APPROPRIATE USE OF DUST SUPPRESSANTS to achieve effective dust control for unpaved roads, construction sites and industrial sites

EnviroTech 2022
Xin Qiu & Amanda Allen
April 21, 2022

global **environmental** and **advisory** solutions

SLR

TOPICS

1. Background
2. Selection of dust suppressants
3. Example of Applications
4. Conclusions

DUST

What is Dust?

- Dust, or Particulate Matter, is a general term for extremely small particles and liquid droplets in the atmosphere.
- $PM_{2.5}$ fine particles
- PM_{10} fine particles

What are common sources of Particulate Matter?

- burning fuels: wood, diesel combustion;
- crushing or grinding;
- dust from unpaved roads, construction sites and other disturbed land surfaces;
- industrial processes;
- Farming activities.

Why are we concerned?

- Breathing high levels of PM_{10} or $PM_{2.5}$ is harmful to lung tissue and aggravates asthma symptoms. Especially in sensitive groups such as the elderly, children, and people with respiratory illnesses.

HEALTH IMPACT

- Particle Pollution impacts the lungs and heart
  - Inhaled particles can pass from the lungs into the bloodstream and impact the cardiovascular system
- Impacts of short-term (acute) exposure:
  - Coughing
  - Shortness of breath
  - Tightness of the chest
  - Irritation of the eyes
  - Irregular heartbeat
- Impacts of long-term (chronic) exposure:
  - Reduced lung function
  - Development of respiratory diseases in children
  - Aggravation of existing heart and lung diseases (asthma)
  - Premature death of people with heart and lung disease

