

Northeast Pavement Preservation Partnership  
Annual Meeting  
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# Cold RAP Recycling

Scott Nazar  
Materials Innovation Management



# Two methods to Produce Cold mix

1. Cold Recycled RAP
  - Plant mixed (cold pug-milled)
  - Paver-mixed (crushed RAP 9.5mm)
2. Cold In place



# Cold RAP Mix Recycling

- Utilizes Surplus Stockpiled RAP Material.
- Can be used to Pave Low-Volume “Dirt” Roads.  
or projects where complete Pavement removal is  
required to Stabilize Subgrade
























# District 1-0 Cold Recycling Operation

- District 1-0 annually paves 70 to 76 miles of secondary roads with cold pug-milled recycled material.
- This RAP material is retained from interstate projects, betterment projects and some maintenance contracts within the District.
- Millings From Federally funded projects are considered a District resource, and may be moved to meet unmet needs.
- Milling are strategically stockpiled at locations near planned work.
- Cold Recycled paving is primarily utilized on four (4) digit State Routes with ADT's up to 3,000.
- District 1-0 has begun using Cold Recycled Pavement on three digit SRs with ADTs up to 5,000, with 10% or fewer trucks.

# The DOT Crew

- DOT Crews are non-traditional maintenance, specialized crews that draw members from a number of counties and perform work across county lines.
- In District 1-0 these crews perform major Department force activities such as cold recycled paving/widening /shoulders and sealcoat, as well as some hot mix paving.
- The goal of these teams is to increase efficiency in several ways: maximizing the use of equipment, combining and sharing the expertise of individuals and organizations, and preparing detailed plans and organizing of the needed resources.

# The DOT Crew

								
Flagger TEOA	Tri Axle TEOB	Tri Axle TEOB	Tri Axle TEOB	Tri Axle TEOB	Tandem TEOB	Tandem TEOB		
								
Paver TEOB	Laborer TEOB	Laborer TEOA	10-T Roller TEOB	RT Roller TEOB	10-T Roller TEOB	Flagger TEOA		
								
Foreman FM3	Loader TEOA	Lg. Loader TEOB	Laborer TEOA	Pugmill TEOB	SA/Tow Brm TEOB	Pugmill Rental	Ex/Dozer County	Crusher Rental
<b>County Provided</b>								

# Material Processing

- Stockpile good and marginal material separately



# District 1-0 Cold Recycling Operation

- RAP crushed to a top size of 1" or 1.25"





# District 1-0 Cold Recycling Operation

- Pug-mill discharging material into truck



# District 1-0 Cold Recycling Operation

- Efficient delivery of material is critical
- Use conventional paving practices



# Paving

- String line to maintain alignment
- Perform depth & yield checks to control lift thickness



# District 1-0 Cold Recycling Operation

- Allow material to break prior to rolling
- Begin rolling on low side
- Use control strip with Non Nuclear Density gauge



# Compaction

- Aggregate applied to surface after initial rolling to reduce material pick-up (Optional)



# Production

- 2000 to 2500 tons per day (7.5 to 8 hours)
- Crusher output controls max production.
- Influenced by number of trucks and cycle time (planning component).
- 30 minutes maximum haul time.
- Supplement crew with host county trucks (10' 8" min. height adjustment to pug-mill).

# District 1-0 Cold Recycling Application

- Paving gravel roads
  - Remove crown first
  - 550 lbs/SY
- Leveling course on Low Volume Roadway
  - 200 – 350 #/SY
- Widening
  - Equal to or greater than existing pavement structure

# District 1-0 Cold Recycling Costs

**'08-09**

Production =	753,059.00	SY
Prod hours =	29,081.50	MH
Tonnage =	121,044.65	Tons

**Cost/ Ton= \$ 29.13**

**Productivity= 0.240 MH/Ton**



# District 1-0 Cold Recycling Costs

1.5" of HMA is structurally equivalent to 2.25" of recycled asphalt. (For comparison use 165 lbs/SY HMA vs. 225 lbs/SY.)

20' Roadway for 1 mile.

