MoDOT AND RECYCLING

Dale A. Williams, PE

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Early RAP Use

- First used in 70's & 80's
- Premature failure
  - Dry mixes – 4% to 5% AC
  - High RAP content – 35% to 40%
- Discontinued use

Why Did We Change

- NCHRP 9-12
- Increasing costs of virgin material
- Underutilization of a valuable resource
- Industry desire to invest in lowering overall cost of mixtures
- MoDOT's desire to become more Environmentally Responsible

Non Superpave (less than 600 trucks)

- 2003 – 15% shoulders only
- 2004 – Allowed use in mainline paving
- 2005 – 20%
- 2008 – Unlimited use, Over 20% testing required

SuperPave

- 2005 – 10% surface, 20% base
- 2008 – Unlimited Use, over 20% testing required
- 2010 – PROPOSED Unlimited use, over 30% replacement testing required

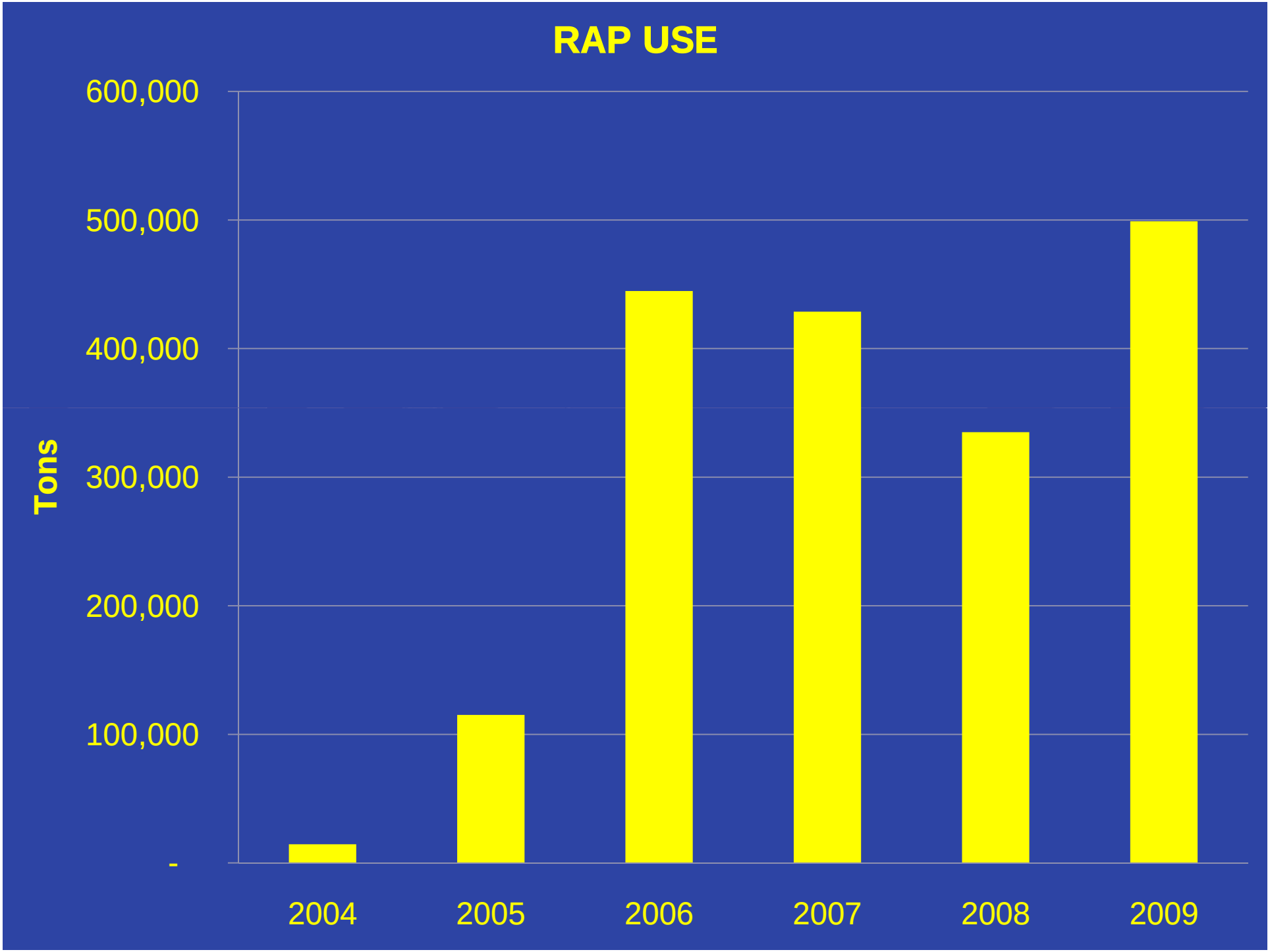
RAP Underutilized

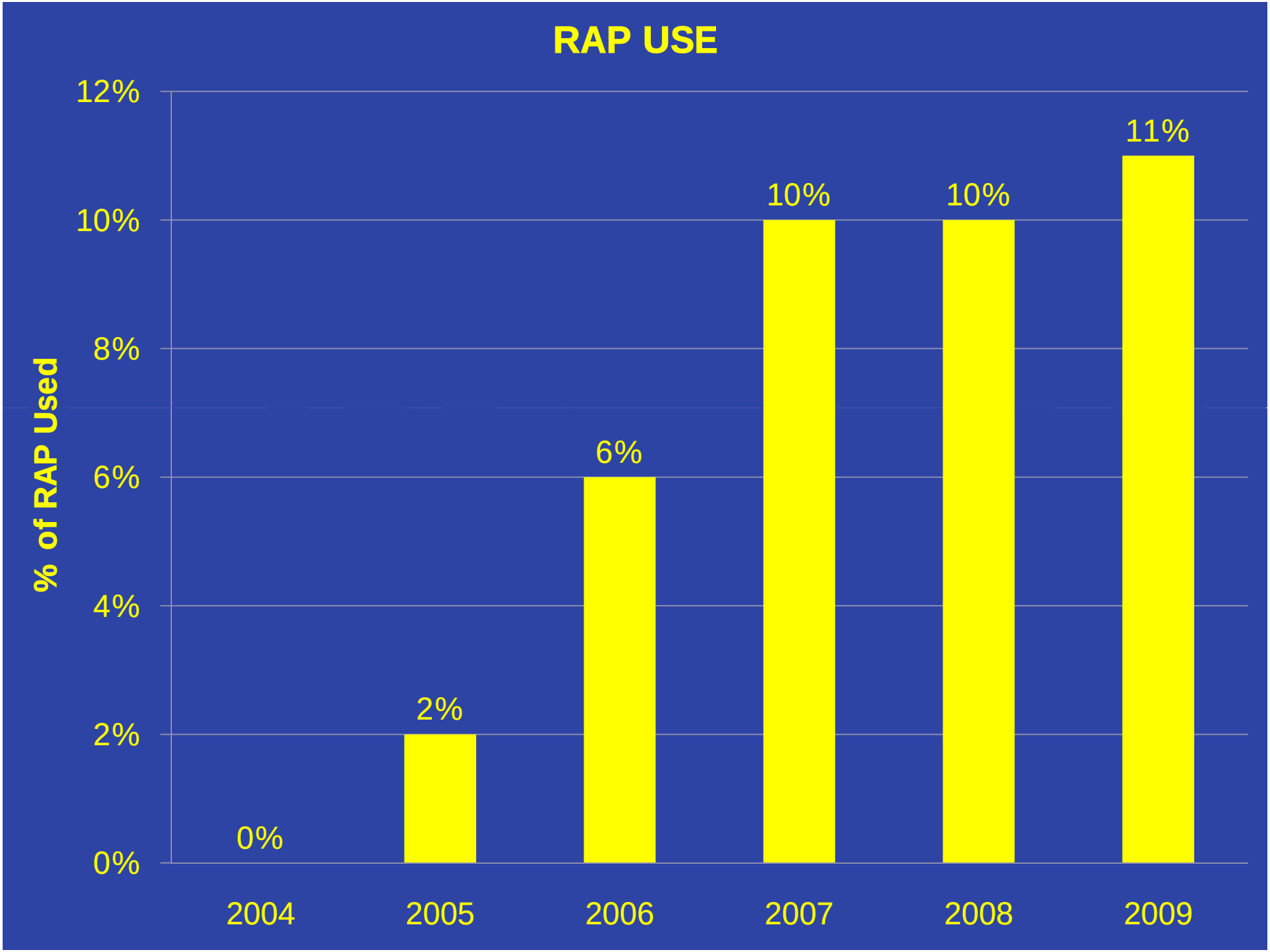
Waste

Misuse

Internal Culture Change

- DOT used to retain all RAP
- Maint. viewed RAP as “FREE” Rock
- Contractor now retains all RAP

