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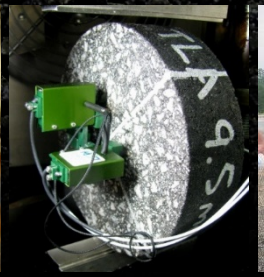
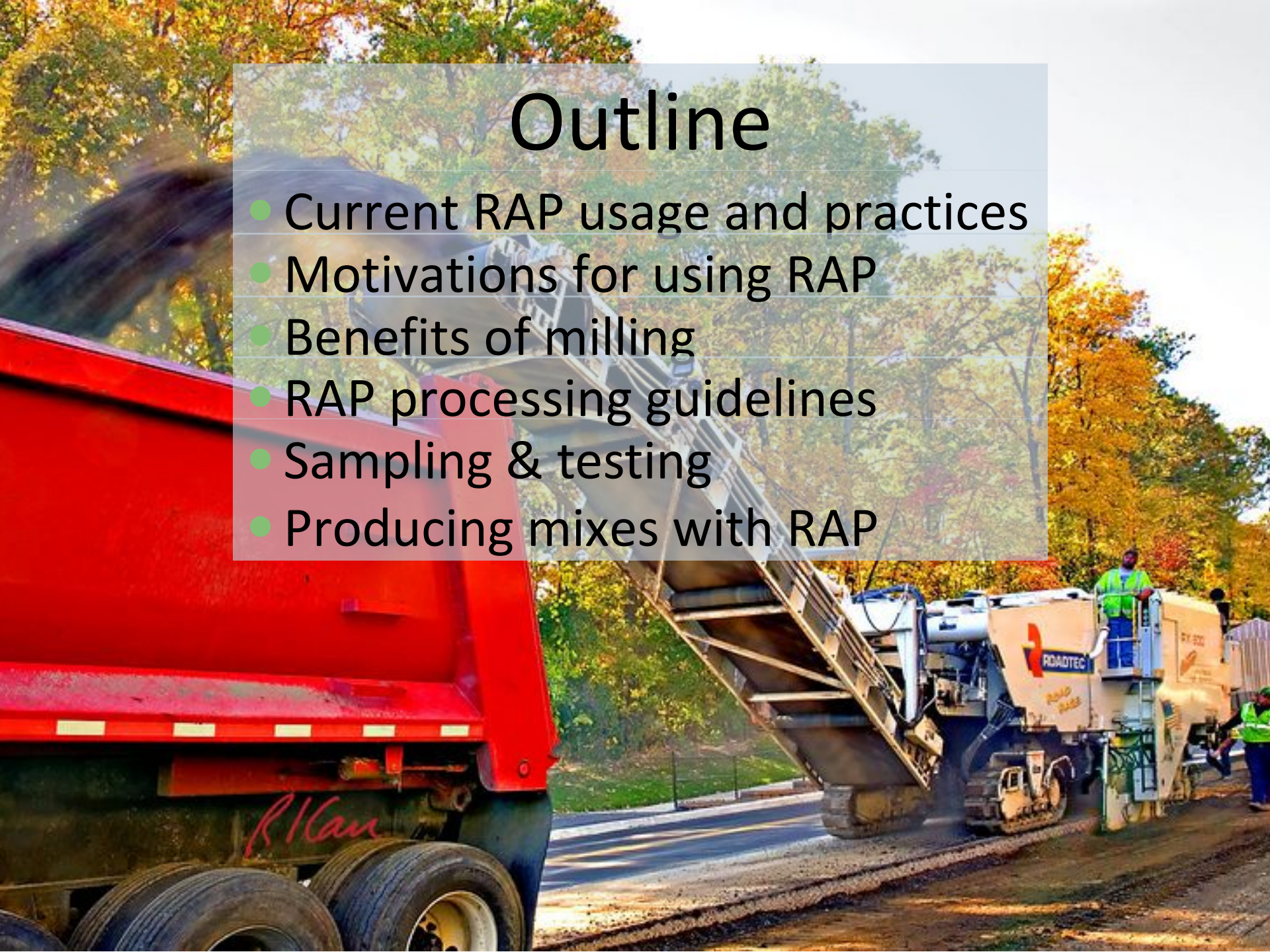
Best Practices for RAP Management

60th Annual Asphalt Paving Conference
Asphalt Pavement Association of Michigan
March 29, 2016
Kalamazoo, MI





Outline

- Current RAP usage and practices
- Motivations for using RAP
- Benefits of milling
- RAP processing guidelines
- Sampling & testing
- Producing mixes with RAP

Estimates of RAP Usage

- NAPA surveys estimate that the national average RAP content slowly increased from 16.2% in 2009 to 20.4% in 2014.
  - RAP contents tend to be higher in commercial projects compared to government projects.
- RAP usage varies considerably from state to state.

