Innovations in Recycled Asphalt Pavements

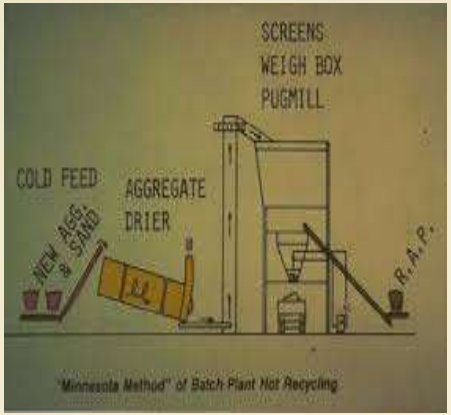
2017 North Dakota Asphalt Conference

Bismarck, ND
March 29, 2017

Donald Matthews, PE
Pavement Recycling Systems, Inc.

What We Know

- Asphalt has always been recyclable. # 2 in world after recycled water
- Valuable Material in Hot Mix Asphalt
  - Provided Feasible and Cost Effective
  - When Nearby to HMA Plant
  - More Going Out Then Into the Facility
    - No Inventory Build Up



Other Historical Low Value Reclaimed Asphalt Pavement (RAP) Uses

- Shoulder Backing
- Trucking & Equipment Yards
- Haul Roads
- Dust Control
- Crushed Miscellaneous Base

These Are Poor Uses for Such a Valuable Asset

No Need to Squander Virgin Aggregate

- RAP In Many Cases Out Performs Native Aggregates
- Neutral Charge, Works Well With Binders
- Cost Effective
- Environmentally Smart

Alternative Uses of RAP in Pavement Preservation

- **Recycled In-Place**
  - HIR - Hot In-place Recycling (Not Discussed)
  - Cold In-place Recycling (CIR)
- **Cold Central Plant Recycling (CCPR)**
- **As Aggregate**
  - RAP Chip Seals
  - RAP Slurry Seals/Micro Surfacing
  - RAP Cape Seals

Cold In-place Recycling (CIR)

Distressed Pavement = New Pavement Using Train of Equipment that:

- **Mills deteriorated pavement - Reclaimed asphalt pavement (RAP)**
- **Crushes RAP to gradation**
- **Mixes with recycling agent**
- **Additive if needed**
- **Re-Paves recycled mix**
- **Compacts to specified density**
- **Readies for surface treatment**

CIR Crushing and Sizing Train (Some Variations But Same Concept)

Pavement Milled

- Main Mill
  - Self-propelled
  - Minimum 12.5 ft cutter
  - Automatic depth controls to maintain the depth
  - Control cross slope
- Supplemental Mill
  - Put millings in front of main mill to pickup and process
  - Shoulders and misc. areas