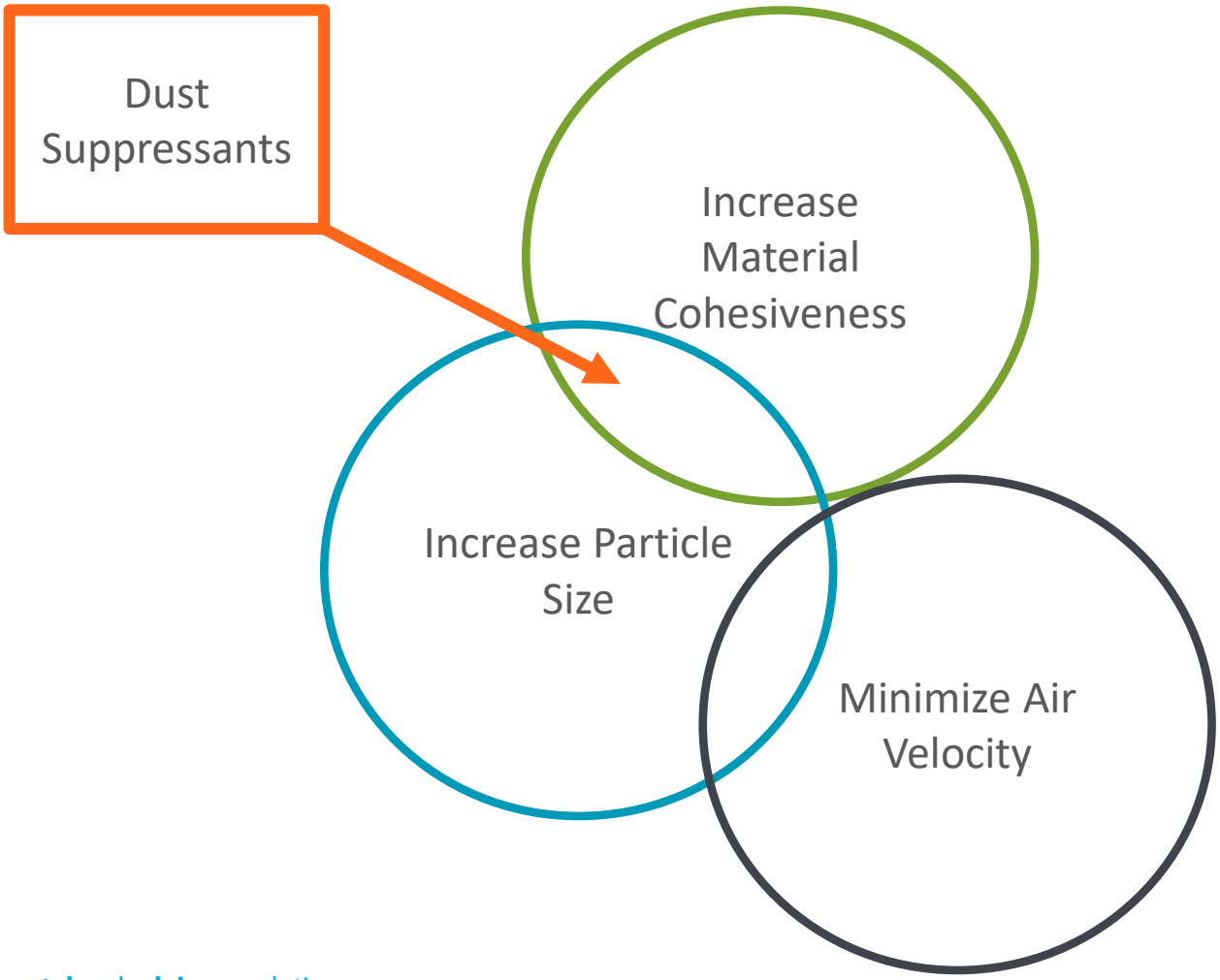
SAFETY IMPACT-VISIBILITY

Image: https://arizonadailyindependent.com/2016/07/19/blowing-dust-reducing-visibility-on-i-10-between-phoenix-and-tucson/
(July 19, 2016, article)

INDUSTRIAL USES BEYOND HEALTH AND SAFETY

- Road maintenance
  - Erosion increases the frequency and cost of road maintenance
  - Increased equipment ware and tear
- Sedimentation
  - Impacts to drainage systems
  - Impact to waterway and potential fish
  - Coating of plants
- Ambient Air Quality
  - Permit and regulatory compliance
  - Corporate citizenship/ license to operate
  - Complaint management

HOW DUST SUPPRESSANT WORKS



LIMITATIONS ON DUST CONTROL

- Construction sites, temporary roads, access points are generally temporary in nature
  - Costs to pave are not justified for short term use
  - Reclamation concerns
- Environmental Permits generally prohibit the use of anything other than fresh water
  - Need to secure appropriate water sources
    - Sustainability/ water conservation
    - Sufficient volumes (drought)
    - Permitting (can be long lead)
  - Cost of logistics
    - Access
    - Transport
    - Number of trucks needed
  - Ineffective
    - In dry conditions water may only work for short periods of time (15 minutes)
    - In cold conditions, water is not suitable as it will freeze and cause concerns with safety

SURVEY (DONE BY SRF CONSULTING GROUP, INC.)

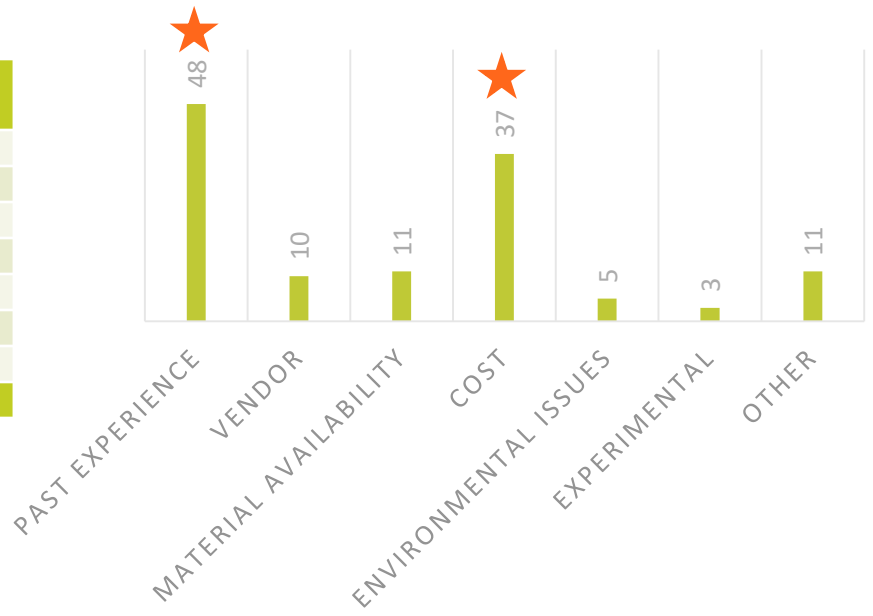
1. Which of the following dust suppressants have you used?