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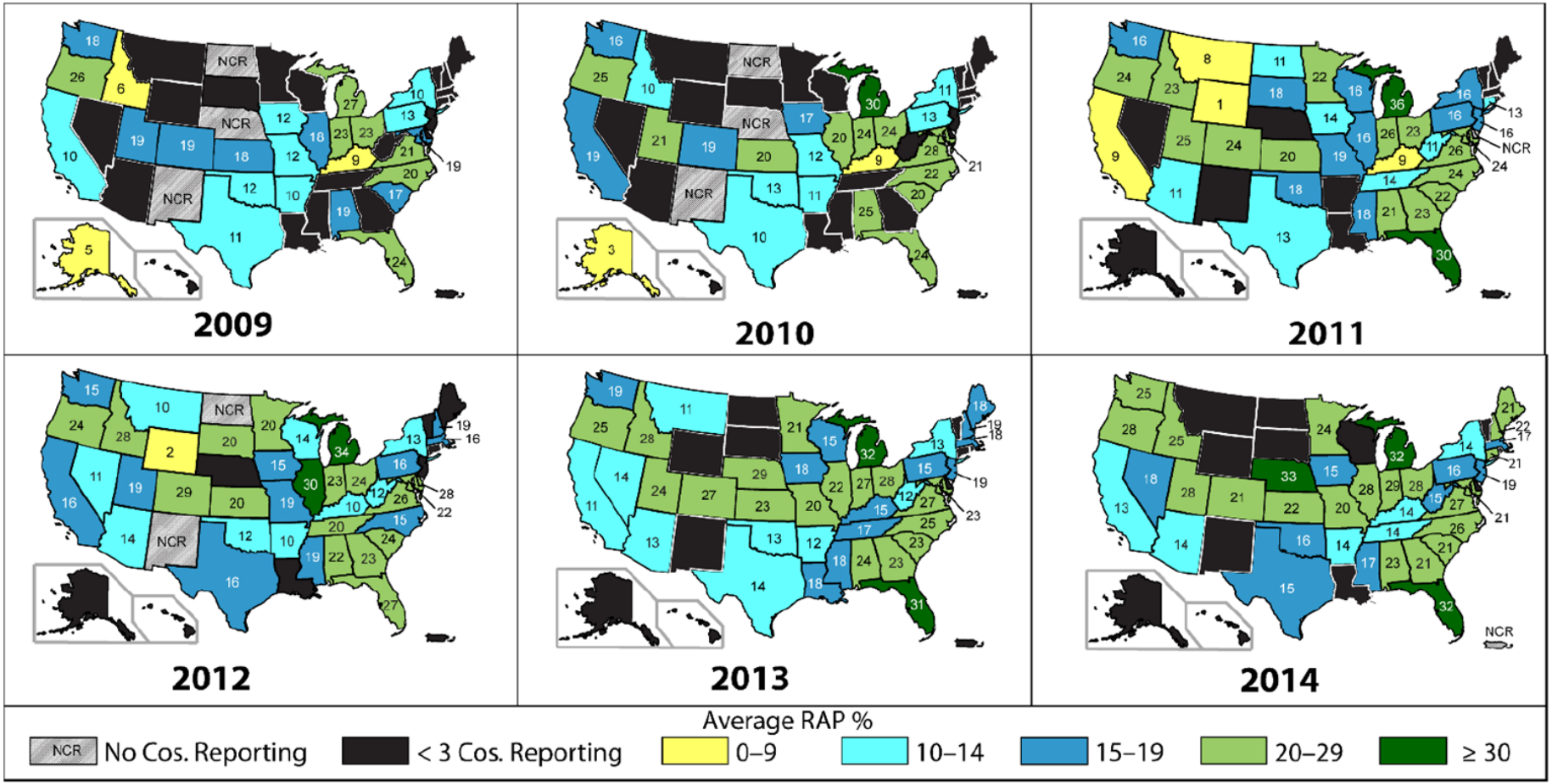
Average RAP contents by state

