

Soil Stabilization and Dust Management

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Road Map

- Soil Stabilization
- Dust Fundamentals
- Dust Management Plan
 - Levels of dust management
 - Institutional controls
 - Road watering
 - Chemical dust suppressants
 - Dustfall Column
 - Applying Calcium Chloride

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Soil Stabilization Manual 2014 Update

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In cooperation with
United States Department of Transportation
Federal Highway Administration
United States Department of the Interior
National Park Service

Managing Degraded Off-Highway Vehicle Trails in Wet, Unstable, and Sensitive Environments



Kevin G. Meyer, *Environmental Specialist/Soil Scientist*
National Park Service, Alaska Support Office
Rivers, Trails, and Conservation Assistance Program

USDA Forest Service
Technology and Development Program
Missoula, MT

2E22A68—NPS OHV Management

October 2002

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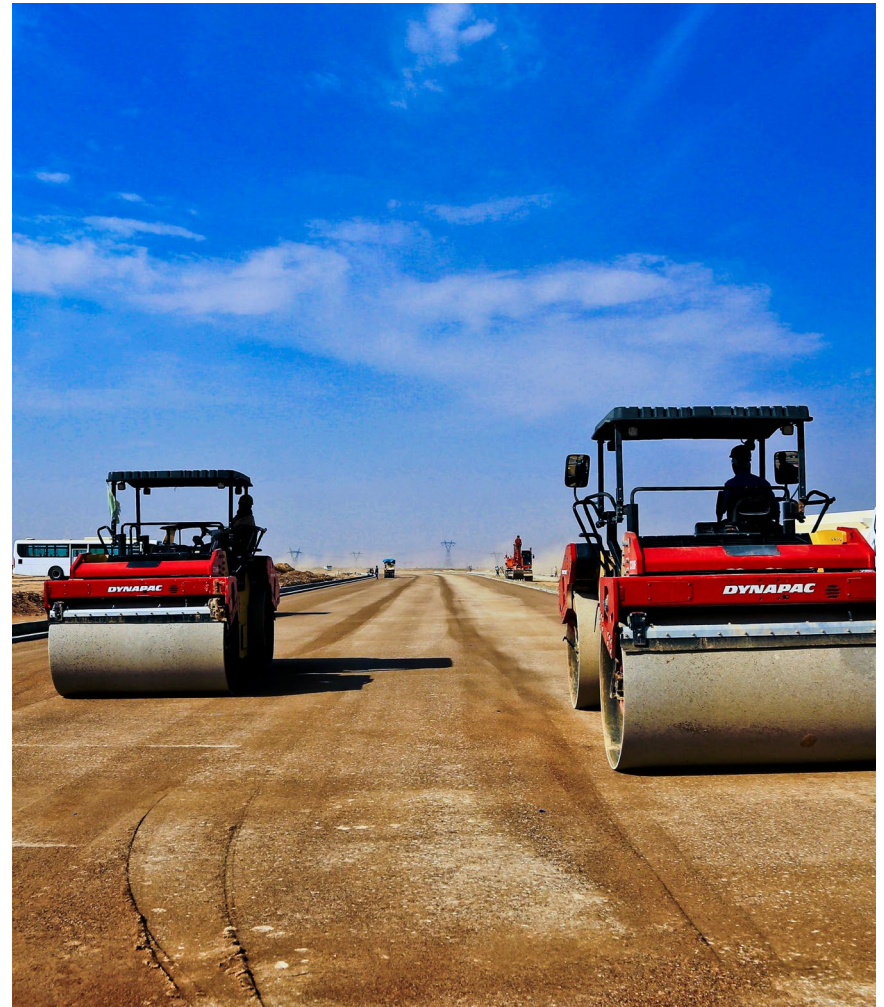
Soil Stabilization

Soil stabilization focuses on changing a natural soil through mechanical, chemical, biological or geosynthetic processes to meet engineering purposes.



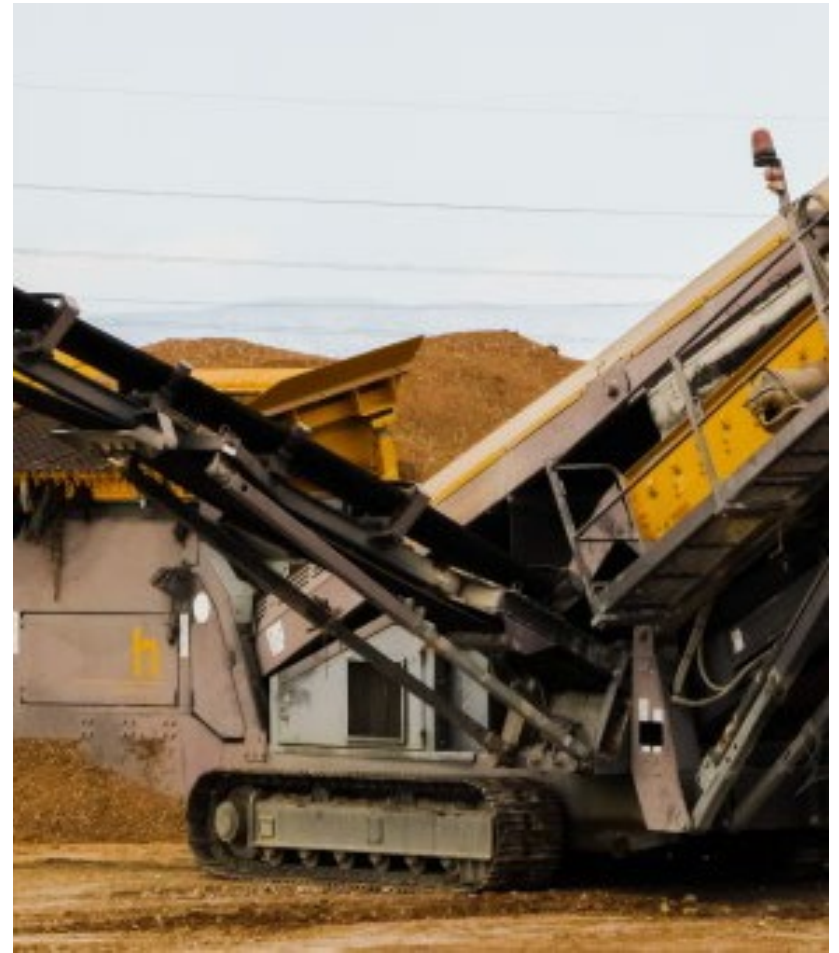
Compaction

- Cost effective
- Requires moisture control
- Don't over compact
- The right equipment
- Layer thickness



