PRODUCTION AND PLACEMENT

WMA Implementation Workshop
Overview

- Consider mixture characteristics and costs
- Review of materials costs
- Determine the bottom line
Characteristics to Consider

- Ability to carry applied stresses
- Workability – handwork, feathering, compactability
- Lift thickness – t/NMAS ratio, lane drop-off
- Aesthetics - smoothness and texture
- Friction
- Noise
- Durability

Refer to NAPA IS 128
Costs to Consider

- Cost of component materials
- Equipment rental or depreciation to add components
- Drying costs of materials
- Productivity (tons/hr)
- Haul/delivery costs
- Placement and compaction costs
- Potential of acceptance/pay penalties
## Mix Production Costs

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depreciation</td>
<td>$1.24</td>
</tr>
<tr>
<td>Maintenance</td>
<td>$1.13</td>
</tr>
<tr>
<td>Labor</td>
<td>$1.79</td>
</tr>
<tr>
<td>Energy/Drying</td>
<td>$2.87</td>
</tr>
<tr>
<td>Electric Power</td>
<td>$0.04</td>
</tr>
<tr>
<td>Equipment</td>
<td>$0.97</td>
</tr>
<tr>
<td>Aggregate</td>
<td>$11.27</td>
</tr>
<tr>
<td>Asphalt</td>
<td>$20.57</td>
</tr>
<tr>
<td>Other</td>
<td>$0.44</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$40.31</strong></td>
</tr>
</tbody>
</table>
### Purchase Price of Materials

**Example**

<table>
<thead>
<tr>
<th>Material</th>
<th>$/ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>#67 stone</td>
<td>12.70</td>
</tr>
<tr>
<td>#78 stone</td>
<td>13.50</td>
</tr>
<tr>
<td>#89</td>
<td>11.00</td>
</tr>
<tr>
<td>Washed #10s</td>
<td>13.00</td>
</tr>
<tr>
<td>Natural sand</td>
<td>10.75</td>
</tr>
<tr>
<td>Hydrated Lime</td>
<td>160.00</td>
</tr>
<tr>
<td>RAP (4.5% binder)</td>
<td>7.45</td>
</tr>
<tr>
<td>PG 67-22</td>
<td>410.00</td>
</tr>
</tbody>
</table>
Hidden Costs of Aggregates

- How much water are you buying?
- How much does it cost to dry the aggregate?
- How much material is wasted or lost?
- What is the asphalt demand for the aggregate?
Cost of Dry Aggregate

$/dry
ton = ($/wet
ton) \times (1+w/100)

Example:

5000 tons of W10’s purchased from a quarry at $13.00/ton. The W10’s had 5.6% moisture at delivery.

$/dry
ton = ($13.00/ton) \times (1+(5.6/100))
$/dry
ton = $13.00/ton \times 1.056 = $13.73

Dry inventory = 5000 tons/(1+w/100)
= 4734 tons
Handling Costs, Including Loss

- Handling costs
  - Stockpiling equipment and space
  - Inventory management

- Loss - all materials purchased do not end up in a finished (sold) product
  - Purchased moisture
  - Yard waste
  - Plant waste
  - Theft
Production Costs

- Depreciation
- Maintenance
- Labor
- Drying
- Electric Power
- Equipment
Drying Costs

![Graph showing the relationship between moisture content and gallons of fuel per ton, with lines for Parallel Flow, Counter Flow, and Double Barrell.]

What is the current cost of fuel?

Astec T-119 Dryer Drum Mixer
Do Covered Stockpiles Payoff?
Moisture

- 1% increase in moisture increases drying cost by 10 to 12%
- 1% increase in moisture decreases production rate by 11%
- Which material stockpiles retain the most moisture?
Plant Diagnostic Tool

- http://www.pahotmix.org/images/bobfrank.swf
Estimated Reduction in Emissions

![Graph showing CO2 emissions (lbs/ton mix) vs. mix temperature (°F). The graph includes lines for different fuel types and moisture contents, indicating a shift in fuel type and moisture content.](image-url)
Special Equipment for Additives
Warm Mix Asphalt

- Cost Additions/Cost Savings: Rules of Thumb
  - Potential Savings
    - Burner fuel
    - Improved in-place density
    - Less wear on plant?
    - Slightly lower asphalt content?
    - Better work environment - improved productivity
    - Higher RAP contents
  - Potential Additions
    - WMA additive
    - Plant modification
    - Anti-strip additive
Hauling & Placement Costs

- Trucking
  - Release agents
  - Tarping & insulation
  - Clean out
- Material Transfer
  - Mix Transfer Vehicle
  - Windrow Sizer
- Paver
- Rollers
- Labor

- Balancing Production and Paving
- Multicool or Pavecool
Production of WMA

- Same plants, may be modified in many cases
- Same hauling and laydown equipment
- Same compaction equipment
Adequate Baghouse Temperatures Must be Maintained

- Low baghouse temperature can cause condensation
  - Corrosion of the baghouse
  - Formation of damp baghouse fines
- Acceptable baghouse inlet temperatures
  - > 220°F for low-sulfur fuels
  - > 240°F for high-sulfur fuels (reclaimed oils)
  - Varies from plant to plant and mix to mix
Maintaining Baghouse Temperatures

