Road Dust Suppressants Research Results

By

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Win Win

- Decreases maintenance cost by prolonging the life of the dirt road.

- Reduces fugitive dust emissions, a major source of particulates in the air.

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Road Dust Suppressants Research Results

- Background Information
- Objectives
- Questions Addressed by this Research
- Types of Dust Suppressants
- Experimental Design
- Research Results
- Conclusions
- Recommendations

Background Information

- Funded by The Mountain Plains Consortium, University Transportation Centers Program
- In Cooperation with the Larimer County Department of Roads and Bridges, CO
- At Colorado State University, Fort Collins, CO
- By Graduate Student, Mr. Jonathon Q. Addo, P.E., MSCE, Hewlet Packard

Objectives

- Determine the relative effectiveness of the different dust suppressants in common use.
- Assess the water quality effects resulting from the use of the different dust suppressants.

Questions Addressed by this Research

- How can we reduce dust stirred up by traffic on unpaved roads?
- What dust suppressing chemicals are most effective?
- What are the WQ Impacts?
- How much aggregate is lost each year?
- What traffic volume is the use of dust suppressants justified?

Types of Dust Suppressants

- Lignosulfanate (lignin derivatives)
- Calcium Chloride
- Magnesium Chloride
- Sodium Chloride
- Bitumens and Tars (resinous adhesives)
- Road Fabrics
- Water

Experimental Design

- Road test sections, one mile, same vehicle and driver, constant speed, three runs for average, 2 years of data
- Colorado State University Dustometer
- Traffic counters
- Aggregate loss measurements, every ¼ mile at the end of the 5 month tests
- WQ measurements

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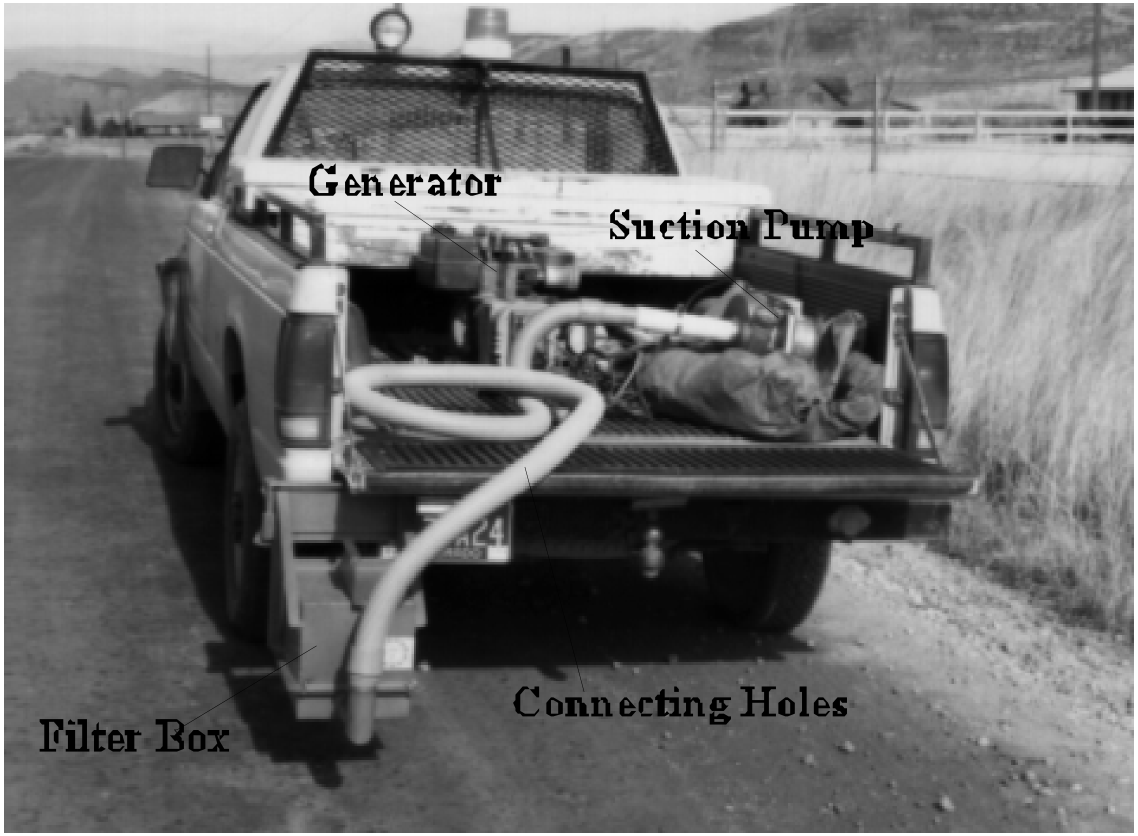
Test Vehicle and Dustometer System