Cracking Pattern Disrupted

70% Rule for Mitigation of Reflective Cracking

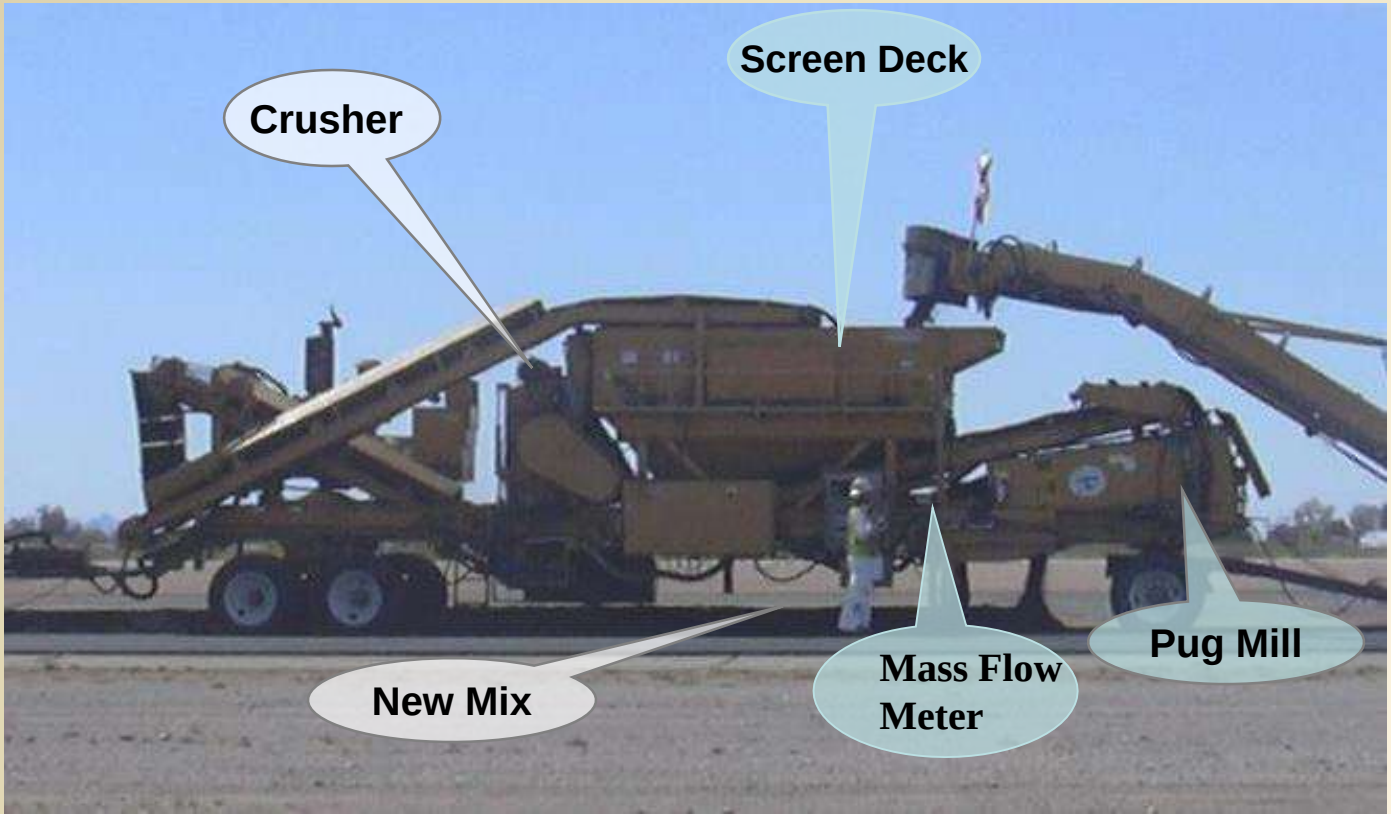
May Add Additive (Dry Cement)

