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Aggregate Roads Dust Control A Brief Synthesis of Current Practices

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Research Project
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Your Destination... Our Priority



Aggregate Roads Dust Control

A Brief Synthesis of Current Practices

FINAL Report

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16. Abstract (Limit: 200 words) <p>More than 50 percent of U.S. roadways are gravel roads, making them a vital part of our transportation system. One of the drawbacks and biggest complaints about gravel roads is the dust they produce when vehicles drive over them. Residents that live on gravel roads deal with the dust that settles on their homes, yards, and parked cars, potentially reducing their quality of life. Dust can also have adverse effects on air quality and the environment and reduce the safety for drivers due to impaired vision. To control the dust on gravel roads, local agencies apply various dust suppressants on their roadways, mainly calcium chloride and magnesium chloride. However, many other dust suppressant options exist.</p> <p>The Minnesota LRRB has developed this document, <i>Dust Control of Aggregate Roads, A Brief Synthesis of Current Practices</i>, to provide local agencies with a summary of research that has been completed on various dust suppressants, their effectiveness, and impacts. Results from two surveys that document dust suppressants that local agencies (within Minnesota and Iowa) use is included as well.</p>			
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Technical Advisory Committee

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Chapter 1: Introduction

More than 50 percent of U.S. roadways are gravel roads, making them a vital part of our transportation system. One of the drawbacks and biggest complaints about gravel roads is the dust that they produce when vehicles drive over them. Residents that live on gravel roads deal with the dust that settles on their homes, yards, and parked cars, potentially reducing their quality of life. Dust can also have adverse effects on air quality, crop yields and the environment and reduce the safety for drivers due to impaired vision. To control the dust on gravel roads, local agencies apply various dust suppressants on their roadways, mainly calcium chloride and magnesium chloride. However, many other dust suppressant options exist.

The Minnesota LRRB has developed this document, *Aggregate Roads Dust Control, A Brief Synthesis of Current Practices*, to provide local agencies with a summary of research that has been completed on various dust suppressants, their effectiveness, and impacts. Results from two surveys that document dust suppressants that local agencies (within Minnesota and Iowa) use is included as well.

Chapter 2: Survey Results

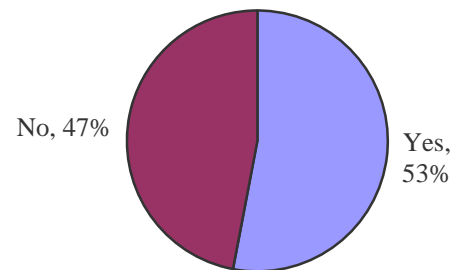
To determine how local agencies are currently combating dust created by gravel roads, two online surveys were completed. The first was a short survey sent to local agencies nationwide to determine if they have a dust control program and what products they have used. The second was a more in-depth survey that was sent to respondents of the first survey who indicated that they had a dust control program. This survey asked them to provide feedback (pros/cons) about the dust control products they have used. The following is a summary of the findings from each survey.

Survey #1

The first online survey was distributed locally to Minnesota county engineers (not cities) and nationally via Local Technical Assistance Program (LTAP) network in November of 2011. A total of 253 people completed the survey (72 from Minnesota and 181 nationwide). Note that the number of total responses per question decreases after the first question, as agencies that do not have a dust control program would not be able to respond to the remaining questions.

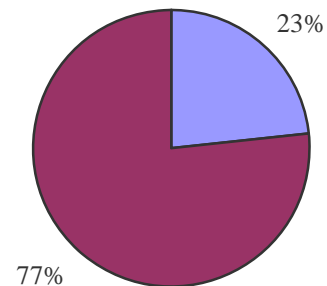
1. Do you currently have a dust control program?

Answer	Response Percent	Response Count
Yes	53%	134
No	47%	119
Total		253



2. Have you had a dust control program in the past?

Answer	Response Percent	Response Count
Yes	23%	28
No	77%	92
Total		120



3. If you no longer have a dust control program, why did you quit using it?

Answer	Response Total
Decreased funding/Lack of funding	7
All roads are hard surface, asphalt or concrete	6
EPA/environmental issues	2
Our program is to provide dust control for contract hauling operations for construction projects. We allow residents to apply non-polluting dust control products on the roadways.	2
Decreased maintenance staff	1
We used soybean oil, issues with cleaning land and expenses	1
Too many complaints	1
We don't use dust control, it is part of living in the country	1
We never really had a program, per say, we just put material down in some trouble spots on a need be basis.	1
The results of applying dust control did not justify the cost	1
The program was privately funded (billed to home owners) and they felt it was too costly. We did obtain a LTAP (?) grant for an experimental project using CaCl / a dust control and road structural improvement	1

4. Which of the following dust suppressants have you used?

Answer		Response Percent	Response Count
Water		19%	28
Water absorbing	Calcium chloride brine and flakes	56%	82
	Magnesium chloride brine	50%	73
	Sodium chloride (salt)	6%	8
Organic petroleum product	Asphalt emulsions	8%	11
	Cutback asphalt (liquid asphalt)	6%	9
	Dust oils	6%	8
	Modified asphalt emulsions	3%	5
Organic nonpetroleum product	Animal fats	0%	0
	Lignosulfonate	6%	8
	Molasses/sugar beet	1%	2
	Tall oil emulsions	0%	0
	Vegetable oils	6%	9
Electrochemical product	Enzymes	1%	2
	Ionic	0%	0
	Sulfonated oils	0%	0
Synthetic polymer product	Polyvinyl acetate	1%	1
	Vinyl acrylic	1%	1
Clay additives	Bentonite	3%	4
	Montmorillonite	0%	0
Recycle in place asphalt		9%	13
Recycled roof shingles		1%	1
Other (see list below chart)		12%	17
Total			146

Other dust suppressants used:

- 15,000 gallons/yr of calcium chloride brine and flakes.
- Magnesium chloride specified as an alternative but never used.
- Program called “Gravel Road Stabilization Program” water used during hauling operations on roads not treated as part of the county stabilization program. Calcium chloride brine and flakes used otherwise.
- 30,000g of calcium chloride brine and flakes.
- Soybean oil product (not successful).
- Oil well brine.
- MWS-150.
- AEDP water base.
- Oil well brine byproduct.

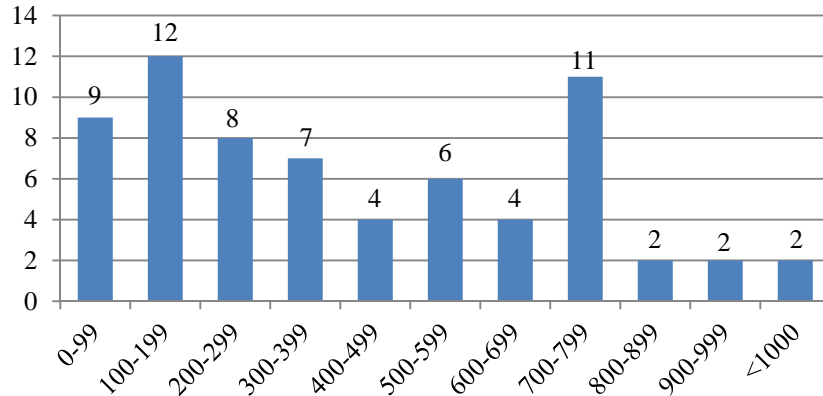
- I don't know. It was before my time.
- We chip and seal our roads in front of any residence on the gravel road. We use MWS-150 and pea gravel.
- None - water when doing construction.
- 38 % and 42% calcium chloride.
- Rotomill/with a 50% gravel mixture.
- The best products are the rotomill w/ 50% gravel and magnesium chloride.
- Base 1 has been used some, not sure which blank that would be.
- Soybean oil by product.
- Calcium chloride pellets.

Survey #2

The second online survey was distributed on February 15th, 2012, to 47 people who indicated that they had a dust control program in the first survey. A total of 39 local agencies completed the survey. In addition, the survey was sent to local agencies in Iowa, via one of the TAP members. A total of 29 local agencies in Iowa completed the survey.