165 lbs/SY of HMA

(968 tons @ \$70/ton)

\$67,760

225 lbs/SY of Recycled Asphalt

(1,320 tons @ \$29.13/ton)

\$38,451

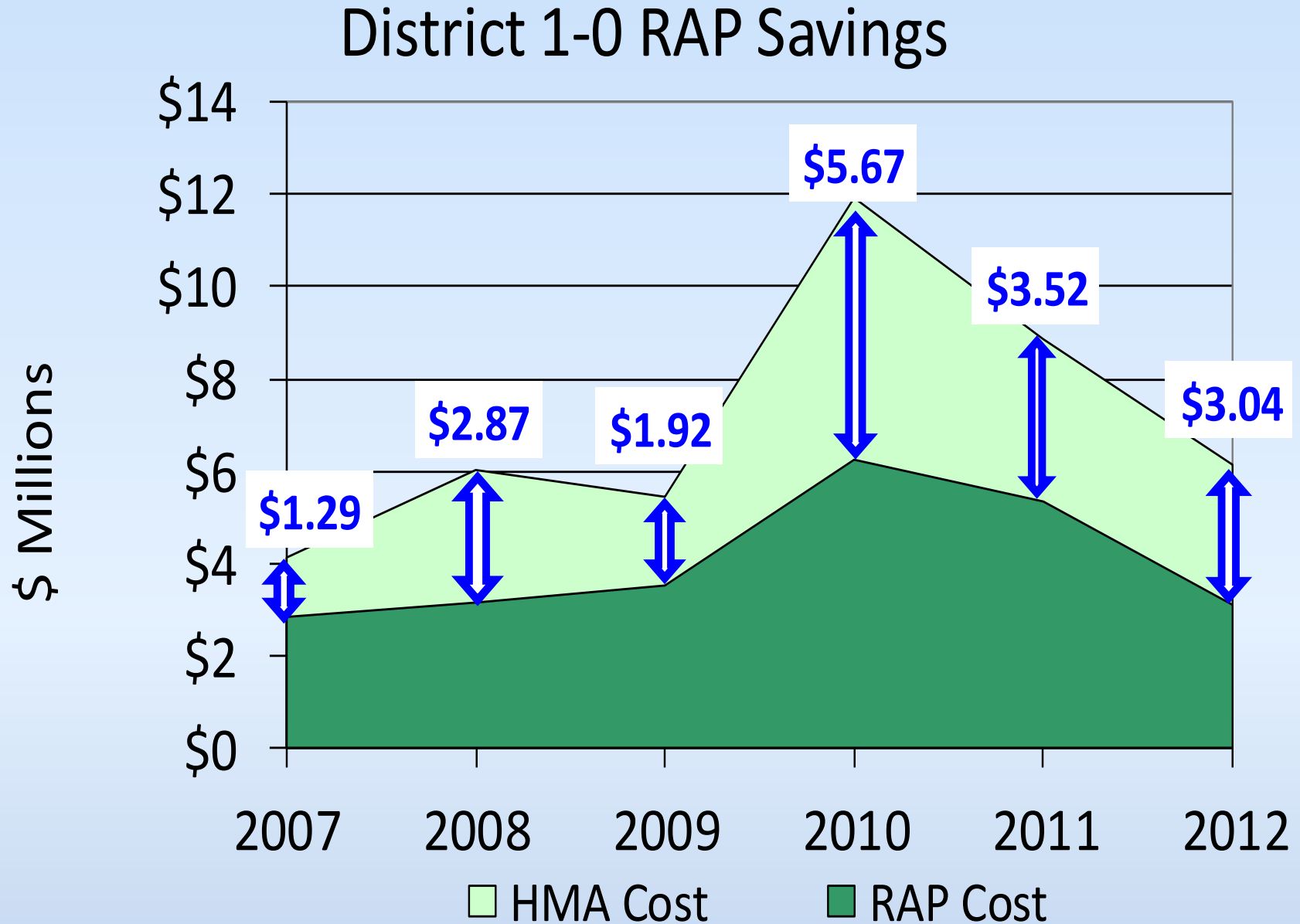
**Net Savings per mile**

**\$29,309**

# RAP Savings Slide

- Purpose:
  - To reflect the trend of District 1-0's Recycled Asphalt Pavement (RAP) realized savings since 2007.
- Source of Information:
  - Maintenance Unit,
  - A historical copy of each year's final RAP total
- Common Use:
  - Used for Business Plan, MPO / RPOs, Executive Staff Meetings, and Community Relations presentations.