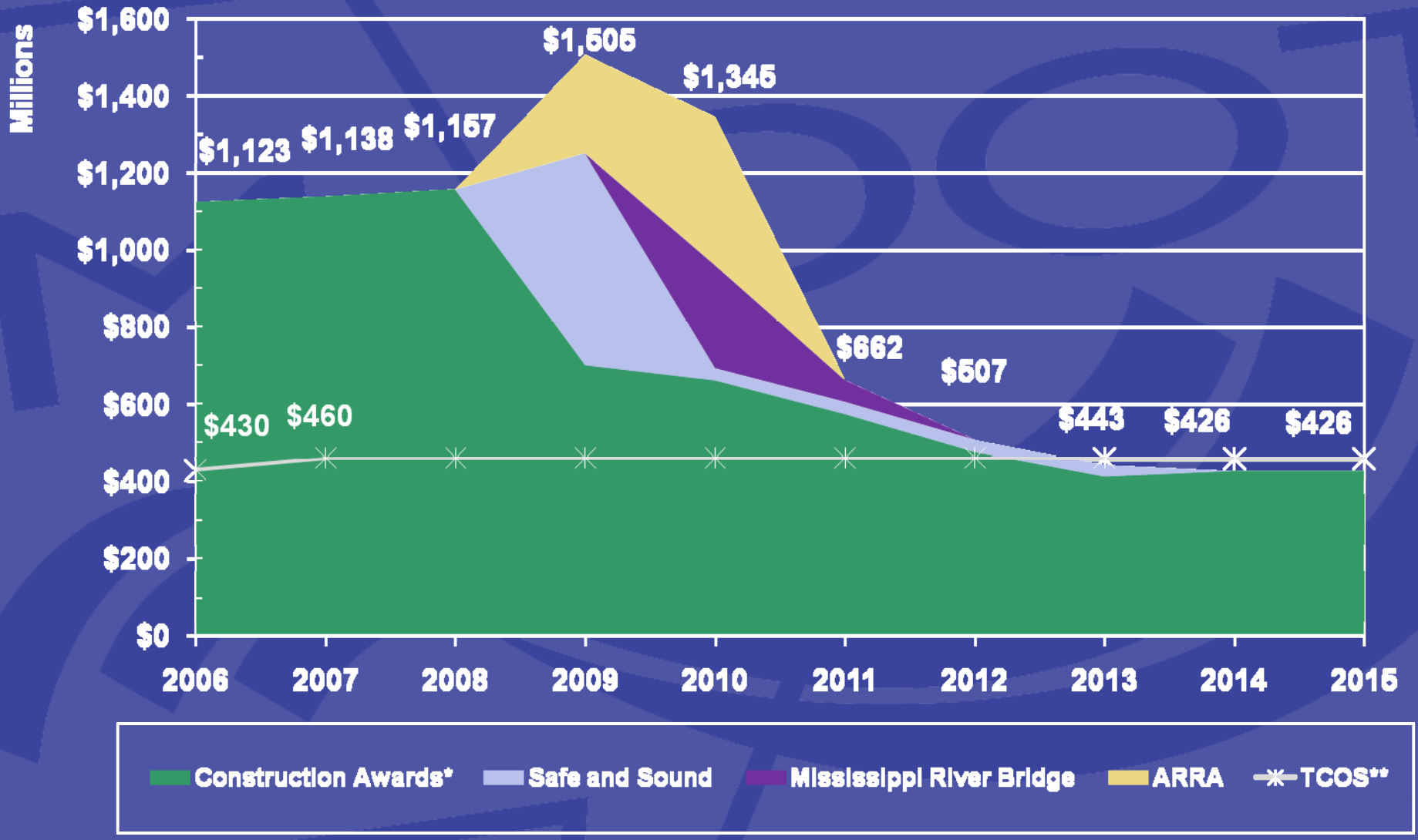

RAP USE
600,000
500,000
400,000
300,000
200,000
100,000
-
Tons
2004
2005
2006
2007
2008
2009


RAP USE
% of RAP Used
12%
10%
8%
6%
4%
2%
0%
0%
2%
6%
10%
10%
11%
2004
2005
2006
2007
2008
2009

RAP Use

- Performance
  - Equal or better than non-RAP mixtures
- Limitations
  - Pavement rehab strategies
  - Budget

Construction Program Cliff



*2010-2015 Awards based on FY09 financial forecast (Excludes engineering, payments and right-of-way)

**MHTC Taking Care of the System (TCOS) Funding Distribution (Includes Engineering)

RAS History

- 2003 – Contractor request
- 2004 – Contractor demonstration project
- 2005 – First DOT pilot project
- 2006 – Specification added

In The Beginning

- Approached by Pace Construction, Peerless Landfill and MO DNR
  - MoDOT Not Using RAP in Mixtures
  - Deleterious Material
  - Stiffness of Asphalt in Shingles

MoDOT Goals

- Engineering Properties First
  - Harmful Effects of Deleterious Material
  - Asphalt Binder Properties
- Traffic Safety – Nails, etc.
- If Everything Else Works Out, Landfilling is Reduced

Concerns

- How Will Deleterious Material Affect the Mixture
- Can the Low Temperature Grading be Maintained at Various Blending Ratios