Spread Just in Front of Mill

Quick Lime Slurry

Applied to Cutting Teeth

Recycling Plant Meets All Calibration Requirements

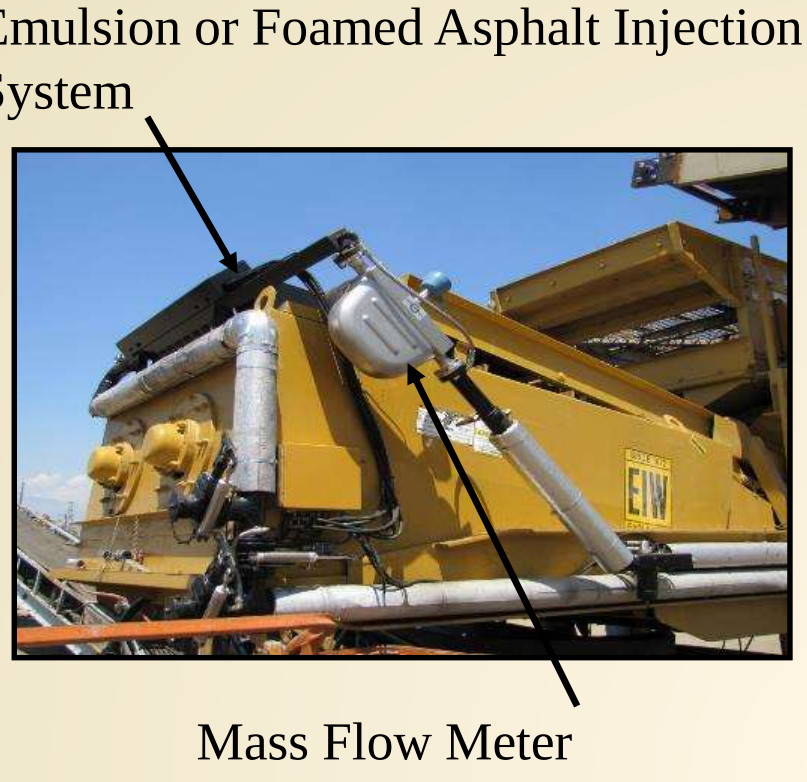


Crushing and Sizing Equipment, 100% Closed Circuit System

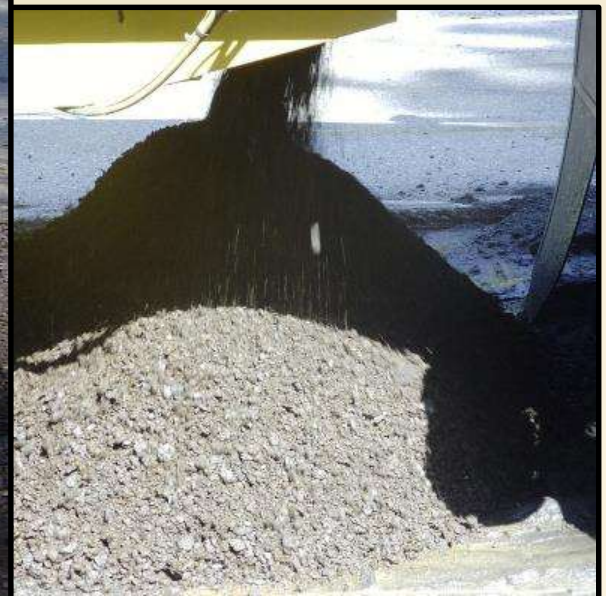
Crushing and sizing equipment capable of reducing RAP to the 100% passing 1-inch to 1¼-inch sieve

Mixed in Pugmill

- Continuous pugmill equipped with paddles to provide sufficient mixing
- Belt scale and integrated microprocessor control
- Automatic controls to obtain the proper amount of binder
- Weighing and measuring devices calibrated



New Recycled Mix Windrowed



Pick Up and Installation


100% Recycled Asphalt

Cold Central Plant Recycling (CCPR)

Stockpiled Clean RAP

= New Pavement

1) Mill and Stockpile RAP

- **Onsite CCPR** - Cold Milled from Roadway and Recycled Back to Same Roadway
- **Imported CCPR** – RAP is Brought from One Project and Recycled to Another
- **Central Facility CCPR** – RAP Stockpiled from Various Projects for Future Use

Onsite CCPR

Same Road - RAP Milled from Roadway to be Reconstructed

Prior to Milling

Cold Milled

Stockpiled Nearby

Imported CCPR

RAP Imported from One Roadway and Processed and Returned to Different Application

