

Performance of Recycled Asphalt Pavement (RAP) in Gravel Roads

2015 Northwest Pavement Management Association Conference

October 21, 2015

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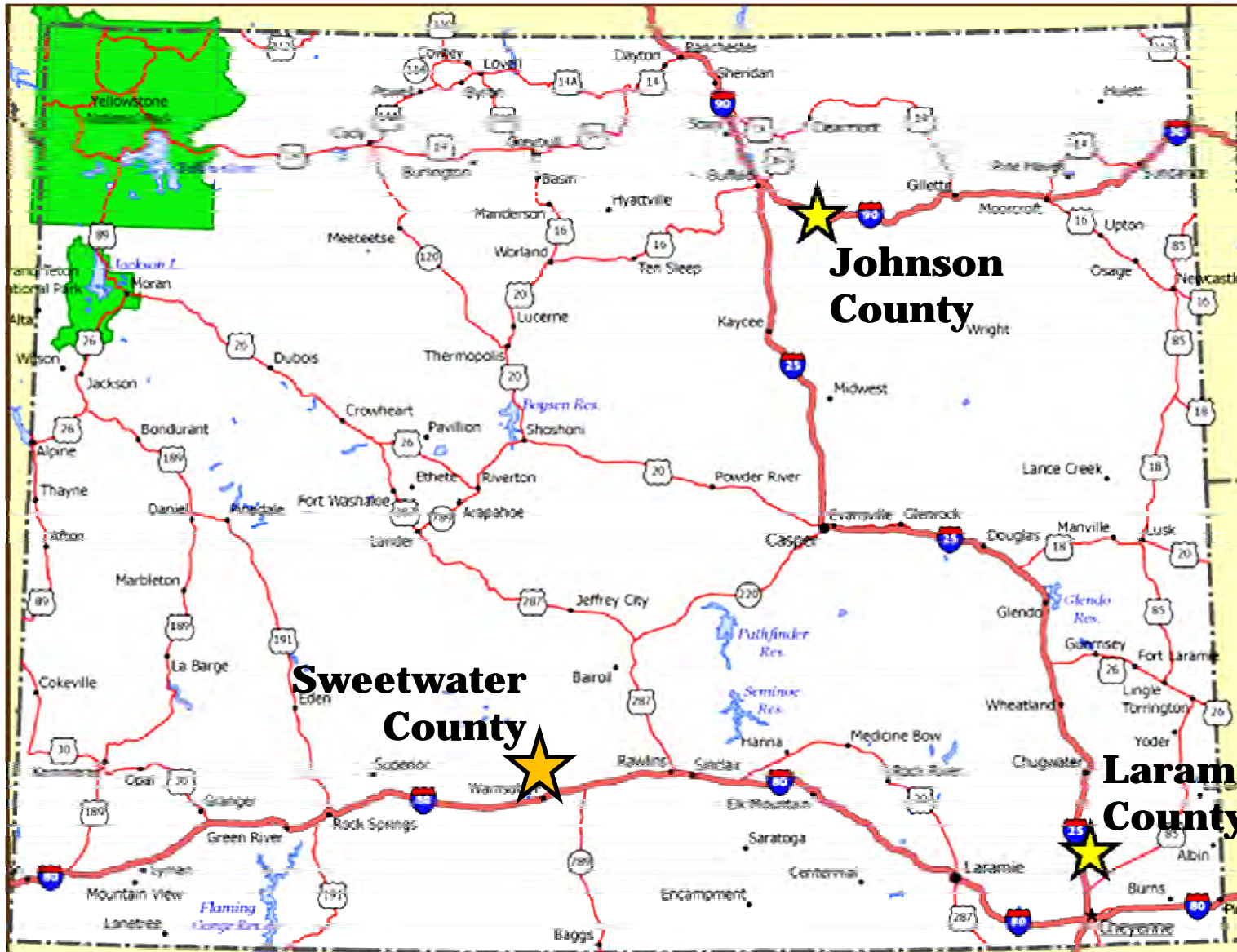


Justification and Funding

- Dust suppression and particulate emissions
 - Heavy industrial use: oil and gas drilling
- WYDOT to Counties RAP program