Altering the Gradation

- Screening
- Crushing
- Blending



Maximum Density Gradation

$$p = \left(\frac{d}{D} \right)^n$$

Use metric units

p = % passing sieve size

D = maximum particle size

d = spec particle size

n = 0.33 and 0.50

0.33 high fines, low permeability

0.50 course high permeability

0.45 commonly used



Geofibers

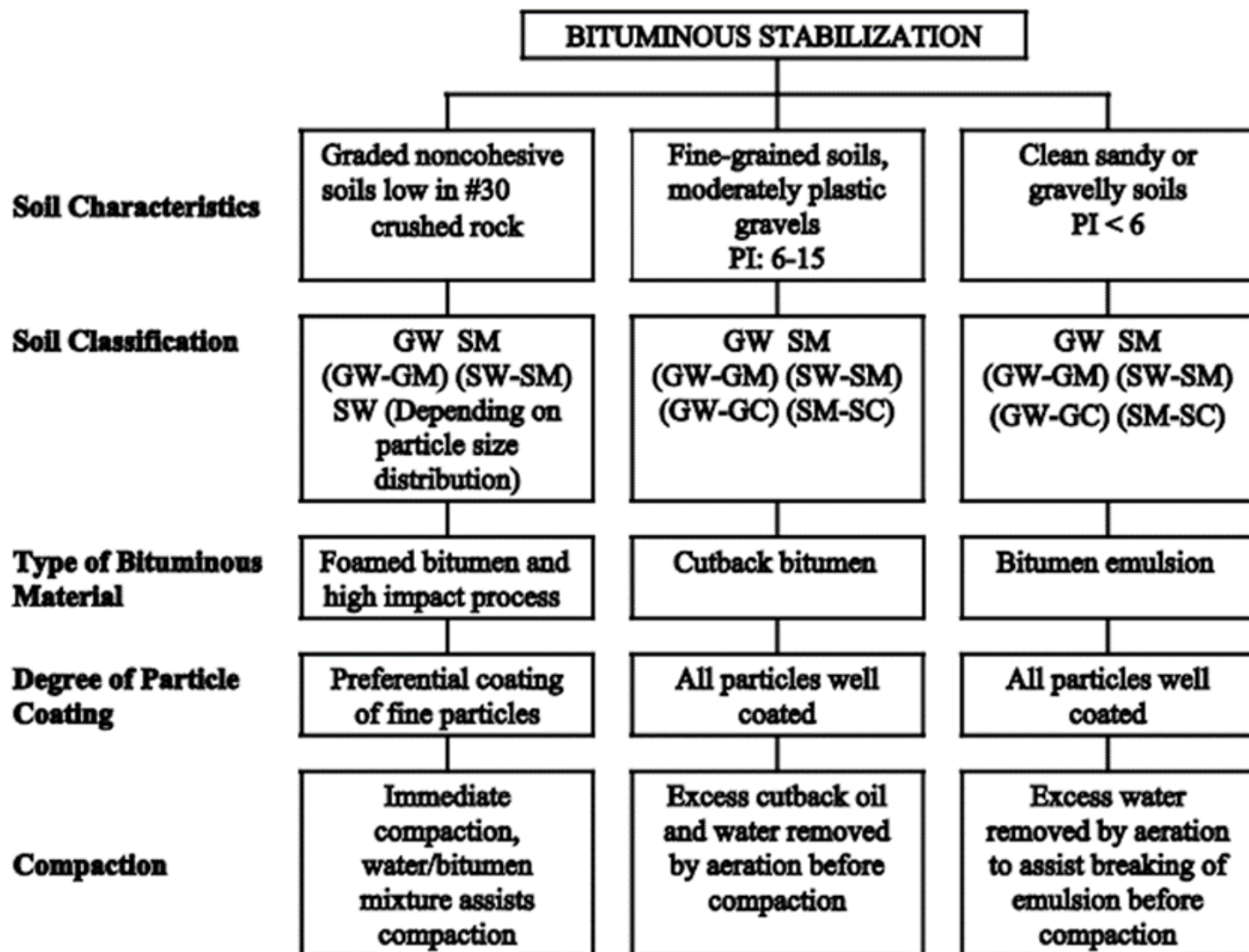
% Fines Added	% Geofibers Added	CBR Improvement
Ottawa Sand 20	0.8	CBR 20 increased to CBR 80
Monterey Sand 20 to 30	0.2 to 0.5	CBR < 20 increased to CBR 85+
Horseshoe Lake Sand* (natural content 6 to 7% P200)	0.5	CBR 25 increased to CBR 45
Fairbanks Silt* n/a	0.2	CBR <35 increased to CBR 60+

*Natural Alaska Material

Geosynthetics

- Choose the right material
- Rely on manufacturer
- Uses
 - Separation
 - Improved support
 - Slope stability
 - Improved performance over permafrost





Portland Cement Stabilization

- Best for coarse-grained soils.
- Uses small quantities of Portland cement
- Can be constructed in-situ or off site
- Depths can range from 6 to 18 inches
- Must be designed
- Shrinkage cracking may be a problem