Location of Each Test Section and Treatment

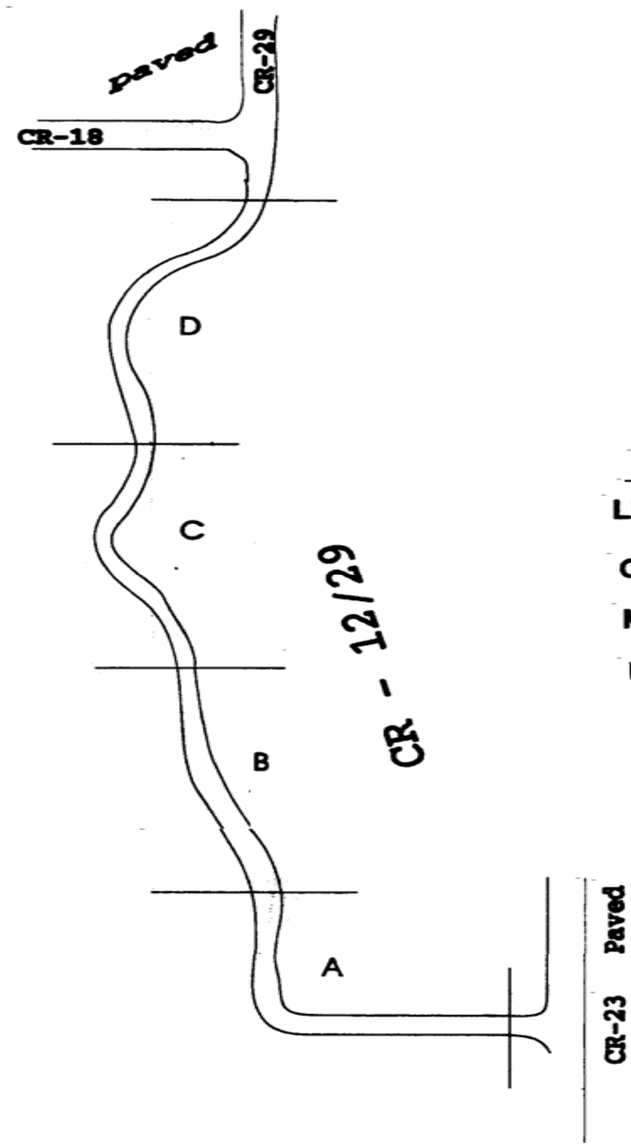
1st Year Evaluation

A : Calcium Lignosulfate

B : Calcium Chloride

C : Magnesium Chloride

D : Calcium Chloride - Special



2nd Year Evluation

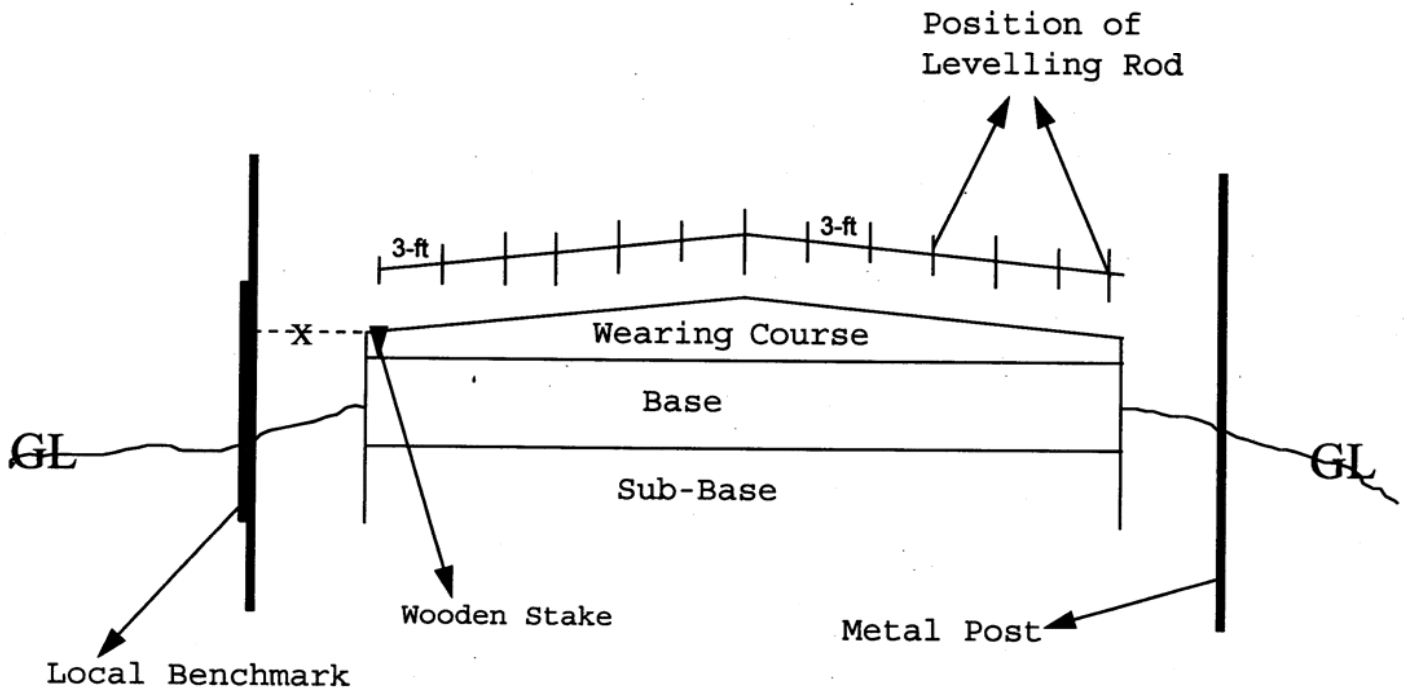
Lignosulfonate

Calcium Chloride

Magnesium Chloorlde

Untreated

Test Road Cross Section



Section - AA

Research Results

- Precision Test
- Dust Generation vs Speed
- Dust Generation vs Time for Each Suppressant
- Aggregate loss for Each Suppressant
- Cost Analyses
- WQ Analyses

Precision Test Analysis

Typical Dust Measurements

Speed : 45 mi/hr

Length of run : 1 mile

Untreated Section

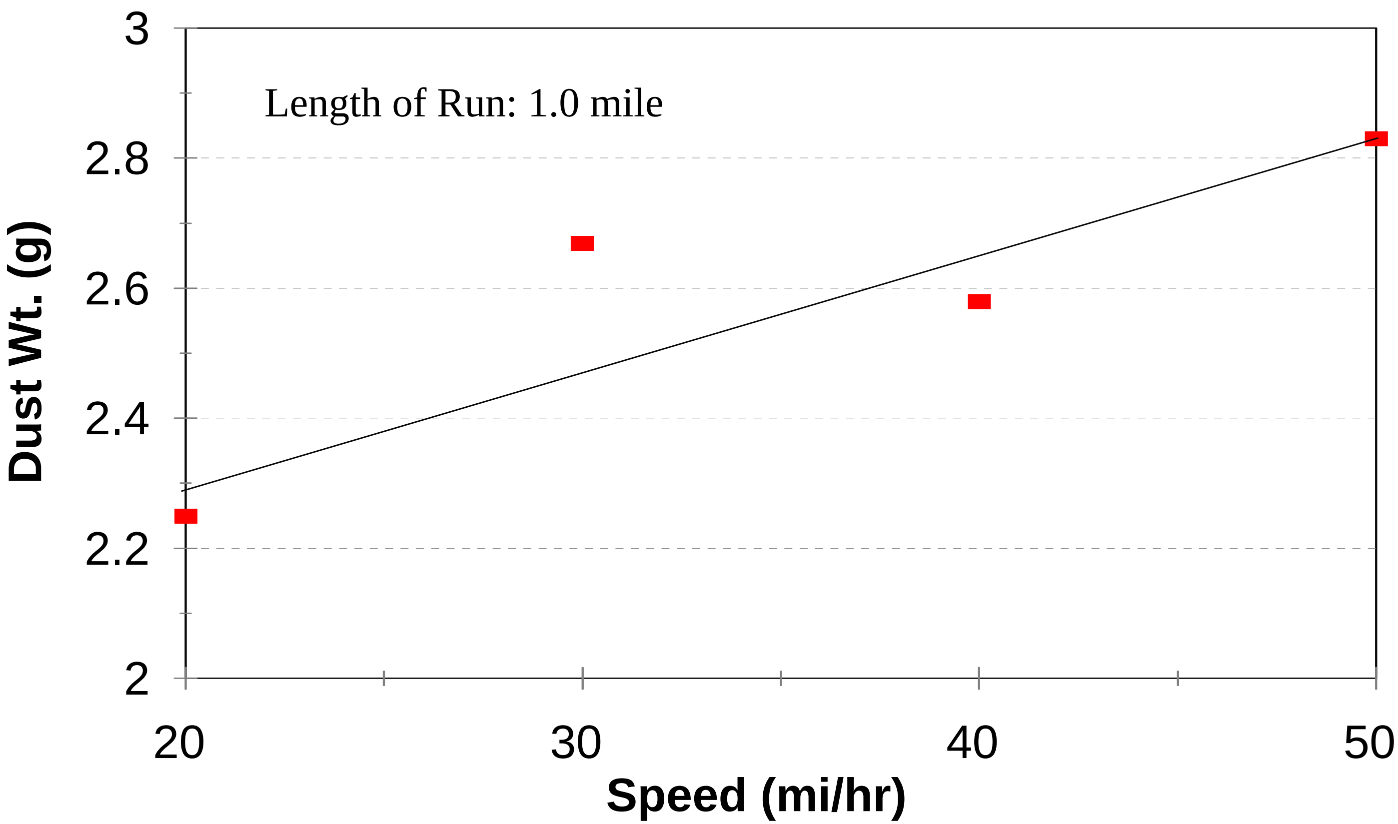
Sample #	Wt. (g)
1	2.85
2	2.60
3	2.83
4	2.86
5	2.87
6	2.47
7	2.62
8	2.48
9	3.09

