Impacts of exposure to dust on unsealed roads

Jeff Bluett, Golder Associates
Context – The Unsealed Environment

Unsealed Roads (km)

- Far North District Council: 853 km
- Wairoa District Council: 641 km
- Marlborough District Council: 550 km
- Hurunui District Council: 1,800 km

Percent of Roads that are Unsealed

- Far North District Council: 59%
- Wairoa District Council: 42%
- Marlborough District Council: 66%
- Hurunui District Council: 71%
Dust from Unsealed Roads?

- What are the **RISKS**?
- What are the options for **MITIGATION**?
- What is the **BENEFIT/COST** of mitigations?
- Management tools?
An **important note** for the Audience

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Research objectives

1. Describe and quantify the impacts of dust exposure from unsealed roads
2. Collect new data to characterise the dust and quantify the impacts of dust
3. Investigate dust mitigation measures.
4. Estimate the costs of the health impacts and the benefits of mitigating the dust
5. Tools to support decision making about mitigation options.

December 7, 2017
Monitoring Site Location:

- **Number and type of vehicles** passing the site each day
- Number of **nearby dwellings**
- **Topography and meteorology** (maximum frequency of cross-road winds).
- **Cell phone coverage** (ability to telemeter the data from site).
- **Suitable locations to install equipment** on roadside (requires permission from private land owners).
- **Power supply available** for equipment (solar powered equipment more expensive to install and problematic to run).

Potential sites in the Far North District:
- Ngapipito Road
- Pipiwai Road
- Mataraua Road
- Piccadilly Road
Monitoring Site Location
Site geology, roadway construction and traffic

- Base geological material is **sedimentary rock**
- The **design and construction** is typical of other unsealed **roads** within the Northland Region.
- The **maintenance schedule** is typical of other unsealed roads in the FNDC.
- **Metal** used to cover the road bases in Northland **varies from road to road** with metals being supplied from close by sources.
- Logging **truck numbers are relatively high**
Monitoring equipment - Dust
Dust Suppression
Monitoring site layout and equipment network
Total suspended particulates and PM$_{10}$
Total suspended particulates and PM$_{10}$

- TSP: 68%
- PM$_{10}$: 32%
Untreated section of road
PM$_{10}$ concentrations - untreated

[Graph showing daily PM$_{10}$ concentrations from December 19 to January 6, 2018, with untreated North 5m and Untreated North 30m data.]
PM$_{10}$ concentrations - untreated

Table 4-1 Summary statistics for daily average PM$_{10}$ monitoring - untreated section of the road

<table>
<thead>
<tr>
<th>Site</th>
<th>Number of days with data</th>
<th>Number of days with PM$_{10}$ concs. &gt;50 μgm$^{-3}$</th>
<th>Campaign average PM$_{10}$ conc. (μgm$^{-3}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated north - 5 m</td>
<td>52</td>
<td>25</td>
<td>83</td>
</tr>
<tr>
<td>Untreated north - 30 m</td>
<td>52</td>
<td>15</td>
<td>47</td>
</tr>
<tr>
<td>Untreated south - 5 m</td>
<td>45</td>
<td>19</td>
<td>101</td>
</tr>
</tbody>
</table>

- Non-NES compliant monitoring method
- Results indicative rather than definitive
- PM$_{10}$ NES exceeded one day in two on the non-treated section of the road at the roadside
- PM$_{10}$ NES exceeded on one day in three the non-treated section of the road at typical exposure locations
Treated section of road
Non-NES compliant monitoring method
- Results indicative rather than definitive

**PM$_{10}$ NES were exceeded at the roadside** of the treated section of the road infrequently, **one day in 15**

**PM$_{10}$ NES is not exceeded on the non-treated** section of the road at typical exposure locations

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**PM$_{10}$ concentrations - treated**

<table>
<thead>
<tr>
<th>Site</th>
<th>Number of days with data</th>
<th>Number of days with PM$_{10}$ concs. $&gt;50$ $\mu$g$\cdot$m$^{-3}$</th>
<th>Campaign average PM$_{10}$ conc. ($\mu$g$\cdot$m$^{-3}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treated north - 5 m</td>
<td>47</td>
<td>3</td>
<td>24</td>
</tr>
<tr>
<td>Treated north - 30 m</td>
<td>55</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>Treated south - 5 m</td>
<td>47</td>
<td>4</td>
<td>26</td>
</tr>
</tbody>
</table>
Vehicle speed as a dust mitigation measure
Respirable silica

- Potentially hazardous components of road dust
- Sampling undertaken at untreated, north 5 m site
- Simple pump and filter set up