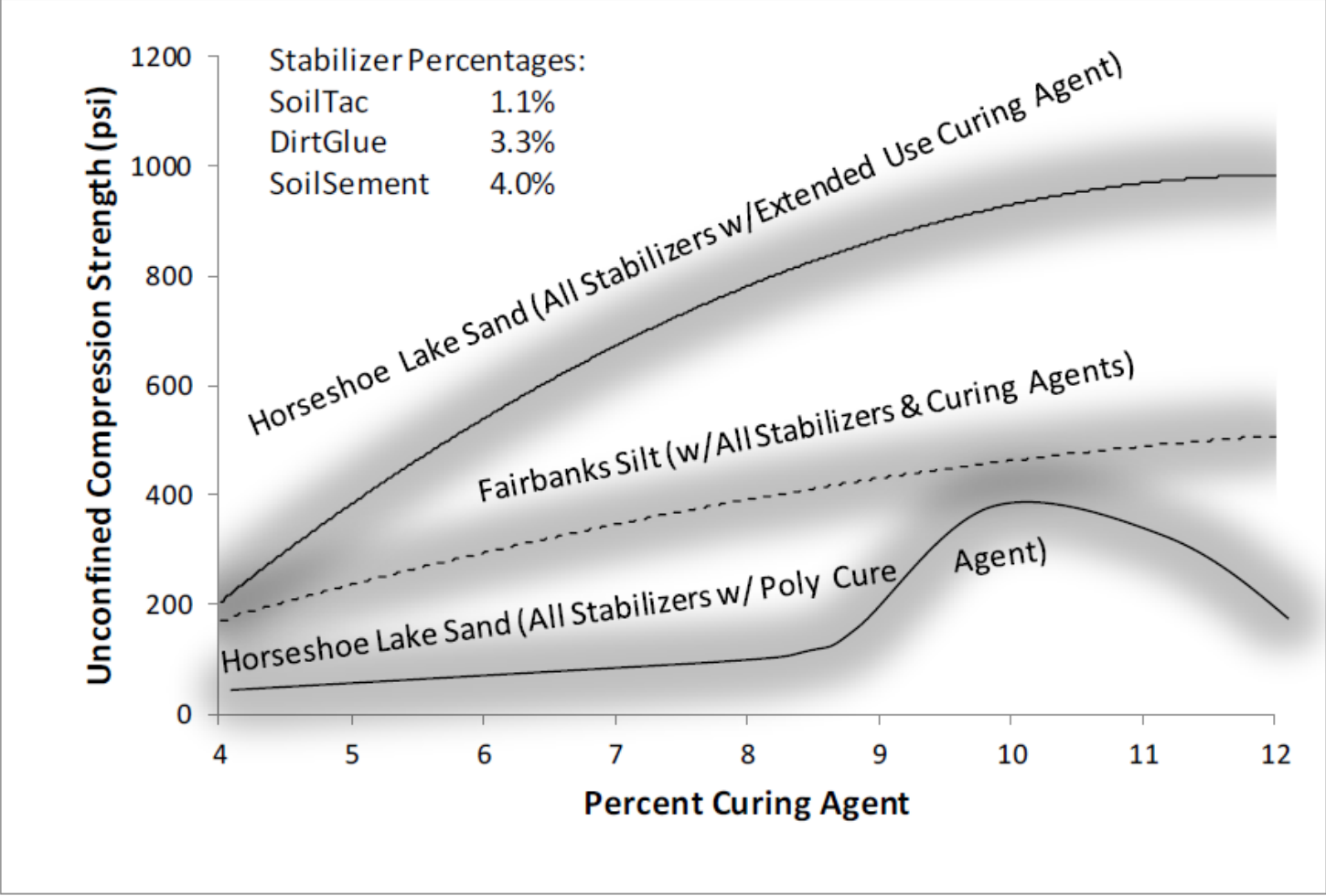
Lime Stabilization

- Best for silts and clays
- Takes longer to cure
- Use quick lime or hydrated lime; not agricultural lime?
- Corrosive: Protect equipment and workers.

Other Chemical Stabilizers

- Enzymes - clay
- Tree Resins - granular
- Polymers - sands and gravels
- Fly Ash - similar to cement
- Salts (magnesium, calcium) - high fines gravels

Polymers



Dust 101



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Photo by ADEC

An Example of the Magnitude of the Problem

Consider: -> 2-mile stretch of unpaved road,

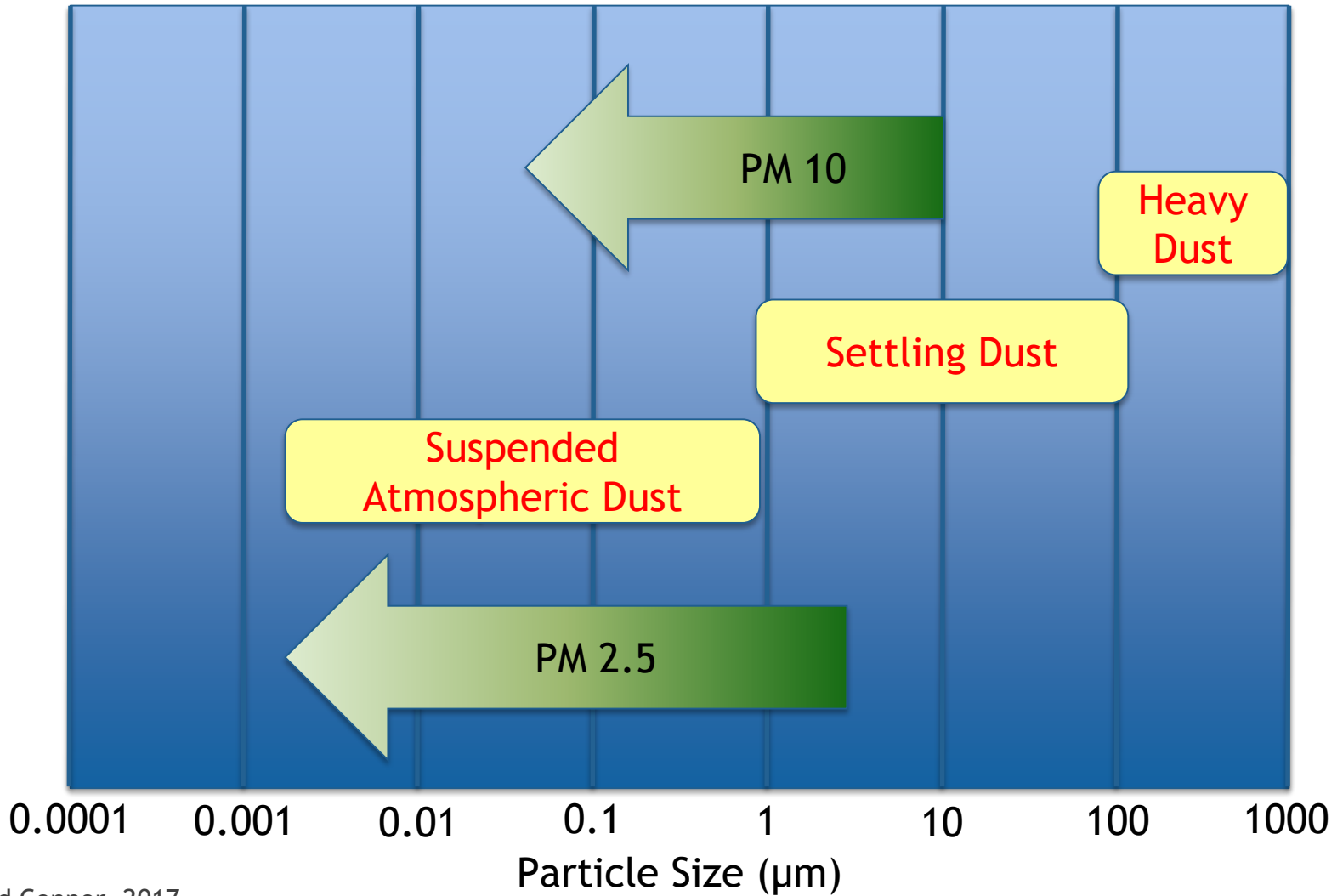
-> 20 vehicles/day,

-> average speed= 30 mph.

Result: 10,920 lbs of dust (PM_{10}) per month

(Roberts et al., 1975)

How Small are These Particles We Are Working With?



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Really Small!