## RAP Savings



## RAP Savings

\*\* For cost savings comparisons, a ratio of 0.75 Tons of Hot Mix/Ton of RAP was used due to strength factors for the respective products.

	Savings	Tons	Unit Cost	Total Cost
2012 RAP		109,210	\$28.44	\$3,105,822.52
2012 Hot Mix		81,907 **	\$75.00	\$6,143,025.00
			2012 Savings:	\$3,037,202.48
2011 RAP		157,556	\$33.93	\$5,346,084.77
2011 Hot Mix		118,167 **	\$75.00	\$8,862,495.36
			2011 Savings:	\$3,516,410.59
2010 RAP		244,636	\$25.55	\$6,251,600.00
2010 Hot Mix		183,477 **	\$65.00	\$11,926,019.00
			2010 Savings:	\$5,674,419.00
2009 RAP		121,044	\$29.13	\$3,525,721.00
2009 Hot Mix		90,783 **	\$60.00	\$5,446,980.00
			2009 Savings:	\$1,921,259.00
2008 RAP		133,973	\$23.55	\$3,155,064.15
2008 Hot Mix		100,479 **	\$60.00	\$6,028,785.00
			2008 Savings:	\$2,873,720.85
2007 RAP		122,376	\$23.24	\$2,844,607.47
2007 Hot Mix		91,782 **	\$45.00	\$4,130,190.00
			2007 Savings:	\$1,285,582.53

- Partnership with AFSCME – 7 year side agreement
- Total Redirected \$ (2007-2012) = \$18.31 M
- FY 11-12 RAP Costs: \$28.44/ton vs. HMA cost of \$75.00/ton

# District 1-0 Cold Recycling Benefits

- Cost effective
- Reestablishes pavement drainage
- Reestablishes roadway profiles
- Reduces reflective cracking
- Increases long-term pavement performance
- Increases structural strength of the roadway section
- Environmentally friendly – balances economic & environmental concerns - saves aggregate and crude oil

# District 1-0 Cold Recycling Benefits

- Smoother roadways
- Longevity of RAP has been equal to or better than HMA
- Most Dirt State Routes in the District have been paved
- Leverage available funding to improve more miles of roadway, serving more customers.
- County personnel have job well-being, satisfaction & ownership
- District 1-0 DOT Crews are stronger as a result of this innovation
- Strengthened Union relationship
- Fiscally responsible

# District 1-0 Cold Recycling Concerns

- Quality of crusher Can limit production
- Stockpile management
  - Avoid excessive handling
  - Segregate good and marginal material
  - Proximity to project
- Availability of RAP
- Quality/capability of rented equipment
- Compaction Control (density testing)
- Proper Planning is key to success
- Pressure from industry to get milled material

# Paver Mixer operations (District 8-0 Pilot)

- RAP E-5 combination provides basically the same performance as FB-1
- Pilot showed that it's a great flexible material for the lower ADT routes
  - (FB mixes are designed to provide flexibility and are used on lower ADT routes with minimal base layers. Lack of stability provided by the base layers requires additional flexibility in surface layers)
- RAP requires less rolling than hot mix
  - ~60-70k tons of material taken from I-81 project and stored at the Shippensburg Stockpile
  - Used 14,768 tons for the pilot
  - I-81 used a special oil designed to not push
    - This special oil needs to be broken down for reusing



# Crushing (Cumberland Pilot)



# Resulting Material (Cumberland Pilot)

Raw Reclaimed Material



Crushed and Ready to Mix with Oil



The raw material must be sized to an average of about 9.5 mm in size to be effective for paving. Thankfully, the material was already very clean.