Deleterious Material

- Nails
- Wood
- Plastic
- Cellophane
- Paper
- Fiber Board

PG 76-22

Shingle Asphalt

1 Hour

4 Years

18 Hours

4 Years

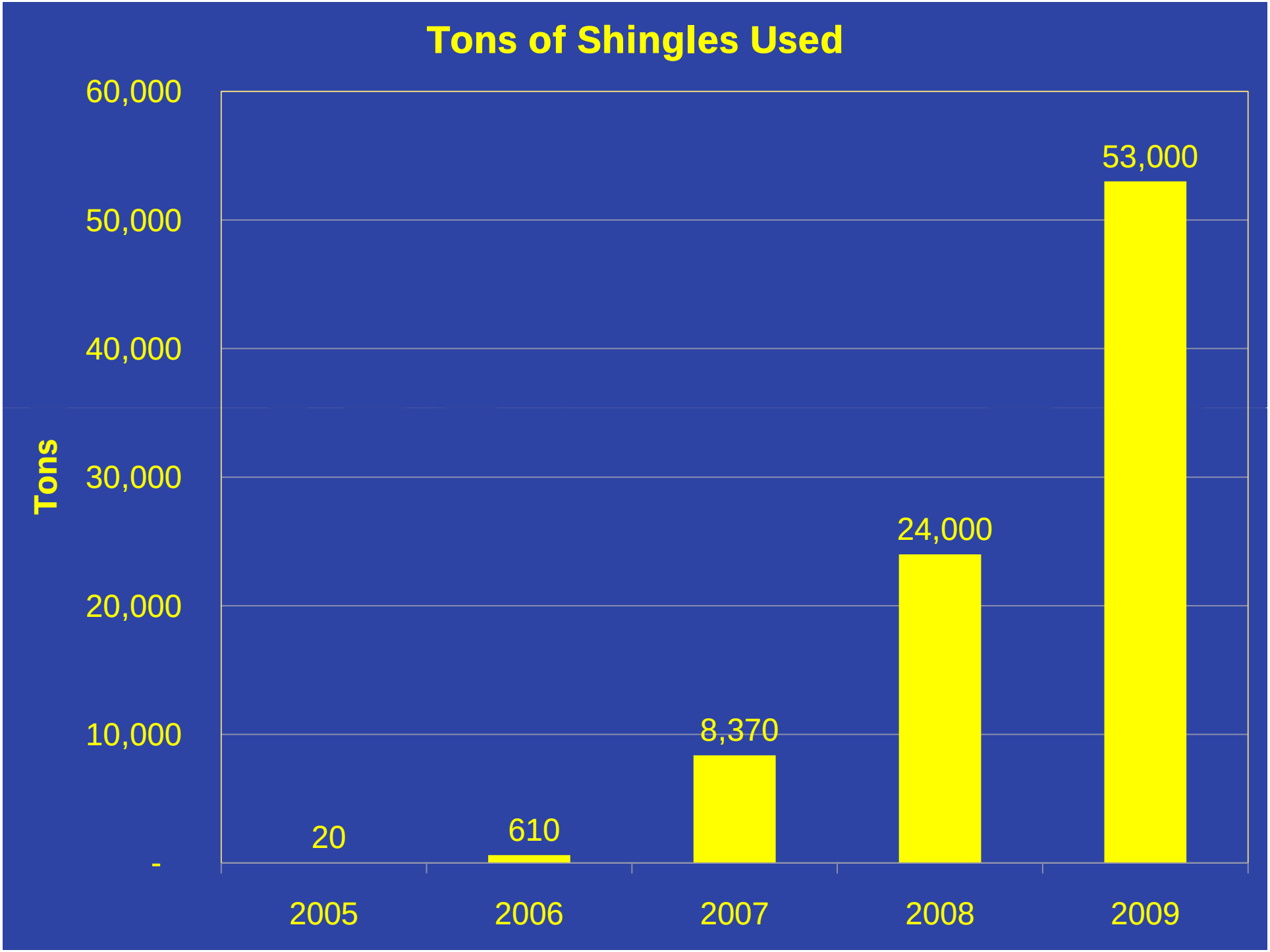
Rte. 61/67, St. Louis Co.
19 mm PG 70-22 Binder Course

1. PG 58-28
2. PG 58-28 / 5% RAS
3. PG 64-22 / 5% RAS
4. PG 64-22

Minimal Reflective Cracking & No Rutting to Date...

Problems with RAS Mixtures

- Sporadic Mixing Problems Confined to Plants not Mixture
- Harder to Place in Cool Weather


Tons of Shingles Used
60,000
50,000
40,000
30,000
20,000
10,000
-
Tons
20
610
8,370
24,000
53,000
2005
2006
2007
2008
2009