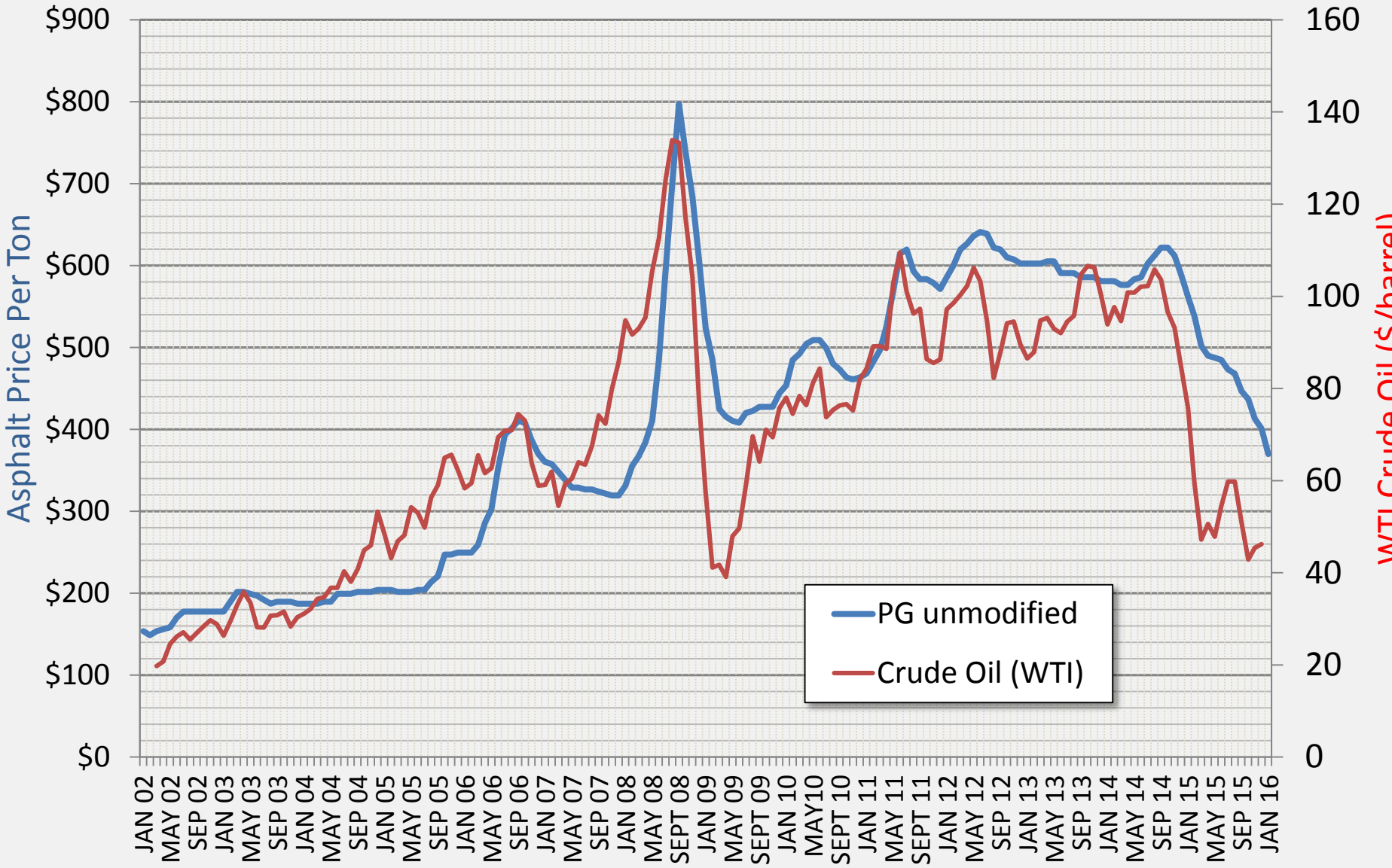


NAPA IS 138, 2015

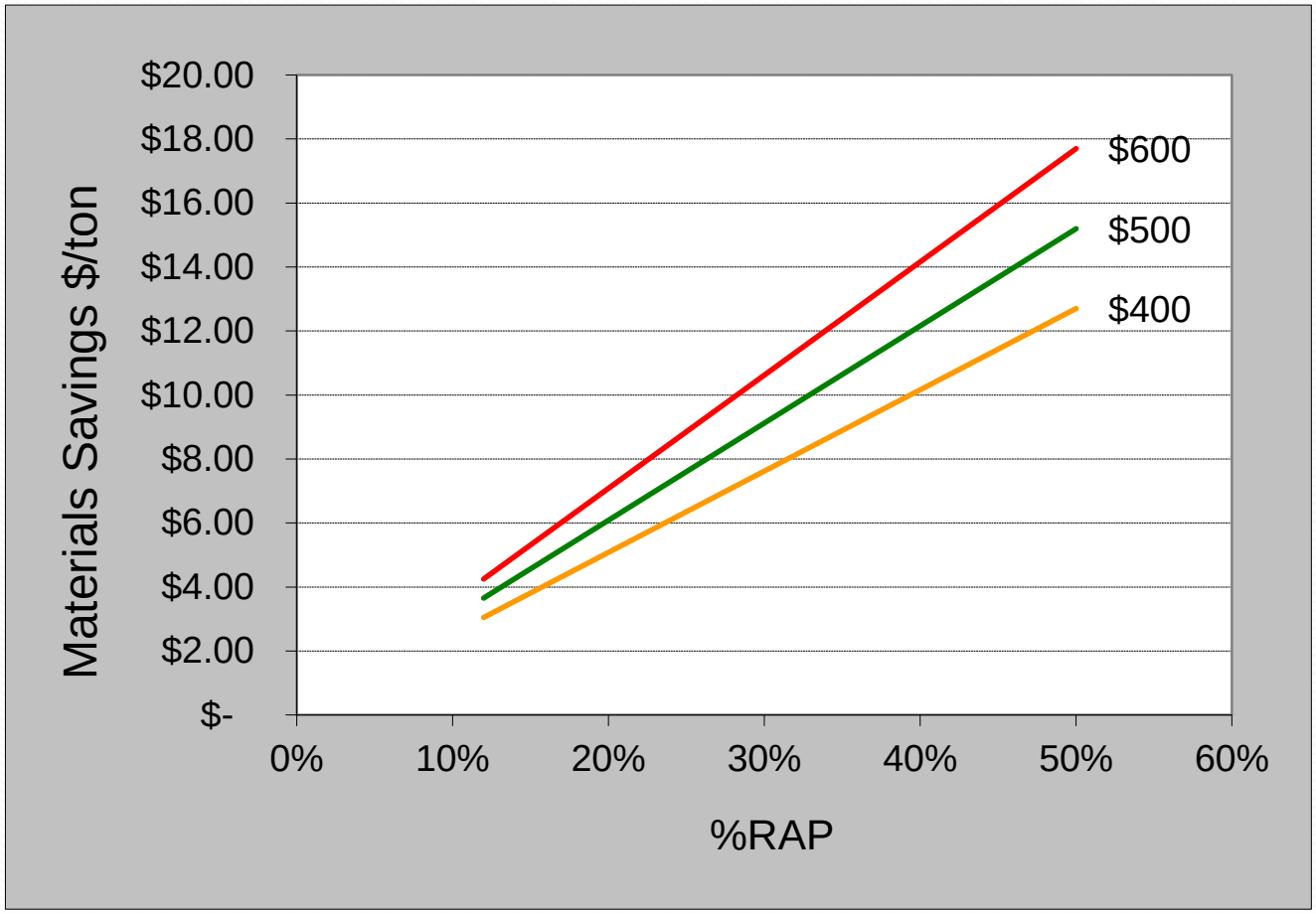
Motivations for Higher RAP Contents

- Economic savings
- Environmental & Sustainability benefits

Unmodified Paving Grade Asphalt and Crude Oil Prices



Recycling Economics Example



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Conservation of Materials

At an average RAP content of 20%, we conserve over 66 million tons of aggregate and 9 million barrels of asphalt each year.

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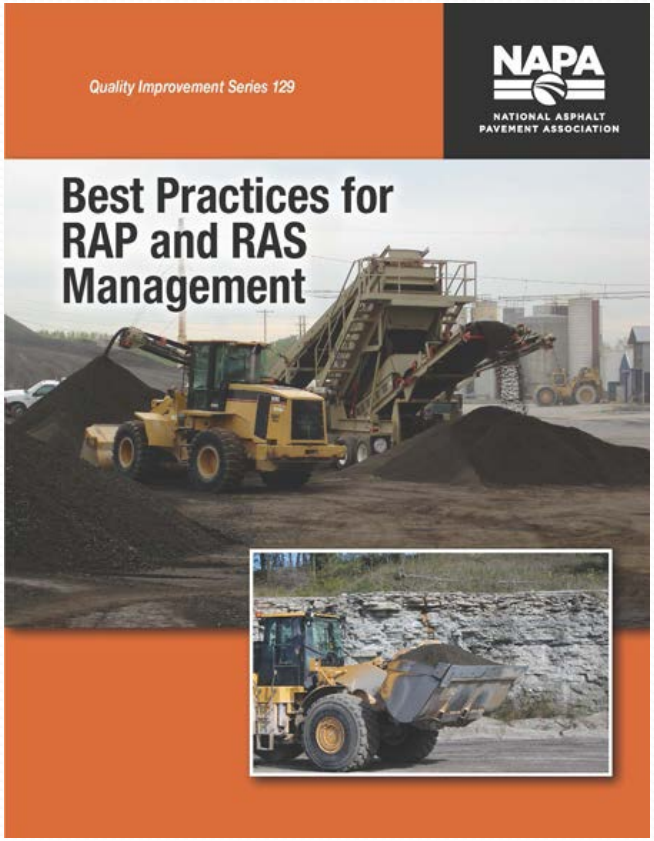
The average RAP content in Japan is 47%

Current RAP Practices

- In most (not all) places across the USA…
  - Project millings become property of contractor
  - Urban contractors have excess supplies of RAP
- RAP Management Best Practices
  - Inventory analysis
  - RAP processing options
  - Quality Control
  - Production concerns



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Benefits of Milling

- Removes distressed pavement layers
- Helps improve pavement smoothness and cross-slopes
- Maintains curb heights, drainage inlets, and bridge clearances
- Creates a rough texture that bonds better with the overlay

Coring Projects as a Routine Part of the Rehabilitation Approach

- Use to determine which layers are damaged
- Set milling/rehabilitation depth
- Use cores to determine asphalt content of layers to be removed

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Identifying Causes and Extent of Pavement Distress

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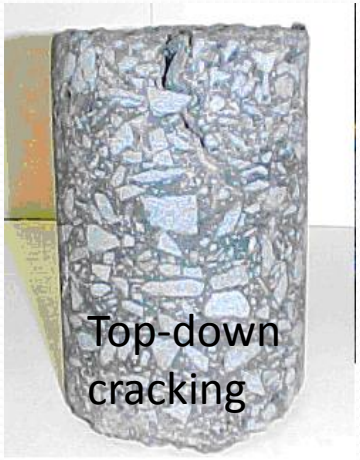
Coring to evaluate damaged layers



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Scabbed Layer Left After Milling

