Chief Scientist & Engineer

# Initial Report on the Independent Review of Rail Coal Dust Emissions Management Practices in the NSW Coal Chain

## NSW Chief Scientist & Engineer

November 2015

NSW GOVERNMENT | Chief Scientist & Engineer

The Hon. Mark Speakman SC MP
Minister for the Environment
Minister for Heritage
Assistant Minister for Planning
52 Martin Place
SYDNEY NSW 2000

Dear Minister,

**Initial Report – Independent Review of Rail Coal Dust Emissions Management Practices in the NSW Coal Chain**

In September 2015 you requested that I undertake a review of coal dust emissions management practices, in line with the Terms of Reference, with an initial report to be provided in November.

The first phase of the Review has been completed and the initial report is attached.

This part of the Review focused primarily on scoping the problem and understanding the issues, including community concerns, scientific knowledge, initiatives in NSW and other jurisdictions, and gaps in knowledge.

In doing this, the Review consulted with community groups, industry, regulators and academics, as well as undertook an extensive review of available literature.

The second phase of the Review will focus on ways on specifying in detail how to find solutions to the key questions identified in this Report.

In the meantime, should you or your staff have any questions, please contact Dr Chris Armstrong, Director, Office of the Chief Scientist & Engineer on (02) 9338 6745 or chris.armstrong@chiefscientist.nsw.gov.au

Yours sincerely,

Digitally signed by Mary O'Kane
Date: 2015.11.30 11:23:19 +11'00'

**Mary O'Kane**
**Chief Scientist & Engineer**
30 November 2015

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# EXECUTIVE SUMMARY

In September 2015 the Minister for the Environment asked the Chief Scientist & Engineer to conduct an independent review of rail coal dust emissions management practices in the NSW Coal Chain (the Review). The Review is part of the Government's response to the NSW Legislative Council Inquiry into the performance of the NSW Environment Protection Authority. This is the initial report of that Review.

Community members and groups expressed concerns to the Legislative Council Inquiry and other reviews about the environmental and human health impacts of dust and particle emissions associated with the NSW coal supply chain, particularly in the Hunter region. These concerns in part relate to dust and diesel emissions from coal trains that connect the region's mines to the Port of Newcastle and the effectiveness of current monitoring and management practices.

This initial Report attempts to settle whether there is a problem or not, the nature of the problem if there is one, and what needs to be done to settle the matter if the situation is uncertain.

The Review scoped the scale and nature of the issues through consultations with community and industry stakeholders, together with a review of available literature. This included studies undertaken locally and internationally to identify the sources of coal loss and emissions in the rail corridor, possible mitigation strategies and analyses of gaps in our knowledge and understanding.

What became evident to the Review from the outset is that there has been a substantial set of activities undertaken over a number of years in the Hunter rail corridor both to measure and to reduce dust and particulates. However there are no existing studies or sets of studies available to date that that can definitely determine if there is a problem. The available studies provide partial information about specific issues.

The gaps in our knowledge exist around localised emissions in and near the rail corridor. Studies indicate that there are increased levels of dust in the rail corridor when some trains pass; but less well understood is the composition of the dust, its source, quantity, concentration and pattern and distance of dispersal.

To address the Terms of Reference fully the Review concludes from its work to date that there are two main questions that need to be answered. These questions are as follows:

1. Is there anywhere in or near the rail line where air quality exceeds Australian standards and, if so, what is the shape and nature of the air particulate profile of the region near the rail line and are the levels higher at all times or in certain time periods?
2. And then, are there any mitigation techniques that would ensure the air quality within this region near the rail line stays within the regulation levels?

In the next phase the Review will investigate in more detail how these questions can be answered.

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# 1 INTRODUCTION

In June 2014 a Legislative Council Inquiry was established by the General Purpose Standing Committee No. 5 to measure the performance of the NSW Environment Protection Authority (EPA) against its objectives under the *Protection of the Environment Administration Act 1991* (NSW)(General Purpose Standing Committee No. 5, 2015).

In the Inquiry's Recommendation 7, it recommended that should the Chief Scientist & Engineer suggest all coal trains be fully covered and all empty wagons be washed to reduce coal dust emissions, the EPA amend the relevant licenses to adopt the Chief Scientist & Engineer's recommendation.

The NSW Government in August 2015, in responding to the Inquiry's Recommendation 7, indicated that "The Chief Scientist & Engineer has agreed to undertake a review of rail coal dust emissions management practices. This will include review of the work the EPA has undertaken in relation to coal dust emissions along the rail corridor in the Hunter Valley, as well as review of environmental monitoring, the literature, and the environmental management practices of operators using the rail network"(NSW Government, 2015).

In September 2015 the Minister for the Environment provided the Terms of Reference for the Independent Review of Rail Coal Dust Emissions Management Practices in the NSW Coal Chain to the Chief Scientist & Engineer with an initial report due by 30 November 2015. Terms of Reference for the Review are at Appendix 1.

## 1.1 CONTEXT

### 1.1.1 Coal supply chain

The coal supply chain or simply 'coal chain', describes the steps, points and stages in the extraction, processing, transporting, storing and use or export of coal from the mine to a ship or power plant. The coal chain includes mine site, loading, cleaning, transport (via train, truck or conveyor), shore based handling of coal stockpiles and shipping or feeding of coal to power stations. The rail corridor is defined as the region between the loading activities at the mine site (whether the train or other transport is filled with coal) and the location where the train unloads the coal at the export terminal or power plant. An overview of NSW coal mines, including location, type and distance to the export terminal is in Appendix 2, providing an indication of the scale of the relevant regions and coal chains in NSW.

### 1.1.2 Community concerns

To understand community concerns better, the Review studied the submissions to and outcomes of relevant inquiries, reports and submissions from community groups and industry, and met with key stakeholders.

There has been considerable concern in the Hunter community about the human health and environmental impacts of dust and particulate emissions along the coal supply chain – from the point of extraction to transport and unloading at the Port of Newcastle. These concerns include impacts from particulates of different sizes, diesel emissions from locomotives and the significant increase in rail movements that has occurred in the last five years. The latter has taken on additional significance in light of the proposed expansion at the Port of Newcastle.

As noted in many studies of air pollution and health, the interaction between the two is complex and dynamic, reflecting multiple sources, pollutants and exposure levels. The difficulties of quantifying and attributing possible health impacts of the rail corridor in smaller communities in the coal chain have clearly contributed to a sense of frustration in the community.

Questions have also been raised about the effectiveness of current monitoring and mitigation strategies, and whether more could and should be done to protect local residents.

### 1.1.3 Senate Inquiry into the Impacts on Health of Air Quality in Australia

In November 2012, the Senate asked its Community Affairs Committee to inquire and report on the health of air quality in Australia, including the level of particulate matter, its sources and effects; populations most at risk and the causes that put those populations at risk; the standards, monitoring and regulation of air quality at all levels of government; and any other related matters.

A key issue throughout the Committee's inquiry was the potential for coal trains to cause fine particulate and diesel emissions. Evidence presented to the Committee suggested coal trains are a source of pollution; however, the amount and nature of that pollution was a disputed point. The Committee noted dust emissions could also be released during the loading and unloading of coal during transport, whether by truck, train or conveyor.

The pros and cons of a number of mitigation strategies were debated by key stakeholders. The Senate Committee recommended state and territory governments require industry to implement covers on all coal wagon fleets (The Senate, 2013).

### 1.1.4 Legislative Council Inquiry into the Performance of the NSW Environment Protection Authority

As discussed above, a Legislative Council Inquiry was held to investigate the performance of the NSW EPA. It looked at, amongst other things, the EPA's investigations into and public statements about the effects of coal dust pollution in the Hunter.

The Inquiry noted key community concerns, including the potential health and environmental effects of coal dust and other particles produced as a result of mining activity and coal transport; coal dust from trains; and the projected increase in train movements linked to a new coal loader earmarked for the Port of Newcastle.

Submissions to the Inquiry also suggested the EPA had not sufficiently addressed the effects of coal dust pollution, and expressed a lack confidence in the Authority's independence. Some groups alleged that there were alterations to the recommendations in a draft report, conducted by Australian Rail Track Corporation (ARTC) at the EPA's direction, about coal dust emissions generated by rail movements prior to its public release.

While the EPA acknowledged that significant amendments were made to the report, it emphasised that in spite of the amendments made, "both the final draft and final report had the same conclusion: there was no appreciable difference between the dust levels measured from the movement of loaded coal trains and other types of freight trains" (General Purpose Standing Committee No. 5, 2015).

### 1.1.5 National Environment Protection (Ambient Air Quality) Measure (NEPM)

National air quality standards have been in place for over 15 years in Australia and include particulate matter (PM). The issues raised in the Parliamentary inquiries were also canvassed in a 2011 review of the ambient air quality (AAQ) NEPM which made a range of recommendations including improved monitoring in regional areas and research into health impacts of air pollution in regional areas. Variations to the AAQ NEPM including $PM_{10}$ and $PM_{2.5}$ have been subject to public consultation and a National Clean Air Agreement is under development.

## 1.2 PROCESS OF THE REVIEW

The first phase of the Review (September - November 2015), has focused primarily on Terms of Reference 1:

"In undertaking the review the Chief Scientist & Engineer will provide advice on coal dust and related emissions in the rail corridor, in particular:

1. Identify, describe and comment on:
    a. key issues, including current scientific knowledge and matters of expressed public concern
    b. initiatives in NSW and other jurisdictions to address issues, including measurement , prevention and management practices
    c. any gaps or issues arising"

A review of available literature was undertaken and public submissions called for. Targeted consultations were undertaken with government agencies, community groups and industry, followed by several site visits.

Effectively this phase was directed at precise understanding of the issues and formal scoping of the problem.

### 1.2.1 Existing studies on coal dust emissions from coal handling and transport

The issue of coal dust emissions from coal handling and transport has been the subject of numerous studies both domestically and internationally over the last decade. NSW initiatives by government agencies, industry, local communities and peak bodies were initially reviewed, followed by studies, reports and regulatory practices in Queensland and jurisdictions overseas to define issues and understand how initiatives elsewhere may apply to NSW. Topic areas included:

- monitoring in or near the rail corridor
- particle characterisation studies
- sources of emissions in the rail corridor
- wind tunnel studies
- nature and effectiveness of mitigation techniques and the specific conditions they were undertaken in
- health studies on effects of air pollution
- studies related to proximity of coal facilities and health effects
- studies to monitor/model the effects of line source pollution (e.g. determine effects on local residents from roads, train lines, etc.)

### 1.2.2 Submissions

The Review considered all submissions that were previously made to both the Senate Inquiry into the Impacts on Health of Air Quality in Australia (2012) and the Legislative Council Inquiry into the Performance of the NSW Environmental Protection Authority (2014) that related to coal dust emissions.

These submissions have provided important fundamental insights into the concerns held by the community, interest groups and industry. It was noted by the Review that the majority of issues raised in the two inquiries remain relevant today.

Notwithstanding extensive documentation available through previous inquiries, it was recognised that stakeholders would want and expect to have opportunities to provide formal input to the Review process. The Review is accepting formal submissions as advertised on the Chief Scientist & Engineer's website and these will continue to be accepted until 1 March 2016 (coaltrains.review@chiefscientist.nsw.gov.au).

A list of those who provided a submission to the Review is provided at Appendix 7 and submissions (unless otherwise requested) are available on the Review website (www.chiefscientist.nsw.gov.au/reports/review-of-rail-coal-dust-emissions).

### 1.2.3 Consultations and site visits

To date, the Review has consulted with a number of stakeholders in government, industry and the community. Several site visits have also been undertaken during this first phase of the Review to view the rail corridor and meet with stakeholders. More visits are planned as the Review progresses. Discussions have focused on:

- understanding stakeholder views on the source and impact of coal loss and emissions in the rail corridor
- data and rationale underpinning views on mitigation strategies
- historic and current industry and regulatory practices to manage coal loss and emissions
- understanding what initiatives for managing rail coal dust emissions have already been implemented, which initiatives are in progress and those that are still being planned.

The Review team also met with Professor Louise Ryan, University of Technology Sydney, to discuss her analysis of the ARTC monitoring study.

A list of meetings undertaken is at Appendix 7.

## 1.3 STRUCTURE OF THIS REPORT

Chapter 2 provides a summary of relevant studies undertaken to date.

Chapter 3 summarises the initial findings of the Review and outlines next steps.

# 2 STUDIES

There have been a number of studies undertaken in NSW and other jurisdictions looking at dust and particle pollution associated with the transport of coal. These studies have attempted to identify and quantify the levels of particulates in and around the rail corridor, their source, how they move in the local environment and any potential impacts to determine whether there is an issue of concern for people living near the rail corridor above ambient or background air quality levels.

This chapter summarises studies focusing primarily on sourcing and measuring emissions, sequentially working through the stages outlined above (i.e. consideration of ambient or background levels followed by localised levels and point sources). This lays the foundation for consideration of potential impacts and, from there, management approaches. For this reason, although a range of other reports relating to mitigation strategies and their efficacy were reviewed in this initial phase of work and are included in the summary of studies and reports in Appendix 4, they are not canvassed here. They will be subject further work as the Review progresses.

## 2.1 AMBIENT AIR QUALITY

Measuring ambient air quality has been the main focus of air quality regulators across Australia, including NSW, to understand the background levels of pollutants better over the long term. In general, the ambient air quality in Australia and NSW is comparatively good relative to world standards.

### 2.1.1 Measurements of ambient pollutant concentrations

Established in 1998, the National Environment Protection (Ambient Air Quality) Measure (AAQ NEPM) is Australia's national air quality standard, and provides a framework for monitoring and reporting common air pollutants ($PM_{10}$, ozone, sulphur dioxide, nitrogen dioxide, carbon monoxide, and lead, a 2003 variation incorporating advisory reporting standards for $PM_{2.5}$). These standards are currently being reviewed and a National Clean Air Agreement is being developed, scheduled for introduction in 2016.

The AAQ NEPM sets out a number of requirements for monitoring stations that form part of the national network to ensure data from around Australia is captured and reported in a consistent, equivalent and reliable manner. The AAQ NEPM standards stipulate methods for assessing concentrations of different pollutant types, and standards for, and calibration of, instrumentation. AAQ NEPM stations must be located in accordance with the requirements for Australian Standard AS2922-1987 (Ambient Air-Guide for Siting of Sampling Units). The locations of the monitors are such that they capture representative general air quality in major population centres.

An extensive air quality monitoring network spans the Upper Hunter region, as well as the Lower Hunter and Newcastle local regions (Appendix 3). This network includes monitors that are part of the national NEPM reporting framework as well as others located closer to pollution sources such as industrial areas and mining activities. Some of these have been put in place in response to community concerns. Information from this network provides a good indication of background or ambient air quality in the region. Data are regularly updated (some hourly) and are available on the Office of Environment and Heritage (OEH) website (http://www.environment.nsw.gov.au/aqms/aqi.htm).

The NSW Air Quality Statement from 2014 found particle levels met the national goal, including allowable exceedances, at all stations except one (Wagga Wagga station), but levels above the $PM_{2.5}$ standards were recorded in Sydney, Hunter Valley and Wagga Wagga (NSW OEH, 2014). Fewer exceedances of the $PM_{10}$ and $PM_{2.5}$ annual national standards in 2014 when compared to the previous year were attributed to fewer bushfires. Annual $PM_{2.5}$ levels above the advisory national standard were recorded in Sydney, Newcastle and Muswellbrook. Beresfield, Camberwell and Singleton recorded levels above the daily national standard (1 day) and Muswellbrook (3 days).

### 2.1.2 Measurements of the composition and source of pollutants in ambient air

Studies in the Lower and Upper Hunter regions have been initiated to provide information on the origins or sources of the particulates in the air.

The Lower Hunter Particle Characterisation Study was initiated in 2013 by the NSW EPA and managed by the CSIRO and ANSTO. The study involves four monitoring sites and is characterising the components of $PM_{2.5}$ (four sites) in the Lower Hunter and the composition of $PM_{10}$ (two sites) in the vicinity of Newcastle Ports over one year. The analysis is still in progress, with four progress reports having been released to date, the final report expected in early 2016. A longer term regional air monitoring study examining $PM_{10}$ and $PM_{2.5}$ concentrations completed as part of this study series has been used as a framework for this study (Hibberd, Keywood, Cohen, Stelcer, Scorgie, & Thompson, 2015).

The Upper Hunter Fine Particle Characterisation Study started earlier and has been completed. This study focussed on $PM_{2.5}$ levels and was conducted at two sites – Singleton and Muswellbrook – two major Hunter towns in close proximity to mines and power stations. The study was commissioned by the NSW EPA and undertaken by the CSIRO and ANSTO. It found secondary sulfate (~20%, from sources such as power stations) and wood smoke (~30%, primarily from residential wood heaters) to be the largest contributing factors to $PM_{2.5}$ levels in Muswellbrook and Singleton respectively. Soil, which includes fugitive coal dust, accounted for 10-14% across the Upper Hunter (Hibberd, Selleck, Keywood, Cohen, Stelcer, & Atanacio, 2013).

## 2.2 AIR QUALITY ASSOCIATED WITH THE RAIL CORRIDOR

Studies initiated by government agencies, industry and community groups have been carried out in NSW and other jurisdictions to understand and characterise coal dust and particulate emissions in and around rail corridors.