Mean = 2.74 g

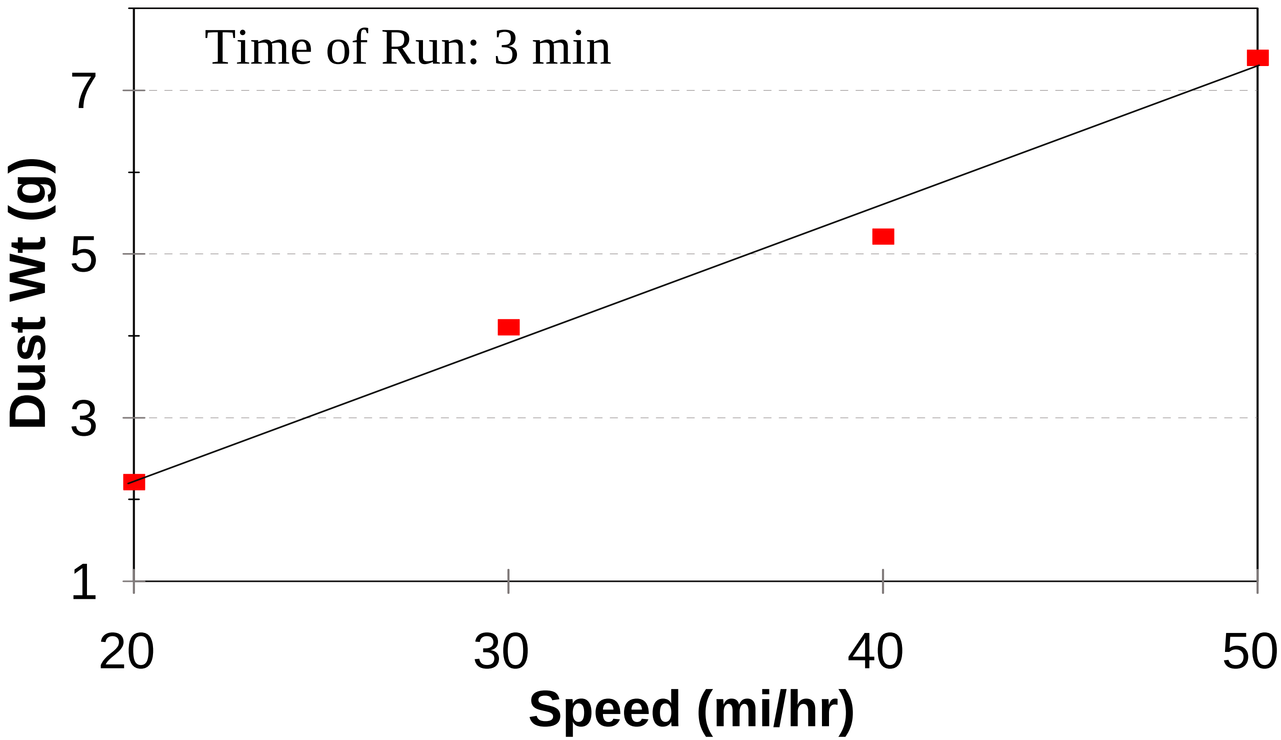
Standard deviation = 0.21 g

Variance = 0.04 g

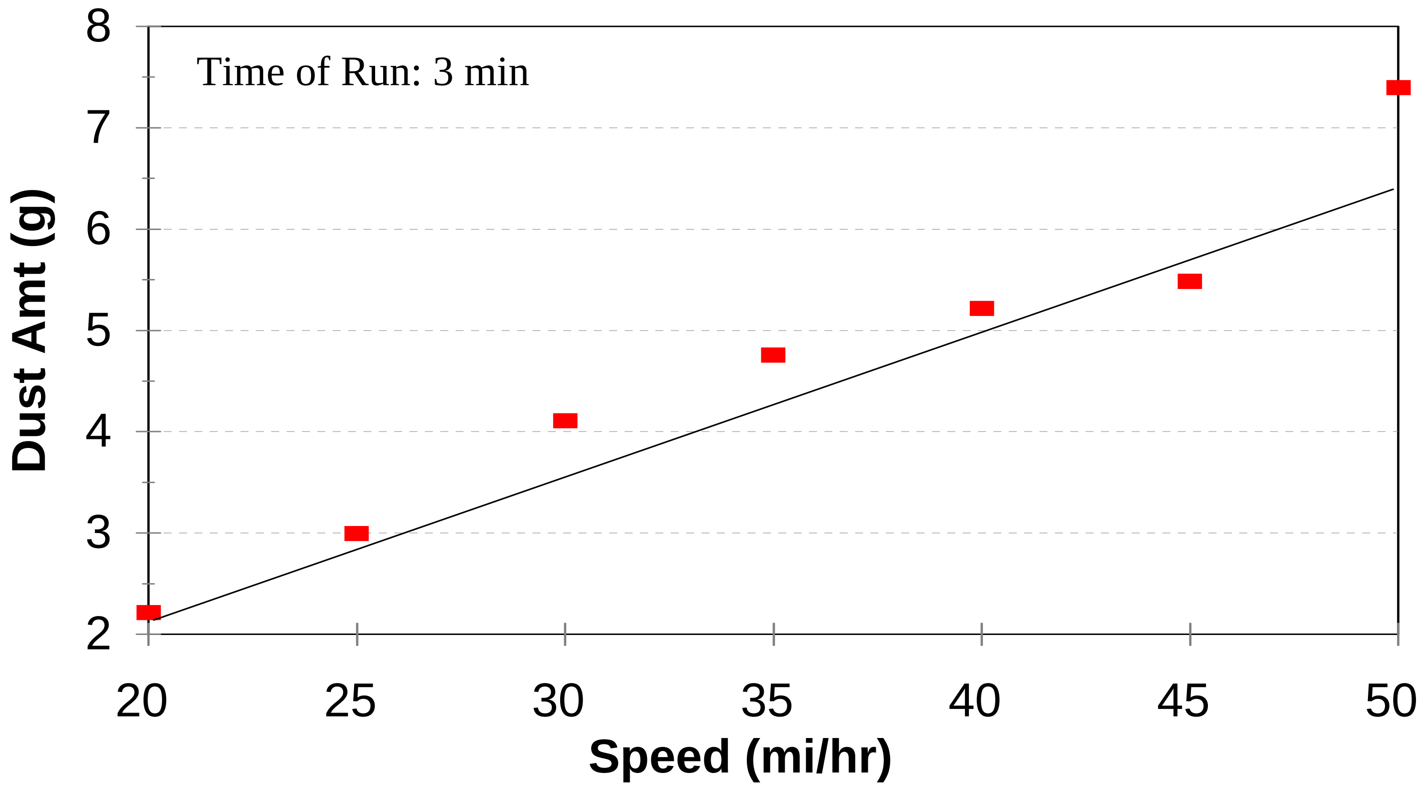