Photo courtesy of Jim Scherocman

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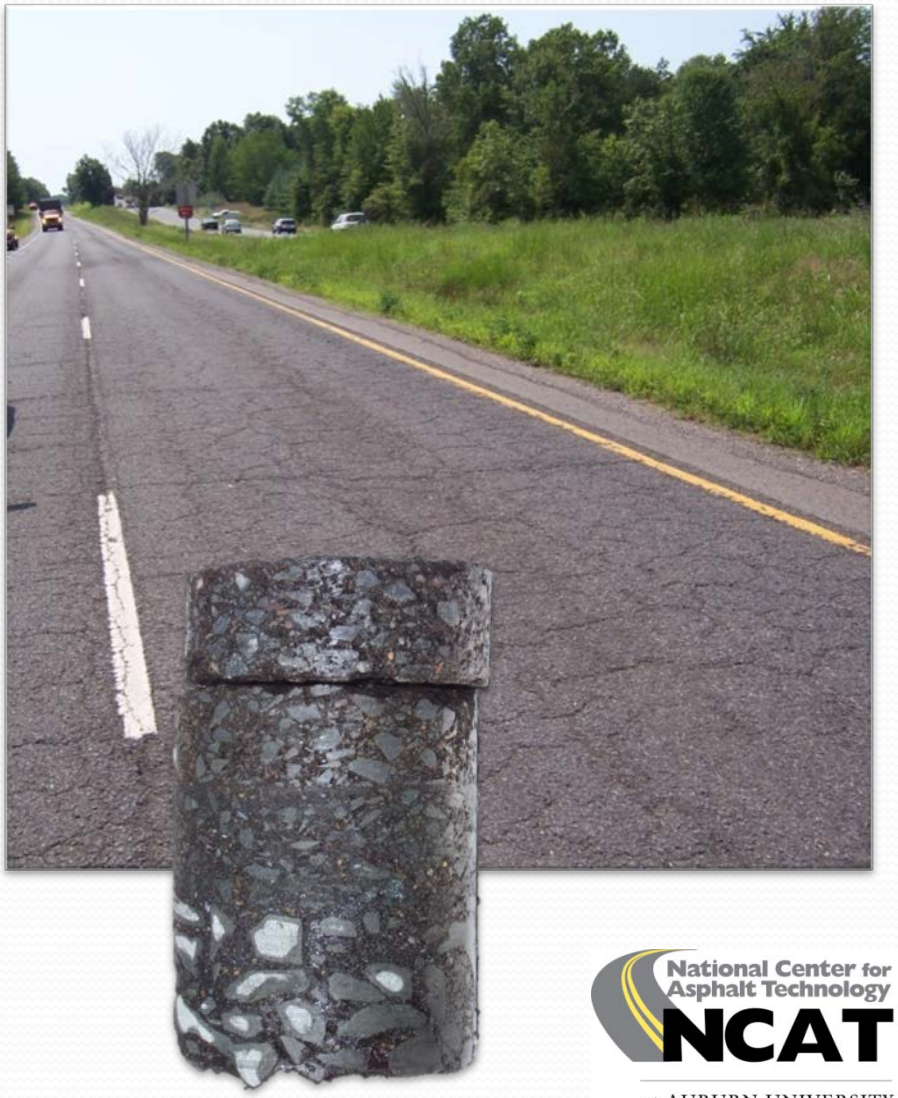
Milling for Success

- The primary reasons for milling is to remove distressed pavement layers and restore a good profile for the overlay.
- Examine cores to assess the competency of existing layers. Set the milling depth to remove damaged layers and to avoid leaving thin layers that are likely to scab.



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Inventory Management

- RAP inventory, RAP usage, RAP supply
- Analysis of barriers to higher RAP contents

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Inventory Management

Single source millings

Multiple source RAP stockpile

Separating stockpiles from single sources or combining all RAP into a multiple source stockpile for later processing

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Avoid Contamination

It is vital to prevent dumping of any deleterious materials in the stockpiles from the beginning.

Clearly instruct all truck drivers hauling materials to the yard where to dump different types of materials

Processing Millings

It is considered a best practice ***not*** to further crush millings, but to use it “as is” in mix designs. It is still necessary to screen the millings to remove oversized particles

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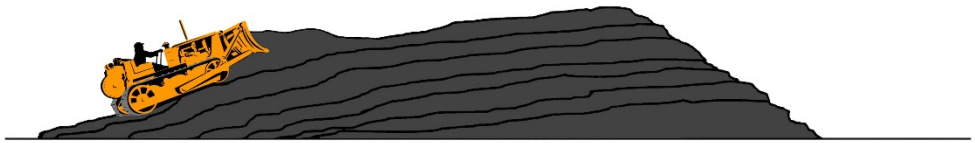
Multi-Source RAP

- Multisource piles can be an agglomeration of materials from milled projects, pavement rubble, rejected mix, and plant waste.
- It should be obvious, but unprocessed multi-source RAP stockpiles **are not suitable** for use in new mixes.

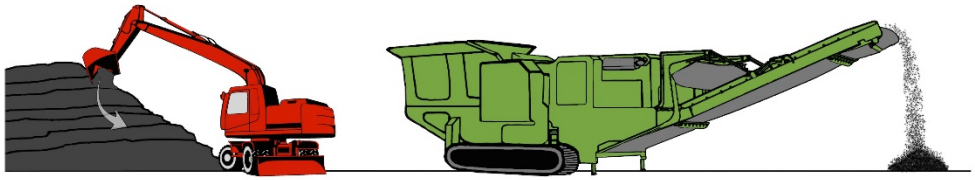
Stockpiling and Processing RAP

Build in layers.