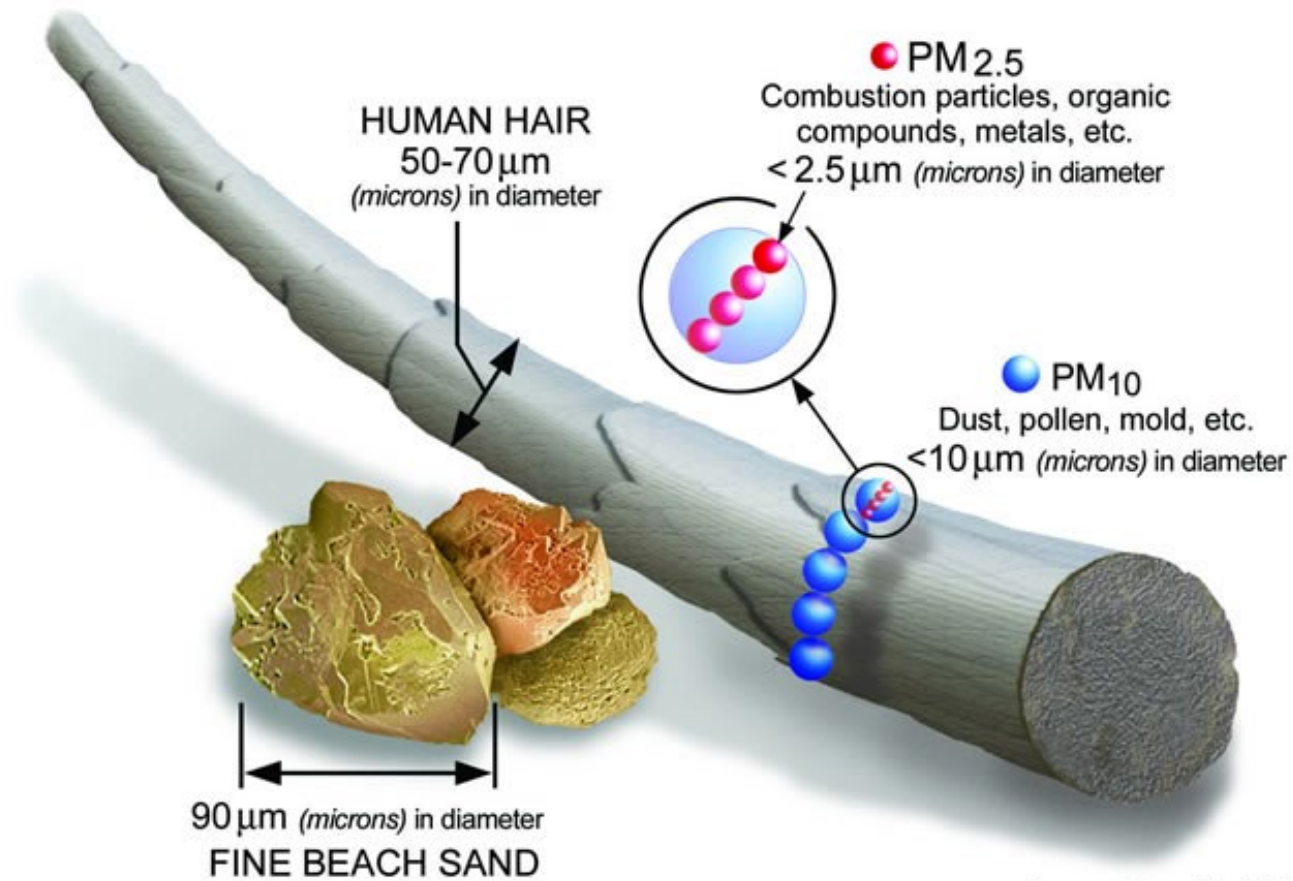
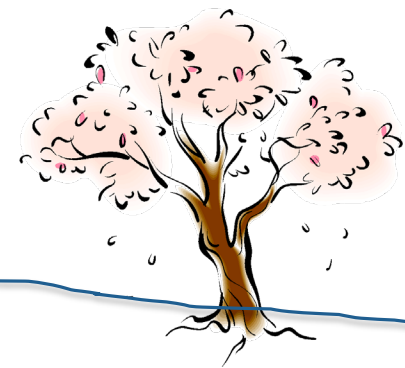
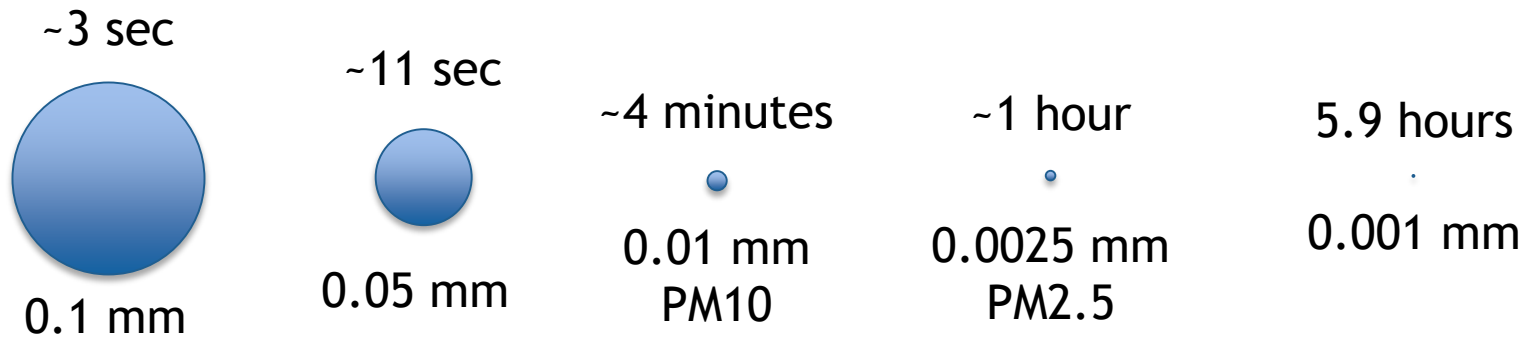


Image courtesy of the U.S. EPA

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Settling time from a 2m loft



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Impacts

- Health
- Economics
- Quality of life
- Environment

Helpful Dust Management Literature

UNPAVED ROAD DUST MANAGEMENT A Successful Practitioner's Handbook

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

January 2013



Central Federal Lands Highway Division
12300 W. Dakota Ave.
Lakewood, CO 80228

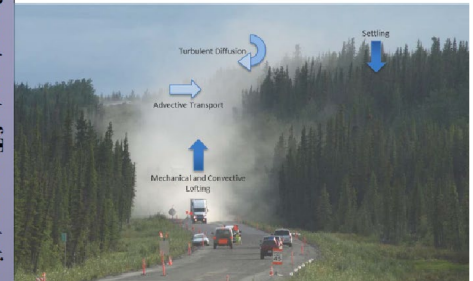
United States
Department of
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Technology &
Development
Program
7700—Transportation System
2000—Water Short and Air Management
November 1980
6977 1207—SD11DG

**Dust Palliative
Selection and
Application
Guide**

Alaska Department of Transportation & Public Facilities
Alaska University Transportation Center