A small number of monitoring programs in NSW have measured particulates (TSP, $PM_{10}$, $PM_{2.5}$, $PM_1$) in close proximity to rail lines; measured particulate levels associated with different types of trains; and compared results from rail corridor monitors against data from the Hunter's ambient air quality monitoring network.

The Review has examined reports from these monitoring programs and other available studies with a view to providing information about the following:

- sources of dust
- contribution of trains to dust and particulate emissions
- levels of rail corridor particulates compared to ambient levels
- associated human health risks.

A summary of the studies is at Appendix 4.

### 2.2.1 Sources of dust in the corridor

The transport of coal from mine to port can generate dust and particle emissions from a number of sources. As shown in Figure 1, dust and particles in the corridor can originate from:

- surface of loaded wagons
- leakage from doors of loaded wagons
- parasitic load
- residual coal in empty wagons
- emissions from diesel locomotives
- dust originating from soil within the corridor or from elsewhere
- re-entrainment of spilled coal or other dust in the rail corridor, including through turbulence caused by passing trains.

There are various factors that affect the movement of dust into and within the corridor from the above sources – some factors can be controlled (e.g. wagon design; loading and unloading practices), others cannot (e.g. meteorological effects such as wind and rain). This is illustrated in Figure 1.

***Studies to determine the origin of the dust – Dust deposition studies***
The Lower Hunter Dust Deposition study (AECOM, 2015) was commissioned by the NSW EPA to examine the quantity of dust deposited in the Lower Hunter and the likely source of the deposit. The study focuses on larger dust particles that are more likely to deposit, and is underway across twelve sites situated in or near the rail corridor. Sampling was undertaken to examine three trends – long-term deposition (over about 30 days), short-term deposition (of a period less than three days), and composition. Results from the study indicated that coal comprised on average 6.2% of the samples, and soil or rock dust made up the largest proportion of samples with an average of 73%.

A similar study undertaken in Queensland (DSITIA, 2012) analysed dust deposited in or near the rail corridor, finding that mineral dust (soil and rock) was the primary depositional component with coal dust accounting for 10-20% of samples taken at six, twenty and 300m from the tracks (rock and soil made up a minimum of 40%).

### 2.2.2 Contribution of coal trains to dust and particulate emissions in the rail corridor

Coal dust can travel into and along the rail corridor due to the movement of coal trains themselves, open wagon surfaces, parasitic coal, and spillage from wagons. Studies have been undertaken to measure whether there is an increase in particulate levels caused by coal and/or other trains and the effects before, during and after the passage of the train on the levels of particulate matter.

***Studies to determine whether dust comes from the top of the open coal wagon***
In NSW, the ARTC, as a result of Pollution Reduction Program requirements of its Environmental Protection Licence (EPL), commissioned a two-month, single location trackside monitoring program at Metford in the Hunter Valley to ascertain dust levels in the corridor. A key driver for the study was determining whether passing uncovered coal trains resulted in an increase in the amount of dust measured by a monitor compared with other train types. Results from the study indicated that particulate levels rose as a result of coal trains passing the monitor (Katestone Environmental Pty Ltd, 2013). The conclusions drawn from the study are informing the debate on the source of emissions from coal trains and the dataset has been the focus of several analyses. As noted in Section 1.1.4, there was a degree of controversy generated around the study, centred on some leaked editorial changes made to a draft report and questions about the robustness of the study design and the original statistical analysis.

| Sources |
|---|
| |
| **Coal sources**<br>S1 – Coal from surface of loaded wagons<br>S2 –Coal leakage from doors of loaded or unloaded wagons<br>S3 – Dust emissions re-entrained from spilled coal in the corridor<br>S4 – Residual coal in unloaded wagons<br>S5 – Parasitic load<br>S6 – Coal due to induced turbulence from two trains passing |
| **Other sources**<br>S7 – Diesel exhaust emissions from locomotives<br>S8 – Other train emissions (eg: brake dust)<br>S9 – Re-suspended dust caused by trains passing through the corridor but dust from other sources (e.g.: soil, sea salt etc.)<br>S10 – Dust from all other ambient sources (agriculture, bushfires, sea salt, power stations/industry, other transport and towns/houses eg. wood smoke) |

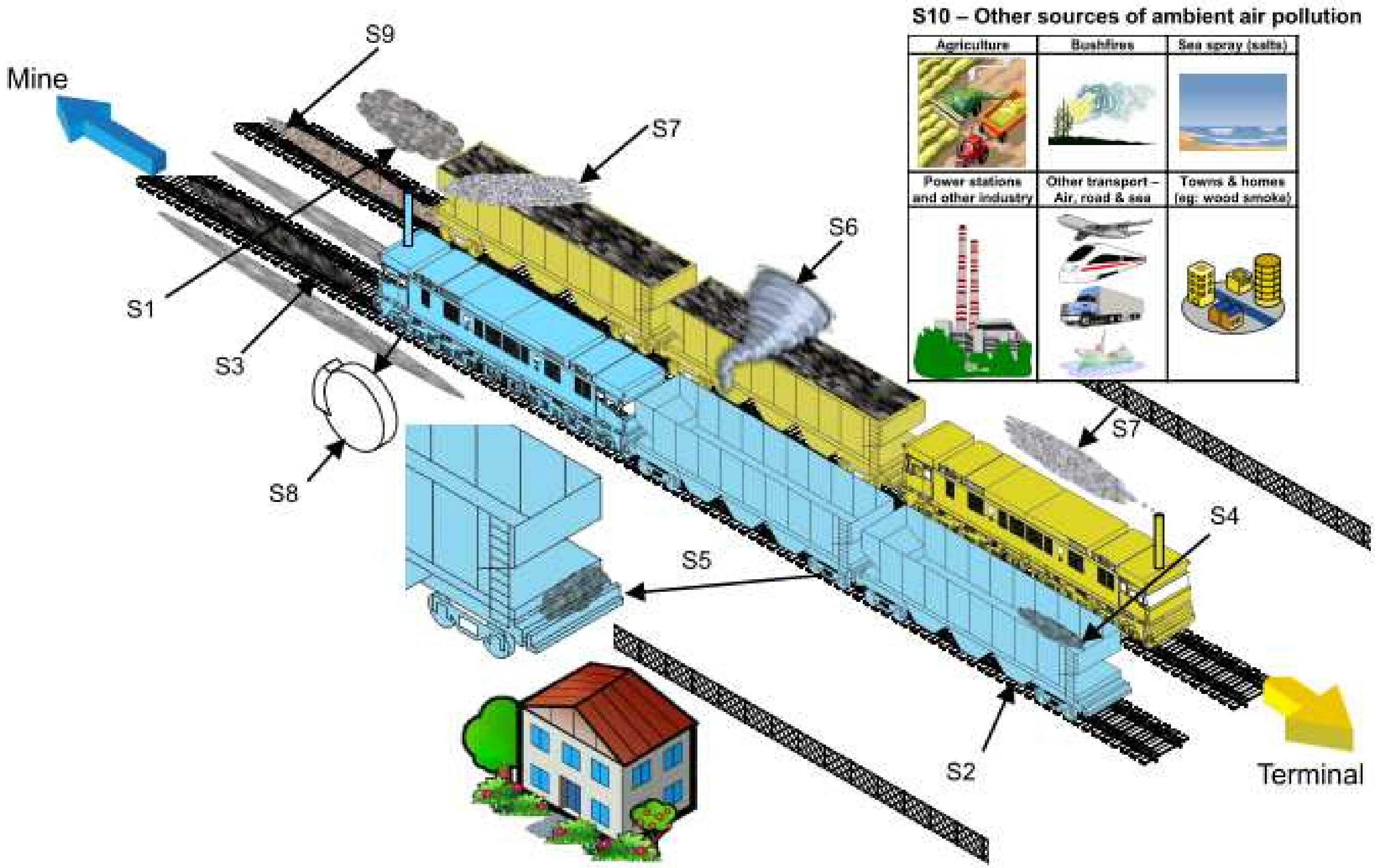


**Figure 1: Potential sources of dust emissions and factors affecting emissions in the rail corridor**

**Factors affecting emissions**

**Environmental factors:** Wind velocity, Wind direction, Precipitation, Temperature, Humidity, Solar radiation, Diurnal effects (i.e. day/night differences), Terrain (this can influence train vibration and locomotive emissions)

**Coal/train factors:** Coal properties, Length/duration of journey, Loading practices, Train velocity, Wagon design, Wagon maintenance, Locomotive design, Locomotive maintenance, Number of locomotives, Fuel quality, Whether coal is treated or untreated, Acceleration/deceleration rate, Unloading practices, Loaded coal train passing another train

The data was reassessed independently by several experts, including Professor Louise Ryan. Professor Ryan found:

- freight and coal trains were associated with increased levels of particulates when passing, by approximately 10% above baseline levels. Particulate levels associated with the passing of unloaded coal trains were higher (not statistically significantly) than those associated with loaded coal trains and freight trains. Professor Ryan postulated that diesel emissions may have been a larger contributor to PM levels, particularly as the levels were also elevated for $PM_{2.5}$ (smaller particles from combustion) and the lack of significantly higher results from loaded coal versus other types of trains (Ryan & Wand, 2014)
- upon reanalysis, when additional rainfall data was provided, that potentially the re-entrainment of particles and dust already on the line was a more significant factor than the dust coming from the tops of wagons, as the amount of dust measured in the air by the monitor was influenced by whether it had rained the previous day in the nearby town of Maitland (Ryan & Malecki, 2015)
- it was difficult to generalise results from a single trackside monitor (Ryan & Malecki, 2015).

Professor Ryan's findings are in contrast to a widely cited report from Queensland that estimated 80% of coal dust emissions come from the surface of exposed wagons (Connell Hatch, 2008).

From a health perspective it should also be borne in mind that due to constraints (time and limited data), the re-analyses assessed relative particle concentrations (increases) from passing trains, but not whether $PM_{10}$ or $PM_{2.5}$ NEPM standards were met or the total particulates that people may have been exposed to.

A Queensland Government commissioned review in Tennyson noted that trains, irrespective of type, increase particulate levels (DSITIA, 2012). As the major deposited amount found was soil and rock, the study concluded that the re-entrainment of ground/surface dust as a result of the train passing was the primary contributor to an increase in airborne particulate matter. The latter conclusion was, for the most part, echoed in another study by the Queensland Department of Science, Information Technology, and the Arts (DSITIA) to evaluate the effectiveness of the veneering program (DSITIA, 2013).

Other community studies have also found that particulate concentrations increased when trains passed. As shown in these studies, the amount by which the concentration of dust increases does appear to vary with train type, or between trains of a particular category. This is demonstrated in some of the data provided to the Review by authors of the Coal Terminal Action Group (CTAG) Coal Train Signature Study (Higginbotham, Ewald, Mozeley, & Whelan, 2013).

The CTAG Study (NSW) reported that 81% of coal trains produced a recognisable signature with pollution levels increasing up to 13 times when coal trains pass. Signatures varied, but the highest increase was for an unloaded train (Higginbotham et al., 2013).

Clean Air Queensland undertook a similar community based study along the West Moreton rail line to determine the pollution signature from passing trains. Eight signatures were reported representing the worst-case scenarios. Loaded trains were found to increase $PM_{10}$ levels between 500-1,000% over pre-train levels; the increase for unloaded was 500-900% and freight 100-150%. The intensity and the peak varied significant between different coal trains. All the coal trains studied were assumed to be veneered (Kane, 2015).

***Field and wind tunnel studies***
A number of wind tunnel studies have been undertaken in an attempt to quantify the amount of dust that may disperse from the top of an open coal wagon and the aerodynamics associated with the height and configuration of the load.

Ferreira, Viegas, and Sousa (2003) conducted tests of coal dust emitted from coal trains. They placed dust-collecting instruments onto wagons carrying coal from a port to a power station in Portugal. The study conducted measurement of TSP emissions from coal wagons over a simulated 350km journey, and found that a 60t semi-covered wagon would lose approximately 0.001% of its load with an undisturbed flow velocity of 13.4m/s (48.2km/hr). The use of a semi-cover system, despite the existence of a 1m wide gap along the upper part of the wagon, significantly reduced the amount of dust released. Connell Hatch in its review of Ferreira et al mentioned that overall the train speeds; transport distances and climatic conditions during the sampling were comparable to conditions in the Queensland study area.

In a later study, Ferreira and Vaz (2004) used scale model trains in a wind tunnel and compared completely open coal wagons with "semi-cover" systems partially covering the upper surface to show that partially covering coal cars reduced dust emissions by more than 80%.

***Studies to determine whether dust falls from doors underneath the coal wagon***
Studies have been undertaken to determine the extent of loss from doors underneath the coal wagon, including the Coal Leakage from Kwik-Drop Doors - Coal Loss Management Project (Aurecon Hatch, 2009). Undertaken in Queensland, the study identified a range of variables that could influence whether and how much coal would be lost from the doors, including coal type and rank, moisture content and meteorological conditions and wagon design.

More recently the NSW EPA has asked the ARTC to investigate coal loss from wagons on the NSW network and the effectiveness of removing it via vacuuming. The outcomes are expected to be available in 2016.

### 2.2.3 Whether particulate levels are higher in the rail corridor than in background locations

There are few studies in NSW that have measured how background or ambient levels compare with baseline levels in the corridor.

The Review considered, among others:

- a NSW community monitoring study that provided a snapshot of air quality close to the coal facilities compared with ambient that found higher levels of particulates at the study monitoring sites (Rogers, Whelan, & Mozeley, 2013). The study used portable air monitors across 12 sites (reported on 11) in the Lower Hunter measuring $PM_1$, $PM_{2.5}$, and $PM_{10}$, and found $PM_{10}$ levels were consistently higher than readings from selected EPA monitoring sites. $PM_{10}$ was also found to be above NEPM standard at a majority of those sites, with one site also exceeding NEPM standards for $PM_{2.5}$. In particular:
    - o for 24 hour $PM_{10}$ the study reported results across 11 sites which included 56 total sample days. It found a total of 17 readings above 50µg/$m^3$ (NEPM 24 hour $PM_{10}$ standard) across 7 sites
    - o for 24 hour $PM_{2.5}$ the study reported results across 11 sites which included 56 total sample days. It found a total of 1 reading above 25µg/$m^3$ (NEPM 24 hour $PM_{2.5}$ standard) across the sites

- the study also compared their results to 4 other monitors (1 Industry and 3 EPA) in the region during the same period, these monitors showed no exceedances (Rogers et al., 2013)

- local $PM_{10}$ levels, from the Review's assessment of data provided in a Queensland study, appear to be slightly higher than ambient levels, but also appear to be within NEPM air quality standards (DSITIA, 2012).

***Dispersion of dust and particulate emissions beyond the corridor***
There does not seem to be much data available on the dispersion of coal dust and particulate matter from the rail corridor into the surrounding community.

There is a body of general knowledge about how particles travel through the air, but this alone does not tell a complete story. The World Health Organisation says that particles between 0.1μm–1μm can stay in the atmosphere for days or weeks and can be transported over long distances i.e. thousands of km. Coarser particles typically travel less than 10 km from place of generation but under some circumstances travel as far as 1,000 km (Joint WHO/Convention Task Force on the Health Aspects of Air Pollution, 2006).

Particle dispersion modelling may go some way towards helping to describe the movement of particles over an area from source to receptor. To date, the Review is not aware of any relevant study having been undertaken in the NSW rail corridor, and there are limitations as to what conclusions can be drawn from available information from sources such as:

- the Queensland Rail study which undertook dispersion modelling using a Gaussian line source model with results stating it was unlikely there would be any exceedances of TSP and $PM_{10}$ beyond the rail corridor; however, the inputs and assumptions to the model are not described in detail in the report (Connell Hatch, 2008)
- the fine particle characterisation study by the NSW EPA in the Upper Hunter towns of Muswellbrook and Singleton which showed 10-14% of $PM_{2.5}$ could be coal (as fugitive coal dust in soil), but it could not categorically determine the source, whether from a mine, coal train, power station, etc. Other sources like wood smoke and secondary sulfate were larger contributors.

The Review will continue to look into this issue.

## 2.3 FUTURE STUDY METHODS

Few studies have specifically focused on emissions originating from the rail corridor. However, numerous studies have been conducted on the monitoring of air quality around roads and, in particular, high-load roads such as freeways. Roads and rail corridors, although functionally different, act in similar manner as a linear source of airborne particulate matter. Therefore, similar monitoring methodologies could be adapted for rail corridor studies from road emission studies.

***Linear source monitoring methodology***
A study by Karner, Eisinger, and Niemeier (2010) reviewed and synthesised methodologies and results from over 40 roadside monitoring studies. It indicated that:

- the most frequently applied method to determine dispersion gradients was to place monitoring equipment, at varying distances, along a vector approximately perpendicular to the source (road)
- the studies typically utilised prevailing wind patterns to orientate monitors in an upwind/downwind configuration from the road, in order to establish a baseline measurement for comparison with the downwind measurements. This was typically in conjunction with collocated meteorological equipment at the monitoring sites to confirm wind direction (Hitchins, Morawska, Wolff, & Gilbert, 2000).