Dust Generation as Function of Speed for One Mile



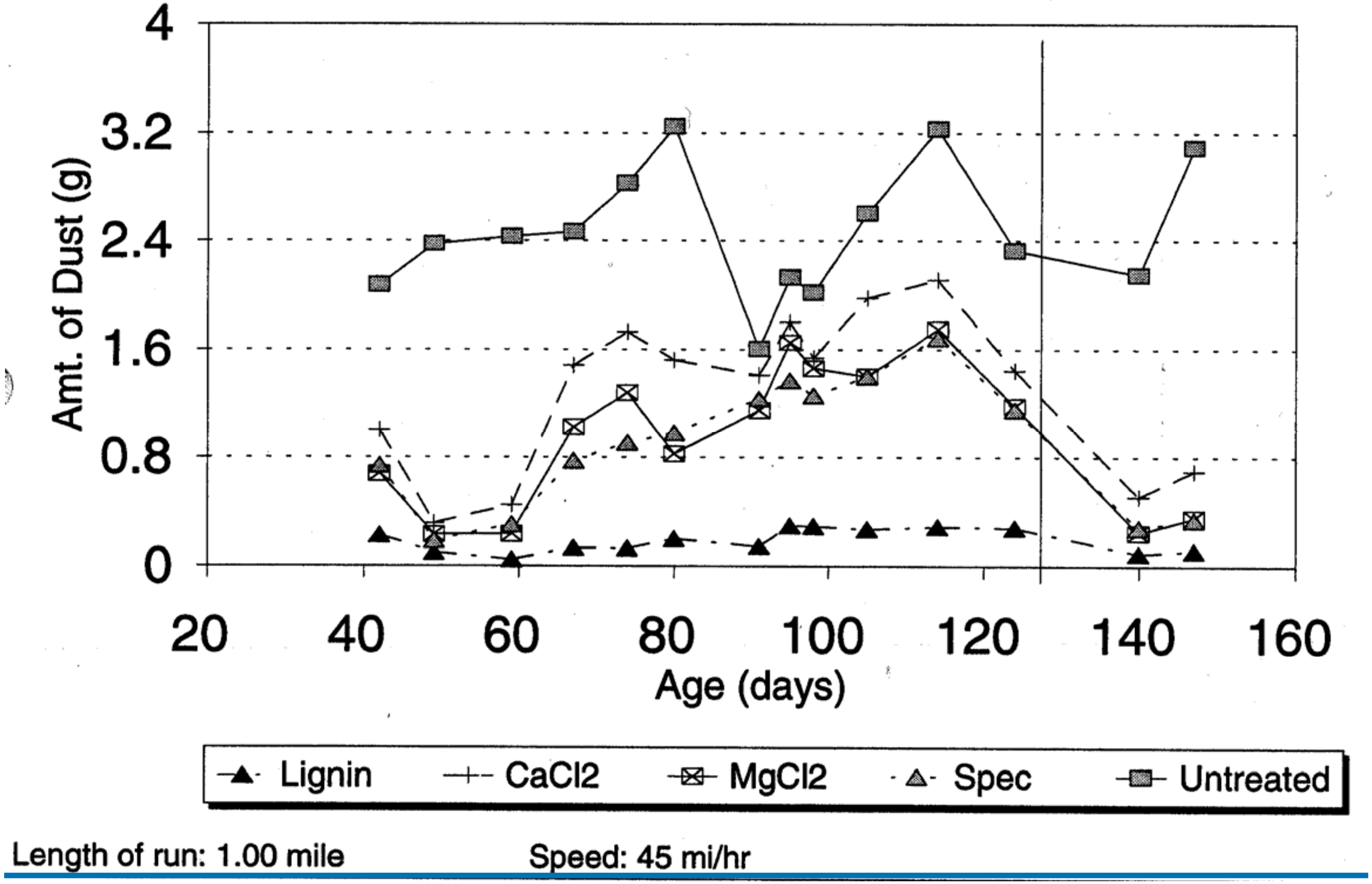
Dust Generation as Function of Speed for Three Minutes