1. How many miles of gravel road do you maintain?

Answer	Response Total
0-99	9
100-199	12
200-299	8
300-399	7
400-499	4
500-599	6
600-699	4
700-799	11
800-899	2
900-999	2
<1000	2
Total	67



**2. How do you determine what segments of roadway to suppress dust on?
(check all the apply)**

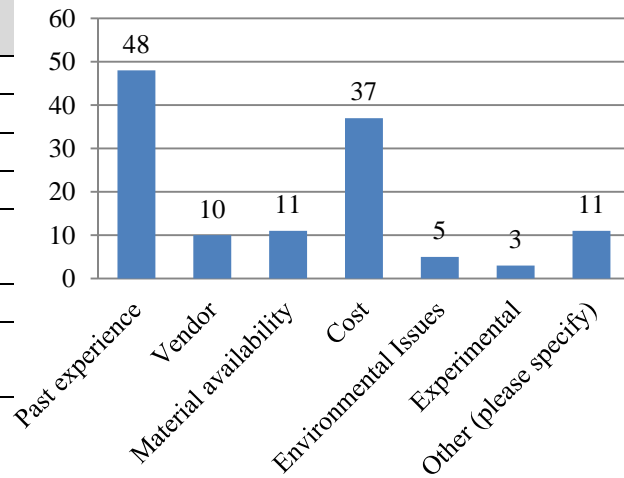
Answer	Response Percent	Response Count
House density	5%	7
Traffic volume	12%	17
Location of parks	1%	2
Number of complaints	4%	6
Safety concerns	9%	13
Construction haul routes	18%	25
Railroad crossings	0%	0
Distance houses are setback from the road	3%	4
Political	3%	4
Service provided at cost to residents	22%	31
Other (see list of responses below)	22%	30
Total		139

Other determining factors:

- Dust control treatment in front of residences on gravel-surfaced roads is initiated by resident upon payment of 50% of the cost of the treatment.
- Save gravel material
- Potential maintenance savings
- Residents may apply at their choice and cost using third party applicators, we must give approval first to ensure road is shaped properly
- Due to small mileage, once it was decided to apply to one road decision was made to do all roads.
- We allow property owner to apply dust treatment at his cost after getting a permit from us.
- Vendor deals directly with the landowner wanting dust control. Dust control is voluntary and up to individual landowners. Landowner pays vendor directly, so the county's budget does not show these expenses. Vendor contacts us before the applications so we can prepare the roads for treatment.
- Detour Routes, otherwise it is up to the resident to pay for their dust control.
- Private dust control areas are permitted by the county and paid for by adjacent property owners. County only applies dust control on sections with threshold ADT and detour routes.
- Maintenance gravel haul routes from county owned pits.
- Homeowner solicits a contractor for placement of dust suppressant, county grades or places gravel on the segment prior to placement.
- Most residents will contract it themselves.
- Residents choose to pay for their own treatment. County pays \$0 towards dust treatment unless excess traffic caused by county construction project
- Agribusiness haul roads
- Residents are allowed to hire an approved contractor and pay all costs themselves.
- We do not suppress dust on our gravel roads
- Through road agreements with quarries, commercial users, conditional use permits, subdivision restrictions
- Property owners arrange and pay for application themselves- we just prep the roadway. We apply if using as haul road.
- Placed on newly surfaced roads.
- Health concerns
- We suppress dust on all gravel roadways
- By request only. Residents are charged all costs.
- resident/ owner request
- We do not place these products for dust control, rather we use them for gravel stabilization and increasing the useful life of gravel. We maintain gravel stabilized with chloride on roads with ADT's of 100 vehicles per day.
- We do not apply "dust suppressants" for dust control. We do it to stabilize the gravel surfacing of the road. Dust control is too objective of a criteria. One car can cause a dust problem for someone who lives close to a gravel road.
- We coat all roads with 250 ADT or more and 300' in front of any homes within 150' of the road.
- Maintenance costs
- County Policy that we do not provide dust control for normal traffic. Dust control is required for all contract hauling operation on the gravel haul roads.
- County pays if traffic is diverted from paved road to gravel road due to construction.
- Locations of higher maintenance

3. How do you decide what dust suppressant to use? (Check all that apply)

Answer	Response Percent	Response Count
Past experience	38%	48
Vendor	8%	10
Material availability	9%	11
Cost	29%	37
Environmental Issues	4%	5
Experimental	3%	3
Other (please specify)	9%	11
Total		125

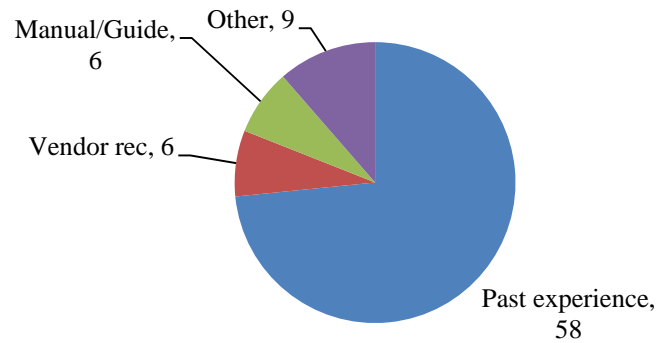


Other determining factors:

- Have always used calcium chloride based on research of performance and cost of alternative treatment types.
- Resident’s choice from approved list.
- Talked to counties with past experience.
- The property owner decides which company they want to use. We allow only approved dust treatment companies. Right now we allow calcium chloride, magnesium chloride and tree sap.
- Homeowners experience with product or contractor.
- Private landowners purchase the material and have it applied. Landowners determine what type of material they would like to use.
- We use calcium chloride as the county program for construction of rock base and for rock roads with 200 vehicles per day by DOT traffic survey. We use seal coat for rock roads with 400 vpd or higher.
- Have used calcium chloride and magnesium chloride in the past. Calcium chloride has usually been cheaper and has been selected most seasons.
- We currently decide between using calcium chloride or magnesium chloride depending on the cost.
- We use calcium chloride.
- The material used for dust control depends on the roadway condition, the amount of traffic and the length of time the hauling operations will be conducted.

4. Is there a resource that you have been using for guidance on? (check all that apply)

Answer	Response Percent	Response Count
Past experience	73%	58
Vendor recommendation	8%	6
Manual/Guide	8%	6
Other (please specify)	11%	9
Total		79



Other resources:

- MnDOT specifications
- Talking with other counties.
- We simply make every effort to allow only environmentally accepted products.
- Vendor chooses dust suppressant, landowner pays vendor.
- Past experience we have had with several materials.
- We operate from a dust control policy.
- Low bid
- Other County Experience
- Dow chemical has several brochures on application guidelines, storage and handling of CaCl.

5. Please select a dust suppressant that you use regularly and provide input on the attributes, limitations, application rate and frequency, environmental impacts, application tips, effectiveness and cost, based on your personal experience.

Twenty respondents provided the information listed above for various dust suppressants. The table on the following pages documents all of the responses received. Note that information that the TAP felt should be highlighted is listed in bold text within the table.

DUST SUPPRESSANT	RESPONSE #	ATTRIBUTES (pros)	LIMITATIONS (cons)	APPLICATION RATE AND FREQUENCY	ENVIRONMENTAL IMPACTS	APPLICATION TIPS	EFFECTIVENESS	COST
Magnesium Chloride Brine	1	Easy to apply and keep track of seems to work as intended. Cheaper than calcium chloride and according to studies, it is more effective.	Loses effectiveness if applied in rain	30% solution with 0.18 gal/sq. yd. application rate			Does as intended	Better pricing than calcium chloride
	2	Magnesium chloride has worked well for us controlling dust and binding the road surface material tight. The maintain costs have dropped to blading 2 to 3 times a summer versus a weekly basis. Residual effect also contributes to the use of mag chloride. 2nd year application is at a lower rate due to the residual carry over	Once the surface is packed and the mag chloride is applied, the rainwater run off does not wash away the mag chloride.					
	3	After a rain event you can touch up or blade the road and not lose its effectiveness.	Can't blade the road during dry conditions.				Works very well for us.	\$0.76 for one application or \$1.49 for two

