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NZ TRANSPORT AGENCY
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New Zealand Government

Cost-effective options for reducing the impacts of dusty rural roads

Research provides a framework for assessing the health risk of dust from unsealed roads and identifying appropriate dust mitigation.

The research project, which involved a two-month monitoring campaign, showed dust levels arising from vehicle traffic along an unsealed road were greater than background dust levels, at a distance over 80m from the road. The fine-particulate component of dust is of particular concern to human health.

The project also involved a dust suppression trial, with the results from this and the monitoring used to develop a dust risk and mitigation decision framework. Local authorities can use the framework when deciding whether to take steps to mitigate dust emissions from unsealed roads, including assessing the best mitigation options for the site, and weighing up the costs and benefits involved.

The issue

Around 40% of New Zealand's road network is estimated to be unsealed roads. In general, unsealed roads service sparsely populated rural areas, with a greater proportion of the roads in these districts remaining unsealed.

However, the recent increase in lifestyle blocks in rural areas has meant a greater number of people are being exposed to dust from unsealed roads, especially as, for economic reasons, new houses tend to be built closer to the road than traditional farm houses. As a result, district health boards and local residents are expressing concern about the health impacts of exposure to dust from roads, encouraging local authorities to consider their options.

Health concerns are not the only adverse effect that can arise from unsealed roads. Dust, generated mainly by the action of vehicle wheels, especially during periods of dry weather, can also have nuisance and ecological impacts. Dust soiled surfaces, both inside and outside buildings, reduce amenity values, and dust is known to interfere with the photosynthesis process in plants, with ramifications for the horticulture and forestry sectors, and the environment.

Nuisance dust is typically made up of larger size particles, referred to as total suspended particulate (TSP). TSP are those particles with an aerodynamic diameter of up to 100 microns. The finer size dust particles, with an aerodynamic diameter of less than 10 microns (referred to as PM10) are the ones that raise concerns with regards to health. Potential health effects from prolonged exposure to high levels of PM10 include coughs, bronchitis, exacerbation of asthma, and other respiratory and cardiovascular-related complaints.

The research

The primary purpose of the research, undertaken by Golder Associates (New Zealand), was to improve the understanding of the impacts that dust emissions from unsealed roads have on people, and to provide a framework for assessing dust risk and identifying sustainable and cost-effective dust mitigation measures.

The Far North District was selected as the location for the monitoring and dust suppression trial. The Far North District Council area has one of the highest proportions of unsealed roads in the country, with around 1,800km of its 2,542km of roads remaining unsealed (71%).

Monitoring was carried out between February and April 2015 on a section of unsealed road 10km south of Kaikohe, with data about meteorological conditions at the site and traffic types and frequencies collected throughout.

The monitoring aimed to collect representative data on dust levels and the extent of the dust plume arising from the roads, and to assess the effectiveness of a dust suppressant. Monitoring was also undertaken to measure nuisance dust deposition rates.

A network of optical nephelometers was used to measure PM10 dust concentrations in air. This method allowed dust data to be recorded on a fine temporal scale and to be collected at distances of up to 100m from the roadside at locations around the trial area. Supplemental beta-attenuation monitoring was also undertaken to calibrate the nephelometer data. In addition, a network of deposition gauges was deployed to measure TSP at 5m from the road and at a background location (80m from the road).

The effectiveness of the dust suppressant was assessed by monitoring dust along a transect adjacent to a section of road treated with a dust suppressant and comparing it with data collected from an untreated section of road. A magnesium chloride dust suppressant was selected, due to its relative ease of application, and continuing effectiveness over time and in differing traffic and weather conditions.

Dust levels – untreated road section

The measured dust deposition rates at a distance of 5m from the road were between 4 and 12 times higher than the Ministry for the Environment's trigger level ($4g/m^2$/month, above background levels) for dust nuisance. However, it is unlikely receptors would be typically located that close to an unsealed road.

The PM10 concentration exceeded the threshold concentration of the National Environmental Standard during 15 of the 52 days monitored (approximately 30% of the days) at a location representative of typical rural-residential setbacks (approximately 30m) from the road. The measured dust plume (PM10 levels above background) extended a distance greater than 80m from the road.

Dust levels – treated road section

The PM10 plume from the treated section of the road extended for less than 30m (compared with over 80m for the untreated section). The PM10 concentrations did not exceed the threshold concentration of the National Environmental Standard at the monitoring location 30m from the treated section of the road during the monitoring period (compared with 30% of the days for the untreated section).

Dust deposition rates measured at a distance of 5m from the treated section of the road were similar to background levels, suggesting the suppressant was effective and acted to reduced nuisance dust levels even close to the road source.

From this, the research team concluded the dust suppressant was effective at mitigating both nuisance and fine-particulate dust discharges from roads. What is more, the effectiveness of the dust suppressant did not appreciably decrease over the two-month duration of the monitoring programme.

The dust risk assessment and mitigation decision framework

A principal outcome of the research was a framework that road controlling authorities can use to support their decision making around whether to mitigate dust from unsealed roads. Three key questions for authorities to ask are:

- Do we need to mitigate road dust?
- What mitigation options are suitable for the site?
- Which mitigation option provides the best benefit-to-cost outcome?