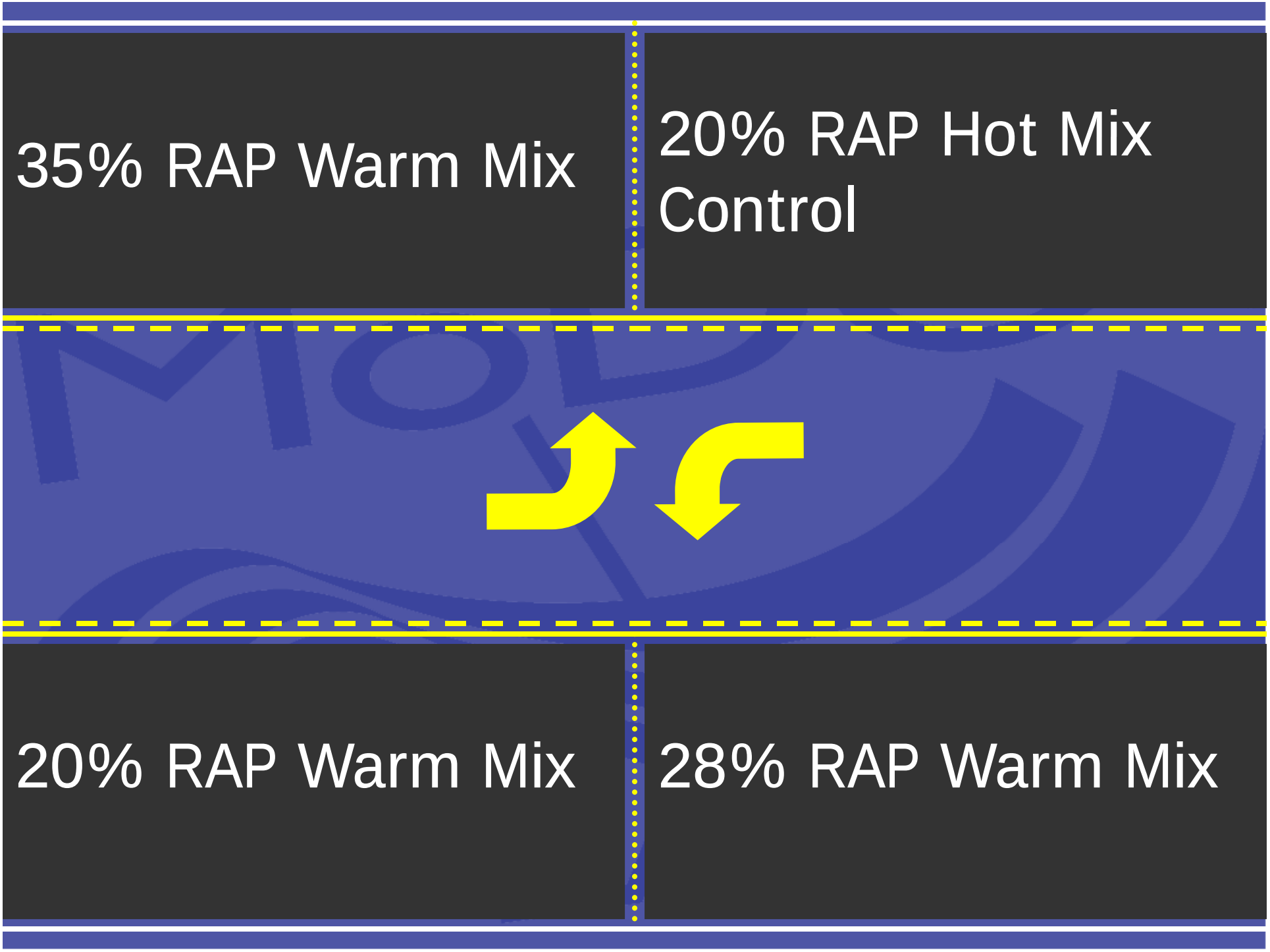
RAS Specifications

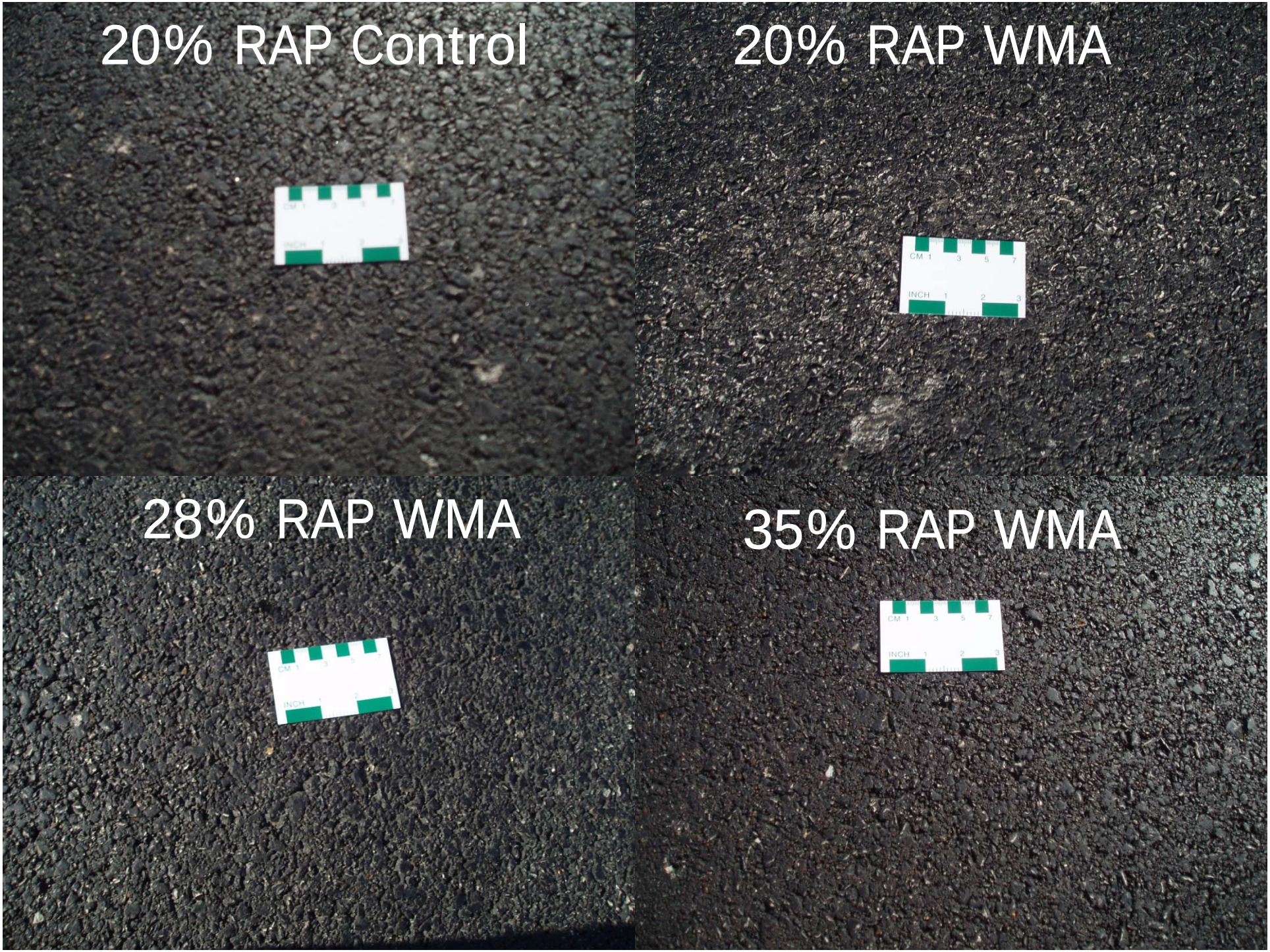
- 7% maximum allowed
  - Manufacturer waste
  - New
  - Post consumer (tear off)
- Not allowed in polymer modified mixes
- 30% replacement requires PG58-22 or PG58-28

QUESTIONS

High RAP Warm Mix Asphalt

- Exceeding the 20% Threshold
  - Blending Charts
  - Softer Binder Availability – $$$
- Oxidation Reduction – Warm Mix
- Evotherm DAT
- NOR I-44 near Six Flags


35% RAP Warm Mix
20% RAP Hot Mix Control
20% RAP Warm Mix
28% RAP Warm Mix


20% RAP Control
20% RAP WMA
28% RAP WMA
35% RAP WMA

High RAP Warm Mix Asphalt

	Control	20% RAP	28% RAP	35% RAP
Pen	29	39	32	28
Viscosity	25,920	16,087	16,738	23,470
Ductility	38	79	54	42
DSR 64	7.35	4.39	5.74	7.56
MSCR	26	42	37	32
DSR 70	3.48	2.11	2.91	3.59
BBR -12	0.394	0.437	0.406	0.393

Further Mixture Testing

- IDT
- Beam Fatigue
- Dynamic Modulus
- Rut Testing