Managing Dust on Unpaved Roads and Airports



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October 2014

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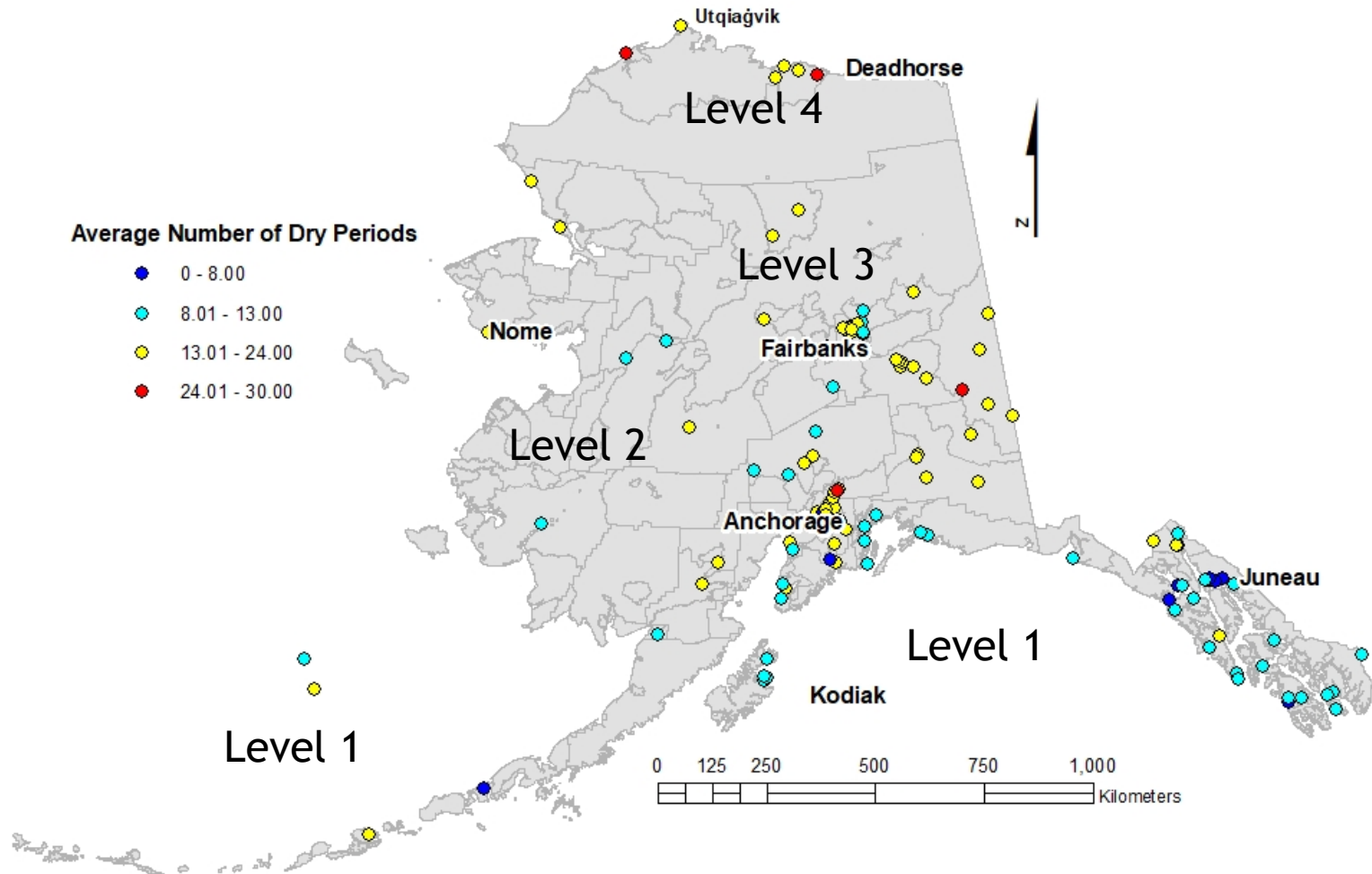
Report No. 4000096



Levels of Dust Management

- Institutional Controls (Level 1)
- Water watering with institutional controls (Level 2)
- Chemical dusts suppressants with institutional controls (Level 3)
- Stabilization (Level 4)

Alaska Dust Management Regions



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A black pickup truck is parked on a wide, unpaved dirt road. The road is surrounded by a dense forest of green trees. The sky is clear and blue. The truck is facing away from the camera, towards the forest.

Good Dust Management Starts with a Good Road

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Measuring the Effectiveness of a Palliative

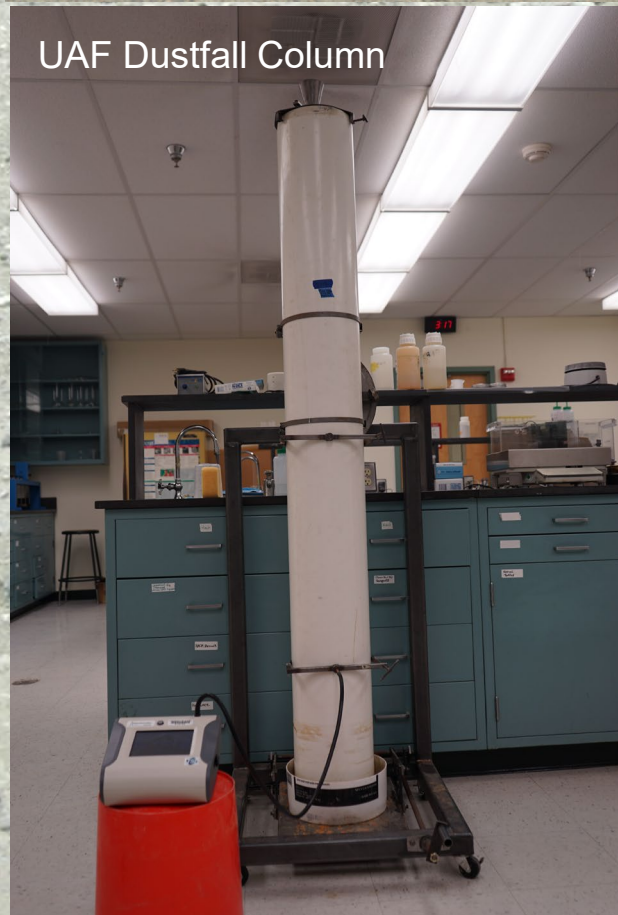




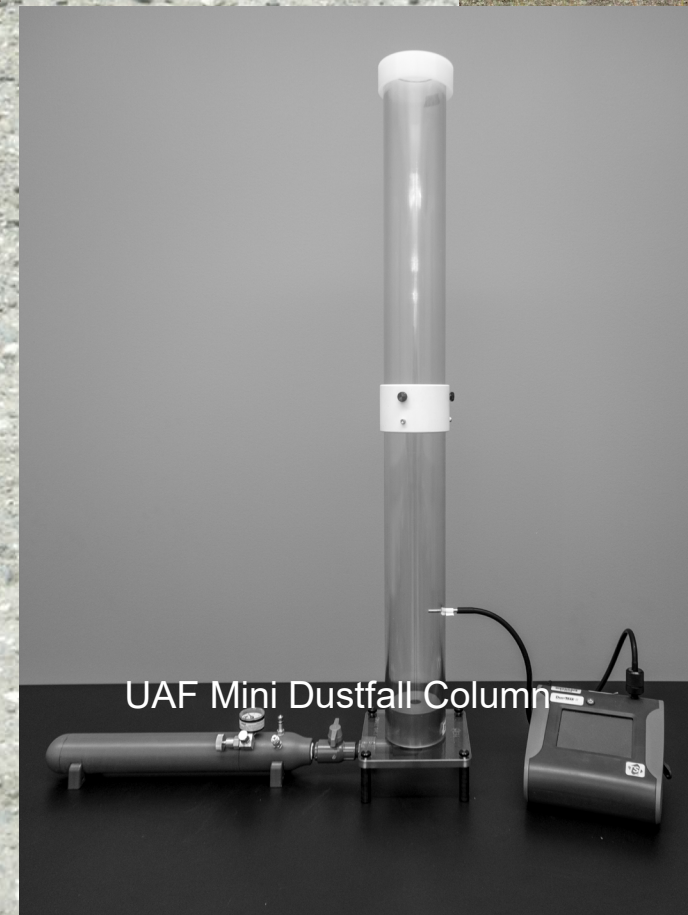
Dust-M



EPA – High-Vol



UAF Dustfall Column



UAF Mini Dustfall Column



Field testing

Institutional Dust Management

- Speed
 - Increase speed from 10 to 20mph \cong double the amount of dust
 - Increase speed from 20 to 30 mph \cong triple the amount of dust
- Limit Driving on the dustiest days
- Control aggressive driving