Furthermore, a study by Baldauf, Watkins, Heist, Bailey, Rowley, and Shores (2009) examining network design identified key factors that need to be considered in the collection and interpretation of near-road air quality data. Many of these factors are applicable to or adaptable to rail corridor studies, including:

- the parameters surrounding traffic, such as the numbers, type and speeds of vehicles
- meteorological measurements, such as wind speed and direction, temperature, relative humidity and atmospheric stability
- monitors appropriate to the variable being measured. For $PM_{10}$ and $PM_{2.5}$, the study indicates a combination of 24-hour sampling (mass measurement via filter-based gravimetric analysis) and continuous PM sampling, as each method has limitations: for example, diurnal variation is missed in the 24-hour sampling whilst some continuous PM sampling monitors use an optical measurement that reduces its accuracy for determining the quantity of smaller particles
- location of monitors relative to structures, vegetation or topographical features that may impact the dispersion of airborne particles
- location of monitors relative to the linear source (road) can influence the actual particle concentration due to numerous variables in that environment, with many studies controlling this via implementing multiple monitoring stations at varying distances from the source.

## 2.4 HUMAN HEALTH

Sanitary, public health and clean air regulatory instruments in a range of jurisdictions and international standards and treaties have been introduced to address emissions from industry, cars and other human activities.

Over the last 40 years a significant body of scientific literature has developed on the impacts of various pollutants on human health, including short and long term exposure (Begg, Vos, Barker, Stevenson, Stanley, & Lopez, 2007; Brook, Rajagopalan, Pope, Brook, Bhatnagar, Diez-Roux et al., 2010; Golder Associates Pty Ltd, 2013; IARC, 2012; Katsouyanni, Touloumi, Samoli, Gryparis, Le Tertre, Monopolis et al., 2001; Lim, Vos, Flaxman, Danaei, Shibuya, Adair-Rohani et al., 2012; NSW Health, 2010; Peters, Skorkovsky, Kotesovec, Brynda, Spix, Wichmann et al., 2000; Pope, Burnett, Thurston, Thun, Calle, Krewski et al., 2004; Pope & Dockery, 2006; WHO, 2013; WHO Working Group, 2004). This growth has been enabled by more sophisticated understanding of the chemical and physical properties and characteristics of substances; advances in instrumentation, monitoring, modelling and computational capacity and development of research methods, assessment protocols for determining the robustness of studies undertaken as well as risk frameworks and tools (Cohen, Crawford, Stelcer, & Atanacio, 2014; Lim et al., 2012; Morawska & Moore, 2004; Ostro, Hu, Goldberg, Reynolds, Hertz, Bernstein et al., 2015; Rahai, 2008; Sangkapichai, Saphores, Ogunseitan, Ritchie, You, & Lee, 2010). Standards and advisories have been refined as findings emerge and are replicated.

Notwithstanding these advances, gaps in knowledge remain; in part due to the complex nature of pollutants, multiple sources and factors that influence their impact, and the quality and scale of studies required for firm conclusions to be drawn (Pope, Burenett, Thun, Calle, Krewski, Ito et al., 2002; Raaschou-Nielsen, Andersen, Beelen, Samoli, Stafoggia, Weinmayr et al.; Simpson, Williams, Petroschevsky, Best, Morgan, Denison et al., 2005; Thurston, Ahn, Cromar, Shao, Reynolds, Jerrett et al., 2015; US EPA, 2009). These complexities have made generalisation of study findings to specific regions or populations difficult. Availability of data and assumptions must also be considered when extrapolating from findings (e.g. some diesel studies draw on occupational exposure to underpin population exposure estimates) and outcomes are not always clear (Dalton, Durrheim, Marks, & Pope, 2014; Hime, 2015; Kunzli, Perez, & Rapp, 2010; Merritt, Cretikos, Smith, & Durrheim, 2013; NSW Health, 2010).

Key to understanding or interpreting human health risk from a chemical or pollutant is to understand both the hazard of the material and the dosage that a person would be exposed to over a time period. Hazard is a function of characteristics such as the chemical nature, particle size and toxicity, while the dosage relates to the quantity of the material, which is dependent on the exposure pathway and concentration inhaled or ingested, along with other factors.

Thus, efforts to determine the nature of the particles, as well as the concentrations and quantities of particles are both important in determining the risks to human health. Some materials have a threshold level below which there is a negligible health impact, whereas other materials do not have known minimum threshold levels (safe level of exposure) and therefore no health advisory guideline (ACTAQ, 2014a, 2014b).

For particulate matter, no threshold has been identified below which exposure is not associated with adverse health effects, so considerable focus of regulatory interventions in Australia are to reduce ambient concentrations of particulate matter to provide benefits to public health.

Exposure to both $PM_{10}$ and $PM_{2.5}$, the particulate matter with an equivalent aerodynamic diameter of 10 and 2.5 micrometres or less respectively, is associated with cardiovascular disease, respiratory disease and mortality and increased symptoms of asthma. Some associations have also been observed between $PM_{2.5}$ exposure and reproductive and development effects such as low birth weight (ACTAQ, 2014a). The International Agency for Research on Cancer (IARC) has also classified outdoor air pollution including diesel engine exhaust as carcinogenic to humans (IARC Group 1). Sections of the population that would be at higher risk from particulates include older people and people with pre-existing conditions including cardiovascular disease, respiratory disease and diabetes (NSW Health, 2010; Pope & Dockery, 2006).

# 3 FINDINGS AND CONCLUSIONS

The Review is being undertaken in a context where there are a lot of pieces of information available, some studies complete, and others underway, but there remains disagreement between industry and community stakeholders as to whether there is or isn't a problem, what the source of the problem is and how it should be fixed.

This Chapter attempts to settle whether there is a problem or not, the nature of the problem if there is one, and what needs to be done to settle the matter if there is not enough information available to determine whether there is a problem or not.

An important contextual issue is that ambient air quality in the Hunter is extensively monitored and is generally within AAQ NEPM guidelines, although some localities do record exceedances. The air quality in the Hunter is similar to other locations in NSW and Australian cities and compares favourably internationally.

So the main questions become:

1. *Is there anywhere in or near the rail line where air quality exceeds Australian standards and, if so, what is the shape and nature of the air particulate profile of the region near the rail line and are the levels higher at all times or in certain time periods?*
2. *And then, are there any mitigation techniques that would ensure the air quality within this region near the rail line stays within the regulation levels?*

## 3.1 THINKING ABOUT QUESTION 1

There are no existing studies or sets of studies available to date that fully answer the first question but there are several studies that provide partial information. These include:

- the Coal Dust in Our Suburbs (CTAG) study (Rogers et al., 2013) used OSIRIS monitors for particulates at 11 sites in Lower Hunter/Newcastle close to the port and rail corridor with a total of 56 sample days. Their results indicated that particulate levels exceeded, in some cases, NEPM standard levels for $PM_{10}$ (17 sample days across 7 sites) and $PM_{2.5}$ (1 sample day at 1 site). Limitations of this study were that it was a snapshot in time, based on limited monitoring sessions and was intended as a preliminary study. This study is described in Section 2.2.3 and Appendix 4
- the Tennyson dust monitoring investigation study (DSITIA, 2012) found that there were no exceedances of $PM_{10}$ above the QLD guidelines at the corridor. We note that it is difficult to compare QLD to NSW studies as there are differences between the coal types. Also, this study did not look at $PM_{2.5}$ levels and only measured $PM_{10}$ levels at one monitoring site. This study is described in Section 2.2.2 and Appendix 4
- the Western Metropolitan Rail Systems Coal Dust Monitoring Program report (DSITIA, 2013) determined that 6 sites in the rail corridor did not show any exceedances for 24 hour $PM_{10}$ and $PM_{2.5}$. This study is also limited in that it is difficult to compare QLD to NSW situations including coal type differences. This study is described in Section 2.2.2 and Appendix 4.

A number of studies that provide information about dust and related emissions in components of the coal supply chain can provide some information to inform research on the shape and nature of the particulate profile in the corridor.

Two sets of well-known such studies in the Hunter rail corridor are:

- the ARTC Study (Katestone Environmental Pty Ltd, 2013) and follow-up analyses (Ryan, 2013; Ryan & Malecki, 2015; Ryan & Wand, 2014). This study found that particulate levels rise during the period of a train passing, about 10% above baseline levels (no-train level) for freight and coal trains both loaded and empty. Limitations of this study are that it was a single monitor on one side of a four track section. The final analysis included rainfall data in two nearby towns, and indicated that there was a strong association between rainfall the day before and particulate levels, suggesting that the stirring up of previously settled dust was the main source of measured particulates

- the Coal Train Signature Study (Higginbotham et al., 2013) measured 73 trains over three days in two sites. The authors found that approximately 80% of coal trains (loaded and unloaded) had a recognisable signature, while 20% didn't have a signature (i.e. didn't change from baseline/pre-train levels). Even similar train types on the same afternoon showed considerable differences between increases in particulate levels from baseline. This study also had limitations in being a short period of time, and only one monitor was used. This monitor was calibrated to a NEPM monitor in Beresfield at the beginning of the study.

Studies to date show elevated levels of PM in the corridor when trains are passing, but there is little evidence that the levels exceed the Australian air quality standards. There is a general consensus from the examined studies that dust levels increase when trains pass through the corridor; but there is uncertainty about how much and why. Is the dust being emitted from uncovered wagons, loaded or unloaded, or is it settled dust being stirred up by passing trains, or is it a combination of sources and dispersal routes?

Trains also emit particulate matter as a component of diesel exhaust, particularly as $PM_{2.5}$. The additional analysis of the ARTC data (Ryan & Malecki, 2015) took account of the number of locomotives that were reported to be associated with the passing train, although there were caveats expressed by ARTC about the reliability of this information. This analysis found a lack of association between particulate levels and numbers of locomotives, which, as stated by the author, "While bearing in mind the ARTC caveat concerning data reliability, dispels, to some extent, the hypothesis that diesel exhaust explains a large proportion of the observed increases in particulate levels associated with train passings."

Another recent particulate monitoring study undertaken in the rail corridor was undertaken in Washington, USA (Jaffe, Putz, Hof, Hof, Hee, Lommers-Johnson et al., 2015) that measured particulate levels with passing trains, with the study concluding that peak $PM_{2.5}$ levels for diesel open coal trains are almost double the peak for diesel freight trains. In addition, the article noted that four out of 74 coal trains studied (5.4%) were 'super dusters'; these outliers caused $PM_{2.5}$ levels between 50 and 250 $\mu g/m^3$ during passage and visible coal dust plumes. The study was not conclusive about the causes of the super dusters.

There are a number of studies that are still underway that will make an important contribution to the evidence base behind particulate levels and their pathways through the system. An important industry study that is being looked at will position monitors above coal wagons to measure the opacity from particulate emissions from the tops of wagons. Other work underway by the EPA will further clarify the composition of dust that is measured in the Hunter area, including that depositing in the rail corridor. The Review will continue to engage with stakeholders in the next phase to obtain these and other results, as they will make contributions to the understanding of the issues described associated with Question 1.

However a systematic monitoring and modelling study is required to answer Question 1 effectively.

In its next phase, the Review will commission experts in the fields of air monitoring, statistics modelling, etc. to look at approaches to monitoring and modelling of the corridor, informed by the studies that have already been completed and are underway, to give a clearer picture of whether there is a problem to address, and what the characteristics of the problem are.

This expert input will be used to provide advice to the Review on options for the design of a monitoring study and the construction of a corridor model. The thinking of the Review to date is that such a study would be designed to provide fine-grained data on particulate characteristics (concentration, composition), train characteristics (identity of train, types of wagons, type of coal, source mine, loaded or unloaded, freight or passenger, speed, duration to pass) and environmental conditions (date, time, wind speed and direction, recent and current precipitation, humidity). See Appendix 5 for more details.

There would be a number of monitors situated on both sides of the track, set at various distances from the track and at differing heights, in around and along a portion of the track. Information on the surrounding topography and land use of the area near the monitors would also be recorded. The monitors would be kept in place for enough time to draw out seasonal and meteorological impacts.

Developing a systematic monitoring study would assist in clarifying some of the uncertainties around what is taking place in and near the rail corridors when trains pass. Are there hotspots along the corridor where there is a particularly high level of particulate matter? Are increased particulate levels in the corridor caused by the corridor itself e.g. by dry soil-derived dust from the corridor being re-entrained or other factors such as dust being dispersed from the top of the wagon, diesel particulates or parasitic coal having dropped to the track being re-entrained with the moving train, or a combination? Do we have 'super dusters' in the Hunter, as found in the study by Jaffe et al. (2015).

The data could then be used to develop a model of the rail corridor, which would allow an examination of the key factors that drive emissions and it could also be used to look at the impact on air quality over different distances from the track if different factors and parameters are varied such as wagon type, train movements etc.

The model would enable interrogation of the cause and effect of different factors on the level of particulates near the corridor. How different meteorological conditions impact emissions could be investigated by comparing similar wagon-types carrying the same coal type while varying the season or meteorological conditions? By sequentially subtracting the signatures of different types of wagon from the model or different types of coal from the model, any correlated change to the emission could be investigated to see whether there is a tipping point in air quality by removing a particular type of wagon. The model could explore whether wind speed and direction, and train speed act together to promote re-entrainment. Other questions could be tackled using such a system, and furthermore the benefit of a model is that it can be used to predict what may happen should certain management choices be made under future scenarios such as with increased coal volumes or peak meteorological temperatures.

## 3.2 THINKING ABOUT QUESTION 2

Monitoring and modelling data are required to answer question 2 regarding what mitigation strategies are required to ensure air quality around the rail line stays within regulation levels.

Across the coal supply chain there are multiple potential sources for coal particulates and emissions. Factors influencing the extent of emissions include coal and load properties; climatic and geographic conditions; operational practices and track, locomotive and train design.

Understanding the exposure pathways and levels of exposure is of key importance for an effective mitigation strategy, but these issues are currently unknown for the Hunter coal chain.

The constituents of the dust and particles (e.g. diesel, coal, dirt etc.) are still an unknown on the whole, but there are studies underway that will provide more clarity when they are completed – including deposition studies that will identify larger dust particles and dust characterisation studies which measure air-borne particles.

Further, the extent of dust dispersal from the rail corridor also remains unknown. The smaller the particulate size, the further it will disperse and the longer it will stay suspended in the air. However the impact that local topographic conditions, meteorological conditions and other factors have on the distance that particulates will be dispersed is a topic for specific study. Is the level of particles at nearby residences at ambient levels, or are levels there increased by the effect of the nearby rail corridor? If impacted by the corridor, what are the characteristics of this (intermittent or long term) and are the levels above a regulatory standard level?

There are a range of strategies that can be deployed along the supply chain, some of which have become standard in NSW (e.g. CCTV and direct observation and wagon door triggers at unloading facilities); some are mostly but not entirely phased in (e.g. automated loading); while others are proposed by some as additional measures (e.g. covering, veneering). These strategies are extensively described elsewhere (Connell Hatch 2008, Katestone 2014). While the relative advantages and disadvantages of some strategies have been well-ventilated (e.g. covering), safety and broader considerations (e.g. unintended consequences) of others have received less scrutiny (e.g. managing waste water from washing).

There may be more targeted mitigation measures that can be implemented based on monitoring information. Some classes of wagon or locomotive may have a disproportionate effect on the system. This could be addressed through EPA licensing and audit activities and may require amendments to EPL requirements. This could include activities such as automation of the loading process and garden bed profiling of coal wagons.

The choice of measures, or a combination of measures, at any stage of the coal chain needs to be informed by an understanding of the factors outlined above under specific conditions (e.g. coal properties; pollutant sources and local climate) prior to any cost-benefit analyses, as these will have a material bearing on their efficacy.

Although a number of studies have been undertaken on mitigation strategies, particularly in the United States and in Queensland, their application in the NSW context is inconclusive to date (PAE Holmes 2010). Examples of these are:

- a US study by BNSF and Union Pacific Railroad (BNSF, 2010) investigated the effectiveness of different chemical treatments to reduce coal dust emissions from wagons and showed that certain topical treatments can reduce coal dust emissions up to 93%
- the Queensland study - Western-Metropolitan Rail Coal Dust Monitoring Program (DSITIA, 2013) discussed above is looking at the impact of coal wagon profiling and veneering after it was implemented in the state. As discussed above this study showed no exceedances in air quality measures.

A number of pieces of work by government and industry in NSW are underway that may be able to provide more information, including industry studies on dust management procedures, loading procedures and residual coal left in wagons, and government studies on dust deposition, particle deposition and coal loss from wagons; however the outcomes are not yet available.

## 3.3 OTHER CONSIDERATIONS

When examining the existing studies, it is clear there are occasions of short-term, high-concentration particulate spikes with some passing trains. Even though, in general, health concerns relate to longer term exposures, this issue of short-term spikes may also be of interest. The Review will consider the issue of spikes further and seek advice from health experts.

## 3.4 CONCLUSION

This initial report has focused on defining the key problems and issues regarding coal dust and related emissions in the coal supply chain and identifying gaps in the knowledge. The final report will focus on setting up the mechanisms to provide solutions.

In the next phase, the Review will commission experts in fields such as air monitoring to look at the feasibility of approaches to understand better the unknowns.

The Review will also take account of ongoing studies currently being undertaken by government and industry as these may provide further answers to the questions.

The Review will also seek advice from health experts regarding the impacts of exposure to particle spikes, caused by passing trains, on residents' health.