Answer		Response Percent	Response Count
Water		10%	28
Water absorbing	Calcium chloride brine and flakes	29%	82
	Magnesium chloride brine	26%	73
	Sodium chloride (salt)	3%	8
Organic petroleum product	Asphalt emulsions	4%	11
	Cutback asphalt (liquid asphalt)	3%	9
	Dust oils	3%	8
	Modified asphalt emulsions	2%	5
Organic non-petroleum product	Animal fats	0%	0
	Lignosulfonate	3%	8
	Molasses/sugar beet	1%	2
	Tall oil emulsions	0%	0
	Vegetable oils	3%	9
Electrochemical product	Enzymes	1%	2
	Ionic	0%	0
	Sulfonated oils	0%	0
Synthetic polymer product	Polyvinyl acetate	0%	1
	Vinyl acrylic	0%	1
Clay additives	Bentonite	1%	4
	Montmorillonite	0%	0
Recycle in place asphalt		4%	13
Recycled roof shingles		0%	1
Others		6%	17
Total			***281***

SURVEY (DONE BY SRF CONSULTING GROUP, INC.)

2. How do you decide what dust suppressant to use?

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***



Beyond **Past Experience**, **Cost** is the only dominating factor to select a dust suppressant in the real world

COMMON FACTORS CONSIDERED TO SELECT A DUST SUPPRESSANT

- Direct cost compared to watering
- Past experience instead of scientific analysis
- Local environmental and regulatory requirements
- Accessibility

COMMONLY MISSED FACTORS TO SELECT AN APPROPRIATE DUST SUPPRESSANT

- Soil/dust analysis (dust particle size, plasticity, etc.)
- Resisting wear by traffic or wind erosion
- Remaining on the road or exposed surface
- Resisting aging
- Surface wetting of material substrate
- Climate and weather conditions
- Cost-benefit life-cycle consideration

TYPE OF SUPPRESSANTS

- Water
- Water Absorbing Products (deliquescent/hydroscopic)
  - calcium chloride brine and flakes
  - magnesium chloride brine
  - sodium chloride (salt)
- Organic Petroleum Products
  - asphalt emulsions
  - cutback asphalt (liquid asphalt)
  - dust oils
  - modified asphalt emulsions
- Organic Nonpetroleum Products
  - animal fats
  - lignosulfonate
  - molasses/sugar beet extracts
  - tall oil emulsions
  - vegetable oils
- Electrochemical Products (Concentrated Liquid Stabilizers)
  - enzymes
  - ionic products
  - sulfonated oils
- Synthetic Polymer Products
  - polyvinyl acetate
  - vinyl acrylic
  - synthetic fluid and synthetic fluid with binder
- Clay Additives
  - bentonite
  - montmorillonite

DUST SUPPRESSANT SELECTION CHART*

Dust Palliative	Traffic Volumes, Average Daily Traffic			Surface Material								Climate During Traffic		
				Plasticity Index			Fines (Passing 75μm, No. 200, Sieve)							
	Light <100	Medium 100 to 250	Heavy >250 (1)	<3	3–8	>8	<5	5–10	10–20	20–30	>30	Wet &/or Rainy	Damp to Dry	Dry (2)
Calcium Chloride	✓✓	✓✓	✓	✗	✓	✓✓	✗	✓	✓✓	✓	✗ (3)	✗ (3,4)	✓✓	✗
Magnesium Chloride	✓✓	✓✓	✓	✗	✓	✓✓	✗	✓	✓✓	✓	✗ (3)	✗ (3,4)	✓✓	✓
Petroleum	✓	✓	✓	✓✓	✓	✗	✓ (5)	✓	✓ (6)	✗	✗	✓ (3)	✓✓	✓
Lignin	✓✓	✓✓	✓	✗	✓	✓✓ (6)	✗	✓	✓✓	✓✓	✓ (3,6)	✗ (4)	✓✓	✓✓
Tall Oil	✓✓	✓	✗	✓✓	✓	✗	✗	✓	✓✓ (6)	✓ (6)	✗	✓	✓✓	✓✓
Vegetable Oils	✓	✗	✗	✓	✓	✓	✗	✓	✓	✗	✗	✗	✓	✓
Electro-chemical	✓✓	✓	✓	✗	✓	✓✓	✗	✓	✓✓	✓✓	✓✓	✓ (3,4)	✓	✓
Synthetic Polymers	✓✓	✓	✗	✓✓	✓	✗	✗	✓✓	✓✓ (6)	✗	✗	✓	✓✓	✓✓
Clay Additives (6)	✓✓	✓	✗	✓✓	✓✓	✓	✓✓	✓	✓	✗	✗	✗ (3)	✓	✓✓

