

**Dust Suppression Options
and the
Triple Bottom Line**

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Dust Suppression Options and the Triple Bottom Line

This paper explores the wide variety of dust suppressants used in New Zealand and overseas and outlines pros and cons of these options, including sealing the road. Products discussed in this paper include water, a variety of salts, bitumen emulsions, lignosulphonates, sugar/molasses based products, tall oil emulsions, enzymes, synthetic polymers and clay additives.

Dust from the road represents a loss of road material that will have to be replaced over time and therefore has a cost. The largest driver for dust suppression, however, is the need to reduce adverse environmental impacts. Dust is recognised as a nuisance by most, a health risk by many and has an impact upon agriculture and horticulture production in some areas.

How do we measure the triple bottom line – and who should pay the price for applying dust suppressants?

How effective are the products currently available – and what about the environmental impact of the dust suppressant itself?

Can one product “do it all” – or do you need a suite of products for different situations?

Should Local Authorities take on the responsibility for dust suppression – or is there scope for private enterprise to fill this role?

ISSUES RAISED BY DUST GENERATED FROM UNSEALED ROADS

- Contributes to total airborne particulates
- Causes increased wear and tear on moving parts of vehicles and other machinery
- Reduces visibility and therefore impacts on road safety
- Contributes to health problems such as asthma and irritation of eyes and lungs for people and animals
- Residents complain about dust in their homes, on their washing line and in their water tanks
- Degrades the quality of horticultural produce by covering crops in dust
- Reduces the effectiveness of pest and weed control sprays that cannot penetrate the dust layer
- Stock grazing near roadsides suffer from worn teeth due to the abrasion of the dust on the pasture they eat, resulting in lower stock weight and reduced sale values
- Dust represents a loss of road material and therefore signals deterioration of the road surface
- More dust generated represents higher costs in replenishing road material
- Managing dust issues impacts on the overall road repair and maintenance cost
- Dust and loose unbound road materials contribute to the silting up of waterways and blocking drainage facilities

How do we measure the costs of all these issues – the triple bottom line?

We can measure the costs of replenishing road materials over time and we can measure the cost of repairs and maintenance to the road. But how do we measure the real cost to people's health? What is the real cost to the environment? What is the real cost to farmers in terms of the resale prices of stock and crops?

And the big question – how much money should we spend trying to measure the costs? Maybe some of you will have these answers or be able to draw some conclusions from the debate in this session.

WHAT HAS CREATED THIS DUST PROBLEM AND WHY IS IT GROWING?

We know why and how dust is generated from unsealed roads. Start with a loose surface, apply some traffic to grind down the large particles into fines on the wearing surface and the air currents from fast moving vehicles will produce clouds of it.

The Environmental Protection Agency (EPA) in the USA has published a formula known as AP-42 to estimate dust generation in the particle size range of 10 micron or less. This empirical equation¹ is based on the properties of the road surface material and the number of passing vehicles as well as their speed. The equation is defined as follows:

$$E=5.9K \frac{S}{12} \left(\frac{V}{30}\right) \left(\frac{W}{3}\right)^{0.7} \left(\frac{w}{4}\right)^{0.5} \left(\frac{d}{365}\right)$$

Where:

E = emission factor (lbs/vehicle-mile) of particles 10 microns or less

K = proportionality constant specific to the aerosol size range of emitted particles (0.45 for 10 microns or less)

S = silt content of the road surface material, in percent of sizes smaller than 75 micron.

V = vehicle speed in miles per hour

W = vehicle weight in tons

w = number of wheels on the vehicle

d = number of dry days per year with less than 0.01 inches of rain

Methods developed for measuring dust include sedimentation, filtration and photometric techniques involving a range of sophisticated dust collection devices. While the above equation has been used with success, field studies show that the AP-42 equation could both under- and over-estimate dust emissions from unsealed roads.

Most residents surveyed found it difficult to relate to the results of the mathematical predictive dust emission equation. Residents and road users were able to identify the problem via other means, however:

¹ Effectiveness and Environmental Impact of Road Dust Suppressants, J.Q. Addo & T.G. Saunders, Dept Civil Engineering, Colorado State University

We know why and how and even how much dust is generated from unsealed roads, but the dust has always been there hasn't it? Why are we being pressured to suppress dust now? What has changed?

In the Rodney District, as with other areas, many of our unsealed roads used to service sparsely populated rural areas in the farming heartland of our country. Over the last 10 years many farms have been broken up into lifestyle blocks. The new residents of these areas arrive for a peaceful life in the country without being prepared for the dust – and with an expectation of a high level of service. The extra volumes of new residents increase the traffic volumes on rural routes and this adds to the grinding down of the aggregate and increases the volume of dust generated.

These “new” rural residents typically build their houses close to the road because it costs more to run power and phone lines down a long driveway. In most rural areas it is noticeable that the original farmhouse is built well back off the road, but the lifestyle houses along with their washing lines are built right beside the road. It is therefore predictable that the roof gets dusty, contaminating their water supply and it is not surprising that the washing and the inside of their homes are plagued by dust.