DUST SUPPRESSANT	RESPONSE #	ATTRIBUTES (pros)	LIMITATIONS (cons)	APPLICATION RATE AND FREQUENCY	ENVIRONMENTAL IMPACTS	APPLICATION TIPS	EFFECTIVENESS	COST
								applications per foot for distances over 300.'
	4	cost effective, works for an extended period, may be part of normal maintenance activity	Depends upon moisture, may make road slimy with light rain, perception of corrosive impact on metal, viewed as damaging toward vegetation	Used at 0.7 gallons per foot of road for our private dust control program with two applications paid for, applied at 0.4 gallons per lineal foot for our construction/safety program with single application to roads with 200 vpd or new rock base both are spread 24' wide	Have not observed any environmental impacts	Apply at control rate and with traffic, our contractor sprays full width from proper traffic side of road	Has proven effective and has been generally popular with residents based upon repeated sign up	We pay \$0.85 per gallon applied at required rates
Magnesium Chloride Brine	5		Agree the road can become slippery after a	Dakota County uses two applications the	Forest service concentration of 400 ppm for trout is way	Dakota County Blades the road prior to	Mag Chloride is extremely effective when used with lime	Magnesium Chloride

DUST SUPPRESSANT	RESPONSE #	ATTRIBUTES (pros)	LIMITATIONS (cons)	APPLICATION RATE AND FREQUENCY	ENVIRONMENTAL IMPACTS	APPLICATION TIPS	EFFECTIVENESS	COST
			<p>long soaking or multiple rainfalls this can be minimized by a 4% crown.</p>	<p>first application is @ .3 gal/y² and second is at .25 gal/yd². (30% solution)</p>	<p>above the 230 ppm definition for an impaired water.</p>	<p>application. We do not add water before treatment or roll the road after treatment.</p>	<p>rock</p>	<p>Solution (30%) Gallon 550,000 \$0.723 \$397,650.00</p>
	6	<p>After repeated applications (year after year), it can work effectively even after a light grading. The material is readily available with several contractors that we typically use. It does not require specialty equipment or application methods. It works well to keep dust to a minimum during typical weather patterns.</p>	<p>During drought periods, it will become dusty again since it cannot attract enough water from the gravel or air. If applying the material when the road is saturated, it has a tendency to run off and not penetrate the surface gravel as well.</p>	<p>We provide program to our citizens where we apply 0.3 gal/sy in June, and another 0.2 gal/sy in August.</p>	<p>None that we have seen if used with the above application rates.</p>	<p>Use computer rate control equipment to monitor the amount of material applied. Make sure it is calibrated to work correctly. Try to grade/blade the gravel surface the day prior to make sure the crown is in good shape and that the surface is somewhat loose to absorb the</p>	<p>It has worked well during typical weather patterns. During drought spells, it tends not to work as well. It has helped minimize washboarding close to intersections with acceleration areas.</p>	<p>We have typically used Mag Chloride over Calcium Chloride since it is somewhat cheaper.</p>

DUST SUPPRESSANT	RESPONSE #	ATTRIBUTES (pros)	LIMITATIONS (cons)	APPLICATION RATE AND FREQUENCY	ENVIRONMENTAL IMPACTS	APPLICATION TIPS	EFFECTIVENESS	COST
						material.		
	7			<p>We apply two applications (per season) at the same rate, approximately 0.2 gallons/square yard of road surface. However, a number are repeat customers from prior year(s), so there could be some residual chemical that allows such a reduced rate of application.</p>			<p>Just as good as our prior experience with Calcium Chloride Brine, as no complaints from our customers.</p>	<p>In 2011 we charged \$80 per 100 lineal feet of application (includes 2 applications). In 2011 we paid \$0.705/gallon for Magnesium Chloride</p>

DUST SUPPRESSANT	RESPONSE #	ATTRIBUTES (pros)	LIMITATIONS (cons)	APPLICATION RATE AND FREQUENCY	ENVIRONMENTAL IMPACTS	APPLICATION TIPS	EFFECTIVENESS	COST
								Brine.
	8			The application rate is .27 gal/sy, same as CaCl				
	9			Beltrami uses Magnesium Chloride brine as specified under MnDOT Spec 3912 at a rate of 0.36 gallons per square yard for the first application of the year (usually in June). A second application is applied (usually in late August) at a rate of 0.18 gallons per square yard.		To get competitive bids Beltrami County allows for Calcium Chloride as an alternative. Calcium Chloride is specified at a different solution and applied at a different rate.		2011 cost for Magnesium Chloride solution was \$0.67 per gallon

DUST SUPPRESSANT	RESPONSE #	ATTRIBUTES (pros)	LIMITATIONS (cons)	APPLICATION RATE AND FREQUENCY	ENVIRONMENTAL IMPACTS	APPLICATION TIPS	EFFECTIVENESS	COST
Calcium Chloride Brine and flakes	10	The best attribute for our county is that St. Louis County allows us to participate in their bid and obtain the lowest possible price compared to just buying a tanker load or a partial tanker load ourselves. We have been able to share a tanker load with another governmental unit in our area in order to reduce cost. We have been allowed to participate in the St. Louis County's bid even though					One application will generally last a couple of years in providing dust control on the low volume roads that we have used it on.	
Calcium Chloride Brine and flakes	11	Performs well as dust suppressant. Helps bind aggregate in place. Seems to last most of the Summer.	Towards fall some pretty significant potholes can develop. Some complaints about corrosion. Cost.	.3 gal per square yard. Done once in the Spring.	Some complaints about vehicle corrosion - not substantiated.	If some grading is needed use tipped blade and try not to carry a windrow. Helps to add a water tension breaking product to the	Seems to work very well for the Summer months	It is bid out each year and typically costs around \$3,000 per mile (20')

DUST SUPPRESSANT	RESPONSE #	ATTRIBUTES (pros)	LIMITATIONS (cons)	APPLICATION RATE AND FREQUENCY	ENVIRONMENTAL IMPACTS	APPLICATION TIPS	EFFECTIVENESS	COST
						brine such as JetWet; provides quicker penetration into the gravel.		
	1 2		I find that the brine works better than MgCl under all conditions. We use less CaCl to get slightly better moisture absorbency.					
	1 3	It has worked well as a dust suppressant and also prevents wash boarding. It also reduces the number of times the road needs to be bladed.	We have received some complaints that it is slimy to drive on when it's wet.	We apply brine at a rate of 0.28 gal/sy once a year.	We have no knowledge of any negative environmental impacts from our experience.	We apply 0.28 gal/sy at a width of 18 feet to cover the majority of the roadway.	We are happy with the effectiveness. We did have one year of complaints of the effectiveness, but we believe the contractor did not apply the appropriate rate.	Our price from 2011 was \$1.03 per gallon.
	1 4	Overall is does a good job of suppressing the dust	When it dry and the atmosphere is dry it looses it effectiveness	In the spring at a rate of 0.25 gallons per square yard (38%				Been very cost effective

RESPONSE #	ATTRIBUTES (pros)	LIMITATIONS (cons)	APPLICATION RATE AND FREQUENCY	ENVIRONMENTAL IMPACTS	APPLICATION TIPS	EFFECTIVENESS	COST
DUST SUPPRESSANT Calcium Chloride Brine and flakes			brine solution)				
	15		Our application rate is .27 gal/sy with 38% concentrate.				
	16	Keeps the dust under control and stabilizes the gravel so we do not lose all our fines as wind blown dust.	Does not work if the weather is too dry and there is low humidity. Also it does not work well through the winter if you put it down in late fall, it does not allow the road surface to freeze and we lose gravel all winter.	We use approximately .2 gallons per square yard.	We have not seen any.	Place in spring and late summer. Roadway must have some moisture from a recent rainfall so it can penetrate when placed or it is wasted.	It works well if you have rain at least twice per month.
17			Beltrami uses Calcium Chloride brine as specified under MnDOT Spec 3911 at a		To get competitive bids Beltrami County allows for Magnesium		2011 cost for brine was \$0.83 per gallon

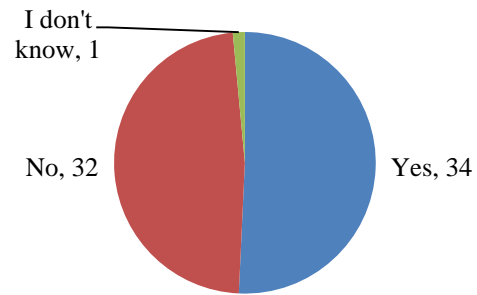
DUST SUPPRESSANT	RESPONSE #	ATTRIBUTES (pros)	LIMITATIONS (cons)	APPLICATION RATE AND FREQUENCY	ENVIRONMENTAL IMPACTS	APPLICATION TIPS	EFFECTIVENESS	COST
				<p>rate of 0.30 gallons per square yard for the first application of the year (usually in June). A second application is applied (usually in late August) at a rate of 0.15 gallons per square yard.</p>		<p>Chloride as an alternative. Magnesium Chloride is specified at a different solution and applied at a different rate.</p>		
Water	18				<p>The DNR restricts the amount of water that can be pumped from surface water sources. Pumping large amounts of water can be environmentally damaging depending on the location of endangered species, the amount of water being removed from a location and the</p>			