Wyoming Study Sites

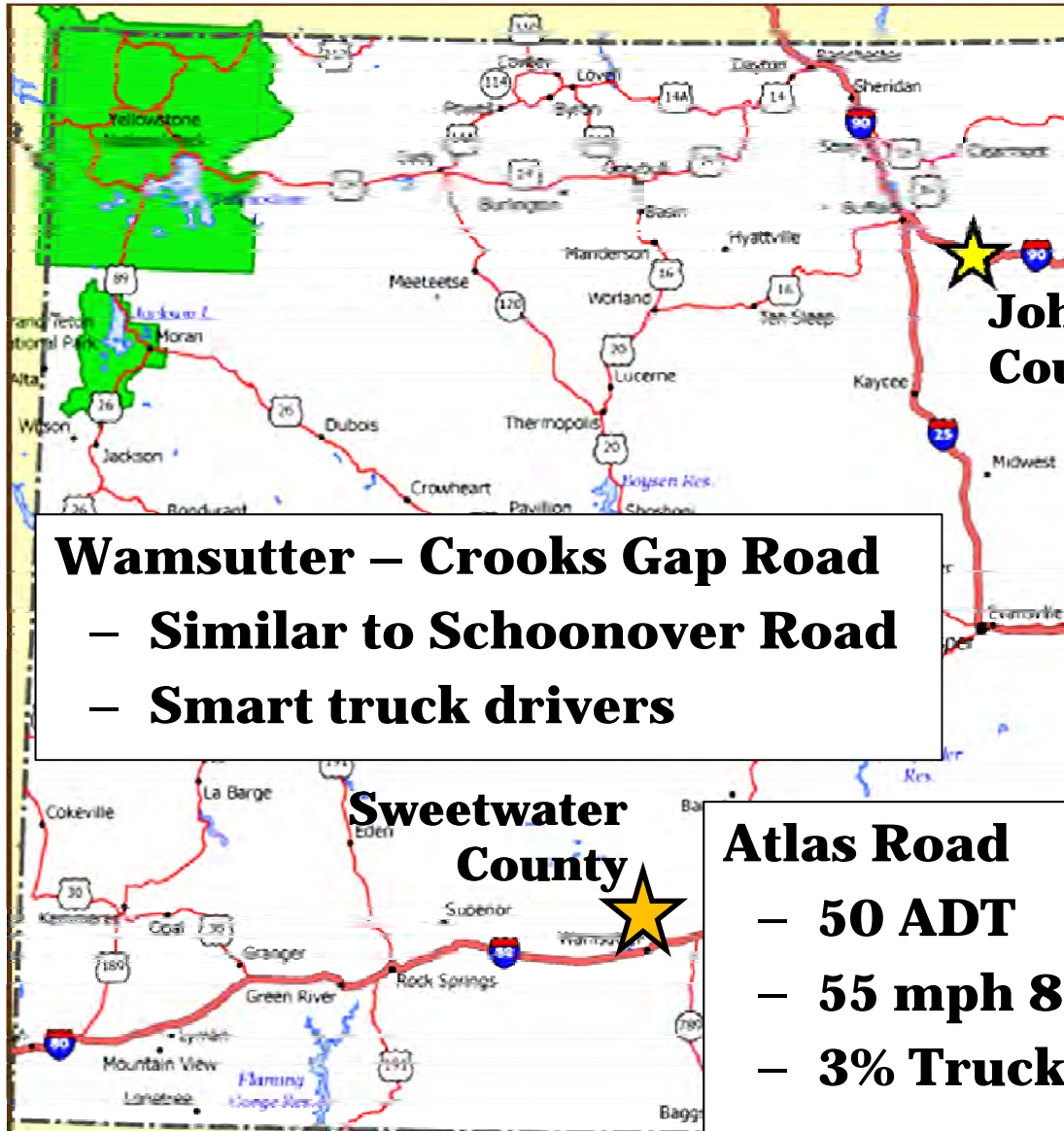


**Sweetwater
County**

**Johnson
County**

**Laramie
County**

Traffic



Schoonover Road

- 188 ADT
- 51 mph 85th%
- 74% Trucks

Wamsutter – Crooks Gap Road

- Similar to Schoonover Road
- Smart truck drivers

Pry Road

- 50 ADT
- 56 mph 85th%
- 12% Trucks

Atlas Road

- 50 ADT
- 55 mph 85th%
- 3% Trucks

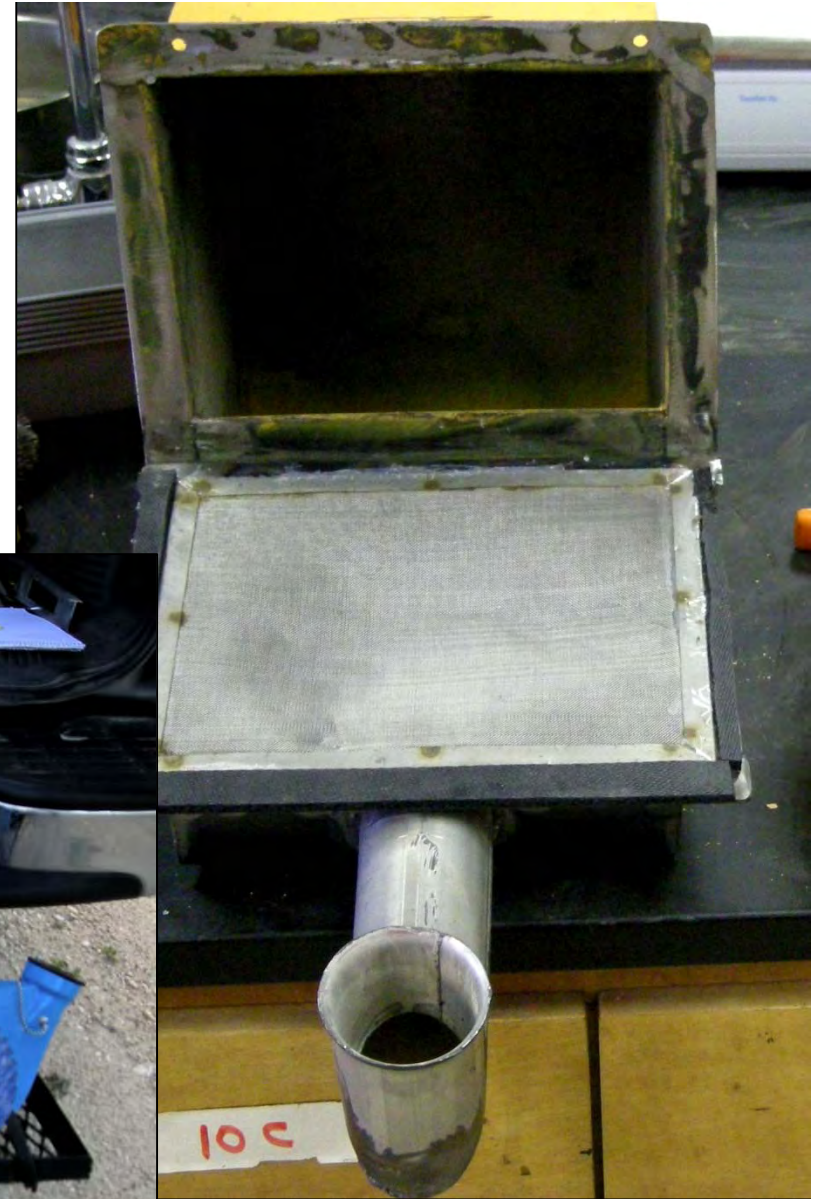
Laramie County

Testing

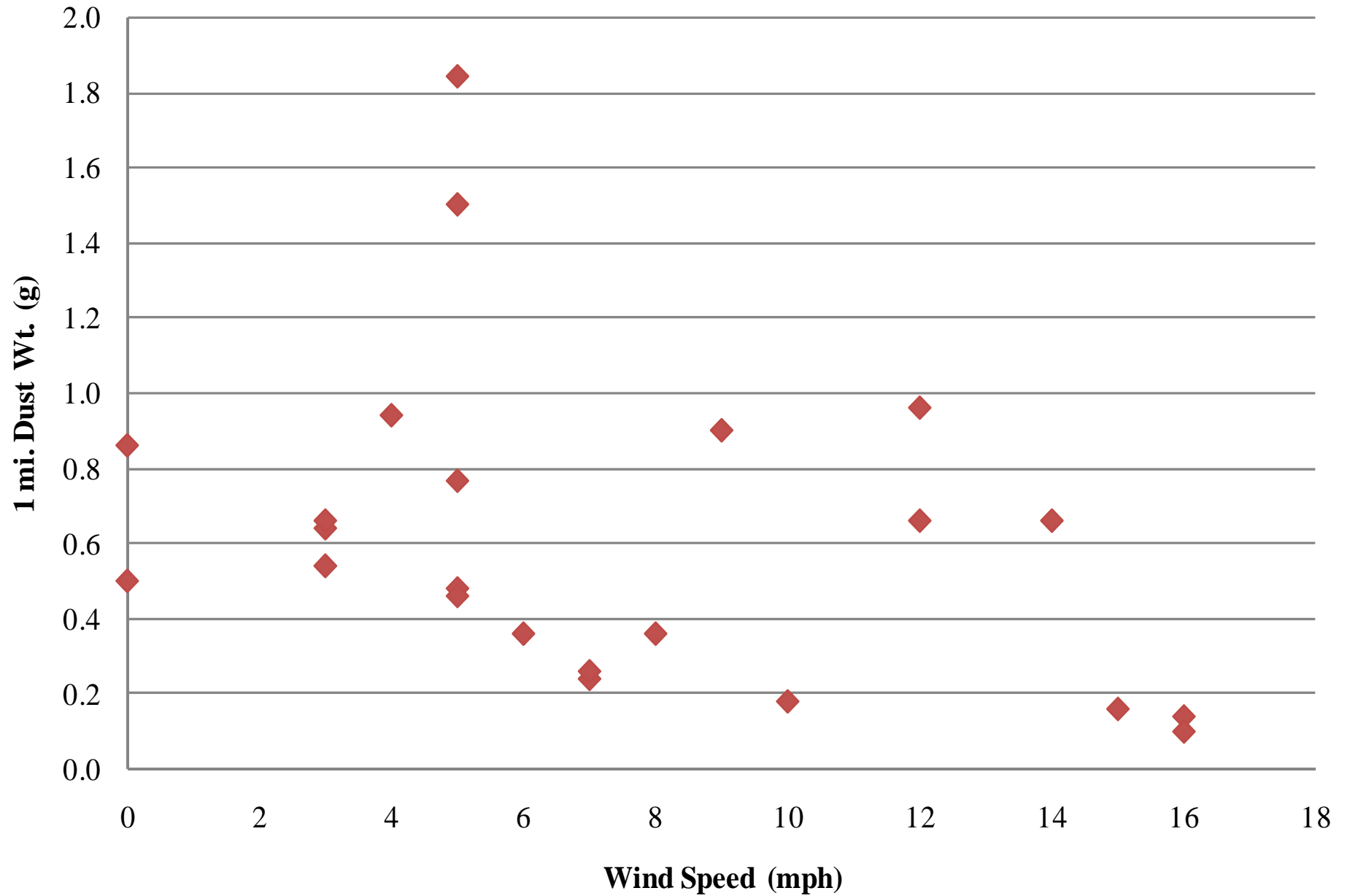
- Dust measurement
- Moisture content
- Unsurfaced Road Condition Index
 - Specific distresses
- Materials properties
 - Gradation
 - Liquid and Plastic Limits
 - R-Value
- Traffic
- Weather