- Mass of respirable silica were below the detection limit
- Preliminary conclusion - residents of Mataraua Road are unlikely to be exposed to annual average concentrations of greater than 5 µg/m³.
- To confirm this conclusion, a more detailed monitoring programme of longer duration would be required.
Dust mitigation 1: Effectiveness of dust mitigation

![Box plot showing the effectiveness of dust mitigation.](image)

- **Untreated**
  - 1st Quartile: 37.6 μg/m³
  - Median: 103.0 μg/m³
  - 3rd Quartile: 180 μg/m³

- **Treated**
  - 1st Quartile: 27.4 μg/m³
  - Median: 20.6 μg/m³
  - 3rd Quartile: 27.4 μg/m³

Note: Top error bars represent 90th percentile values. Bottom error bars represent minimum values.
No sign of reduced effectiveness of suppressant over the life of the monitoring programme.

Qualitative assessment (multivariate statistics could be employed)
Method to Assess health impacts of changes in PM$_{10}$ concentrations

- Assess annual PM$_{10}$ exposure (Mataraua Road data)
  - Untreated road (Baseline)
  - Treated road
  - Sealed road
- Calculate the health cost of dust exposure (HAPINZ)
  - Untreated road (Baseline)
  - Treated road
  - Sealed road
- Calculate the health benefits of mitigation
  - Baseline cost - Treated road cost
  - Baseline cost - Sealed Road cost
Calculating the costs of mitigation

- Baseline (untreated an unsealed road)
  - Maintenance (grading and metal)
- Treated road
  - Chemical suppressant
  - Maintenance (grading and metal)
- Sealed road
  - Sealing
  - Maintenance
### Benefit to cost ratio of dust mitigation

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Annual av. PM$_{10}$ conc. (µg/m$^3$)</th>
<th>Annual health cost ($000)</th>
<th>Annual health benefit of PM$_{10}$ mitigation ($000)</th>
<th>Annual roading costs ($000)</th>
<th>Annual additional cost of M&amp;M$^a$ ($000/km)</th>
<th>Benefit/cost ratio (mitigation vs no mitigation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unsealed and untreated road</td>
<td>~2</td>
<td>41</td>
<td>NA</td>
<td>10</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Unsealed and treated road</td>
<td></td>
<td></td>
<td>17</td>
<td>$20.2</td>
<td>15</td>
<td>1.2</td>
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<tr>
<td>Sealed road surface (40-yr life)</td>
<td></td>
<td></td>
<td>29</td>
<td>$20.6</td>
<td>$15.4</td>
<td>1.9</td>
</tr>
<tr>
<td>Sealed road surface (10-yr life)</td>
<td></td>
<td></td>
<td>29</td>
<td>$37.9</td>
<td>$32.7</td>
<td>0.9</td>
</tr>
</tbody>
</table>

(a) M&M = maintenance and mitigation

December 7, 2017
Dust mitigation - decision making process

Figure 7.1 Dust mitigation - decision making process

- Is there a need to mitigate road 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
Release of an approved methodology for assessing the merits of undertaking dust mitigation and how this fits within the investment assessment process for the Road Maintenance Activity Classes.

**HOW COULD DUST MITIGATION BE FUNDED IN THE NLTP?**

RCAs will be responsible for determining the optimal balance of the scope, timing and expenditure within their approved road maintenance allocation. Please discuss any proposed dust mitigation within your current approved road maintenance allocation (2015 – 2018) and the impacts on your wider network maintenance programme with your Regional Planning and Investment staff.

Should an RCA determine there is merit in investing in dust mitigation but that it does not have the ability to fund this within the current approved maintenance allocation then a cost scope adjustment must be applied for in the usual way. As with all cost scope adjustments the ability of the Transport Agency to support the request for additional funding in part or full will be subject to the ability of the Transport Agency to support the request for additional funding in part or full will be subject to there being a robust case (based on the attached methodology and NPV calculation) for investment and funding being available in the relevant activity classes.

Requests for funding assistance for dust mitigation in future NLTPs will be considered as part of the overall road maintenance negotiations with each RCA and will be subject to all the applicable funding criteria for the relevant NLTP.