DUST SUPPRES SANT	RESPONSE #	ATTRIBUTES (pros)	LIMITATIONS (cons)	APPLICATION RATE AND FREQUENCY	ENVIRONMENTAL IMPACTS	APPLICATION TIPS	EFFECTIVENESS	COST
Organic petroleum product - cutback asphalt (liquid asphalt)	19	We use this product in two versions. MC70 is used as dust control in our "oil" program with private payment. It is also used as tack for our county provide seal coat. MC300 is used with chips as our seal coat. These provide a long lasting dust control over stable rock base. They provide an attractive surface. Seal coat provides the base for additional seal coats and for paving as traffic increases.	Much more costly. Private owners attempt to get too much longevity and compromise routine county maintenance. Depend on subbase and disappoint when they fail.	0,25 gallons per square yard with 20 lbs. of sand per square yard for MC 70 as oil or tack 0,30 gallons per square yard 30 lbs. of washed chips cover aggregate for MC 3000 as seal coats	time of year. Have not observed environmental impacts along roads with product applied	proper rates for liquid asphalt and chips is very important washed chips are used and dust up for some time if applied at rate above set rate uniform chip application and compaction is important to quality look and ride	very effective long term	MC 70 cost \$2.00 per square yard for application of asphalt and sand Mc3000 cost \$2.50 per square yard for application of asphalt and sand

DUST SUPPRESSANT	RESPONSE #	ATTRIBUTES (pros)	LIMITATIONS (cons)	APPLICATION RATE AND FREQUENCY	ENVIRONMENTAL IMPACTS	APPLICATION TIPS	EFFECTIVENESS	COST
Organic nonpetroleum product - vegetable oils	20	We have found that the vegetable oils are very effective and can have an extended life especially when applied to asphalt millings.	Maintenance becomes difficult	Annual with a very strong residual effect.	The oils are generally used French fry oils. We have not experienced any environmental effects. They do not appear to attract wildlife.	It has been applied with a commercial sprayer with holes drilled in PVC pipe as a sprayer or with holes in a milk jug.	Very effective	Used French fry oil is very economical but new oil can be expensive.

6. Do you have specifications for applying dust suppressants?

Answer	Response Percent	Response Count
Yes	51%	34
No	48%	32
I don't know	1%	1
Total		67

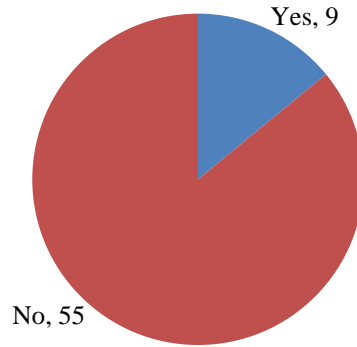


7. What are your specifications for the following categories?

Category	Specification	Response Count
Product Concentration	CaCl [38%]	15
	MgCl [30%]	10
Application Rate [gal/yd^2]	.15-.20	5
	.21-.25	8
	.26-.30	7
	>0.3	2
Time of Year	Spring (April to May)	8
	Late Spring/Early Summer (May to June)	11
	Summer or Fall (July or later)	4
Temperature [°F]	71-80	1
	61-70	2
	Above freezing	2
	No restriction	8
Wind Conditions	No Wind	2
	Less than 20 mph	3
	No restriction	9
Humidity Level Restriction	Yes (dry or light moisture)	6
	No restriction	8

8. Do you know of other agencies or vendors that have specifications for dust control products?

Answer	Response Percent	Response Count
Yes	14%	9
No	86%	55
Total		64



Listed product and agency/vendor:

- Marshall County
- Other counties.
- Calcium Chloride - Jerico Services Indianola, IA
- CaCl₂ industry.
- Envirotech (purchased Dustcoating Inc.)
- Clay County has similar specifications to Beltrami's. Hubbard County and Cass County also use MgCl/CaCl alternate bidding but use different application rates.
- MN/DOT.
- Hubbard County/Cass County.
- Goodhue County, Olmsted County, and Mower County.
- Many agencies appear to have specifications.

9. Are there other products out there that you haven't used but would like to know more about? Please list.

- Base One & Permazyme
- Ethanol production byproduct syrup.
- Anything that is available would be nice to know more about.
- We have heard about a product the vendor called glycerin, which is a soy based sugar product.
- TEAM Dust control.
- Mag Chloride and Calcium Chloride.
- Alternatives to chlorides that could be manufactured locally.
- We have some experience with lignon products through our private dust control permit process. With ethanol production, this product may prove to be more cost effective. Quality control and effectiveness appear to be of interest with this product if it is to be used for county funded programs.
- Beet derivative products.
- All options. I'm interested in Benefits vs. Cost.
- Anything that is cheaper than liquid CaCl.
- Magnesium chloride.
- A cost effective non-chloride product with comparable results.
- The general year to year updating of products.

10. What knowledge have you gained through your experience with dust control that should be shared with other agencies?

- Having a 50% cost share program seems to be a good way to keep dust control costs under control, yet provide the service for those who want it. Has been an effective tool to deal with nuisance dust complaints that we get, especially during dry periods.
- It can also reduce blading, hold the road together longer, and prevents washboards.
- Should be using a modified class 5 gravel with the 200 passing being 8 to 10 %.
- The public feels that once the dust control is applied, they own that section of roadway; people need to understand that the investment they make in dust control has no implied or guaranteed life.
- Our experience seems to indicate that higher gravel binder content provides for a longer lasting benefit from the application.
- We had persons apply cooking grease (French fry grease); this is no longer allowed because of a number of problems experienced.
- The pros and cons from the spreadsheet provided pretty much mirror our uses.
- None of it lasts as long as advertised. Weather and traffic are deciding factors.
- Effectiveness of the dust control depends greatly upon the characteristics of the soil type and amount of clay, and the fines type and percent in the road surface material, i.e. limestone or gravel.
- The term dust control is a misnomer. A better term would be dust suppressant. The point here is that many new rural residents associate dust control with not having any dust. The real fact, in my experience, is that you have less dust with treatment than you would without it. Ever wonder why the old timers set their houses back so far from the rock road? It wasn't just to have a lot to graze sheep!
- The competitive market does not really exist with chloride products. Envirotech supplies most of the local contractors, which does not help in controlling the material cost very well.
- We have allowed through permit several products to be applied as dust control, including: ground asphalt shingle, soy oil, lignon, magnesium chloride, and various mixtures of liquid asphalt. It is clear that success is possible with proper preparation and placement for all these products and with realistic expectations. Allowing choice and protecting the public through permitting and contractor responsibility has provided affordable and effective dust control along rock roads with very low traffic volumes.
- Some types of material attract moisture while some products tend to encapsulate the surface material.
- Personally, I am just starting as Maintenance Engineer, but through the years the department has pretty much singled in on calcium chloride as our preferred method of dust control.
- We were a participant in a LRRB study completed a few years ago.

10. What knowledge have you gained through your experience with dust control that should be shared with other agencies? (*continued*)

- The County facilitated providing dust control to residents. I determined this was an inefficient use of county resources, since a majority of the sites were not on the 151 miles of county granular surfaced roads, but rather on the 512 total miles of local township roads. Residents now work directly with their local township officials to arrange for dust control. Local control is better.
- It is our opinion that magnesium chloride and calcium chloride both perform similarly well. If you didn't test side-by-side you wouldn't be able to tell the difference.
- For our area of the State CaCl and MgCl perform equally when applied as specified. The life cycle is very dependent of what the summer season gives you with respect to rainfall. The past two years we have not applied a second application due to timely rainfall events.
- Better results with history of application; better results when surface material is not too dry or too wet; blading or maintaining the surface after application shortens life; higher traffic volumes shortens life
- The CaCl used for dust control and the CaCl used for prewetting for ice control have different percentages of concentration and substantially different freezing points. Don't try to use any leftover 38% CaCL for ice control.
- Limit the application amount, for products other than water, to what works instead of over applying. If more is needed, use another application. Most residents want it done for aesthetics - quality of life, but it's also important to provide visibility for safety.
- Realizing that the dryer and sandier the material is the less benefit you get out of dust suppressants.
- Program has been turned over to independent contractors. This has worked well.