Don't push over edge of slope.



Excavate through layers to feed crusher.



Feed loader from side of stockpile, working up through layers.

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Fractionating RAP

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Should You Fractionate RAP?

If you answer "yes" to the following six questions, you should consider fractionating RAP.

1. Can your plant produce mixes containing ≥30% RAP without emissions problems or significant decline in production rate?
2. Does the market this plant supplies allow RAP contents above 30%?
3. Does your plant have an excess amount of RAP?
4. Do you have difficulty meeting mix design requirements such as minimum VMA, dust proportion or $P_{0.075}$ content?
5. Do you have trouble keeping RAP mixes within quality control and acceptance limits?
6. Does your plant site have enough additional stockpile area for a RAP fractionation plant?

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Sampling RAP

- The goal of sampling RAP is to obtain representative samples for evaluating materials properties.
- Samples are needed from throughout the stockpile to assess variability. A minimum sampling frequency of 1 per 1000 tons with a minimum of 10 samples is strongly recommended.

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Sampling RAP






Photos courtesy of Tim Murphy

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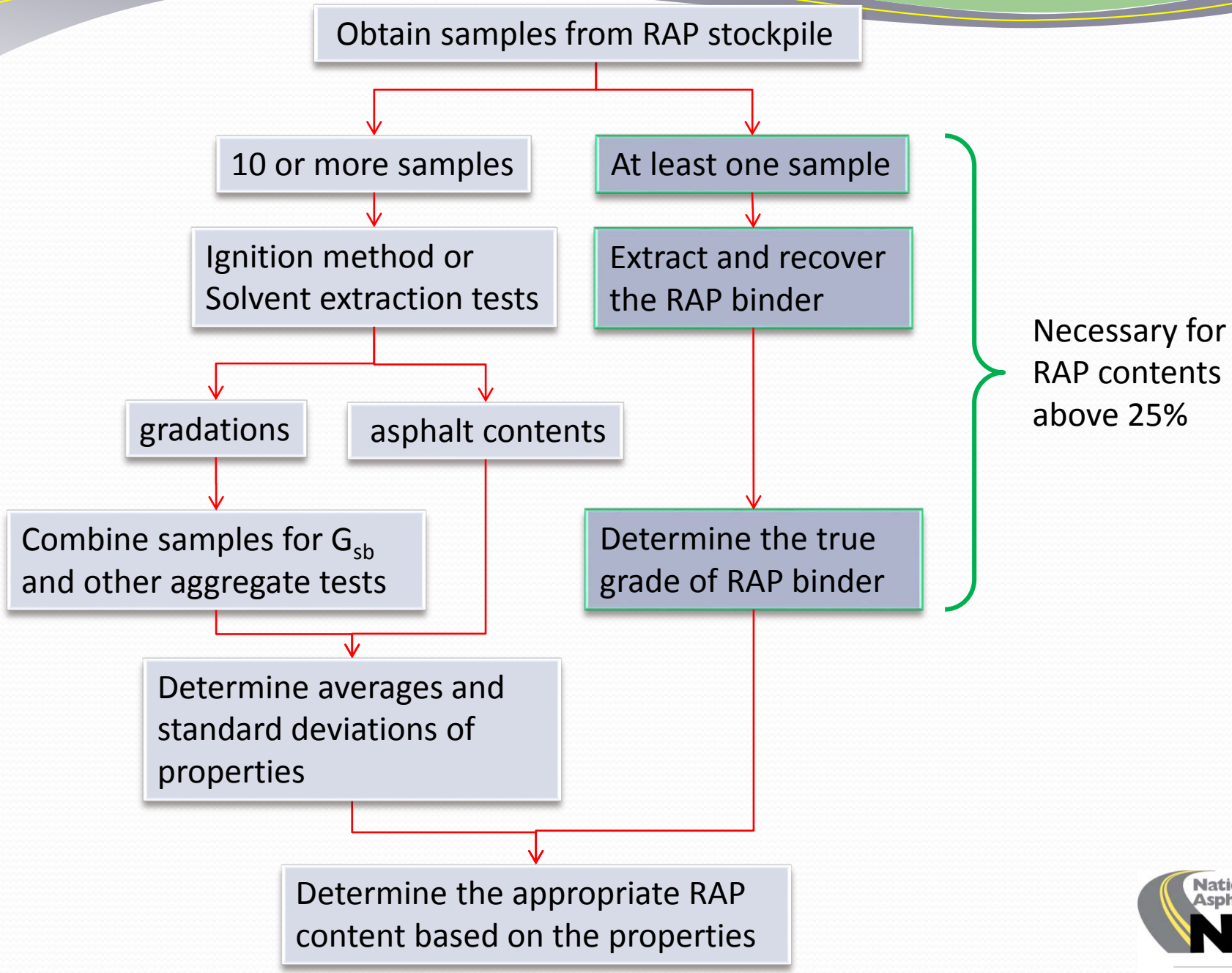