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# Acronyms, abbreviations and glossary of terms

| Acronym | Definition |
| --- | --- |
| **AAQ** | Ambient air quality |
| **ABS** | Australian Bureau of Statistics |
| **ACARP** | Australian Coal Association Research Program |
| **ACTAQ** | The NSW Government's Advisory Committee on Tunnel Air Quality |
| **AECOM** | An American worldwide provider of professional technical and management support services |
| **AERMOD** | An atmospheric dispersion modeling system developed by the AERMIC (American Meteorological Society (AMS)/United States Environmental Protection Agency (EPA) Regulatory Model Improvement Committee) |
| **AHS** | Area Health Service |
| **ANSTO** | Australian Nuclear Science and Technology Organisation |
| **ARTC** | Australian Rail Track Corporation |
| **ASP** | Aerosol sampling program |
| **BAM** | Beta attenuation monitor |
| **BNSF** | Burlington Northern Santa Fe Corporation |
| **BOM** | Bureau of Meteorology |
| **CCTV** | Closed circuit television (aka CCT) |
| **CFD** | Computational fluid dynamics |
| **CPCFM** | Correct Planning and Consultation for Mayfield group |
| **CSE** | Chief Scientist and Engineer (NSW) |
| **CSIRO** | Commonwealth Scientific and Industrial Research Organisation |
| **CTAG** | Coal Terminal Action Group |
| **CVD** | Cardio vascular disease |
| **DEM** | Dust extinction moisture level |
| **DLMM** | Door loss measurement mechanism |
| **DPM** | Diesel particulate matter |
| **DSITIA** | Queensland Department of Science, Information Technology, Innovation and the Arts |
| **EPA** | Environment Protection Authority |
| **EPL** | Environmental Protection Licence |
| **EPP** | Environmental Protection (Air) Policy |
| **GENT** | Institute for Nuclear Sciences, University of Gent, Belgium |
| **H1N1** | Influenza A (H1N1) virus is the subtype of influenza A virus that was the most common cause of human influenza (flu) in 2009. |
| **HNE** | Hunter New England |
| **HVOL** | High volume air samplers |
| **IARC** | International Agency for Research on Cancer |
| **LGA** | Local government area |
| **NATA** | National Association of Testing Authorities, Australia |
| **NEPM** | National Environment Protection Measure |
| **NLAQMN** | Newcastle Local Air Quality Monitoring Network |

| | |
|---|---|
| **NOX** | Nitrous oxide |
| **NPI** | National Pollutant Inventory |
| **NSW** | New South Wales |
| **NZS** | New Zealand Standards |
| **OCSE** | Office of the Chief Scientist and Engineer (NSW) |
| **OEA** | Office of Environmental Analysis (USA) |
| **OEH** | Office of Environment and Heritage |
| **PHS** | Population health survey |
| **PMF** | Positive matrix factorisation |
| **POEO** | Protection of the Environment Operations (Act) |
| **PRP** | Pollution Reduction Program |
| **PWCS** | Port Waratah Coal Services |
| **QLD** | Queensland |
| **RISSB** | Rail Industry Safety and Standards Board |
| **ROM** | Run of mine coal. Mined ore of a size that can be processed without further crushing. |
| **SCAN** | South Queensland Coal Health Action Network |
| **SEM** | Scanning Electron Microscopy |
| **SFU** | Stacked Filter Units |
| **T4** | Port Waratah Coal Services' proposed Terminal 4 coal export facility |
| **TEOM** | Tapered element oscillating microbalance |
| **TSI** | TSI DustTrak™ Aerosol Monitors |
| **TSP** | Total suspended particulate |
| **UCTC** | University of California Transportation Center |
| **UHAQMN** | Upper Hunter Air Quality Monitoring Network |
| **US EPA** | US Environmental Protection Agency |
| **UTS** | University of Technology Sydney |
| **VIT** | Vehicle-induced turbulence |
| **WHO** | World Health Organization |

## Abbreviations

| | |
|---|---|
| **μg/m3** | micrograms per cubic metre |
| **μm** | microns |
| **m** | metre |
| **m/s** | metres per second |
| **$m^2$** | square metres |
| **$m^3$** | cubic metres |

| | |
|---|---|
| **$m^3/s$** | cubic metres per second |
| **mg** | milligram |
| **t** | tonnes |
| **tpa** | tonnes per annum |
| **PM** | Particulate matter (fine dust) |
| **TSP** | Total suspended particles |
| **CO** | Carbon monoxide |
| **$CO_2$** | Carbon dioxide |
| **Mt** | Million ($10^6$) tonnes |
| **Bt** | Billion ($10^9$) tonnes |
| **mg** | Milligram |
| **ML** | Megalitre |
| **NO** | Nitrous oxide |
| **$NO_2$** | Nitrogen dioxide |
| **$NO_x$** | Oxides of nitrogen |
| **PM2.5** | Particulate matter with an aerodynamic diameter of less than 2.5 µm |
| **PM10** | Particulate matter with an aerodynamic diameter of less than 10 µm |
| **PPM** | Parts per million; equivalent to mg/kg |
| **rpm** | Revolutions per minute |
| **$SO_2$** | Sulfur dioxide |

## Glossary of terms

| | |
|---|---|
| **Dust Extinction Moisture (DEM)** | Dust Extinction Moisture (DEM) is defined as the total moisture at which a dust number of 10 is attained on the dust/moisture curve. DEM is a useful point for comparing different coals and the effectiveness of reagents. The Australian standard document AS4156.6 "Determination of Dust/moisture Relationship for Coal" is now the standard for determining DEM in Australia. |
| **Parasitic Coal** | Coal that is deposited and carried on the external parts of a coal wagon, such as on: sills, shear plates and bogies. Parasitic coal is normally deposited during wagon loading and unloading |
| **Ploughing** | Occurs at unloading when coal wagons are driven through coal that has accumulated above the rail and unloading hopper. Ploughing is associated with coal wagons that unload via Kwik-Drop doors. Coal may accumulate above the rail when the rate of discharge from the wagon exceeds the capacity of the unloading hopper. |
| **Residual Coal/Carry-back** | Is coal that fails to discharge from the wagon whilst passing through the unloading station and are carried back to the mine. Coals that have poor discharge/flow properties and are significant contributors to residual coal in wagons are referred to as sticky coals. |
| **Veneering** | Veneering is the application of a biodegradable binding agent (suppressant) on the surface of the loaded coal in the wagon. The suppressant binds the coal particles together, forming a crust, which is resistant to lift-off from wind. |
| **Profiling** | Profiling is the practice of creating a consistent, uniform coal surface in a loaded wagon. A flat (also referred to as 'garden bed' or 'bread top') profile reduces wind erosion, and has a consistent cross section and height above the wagon sill |
| **Covering** | Covering refers to the use of wagon lids to cover the coal wagons. The wagon lids can be retrofitted onto the top of the coal wagons, and will completely enclose the wagon. |

# APPENDICES

## APPENDIX 1 TERMS OF REFERENCE

**Review of rail coal dust emissions management practices in the NSW coal chain**

The Government response to Recommendation 7 of the Inquiry into the Performance of the NSW Environment Protection Authority was that 'The Chief Scientist & Engineer has agreed to undertake a review of rail coal dust emissions management practices. This will include a review of the work the EPA has undertaken in relation to coal dust emissions along the rail corridor in the Hunter Valley, as well as review of environmental monitoring, the literature, and the environmental management practices of operators using the rail network."

In undertaking the review the Chief Scientist & Engineer will provide advice on coal dust and related emissions in the rail corridor, in particular:

1. Identify, describe and comment on:
    a. key issues, including current scientific knowledge and matters of expressed public concern
    b. initiatives in NSW and other jurisdictions to address issues, including measurement , prevention and management practices
    c. any gaps or issues arising
2. Describe advances in technology for sampling and monitoring air emissions from the coal chain in the rail corridor.

The review report will also include contextual information on air quality including dust and particulate emissions across the coal supply chain, and approaches used by NSW and other jurisdictions to measure, assess and manage these.

In undertaking the review the Chief Scientist & Engineer may consult with stakeholders and engage experts as needed.

The NSW Chief Scientist & Engineer will provide to the Minister for the Environment an initial report by 30 November 2015 and a final report by 31 March 2016.

# APPENDIX 2 NSW COAL MINES, COMMUNITIES AND CORRIDORS

Table 1: NSW mines, communities and corridors

| Mine site | Mine type | Community (city/town) | Sole or major owner (parent company in brackets) | Distance mine to coal export terminal km [b, c] | Cycle time (hrs)[d] |
|---|---|---|---|---|---|
| **Central west. Total mines 10** | | | | | |
| Airly (reopened) | Underground | Lithgow | Centennial Coal Company Ltd | 300 | 19 |
| Charbon (temporarily closed) | Underground | Kandos-Rylstone | Centennial Coal Company Ltd | 325 | 20 |
| Clarence | Underground | Lithgow | Centennial Coal Company Ltd | 221 | 15 |
| Cullen Valley (temporarily closed) | Open cut | Lithgow | Coalpac Pty Ltd | 270 | 17 |
| Invincible (temporarily closed) | Open cut & Highwall | Lithgow | Coalpac Pty Ltd | 159 | 11 |
| Moolarben | Open cut/ Underground | Mudgee | Moolarben Coal Mines Pty Ltd (Yancoal Australia Pty Ltd) | 280 | 18 |
| Pine Dale (reopened) | Open cut | Wallerawang | Energy Australia (CLP Holdings) | N/A | N/A[e] |
| Springvale | Underground | Lithgow | Centennial Coal Company Ltd | 240 | 16 |
| Ulan | Underground | Mudgee | Ulan Coal Mines Ltd (Glencore) | 280 | 18 |
| Wilpinjong | Open cut | Mudgee | Wilpinjong Coal Pty Ltd (Peabody Energy Australia) | 275 | 18 |
| **Lower Hunter. Total mines 9** | | | | | |
| Abel | Underground | Newcastle | Donaldson Coal Pty Ltd | 25 | 4 |
| Austar | Underground | Cessnock | Yancoal Australia Pty Ltd Awaba | 65 | 6 |
| Bloomfield | Open cut | East Maitland | Bloomfield Group | 25 | 4 |
| Chain Valley | Underground | Wyong-Lake Macquarie | LDO Coal Pty Ltd Donaldson | 60 | 6 |
| Duralie | Open cut | Gloucester-Stroud | Gloucester Coal Ltd | 156 | 11 |
| Mandalong | Underground | Lake Macquarie-Morisset | Centennial Coal Company Ltd | 29 | 4 |
| Myuna | Underground | Lake Macquarie-Wangi Wangi | Centennial Coal Company Ltd | 35 | 5 |
| Stratford | Open cut | Gloucester | Gloucester Coal Ltd | 136 | 11 |
| West Wallsend (closing mid 2016) | Underground | Newcastle-Killingworth | Glencore | 25 | 4 |
| **Upper Hunter. Total mines 18** | | | | | |
| Ashton (temporarily closed) | Underground | 14km northwest of Singleton | Ashton Coal Operations Ltd (Yancoal Australia Pty Ltd) | 114 | 9 |
| Beltana | Underground | 18km south of Singleton | Glencore | 90 | 8 |
| Bengalla | Open cut | 4km west of Muswellbrook | Coal and Allied (Rio Tinto) | 134 | 10 |
| Bulga | Open cut | 15km southwest of Singleton | Glencore | 90 | 8 |
| Drayton | Open cut | 10km south of Muswellbrook | Anglo American Metallurgical Coal Pty Ltd Hunter Valley Operations | 120 | 9 |

| Mine site | Mine type | Community (city/town) | Sole or major owner (parent company in brackets) | Distance mine to coal export terminal km [b, c] | Cycle time (hrs)[d] |
|---|---|---|---|---|---|
| Glendell | | 25km northwest of Singleton | Glencore | 93.1 | 8 |
| Hunter Valley Operations | Open cut | 24km northwest of Singleton | Coal and Allied Industries Ltd (Rio Tinto) | 108 | 9 |
| Integra Coal Operations (temporarily closed) | Underground | 10km northwest of Singleton | Integra Coal Operations Pty Ltd (Vale Australia) | 91 | 8 |
| Liddell | Open cut | 18km northwest of Singleton | Liddell Coal Operations Pty Ltd (Glencore) | 107 | 9 |
| Mangoola | Open cut | 7km northwest of Denman, Hunter Valley | Glencore Mangoola Coal | 130 | 10 |
| Mt Arthur Coal | Open cut | 5km southwest of Muswellbrook | Mt Arthur Coal Pty Ltd (BHP Billiton) Mount Owen Complex | 120 | 9 |
| Mount Owen Complex | Open cut | 25km northwest of Singleton | Glencore Mt Owen | 105 | 9 |
| Mount Thorley Warkworth | Open cut | 14km southwest of Singleton | Coal and Allied (Rio Tinto) | 89 | 8 |
| Muswellbrook No 2 | Open cut | 3km northeast of Muswellbrook | Idemitsu Australia Resources Pty Ltd Narama | 125 | 10 |
| Narama | Open cut | 25km northwest of Singleton | Glencore | 105 | 10 |
| Ravensworth Operations | Open cut/ Underground | 20km northwest of Singleton | Glencore | 110 | 9 |
| Rix's Creek | Open cut | 5km northwest of Singleton | Rix's Creek Ltd (Bloomfield Group) | 88 | 8 |
| Wambo | Underground | 16km west of Singleton | Wambo Coal Pty Ltd (Peabody Energy Australia) | 95 | 8 |
| **New England/North West. Total mines 6** | | | | | |
| Boggabri | Open cut | 17km northeast of Boggabri | Boggabri Coal Pty Ltd (Idemitsu Australia Resources Pty Ltd) | 364 | 23 |
| Narrabri North | Underground | 17km southeast of Narrabri and 70km northwest of Gunnedah | Narrabri Coal Operations Pty Ltd (Whitehaven Coal Mining Ltd) | 410 | 25 |
| Rocglen | Open cut | 28km north of Gunnedah | Whitehaven Coal Mining Ltd | 316 | 20 |
| Sunnyside | Open cut | 15km west of Gunnedah | Whitehaven Coal Mining Ltd | 320 | 20 |
| Tarrawonga | Open cut | 16km east of Boggabri | Whitehaven Coal Mining Ltd/ Idemitsu Australian Resources Pty Ltd | 316 | 20 |
| Werris Creek | Open cut | Quirindi, 4km south of Werris Creek | Werris Creek Coal Pty Ltd (Whitehaven Coal Mining Ltd) | 275 | 18 |
| | | | **Northern Rail System Maximum** | **410** | **25** |
| | | | **Northern Rail System Minimum** | **25** | **4.3** |
| | | | **Northern Rail System Average** | **162** | **12** |
| **Illawarra. Total mines 7** | | | | | |
| Appin/ West Cliff | Underground | Appin-Douglas Park | Illawarra Coal | 49 | N/A[f] |
| Dendrobium | Underground | Wollongong-Mt Kembla | Illawarra Coal | 7 | 3.3 |
| Metropolitan | Underground | Wollongong-Helensburgh | Helensburgh Coal Pty Ltd (Peabody Energy Australia) | 43 | 5 |

| Mine site | Mine type | Community (city/town) | Sole or major owner (parent company in brackets) | Distance mine to coal export terminal km [b, c] | Cycle time (hrs)[d] |
|---|---|---|---|---|---|
| NRE No. 1 | Underground | Wollongong | Wollongong Coal Pty Ltd | 15 | 4 |
| NRE Wongawilli | Underground | Wollongong | Wollongong Coal Pty Ltd | 15 | 4 |
| Tahmoor | Underground | Wollongong-Tahmoor | Glencore | 122 | 10 |
| West Cliff | Underground | Appin-Wollongong | Endeavour Coal Pty Ltd (BHP Billiton) | 43 | N/A[f] |
| | | | **Southern Rail System Maximum** | **122** | **10** |
| | | | **Southern Rail System Minimum** | **7** | **3.3** |
| | | | **Southern Rail System Average** | **42** | **5** |
| **Total operating mines in NSW, 50. Of these, 43 are in the Hunter and 7 are in the Illawarra** | | | | | |

**Notes:**
a. Source: NSW Minerals Council Key Industry Statistics 2011
b. Taken as Kooragang Island or Port Kembla for Hunter or Illawarra respectively (except for mines which are N/A as they supply power stations which are domestic only).
c. Distances taken as the longest from various sources. Sources: Aurizon Hunter Valley Corridor Fact Sheet (2013), Katestone Environmental Pty Ltd (2014), NSW Department of Industry, Resources & Energy (2014).
d. Cycle times are from the NSW Coal Industry Profile 2014 (time from starting point to starting point). Because most of the coal trains are 120t wagon trains, the coal network tends to be limited to a planned maximum speed of 60km/h in the loaded direction and 80km/h in the unloaded direction.
e. Some mines in the Central West and Lower Hunter transport their coal either by truck or overland conveyor directly to customers. Rail transport times are therefore not relevant to these mines.
f. Some mines in the Illawarra transport their coal either by truck or overland conveyor directly to customers. Rail transport times are therefore not relevant to these mines.