**11. Are there questions about dust control that you are seeking more information about?
(Please elaborate)**

- We are interested in how many counties used dust control and what they budget every year. Will this be an area to be cut or at least reduced due to budget issues?
- Is there anything as effective and as inexpensive as CaCl or MgCl?
- TEAM laboratories.
- What is the best dust control measure for a low plastic, silt or clay material?
- Looking for alternatives (competition) to chlorides that would be proven to be just as effective.
- Additional products present themselves periodically. Getting base information concerning spread rate and effectiveness assists in evaluating proposals. Comparison of effectiveness at various application rates for the various products would help. Having some standard of comparison for dust suppression would make discussion with suppliers more reasonable.
- For the past two years we have only received a bid from one vendor. Is there other competition out there?
- Optimum application rates.
- Need verification on what the appropriate application rates for MgCl and CaCl should be to correctly compare in alternate bidding. At their common given solutions, what is the proper application rate for MgCl to have the same effectiveness of an application of CaCl?
Some Counties (Hubbard and Cass) are using the same application rates for each Chloride. Others (Beltrami and Clay) are using different application rates for each Chloride.
- How many agencies apply dust control as a means of saving on gravel loss as opposed to just applying in front of homes? In other words, can the cost of applying CaCl over the entire road (not just in front of homes) be justified by the amount of gravel savings?
- Are there road authorities that are applying dust control nearly system wide due to benefits from reduced maintenance costs (i.e. reduced maintenance blading, reduced quantity of maintenance gravel)? Would they have cost/benefit information available to share?

National Survey

An additional survey was conducted by the Federal Highway Administration for dust control at a national level. This report documents survey results regarding the state of the practice of using chemical treatments on unpaved roads. It provides insights into road manager choices and challenges and is useful supplementary reading to the accompanying *Unpaved Road Dust Management, A Successful Practitioner's Handbook* by Jones et al. (2013). A summary and the findings of this survey can be accessed at the link below. Upon reviewing the national survey results, it was found that there is a lot of “user” information/experience within this national survey that parallels information provided in the Minnesota survey. Example findings are included in the summary below.

Unpaved Road Chemical Treatments, State of the Practice Survey

Author(s): Kociolek

Publication Yr: 2013

Agency: Federal Highway Administration, Central Federal Lands Highway Division, Lakewood, CO, U.S.A.

Publication No: FHWA-CFL/TD-13-002

Website: <http://www.cflhd.gov/programs/techDevelopment/materials/DustSurvey/documents/UnpavedRoadChemicalTreatmentsStateOfThePracticeSurvey.pdf>

Summary: This report documents survey results regarding the state of the practice of using chemical treatments on unpaved roads. It provides insights into road manager choices and challenges and is useful supplementary reading to the accompanying *Unpaved Road Dust Management, A Successful Practitioner's Handbook* by Jones et al. (2013). Roughly 80% of the survey respondents used chemical treatments for six or more years. Ninety eight percent (98%) of those indicated it was to control (fugitive road) dust, in part, to comply with federal regulations, for human and livestock health, in response to public complaints, or as a courtesy to the public. Other top reasons were to reduce maintenance costs and extend grader maintenance intervals. The most common treatment method was spray-on surface application with the top three chemical treatments being magnesium chloride, calcium chloride, and lignin sulfonate, respectively.

Findings: The following information and graphs are examples of some of the findings from the national survey:

Most respondents (73%; n = 274) indicated their agency uses chemical treatments on unpaved roads for dust control, soil stabilization, reduced maintenance, etc. Twenty five percent (25%) indicated their agency does not use chemical treatments and 2% did not know whether or not their agency uses chemical treatments on unpaved roads.(Page 16)

Figure 9. Graph. Rationale for using chemical treatments on unpaved roads. Respondents were asked to check all that apply. (n = 164)

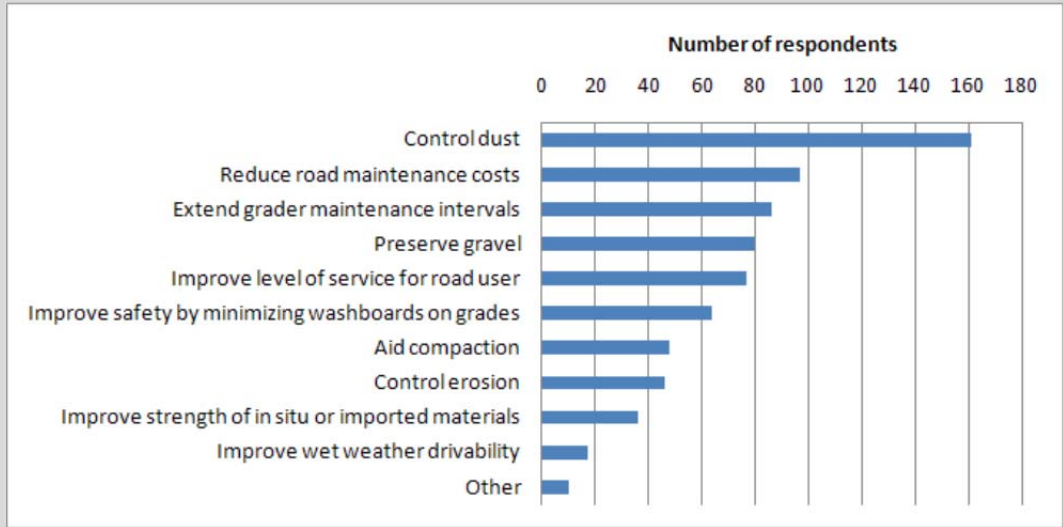


Figure 10. Graph. Methods by which agencies apply chemicals. Respondents were asked to check all that apply. (n = 164)

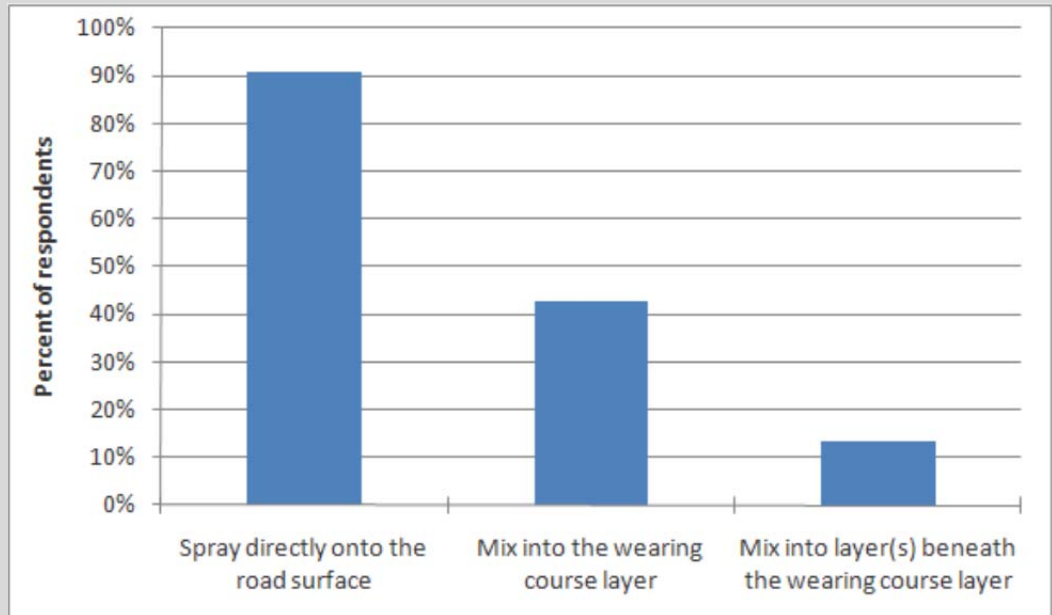


Figure 11. Graph. Use of chemical treatment by application method. Parenthesized number refers to the total number of respondents per treatment type regardless of application method. Respondents were asked to check all that apply. (n = 161)