CSU Dustometer

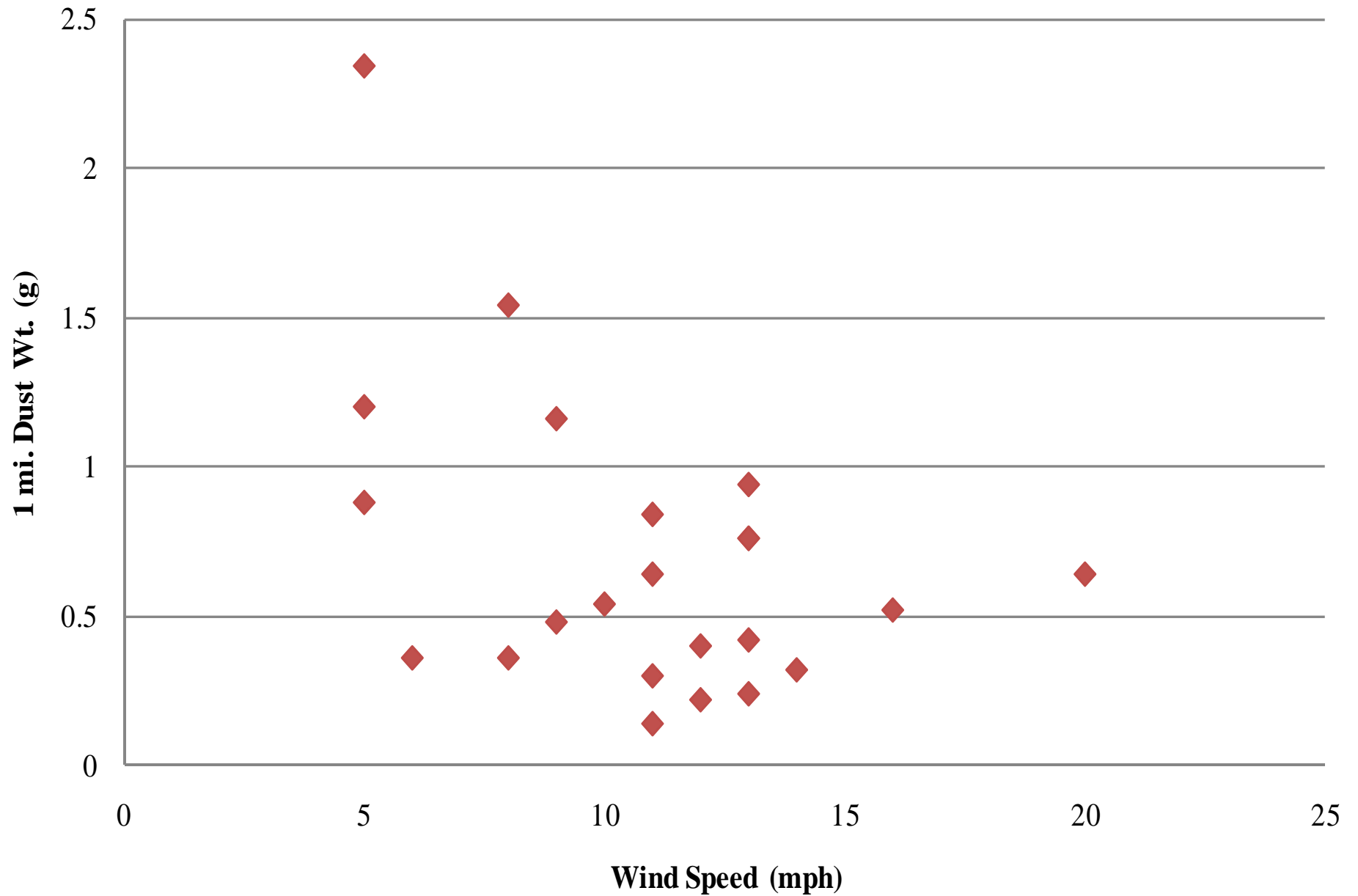
Material passing a
#100 (150 μm) screen



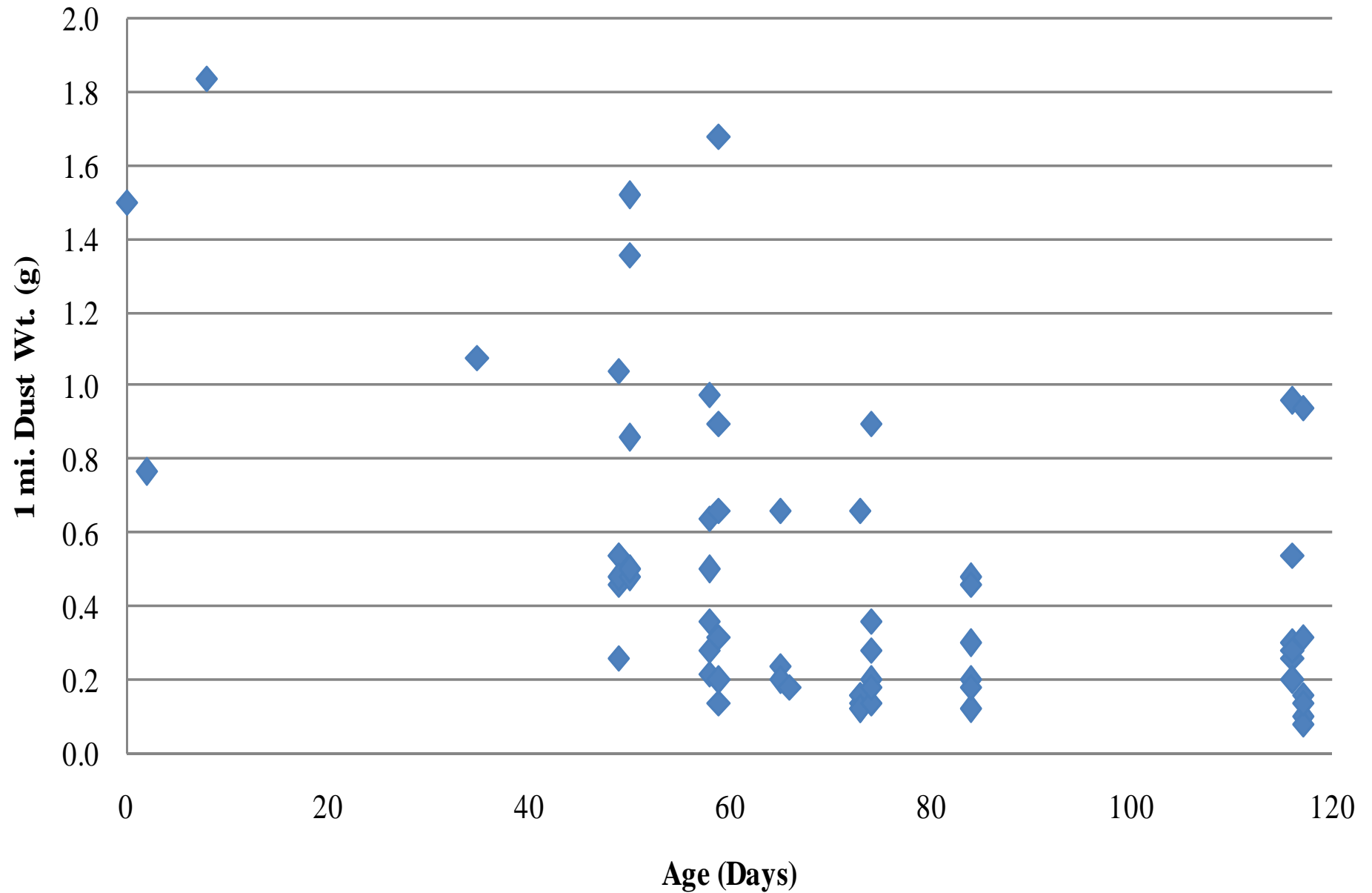
Section S2: Dust vs Wind Speed



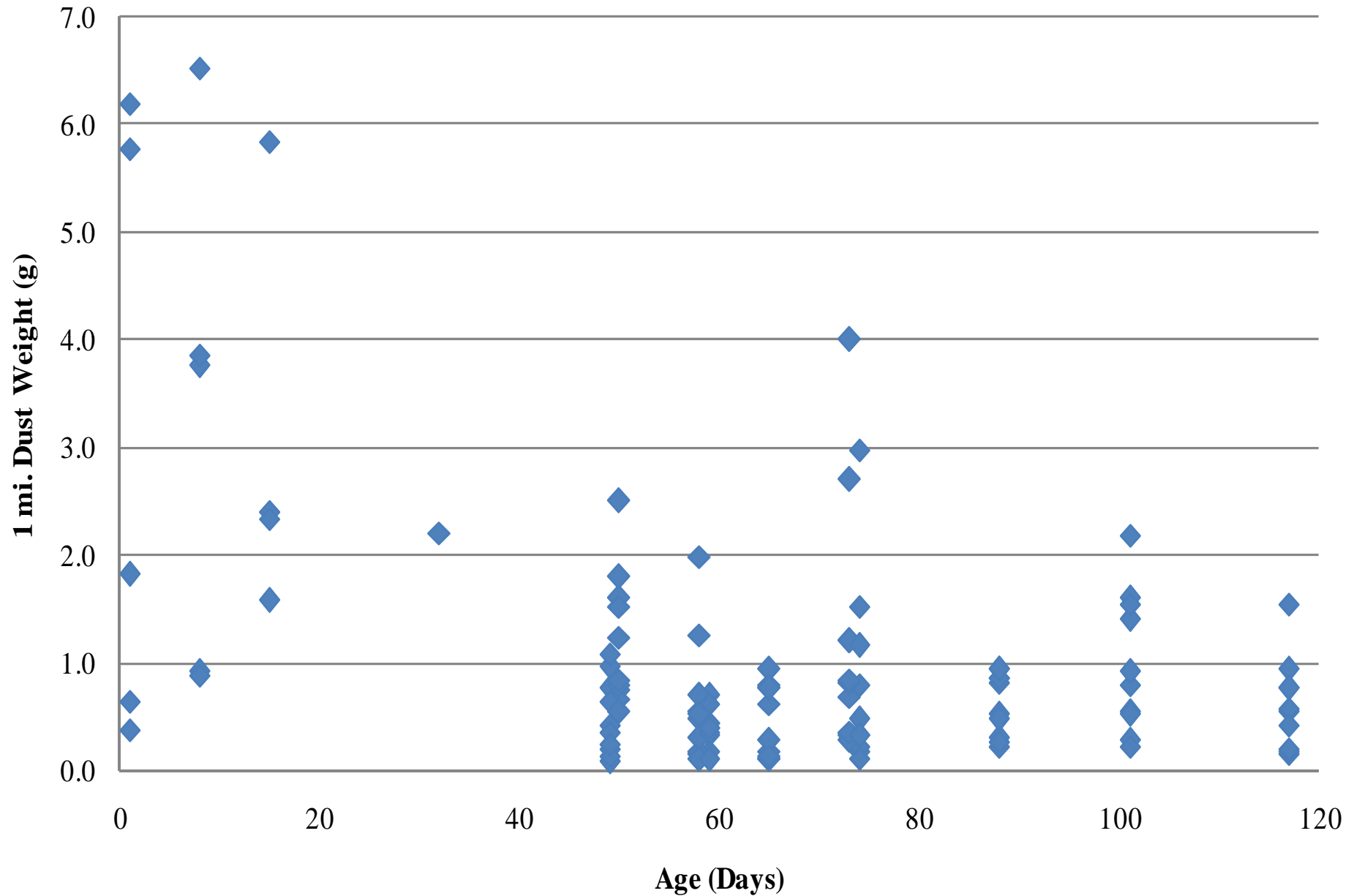
Section P1: Dust Wt. vs Wind Speed



Johnson County Dust Wt. vs Age



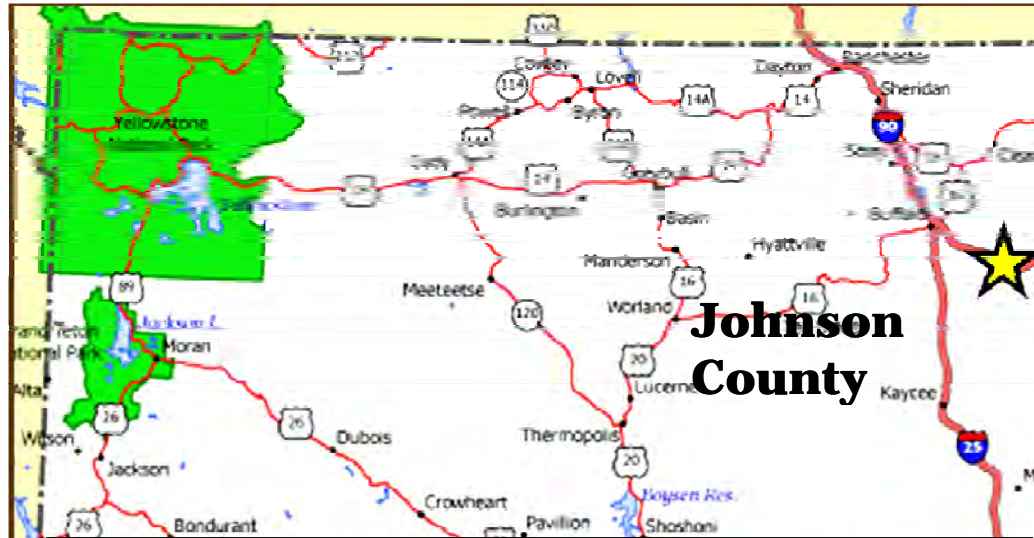
Laramie County Dust Wt. vs Age



Construction Methods