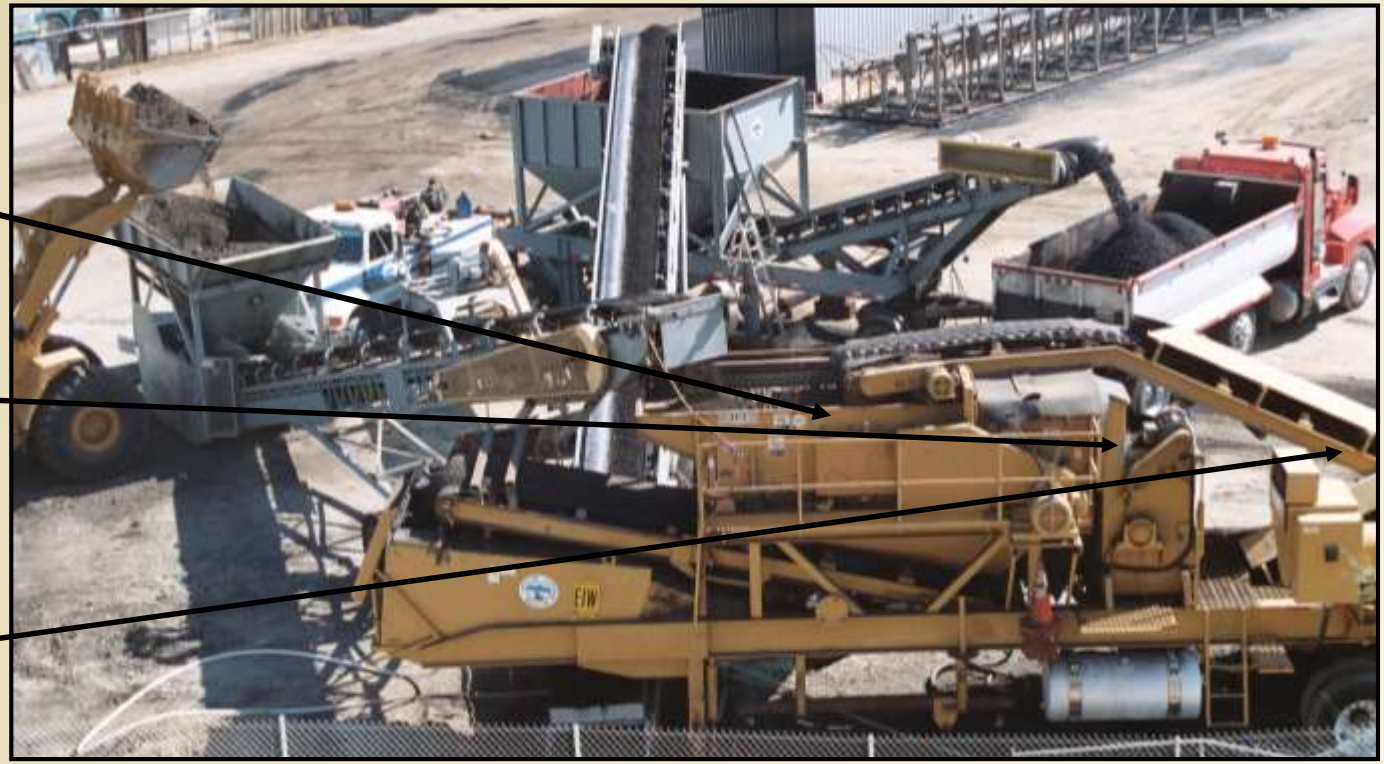
Central Facility CCPR

RAP Imported from Various Projects and Stockpiled for Future Use

2) RAP is Sized (Typically 1” to 11/4” Max)