Legend

✓✓ = Good ✓ = Fair ✗ = Poor

*UCPRC 2017: Guidelines for the Selection, Specification, and Application of Chemical Dust Control and Stabilization Treatments on Unpaved Roads

COMPARISONS OF DUST SUPPRESSION TECHNOLOGIES

Chemistry	Intangible	Intangible & Immeasurable		
	Frequency	Safety Environment	Ease of Cleanup	Other
Water	Multi/day	X-tra Traffic Wet/slippery	Yes	Muddy, Morale
Oils/Tar Emul	7-14 days	Slippery Run-off (PAHs)	No, Morale	Oil base, Non-renewable
$Ca/MgCl_2$	30-45 days	Toxic	Yes	Highly corrosive!
Humectant & Organic Poly	30-120 days	Bio-degrades	Yes	Renewable resource

ChemTreat's Steel Industry Water Conference 8-2 to 8-3-2016 , Blytheville Arkansas

CHEMICAL TREATMENT CATEGORY USES

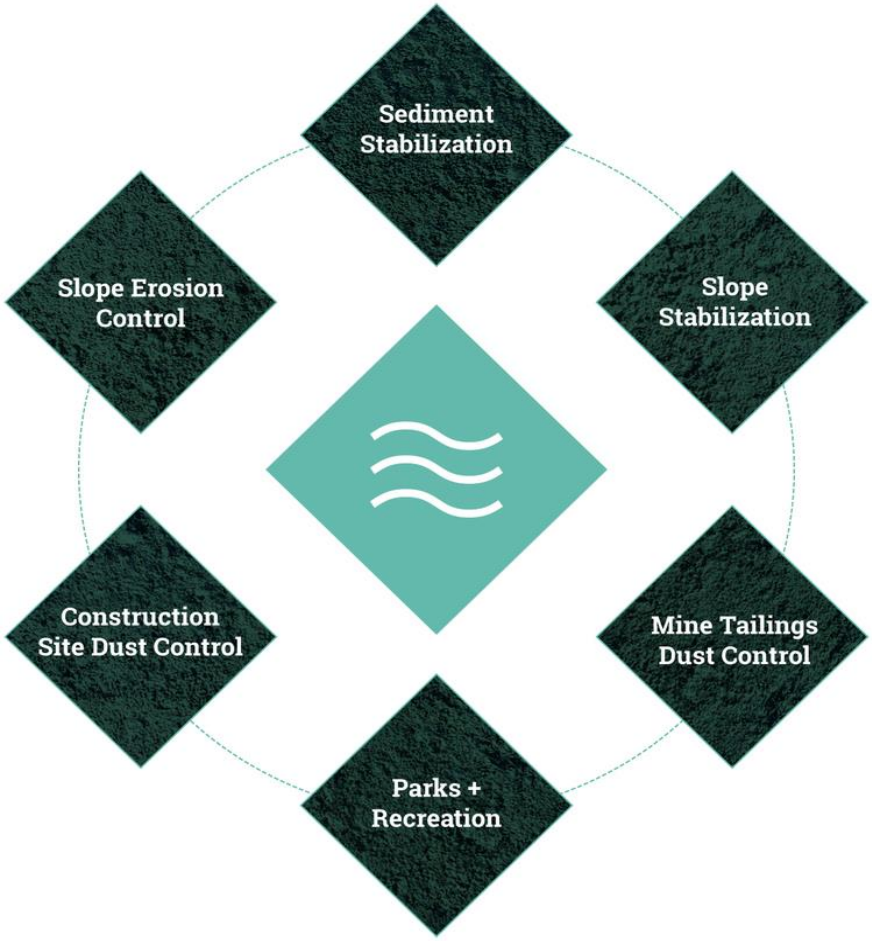
Category	Sub-Category	Use
Water and water with surfactants	Water	▪ Short-term dust control
	Water with surfactant	▪ Short-term dust control
Water absorbing	Calcium chloride	▪ Fines preservation/dust control
	Magnesium chloride	▪ Fines preservation/dust control
	Sodium chloride brine	▪ Fines preservation/dust control
Organic non-petroleum	Glycerin/glyceride based	▪ Fines preservation/dust control
	Lignosulfonate	▪ Fines preservation/dust control
	Molasses/sugar	▪ Fines preservation/dust control
	Plant oil	▪ Fines preservation/dust control
	Tall oil pitch rosin	▪ Fines preservation/dust control
Organic petroleum	Asphalt emulsion	▪ Stabilization/all-weather passability if mixed into top 6 in. (150 mm) ▪ Fines preservation/dust control
	Base and mineral oils	▪ Fines preservation/dust control
	Petroleum resin	▪ Fines preservation/dust control ▪ Stabilization/all-weather passability if mixed into top 6 in. (150 mm)
	Synthetic fluid	▪ Fines preservation/dust control
	Synthetic fluid plus binder	▪ Fines preservation/dust control ▪ Stabilization/all-weather passability if mixed into top 6 in. (150 mm)
Synthetic polymer emulsion	Typically polyvinyl acrylate, polyvinyl acetate, polyvinyl chlorate, or styrene-butadiene-styrene based	▪ Fines preservation/dust control ▪ Stabilization/all-weather passability if mixed into top 6 in. (150 mm)
Concentrated liquid stabilizers	High acidity	▪ Stabilization/all-weather passability if mixed into top 6 in. (150 mm)
	Low acidity/enzyme	▪ Stabilization/all-weather passability if mixed into top 6 in. (150 mm)
Mechanical stabilization	Bentonite or suitable locally available clay	▪ Mechanical stabilization ▪ Fines preservation/dust control