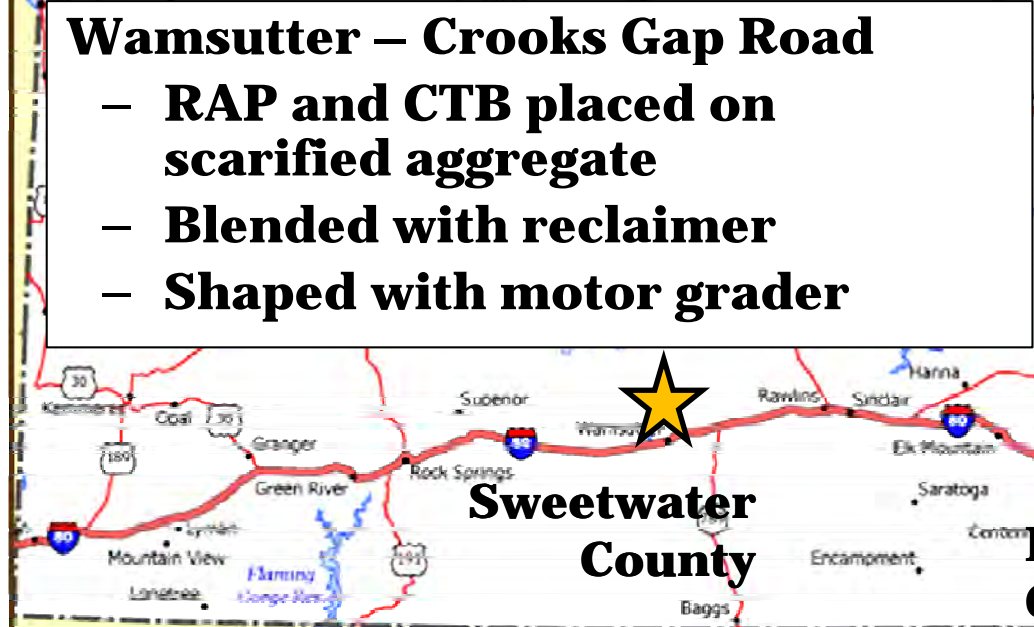
Schoonover Road

- RAP and aggregate blended off-site
- Shaped with motor grader
- Compacted with roller
- CaCl_2 flakes placed and watered



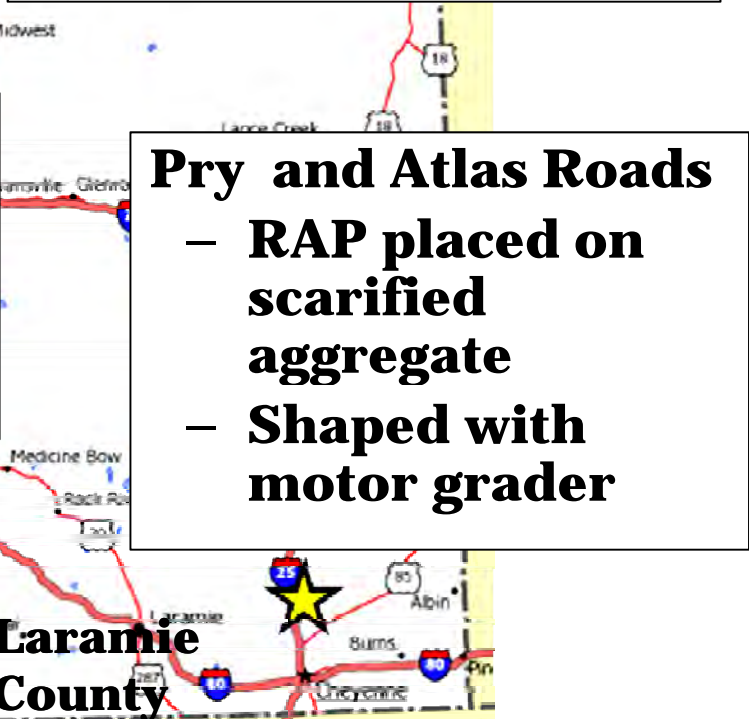
Wamsutter – Crooks Gap Road

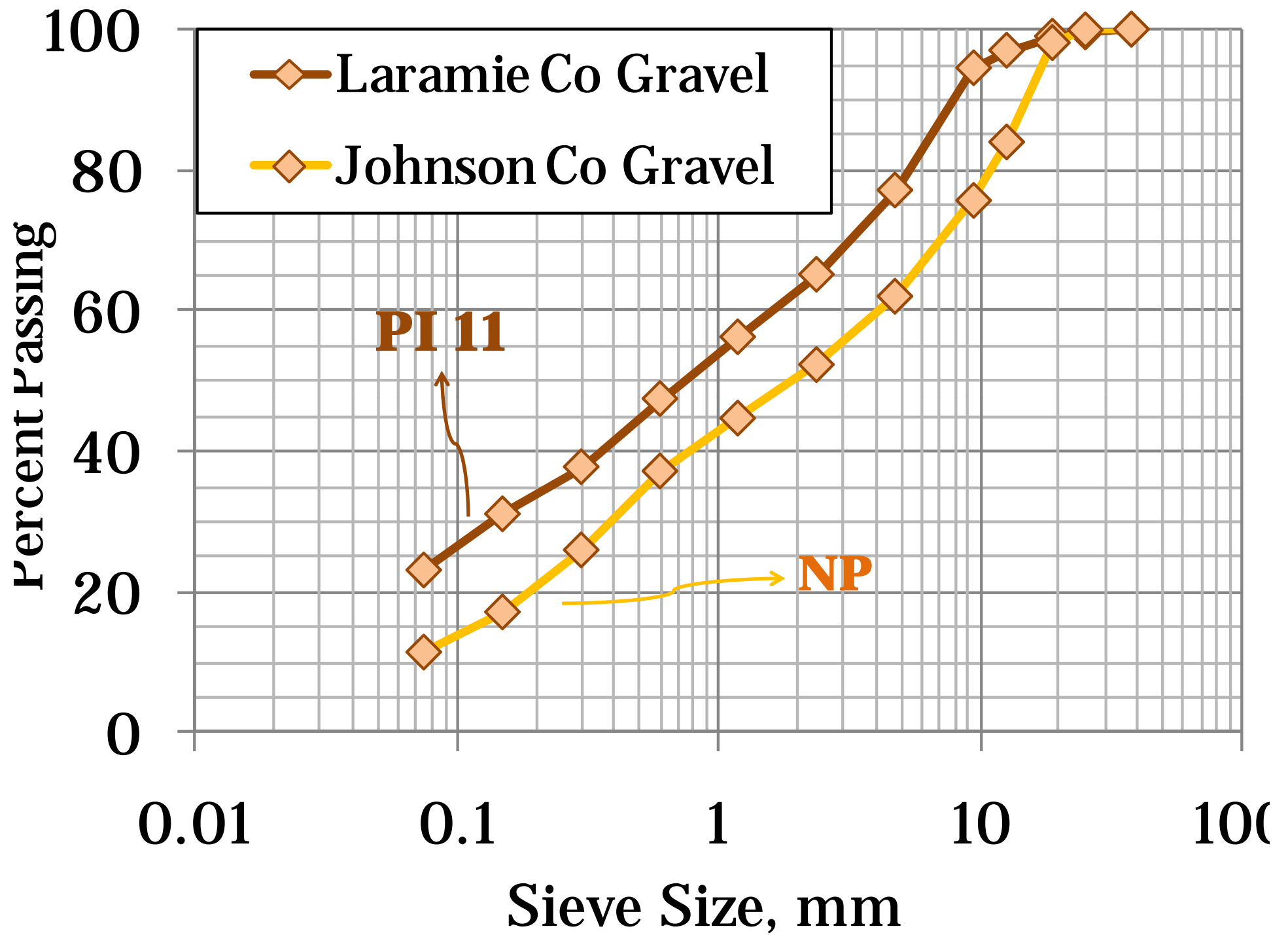
- RAP and CTB placed on scarified aggregate
- Blended with reclaimer
- Shaped with motor grader

