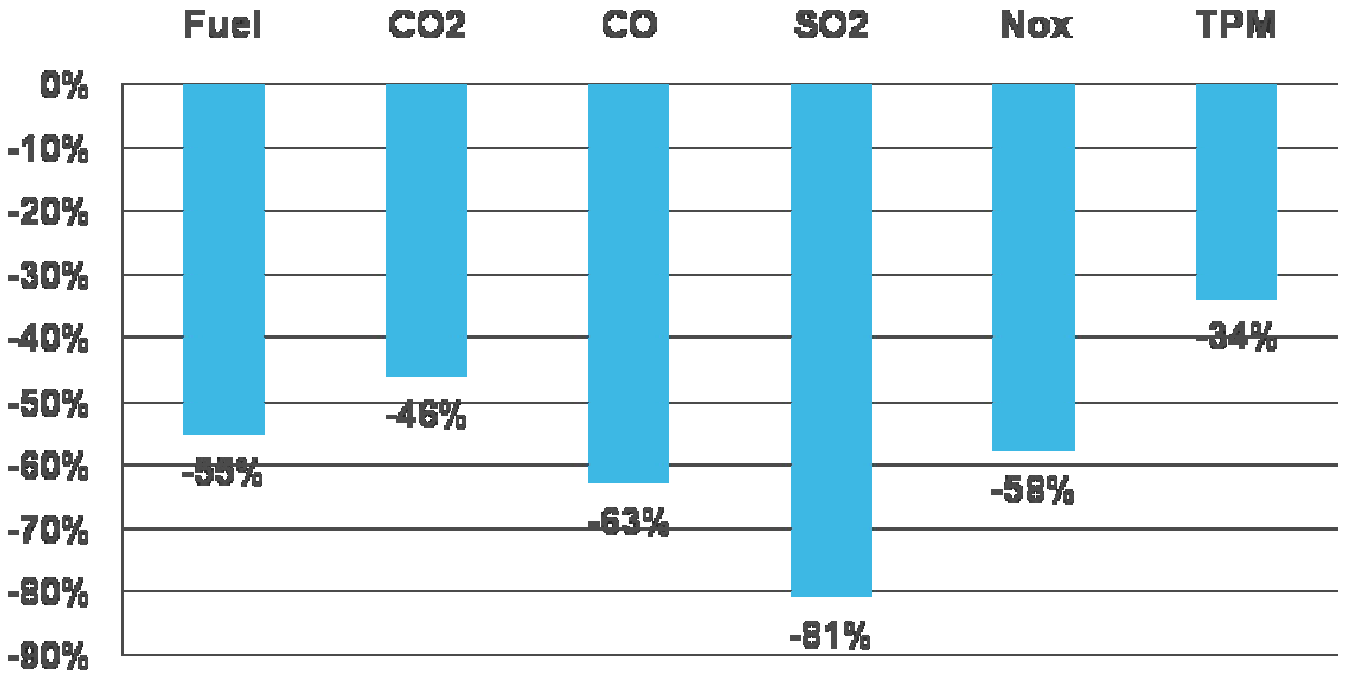
Lower stack emissions with Evotherm compared to HMA