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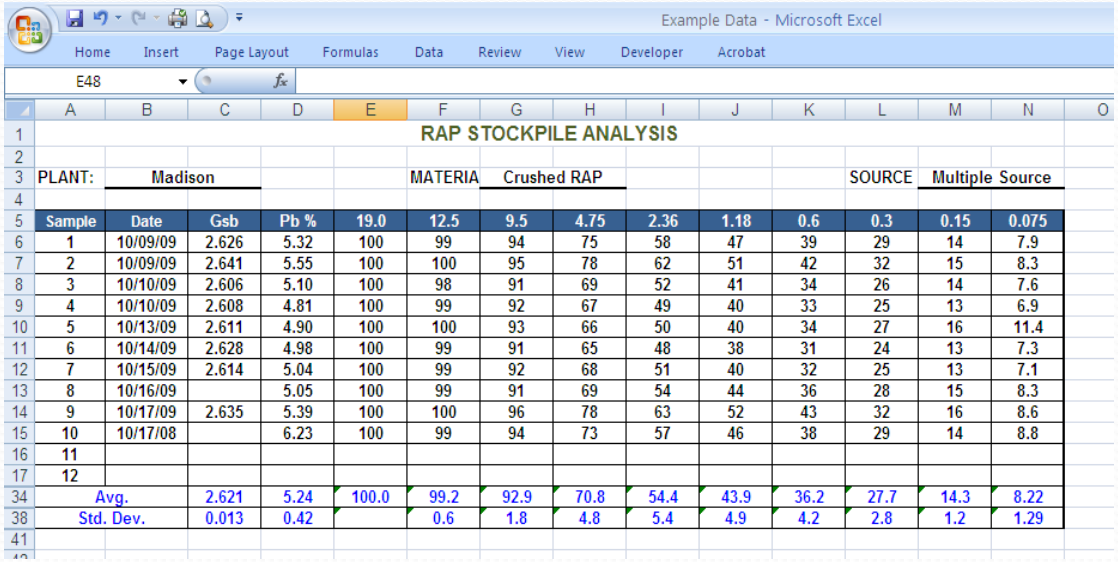
Summary & Analysis of RAP Data

Calculate average and standard deviation of asphalt contents, gradations, and estimated G_{sb}



RAP STOCKPILE ANALYSIS

PLANT: Madison MATERIA Crushed RAP SOURCE Multiple Source

Sample	Date	Gsb	Pb %	19.0	12.5	9.5	4.75	2.36	1.18	0.6	0.3	0.15	0.075
1	10/09/09	2.626	5.32	100	99	94	75	58	47	39	29	14	7.9
2	10/09/09	2.641	5.55	100	100	95	78	62	51	42	32	15	8.3
3	10/10/09	2.606	5.10	100	98	91	69	52	41	34	26	14	7.6
4	10/10/09	2.608	4.81	100	99	92	67	49	40	33	25	13	6.9
5	10/13/09	2.611	4.90	100	100	93	66	50	40	34	27	16	11.4
6	10/14/09	2.628	4.98	100	99	91	65	48	38	31	24	13	7.3
7	10/15/09	2.614	5.04	100	99	92	68	51	40	32	25	13	7.1
8	10/16/09		5.05	100	99	91	69	54	44	36	28	15	8.3
9	10/17/09	2.635	5.39	100	100	96	78	63	52	43	32	16	8.6
10	10/17/08		6.23	100	99	94	73	57	46	38	29	14	8.8
11													
12													
Avg.		2.621	5.24	100.0	99.2	92.9	70.8	54.4	43.9	36.2	27.7	14.3	8.22
Std. Dev.		0.013	0.42		0.6	1.8	4.8	5.4	4.9	4.2	2.8	1.2	1.29

Compare to these recommended tolerances

RAP property	Max. Standard Deviation (%)
Asphalt Content	0.5
% Passing Median Sieve	5.0
% Passing 75 micron Sieve	1.5

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Producing Mixes with RAP

Steep-sided RAP bin for better flow onto feeder belt

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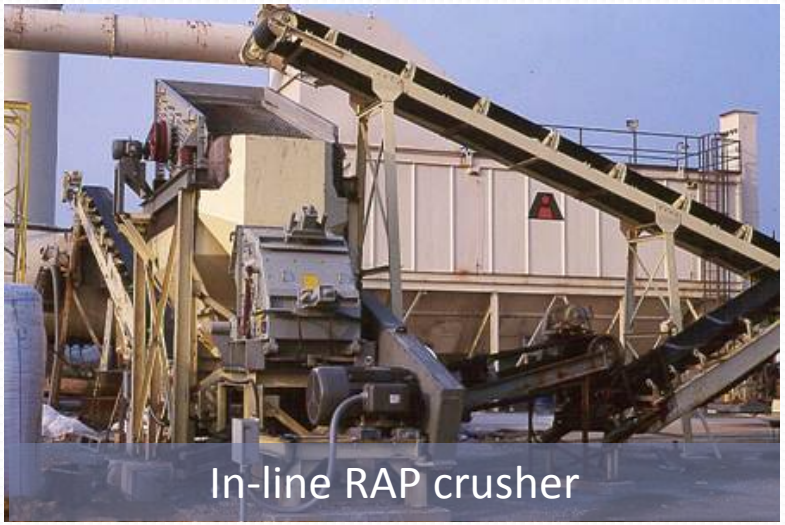
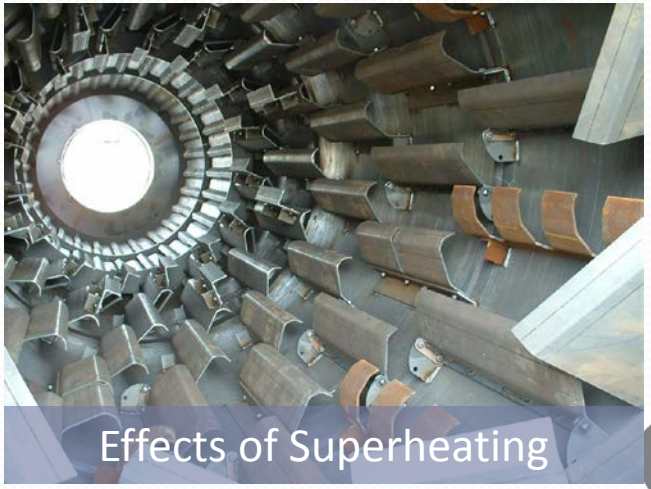
Producing Mixes with RAP