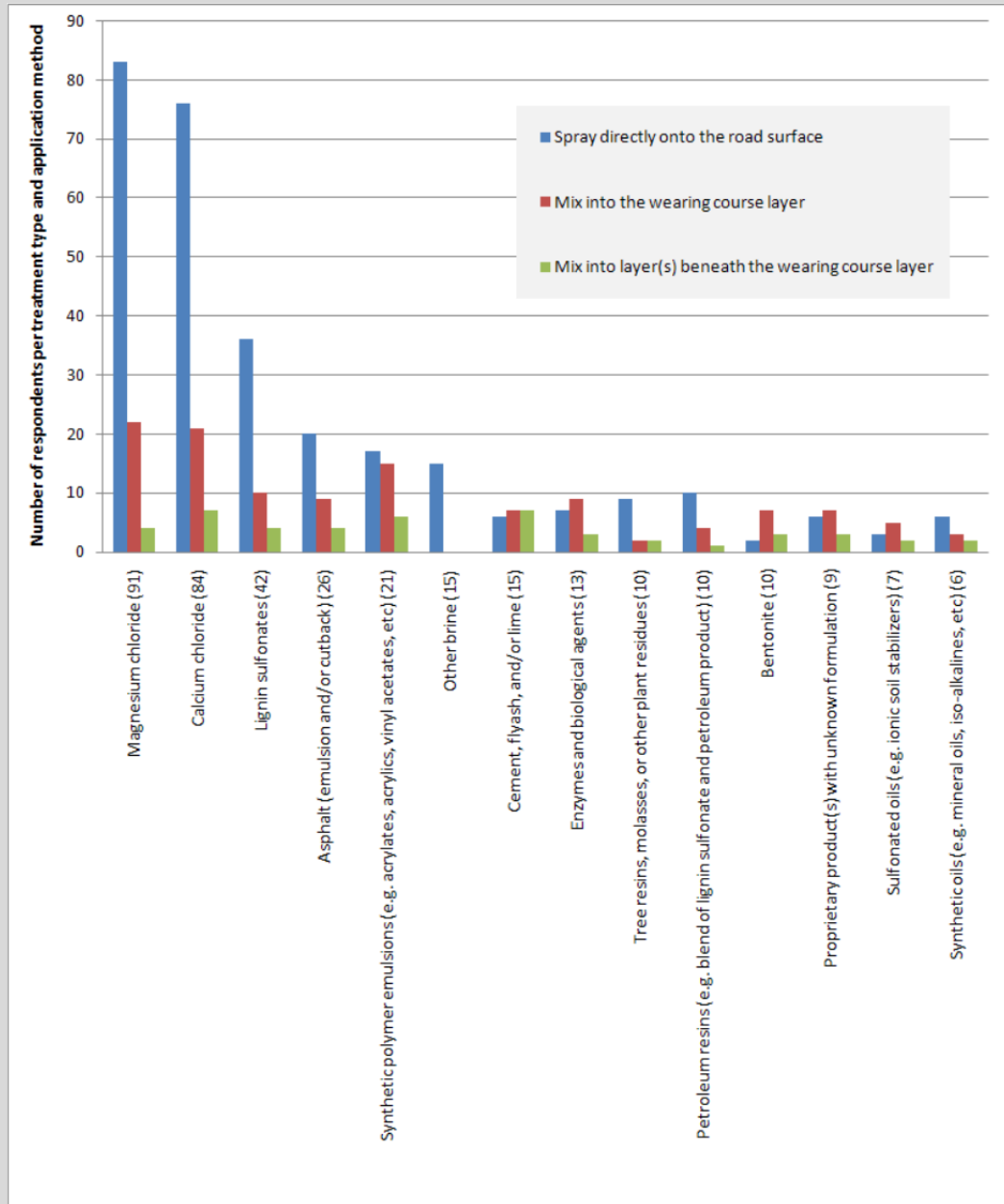
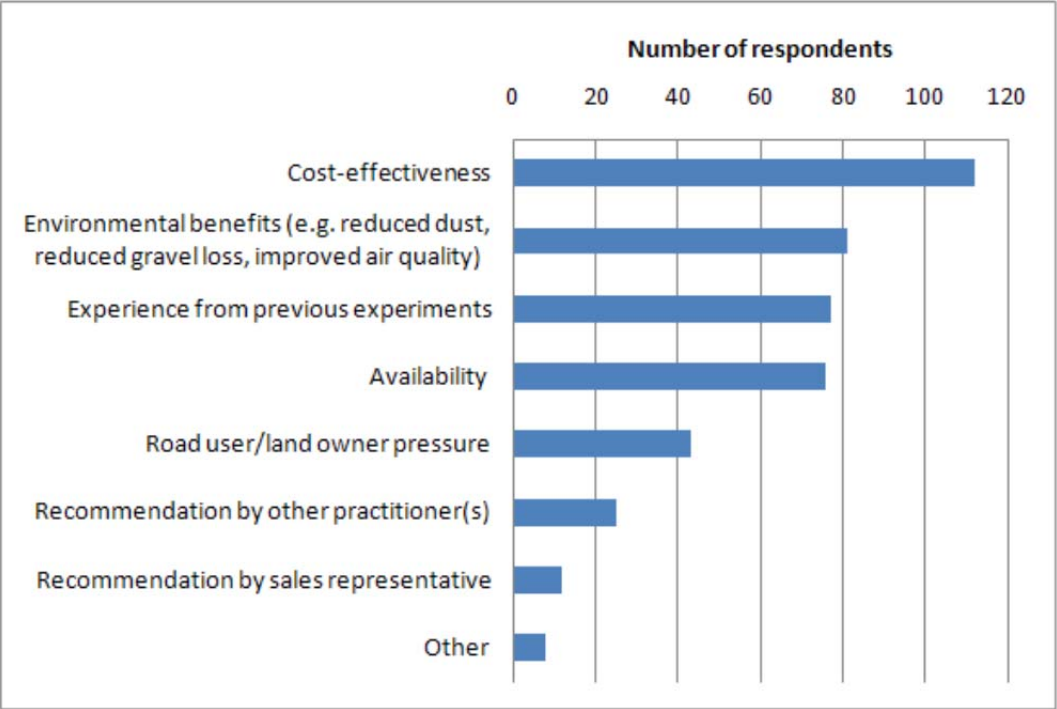


Figure 13. Graph. Rationale for choosing their agency’s most commonly used chemical treatment. Respondents were asked to check all that apply. (n = 156)



Chapter 3: Resources

A literature search was completed to identify resources that could assist local agencies in determining the best dust suppressants to use on their roadways, effectiveness, and impacts. Three resources that were found to be the most helpful are listed below. The *Unpaved Road Dust Management, A Successful Practitioner's Handbook* was recently released (May 2013) and is based on a scan tour conducted to observe real-world dust control issues. The *Unpaved Road Chemical Treatments, State of the Practice Survey* is an accompanying document to the guidebook mentioned above and was also referenced in the survey section above. The last resource, *Dust Palliative Selection and Application Guide*, includes a detailed table starting on page 9 of the report, which lists the various dust suppressant categories as well as the attributes, limitations, application, origin, and environmental impacts of each. This resource was developed in 1999, but it is still considered accurate by industry experts. At the time this report was published, the author of the *Dust Palliative Selection and Application Guide* indicated that an updated version may be available in the future.

Unpaved Road Dust Management, A Successful Practitioner's Handbook

Author(s): Jones; David, Kociolek; Angela, Surdahl; Roger, Bolander; Peter, Drewes; Bruce, Duran; Matthew, Fay; Laura, Huntington; George, James; David, Milne; Clark, Nahra; Mark, Scott; Andrew, Vitale; Bob, and Williams; Bethany

Publication Yr: 2013

Agency: Federal Highway Administration, Central Federal Lands Highway Division, Lakewood, CO

Publication No: FHWA-CFL/TD-13-001

Website: <http://www.cflhd.gov/programs/techDevelopment/materials/Handbook/documents/UnpavedRoadDustManagementASuccessfulPractitionersHandbook.pdf>

Summary: This handbook provides broad programmatic aspects of unpaved road management. It is based on observations made during a national scan tour and provides useful and insightful excerpts of real world examples and includes practical how-to instructions for determining what type of treatment may be needed for different situations. It ultimately strives to encourage road managers to think broadly about the process of unpaved road management rather than just focusing on a specific type of chemical treatment.

