• What are indicators & measures of growth?
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• What’s next?
1. The number of warm mix projects increases:
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<table>
<thead>
<tr>
<th>Location</th>
<th>Grade</th>
<th>Mix Details</th>
<th>Performance</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indianapolis, IN</td>
<td>PG 64-22</td>
<td>12.5 Dolomite, 10%RAP</td>
<td>680</td>
<td></td>
</tr>
<tr>
<td>Toronto (Aurora), Canada</td>
<td>PG 58-28</td>
<td>19.0 LS base &amp; 9.5 LS surface</td>
<td>510</td>
<td></td>
</tr>
<tr>
<td>Kansas City, MO</td>
<td>PG 64-22</td>
<td>12.5 LS surface</td>
<td>330</td>
<td></td>
</tr>
<tr>
<td>Beijing, China</td>
<td>AC 20</td>
<td>13.2 LS surface</td>
<td>220</td>
<td></td>
</tr>
<tr>
<td>Calgary, Canada</td>
<td>120/150 pen</td>
<td>12.5 Silicate surface</td>
<td>750</td>
<td></td>
</tr>
<tr>
<td>Greenwich, NY</td>
<td>AC 20</td>
<td>12.5 Dolomite surface</td>
<td>500</td>
<td></td>
</tr>
<tr>
<td>Toronto (Remara), Canada</td>
<td>PG 58-28</td>
<td>16.0 LS surface</td>
<td>1100</td>
<td></td>
</tr>
<tr>
<td>NCAT Test Track, AL</td>
<td>PG 67-22 &amp; PG 76-22*</td>
<td>9.5 G**/LS surface &amp; 12.5 G/LS base</td>
<td>270</td>
<td></td>
</tr>
<tr>
<td>San Antonio, TX</td>
<td>PG 64-22 &amp; PG 84-22*</td>
<td>9.5 LS surface</td>
<td>740</td>
<td></td>
</tr>
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1. The number of warm mix projects increases: by 2007, over 75 Evotherm projects worldwide in China, Europe, & North America closing in on 100,000 tons
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   by 2007, over 75 Evotherm projects worldwide in China, Europe, & North America closing in on 100,000 tons

   **2008 forecast:** 500,000 – 1,000,000 tons
1. The number of states with projects increases:
in the US alone, the majority of states have had
WMA projects.
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US States that have conducted WMA Projects

Escondido
Stockton
Aromas
Oreville
San Luis Obispo
…. more

Indicators & measures of growth 1-4
Performance results 1-3
Reasons for growth 1-3
What’s next
2. Numerous municipalities, states, provinces, & countries are accepting provisional, supplemental specifications for WMA:
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PA has created a “model” WMA specification
3. Proliferation of WMA technologies:

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2005: There were three WMA technologies:
- Aspha-min – foam zeolite
- Sasobit – wax
- Evotherm – surfactant
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- Aspha-min – foam zeolite
- Sasobit – wax
- Evotherm – surfactant

2008: > 16 WMA Technologies
4. Federal, state, & association support increases to formalize tests, specs, & designs for WMA:

NCHRP studies due in ’08 & ’09
9-43 $0.5 MM;
9-47 $1.2 MM (D-18);
D-19 $0.4 MM “Eval. of emission/fumes of WMA”
candidate for funding

NAPA “Best Practices Manual”

NAPA formalization of testing for emissions/fumes
4. Federal, state, & association support increases to formalize tests, specs, & designs for WMA:

Standardization of WMA use:
“Best Practices Manual”
published by National Asphalt Paving Assocation

German “Merkblatt” for WMA est’d by BASf
1. Sustainability continues as key driver

- Indicators & measures of growth 1-4
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- What’s next
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   Reduction in fossil fuel consumption
   Dense-graded batch mixes use $\frac{1}{2}$ the fuel of HMA
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   Reduction in fossil fuel consumption
   Dense-graded batch mixes use ½ the fuel of HMA
   Reduction in emissions & fumes
   Stack emissions dropped by ½ the level of HMA
   Paver fumes reduced by ½ compared to control
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   Reduction in emissions & fumes
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Emissions & fumes studies from several testing labs have substantiated these emissions & fumes reductions.
2. Improved compactability of WMA technologies has driven interest in high-altitude paving, cold-weather paving, & use with coarse mixes.
3. Good performance in lab & field as regards three main pavement failure modes:
   - Deformation
   - Cracking
   - Moisture damage
PERFORMANCE: NO DEFORMATION

Tandem-wheel truck tire, 40kN (9000 lb) load; Pavement temperature is 50 ± 4°C at 50 mm below surface

Research conducted by David Jones, University of California Pavement Research Center, Davis, California, for California Transportation Dept.
PERFORMANCE: NO DEFORMATION

HEAVY VEHICLE SIMULATOR TESTING

Research conducted by David Jones, University of California Pavement Research Center, Davis, California, for California Transportation Dept.
PERFORMANCE: REDUCED CRACKING

Small cut (mouth) made in specimen

Sinusoidal load applied

ASTM 7313-06 is also known as Disk-Shaped Compact Tension Test or the DC(T) test

Research conducted by Prof. William Buttlar, University of Illinois, & P. Blankenship, Asphalt Institute
~ 50% Higher fracture energy (resistance to Crack-Mouth Opening Deformation, CMOD) may be due to the lower heat-induced binder aging in Evotherm mixes compared to HMA controls.

Research conducted by Prof. W. Buttlar, University of Illinois, & P. Blankenship, Asphalt Institute
Specifications & mix design protocol created

Much larger individual projects

More WMA overlay of distressed PCC with rubberized crack filler

Asphalt Rubber WMA

High-RAP WMA

Indicators & measures of growth 1-4  
Reasons for growth 1-3

Performance results 1-3  
What’s next
THANK YOU