Application of magnesium chloride to Mataraua Road

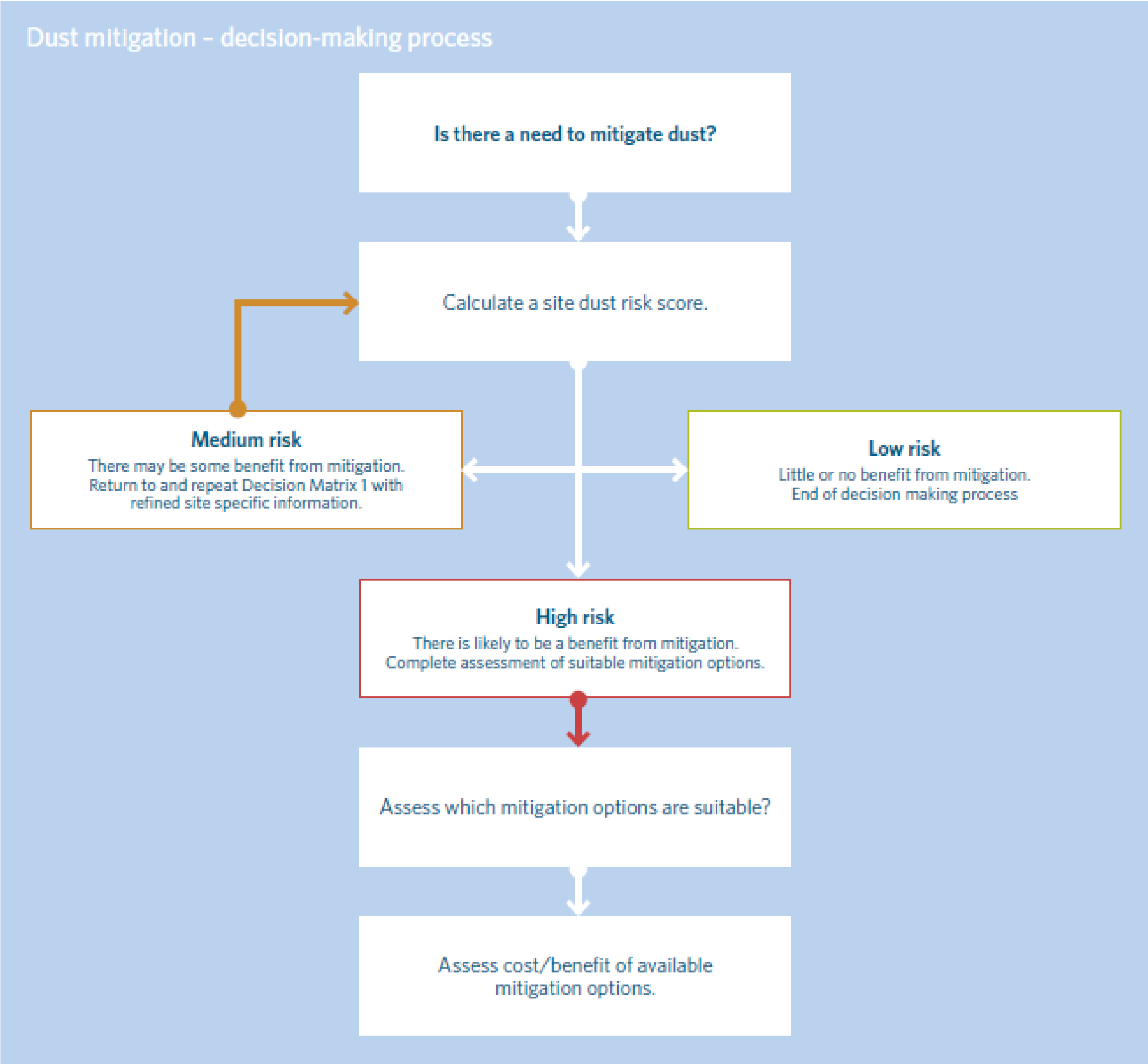
The framework, and its associated tools, enable these questions to be answered.

The first question (need) is answered by calculating a site dust risk score for a particular section of road. The score categorises sites as low, medium or high risk. Factors taken into account include:

- traffic characteristics (number, nature and speed of vehicles)
- site characteristics (local meteorology and topography)
- the location and number of receptors sensitive to dust (residential dwellings and sensitive ecological or horticultural areas)
- how long significant volumes of heavy vehicle traffic (eg logging trucks) are anticipated to operate in the area.

For high-risk sites, assessment criteria are then provided to answer the second question as to which (if any) dust mitigation measures are suitable.

Once the best option or options have been identified, guidance is provided on how to undertake a basic cost-benefit assessment with respect to them. This assessment monetises the health benefit of dust mitigation using a New Zealand health effects model, and compares it with the implementation cost. The health benefit is directly related to the population density adjacent to the road and the effectiveness of the dust mitigation measures.


Dust mitigation – decision-making process
Is there a need to mitigate dust?
Calculate a site dust risk score.
Medium risk
There may be some benefit from mitigation. Return to and repeat Decision Matrix 1 with refined site specific information.
Low risk
Little or no benefit from mitigation. End of decision making process
High risk
There is likely to be a benefit from mitigation. Complete assessment of suitable mitigation options.
Assess which mitigation options are suitable?
Assess cost/benefit of available mitigation options.