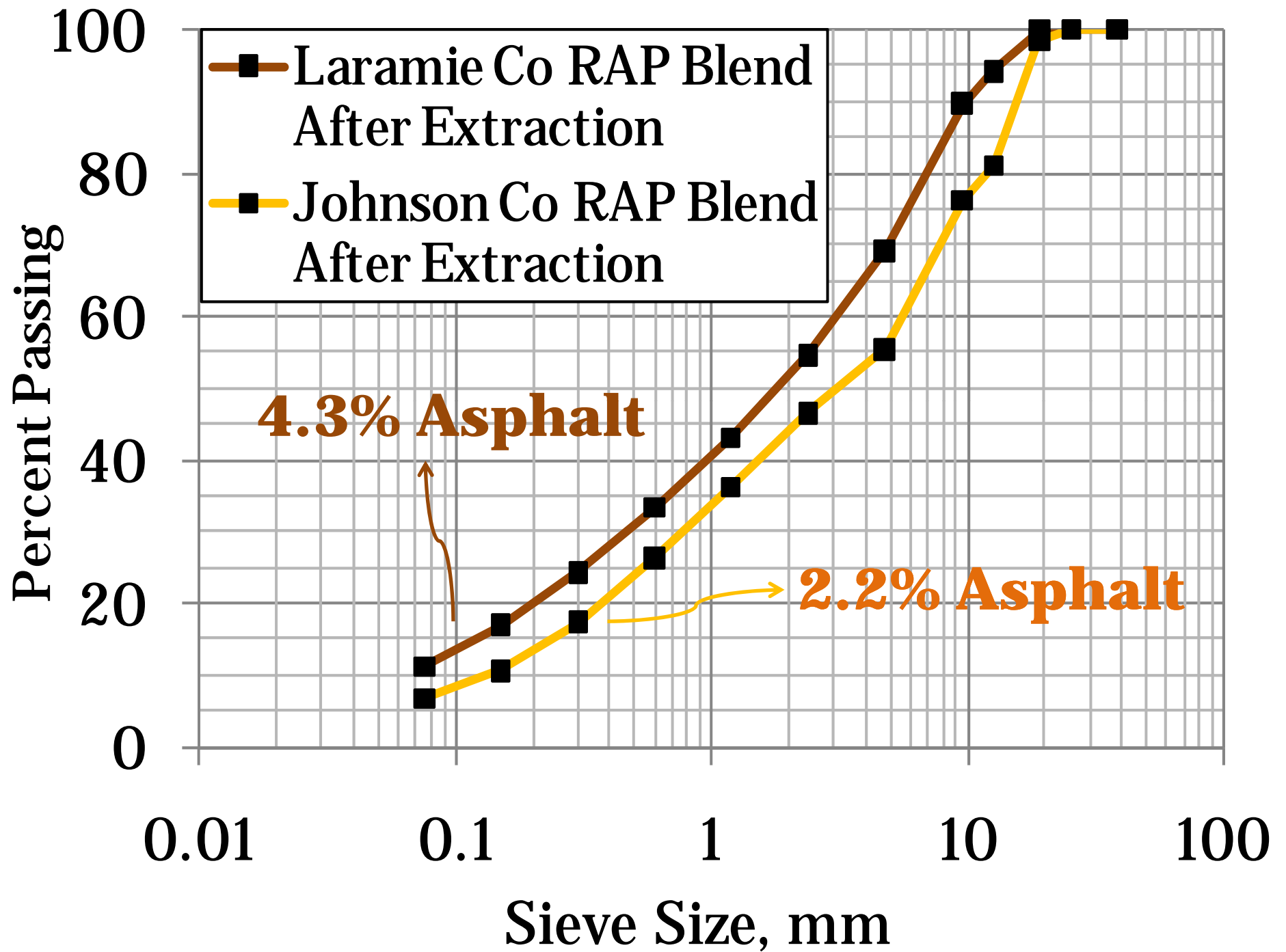


Pry and Atlas Roads

- RAP placed on scarified aggregate
- Shaped with motor grader







Laramie County Sites

Pry Road

Pry Road

- 50 ADT
- 56 mph 85th%
- 12% Trucks

Atlas Road

Atlas Road

- 50 ADT
- 55 mph 85th%
- 3% Trucks

Pry and Atlas Roads

- RAP placed on scarified aggregate
- Shaped and blended with motor grader

Image USDA Farm Service Agency
Image U.S. Geological Survey
© 2011 Google
Image © 2011 DigitalGlobe

2.71 mi

Imagery Date: 7/4/2009

41°19'45.45" N 104°45'30.43" W elev. 6122 ft

85

Eye

Laramie County Construction



RAP stockpile near Atlas Road. The RAP was milled from nearby I-25 about five years earlier.

Laramie County Construction



Sampling virgin aggregate stockpile at the Atlas Pit



Laramie County Construction



Laramie County Construction



Laramie County Construction



Laramie County
One Month Later











Laramie County Two Months Later



Laramie County Three Months Later













A photograph of a gravel road in Laramie County, four months later. The road is made of dark grey gravel and runs straight into the distance. On the left side, there is a fence line with wooden posts and a grassy field. On the right side, there is another fence line, some trees, and a white building in the background. The sky is clear and blue.

Laramie County
Four Months Later

A long, straight gravel road stretches into the distance through a flat, grassy landscape. The road is composed of small, dark and light-colored stones. On either side of the road, there is a fence line made of wooden posts and wire, with tall grasses growing behind it. The horizon is flat and extends to the edge of the frame. The sky is a pale, overcast blue.

**Laramie County
Five Months Later**

Laramie County Six Months Later











Laramie County Summary

- Blade mixing was ineffective
 - Remixed later in the summer
 - Need better spread from the haul trucks
- ‘Fat’ spots will set up
 - Chunks need to be broken up during maintenance
- Construction issues cloud the dust and condition data
- Loose aggregate considerably lowered URCI values

Johnson County Site

Schoonover Road

- 188 ADT
- 51 mph 85th%
- 74% Trucks

Schoonover Road

Schoonover Road

- RAP and aggregate blended off-site
- Shaped with motor grader
- Compacted with roller
- CaCl₂ flakes placed and watered

Image USDA Farm Service Agency
Image © 2011 DigitalGlobe
© 2011 Google

44°09'48.05" N 106°14'33.03" W elev 4347 ft

Eye a

Johnson County



Johnson County *Initial Construction*











Johnson County
Surface pre-wetted
CaCl₂ flakes



**Surface pre-wetted
CaCl₂ flakes**







RAP blend only

Johnson County
Two Months Later



RAP blend with CaCl_2





**Aggregate only
with CaCl_2**

Johnson County
Three Months Later

**RAP blend
with CaCl_2**

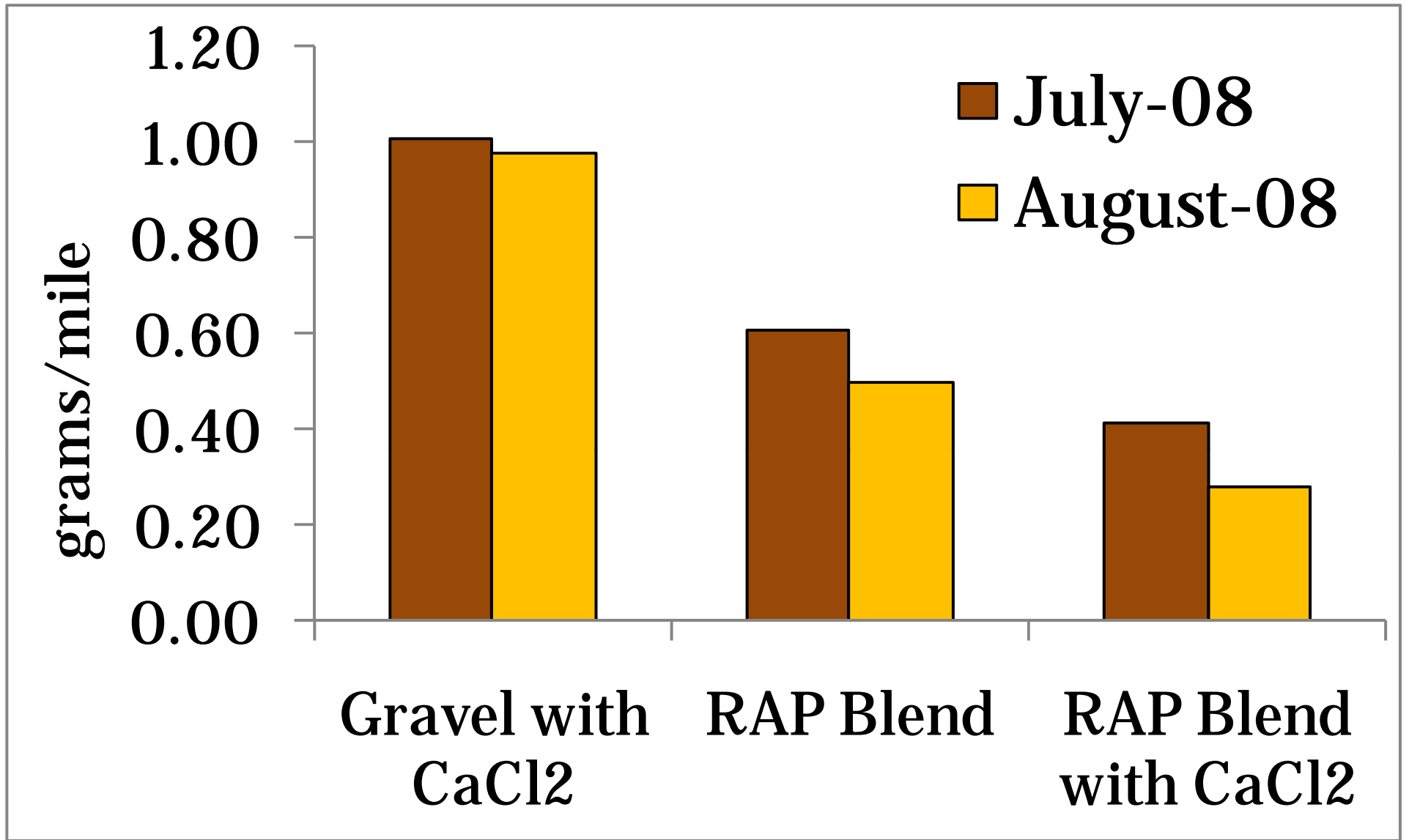
Johnson
County

*Four Months
Later*



RAP blend only





Johnson County Dust Measurements

Johnson County Summary

- The gravel-with-CaCl section showed more loose aggregate than the RAP-blend-with-CaCl section.
- The RAP-blend section displayed more loose aggregate than the RAP-blend-with-CaCl section. The use of CaCl helped in stabilizing the road surface and in reducing the amount of loose aggregate.
- The sections with CaCl had more rutting than the section without CaCl.
- The use of RAP in the roadway reduced dust loss. RAP with CaCl reduced dust loss even more.