200 °F Evotherm, 310°F HMA control

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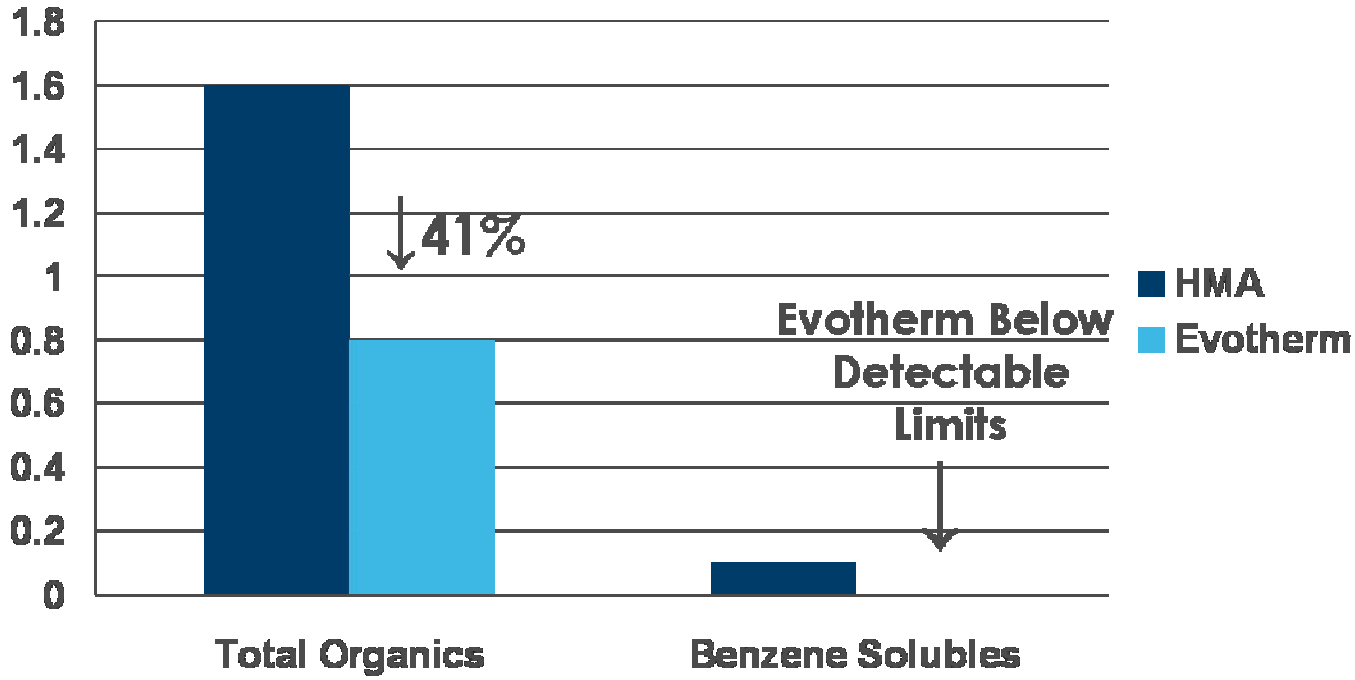
Fume exposure compared to HMA



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WMA Construction Differences?

WMA is NOT a cure for bad construction practices.

Aggregate absorption: reduced AC

Evotherm

Hot mix control

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The Evotherm Difference

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The Evotherm difference

Easy to use

- Any mix plant
- No equipment to purchase or maintain
- Drop-in laboratory evaluations

Lowest temperatures

Proven performance

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The Evotherm difference

Easy to use

Lowest temperatures

- Reduced thermal segregation
- Lower emissions
- Energy savings
- Long hauls
- Extended paving season

EVOTHERM®

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The Evotherm difference

Easy to use

Lowest temperatures

Proven performance

- Thousands of projects
- >250 million mix tons
- Projects in 50 states, more than 25 countries
- 30 million ESAL's on NCAT test track with less than 2mm of rutting

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Easy to use, lowest temperatures, proven performance

EVOTHERM®
WARM MIX ASPHALT TECHNOLOGY

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Evotherm Technical Support

Evotherm technical support team

QA/QC based approach to supporting Evotherm

Industry experienced technicians

- Mix design
- Production lab
- Plant setup of WMA equipment
- Roadway density
- Overall best paving practices
- Other WMA technologies