- Seal air leaks
- Preheat the baghouse for 15 to 20 minutes
- Inspect fine return lines for buildup
- Occasionally paint corroded interior surfaces with epoxy-based paint
Burner Adjustments

- Burner may need to be tuned to run efficiently at lower temperatures
- Improper burner adjustment can cause the burner to not add enough air to burn all of the fuel
  - Expensive
  - Mix contamination
Signs of Unburned Fuel

- Brown film around coated aggregate
- Increased susceptibility to rutting
- Lower dynamic modulus (E*) values
- Increased carbon monoxide (CO) levels
- Fuel in baghouse
Differences with WMA Production

- Addition of the WMA additive or foaming the binder
- Setting the production temperature
  - Start production at normal HMA temperatures, then decrease the temperature to the WMA target
Astec Double Barrel Green Foaming System

- One pound of water per ton of mix, or about two percent of the asphalt flow rate. This is 0.05% moisture in the mix.
Foaming Warm Mix Process

- Existing AC Pump
- Expansion Chamber
- Water Tank
- Water Pump
- Counterflow Drum
- Existing AC pipe
- Foam Injection pipe running along side existing AC pipe
WMA Dosing

- Refer to product manufacturer for dosage rates
- Ensure injection systems are cleaned and calibrated regularly for accurate dosing
Removing Moisture

- Increase aggregate retention time
- Insulate dryer shell
- Use variable frequency drive (VFD)
- Reduce stockpile moisture content
Plant Addition of Aspha-min
Plant Addition of Sasobit
Chemical Additives

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

Plant burners may not be properly tuned even for normal HMA production

Incomplete fuel combustion leads to:

- Poor fuel efficiency
- Fuel contamination of the mix (liquid fuels)
- Stack emission problems (CO and THC)
- Potential for a baghouse fire
WMA Production Concerns

- Amperage on motors for drag slat conveyors, coaters, etc.
- Incomplete coating of aggregate
Plant Concerns with WMA

- Condensation in the baghouse could cause:
  - Mudding of the bags
  - Increase draw on exhaust fan motor
  - Formation of corrosive acids with gases from high sulfur fuels

\[ \text{H}_2\text{SO}_4 \]
Other Concerns with WMA

- Activation/melting of RAP or RAS binder at lower temperatures
- Additional expense
- One more material/process to control
WMA Mix Test Concerns

- Lower mix temperature results in less aging of the binder that could result in increased:
  - Moisture susceptibility
    - Lower tensile strengths
    - TSRs
  - Rutting potential
    - APA
    - Hamburg
    - Flow Number
Combining WMA & RAP

- Superheating solves baghouse problem without plant modification or efficiency loss
- Superheating assures virgin aggregates are dried
- Provides the greatest economic and environmental benefit
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Combining WMA and RAP

- WMA technologies can improve the ability to properly coat aggregates and RAP during production.
- Lower production temperatures will reduce plant aging of binders which may allow for increased use of RAP without grade bumping.
Rate of Cooling Variables

- Layer Thickness
- Air Temperature
- Base Temperature
- Mix Laydown Temperature
- Wind Velocity
- Solar Flux
Example Paving Temperature Decrease

Hot Mix 314 °F

Aspha-min Mix 254 °F

138.1 pcf

138.5 pcf
Better Work Environment

- Studies to quantify fumes have shown that WMA:
  - Reduces Total Organic Material > 90%
  - Drops Benzene Soluble Matter below detectible limits
Better Temperature Uniformity

- The key is getting density and getting it uniformly
Compactive Effort

- WMA has been seen to require less compactive effort even with the lower temperatures
- Changes may need to be made with WMA due to higher densities
  - Change rolling pattern
  - Decrease binder content
- Check with non-destructive device calibrated to cores
Temperature Segregation

- Temperature differentials in the mat can cause density problems.
  - Temperature differentials exceeding 30°F can cause an 80% reduction in fatigue life (NCAT).
  - TTI recommends keeping temperature differentials below 25°F.
Infrared (IR) Bar

- Collects and displays pavement temperatures across the mat.
- Allows for corrections to improve overall uniformity
HMA: 62° Difference
WMA: 24° Difference
Making Field Adjustments to Mixes

- It is almost a certainty that any mixture will require some adjustments to meet acceptance targets (air voids, asphalt content, etc.)
- Differences between the lab mix design and plant produced mix can be caused by:
  - Changes in the aggregate properties
  - Breakdown of aggregate through the plant
  - Incomplete drying
  - Surges in baghouse fines return
  - Differences in aging and absorption
  - Inaccurate plant calibration
  - Different laboratory equipment
  - Different technicians
Making Field Adjustments to Mixes

- Maintain current data on stockpile gradations. This will provide a heads up on changes from the mix design.
- Make sure plant is “leveled out” before taking a mix sample. For most plants, this takes about 80 to 100 tons.
- Conduct tests to determine Pb, gradation, Gmm, and Gmb
WMA is not a cure for bad construction practices!
Additional Resource