Crooks Gap Road

- Heavy drilling traffic
- Smart (okay, trainable) truck drivers

Sweetwater
County Site

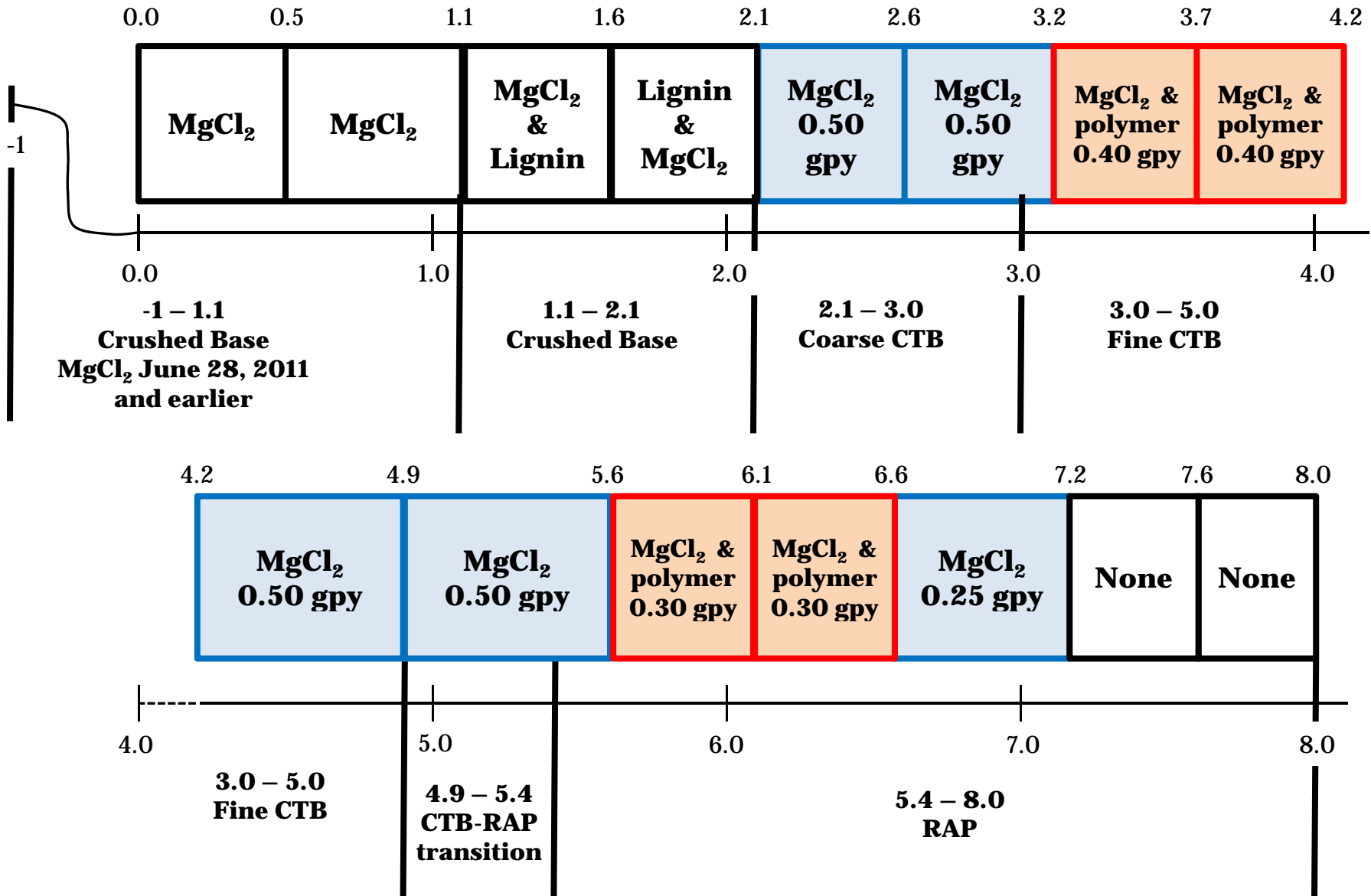
Crooks Gap Road

Crooks Gap Road

- RAP and CTB placed on scarified aggregate
- Blended with reclaimer
- Shaped with motor grader



June 2, 2011 Drive Through: Before Dust Suppressant Application



CTB & RAP sections

Sweetwater County
Initial Construction





Formed Native Earth



Formed Native Earth



Formed Native Earth



Formed Native Earth



Formed Native Earth



RAP blend



RAP blend



RAP blend



RAP blend



RAP blend



RAP blend



RAP blend



RAP blend



CTB-RAP Transition



CTB-RAP Transition



CTB-RAP Transition



CTB-RAP Transition



CTB-RAP Transition



Finer CTB



Finer CTB



Finer CTB



Finer CTB



Finer CTB



Finer CTB



Truck turned off, waited for the next one



Coarser CTB



Coarser CTB



Coarser CTB



Coarser CTB



Crushed Base



Crushed Base



Crushed Base



Crushed Base



Crushed Base – slowed down – we're on his tail



Crushed Base with MgCl_2



Crushed Base with $MgCl_2$



Crushed Base with $MgCl_2$



Crushed Base with MgCl_2






Dawn pre-wetting of RAP-
aggregate blend, One Month
Later

Shaping and placing dampened RAP and aggregate blend



Damp
RAP-
aggregate
blend



A large truck is shown from a side-rear perspective, equipped with a long spray bar. Multiple nozzles along the bar are spraying a white, foamy liquid onto a dark gravel surface. The truck's body is white with red reflective stripes. In the background, another white truck is parked on a dirt area, and the landscape is a flat, open field under a clear sky. The text "MgCl2 brine application" is overlaid in white on the right side of the image.

MgCl₂ brine
application

Recently applied
 MgCl_2 brine



MgCl_2 brine about one hour after application

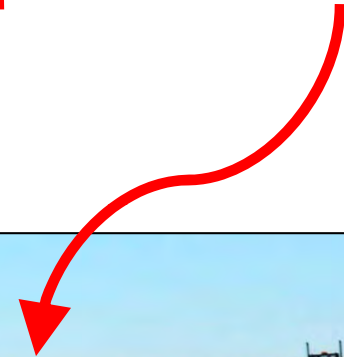


Compacting RAP-aggregate blend after MgCl_2 brine application





Dust on untreated limestone crushed base on hill and on flat.



Dust on untreated finer CTB blend.



Dust on untreated coarser CTB blend



**CTB blend three weeks after MgCl_2
application, two months after
construction.**



CTB blend eight weeks after MgCl_2
application, three months after
construction.



Untreated RAP blend Initial Construction



**RAP blend three weeks after MgCl_2 and
polymer application, five months after
construction.**



**RAP blend three weeks after MgCl_2 application,
five months after construction.**



Untreated RAP blend six months later



**RAP blend eight weeks after MgCl_2 application,
Six months after construction**

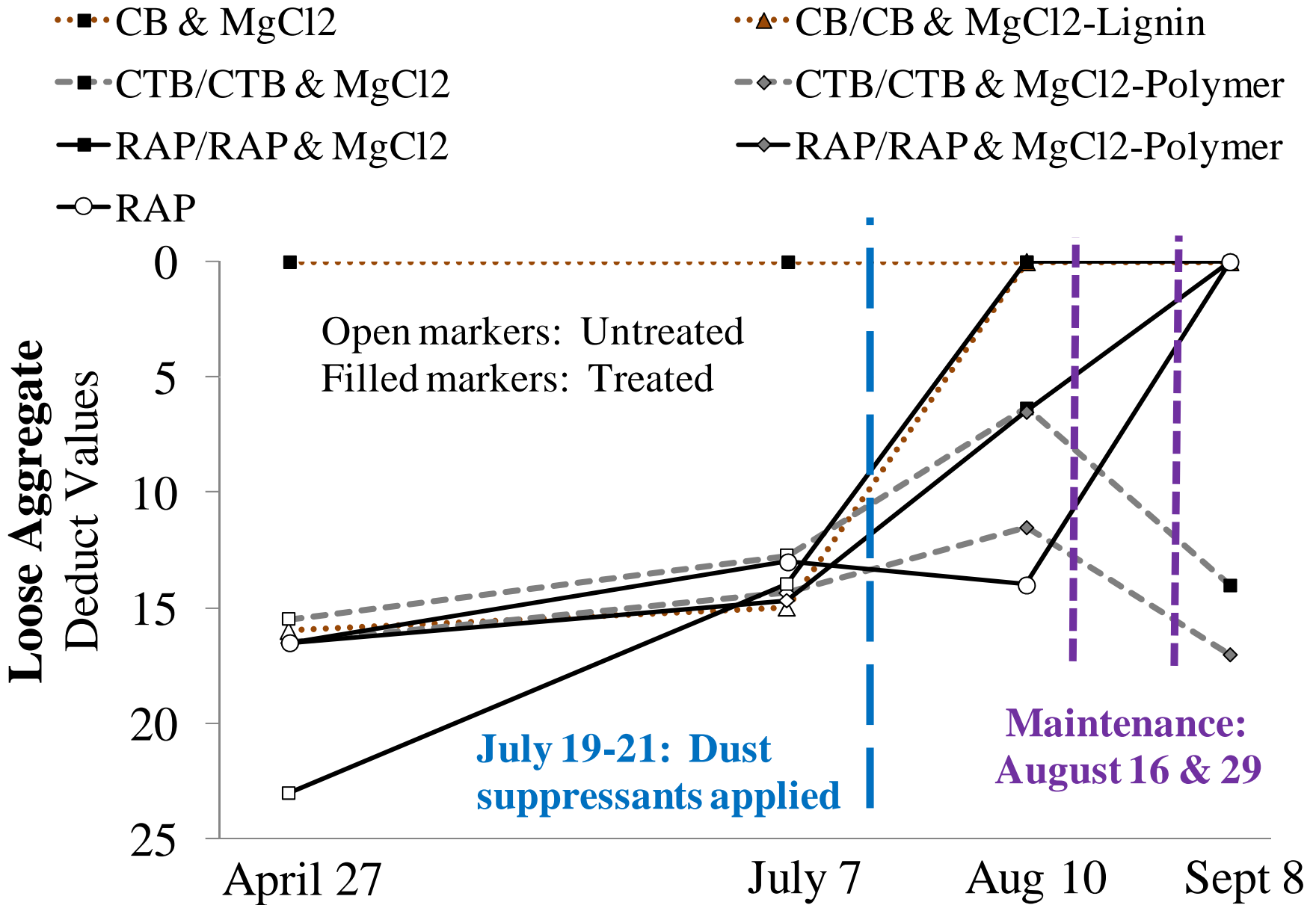


**RAP blend eight weeks after polymer and $MgCl_2$ application,
Six months after construction**



Untreated RAP blend Six months after construction





- CB & MgCl₂
- CTB/CTB & MgCl₂
- RAP/RAP & MgCl₂
- RAP
- ▲● CB/CB & MgCl₂-Lignin
- ◆ CTB/CTB & MgCl₂-Polymer
- ◆ RAP/RAP & MgCl₂-Polymer