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Institutional Dust Management



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Community Involvement



Speed limit signs are showing up everywhere in Bethel, but the city is not behind them. (Lisa Demer/Alaska Dispatch News)

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Where do you apply dust suppression?

- Prioritize using the following
 - Traffic data
 - Where people congregate (school, community hall, store, post office clinic, etc.)
 - People with respiratory issues (young, elderly and ill)
 - Environmentally sensitive areas
 - Food preparation areas
- Go down the list as far as your budget will allow.

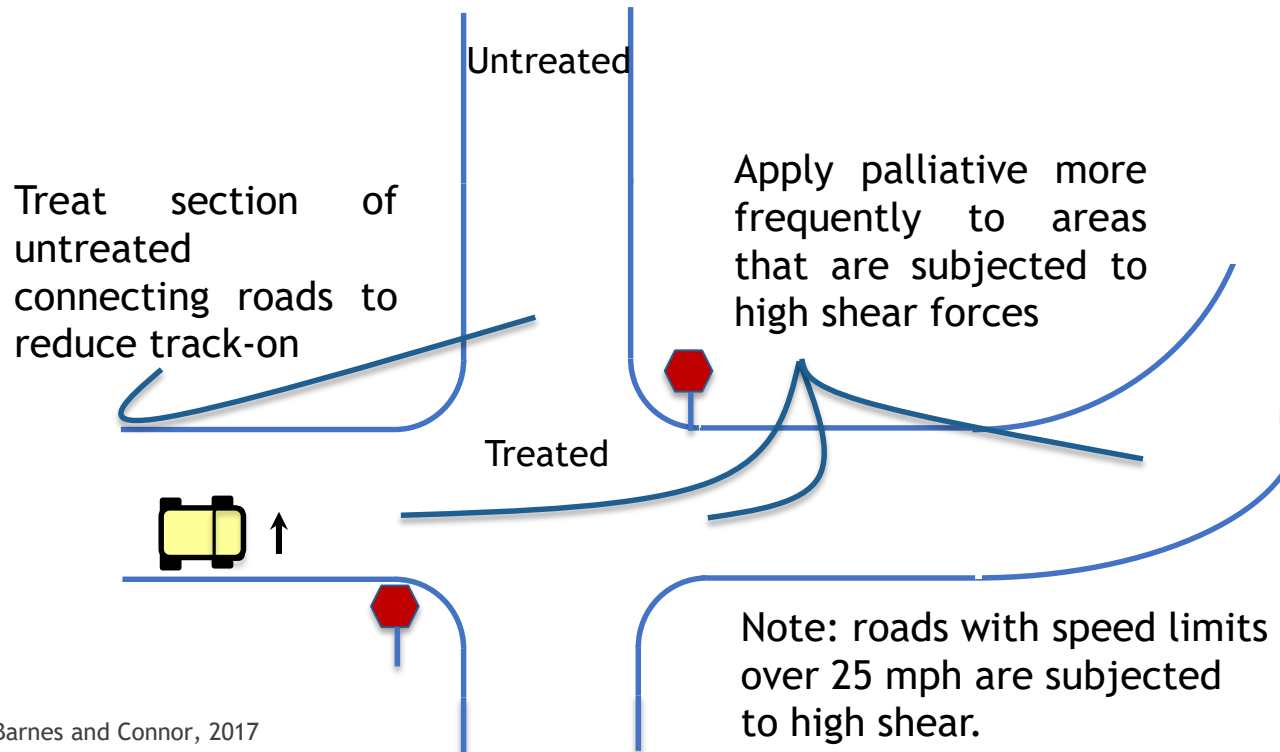


General Considerations (for all dust suppressants)

- Consider Track on/track off
- Salts and synthetic fluids
 - Minimize abrasion by good driving habits
 - Consider recompacting every few weeks
- Pavements
 - Encourages increased use for skateboards, bicycles and use by elderly in wheelchairs
 - Requires annual maintenance.



Product Application and Maintenance



Road Watering



Photo credit: Skorseth and Selim.

- Effects are short lived
- Overlapping fans
- Regular watering during dusty periods as opposed to less frequent heavy watering

Reasons for Poor Performance

- Surface too sandy (low fines)
- Material too dense to allow penetration of the selected product
- Weather
- Too little product applied
- Use wrong equipment for application
- Not applied in multiple passes

Synthetic Fluids: SoilTac, EnviroKleen, EK-35

- Application Rate: 30 - 40 sq. ft./gal
- Cost: \$18,000/mile
- Life: about 1 summer; 2 years on airports
- Can be frozen
- Non-Corrosive
- Must have uniform application
- Best used on good surface course
- Cons
 - Must be careful of weather
 - Difficult to wash off vehicles



Synthetic Fluids

- Petroleum Products
- Meet all EPA/DEC toxicity requirements
- Naturally clear liquid but may have additives
- Non-corrosive
- More expensive than CaCl_2
- Liquid below -40 F
- Performance improve when fines between 9 and 12%
- Use on Roads that are sensitive (generally in town)



Application Methods

- Synthetic fluids
 - Increases apparent cohesive forces in aggregate
 - Reduces water evaporation rate
 - Topical application (no water trucks)
 - 9 to 14% fines content (ask the contractor for a soil gradation)
 - Typical application rates: 30 to 40 ft²/gal
 - Multiple application passes
 - Re-compact treated roads every few weeks

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Application Rate

- Get your soil tested
 - Gradation
 - Focus on fines content
- Use the right palliative at the right application rate
- Apply evenly



Comparison of performance of synthetic fluids relative to untreated soil using dust column