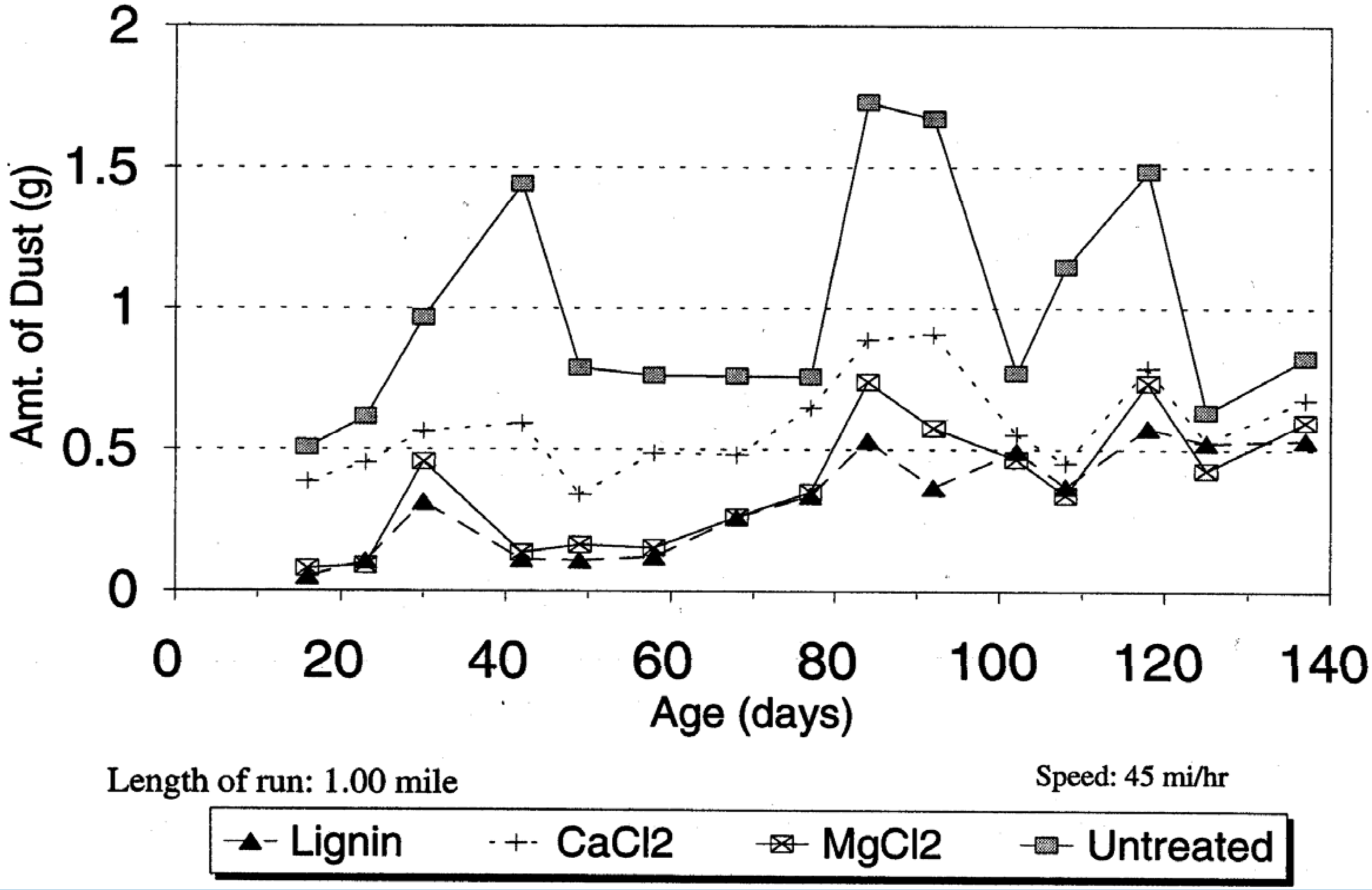
Dust Generation as Function of Speed for Three Minutes, all data



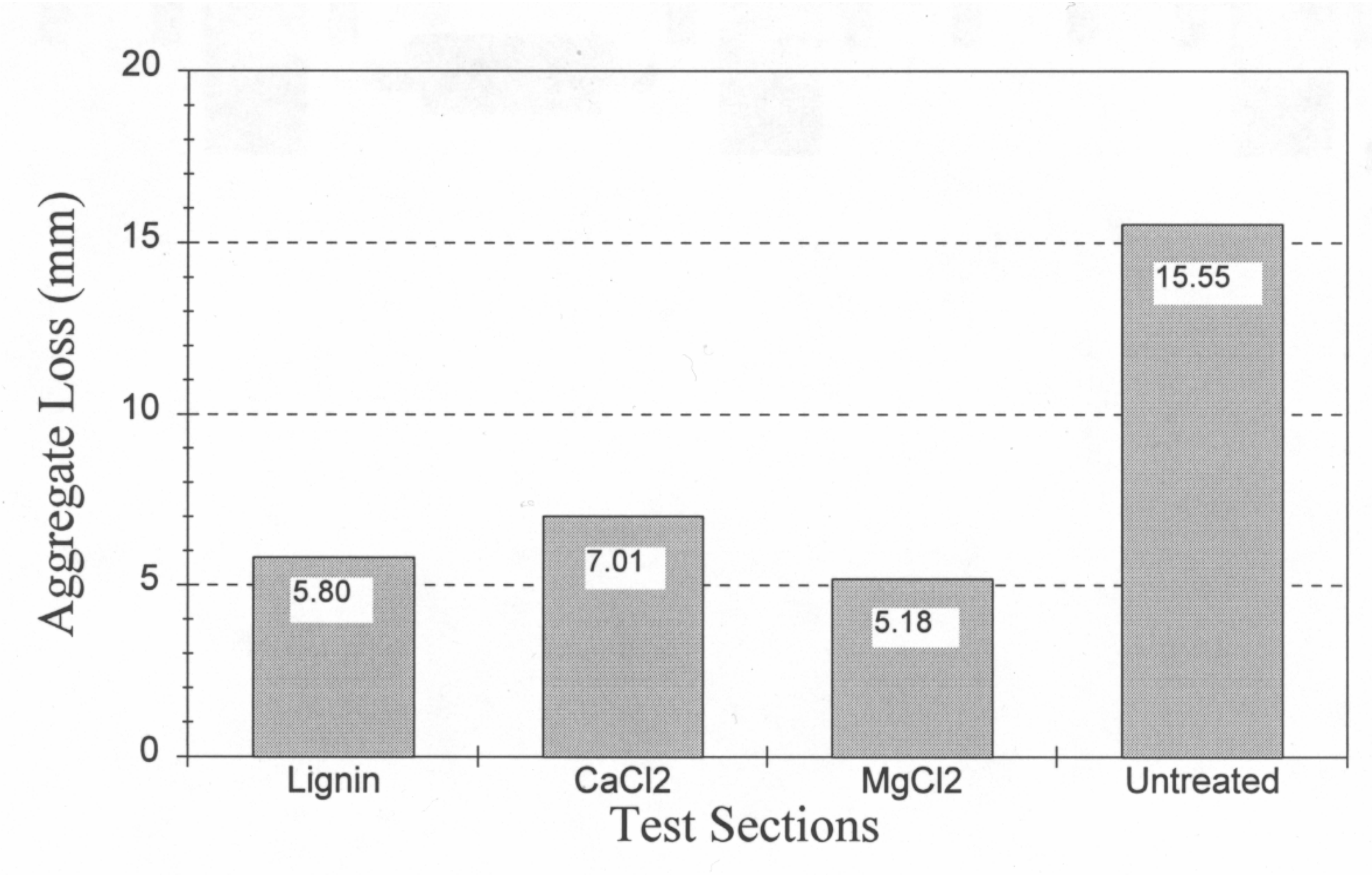
Dust Measurements from all sections First Year