Unpaved Road Chemical Treatments, State of the Practice Survey

Author(s): Kociolek

Publication Yr: 2013

Agency: Federal Highway Administration, Central Federal Lands Highway Division, Lakewood, CO

Publication No: FHWA-CFL/TD-13-002

Website: <http://www.cflhd.gov/programs/techDevelopment/materials/DustSurvey/documents/UnpavedRoadChemicalTreatmentsStateOfThePracticeSurvey.pdf>

Summary: This report documents survey results regarding the state of the practice of using chemical treatments on unpaved roads. It provides insights into road manager choices and challenges and is useful supplementary reading to the accompanying *Unpaved Road Dust Management, A Successful Practitioner's Handbook* by Jones et al. (2013). Roughly 80% of the survey respondents used chemical treatments for six or more years. Ninety eight percent (98%) of those indicated it was to control (fugitive road) dust, in part, to comply with federal regulations, for human and livestock health, in response to public complaints, or as a courtesy to the public. Other top reasons were to reduce maintenance costs and extend grader maintenance intervals. The most common treatment method was spray-on surface application with the top three chemical treatments being magnesium chloride, calcium chloride, and lignin sulfonate, respectively.

Dust Palliative Selection and Application Guide

Author(s): *Bolander, Peter; Yamada, Alan*

Publication Yr: *1999*

Agency: *United States Department of Agriculture, Forest Service, Washington, DC, U.S.A.*

Publication No: *9977 1207—SDTDC*

Website: http://www.ecy.wa.gov/programs/air/pdfs/Dust_Palliative.pdf

Summary: The purpose of this publication is to help practitioners understand and correctly choose and apply the dust palliative that is appropriate for their particular site, traffic conditions, and climate. In addition, this publication describes the expected performance, limitations, and potential environmental impacts of various palliatives. This guide examines most of the commonly available dust palliatives currently available and does not endorse any particular product. Since new products will become available and existing products will most likely change following publication of this report, it is recommended that this guide be used as a starting point for determining which palliative would be most appropriate for a given situation.

Additional resources to consider:

A significant amount of research has been completed on dust control, and it was a challenge to identify what resources were the best. The following list includes frequently used resources available at the time that this report was published. The resources below are listed alphabetically by the last name of the author.

Road Dust Suppression: Effect on Maintenance Stability, Safety and the Environment (Phases 1–3)

Author(s): *Addo, Jonathan Q., Thomas G. Sanders, Melanie Chenard*

Publication Yr: *2004*

Agency: *Colorado State University, Fort Collins, Colorado, U.S.A.*

Publication No: *N/A*

Website: <http://www.mountain-plains.org/pubs/pdf/MPC04-156.pdf>

Summary: This report describes research conducted at Colorado State University to evaluate the effect of road dust suppression on unpaved road maintenance schemes. A field-based method was used to measure the effect of road soil physical characteristics on the effectiveness of some of the commonly used dust suppressants. The study also evaluated the stabilization of unpaved road base material because of the use of dust suppression. The effect of dust suppression on safety and driving conditions on unpaved roads was examined. The chloride compounds and ligninsulfonate commonly used as dust suppressants are water-soluble and can be leached into the environment. They contain chlorides, heavy metals, and organic compounds that are regulated. Their potential to have adverse environmental impact was examined.

Environmental Effects of Dust Suppressant Chemicals on Roadside Plant and Animal Communities (research in progress)

Author(s): *Calfee, Robin; Finger, Susan; Little, Ed; Williams, Bethany*

Publication Yr: *Future- 2014*

Agency: *USGS- US Geological Survey*

Publication No: *N/A*

Website: <http://www.cerc.usgs.gov/Projects.aspx?ProjectId=77>

Summary: Over 25 % of the roads in the United States are unpaved, and frequently result in dusty conditions. Road dusts pose a safety hazard for drivers, and health hazards for people living near such roads. In addition, such roads cause environmental impacts ranging from erosion to contamination of biota. A variety of substances are used in dust suppression. The impact of such chemicals is not well documented for the variety of terrestrial and aquatic plants and animals that can potentially be exposed during application and from run-off and erosion. The persistence of toxicity will be determined for selected dust suppressant agents. The data will provide Road Maintenance Managers scientifically based information with which to make informed decisions regarding selection and used of suppressant chemicals.

Dust Control Guidance and Technology Selection Key

Author(s): *Gebhart, R.L.; Denight, M.L.; Grau, R.H.*

Publication Yr: *1999*

Agency: *US Army Construction Engineering Research Laboratories, Champaign, IL, U.S.A.*

Publication No: *USACERL Report 99/21*

Website: <http://aec.army.mil/usaec/technology/dustbooklet.pdf>

Summary: Although considerable research has been conducted by the U.S. Army Engineer Waterways Experiment Station, U.S. Army Construction Engineering Research Laboratories, product manufacturers, and other Federal and State agencies concerning dust control, results from this body of work have been published in a number of diverse and obscure documents that are largely unavailable or inaccessible to Army environmental, safety, public works, and natural resources managers. This lack of readily available information limits the ability of Army environmental, safety, public works, and natural resources managers to make informed, cost effective decisions regarding the selection and application of appropriate dust control products with proven performance characteristics and maintenance requirements. The objective of this work was to produce a sample to use guidance document for dust control on roads, trails, and landing strips which summarizes, to the greatest extent possible, results from previous research that has experimentally documented (1) research site characteristics, (2) chemical composition of dust control products tested, (3) application rates and techniques, and (4) performance, durability, cost, and maintenance requirements. Summarized data was subsequently used to develop a dichotomous key that allows the user to select the most appropriate/environmentally acceptable dust control product based on site specific information such as climate, underlying soil types and textures, trafficked surface and aggregate material characteristics, vehicle type, anticipated traffic volumes, and length of service required.

Dust Control on Unpaved Roads

Author(s): Han; Chunhua, PhD

Publication Yr: 1992

Agency: Minnesota Local Road Research Board, St. Paul, Minnesota, U.S.A.

Publication No: 1992-07

Website: Not available online – contact the LRRB for a copy <http://www.lrrb.org/contact-us>

Summary: This report summarizes dust control procedures used by various states and local agencies for unpaved roads. The research results related to dust control are also outlined. The report starts with a brief introduction on dust problems associated with unpaved roads and three main dust control methods: chemical, mechanical, and administrative. Preliminary concepts and background of a temporary surface treatment for dust control are presented. The relative effectiveness of a dust control program is estimated based on traffic levels, road conditions, and the climate. The report discusses various materials used in dust control, selection of a proper dust palliative, dust control.

Gravel Road Management: Implementation and Programming Guide

Author(s): Huntington, G. and Ksaibati, K.

Publication Yr: 2010

Agency: Wyoming Technology Transfer Center, Laramie, WY, U.S.A

Publication No: FHWA-WY-10/03F Volume 1

FHWA-WY-10/03F Volume 2

FHWA-WY-10/03F Volume 3

Website: [http://wwweng.uwyo.edu/wyt2/Gravel%20Roads/OCT_2011_Gravel_Roads_Management_FINALE_REPORT_Oct2010\[1\].pdf](http://wwweng.uwyo.edu/wyt2/Gravel%20Roads/OCT_2011_Gravel_Roads_Management_FINALE_REPORT_Oct2010[1].pdf)

[http://wwweng.uwyo.edu/wyt2/Gravel%20Roads/OCT_2011_Gravel_Roads_Management_IMPLEMENTATION_GUIDE_Oct2010\[1\].pdf](http://wwweng.uwyo.edu/wyt2/Gravel%20Roads/OCT_2011_Gravel_Roads_Management_IMPLEMENTATION_GUIDE_Oct2010[1].pdf)

http://www.dot.state.wy.us/files/live/sites/wydot/files/shared/Planning/Research/Gravel_Roads_Management_PROGRAMMING_GUIDE_Oct2010_Vol3.pdf

Summary: Volume 1

This section outlines the Background, Problem Statement, Objectives, Report Organization, Analytical Methods, and Summary and Conclusions.

Volume 2

This section is designed to assist local road and street departments with implementation or improvement of a gravel roads management system. It is written primarily for road managers tasked with acquiring the necessary information to develop an information systems process.

Volume 3

This section is intended to assist programmers and database managers with programming the information needed to implement a gravel roads management system.

Testing of Dust Suppressants for Water Quality Impacts

Author(s): Irwin, K.; Hall, F.; Kemner, W.; Beighley, E.; Husby, P.

Publication Yr: 2008

Agency: U.S. Environmental Protection Agency, Cincinnati, OH, U.S.A.