Open markers: Untreated
 Filled markers: Treated

Washboards/Corrugations

Deduct Values

0
10
20
30
40

April 27

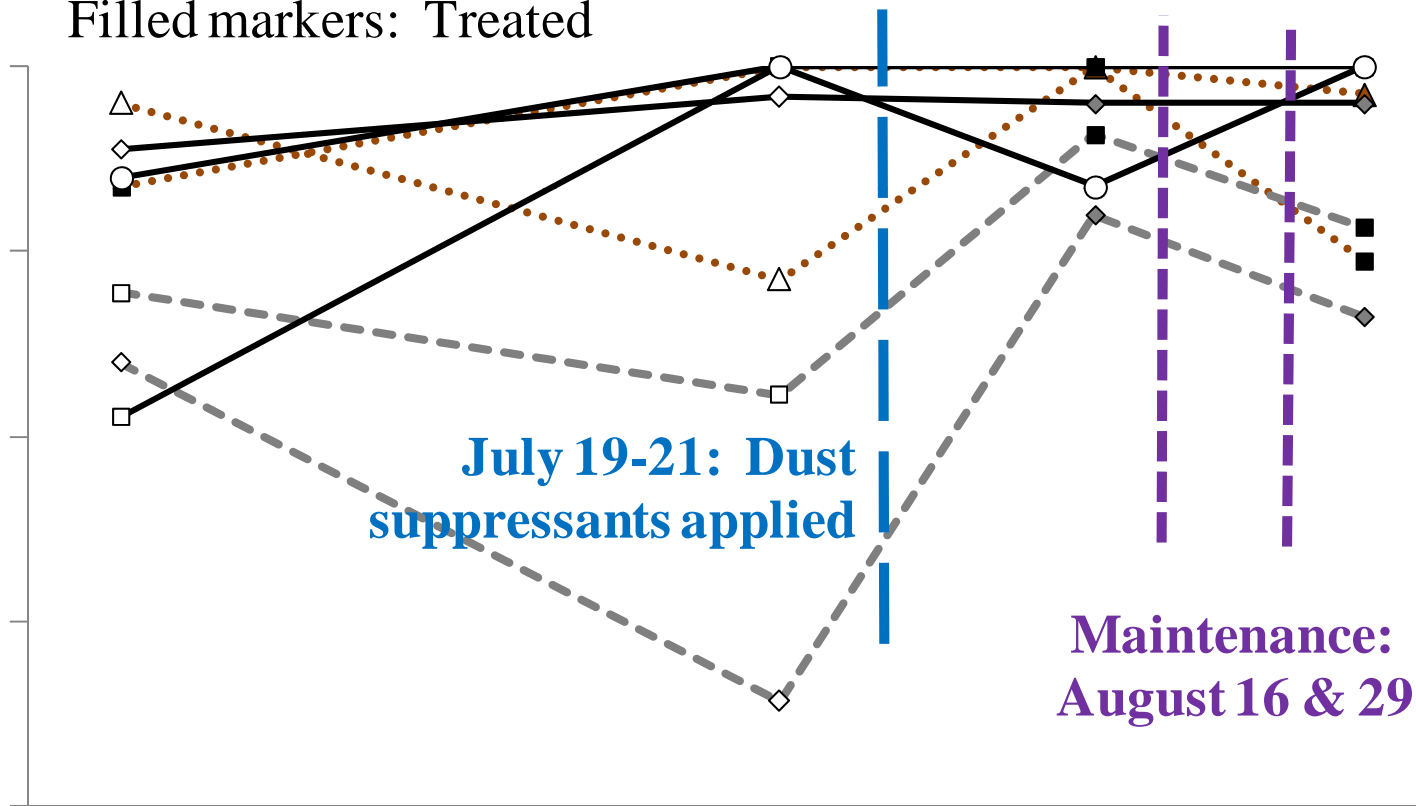
July 7

Aug 10

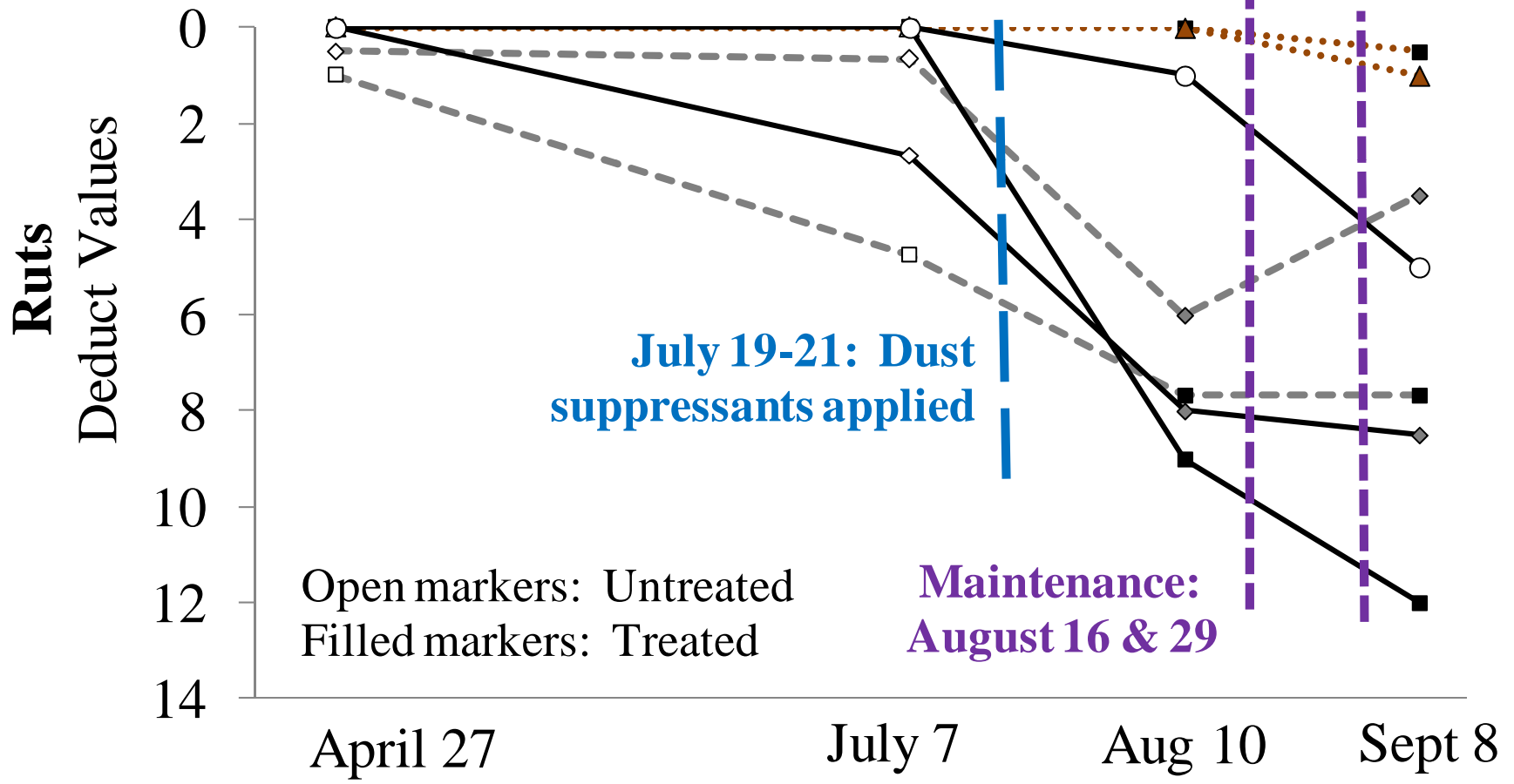
Sept 8

July 19-21: Dust suppressants applied

Maintenance: August 16 & 29



- CB & MgCl2
- CTB/CTB & MgCl2
- RAP/RAP & MgCl2
- RAP
- ▲● CB/CB & MgCl2-Lignin
- ◇ CTB/CTB & MgCl2-Polymer
- ◇ RAP/RAP & MgCl2-Polymer



●■● CB & MgCl2

-■- CTB/CTB & MgCl2

-■- RAP/RAP & MgCl2

-○- RAP

●▲● CB/CB & MgCl2-Lignin

-◇- CTB/CTB & MgCl2-Polymer

-◇- RAP/RAP & MgCl2-Polymer

July 19-21: Dust suppressants applied

Maintenance: August 16 & 29

Potholes
Deduct Values

0
1
2
3
4
5

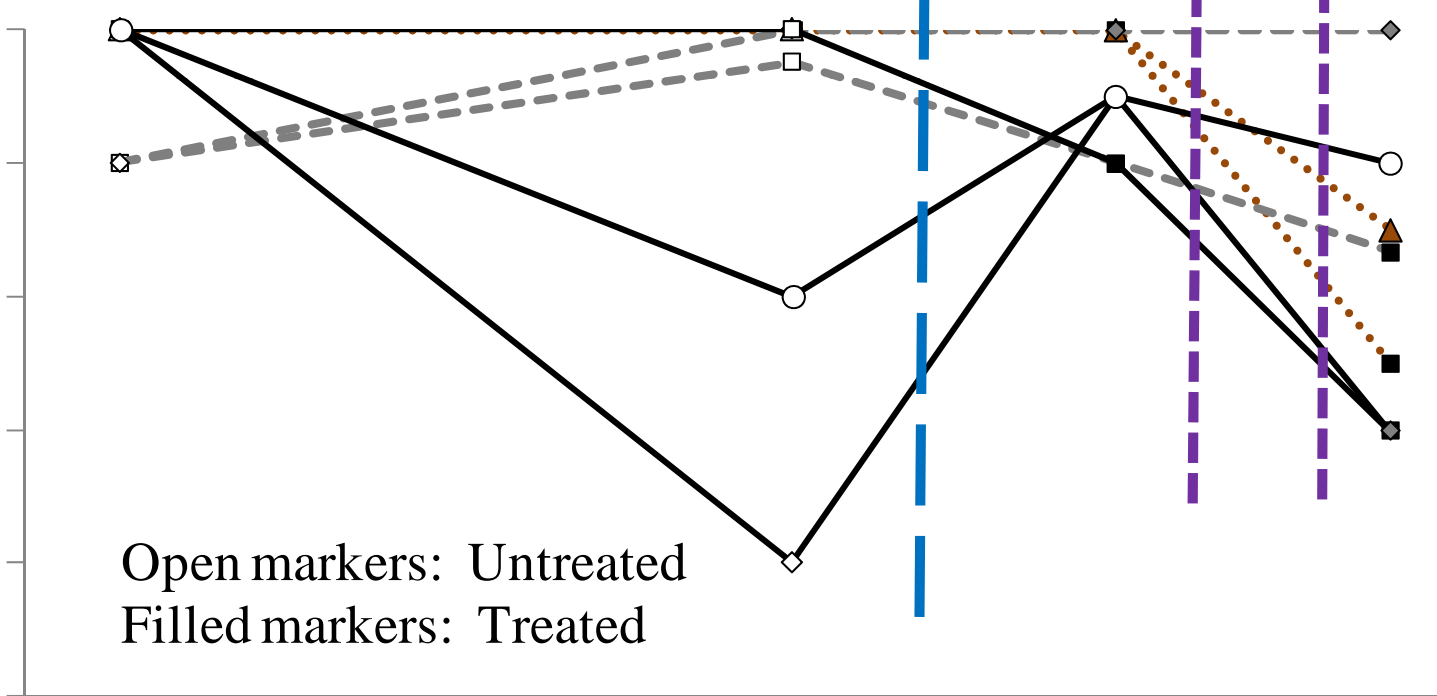
Open markers: Untreated
Filled markers: Treated