Application Rate sq. ft./gal	% Reduction
30	92
40	85
50	81
60	77



It has to be
done right



Calcium Chloride on Village Roads

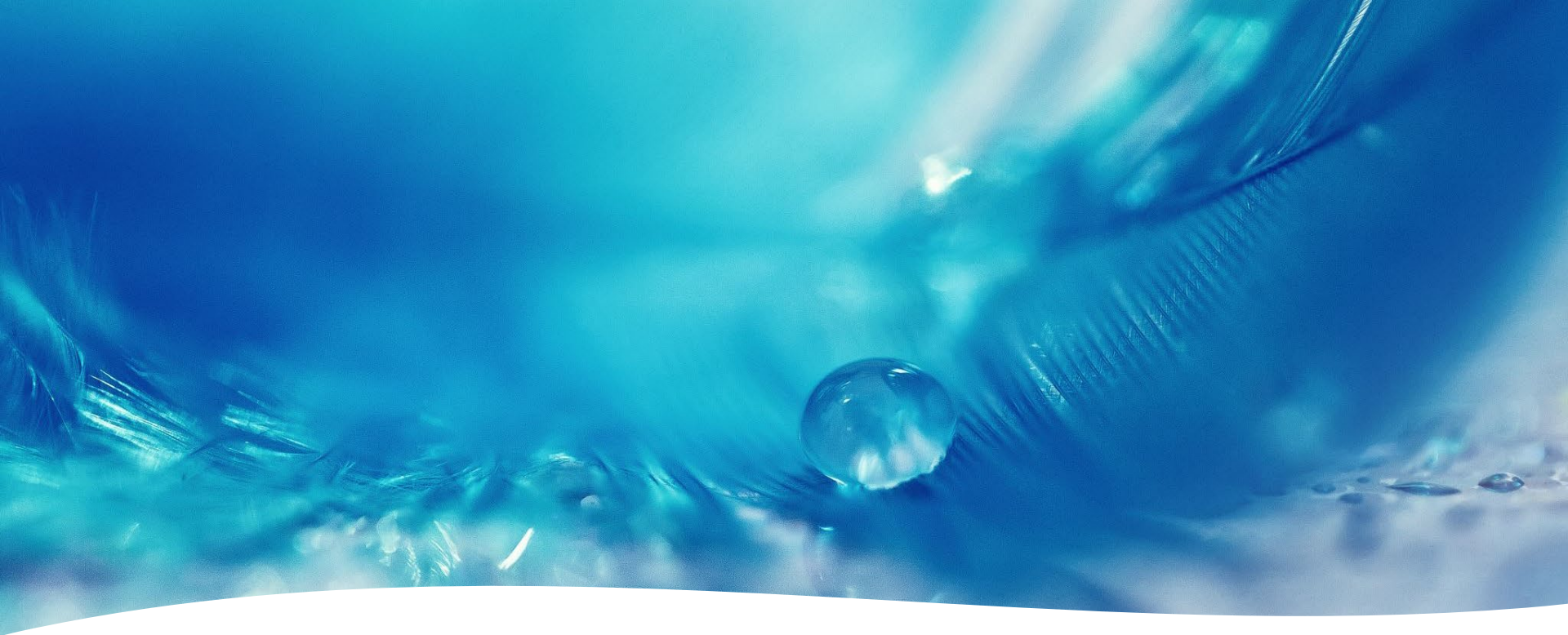


What is Calcium Chloride

Calcium Chloride is a salt like sodium chloride but tends to be stronger.

It is used as a deicing/anti-icing chemical as well as a dust palliative.





How does it
work as a
palliative?

- Calcium chloride has a strong affinity for water. It will attach to moisture in the air or soil and hold it.



Why use Calcium Chloride

- It is the second most common palliative besides water.
- Except for water, it is the most cost-effective palliative.
- It requires minimal equipment to put down.
- Workforce development is minimal.
- It has proven to be safe when used as a palliative.



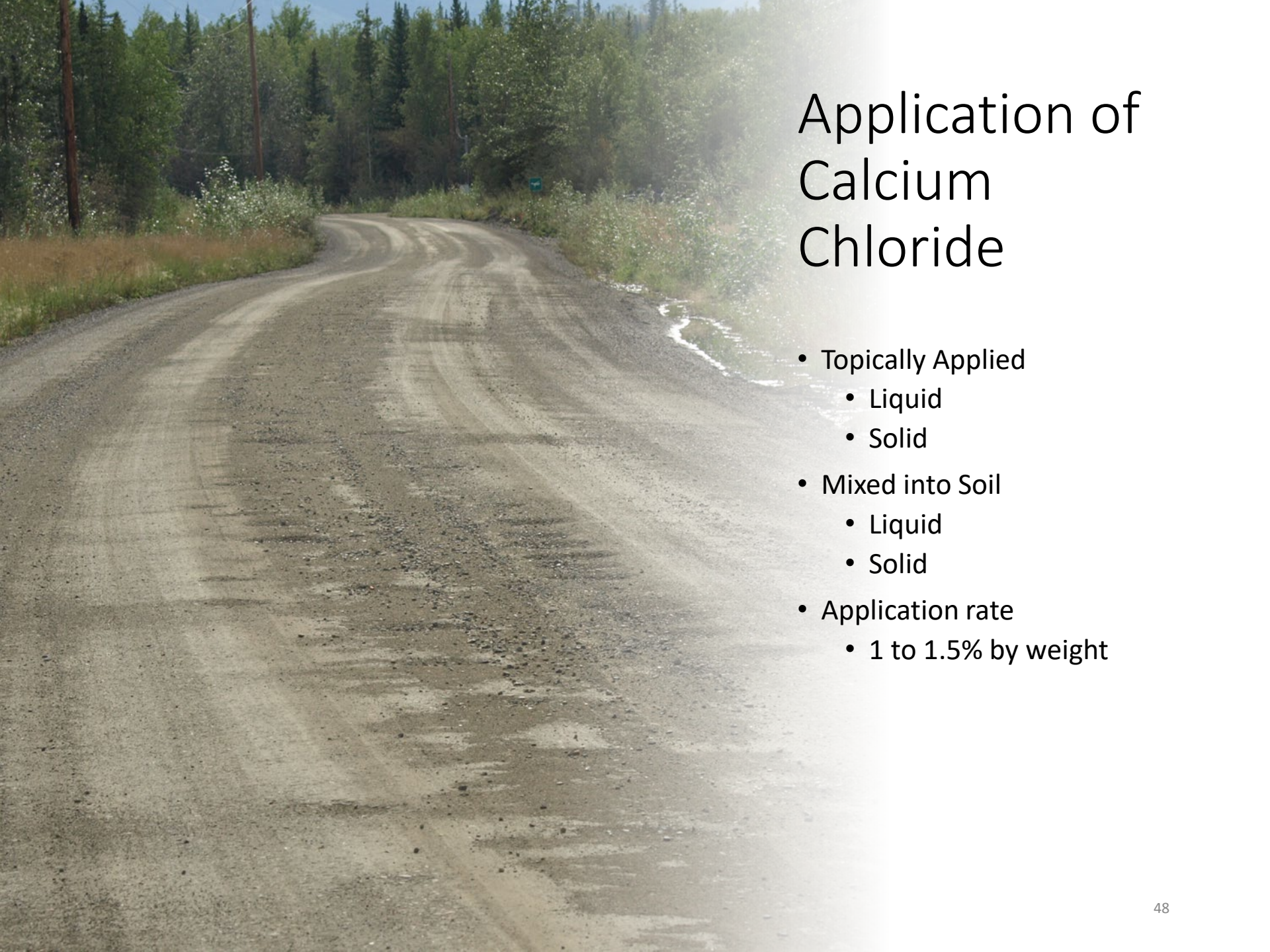
Downsides

- Calcium Chloride is an irritant.
- Strong bitter taste.
- Corrosive.
- Improperly manage can be detrimental to the environment.