Publication No: N/A

Website: <http://www.epa.gov/region9/air/dust/DustSuppressants-sept2008.pdf>

Summary: The purpose of this research was to identify dust suppressant products with minimal to no adverse impacts on water quality and aquatic life relative to use of water alone. Simulated stormwater runoff from small-scale soil plots treated with six dust suppressant products was evaluated for water quality and aquatic toxicity. The study also evaluated the quality of water leached through soils treated with dust suppressant products.

Best Practices for Dust Control on Aggregate Roads

Author(s): *Olson, Roger; Johnson, Eddie*

Publication Yr: 2009

Agency: *Minnesota Local Road Research Board, St. Paul, Minnesota, U.S.A.*

Publication No: 2009-04

Website: *Full report: <http://www.lrrb.org/pdf/200904.pdf>
Technical Summary of report: <http://www.lrrb.org/media/reports/200904TS.pdf>*

Summary: The aim of this study was to evaluate the effectiveness of several common dust control products when applied to a variety of gravel surface roads at various schedules. The findings of this study would be used to better control the dust on rural roads and reduce the number of calls for service, particularly from residents moving to the country from the city who have higher expectations for dust-free roads.

Dust Control Field Handbook: Standard Practices for Mitigating Dust on Helipads, Lines of Communication, Airfields, and Base Camps.

Author(s): *Rushing, J.; Tingle, J.*

Publication Yr: 2006

Agency: *US Army Engineer Research and Development Center, Vicksburg, MS, U.S.A.*

Publication No: ERDC/GSL SR-06-7

Website: <http://www.soilworks.com/docs/soilworks-army-dust-control-field-handbook-2006.pdf>

Summary: The U.S. Army Engineer Research and Development Center has evaluated potential chemical dust palliatives for mitigating fugitive dust in military operations. The products were compared in laboratory testing and several field trials. The results of these efforts are compiled in this document to provide assistance for selecting and applying chemical dust palliatives for use on helipads, roads, airfields, and base camps. This document summarizes recommendations and conclusions derived from individual research projects. The information is intended to serve as a guide for acceptable dust mitigation. Variations of the procedures documented may be necessary to meet specific requirements.

Gravel Roads: Maintenance and Design Manual

Author(s): *Selim, Ali; Skorseth, Ken*

Publication Yr: 2000

Agency: *U.S. Department of Transportation, Washington, DC, U.S.A.*

Publication No: N/A

Website: http://water.epa.gov/polwaste/nps/gravelroads_index.cfm

Summary: The purpose of this manual is to provide clear and helpful information for maintaining gravel roads. Very little technical help is available to small agencies that are responsible for managing these roads. Gravel road maintenance has traditionally been "more of an art than a science" and very few formal standards exist. This manual contains guidelines to help answer the questions that arise concerning gravel road maintenance such as: What is enough surface crown? What is too much? What causes corrugation? The manual is designed for the benefit of elected officials, managers, and grader operators who are responsible for designing and maintaining gravel roads. The information is as nontechnical as possible without sacrificing clear guidelines and instructions on how to do the job right. The manual is presented in the following sections: (I) Routine Maintenance and Rehabilitation; (II) Drainage; (III) Surface Gravel; (IV) Dust Control/Stabilization; and (V) Innovations. Numerous photographs accompany the text and an index is provided.

Guidelines for Cost Effective Use and Application of Dust Palliatives

Author(s): *Smith, G.A.; Makowichuk, P.B.; Carter, D.J.E.*

Publication Yr: *1987*

Agency: *Transportation Association of Canada, Ottawa, Canada*

Publication No: *N/A*

Website: *N/A*

Summary: Dust palliatives are used extensively in all provinces and territories of Canada to control dust problems on local road networks and thus improve visibility and safety. The objectives of this study were to: 1) identify existing dust palliatives in use in Canada, 2) identify conditions which warrant the use of dust palliatives and develop performance evaluation measures, 3) quantify the costs and benefits, 4) determine application procedures, 5) identify known environmental risks, and 5) establish guidelines for use and application. Canadian experience with dust palliatives is summarized based on a questionnaire survey of road agencies across the country. The paper concludes with suggestions for future research in the area of dust control. (TRRL)

Environmental Evaluation of Dust Stabilizer Products

Author(s): *Steevens, J.; Suedel, B.; Gibson, A.; Kennedy, A.; Blackburn, W.; Splichal, D.; Pierce, J.T.*

Publication Yr: *2007*

Agency: *U.S. Army Corps of Engineers, Vicksburg, MS*

Publication No: *ERDC/EL TR-07-13*

Website: <http://el.erd.c.usace.army.mil/elpubs/pdf/trel07-13.pdf>

Summary: Personnel of the U.S. Army Engineer Research and Development Center (ERDC and Navy Environmental Health Center (NEHC) evaluated the environmental fate and effects of six commercially available dust stabilizer products. As part of the evaluation, a relative risk comparison was made of the six materials to other materials that have been used historically to control dusts (i.e., diesel, crude oil, fuel oil). Data for this evaluation were obtained primarily through literature review, communication with the manufacturers of the products, and through some limited analytical chemistry. Data gaps and uncertainties were also identified and described. Conclusions were derived from the results of the evaluation, with each stabilizer group presented separately along with general conclusions applicable to all stabilizers studied.

Alaska Rural Dust Control Alternatives

Author(s): *Withycombe, Earl; Dulla, Robert*

Publication Yr: *2006*

Agency: *Alaska Department of Environmental Conservation, Juneau, AK, U.S.A.*

Publication No: *SR2006-03-03*

Website: http://www.dec.state.ak.us/air/anpms/Dust/Dust_docs/DustControl_Report_032006.pdf

Summary: Air quality monitoring data collected in several rural Alaska communities over the past few years reveal elevated levels of fine particulate matter smaller than 10 microns in diameter (PM10). The high readings are coupled with complaints of heavy dust conditions reported to the Alaska Department of Environmental Conservation (ADEC) from residents of these communities together with anecdotal information from local hospitals of increases in health problems and visits during these periods. Review of information collected from emission inventories and interviews of rural community residents has led ADEC to conclude that unpaved road use is a significant contributor to elevated PM10 levels in these communities. ADEC is interested in evaluating alternative methods for control of dust emissions from unpaved road use to assist the communities in air quality improvement. ADEC also believes that control measures that reduce emissions from unpaved road use will also reduce emissions from unpaved airfield use and from windblown dust emissions from these surfaces. ADEC has requested that a study be conducted of these control measures that would (1) Develop a matrix of feasible dust control strategies for reducing road and airport dust emissions (2) Identify costs and benefits of various dust control materials and strategies; and (3) Identify and prioritize needs for identifying, selecting, and implementing effective, economic, and environmentally sound dust control measures. For this study, Sierra performed a literature search on dust control from unpaved roads and collected specific data relative to dust problems in two rural Alaska communities and promising dust control measures.

Potential Environmental Impacts of Dust Suppressants: "Avoiding Another Times Beach": An Expert Panel Summary.

Author(s): N/A

Publication Yr: 2004

Agency: Environmental Protection Agency, Washington, DC, U.S.A.

Publication No: EPA/600/R-04/031

Website: <http://www.epa.gov/esd/cmb/pdf/dust.pdf>

Summary: The purpose of this report is to summarize the current state of knowledge on the potential environmental impacts of chemical dust suppressants. Furthermore, the report summarizes the views of an Expert Panel that was convened on May 30-31, 2002 at the University of Nevada, Las Vegas to probe into the potential environmental issues associated with the use of dust suppressants.

Guidelines for Geometric Design of Very Low-Volume Local Roads (ADT \leq 400), 1st Edition.

Author(s): N/A

Publication Yr: 2001

Agency: American Association of State Highway and Transportation Officials (AASHTO), Washington, DC, U.S.A.

Publication No: N/A

Website: Not available online – can be purchased at
https://bookstore.transportation.org/item_details.aspx?id=157

Summary: These guidelines address the unique design issues highway designers and engineers face when determining appropriate cost-effective geometric design policies for very low-volume local roads. This approach covers both new and existing construction projects. Because geometric design guidance for very low-volume local roads differs from the policies applied to high-volume roads, these guidelines may be used in lieu of *A Policy on Geometric Design of Highways and Streets*, also known as "The Green Book." Design values are presented in both metric and U.S. customary units.