Dust Measurements from all sections Second Year



Aggregate Loss Measurements from Second Year



Estimated Aggregate Loss – 2nd Yr (Tons)

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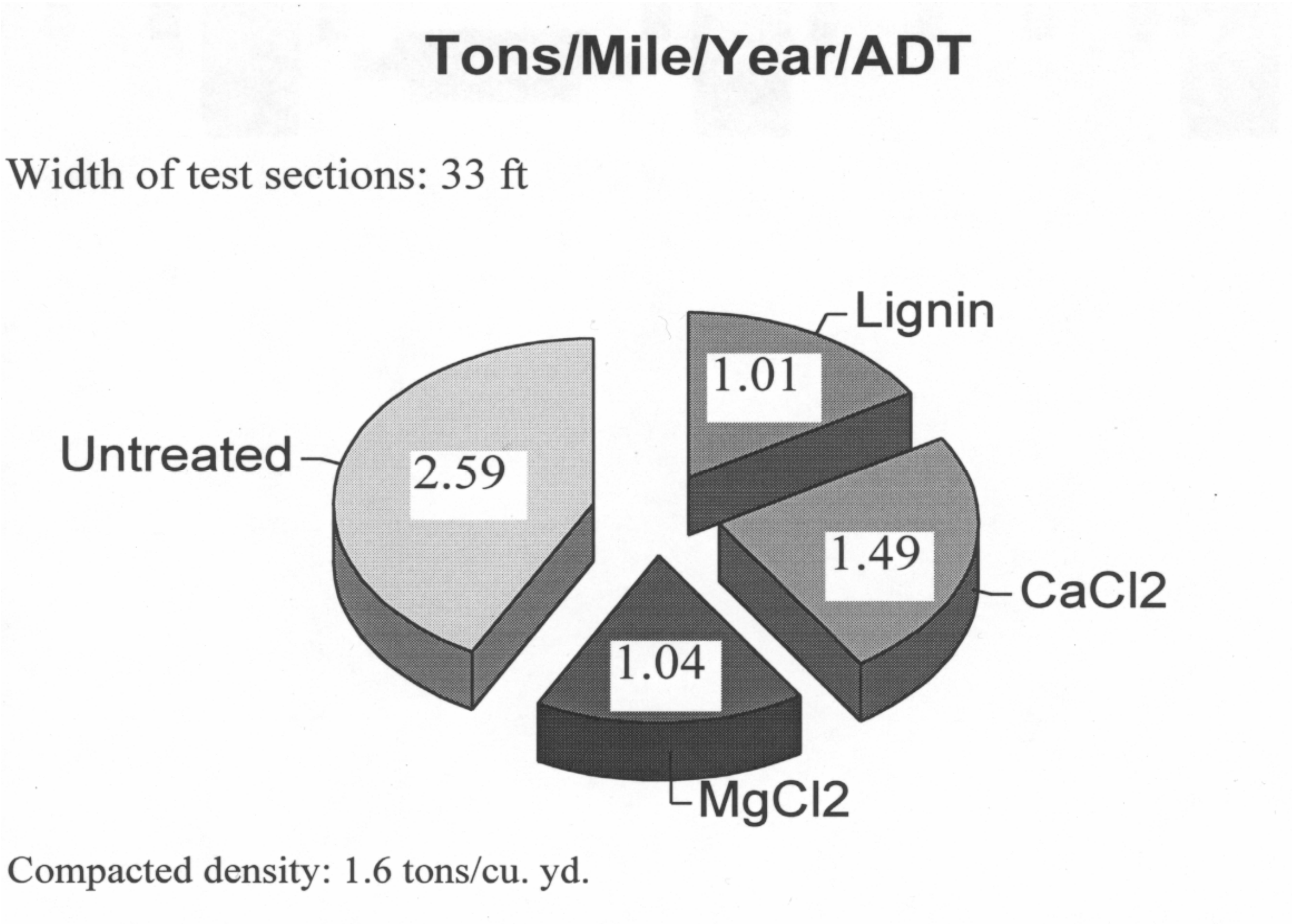


Cost Analysis for Aggregate Replacement

Cost Analysis – 2nd year evaluation

Length of test section : 1.00 mi (5280 ft)

Width of test section : 33 ft

Compacted density : 1.6 ton/cu yd

Cost of gravel : $11.57/ton in place

ADT : Average Daily Traffic

PM : Periodic Maintenance

M+L+E : Cost of Material (suppressant), Labor and Equipment

Actual Total Cost : include cost of M+L+E, cost of PM and cost of Aggregate replacement

Cost of Suppressants per gallon are the same for all three compounds.

The Lignin treatment cost $760.65 more in Labor and Equipment than the CaCl2 and MgCl2 treatments.