Capable of support on any mix or plant types

Regional approach to support

Services provided at no added cost

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Buy one, get one free

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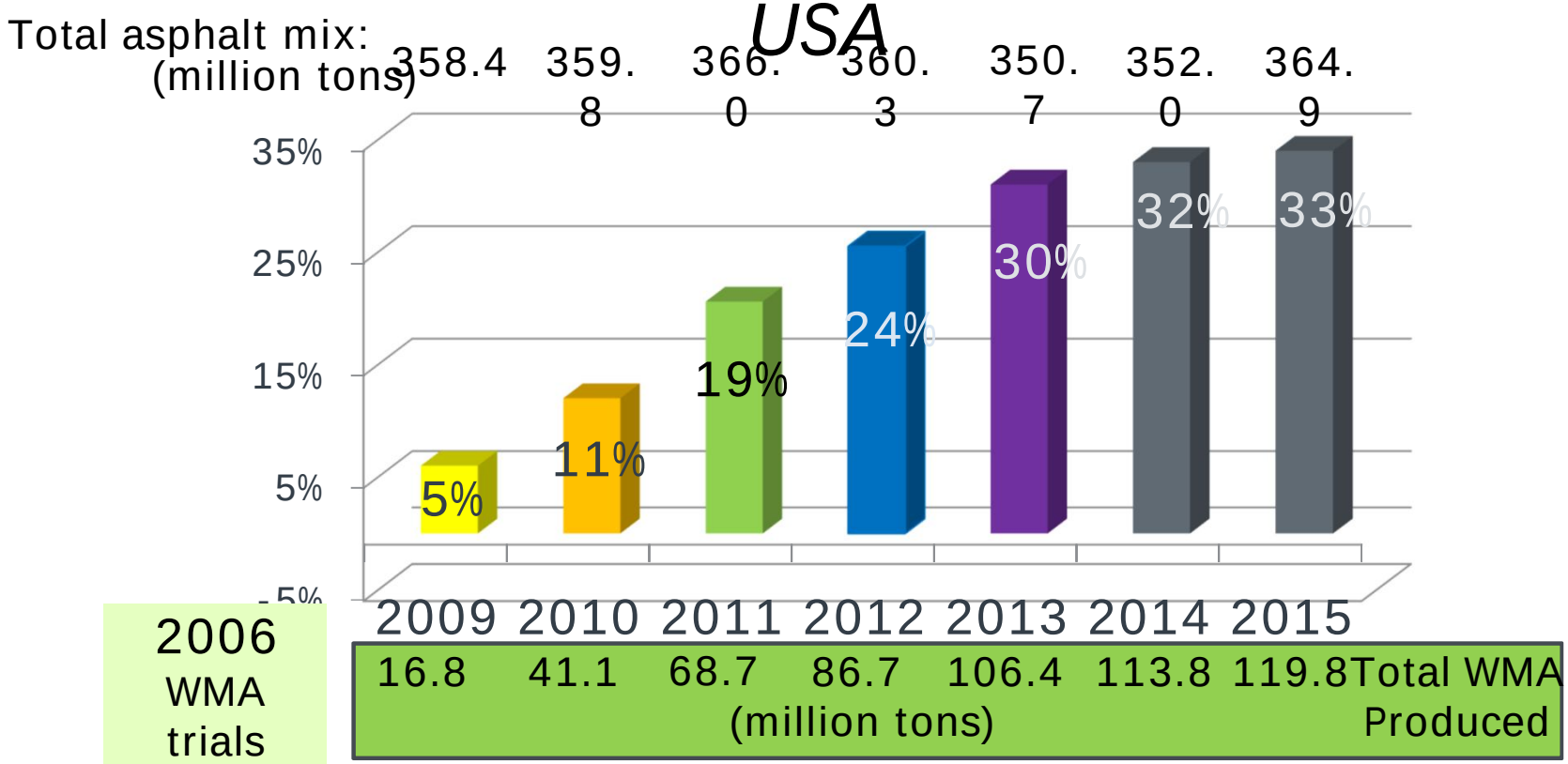
WMA Usage in HMA/WMA