Using a Scalping Screen on the Feed Hopper of Processing Plant

100% RAP Crushed and Screened Closed Loop System

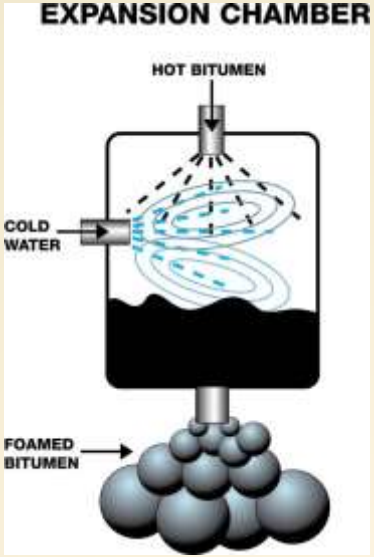


RAP Fractionization

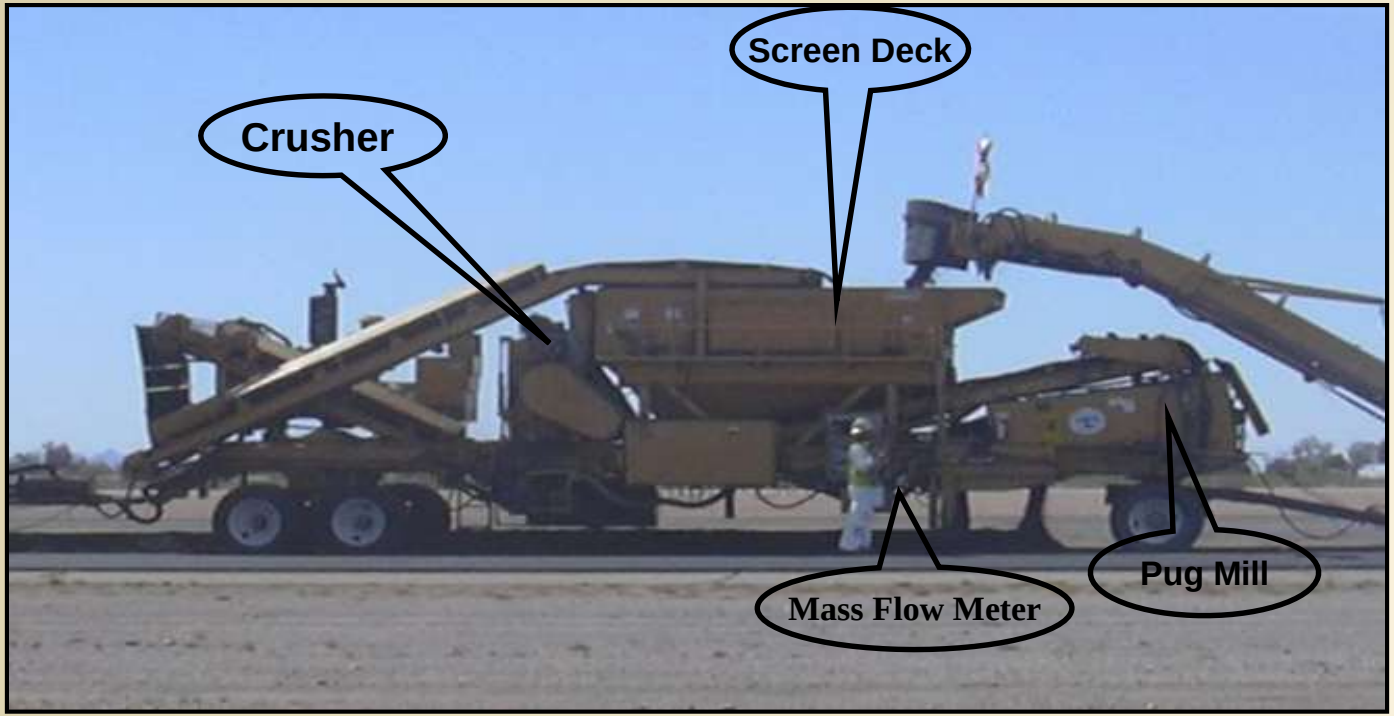
3) Can Supplement with New Aggregate

4) Mix with Water and Recycling Agent Adding Recycling Additives if Necessary

- Recycling Agents
  - Emulsified Asphalt
    - Engineered Emulsions
    - Polymer Modified Emulsions
    - Solvent Based Emulsions (CMS2s)
  - Expanded Asphalt (Foam)
- Recycling Additives (added in small quantities)
  - Cement Dry
  - Lime Slurry