Any investment through the NLTP in dust mitigation will be at the RCA’s normal funding assistance rate.
Assessing the Dust Risk

100% (1870 km) of roads have a risk score ≥ 6

17% (320 km) of roads have a risk score ≥ 15

8% (155 km) of roads have a risk score ≥ 16
Dust risk mapping
Road Construction Planning Tool (source UCPRC)

- **Shrinkage product**: Increasing plasticity
- **Grading coefficient**: Increasing coarseness / increasing gap

- **0** to **365**
  - **0** to **100**: Erodible
  - **15** to **35**: Corrugates and ravels
  - **15** to **365**: Really good
  - **35** to **365**: Good but dusty
  - **35** to **100**: Slippery and dusty
  - **100** to **240**: Ravels
  - **240** to **365**: Increasing plasticity

December 7, 2017
Chemical Suppressant Selection Tool: source UCPRC

Unpaved Road Chemical Treatment Selection Tool

Roadway Parameters
- Traffic (AADT)
- Climate
  - < 100
  - Damp

More Than 10% Trucks
Steep Grades
Sharp Curves

Environmental & Other Influences

Material Test Results
- %Passing 25: 100
- %Passing 0.425: 25
- %Passing 4.75: 61
- %Passing 0.075: 16
- %Passing 2.36: 46

Objective
- Short-term dust control (spray-on)
- Long-term fines preservation (spray-on)
- Long-term fines preservation (mix-in)
- Long-term stabilization (mix-in)

Predicted Material Performance for Untreated Road

Treatment Ratings

<table>
<thead>
<tr>
<th>Treatment</th>
<th>TR</th>
<th>CL</th>
<th>PI</th>
<th>FC</th>
<th>HV</th>
<th>SG</th>
<th>SC</th>
<th>Rating</th>
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<tbody>
<tr>
<td>Calcium Chloride</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
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<td>1.0</td>
</tr>
<tr>
<td>Magnesium Chloride</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
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</tr>
<tr>
<td>Glycerin Based</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
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<tr>
<td>Lignosulfonate</td>
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<td>1</td>
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<td>0</td>
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<tr>
<td>Tall Oil</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
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<tr>
<td>Petroleum Resin</td>
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<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Synthetic Fluid</td>
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<td>1</td>
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<td>1</td>
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<td>0</td>
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<td>1.0</td>
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<tr>
<td>Synthetic Fluid + Binder</td>
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<td>1</td>
<td>1</td>
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<td>0</td>
<td>0</td>
<td>1.0</td>
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<tr>
<td>Sodium Chloride Brine</td>
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<td>2</td>
<td>1</td>
<td>1</td>
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<td>0</td>
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<tr>
<td>Molasses/Sugar</td>
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<td>1</td>
<td>2</td>
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<tr>
<td>Plant Oil</td>
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<td>1</td>
<td>2</td>
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<td>2.0</td>
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<tr>
<td>Base Oil</td>
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<td>1</td>
<td>2</td>
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<td>0</td>
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<tr>
<td>Synthetic Polymer</td>
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<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2.6</td>
</tr>
<tr>
<td>Asphalt Emulsion</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3.0</td>
</tr>
<tr>
<td>Water</td>
<td>3</td>
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<td>3</td>
<td>3</td>
<td>3</td>
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<td>NA</td>
<td>NA</td>
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<tr>
<td>Water + Surfactant</td>
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<td>3</td>
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<td>0</td>
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<td>NA</td>
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<tr>
<td>Concentrated Liquid Stabilizer</td>
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<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>0</td>
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<tr>
<td>Bentonite</td>
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<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>NA</td>
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</tbody>
</table>
Resource Repository (soon to be available).

Welcome to the City and County Pavement Improvement Center (CCPIC).

The City and County Pavement Improvement Center (CCPIC) hosted by the University of California Pavement Research Center is dedicated to increasing pavement knowledge and technical capability among local government technical staff, planners, and managers by providing timely, relevant, and practical technical support, training, research, publication, and outreach.
Acknowledgements

- **NZTA:** Funding – Research project TAR14/31.
- **Project Steering Group:** Rob Hannaby (NZTA), Jon Cunliffe (Marlborough District Council), Frances Graham (Ministry for Health) Greg Haldane (NZTA) and Iain McGlinchy (Ministry of Transport)
- **Far North District Council:** for hosting the dust monitoring programme.
- **Transfield Services:** (Mike Grimshaw, Far North Branch) for applying the dust suppressant.
- **Air Quality Limited:** (Mark Bart and Paul Baynham) For commissioning and operation of the equipment and processing the monitoring data.
- **Dust Control Solutions:** (Anthony Stewart) for advice on dust suppressant type and for supplying the dust suppressant.
- **Equipment hosts:** Kaingahoa Marae (Jane Whiu), Tasha Whiu, Doug Boyd, Colin Pinkney for hosting the monitoring equipment on their Mataraua Road properties.
- **Northland Regional Council:** for assistance with clarifying the activity status of applying the dust suppressant
Questions?

It's QUESTION TIME!!