# APPENDIX 3 HUNTER REGION AIR QUALITY MONITORING NETWORK

**Table 2: Hunter region air quality network**

| Location | Distance to corridor (m, ± 25 m) | Monitoring Station Network Status | $PM_{10}$ | $PM_{2.5}$ | $SO_2$ | $NO_x$ | $O_3$ | CO / $NH_3$ | Meteorological Variables Measured | Sampling Techniques & Period |
|---|---|---|---|---|---|---|---|---|---|---|
| **Newcastle and Lower Hunter Valley** | | | | | | | | | | |
| Beresfield | 200 | NEPM- monitor | ✓ | ✓ | ✓ | ✓ | ✓ | | Wind speed, wind direction, sigma theta, relative humidity, ambient temperature | TEOM ($PM_{10}$ and $PM_{2.5}$), Fine particles via nephelometry |
| Newcastle | 870 | NEPM- monitor | ✓ | | ✓ | ✓ | ✓ | **CO** | Wind speed, wind direction, sigma theta, relative humidity, ambient temperature | TEOM ($PM_{10}$), Fine particles via nephelometry |
| Wallsend | 3840 | NEPM- monitor | ✓ | ✓ | ✓ | ✓ | ✓ | | Wind speed, wind direction, sigma theta, relative humidity, ambient temperature, net radiation | TEOM ($PM_{10}$ and $PM_{2.5}$), Fine particles via nephelometry |
| Carrington | 600 | NLAQMN | ✓ | ✓ | ✓ | ✓ | | | Wind speed, wind direction, sigma theta, relative humidity, ambient temperature | TEOM ($PM_{10}$), BAM ($PM_{2.5}$) |
| Mayfield | 1200 | NLAQMN | ✓ | ✓ | ✓ | ✓ | | | Wind speed, wind direction, sigma theta, relative humidity, ambient temperature | TEOM ($PM_{10}$), BAM ($PM_{2.5}$) |
| Stockton | 900 | NLAQMN | ✓ | ✓ | ✓ | ✓ | | **$NH_3$** | Wind speed, wind direction, sigma theta, relative humidity, ambient temperature | TEOM ($PM_{10}$), BAM ($PM_{2.5}$) |
| **Upper Hunter Valley** | | | | | | | | | | |
| Singleton | 1800 | UHAQMN | ✓ | ✓ | ✓ | ✓ | | | Wind speed, wind direction, sigma theta | TEOM ($PM_{10}$), BAM ($PM_{2.5}$) |
| Muswellbrook | 600 | UHAQMN | ✓ | ✓ | ✓ | ✓ | | | Wind speed, wind direction, sigma theta | TEOM ($PM_{10}$), BAM ($PM_{2.5}$) |
| Maison Dieu | 7350 | UHAQMN | ✓ | | | | | | Wind speed, wind direction, sigma theta | TEOM ($PM_{10}$) |
| Bulga | 6400 | UHAQMN | ✓ | | | | | | Wind speed, wind direction, sigma theta | TEOM ($PM_{10}$) |
| Mt Thorley | 250 | UHAQMN | ✓ | | | | | | Wind speed, wind direction, sigma theta | TEOM ($PM_{10}$) |

| Location | Distance to corridor (m, ± 25 m) | Monitoring Station Network Status | $PM_{10}$ | $PM_{2.5}$ | $SO_2$ | $NO_x$ | $O_3$ | CO / $NH_3$ | Meteorological Variables Measured | Sampling Techniques & Period |
|---|---|---|---|---|---|---|---|---|---|---|
| Camberwell | 1600 | UHAQMN | ✓ | ✓ | | | | | Wind speed, wind direction, sigma theta | TEOM ($PM_{10}$), BAM ($PM_{2.5}$) |
| Singleton NW | 395 | UHAQMN | ✓ | | | | | | Wind speed, wind direction, sigma theta | TEOM ($PM_{10}$) |
| Singleton South | 1820 | UHAQMN | ✓ | | | | | | Wind speed, wind direction, sigma theta | TEOM ($PM_{10}$) |
| Warkworth | 270 | UHAQMN | ✓ | | | | | | Wind speed, wind direction, sigma theta | TEOM ($PM_{10}$) |
| Jerrys Plains | 14470 | UHAQMN | ✓ | | | | | | Wind speed, wind direction, sigma theta | TEOM ($PM_{10}$) |
| Muswellbrook NW | 830 | UHAQMN | ✓ | | | | | | Wind speed, wind direction, sigma theta | TEOM ($PM_{10}$) |
| Aberdeen | 825 | UHAQMN | ✓ | | | | | | Wind speed, wind direction, sigma theta | TEOM ($PM_{10}$) |
| Wybong | 15380 | UHAQMN | ✓ | | | | | | Wind speed, wind direction, sigma theta | TEOM ($PM_{10}$) |
| Merriwa | 27000 | UHAQMN | ✓ | | | | | | Wind speed, wind direction, sigma theta | TEOM ($PM_{10}$) |

**Notes:**
NLAQMN: Newcastle Local Air Quality Monitoring Network
UHAQMN: Upper Hunter Air Quality Monitoring Network
TEOM: Tapered Element Oscillating Microbalance
BAM: Beta Attenuation Monitor

# APPENDIX 4 TABLE OF STUDIES

**Table 3: Studies**

| **Title<br>Date/ Stage / Jurisdiction** | **Author** | **Focus/<br>Questions addressing** | **Methods** | **Results/<br>Conclusions** |
|---|---|---|---|---|
| **General or comprehensive studies (including literature review/gap analysis/modelling/mitigation/etc.)** | | | | |
| *Literature Review of Coal Train Dust Management Practices*<br><br>Dec 2014/ final report/ NSW (reviews other jurisdictions)<br><br>(Katestone Environmental Pty Ltd, 2014) | Katestone Environmental Pty. Ltd. for NSW EPA | Focus on current literature surrounding coal train dust management practices and measures relevant to the Hunter Valley rail corridor and other coal rail corridors in NSW<br><br>Focus: rail corridor and ambient | Literature review, which:<br>• Explains the regulatory framework for rail coal dust in Australia (includes NSW, Qld - which includes Aurizon as both the 'above' and 'below' rail operator and the US Railway Regulations.<br>• Describes and evaluates measures used both nationally and internationally to control coal dust emissions from trains, including coal loading and unloading, wind erosion from coal in wagons and coal spillage in the rail corridor.<br>• Ranks techniques and studies according to their perceived effectiveness or relevance to NSW. | Literature indicates:<br>• Dust levels increase when trains pass for loaded, unloaded, freight and passenger<br>• No exceedances of NEPM standards were found at monitoring stations in or near the rail corridor when monitors were used in accordance with Australian standards<br>• Effectiveness of most management practices not well documented in literature (except water or veneer suppressant which are claimed to reduce top of wagon emissions by 50-99%)<br>• Wagon lids are estimated to reduce dust off the top of the wagons by 99% but have significant disadvantages<br>• Veneering costs for NSW were estimated at $0.02- 0.04 per tonne; water at $0.005 per tonne |
| *Impacts of fugitive dust from coal trains in NSW – stage 1 gap analysis*<br><br>Feb 2010/ final report/ NSW | PAE Holmes for ARTC | Undertaken by the ARTC as mandated by a Pollution Reduction Program (PRP 4) in their Environmental Protection Licence (EPL) to investigate technologies to reduce fugitive coal dust emissions associated with | Stage 1- desktop review of literature, (including Connell Hatch (2008) report and how applies to NSW) and data - gap analysis<br>In particular, the study investigated how applicable the Connell Hatch report for Queensland Rail (2008) was to the situation in NSW. | The gap analysis, in reviewing Connell Hatch (2008), accepted that erosion off the surface of the wagon is likely to be the major contributor to emissions from wagons. But it acknowledged many factors would be different and those needed investigation. |

| Title<br>Date/ Stage /<br>Jurisdiction | Author | Focus/<br>Questions addressing | Methods | Results/<br>Conclusions |
|---|---|---|---|---|
| (Holmes, 2010) | | rail transport in NSW. Study to determine extent of issue, any potential environmental harm and possible mitigation measures.<br><br>Focus: rail corridor | | The report notes that in order to fully understand the issue in NSW and evaluate the effectiveness of mitigation measures (compared with Queensland), the following needs to be analysed for NSW:<br>● increase in coal transport<br>● dust extinction moisture (DEM) levels for NSW coals<br>● wind speeds for dust lift off of NSW coals<br>● other NSW coal property data (e.g. fines content, density, strength, etc.)<br>● train speeds in NSW<br>● evaluate differences in TSP emission estimates between Connell Hatch report and other studies<br>● applicability of veneering studies for NSW<br>● loading/unloading practices in NSW<br>● potential contribution of coal spillage and re-suspension<br>Note: Since the report's publication, NSW industry (see NSW Mining website) has been undertaking wind tunnel testing, DEM testing, testing effectiveness of veneering, etc. Some of the outcomes of this work are not yet available. |
| *Final Report - Environmental Evaluation of Fugitive Coal Dust Emissions from Coal Trains Goonyella, Blackwater, and* | Connell Hatch for Queensland Rail Limited | Environmental Evaluation conducted by Connell Hatch for QR Limited (later Aurizon) in response to a notice by the Queensland EPA to identify, quantify, assess risk and propose | ● Reviewed three previous rail corridor monitoring studies<br>● Undertook TSP monitoring over 4 months at 14 sites (6 within corridor) using Partisol monitors<br>● Compared against air quality goals for TSP and PM10<br>● Dispersion modelling using Cal3QHCR (Gaussian line source model) | ● Concluded that TSP did not exceed the guideline of 150 µg/m3 (EPP (Air) Goal) over monitoring period for each site<br>● Assuming PM10 is 50% of TSP and comparing TSP results to PM10 NEPM standards, they |

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| *Moura Coal Queensland Rail Systems*<br><br>March 2008 / final report/ Qld<br><br>(Connell Hatch, 2008) | | mitigation measures relating to fugitive dust emissions from coal trains.<br><br>Aim to quantify ambient concentrations of coal dust in rail corridor in Central Queensland.<br><br>Analysis to quantify source of dust emissions and evaluate various mitigation options: (e.g.:<br>Appendix C - *Wind Tunnel Program to Determine the Extent of Dust Lift-Off From the Surface of Typical Coal Types When Treated With Surface Veneer Chemicals Under Simulated Rail Transport Operations*<br>Appendix D - *Wagon and load profiling wind tunnel – University of Sydney and Computational Fluid Dynamics)*<br><br>Focus: rail corridor and ambient | • Literature review of emissions factors and estimation of dust lift off from exposed surface and from other sources<br>• Desktop analysis of the cost benefits of various mitigation options<br>The study characterised the dust emissions rate from the surface of the wagons, leakage from doors, wind erosion of spilled coal, residual coal in empty wagons and parasitic load.<br><br>Methods used included:<br>**Surface of wagons:**<br>• literature review<br>• a mathematical model derived from a computational fluid dynamics (CFD) model by Witt et al. 1999<br>• wind tunnel testing to confirm the CFD model<br>• model estimated that rail wagons would lose an average of 9.6 g/km/wagon (or 0.0035 percent) of their total load<br><br>**Leakage from doors**<br>• Refer to *Coal Leakage from Kwik-Drop Doors - Coal Loss Management Project* detailed under *Veneering studies/testing effectiveness of mitigation techniques* below. | concluded that exceedances of PM10 at monitoring sites were unlikely<br>• Contribution by coal dust in cases of exceedances found to be minor<br>• Based on modelling results, concluded that exceedances beyond the corridor are unlikely<br>• The emission rate of coal (TSP) is estimated to be 5416 tonnes per year for the Blackwater, Moura and Goonyella systems, with and estimated growth to 7882 tonnes per year by 2014/15<br>• At least six ambient air quality monitoring studies were conducted since 1993 to investigate PM adjacent to the coal rail corridor, with all concluding that they did not find the potential for any adverse health impacts to those inside or outside of the rail corridor<br>• The Callemondah (2007) and Moura, Goonyella and Blackwater studies indicate that the effect of coal dust emissions on ambient dust concentrations is measureable at 15 m from the rail centreline, with some mines having dustier coal types.<br>• Estimated 80% of coal dust emissions from surface of wagon; 9% spilled coal; 6% door leakage; 4% parasitic coal; 1% residual coal in unloaded wagons |

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| | | | | • Laboratory testing indicated that on seven typical coal types transported by QR Ltd. and five surface veneer products (applied at one L/m2) resulted in a significant reduction in emissions (dust lift-off) when compared to no treatment<br>• Whilst wagon lids may reduce coal dust emissions, there are other factors that need to be considered - potential operational costs, reliability and maintenance requirements, and facility requirements.<br>• Indicated that emission rates from the top of the wagon (i.e. coal lift-off) may increase by a factor of 5-10 when a unloaded train passes due to the increase in turbulence and the speed at which empty trains travel (up to 100 km/hr)<br>• Wind erosion of spilled coal – A preliminary upper bound estimate of the amount of coal dust emitted from coal deposited in the corridor is 600 tonnes per annum.<br>• Residual coal in empty wagons – On average, the worst-case coal carry-back was found to be 0.13 tonnes per wagon (CSIRO et al, 2007). |
| *Draft Environmental Impact Statement, (relevant air quality sections)*<br>April 2015/ USA | Tongue River Railroad Company, Inc. | The Tongue River Railroad is a planned rail line in Southern Montana that would connect the region around Ashland, Montana | • In Chapter 4, the Surface Transportation Board's (Board) Office of Environmental Analysis (OEA) analysed the risks of airborne coal dust using US EPA approved methods to estimate emissions.<br>• In Chapter 6, OEA also analysed how coal dust could | **Coal dust and diesel emissions:** The OEA found that aggregate concentration of all types of particulate matter, including airborne coal dust, would be below air quality |

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| (OEA, 2015) | | with a BNSF Railway line to the north.<br><br>Chapter 4 describes the impacts on air quality that would result from construction and operation of the railroad.<br><br>Chapter 6 describes the impacts from coal dust on people, property, and ecosystems that could result from construction and operation of the railroad.<br><br>Appendix E provides information on the inputs and emissions calculations used for estimating the BNSF Railway Company (BNSF) locomotive fleet emissions for operating the railway lines. It also provides information on the size distribution of coal dust particles.<br><br>Appendix G provides the details of the modelling analysis of coal dust ingestion and its impacts on human health and ecological receptors.<br><br>Focus: rail corridor and ambient | affect human health if it were to be ingested by humans or to make its way into soil or water.<br>**Appendix E, Air Quality, Emissions, and Modelling Data:**<br>● This Appendix used concentration and deposition modelling to estimate coal dust emissions.<br>● OEA used the US EPA AERMOD dispersion model (U.S. Environmental Protection Agency 2004) with the estimated emission rates, along with meteorological data for the study area, to estimate the concentrations of airborne pollutants and the deposition of particulate matter that could result from operation of the proposed rail line.<br>● The emissions calculations were based on three coal production scenarios—low, medium, and high.<br>● OEA evaluated the locomotive emissions for the initial production year, along with intermediate years 2023 and 2030 and the full build-out scenario of 2037.<br>● OEA developed these estimates by modelling the coal dust emissions from the coal trains along with other key inputs, including hourly meteorological data, terrain data, land-use information, coal dust particle size, train speed, type of coal, and application of a topper agent.<br>**Appendix G, Coal Dust Analysis:**<br>● This Appendix used a deposition model combined with a fate and transport model to estimate both human health and ecological impacts.<br>● In a search of the available scientific literature, OEA did not identify any scientific studies that specifically examined the human health risks associated with coal dust from moving rail cars. | standards for particulate matter. The OEA determined that exposure would be within applicable standards and guidelines for all emissions including:<br>● Locomotive exhaust emissions<br>● Coal dust emissions from rail cars<br>● Particulate matter emissions from wind erosion<br>● Exhaust emissions from motor vehicles delayed at grade crossings<br>● Coal dust deposition<br>● Visible airborne dust<br>● Risk of wildfires and subsequent pollutant emissions<br>OEA concluded that coal dust from rail cars on the proposed rail line would not affect human health. |
| **Monitoring of particulate levels in or near the rail corridor** | | | | |
| *Pollution Reduction* | Environ Australia | Pilot monitoring program by | ● Two monitoring sites in rail corridor at Metford and | ● At the Metford monitoring |

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| *Program (PRP) 4 - Particulate Emissions from Coal Trains*<br><br>Sept 2012/ study complete/ NSW<br><br>Note: PRP 4.1 followed from PRP4 Stage 1 Gap Analysis by PAE Holmes 2010 (see row 2 above)<br><br>(ENVIRON, 2012) | (for ARTC) | ARTC as mandated by PRP 4.1 to investigate whether coal trains and rail transport contribute to particulate levels along Hunter rail network<br><br>Focus: rail corridor | Mayfield were set up over one month using Osiris equipment to measure TSP, PM10, PM2.5<br>• Wind direction and speed was recorded for each train passing<br>• Continuous measurements made whether trains or no trains | station, TSP, PM10 and PM2.5 concentrations recorded coinciding with all trains, including loaded coal, unloaded coal, freight and passenger were statistically greater than the 'no train' data set.<br>• There was no significant difference between loaded and unloaded coal trains.<br>• At the Mayfield site, there was a statistical difference between the 'no train data' and the concentrations recorded to coincide with all of the train categories, including loaded coal, unloaded coal, freight and passenger for TSP and PM10. When examining PM2.5 and the 'no train data' there was only a statistical difference for the freight and passenger train types.<br>• The Mayfield results were found to be unreliable due to high % of multiple trains passing, slow train speeds, difficulty matching pass by with train type.<br>• The pilot didn't investigate compliance against standards or health assessment, as not in scope. Commented briefly on levels compared to Newcastle, and found to be slightly higher.<br>Note: single monitor not equidistant to multiple parallel tracks |
| *Pollution Reduction Program 4.2 Particulate Emissions* | Katestone Environmental Pty. Ltd. (for | ARTC required under PRP 4.2 to undertake monitoring further to pilot (PRP4.1) at | • Used Osiris monitor for TSP, PM10, and continuous PM2.5 concentrations 3-4 metres from the nearest of four parallel tracks | • Passenger and freight trains were not associated with a statistically significant difference in TSP, |