Combination Processing Plant



After Sizing Standard Pugmill

5) Loaded into Trucks and Transported To Laydown Area

Swept and Tacked Prior to Paving

6) Pave Recycled Mix

7) CIR and CCPR - Compact to Specified Density

Pneumatic-tired roller at least 22 to 25 tons

Double drum vibratory steel-wheeled roller at least 10 tons

Cold Recycle Surface Before Sealing

8) CIR and CCPR- Protect for Temporary Traffic

Apply fog-seal

Apply sand blotter

Release to traffic

9) CIR and CCPR - Cure and Reroll if Necessary

Typically 2 to 10 days

Reroll (supplemental compaction) if required (typically for emulsified asphalt)

10) CIR and CCPR - Final Surfacing

Slurry or Micro Surfacing – Low Volume Shoulders and Lots

Because of Higher Void Ratio Must Be Sealed

HMA Overlay – Higher Volume Highways High Shear Areas

Chip Seal – Low Volume Highways

City Of Menifee Newport Road 3” CCPR over 10” FDR Cement

Auto Auction 1-Million Square Feet 100% CCPR Recycled

CIR Rural Areas – Caltrans State Route 36

CIR Urban Areas – City of Beverly Hills

Eucalyptus Avenue Moreno Valley, July 2009

Project Profile; Moreno Valley, July 2009 “Energy and Cost Savings”

- 8,744 tons of asphalt removed and repaved.
- 840 fewer trucks used utilizing CIR, compared to a mill and fill operation.
- 1,649 fewer barrels of oil used.
- 79.6% fewer carbon emissions utilizing CIR compared to mill and fill operation.
- Cost savings to the City $262,320.00.
- Cut 30% off the project schedule.

RAP Aggregates

Single stones and conglomerations

Residual asphalt content will vary by sample

RAP Chip Gradations

Sieve Size	Percent Passing[1]	
	Medium 3/8”	Medium Fine 5/16”
1/2" (12.5 mm)	100	
3/8" (9.5 mm)	85-100	100
No. 4 (4.75mm)	0-15	0-50
No. 8 (2.36 mm)	0-5	0-15
No. 16 (1.18 mm)	-	0-5
No. 200 (75 um)	0-2	0-2
Residual Asphalt Content[2]	3.5% Min. (Based on dry weight of aggregate)	3.5% Min. (Based on dry weight of aggregate)