Ideal Road and Materials

- Define project limits
- Establish drainage
- If necessary, refresh surface course
 - Ideally $\frac{3}{4}$ dense graded material with 8 to 15% passing 200 sieve.
 - Ideally a minimum of 4" thick for grading
- Establish grade
- If you have silt or clean sand, calcium chloride is not a good choice.

A photograph of a dirt road winding through a forest. The road is the central focus, curving to the right. On the right side of the road, there is a stream with white water. The background is filled with dense green trees and foliage. The overall scene is bright and natural.

Application of Calcium Chloride

- Typically Applied
 - Liquid
 - Solid
- Mixed into Soil
 - Liquid
 - Solid
- Application rate
 - 1 to 1.5% by weight

Required Equipment

- Applied as a solid
 - Grader
 - Spreader
 - Water truck
 - Compactor (optional)
- Applied as a Liquid
 - Grader
 - Water Truck
 - Compactor (optional)
 - Forklift (optional)





Steps to Apply Solid Topical Application

- Shape Road
- Compact
- Loosen upper 2 inches
- Add Salt
- Water
- Compact



Steps to mix (2 to 4 inches)

- Windrow to centerline
- Add salt to windrow
- Blend
- Shape
- Water
- Compact



Steps to Typically Applied Brine

- Shape Road
- Apply Brine
- Compact

Steps to Blending Brine (2 to 4 inches)

- Loosen roadway to desired depth
- Apply Brine
- Blend
- Shape
- Compact





Worker Safety

- Provide coveralls, gloves, safety vests and safety glasses to all workers. Calcium chloride is a strong irritant.
- Provide plenty of drinking water.
- Provide showers at the end of the work shift.
- Consider providing hand creams and body lotions.



Equipment

Prevent corrosion by washing equipment at the end of every shift.

Lubricate more frequently.

Check for excess corrosion daily.



How much calcium chloride Should I use?

The target is 1% to 1.5% by weight of treated soil.

Assuming the surface course weighs 3,500 lbs/cy you would use

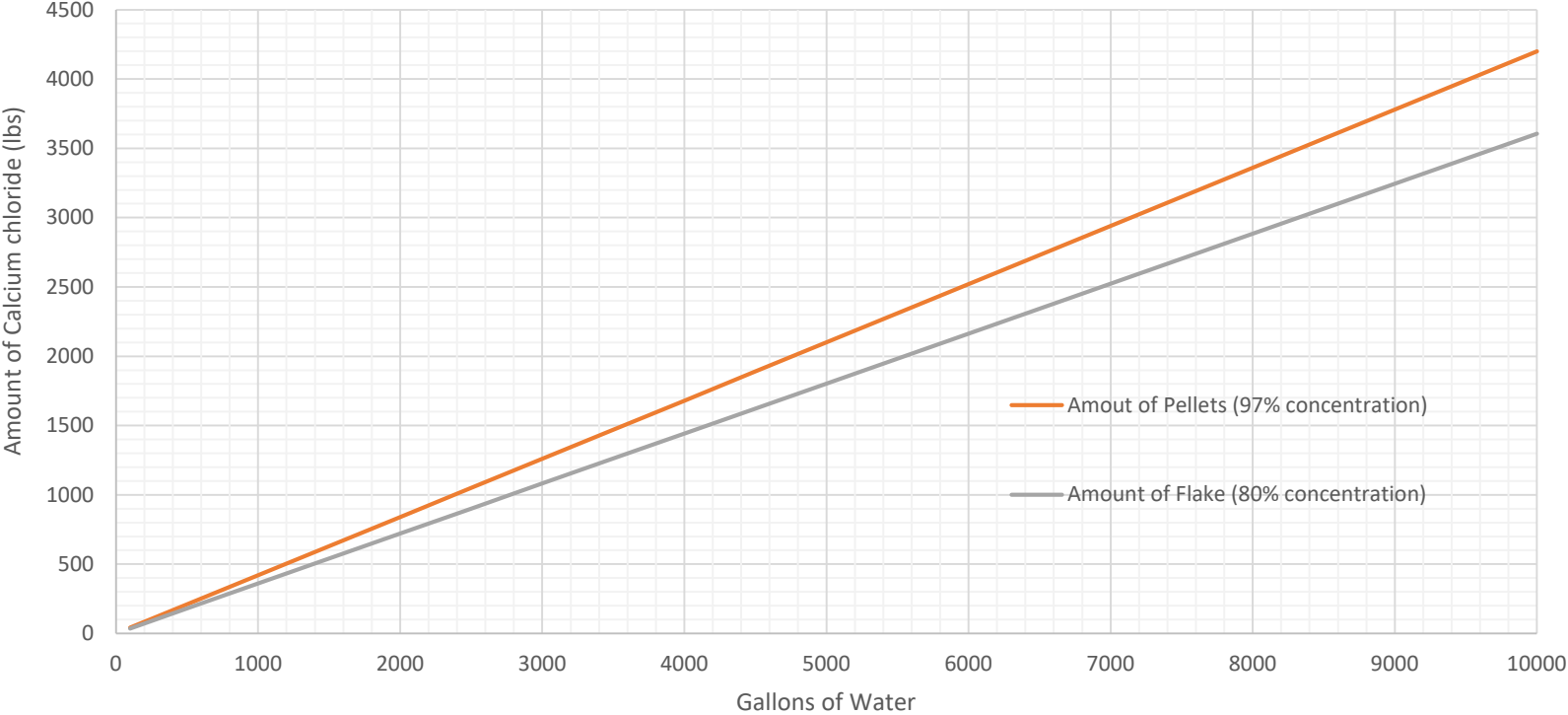
Between 35 lbs and 53 lbs, $(3,500 \times .01)$, calcium chloride.

Road Dust Control with Calcium Chloride Typically Applied

Equivalent Rates of Application

Flake	Pellet	Liquid (Concentrations)		
		38%	35%	32%
lbs./sq.yd.	lbs./sq.yd.	gal./sq.yd.		
0.5	0.41	0.09	0.1	0.11
0.75	0.61	1.13	0.15	0.16
1.00	0.82	0.17	0.19	0.22
1.25	1.02	0.22	0.24	0.27
1.50	1.23	0.26	0.29	0.33

Amount of Calcium Chloride (35% solution)



Spreaders





Water Trucks



Parting thoughts

- There are several ways to apply calcium chloride. Choose the way that fits the equipment you have.
- Plan where you are going to apply calcium chloride carefully. Generally, focus on the higher trafficked areas.
- Plan early. Order early.
- Order bags if you can't handle super sacks.
- Keep the product dry.
- Protect your people and your equipment.



Questions?

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