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| *from Coal Trains*<br><br>May 2013 / study complete/NSW<br><br>(Katestone Environmental Pty Ltd, 2013) | ARTC) | Metford<br><br>The objective was to determine whether:<br>• trains on the Hunter network are associated with elevated particulate matter concentrations;<br>• loaded coal trains have a stronger association with elevated PM than unloaded coal trains or other trains on the network (and by inference contributing to ambient rail corridor particulate levels)<br><br>Focus: rail corridor | • Wind direction and speed were measured<br>• Compared measurements with the concentration of particulate matter when no train was present.<br>• | PM10 and PM2.5 concentrations when compared with the concentrations recorded when no train was passing the monitoring station; loaded trains were associated for TSP only but unloaded trains were associated for TSP, PM10, and PM2.5.<br>• There was no trend in concentration changes with train speed or ambient wind speed<br>• When wind blew toward monitor, average increase in TSP, PM10, and PM2.5 for unloaded trains was 23%, 24%, 21% respectively; for loaded trains 14%, 14%, 11% respectively. The source of the dust wasn't examined.<br>• The report showed a brief comparison of measured PM10 and PM2.5 24-hour levels against 3 OEH sites in the Hunter and generally found the levels at the study sites to be slightly higher, but limited data was provided in the report. |
| *Re-analysis of ARTC Data on Particulate Emissions from Coal Trains*<br><br>Feb 2014 / study complete/NSW<br><br>(Ryan & Wand, 2014) | Professor Louise Ryan from UTS | Particulate levels in or near the rail corridor<br><br>Focus: rail corridor | The ARTC PRP 4.2 monitoring data was analysed using a variant of linear regression, with outcome variables corresponding to one of the four particulate measures (PM1, PM2.5, PM10 or TSP).<br>The regression analysis took into consideration the likelihood of serial correlation due to the time-series nature of the data.<br><br>Note: the ARTC data or report were also the subject of a July 2013 peer review by Dr Luke Knibbs and September 2013 by Professor Louise Ryan | Regression analysis conducted by Professor Ryan showed;<br>• evidence that PM levels were elevated when trains pass for TSP, PM10, PM2.5 and PM1<br>• particulate levels were elevated in the few minutes before, during, and the few minutes after a train passed<br>• the effect was around 10% above background for both freight and coal trains (unloaded and loaded) |

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| | | | | • elevated levels from passenger train was a smaller magnitude, though still mostly statistically significant except it was nonsignificant when a passenger train was passing on its own (no multiple passing)<br>• due to increased levels of the smaller particle sizes, diesel may be of more concern than coal dust<br>Note: The advantage of regression analysis over the analyses undertaken in the Katestone (2013) report, is that it allows for simultaneous adjustment with respect to various confounding factors that may otherwise bias or distort the analysis. |
| *Additional analysis of ARTC data on particulate emissions in the rail corridor*<br><br>Aug 2015 / study complete/NSW<br><br>(Ryan & Malecki, 2015) | Professor Louise Ryan from UTS | Particulate levels in or near the rail corridor<br><br>Focus: rail corridor | The regression modelling was continued with analysis including further data - precipitation records and the number of locomotives pulling each train.<br><br>Precipitation data were made available from a monitoring station in Maitland that recorded rain (in mm) on a daily basis and another monitor in Cessnock that recorded data on a 30 minute basis. | • The reanalysis found that the number of locomotives had little impact on particulate levels. (Caveat: ARTC warned that they do not believe that the locomotive data are entirely accurate.)<br>• The author noted that the findings dispel, to some extent, the hypothesis that diesel exhaust explains a large proportion of the observed increases in particulate levels associated with trains passing.<br>• There was a strong association with previous day's rain in Maitland, suggesting that a key mechanism for the increased particulate levels was passing trains stirring up dust that had |

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| | | | | previously settled on the tracks.<br>● The impact of the previous day's rain was the same, regardless of which type of train was passing. |
| *Coal Dust in our Suburbs*<br><br>March 2013 / study complete/NSW<br><br>(Rogers et al., 2013) | Coal Terminal Action Group - community monitoring study | Focus on PM exposure levels for people living in the rail corridor. 'Snapshot' of air quality in residential areas close to corridor and Port of Newcastle.<br><br>Focus: rail corridor | Three Osiris DustTrack portable air monitors across 12 sites in the Lower Hunter measuring for PM1, PM2.5, PM10 at 1 or 10 min intervals over Dec 2012 and January 2013; wind speed and direction was monitored<br><br>Data was compared against the closest EPA monitors at Newcastle, Beresford, or Stockton | ● 7 of 11 sites recorded exceedances to 24-hour PM10 NEPM standard; OEH monitors did not record exceedances<br>● 1 of 11 recorded a PM2.5 24-hour exceedance of the advisory guidelines; OEH sites did not record exceedances<br>Note: Osiris monitor is not a compliance monitor and as such, the results are stated as not suitable for comparison against NEPM ambient air quality standards; source of PM not identified as out of scope |
| *Coal Train Pollution Signature Study*<br><br>August 2013 / study complete/NSW<br><br>(Higginbotham et al., 2013) | Coal Terminal Action Group - community monitoring study | Study to investigate particulate signatures and increases in particulate levels from passing coal trains for residential areas close to rail corridor<br><br>Focus: near the rail corridor and other coal facilities (ports, mines, etc.) | Used Osiris monitors to record continuous PM10, PM2.5, and PM1 from 15-17 July 2013 at Beresfield and Hexham. Wind speed, direction, train speed and type also recorded. Pre-train results measured during the 2 minutes before a train passes were compared against the measurements during the train's' passage. Monitors were calibrated against EPA monitor at Beresfield site | ● 81% of coal trains produced a recognisable pollution signature; 19% did not.<br>● Results focused on 8 signatures (of 73 measured train passings), finding that PM10 levels rose between 94% and 427% for loaded coal trains; an unloaded coal train signature increased 1210%; while coal trains pass, particulate pollution increase up to 13 times; freight trains showed much lower increases |
| *Western - Metropolitan Rail Systems Coal Dust Monitoring Program Final report* | The Queensland, Department of Science, Information Technology, Innovation and | Air quality scientists at the QLD Department of Science, Information Technology and the Arts (DSITIA) independently assessed both health and | Dust monitoring was conducted over a four-month program between early March and early July 2013, and provides an assessment of the impact of coal wagon veneering on ambient particle levels along the rail corridor following the commencement of coal wagon load profiling and veneering at the New Acland Mine on 2 May 2013. | The study reported:<br>● PM10 and PM2.5 24 hour concentrations complied with ambient air quality objectives during the investigation period (study noted lot of rain during |

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| Oct 2013 / study complete/QLD<br><br>(DSITIA, 2013) | the Arts (DSITIA) | nuisance impacts of dust from all sources at six sites along the rail corridor into the Port of Brisbane. Study commissioned by a group comprising coal producers and supply chain service providers.<br><br>The study collected data on:<br>• PM10 and PM2.5 levels<br>• Deposited dust<br>• Changes in particles when coal trains pass (focus not on type of trains but effectiveness of veneering)<br><br>Focus: rail corridor | Monitoring was conducted at six locations along the Western and Metropolitan rail systems used to transport coal to the Port of Brisbane (Oakey, Willowburn (Toowoomba), Dinmore, Tennyson, Fairfield and Coorparoo) and one background location on a section of the Metropolitan rail system not used by coal trains (Chelmer).<br>Partisol® Model 2025 or dichotomous Partisol® Model 2025-D sequential low-volume air samplers<br>Model 8533 Dusttrak™ DRX Aerosol Monitor (non-compliant) to determine the five minute averaged particle measurements<br><br>Note:<br>The South Queensland Coal Health Action Network (SCAN), an alliance of community groups concerned about the health impacts of coal mining and transportation, were critical of the method used in the report, stating that, “The Western Metropolitan Coal Dust report only reports on 24 hour average concentrations at each location and makes no mention of short term 'spikes' as coal trains pass. Short-term exposure to elevated particle pollution causes adverse health impacts.” It also noted monitoring was undertaken during a wet month. (Source: http://www.lockthegate.org.au/mr_airqualityseq) | pre-veneering period).<br>• A general trend towards decreased dust deposition rates and lower levels of coal dust in the deposited dust samples was observed at most monitoring sites following the implementation of veneering.<br>• Changes in particle levels resulting from the passage of trains were determined to mainly be the result of re-entrained particles from surfaces within the rail corridor rather than direct emissions from trains<br>• Trains were found to result in little change in the 10 minute average PM10 and PM2.5 levels at 3 sites within the corridor. There also appeared to be little difference between train types.<br>• PM10 and PM2.5 levels at corridor site may not be rail emissions but regional urban PM - conclusion made because close correlation between rail monitors and ambient network in Brisbane<br>• Insoluble dust deposition rates did not exceed the trigger level for dust nuisance of 4g/m$^2$/30days above background levels (or 130 mg/m$^2$/day averaged over a 30-day period) recommended by the New Zealand Ministry for the Environment at any of the rail corridor monitoring sites during both the pre- and post-veneering |

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| | | | | monitoring periods.<br>● Examination indicated that mineral dust (soil and rock) was the major component, accounting for 50-90% of particles<br>● Coal dust was consistently detected in the deposited dust from all monitoring sites along the rail corridor used by coal trains (most around 10% - ranging from trace to 20%). At most sites, rubber dust also made up 10%. |
| *Health hazard in our suburbs: particulate pollution along the South-East Queensland coal dust corridor*<br><br>May 2015 / study complete/QLD<br><br>(Kane, 2015) | Michael Kane for Clean Air Queensland Alliance - community monitoring study | The study undertook preliminary particle pollution monitoring at several sites along the West Moreton rail line determine the pollution signatures from passing coal trains, both loaded and unloaded, in response to residents' long-term pollution and health concerns.<br><br>Focus: rail corridor | ● Nine monitoring sessions at Wynnum, Morningside, and Fairfield<br>● monitoring site where trains typically travel between 60-80 km/hr, free of environmental interference, close to and on downwind side of tracks<br>● Osiris monitors 'directly adjacent to coal rail line' and downwind to measure TSP, PM10, PM2.5, PM1<br>● Stored data downloaded using AirQ32 software<br>● Measured ambient (5 minutes before train passed), 2 minutes during passage, 5 minutes after<br>● weather data collected from BOM<br>● pre-train arrival used as ambient value<br>● 8 signatures were examined for the study which represented the 'worst-case' events | ● For the 8 signatures reported, loaded coal trains showed increases of 500% - 1000% over ambient levels of PM10 prior to the train passing; 500% - 900% for unloaded. The intensity of the peak varied significantly between different coal trains. Some coal trains showed no signature.<br>● Data gathered after rain events show little or no signature.<br>● Freight trains showed increases in particle pollution readings while the diesel locomotive passed, ranging between 100% and 150% of the ambient levels of PM10 prior to the train passing.<br>● During train passing, areas adjacent to coal corridor experience intense PM pollution between 5-9x pre-passing levels.<br>● Trains were assumed to be veneered, with study questioning |

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| | | | | the effectiveness of veneering in suppressing dust |
| *Diesel particulate matter and coal dust from trains in the Columbia River Gorge, Washington State, USA*<br><br>Oct 2015/study complete/USA<br><br>(Jaffe et al., 2015) | Jaffe, Daniel et al (University of Washington, School of STEM, Bothell, WA USA) | For people living near rail lines:<br>1. What is the exposure to particulate matter—diesel PM and coal dust?<br>2. Can the current and potential future exposure to PM be estimated?<br>3. What are the diesel PM emissions factors from the diesel trains? What fraction of diesel PM is black carbon?<br>4. Do coal trains emit coal dust into the air? | • Measured particulate matter (PM1, PM2.5 and PM10), $CO_2$, black carbon (BC) and meteorology.<br>• Measurements were taken during 367 train passages every 10 seconds<br>• Measurements were made at a site between the towns of Lyle and Dallesport, Washington, between June 7–August 10, 2014.<br>• The instruments were located about 10 meters above and 20 meters northeast of the rail line on private property with relatively few other PM sources.<br>• Two motion–activated video cameras were used for train identification.<br>• A TSI DustTrak DRX Aerosol Monitor was used to measure PM.<br>• The DustTrak measurements are different to mass-based measurements, they required careful calibration against reference methods.<br>• Only trains that could positively be identified as freight or coal were used in the analysis, so this excluded night-time trains.<br>• Absolute enhancements were calculated by subtracting out the PM, BC and $CO_2$ maximums during train passage from the background concentration measured prior to each trains passage. | • Found a diesel PM mean value of 1.2 gm/kg fuel. This agreed well with a US EPA projection for 2013.<br>• Found that nearly all coal trains appeared to generate some degree of coal dust (PM2.5) based on the following evidence:<br>  ○ coal trains were associated with PM2.5 peaks that were 78% higher than freight trains.<br>  ○ Passage of diesel open coal trains resulted in almost double PM2.5 levels compared with freight trains<br>  ○ most freight trains (52%) showed a good correlation between PM2.5 and $CO_2$, whereas very few coal trains (16%) showed this relationship<br>  ○ The BC/PM2.5 fraction were statistically higher for freight trains compared to coal trains.<br>  ○ The PM1/PM2.5 fraction were statistically higher during passage of freight trains compared to coal trains.<br>• Found that 4 out of the 74 coal trains (5.4%) were “Super Dusters” meaning they were responsible for large clouds of visible coal dust and high PM2.5 (50-250 ug/$m^3$) and PM10. This was confirmed by both the PM measurements and the video record.<br>• In Seattle and Bellingham, there |

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| | | | | was some evidence for coal dust, but diesel PM was likely the most important PM source. This was attributed to trains going more slowly in urban areas.<br>• Diesel PM enhancements from trains in Seattle and Bellingham were significant for homes and businesses along the rail lines.<br>• A significant increase in the amount of rail traffic would put these locations at risk of exceeding the air quality standards. |
| **Particle characterisation and dust deposition studies** | | | | |
| *Lower Hunter Dust Deposition Study - Interim Results Oct 2014 - April 2015*<br><br>July 2015/ in progress/ final report anticipated early 2016/NSW<br><br>(AECOM, 2015) | AECOM for NSW EPA | The study was designed to examine the quantity of dust deposited in the Lower Hunter and the likely sources of this deposition. This was a result of concern expressed by Lower Hunter residents over the quantities of black dust that was in their area.<br><br>Focus: near or in rail corridor<br><br>Note: rail corridor was defined by the EPA as being within the boundaries of the train tracks up to the fence or up to 10 metres if there is no fence. | Sample sites, of which there were 12, were based on the distribution and intensity of complaints received by the EPA regarding air quality over the last 2-3 years.<br>In addition, sites were added along the rail corridor.<br>The sites were located at Stockton (North and South), Tighes Hill, Mayfield (East and West), Newcastle (City and East), Waratah, Islington, Tighes Hill, Hamilton, Carrington and Wickham<br>Dust monitoring methods were categorised into three categories:<br>• long-term trends: dust deposition gauges (DDGs), collected every 30 ± 2 days (AZ/NZS 3580.10.1:2003) and were analysed for insoluble solids, as content and combustible material<br>• short-term spot checks: Petri dishes (without growth medium) at periods < 3 days - samples were analysed in a similar manner to the long-term DDGs<br>• Identify composition: brush sampling is an active method for dust deposition collection, collecting dust samples into a clean Petri dish from suitable locations. No time dimension for the collected sample, so the source cannot be accurately specified<br>Laboratory analysis used Standard Depositional Dust | • Six-month averages for dust deposition collected at the sites (October 2014-April 2015) ranged from 0.7 - 1.4 $g/m^2$ per month (notably below the EPA criterion of 4 $g/m^2$)<br>• Coal was detected in measurable amounts in 22/29 samples, and comprised an average of 6.2% of the sample (range: 5-20%).<br>• Coal was not detected in one sample, and in trace amounts in the other six samples<br>• Soil or rock dust comprised the greatest proportion of samples, at an average of 73% (maximum 95%)<br><br>Note: To ensure the views of the community are fully considered, the EPA established the Lower Hunter Dust Deposition Project Reference |

