PAVING WITH PLASTIC
• Trade Association representing asphalt industry

• NAPA’s Mission
  • Support
  • Advocate
  • Advance

What Is NAPA?
Sustainability
• Three E’s
  • Engineering
  • Economics
  • Environment

• FHWA, 2015

FHWA Recycling Policy
Current Status

Plastic Waste Management: 1960-2017

(EPA, 2020)
• Social media explosion
• Washington Post
• The Economist
• Addressing America’s Surface Transportation Infrastructure Needs
• American Chemistry Council
• Plastics Industry Association

When Asphalt Went Viral
- Reclaimed asphalt pavement
- Recycled asphalt shingles
- Recycled tire rubber
- Plastics?

Recycling Responsibly
## It’s Just Plastic, Right…?

<table>
<thead>
<tr>
<th>Number</th>
<th>Type</th>
<th>Application</th>
<th>Melting Point (F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Polyethylene Terephalate (PET)</td>
<td>Water Bottles</td>
<td>&gt;482</td>
</tr>
<tr>
<td>2</td>
<td>High Density Polyethylene (HDPE)</td>
<td>Plastic bags</td>
<td>266 but can vary</td>
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<tr>
<td>3</td>
<td>Polyvinyl Chloride (PVC)</td>
<td>Pipes</td>
<td>212-500</td>
</tr>
<tr>
<td>4</td>
<td>Low Density Polyethylene (LDPE)</td>
<td>Trays</td>
<td>230-248</td>
</tr>
<tr>
<td>5</td>
<td>Polypropylene (PP)</td>
<td>Hinges</td>
<td>320-330</td>
</tr>
<tr>
<td>6</td>
<td>Polystyrene (PS)</td>
<td>CD Casing</td>
<td>GS at 212</td>
</tr>
<tr>
<td>7</td>
<td>Others</td>
<td>Baby bottles</td>
<td>---</td>
</tr>
</tbody>
</table>
Plastic Breakdown in MSW

(DuBois, 20202; based on EPA, 2017)
• Plastics Recycling
• Collection
• Shredding
• Washing
• Decontamination

• Significant investment needed
When In Doubt ... Do A Lit Review

### Number of Literature Documents

<table>
<thead>
<tr>
<th>Category</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory Testing</td>
<td>87</td>
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<tr>
<td>Field Project</td>
<td>28</td>
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<tr>
<td>Literature Review</td>
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<td>Cost Analysis</td>
<td>4</td>
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<td>Pavement Design</td>
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<td>Product Introduction</td>
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<td>Accelerated Pavement Testing</td>
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<td>Agency Specification</td>
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<td>Wet Process</td>
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<tr>
<td>Dry Process</td>
<td>35</td>
</tr>
<tr>
<td>PE (LLDPE, LDPE, HDPE)</td>
<td>80</td>
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<tr>
<td>Proprietary Product</td>
<td></td>
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<tr>
<td>PS</td>
<td></td>
</tr>
</tbody>
</table>
- Wet Process
  - Modification or replacement?
  - 2 – 8% by weight of binder
  - Low melting point needed
- Dry Process
  - Aggregate replacement
  - Mixture modifier
  - Aggregate modifier
  - 0.2 – 1% by agg weight
• Binder Performance
• Plastic stiffens asphalt binder
• Little data on fatigue
• Little data on low-temperature
• Phase separation tendencies
• Additives may help
• PE insoluble in many solvents

Laboratory Binder Testing
• Marshall stability
  • Increased Marshall stability
• Increased stiffness
• Increased rutting resistance
  • Wet – Stiffer binder
  • Dry – Increased agg friction
• Moisture damage
  • Positive or no impact

Laboratory Mixture Characterization
• Most documentation on plant operations relates to Novophalt®
• High-shear blending unit
• One study documented construction
  • Difficult to compact
  • Heavy rollers required
• French construction
  • Temperature sensitive, but compaction not an issue
• Two potential concerns in literature
  • Leaching of toxic components
  • No adverse effects (one study)
• Chlorine-based gases from PVC
• Environmental Benefits
  • Preservation of resources
  • Reduction of solid waste
  • Emission reduction
• Environmental Concerns
  • Future recyclability
  • Ongoing work
• 200 Field Projects in Literature
  • Improved rutting
  • More cracking
• New field projects
  • India
  • Australia
  • Canada
  • New Zealand
  • And More...
• Sourcing of plastics
• Methods of incorporation
  • Modifier or replacement
• Binder characterization
• Mixture characterization
• Plant operations
• Construction
• H&S
• Environmental
• Field performance

Knowledge Gaps
• Patience
• Partnership
• Communication

Moving Forward
RECycled Plastics in asphalt Part A:
State of the Knowledge

Richard Willis, PhD
Fan Yin, PhD, PE
Raquel Moraes, PhD

RECycled Plastics in asphalt Part B:
Literature Review

Fan Yin, PhD, PE
Raquel Moraes, PhD
Anurag Anand
- NCHRP 9-66
- FHWA Project
- Field Projects
  - California
  - Texas
  - Michigan
  - Wisconsin
  - Pennsylvania
  - More…

What’s Happening
THANK YOU!

RWILLIS@ASPHALTPAVEMENT.ORG