# Paver Mixer operations (Cumberland Pilot)

- E5 oil
  - breaks down existing oil in the RAP milling material
  - Different oils/amounts required depending on road surface that material is reclaimed from
- Lab tested many different %'s of mixes
- 10% mixture was the best

# Paving (District 8-0 Pilot)



# Paving (Cumberland Pilot)



The 2,500 gallon emulsion tank of the Mix Paver being filled with E-5 oil

# Paving (Cumberland Pilot)



# Paver Mixer Paving (Cumberland Pilot)

- Raw RAP material dumped directly into Mix Paver
- Mix Paver mixes material with the E5 oil
  - 14gal oil / ton
- Aggregate is applied at 140°-170°
  - Compared to Hot Mix which is ~310°
- Scratch Coat
  - Paving 1.5” scratch coat (will top off with another 1.5” of top coat)
  - Shouldn’t lay more than 3”-3.5” at a pass (too soft for more)
  - 10’ wide
- When aggregate is too fine, it binds too much. Can’t pave fast – just too dense of material

# Paver Mixer Paving (Cumberland Pilot)





# Paver Mixer Costs (Cumberland Pilot)

- The money spent in aggregate is solely in hauling it
  - There are external costs:
    - To rent the motor paver
    - The E-5 oil is (\$2.75/gal)
      - Residual oil in the RAP provides for additional binder
      - Pilot required 153,380 gal
    - The Crusher
    - The in house costs are manpower and hauling
- Aggregate costs for FB-1 mixes run about \$8/ton...and about \$15/ton delivered. So not including time to reclaim the asphalt or get it into proper shape for paving...there can be **cost savings of at least \$6/ton** (or more if the RAP is fairly clean) given the difference

# Paver Mixer Benefits (Cumberland Pilot)

- Roadway should last 10 years
- Costs savings
- A Seal Coat was applied to the cold laid pavement.

# Specifications

- SECTION 341 – COLD RECYCLED BITUMINOUS BASE COURSE, COLD-IN-PLACE
  - Utilizes On-Grade Construction and Processing of Material.
- SECTION 342 – COLD RECYCLED BITUMINOUS BASE COURSE, CENTRAL PLANT MIX
  - Operates from an Off-Site Central Mix Plant requiring Reclaimed Asphalt Material (RAP) to be hauled to and from the project site.

# Cold In-Place

## **Cold in-place Recycling**

- High Production (Approximately 2 lane miles per day).
- More Economical.
- Reduced Emissions (Environmentally Friendly).
- Improved M & P of Traffic.

# Cold In-Place

- Helps assure the success of cold recycling project.
- Requires evaluation of existing pavement conditions including: pavement, base, subbase and subgrade materials.

Candidate projects should be structurally sound with well drained bases and subgrades.

- Good candidates include Composite and Full-Depth Bituminous Pavements exhibiting Fatigue Cracking, Thermal Cracking, Reflective Cracking or Raveling

# Project Selection

- Full-Depth Bituminous Pavement- Fatigue and Thermal Cracking



# Project Selection

Composite Pavement Section-  
Built on weak 6" Parabolic  
Concrete



# Project Selection

## Composite Pavement with Bituminous Widening Failure





# Construction

## RECYCLED TRAVEL LANE (UNCOMPACTED MAT)



# Traffic – ADT Criteria

- 1,000 and less. Provide a surface treatment (double application) as a minimum for wearing surface.
- 1,001 to 3,000. Provide a hot mix or cold mix wearing course.
- 3,001 to 10,000. Provide a hot mix wearing course.
- More than 15,000. Do not Recycle.
- Projects carrying significant heavy truck traffic (i.e. 200 or more daily ESALs) should not be selected for cold recycling.

# Summary

- Study of Control Sections (Conventional Overlay) vs. Cold Recycling.
  - ✓ Control Sections had approximately 3 times more Reflective Cracking (LF) than adjacent Cold Recycled Sections.
  - ✓ Rate of Increase in Roughness higher in Control Sections than Cold Recycled Section.
- Backcalculated Cold Recycled Pavement Modulus comparable to Typical Plant Mixed HMA (250,000 – 450,000 psi.)
- On average, Cold Recycling extends Project Service Life an approximately 4 years compared to Conventional Overlay Treatments.

# Questions

Thank You