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| | | | Suite, Stereomicroscopy, Scanning Electron Microscopy (SEM) and Energy Dispersive X-Ray Spectroscopy.<br>Standards of sample handling was maintained by Chain of Custody (CoC) protocols.<br>Meteorological data was obtained from the OEH monitor at Carrington. | Group, which consists of two community, two industry, two independent technical experts and two EPA staff representatives. |
| *Lower Hunter Particle Characterisation Study: 4th Progress report (Summer: Dec. 2014 - Feb. 2015 )*<br><br>April 2015/ In progress/ final results anticipated early 2016/NSW<br><br>(Hibberd et al., 2015) | CSIRO and ANSTO for NSW EPA | This study was initiated in 2013 to characterise the components in $PM_{2.5}$ in the Lower Hunter and the composition of $PM_{10}$ in the vicinity of the Newcastle ports.<br>This study used four monitoring sites to conduct sampling over the period of one year.<br>• Newcastle ($PM_{2.5}$),<br>• Beresfield ($PM_{2.5}$),<br>• Mayfield ($PM_{2.5}$ and $PM_{10}$); and,<br>• Stockton ($PM_{2.5}$ and $PM_{10}$)<br><br>In addition, the study is considering the results of long-term monitoring of PM10 and PM2.5 at four sites (Newcastle, Beresfield, Stockton and Wallsend) which provide an indication of the regional air quality and are being used as a framework for the characterisation study.<br><br>Focus: ambient and effects of port | Sampling was conducted at four sites between March 2014 and February 2015. Two sampling methods are being used:<br>• ANSTO Aerosol Sampling Program (ASP) $PM_{2.5}$ cyclone samplers<br>• GENT Stacked Filter Units (SFU) sampling ‘coarse’ ($PM_{2.5}$-$PM_{10}$) particles and ‘fine’ ($PM_{2.5}$) particles simultaneously<br>These monitors are operated by the OEH (except for the Stockton monitor).<br><br>All samples will be analysed using positive matrix factorisation (PMF) to identify source ‘fingerprints’.<br><br>The results for the characterisation component of the study are pending. Some preliminary results for the PM10 and PM2.5 levels are provided in the progress reports, but are not fully analysed. Some average levels are reported.<br><br>Results from the long-term regional air quality monitoring (PM10 and PM2.5) have been published in the four progress reports. These are described in the next column. | Long-term regional air quality monitoring results from 2013 and 2014 indicate that:<br>• PM10<br>  ○ For $PM_{10}$, there are exceedance recorded at most sites in 2013 and 2014, with a peak of 104.3 µg/$m^3$ recorded at Stockton.<br>  ○ No exceedances were recorded at Beresfield in 2014 and Wallsend in 2014<br>  ○ A total of 68 days showed exceedances, although this number was primarily driven by the Stockton monitor (28 / 27 exceedances in 2013 / 2014 respectively)<br>  ○ Stockton results were likely to contain a significant proportion of sea salt.<br>• PM2.5<br>  ○ The average of the 24-hour averages across the study is below the advisory guidelines of 25 µg/m3 at all sites<br>  ○ However, these values are above the annual mean of 8 µg/m3 - the median values of below 8 µg/m3 |

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| | | | | suggests that this average is skewed as a result of exceedances well above the average.<br>○ This is confirmed, with exceedances well above the 24-hour average at all sites, with a maximum of 40.8 µg/m3 (Beresfield 2013).<br>○ in total, there was 17 days over 2013/14 that exceeded 25 µg/m3<br>● Note:<br>○ Newcastle (2013) had no data<br>○ Newcastle (2014) and Wallsend (2014) did not show any exceedances. |
| *Upper Hunter Valley Fine Particle Characterization Study*<br><br>Sept 2013/ 12 month study complete/NSW<br><br>(Hibberd et al., 2013) | CSIRO and ANSTO for NSW EPA | Characterising the major components of $PM_{2.5}$ particles that communities in the Upper Hunter are exposed to, their relative proportions and if there are any temporal changes or patterns in $PM_{2.5}$ particulate matter. Dust characterisation was conducted at two sites, Singleton and Muswellbrook, as these are the major population centres in the Upper Hunter in close proximity to two nearby power stations and open cut mines.<br><br>Focus: ambient | 8 factors investigated:<br>● wood smoke<br>● vehicle / industry<br>● secondary sulfate<br>● biomass smoke<br>● industry aged sea salt<br>● soil (which includes fugitive coal dust)<br>● sea salt<br>● secondary nitrate<br>Collected samples analysed at CSIRO and ANSTO, with researchers from both institutes evaluating and reporting on the results. | Soil (which includes fugitive coal dust) contributed 12 ± 2% and 11 ± 1% to th total annual $PM_{2.5}$ mass for Singleton and Muswellbrook respectively.<br>The primary contributing factor to the total annual $PM_{2.5}$ mass for Singleton was secondary sulfate (20 ± 2%), which includes local and regional sources of $SO_2$ such as power stations.<br>For Muswellbrook, wood smoke contributed 30 ± 3% to the total annual $PM_{2.5}$ mass. The primary source of woodsmoke is residential wood heaters.<br><br>Note: the study conducted an analysis of the characterisation of the samples, but the source of the particles was not determined |

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| *Bloomfield Colliery Annual Environmental Management Report 2014*<br><br>2014/ in relation to ongoing dust deposition monitoring<br><br>(The Bloomfield Group, 2014) | Bloomfield Collieries Pty Ltd | Ongoing monitoring of deposited dust near mine | Total of 10 dust deposition gauges and 2 high volume air samplers (HVOL) in and around the mine, with one site adjacent to the main north rail line (since 1997).<br><br>Note: the Review is aware that other operators also undertake similar ongoing dust monitoring, which it will seek information on for the next phase of the Review. | • Results from January to December 2014 showed insoluble solids to be between 0.7 and 3.0 g/m$^2$/month. EPA guidelines are 4 g/m$^2$/month<br>• Composition of dust not determine<br>• Dust deposition monthly results for 2014 at the site near the rail line were similar to those for a site near the New England highway (note: exact distances from highway and rail line not known), with the highway site recording one month of exceedances (6 4 g/m$^2$/month for November 2014) |
| *T4 Project Environmental Assessment, Volume 1, Chapter 12 Air Quality 2012*<br><br>Feb 2012 (study by PWCS from 2006 to 2010)/NSW<br><br>(EMGA Mitchell McLennan, 2012) | EMGA Mitchell McLennan for Port Waratah Coal Services (PWCS) | This chapter of the coal export terminal 4 (T4) Project Environmental Assessment (EA) assesses the existing ambient air quality and the anticipated air quality impacts due to the T4 project.<br><br>Focus: PWCS coal export terminal | The T4 Project EA reported that, in response to community enquiries, PWCS commissioned several microscopic examinations of dust samples in the local area from 2006 to 2010.<br>The sampling was undertaken at Stockton and Fern Bay which are both close to the Kooragang coal terminal at 1.8km away 1.9km away respectively. | An analysis of dust deposition samples collected from Stockton and Fern Bay found that the contribution of coal particles to annual dust deposition ranged from 5% to 16%.<br><br>Note: the Review was unable to locate the actual dust examination (2006 - 2010) report |
| *Tennyson Dust Monitoring Investigation September to October 2012*<br><br>Dec 2012 / study complete/QLD<br><br>(DSITIA, 2012) | Queensland Department of Science, Information Technology, Innovation and the Arts (DSITIA) | Particulate levels ($PM_{10}$) and dust deposition in or near the corridor; contribution of coal particles in deposited dust<br><br>Focus: rail corridor | Measured PM10 to compare against health guidelines, deposited dust for nuisance, and component of coal in dust.<br><br>The study measured $PM_{10}$ (one site in rail corridor) and deposited dust at three different locations (approx. 6, 20 and 300 m from track). Wind speed and direction was also recorded. The report noted there was little rainfall during the study period. | • Study found PM10 levels at the Tennyson station site did not exceed the Queensland Environmental Protection (Air) Policy 2008 (EPP Air) 24-hour average air quality objective (50 µg/m3) during the study period. Average was 26.6 µg/m3. The report noted that on a day with only four freight trains passing, a |

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| | | | **Air sampling:**<br>Partisol Model 2025 sequential low-volume air sampler (AS/NZS 3580.9.10.2006) at Tennyson station measuring daily 24-hour average PM10, Model 8533 DustTrak DRX Aerosol (non-compliant) to determine the five minute averaged particle measurements (laser based method, not mass based like the Partisol)<br><br>**Dust deposition**:<br>In accordance with the Australian standard for deposited matter (AS/NZS 3580.10.1.2003) | reading of 19.0µg/m3 may be indicative of the typical background level in the Tennyson community in the absence of train and motor vehicle sources.<br>• Insoluble dust deposition did not exceed the trigger level for nuisance dust based on the New Zealand Ministry for the Environment standard, although it was noted that the deposited dust may be highly visible to residents. Trigger levels were 4 g/m2 /30 days or 130 mg/m2 /day.<br>• Mineral dust (crushed soil and rock particles) was the primary depositional component, with coal dust accounting for 10-20% of the deposited samples at each of the sites.<br>• On average, particles less than 20µm increase by an average of 5 µg/m3 due to passing trains, with loaded coal trains having the greatest impact.<br>• Concluded that trains, irrespective of type, increased particulate matter in the air. As the major depositional component was soil and rock dust, the study concluded that the re-entrainment of surface dust as a result of the train passing was the primary contributor to an increase in airborne particulate matter. |
| **Wind tunnel studies/computational fluid dynamics to determine dust lift off / testing other sources / examining mitigation techniques** | | | | |

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| PRP 5.0 Investigation of Coal Loss from Rail Wagons on the ARTC Network<br><br>March 2016/ for final Report<br><br>The ARTC must provide a report summarising the findings of the assessments to the EPA by 1st March 2016. | ARTC for the NSW EPA | Laying drop sheets on track to capture any potential spilled coal during rail transit to identify quantities and source of spill from the train.<br><br>Focus: rail corridor | The ARTC is undertaking an initial program to investigate coal deposition on departure roads and to assess the effectiveness of removing coal deposition with vacuum equipment.<br><br>The licensee will undertake the following investigations into the presence of coal on empty coal roads:<br>a. An assessment of the rate of coal deposition on empty coal roads through field observations, photographic surveys and where possible quantitative measures; and<br>b. An assessment of the effectiveness of removing coal deposition from the ballast through vacuuming.<br><br>Complementary to this, the EPA is in discussion with rolling stock operators, licensed coal loading premises and coal terminals regarding their existing management of coal transport including controls and measures in place to prevent loss of coal from wagons to the rail formation. | Results are pending |
| *Dust Emission Investigation of 6 Xstrata Coal Samples Report #7761-2*<br><br>September 2012/ report complete/ NSW<br><br>(Tunra Bulk Solids, 2012) | Tunra Bulk Solids Handling Research Associates (Newcastle Institute for Energy and Resources) for Xstrata Coal | Study to measure the Dust Extinction Moisture (DEM) and wind tunnel lift off characteristics for six types of Hunter Valley coal. | The DEM was determined using a procedure set down in Australian Standard AS-4156.6-2000.<br><br>Wind tunnel: material greater than 6.3mm was removed (larger sizes less likely to lift off). The sample screening procedure was adopted from Australian Standard AS-4156.6-2000. The test program involved testing of each coal sample under six scenarios:<br>1. Dust lift-off at fines production total moisture (TM) level on a normal day<br>2. Dust lift-off at fines production TM level with pre-drying<br>3. Dust lift-off at DEM level on a normal day<br>4. Dust lift-off at DEM level with pre-drying<br>5. Dust lift-off at DEM level with water only suppression and pre-drying<br>6. Dust lift-off at DEM level with veneering suppression and pre-drying | • The DEM values for -6.3mm size fraction of tested coal were 4.2% (Tahmoor), 5.9% (Bulga), 7.2% (Rav UG), 7.3% (Liddell), 8.8% (Ulan), and 11.6% (Mangoola). (sample name)<br>• The average full size production total moisture for the six samples was 8.4% (Tahmoor), 10.0% (Bulga), 8.0% (Rav UG), 10.0% (Liddell), 10.5% (Ulan) and 13.0% (Mangoola).<br>• The production moistures are above DEM which indicates that unless significant surface drying occurs, potential dust lift off during railway transport at those moisture levels is expected to be minimal.<br>• The estimated fines total |

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| | | | | moisture is 1.7-3.4 times the DEM of the coal samples<br>• Wind tunnel testing: there was no measurable lift off for scenarios one, two, five and six except for a small amount from the Ulan sample under scenario five (which due to a longer travel distance was tested for 8 hours instead of 4).<br>• For all coal samples, dust emissions were recorded for scenarios 3 and 4 due to pre-drying causing an increase in dust emissions whilst the samples were exposed in the wind tunnel. Overall, significant dust emissions were recorded for the Bulga and Tahmoor samples (in excess of 100g during exposure) whereas the Rav UG, Mangoola, Ulan and Liddell samples recorded dust lift off of 50g or less. |
| *Duralie Extension Project, Study of Dust Emissions from Rail Transport*<br><br>Feb 2012 / study complete/NSW<br><br>(Katestone Environmental Pty Ltd, 2012) | Katestone Environmental Pty Ltd for Duralie Coal Pty Ltd | Katestone Environmental and Introspec Consulting were commissioned by Duralie Coal Pty Ltd (NSW) to prepare a study of dust emissions from rail transport between Duralie and Stratford coal mines (20km).<br><br>Focus: rail corridor | The study included the following:<br>• Site inspection and review of the Duralie Extension Project<br>• Review of the history of complaints relating to dust emissions from laden coal trains<br>• Identification of the significance of dust emissions from laden coal trains<br>• Review of literature relating to dust emissions from laden trains<br>• Laboratory wind tunnel testing of Duralie coal to investigate dustiness conducted by TUNRA Bulk Solids at the University of Newcastle.<br>• Cost benefit analysis of potential dust controls<br>• Recommendations for control of emissions from laden | The findings were:<br>• Of 527 complaints received by Gloucester Coal in relation to the Duralie and Stratford Coal Mines from 2002 to 2011, two were possibly related to dust issues associated with the railing of coal between the mines.<br>• The coal surface of the wagons of laden coal trains was found to be the most significant source of rail generated dust in the case of the Duralie Extension Project. Maximum 24 hour |

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| | | | coal trains<br><br>Note: A detailed peer review of the air quality assessment of the Duralie Extension Project was conducted by Heggies Australia with particular attention given to the aspects relating to railing coal between the Duralie and Stratford Coal Mines.<br>The Heggies review concluded that quantification of dust emissions from wagons carrying coal was consistent with contemporary practice and would provide a conservative estimate of potential emissions of coal dust (e.g. the emission rate was consistent with the QR Environmental Evaluation [ Section 6.1]). | concentrations of PM10 at 20m from the rail centre line were predicted to be approximately 4µg/$m^3$. In comparison, the 24hr criteria for PM10 is 50µg/$m^3$.<br>● Dust extinction moisture level for Clareval Coking ROM coal was determined to be 4.1%. (For comparison, the typical minimum moisture content of NSW coals is 9-11%)<br>● The additional cost of chemical surface veneer above that for the application of water alone was estimated to be $0.05 per tonne of coal.<br>● The recommended method for control of emissions from wagons was continued use of the two-stage water spray system at the rail loadout facility which was reported to be 98% effective in controlling dust lift-off, reducing lift-off to almost nil.<br>● Since veneering was found to be only slightly more effective than water, it was not recommended. |
| *Coal Leakage from Kwik-Drop Doors - Coal Loss Management Project*<br><br>July 2009 / study complete/QLD<br><br>(Aurecon Hatch, 2009) | Aurecon Hatch (formerly Connell Hatch) for Queensland Rail | To provide a more reliable estimate of coal leakage from Kwik-Drop doors.<br><br>Focus: rail corridor | Used an innovative Door Loss Measurement Mechanism (DLMM) to capture losses for both loaded and unloaded coal trains through the Kwik-Drop doors during a week-long trial in Goonyella and Blackwater.<br>The DLMM design incorporated four overlapping trays housed in a frame attached to the bottom of the wagon.<br>Outlined potential errors:<br>● mine offset - losses that occur at the mine site, such as loading practices.<br>● ploughing - this was suggested to be a result of the larger particles (>9.5 mm) that were present on the | Goonyella<br>● Average coal collected per tray was 143.6 g, which equates to 574.4 g per door set<br>● When extrapolated to the average train size in the Goonyella system, which has 440 door sets, the average loss per train is 253 kg.<br>● The average number of trains per week is 144.7, and this |

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| | | | sampling trays - study concluding that ploughing at the ports during unloading would be the most logical source of these particles<br><br>Note: The study identified variables that may influence coal loss through the doors that include (but are not limited to):<br>● Coal type and rank<br>● Meteorological conditions<br>● Moisture content<br>● Washed/unwashed coal<br>● Proportion of fines<br>● Longitudinal travel forces<br>● Wagon design (door design and wagon stiffness)<br>● Track geometry and condition<br>● Wagon condition and maintenance | would result in an annual loss of 1900t, or 0.0022% of the yearly tonnage<br>Blackwater<br>● Average coal collected per tray was 209.8 g, which equates to 839.2 g per door set<br>● when extrapolated to the average train size in the Blackwater system, which has 320 door sets, the average loss per train is 276 kg.<br>● The average number of trains per week is 126.4, and this would result in an annual loss of 1750t, or 0.0034% of the yearly tonnage<br><br>There was no significant correlation between coal loss and door clearance measurements, nor was there any increasing trend between these variables.<br><br>Determined that due to 83% of the wagons following the same trend in losses, that coal loss is dependent on the source of the coal. However, indicated that two trials that serviced the same mine showed different results that indicate that there could be factors other than coal type alone that may influence the quantity lost.<br><br>Concluded that two-thirds of all losses are particles < 2 mm. As the nominal design clearance of the wagon doors is between 2-3 mm (largest was 8 mm), it is expected |

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| | | | | that door clearance does not have a significant impact on the particle size distribution of coal loss through the Kwik-Drop doors. |
| *Managing Dust Emissions from Mine to Port*<br><br>Abstract in ACARP Matters, 24 June 2012<br><br>(ACARP, 2012) | John Planner at Introspec Consulting for ACARP | Review of current best practice in dust control techniques across the coal industry, from mine to port | Note: Review examined abstract only and will seek full report for further analysis. | Abstract primarily focused conclusions on controlling moisture content of coal.<br>Suggested measures related to coal transport include:<br>● keeping coal above its DEM level during transport and handling<br>● applying a veneer chemical treatment to coal surface for long distance rail travel<br>● install moisture monitoring equipment at rail discharge facilities<br>● using water sprays at rail discharge facilities when needed<br>● establish minimum discharge height for stacking<br>Abstract noted companies should conduct DEM testing on each product and continually monitor actual moisture at sampling points along chain. |
| *Reduction of carry-back and coal spillage in rail transport*<br><br>Dec 2008 / study complete/QLD<br><br>(ACARP, 2015) | ACARP Project Number C15071 Einicke, G, Hargrave, C, Haustein, K et al, CSIRO | Consider carry-back coal to mines and develop a carry-back detection system which automatically generates alerts when volumes exceed threshold | Note: Review examined abstract only and will seek full report for further analysis. | The abstract noted:<br>● Carry-back coal can cause spillage and cross contamination.<br>● Spillage can contaminate the ballast and possibly lead to derailments and excess coal can jam doors<br>● Industry surveys showed from March to Aug 2007, carry-back was 0.36 tonnes per wagon and for two rainy months during the |