The other point of interest is that demand for dust suppression on unsealed roads tends to be high on the roads with 50 – 150 vpd and not so high on the roads with 150 – 300 vpd. This may be because the busier through roads are not as attractive for lifestyle block owners to live on, however, the dust generated from the higher trafficked routes is still having an impact on the environment and the farming community.

So whose problem is it? Didn't the new rural residents notice that the road wasn't sealed when they brought the property? Should we enforce consent conditions that ensure that houses are built well off the road? Is Council responsible for dust control? We certainly wouldn't be allowed to employ staff to work in a dusty environment without OSH stepping in and making everyone wear masks, or at least trying to reduce the hazard. If it were a workplace we would go through the steps of Eliminate, Minimise, Isolate.....What should a Council do about the dust off the road?

If we look to the USA for examples of who takes responsibility we find that in the State of Idaho, the Department of Environmental Quality² has strict rules about Air Pollution which require that “all reasonable precautions be taken to prevent the generation of fugitive dust.”

Another section of the Idaho Code² addresses the nuisance issue. The code defines a nuisance in part as, “Anything which is injuring to health or morals, or is indecent, or offensive to the senses, or an obstruction to the free use of property, so as to interfere with the comfortable enjoyment of life or property...” Dust from an unsealed road would certainly be considered a nuisance under this definition!

Back to NZ examples, we often see conditions of subdivision consent that require the developer to apply dust suppressant to all haul roads during construction. We have recognised the need to protect the people and the environment from dust generated on private property, so maybe we do wish to employ dust suppressants on public roads?

WHAT ARE THE COMMON TYPES OF DUST SUPPRESSANT AVAILABLE?

- Water
- Chlorides/salts
- Lignosulphonates
- Enzymes
- Bitumen emulsions
- Synthetic polymers
- Sugar/molasses
- Tall oil emulsions
- Clay additives

Soil type, rainfall, traffic speed and the number of heavy vehicles on the road influence the performance of each of these. Some of the sales brochures for these products sound impressive, quoting several months of effective dust suppression from just one application – but in some cases you find that the trial site used was in the desert and the product actually gets washed away in higher rainfall environments.

HOW DO DUST SUPPRESSANTS WORK?

The common mechanisms are:

- Surrounding and adhering to adjacent particles making it difficult to dislodge them
- Attracting and trapping moisture from the air to keep the road surface moist
- Acting as a wetting agent/dispersant for the clay, making the clay more plastic and more dense
- Increasing the weight of the dust particles so they don't transport through the air as readily
- Resisting wear from traffic
- Increasing the water resistance of the road surface to stop water damage to the road

² Manual for Managing Dust on Unpaved Roads for the Local Highway Jurisdiction of Idaho, March 2001

ENVIRONMENTAL IMPACTS OF THE DUST SUPPRESSANT

Any suppressant ingredient may migrate into the environment due to:

- Carelessness during application/spills
- Run off/leaching from the road into waterways
- Dust particle drift once the surface does start to break up
- Adhesion onto vehicles

The main concern is the impact on:

- a) Groundwater quality – this depends on the permeability of the soil type, which varies considerably between sandy soils and clay soils. Sampling and testing of ground water can determine levels of toxins present.
- b) Plant life – measured by observation only.
- c) Freshwater aquatic environment – this is measured by the “toxicity to fish” (LC50) rating on the Safety Data Sheet of each product. The LC50 is the lethal concentration of product in ppm that will produce a 50% mortality rate in the test group in 96 hours. The larger the concentration the less toxic the material. An LC50 of less than 100ppm is considered toxic; an LC50 of 1000ppm is considered practically non-toxic and ; an LC50 of greater than 10,000 is totally non-toxic.

Note on salts: When used for de-icing roads in winter there is a large dilution factor, but during summer with low rainfall, salts leach into the ground water in high concentrations and have potentially high impacts on plant life.

COMPARISONS OF DUST SUPPRESSANT TYPES

Water

- Water cart spray application
- Agglomerates surface particles together
- Evaporates quickly - controls dust for less than a day
- No environmental impact

Calcium, Magnesium or Sodium Chloride

- Water cart spray application
- Needs high humidity environment to agglomerate surface particles together
- Corrosive to plant and vehicles
- Adverse impact on fresh water aquatic environment and plant life
- Concern with spills of liquid concentrate into waterways
- Effectiveness destroyed by rain

Lignosulphonates

- Water cart spray application
- Binds surface particles together
- Good penetration into road surface
- Increases strength of road material – resistant to load stress
- Effectiveness destroyed by heavy rain – soluble in water
- No impact on water quality or plant life
- Biodegradable

Enzymes

- Stabilising machinery to mix in to road surface – increased application costs
- Organic strengthening of road surface
- Needs 4 days of no traffic to harden – road closures required
- Effectiveness destroyed by heavy rain
- Environmental impact unknown - none expected

Bitumen Emulsions

- Water cart application
- Binds surface particles with asphalt adhesive properties
- Serves to waterproof the road
- Forms a crust which breaks up under shear forces of traffic
- Potentially toxic to environment

Synthetic Polymers

- Water cart application
- Binds surface particles with polymer adhesive properties
- Serves to waterproof the road
- No environmental impact for water or plant life

Tall oil derivatives

- Stabilising machinery/mix in with grader – increased application costs
- Adheres surface particles together
- Increases strength of road material under dry conditions
- Effectiveness destroyed by heavy rain – water soluble
- Potential environmental impacts on water and plant life

Clay additives

- Grader required to mix into road surface
- Agglomerates with fine dust particles
- Treated surface becomes slippery when wet
- No known environmental impacts

HOW LONG DO DUST SUPPRESSANTS WORK?