CONSIDERING ENVIRONMENT FRIENDLY

Synthetic fluid	▪ Must meet EPA environmental-based criteria for synthetic (sediment toxicity, biodegradability, PAH content, aquatic toxicity, and oil sheen free) ▪ Impacts to water quality: none. May be a concern if large volumes are spilled ▪ Impacts to fresh water aquatic biota: none ▪ Impacts to plants: none ▪ Impacts to mammals: none ▪ Potential concerns with spills
Synthetic fluid plus binder	▪ Impacts are dependent on specific binder chemistry but combination usually still meets EPA environmental based criteria for synthetic ▪ Impacts to water quality: none expected ▪ Impacts to fresh water aquatic biota: none expected ▪ Impacts to plants: none expected ▪ Impacts to mammals: none expected ▪ Potential concerns with spills
Typically polyvinyl acrylate, polyvinyl acetate, polyvinyl chlorate, or styrene-butadiene-styrene based	▪ Limited documented research on environmental impacts ▪ Impacts are dependent on specific product chemistry ▪ Chemical analysis and results of environmental testing from an accredited laboratory should be requested ▪ Impacts to water quality: none expected. May be a concern if large volumes are spilled. ▪ Impacts to fresh water aquatic biota: none expected ▪ Impacts to plants: none expected ▪ Impacts to mammals: none expected ▪ Potential concern with spills

EXAMPLE OF SUPPRESSANTS - ECOANCHOR*

- EcoAnchor is in a form of liquid copolymer
- Environment friendly
- Designed for **non-traffic** erosion and dust control
- Hydraulically applied for erosion control and dust suppression.
- Outperforms traditional methods, including erosion blankets-and it does so at a fraction of the cost.



**Disclaimer: Does not represent any commercial products for sale or promotion.*

GERMINATION FIELD TESTS – ECOANCHOR*

- TRI/Environmental, Inc. (TRI) performed biotic soil amendment testing (2017-2018).

Germination / Vegetation Growth Summary
ASTM D 7322:

STANDARD INDEX TEST METHOD FOR the DETERMINATION of TEMPORARY DEGRADABLE RECP PERFORMANCE IN ENCOURAGING SEED GERMINATION AND PLANT GROWTH

Property	Units	Day	Concurrent Control	2017-2018 Average Control	EcoAnchor	EcoAnchor
					vs. Concurrent Control	vs. 2017-2018 Avg. Control
Seeds Germinated per Area	% of Control	7	100%	100%	222%	568%
		14	100%	100%	122%	160%
		21	100%	100%	124%	121%
Average Plant Height	% of Control	7	100%	100%	-	-
		14	100%	100%	146%	190%
		21	100%	100%	133%	142%
Plant Mass per Area	% of Control	21	100%	100%	158%	196%