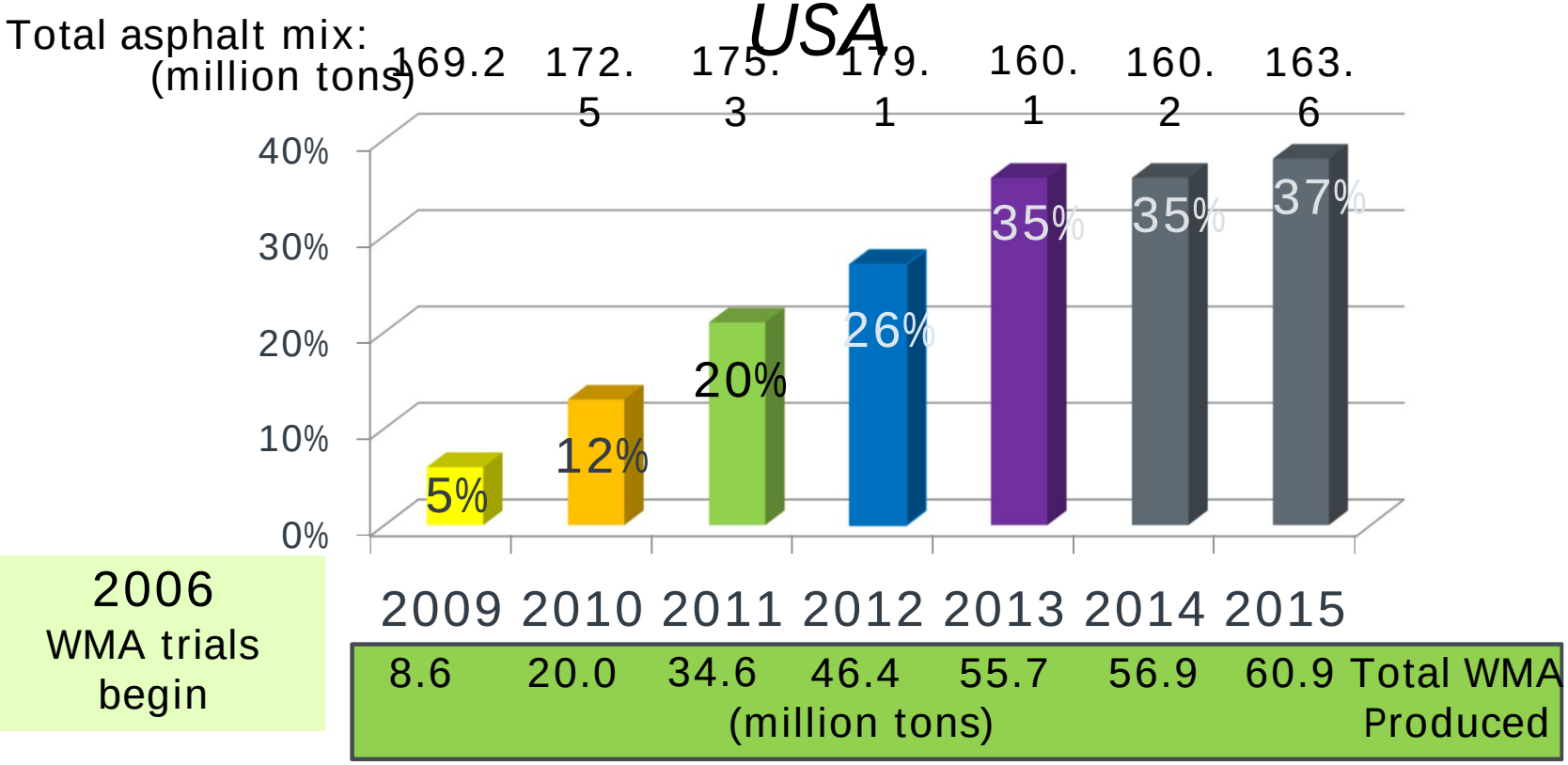
*Percentage of **Total** Mix Production in USA*



2006 WMA trials begin

State DOT WMA Usage in HMA/WMA

*Percentage of **State** Mix Production in USA*



2006
WMA trials begin

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Questions?

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