It depends. There are huge variables determined by rainfall and traffic volume, speed and percentage of heavies. The choice of product and how long it lasts will depend on your particular network climate and geography. Below are some guidelines:

- Extra shear forces exist from traffic on steep and windy sections of road, these forces will break the surface crust of a bitumen emulsion.
- In areas of medium to high rainfall many dust suppressant types will be washed off the road or will leach into waterways. For these areas choose a product with water resistance such as bitumen emulsion or a synthetic polymer.
- For long term dust suppression the road surface needs to resist damage from water and traffic, otherwise dust suppressant will be lost in next maintenance grading cycle.

- Light rainfall can have the effect of ‘rejuvenating’ the effectiveness of many dust suppressants, giving just enough moisture to help vehicular compaction of the surface.
- Cost of individual products vary, but the major influence on costs is the application method (plant and labour costs). If dust suppressant is being applied as part of maintenance cycle and grader/stabiliser will be on site then products that require this mixing into the road surface may be used economically. Cheapest application method from products that are sprayed from a water cart only.

ADDED BENEFITS TO AIM FOR

The ideal situation is to find a product that will also do the following:

- Sufficient reduction in dust to give better visibility to drivers, increased level of road user comfort and reduction in adverse impacts on health and environment.
- Surface is bound up, so no loose aggregate being thrown off the road into the watercourses by traffic.
- The hard, firmly bound surface eliminates sliding hazards of loose gravel and therefore increases safety factors on the unsealed network.
- Increased water resistance of road surface reducing water damage to road and therefore longer time between maintenance cycles - achieve watershed instead of mud patches.
- Surface is more resistant to wear – less road material to be replaced, material costs reduced.
- Stable surface will delay the formation of potholes and corrugations resulting in better driver comfort and reduced maintenance costs.

UNSEALED ROADS WITH OVER 250VPD

- For these higher volume unsealed roads, dust is a small issue compared to other maintenance issues.
- Benefits described above are unlikely to be achieved at these higher traffic volumes.
- Frequent pot-holes and corrugations reduce road user comfort and increase wear and tear on vehicles.
- Overall cost of maintenance is high.
- Probably need to grade every month to maintain surface in acceptable condition.
- Dust suppressant applications will be lost each grading cycle. Could choose lowest cost product and just reapply every month, but this would increase overall maintenance costs.
- What is the cost of customer dissatisfaction?

THE CASE FOR LOW COST DUST SEAL

- Sweeten and seal options – can we just seal what is there?
- Review of Engineering Standards – road width issues for ‘low volume’ roads
- Impact of seal on traffic speed and safety – geometrics and delineation factors
- Community support – willingness of community to depart from standards to get their road sealed.

WHO PAYS?

- Council?
- Contributions from subdivision development – are these enough?
- Cost sharing between Council and “self-help” residents?
- User-pays – residents or road users?

WHO BENEFITS?

- Residents
- Travelling public
- Commercial transport operators
- Farmers
- The environment

IS THERE ROOM FOR PRIVATE ENTERPRISE?

Some Local Authorities have decided on a total user-pays philosophy and will organise a local contractor to apply dust suppressant if the resident is willing to pay 100% of the costs. If this approach is adopted, is there a need for Council to be involved at all? Should we be encouraging private enterprise?

Local contractors could market dust suppression services to the public, or, the local farmer could buy the concentrate, mix it up and spray it out of the boom attached to his tractor. Perhaps a whole new franchise could evolve?

BUT – do we let anybody apply dust suppressant on “our” roads? Who controls the environmental impact of the product they use? Does the contractor ensure environmental compliance? Who monitors this? Maybe we only let ‘approved contractors’ apply products on our roads? What about the impact of the next grading cycle on recently treated roads? Who administers this?

YOU CHOOSE

Do you have the data or the time to measure and fully understand the “Triple Bottom Line”? From all the negative impacts arising from dust and the positive impacts of controlling dust is there enough Triple Bottom Line incentive to act?

Product selection, physical work and payment methods can be carried out by Council, by the Council nominated contractor or by private enterprise. How much control do you want to have? Which product will work for your network? Who should do it?

Does Council have a responsibility to control how much dust impacts on the environment and on the public? Is this just another ‘level of service’ agreement that needs to be defined in maintenance contracts? Do we want to take advantage of the other benefits associated with lower losses of road material? Are there some roads that should just be sealed? To what standard?

You choose. Thank you.