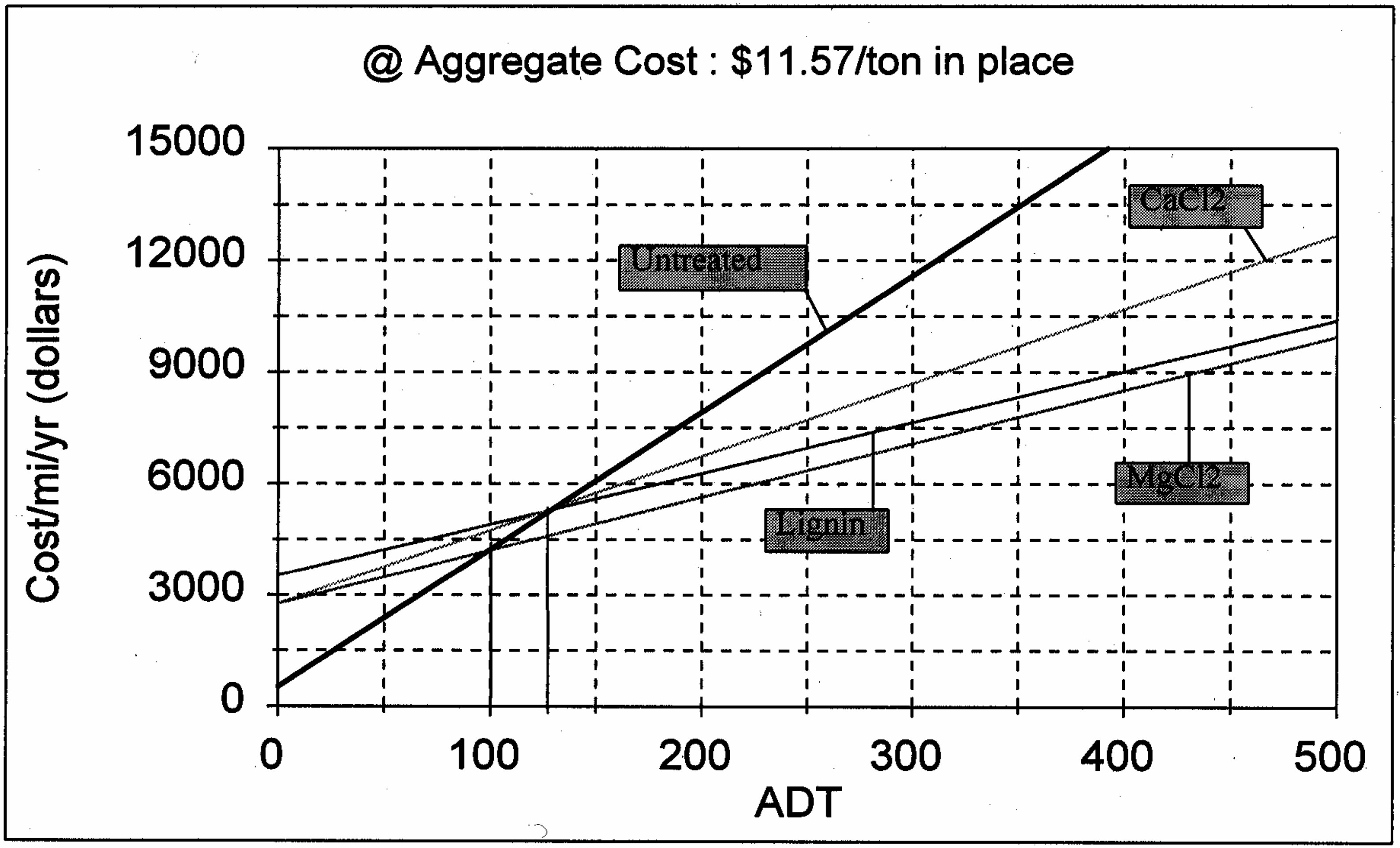
Test Sections	ADT # veh.	Measured Aggregate Loss/ mi/4.5 months (ft)	Estimated Aggregate Loss/ mi/yr (ft)	Estimated Aggregate Loss/ mi/yr (ton)	Cost of Test Sections							
					Aggregate Loss/ mi/yr (dollars)	(M+L+E)/mi/yr (dollars)	PM/mi (dollars)	*** * PM/yr	Actual Total Cost/mi/yr (dollars)	Actual Total Cost/mi/yr/ADT (dollars)	@ ADT of 50 (dollars)	@ ADT of 100 (dollars)
Lignin	515	0.019	0.050	519.88	$6,015.02	$3,528.32	$529.00	2	$10,601.34	$20.59	$1,029.26	$2,058.51
CaCl2	421	0.023	0.061	629.33	$7,281.34	$2,767.67	$529.00	2	$11,107.01	$26.38	$1,319.12	$2,638.24
MgCl2	448	0.017	0.045	465.16	$5,381.86	$2,767.67	$529.00	2	$9,207.53	$20.55	$1,027.63	$2,055.25
Untreated	538	0.051	0.135	1,395.47	$16,145.57	$0.00	$529.00	8	$20,377.57	$37.88	$1,893.83	$3,787.65

*** The Periodic Maintenance performed is with a Water Truck and Compactor.**

If this were being performed without these tools, we anticipate that the Periodic Maintenance would have to be done weekly.

* Duration of Study is 4.50 months

Cost/Mile/Yr vs ADT



Cost of Aggregate/Ton vs Minimum ADT

	Lignin	$CaCl_2$	$MgCl_2$
Cost of Agg./ton	ADT	ADT	ADT
$5.00	232	225	180
$7.50	180	180	140
$11.57	130	130	100
$15.00	105	105	80