**Disclaimer: Does not represent any commercial products for sale or promotion.*

COST-BENEFIT CONSIDERATION - ECOANCHOR*

- EcoAnchor is a hydraulically applied copolymer dispersion designed to control erosion & dust on non-traffic areas. This liquid copolymer creates an environmentally friendly membrane by binding the soil particles together, reducing the turbidity of run-off water.
- Once cured, EcoAnchor's unique membrane structure prevents water erosion, while still allowing moisture and oxygen to permeate through the soil. Soil moisture is also maintained for longer durations, which protects both the soil and vegetation from rapid dehydration.
- **The savings from <u>reducing seed loss due to erosion, promoting germination and reducing dust</u> could largely compensate the cost of dust suppressant applications, from life-cycle point of view.**

**Disclaimer: Does not represent any commercial products for sale or promotion.*

CONCLUSIONS

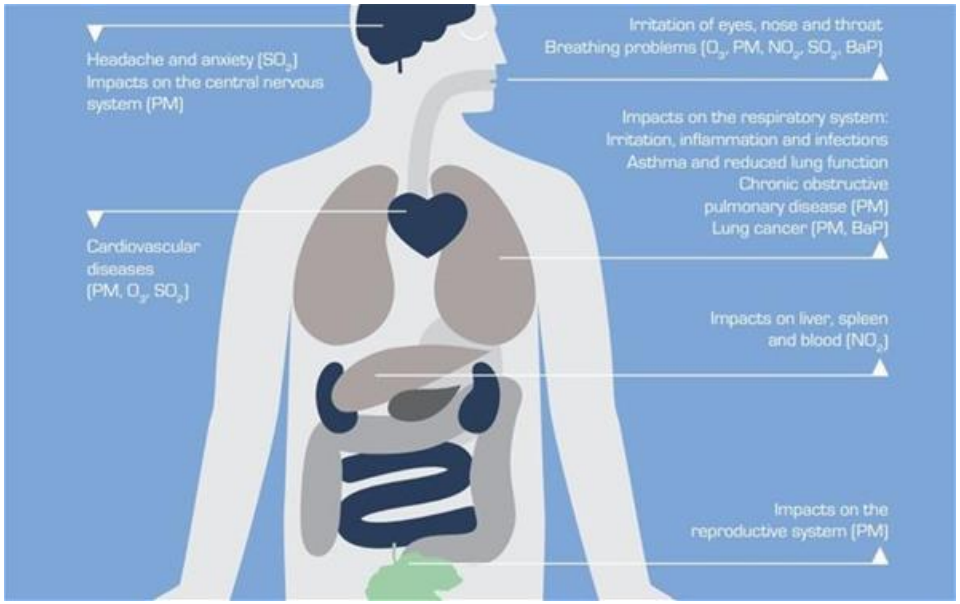
- Dust suppressant is the use of water alone or in conjunction with specialized non-hazardous chemicals to wet and ‘agglomerate’ or bind small particles together preventing them from becoming airborne
- There are many kinds of dust suppressants. To select an appropriate product, consideration should include not only the cost, but also life-cycle cost-benefit from environmental to productivities.
- Recent development of eco-friendly, synthetic polymer or copolymer, synthetic fluid + binder, may provide a new cost-saving option other than traditional water absorbing products (e.g., $CaCl_2$, $MgCl_2$)

ADVANTAGE AND DISADVANTAGE OF DIFFERENT APPLICATIONS

	Pros	Cons
Water	• Least expensive • Limited carryover effect is possible • When good mixture of water and material is possible, quite effective	• Some materials can't tolerate excess moisture or repel water • Can't use in freezing temperatures • Large volumes of water and over wetting is common • Water evaporates – reapplication is necessary
Surfactants	• Efficiency can be higher than water • Equivalent efficiency may be using less water	• Not all materials tolerate surfactants • Material is contaminated with surfactants • Capital, operating and maintenance costs
Foam	• Best efficiency when effective mixing of foam and material can be achieved • Moisture addition is low	• Material is contaminated with foam • Compressed air is usually required • Capital, operating and maintenance costs
Binders	• Eliminates the need for re-application • Better efficiency • Applied at multiple transfer points	• Nozzle and equipment maintenance • Capital, operating and maintenance costs

HEALTH IMPACT

- Exposure to particle pollution is a public health hazard
- When inhaled, particle pollution can travel deep into the lungs and cause or aggravate heart and lung diseases. Exposure to particle pollution causes increases in:
  - Doctor and emergency room visits
  - Hospital admissions
  - Use of prescription medication
  - Absences from work and school



QUESTIONS?

Thank you!