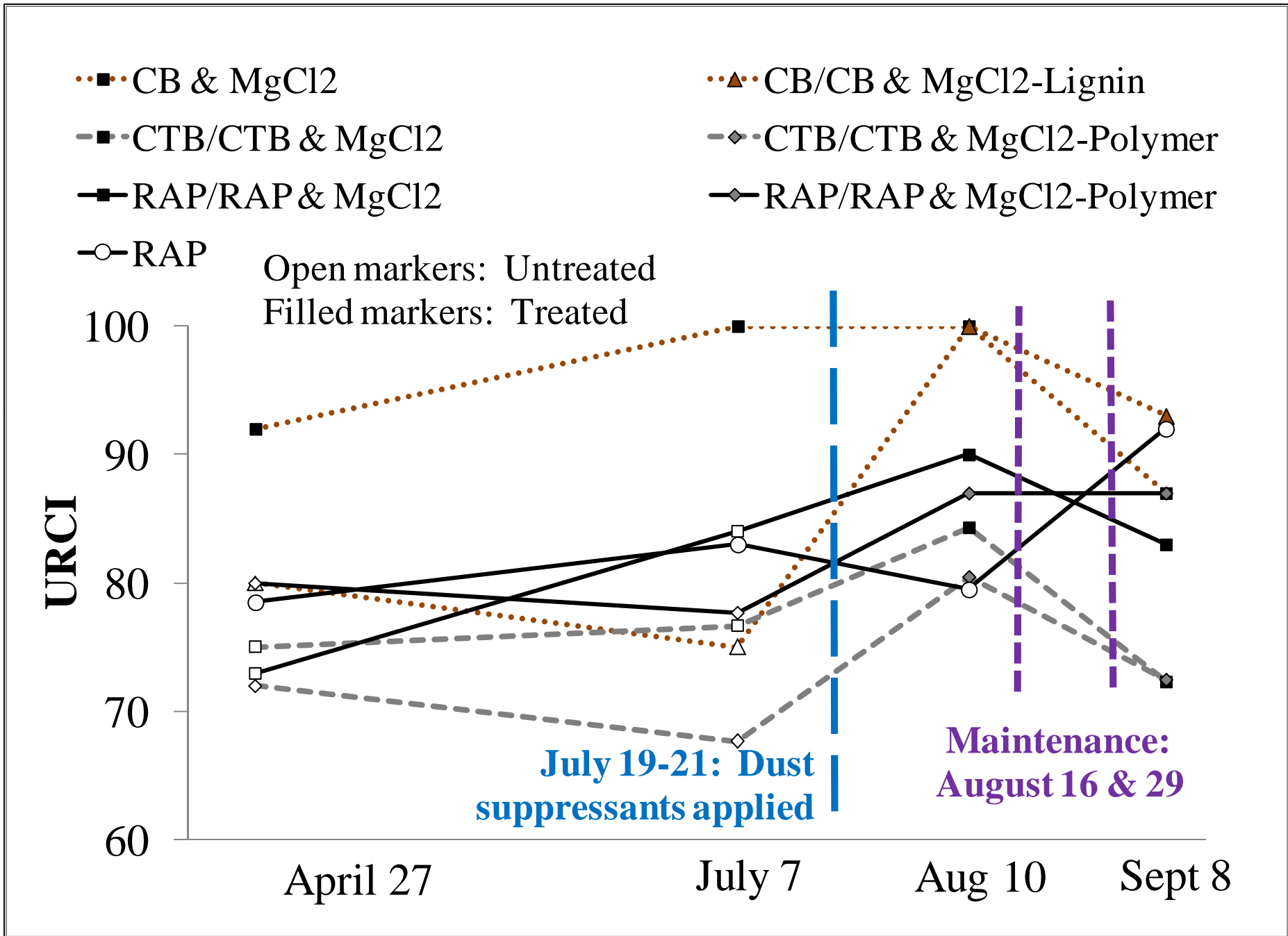
April 27

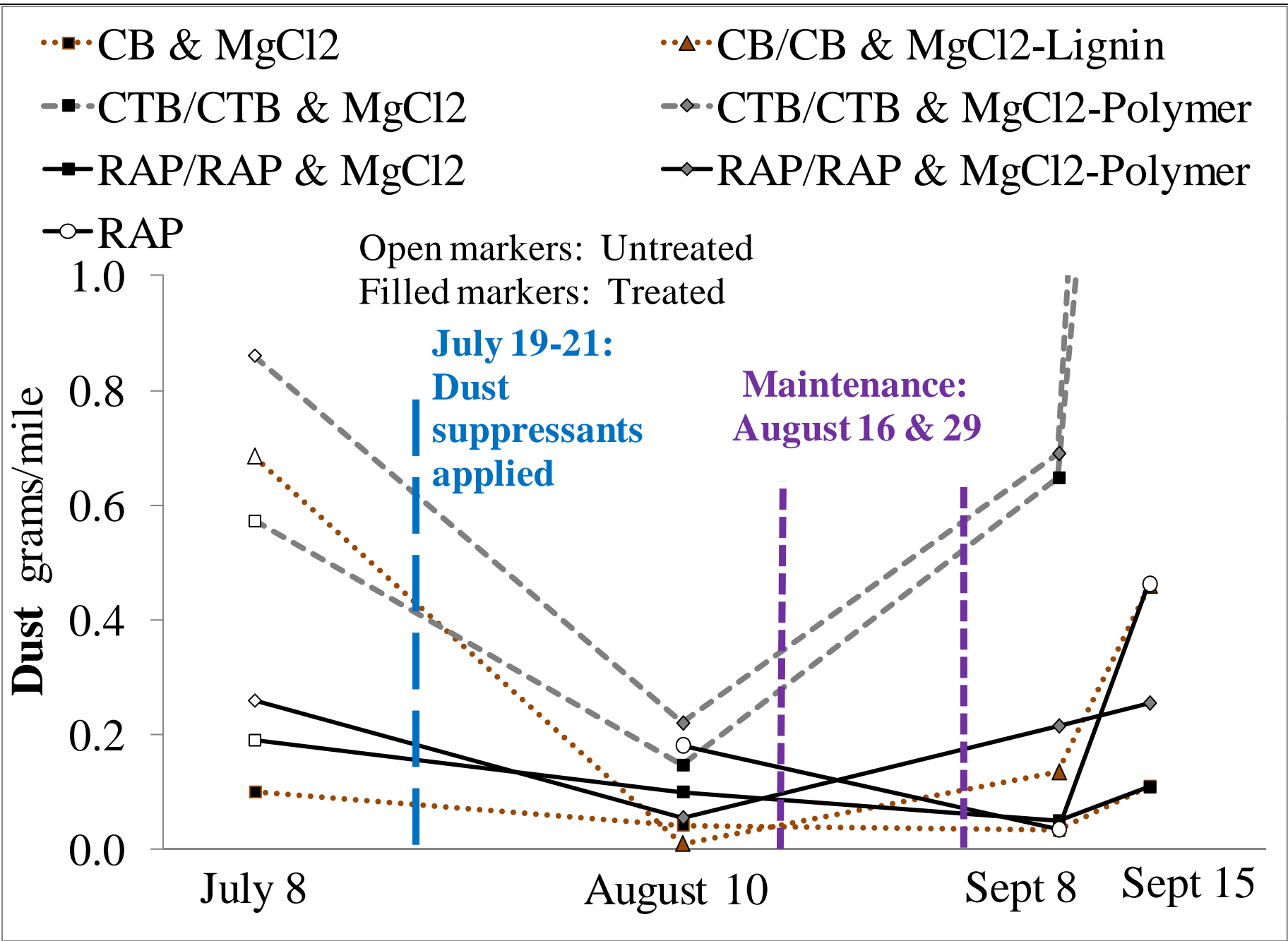
July 7

Aug 10

Sept 8







PRELIMINARY ANALYSIS CONCLUSIONS

- **Dust loss decreased with age.**
- **Dust collection should not be performed when wind speeds are excessively high.**
- **Dust was collected when roadway was dry and moisture content was low. Therefore, at low moisture contents dust was not significantly affected by moisture content.**

CONTRAST ANALYSIS CONCLUSIONS

- **Sections without RAP generated 147% more dust than sections with RAP.**
- **Sections without CaCl₂ generated 354% more dust than sections with CaCl₂.**
- **Laramie County sections exhibited 288% more dust than Johnson County sections**

CONTRAST ANALYSIS CONCLUSIONS

- **Sections without RAP had better URCI than sections with RAP due to more loose aggregate associated with RAP sections.**
- **Sections without CaCl₂ had better URCI scores than sections with CaCl₂ due to rutting in CaCl₂ sections.**
- **Laramie County sections had better URCI scores than Johnson County sections due to difference in traffic loading, especially trucks.**

CONCLUSIONS

- RAP significantly reduced dust loss.
- RAP did not adversely affect the roads' serviceability
 - Increased loose aggregate
 - CaCl_2 sites had less dust but more rutting.

Wyoming Technology Transfer Center



Performance of Recycled Asphalt Pavement (RAP) in Gravel Roads

Questions? Comments?



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