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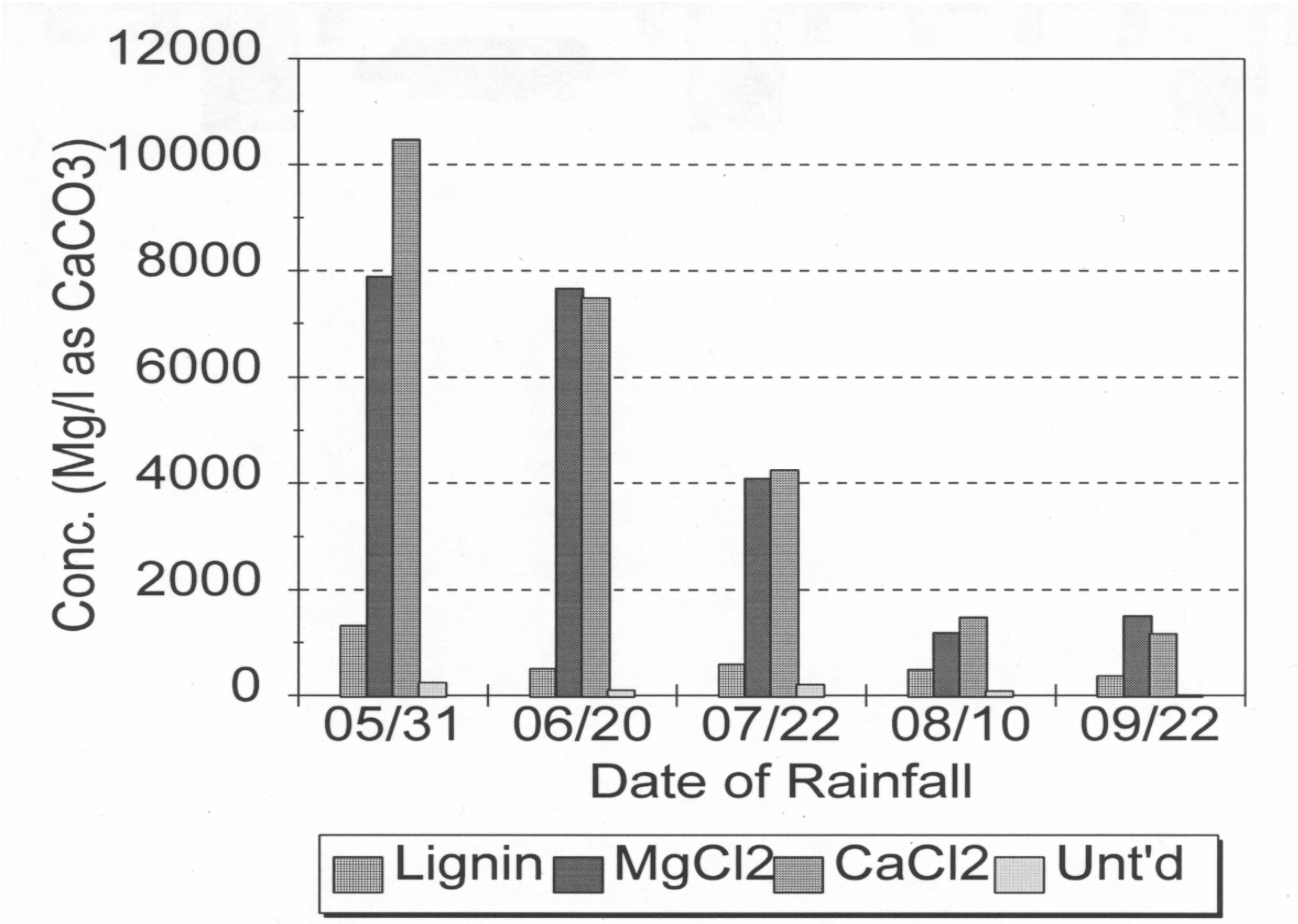
WQ Hardness vs Time for Each Suppressant



WQ After a Rainfall Event

Test Sections Surface Runoff Analysis (07/22/94)

Date of Rain: 07/22/94
Rainfall amt. av. = 0.42 in (10.75 mm)

Variables		Test Sections			
		Lignin	$CaCl_2$	$MgCl_2$	Untreated
pH		6.05	6.28	6.98	7.20
E.C.	μmhos	1,428.75	8,517.50	7,655.00	485.75
TDS	|	957.26	5,706.73	5,128.85	325.45
Ca	|	239.30	1,538.50	90.73	52.75
Mg	|	58.00	96.53	926.25	18.55
Cl	|	267.18	2,725.75	3,728.48	83.58
Na	|	16.55	33.70	20.83	5.78
K	|	9.70	6.18	6.45	0.63
B	|	0.40	0.26	4.45	0.11
P	|	0.25	0.33	4.38	0.10
Al	|	0.83	0.25	0.90	0.15
Fe	|	9.73	0.26	0.28	0.07
Mn	mg/l	3.09	0.88	0.10	0.03
Cu	|	0.06	0.01	0.19	0.01
Zn	|	0.10	0.15	0.01	0.12
Ni	|	0.09	0.02	0.11	0.02
Mo	|	0.02	0.02	0.06	0.02
Cd	|	<0.01	<0.01	<0.01	<0.01
Cr	|	0.04	0.09	0.07	0.01
Ba	|	0.26	0.70	0.23	0.05
Pb	|	<0.05	<0.05	0.11	<0.05
SO_4	|	129.10	486.93	455.80	44.45
Hardness as $CaCO_3$	|	589.92	4,248.44	4,086.19	209.17

N.D : Not Determined

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WQ Data from Many Rainfall Events

Water Quality Data from Runoff
Measured in Total Hardness (mg/L as $CaCO_3$)

Date of rain	Amount of rain (in)	Lignin treatment	CaCl2 treatment	MgCl2 treatment	CaCl2(spec) treatment	Nonroad runoff
05-18-93	0.13	-	-	15,666	1,130	-
05-24-93	0.06	-	-	3,400	1,805	-
06-16-93	0.28	840	823	3,128	605	50
06-18-93	0.21	333	475	561	98	35
07-13-93	0.64	675	330	190	156	30
07-20-93	0.06	685	887	1,412	-	-
08-02-93	0.08	-	-	3,040	-	-
08-05-93	0.55	933	543	438	327	-
08-19-93	0.18	790	1,250	780	270	-
09-07-93	0.19	977	320	390	350	32
09-13-93	0.99	970	134	200	120	30
09-15-93	0.83	-	280	112	66	30

Stock solution (mg/L as $CaCO_3$)

Lignin	45,000
CaCl2	454,800
MgCl2	448,000
CaCl2(spec)	310,000

Conclusions

- Colorado State University Dustometer is precise, portable, inexpensive.
- Substantial reduction of Dust using any of the Suppressants.
- Dust Production was linearly related to vehicle speed.
- Lignin suppressant was best under high temp and low humidity (but degraded).
- 41-61 % reduction of aggregate loss.

Conclusions (Cont)

- 30-46 percent reduction in total annual maintenance of treated vs untreated road.
- ADT over 120 any Dust suppressant was cost effective.
- Aggregate loss, Tons/Mile/Year/ADT, Untreated, 2.59, Lignon, 1.01, $CaCl_2$,1.49, $MgCl_2$,1.04
- WQ has significant concentrations but total mass going into environment is small

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Recommendations

- Study effects of vehicle weight, number and size of wheels on fugitive dust emissions.
- Determine relationship of Dustometer dust measurements and total dust production from a vehicle.
- Determine optimal application procedures to minimize costs.
- Determine relationship between dust production and aggregate loss.
- Determine portion of dust of 10 microns (PM_{10}) or less that might cause respiratory problems.

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Q & A

Thank You