1. On unextracted RAP 2. On extracted RAP

RAP Chips

Appearance may be dusty but the dust is actually asphalt

No need to wash. Wet with an emulsion and keep dry for asphalt rubber

Bonding is excellent

RAP 3/8” Terminal Blend Asphalt Rubber Chip Seal

RAP 5/16” PME Chip Seal

RAP Chip Seal San Bernardino County El Rivino Road 2006 5/16” Chips

Before

RAP Chip Seal

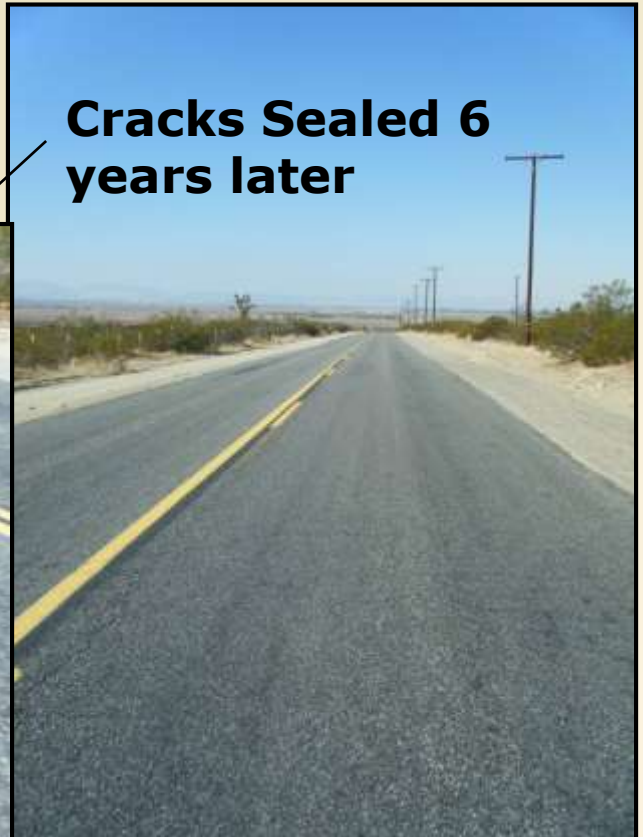
10 years later

RAP Chip Scrub Seal Los Angeles County 2009 Avenue J

Scrub Seal with Polymer Modified Rejuvenating Emulsion Broomed into Cracks

RAP Chip Seal 2015 After

Los Angeles County



RAP Aggregates - Type II Slurry and Micro Surfacing

RAP Slurry and Micro Surfacing Aggregates

Very Few Conglomerations

Residual Asphalt Remains Consistent

Type II RAP Slurry Aggregate

RAP vs Conv. Agg. Differences

- RAP Slurry Light on Fines for Type II
  - Coating of Asphalt Limits Crushed Fines
- Need to Prevent Clumping
  - Limit Amount of Material Stockpiled
  - Rescreen if Necessary
- Needs to Be Rubber Tire Rolled
- 3% Latex Modified Minimum
  - Adds Early Retention Until Asphalts Meld

RAP Slurry Seal

	RAP	ISSA Type II
Component	**Amount**	**Amount**
Emulsion	10% - 14%	12% - 18%
Residual AC	12.5% Min.	7.5% - 13.5%

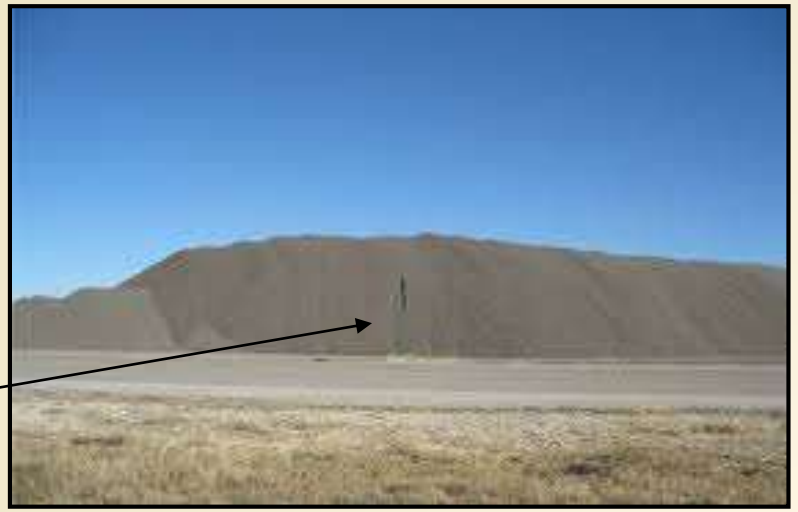
Conventional Equipment Can Be Used

RAP Slurry compared to Conventional, City of La Mirada, California. Side by Side – One Year later, RAP is Blacker

Methods of RAP Management

- Require RAP Materials in Conventional Bids
- Utilization of In-house RAP
  - On Site Method

Existing RAP Stockpile or New RAP Stockpile Developed



RAP Aggregate Central Production Facility

5/16” Chips Made from RAP

ASPHALT
100% RECYCLABLE

Recycle Your RAP on Site

Urban Quarry

Caltrans On-Site Management

RAP Chip and RAP Slurry (RAP Cape) Aggregates Produced Simultaneously

Some of the Best Aggregates Are in Our Roads
Increasingly Difficult to Open New Pits

Solution
Use Your RAP!

Questions?

Don Matthews, PE
Technical Services Manager
Pavement Recycling Systems, Inc.
10240 San Sevaine Way
Jurupa Valley, CA 91752
(951) 934-4753 (T)
dmatthews@pavempentrecycling.com
www.pavementrecycling.com