Two RAP bins for fractionated RAP


In-line RAP crusher


In-line RAP crusher


Effects of Superheating

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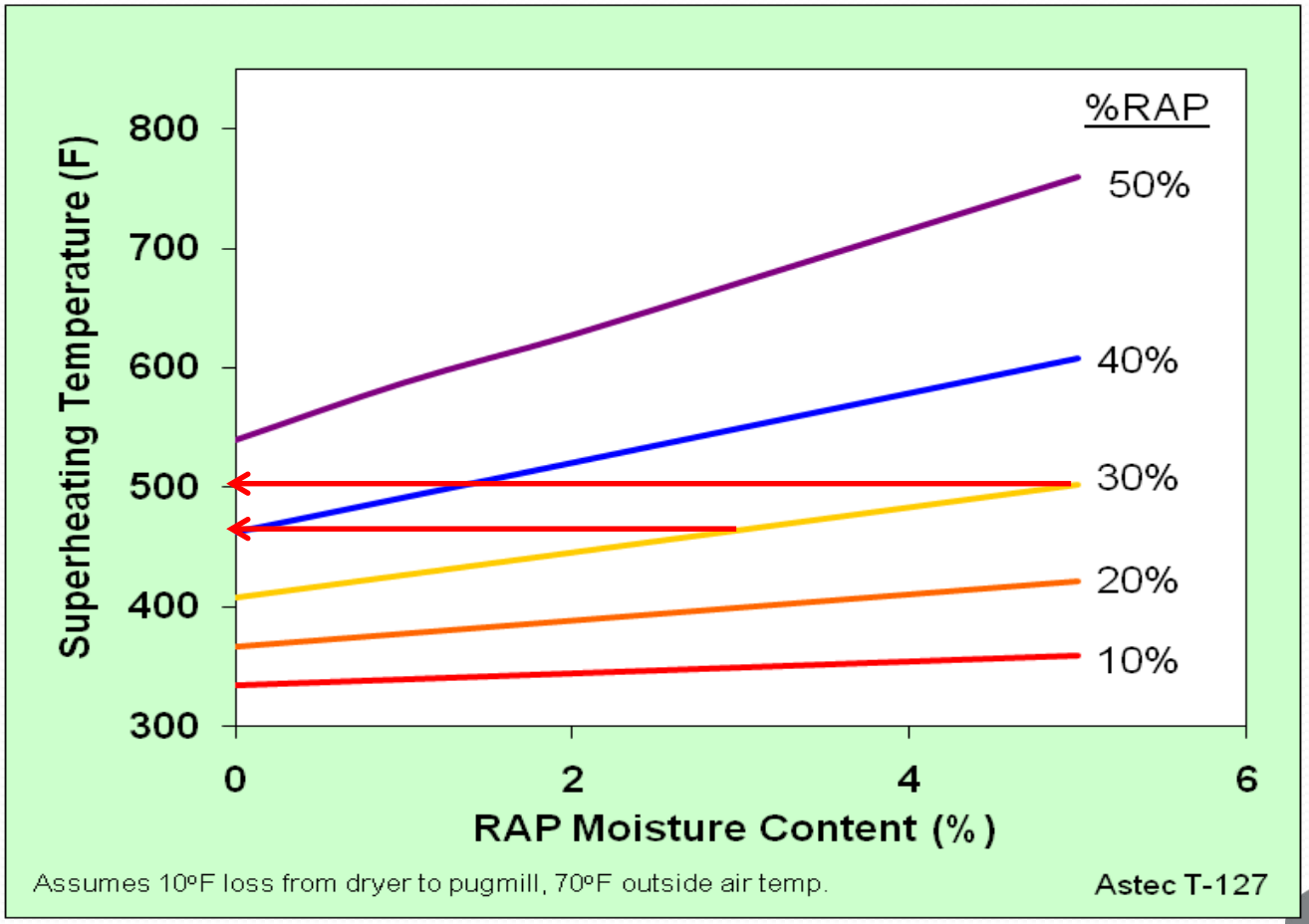
Effect of RAP Moisture on Superheating Temperature



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Thank You!