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| | | | | period, were closer to 0.93 tonnes per wagon, or one wagon per train.<br>● The carry-back costs the industry between $42M and $102 M annually<br>● suggests installing automatic vibrators at ports |
| BNSF Super Trial<br><br>2010 / study complete/USA<br><br>(BNSF, 2010) | BNSF and Union Pacific Railroad | Phase 1 - tested the effectiveness of seven different chemical agents in suppressing coal dust emissions from loaded trains<br><br>Phase 2 to test railcar compaction and shaping prototype - to apply physical forces to a loaded railcar to drive coal fines away from the open top of a railcar, displacing coal dust particles from the upper profile of a loaded car, which is most vulnerable to winds during transport.<br><br>Focus: rail corridor | Trackside Monitors - weather/aerosol monitors<br>Passive Dust Collectors on wagons<br>Portable weather stations on wagons<br>Tested 1,633 trains; half the trains were treated - some treated before coal loaded, some topically on the load | ● Phase 1 - Results of passive dust collector tests on 115 treated trains showed that topical treatment reduced emissions 75-93%; body treatment to the coal did not significantly reduce emissions.<br>● The veneering requires proper application to increase effectiveness<br>● Results from Phase 2 not located.<br><br>Note: BNSF, the below track operator, noted coal on tracks was a significant operational issue and now requires operators to reduce emissions from wagon surface by 85% from untreated levels through Coal Profiling Rule and veneering. |
| *Wind tunnel studies of coal dust release from train wagons*<br><br>2004 / study complete/Portugal<br><br>(Ferreira & Vaz, 2004) | Ferreira A D, Vaz P A<br>Journal of Wind Engineering and Industrial Aerodynamics | Ferreira and Vaz (2004) used scale model trains in a wind tunnel to show that covering coal wagons reduced dust emissions by more than 80 percent.<br><br>Focus: rail corridor | This paper presents a wind tunnel study to assess the coal dust released due to aeolian erosion from wagons equipped with two different shelter cover systems.<br>A 1:25 scale model was used, comprising one locomotive and four train wagons with a 3.55 m maximum length. | ● Several tests were conducted for different train configurations, and two initial load levels.<br>● The study conducted measurement of TSP emissions from coal wagons over a simulated 350km journey, and found that a 60t semi-covered wagon would lose approximately 0.0007% of its load with an |

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| | | | | undisturbed flow velocity of 13.4 m/s (48.2km/hr).<br>● The use of the semi-cover system, despite the existence of a 1m wide gap along the upper part of the wagon, significantly reduced the amount of dust released.<br>● Compared to the no-cover situation, the semi-cover reduced the dust amount released more than 80% for the full-load situation.<br>● The results for the last two wagons showed considerably larger quantities being eroded, suggesting the benefit of covering the last two cars in a unit train during train transportation of granular material.<br>● However, the authors noted that this suggestion needed further experiments to be fully supported. |
| *Full-scale measurements for evaluation of coal dust release from train wagons with two different shelter covers*<br><br>2003 / study complete/Portugal<br><br>(Ferreira et al., 2003) | Ferreira AD, Viegas DX and Sousa ACM Journal of Wind Engineering and Industrial Aerodynamics | Ferreira et al. (2003) conducted full-scale tests on coal wagons in Portugal to evaluate the effectiveness of two different types of partial covers.<br><br>Focus: rail corridor | Coal dust was collected using special dust collectors mounted on top of the wagon whilst the train travelled from a port to a power station.<br>The average train speed for a 350km transit was estimated to be between 55 and 60km/hr. Train speeds reached a peak of 65km/hr to 85km/hr.<br>Connell Hatch in the 2008 Environmental Evaluation report (2008) considered that the overall train speeds, transport distances and climatic conditions during the sampling were comparable to conditions in Queensland. | ● An extensive literature search conducted by the authors revealed that there was an apparent lack of reliable quantitative information based on studies involving full-scale, or even small-scale, studies devoted to the problem of ‘‘fugitive’’ dust releases during the process of long-distance transportation using train wagons.<br>● Ferreira observed that coal cars equipped with even partial |

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| | | | | covers emitted much less coal dust than those without covers. The wagons tested had partial covers with a gap of 1m.<br>● The paper concluded that fugitive dust emissions amounted to less than 0.001% of the 60 tons net load of coal for partly covered wagons, using a 95% confidence interval, over a particular 350 km run. |
| **Other related work by NSW EPA** | | | | |
| *Environmental Compliance Report - Compliance Audit of coal train loading and unloading facilities*<br><br>Dec 2014 / study complete/NSW<br><br>(NSW EPA, 2014a) | NSW EPA | NSW EPA completed a compliance audit program of eleven coal train loading and four unloading facilities in NSW. Ten of the coal loading facilities transport coal to the Port of Newcastle and three unloading facilities are located in the Newcastle area.<br><br>Focus: rail loading and unloading facilities | Audit and inspections<br><br>Note: The EPA has undertaken follow-up inspections of all premises that had non-compliances. Considerable progress had been made at most premises to address the issues raised by the audit. These changes include installation of additional loading infrastructure and monitoring equipment, updated procedures and enhanced training of staff.<br><br>The inspection program is targeting parasitic coal prior to arrival and at departure from facilities, dust emissions and ploughing – coal extending above the railway lines in the discharge hoppers and being caught up in the wagon undercarriages.<br><br>Hunter Region is in discussion with the port-end coal unloaders/loaders to identify and implement actions to reduce parasitic coal on coal wagons leaving the coal handling facility. The discussions may lead to the inclusion of a PRP on the coal loaders' EPLs.<br><br>In addition, the EPA is carrying out an inspection program on a number of coal loading and unloading facilities in the Illawarra in November/December 2015. | ● A number of non-compliances found<br>● Issues with the loading of the wagons – 10/11 (one unknown) non compliances with EPL condition "carrying out train loading activities in a manner which minimises or prevents coal spills and dust emissions from the tops of wagons during rail transport"<br>● Unloading facilities rated better, with some 'unknown' compliance status around carrying out unloading activities to minimise or prevent small amounts of coal dust emissions from the interiors of empty wagons. |
| *Review of regulation of 'railway systems* | NSW EPA | The objective of the review is to determine the most | The EPA is proposing an amendment to 'railway systems activities' under the POEO Act to implement the preferred | The position paper outlined 10 options with the preferred option to |

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| *activities' under the Protection of the Environment Act 1997*<br><br>Sept 2014 - position paper released<br><br>(NSW EPA, 2014b) | | effective framework for regulating the impacts of rail construction and operational rail activities on the NSW environment and community.<br>Focus: rail corridor | alternative regulatory framework.<br><br>EPA is working with the Parliamentary Counsel's Office to finalise a draft amendment regulation. This draft is expected to be placed on exhibition on the EPA website in late November/early December 2015. Should the amendment regulation be passed, licensing of rolling stock operators as a separate scheduled activity would commence in end 2016/ early 2017. | licence both the above and below rail operators. |
| *Locomotive Emissions Project: Scoping Study of Potential Measures to Reduce Emissions from New and In-Service Locomotives in NSW and Australia*<br><br>March 2013 scoping study – Other work in progress /NSW (ENVIRON, 2013) | Prepared for: NSW EPA by: ENVIRON Australia Pty Ltd | NSW EPA undertaking a joint project with a large NSW rail operator to determine potential emissions reductions and fuel efficiency from diesel engines by installation of emissions upgrade kits on older diesel locomotives at scheduled rebuilds.<br><br>Focus: rail corridor | Performed cost effectiveness studies and annual health benefits ($) for different options.<br>Health costs were estimated overall for rural and urban areas using emissions factors and fuel usage. | The largest health benefits were potentially from upgrading old and having new locos meet Tier 4 standards. Annual health costs in Australia from diesel locomotive emission exposure estimated at $65.6 million. |
| Development of industry environment standard<br><br>Work in progress/ outcomes pending | Rail Industry Safety and Standards Board (RISSB) with NSW EPA participation | The Rail Industry Safety and Standards Board (RISSB) is working towards an Industry Rail Environment Standard, covering air and noise emissions.<br><br>Focus: rail corridor and broader | RISSB are developing a suite of 178 Australian Railway Standards over the next 10 years, which will gradually replace the Manual content | Outcomes pending |
| **Proximity to coal mines and coal generated power stations and health** | | | | |
| *Investigating the health impacts of particulates associated with coal mining in the Hunter* | Dalton et al (2014)<br>Air Quality and Climate Change Volume 48 No. 4. | Challenges of health studies in small populations like Hunter Valley; report on studies to date | Reviews methodological challenges of air quality-health studies; studies undertaken in the Hunter including NSW Health (2010); Merritt et al (2010) and other studies near open cut coal mines – noting limits and mixed outcomes of findings. Summarises publicly available air monitoring data | • Need to integrate understanding of dose response relationships between particulate exposure and health outcomes from large population based studies |

| Title<br>Date/ Stage /<br>Jurisdiction | Author | Focus/<br>Questions addressing | Methods | Results/<br>Conclusions |
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| *Valley*<br><br>(Dalton et al., 2014) | November 2014 | | for upper and lower Hunter valley towns relative to international findings. Comments on issues with placement and interpretation of monitoring data; and limits of using emission inventory data as a proxy for human exposure | • Comprehensive air monitoring program proposed to obtain good measures of variation in exposure<br>• Relative to international standards air quality good although monitoring data shows annual average PM2.5 exceeded NEPM standard 8µg/m3 in Muswellbrook and Camberwell; absent of PM2.5 thresh-hold below which no one affected leads to conclusion important to safeguard against any deterioration in airshed. May be better to limit incremental increases in pollution rather than planning to allow levels to rise to a designated cumulative limit<br>• Challenges of epidemiological studies on association between air pollution and health impacts: difference between lowest and highest levels of pollution is often less than three-fold and lack unexposed subjects. Need large scale for power; confounders (temperature, smoke, socioeconomic status); effect sizes small (smaller studies likely to miss small but important impacts).<br>• Challenges cross-sectional studies (current exposure and current health status) more feasible but difficult to interpret as past exposure more likely to be cause of current health status |
| *The health of Hunter* | Merritt TD et al | Population health in areas | Review of general practice data lodged through the | No evidence of significantly elevated |

| Title<br>Date/ Stage /<br>Jurisdiction | Author | Focus/<br>Questions addressing | Methods | Results/<br>Conclusions |
|---|---|---|---|---|
| *Valley communities in proximity to coal mining and power generation, general practice data 1998-2010*<br><br>(Merritt et al., 2013) | (2013)<br>NSW Public Health Bull. 2013 Nov; 24(2); 57-64 | proximate to coal mining and power generation | Bettering the Evaluation and Care of Health (BEACH) program for rural communities in close proximity to coal mining and coal-fired power generation in the Hunter Valley was compared with data for all other rural NSW residents | health issues for residents in the Hunter Valley. However, the rate for respiratory problems did not change significantly for the Hunter Valley group, but was significantly lower for the remainder of NSW, which is worthy of further inquiry |
| *Respiratory and cardiovascular diseases and cancer among residents in the Hunter New England Area Health Service*<br><br>(NSW Health, 2010) | NSW Health (2010)<br>Population Health Division, NSW Department of Health | Health and disease profile compared to wider state statistics | Draws on routinely collected health data (attendance at emergency departments [EDs], hospital separation [HS] and population health survey [PHS] for period 2007-09) for residents in HNE AHS [HNE] - in close proximity to coal mining and power generation (six fold increase open cut mining over last 3 decades and 4 of 6 coal fired stations in scope- Muswellbrook ('M') and Singleton ('S') LGAs.<br><br>Limits: hospital data may represent use rather than morbidity; coding may be inconsistent; health service data does not directly compare exposed and unexposed communities; in 2009, pandemic (H1N1) influenza virus caused significant increases in ED presentations across NSW for all types of respiratory illness, and smaller increases for asthma presentations | Mixed picture<br>ED: presentations for all respiratory illnesses in M and S higher than total for HNE & Sydney but below 3 other major LGAs in HNE (all ages); M has highest LGA asthma presentations ages 0-34 but 2-3 other LGAs higher in older age groups with S 3rd highest for those aged 35-64); M & S have highly ranked ED presentations for conditions unrelated to air pollution<br>HS: M and S have higher HS rates CVD than all HNE or NSW but other HNE LGAs also do; M higher HS rate but S lower for all respiratory disease compared with NSW; mixed pattern for asthma also.<br>PHS: no differences on key data self-reported health and differences in higher adult asthma outside areas with high exposure to coal mines or stations<br>Report notes that "*There are no published Australian cohort studies on the association between particulate matter and long term deaths*." (p. 53). |
| **Proximity to rail freight lines or yards and health** | | | | |
| *Respiratory Health Risks for Children* | Spencer-Hwang et al | Assess proximity to rail yard and respiratory health | Health impacts on elementary school children located approx. 800metres from the San Bernardino Railyard | Children attending school near the railyard were significantly more likely |

| **Title**<br>**Date/ Stage /**<br>**Jurisdiction** | **Author** | **Focus/**<br>**Questions addressing** | **Methods** | **Results/**<br>**Conclusions** |
|---|---|---|---|---|
| *Living Near a Major Railyard*<br><br>(Spencer-Hwang, Soret, Knutsen, Shavlik, Ghamsary, Beeson et al., 2015) | J Community Health (2015) 40:1015–1023<br>Ca, USA | in school children | (intermodal facility), one of the busiest goods movement facilities in Ca, matched with children at school 7 miles (11km) away. Respiratory screening undertaken at the two schools and parental logs and surveys | to display respiratory health challenges, including airway obstruction with higher prevalence of abnormal peak expiratory flow. However, the association with inflammation was less clear.<br>2014 qualitative study by same group Experience of a Rail Yard Community: Life is Hard –notes socio-economic disadvantage of community and multiple challenges; air quality specific: point source monitoring, clean engines, vegetation border & other strategies recommended |
| *Global trade, local impacts: lessons from California on health impacts and environmental justice concerns for residents living near freight rail yards*<br><br>(Hricko, Rowland, Eckel, Logan, Taher, & Wilson, 2014) | Hricko et al (2014)<br>Int J Environ Res Public Health 2014; 11(2):1914-41 | Profile of populations living in the highest estimated cancer risk zones near 18 major rail yards in Ca | Describes cancer risks for residents in Ca USA living in close proximity to rail yards with emissions of diesel particulate matter pollution from locomotives, trucks and yard equipment; and the demographics (income, race/ethnicity) of residents | The majority are over-represented by either lower-income or minority residents (or both). |
| *Diesel particulate matter emission factors and air quality implications from in-service rail in Washington State, USA*<br><br>(Jaffe, Hof, Malashanka, Putz, Thayer, Fry et al., 2014) | Jaffe et al (2014)<br>Atmospheric Pollution research 5 (2014) 344-351 | Role of diesel in emissions and impacts for residents near rail lines | Quantify exposure to diesel particulate matter (DPM) and airborne coal dust from trains for residents living near rail lines at 2 sites and measure the DPM and black carbon emission factors (EF). | No significant differences in average DPM EFs measured at the 2 sites<br>Open coal trains have a significantly higher concentration of particles >1µm diameter, likely coal dust<br>Measurement of black carbon at one site show a strong correlation with $PM_1$ and give an average BC/DPM ratio of 52% from diesel rail emissions<br>Living near rail line significantly increases $PM_{2.5}$ exposure |

| Title<br>Date/ Stage /<br>Jurisdiction | Author | Focus/<br>Questions addressing | Methods | Results/<br>Conclusions |
|---|---|---|---|---|
| | | | | For one month at Seattle site average PM2.5 near rail line 6.8µg/m3 higher compared to several background locations; as PM2.5 linear relation to diesel traffic, a 50% increase in rail traffic may put residents above the new USA AAQ standards, an annual average 12µg/m3 |
| *Corridor-Level Air Quality Analysis of Freight Movement - North American Case Study*<br><br>(Farzaneh, Lee, Villa, & Zietsman, 2011) | Farzaneh et al (2011)<br>Journal of the Transportation Research Board | Methodology to assess impact of truck and rail freight on air quality along rail corridors, using Mexico City to Montreal Canada route | Network and freight activity data established for base (2010) and future (2035) case linked to emission rates from US EPA emission model (MOBILE6.2). Rail emission calculations based on average emission and fuel consumption, revised to reflect ongoing improvements in locomotive engine standards | Current levels of emissions not significant compared with trucks, however, share of rail for some pollutants (PM and NOx) emissions will continue to increase over time and will be significant<br>Need for improved analytical tools and estimation methods for rail fuel consumption and emissions.<br>Limits: high level of uncertainty in rail freight movement data and emission estimate methods aggregate- therefore large uncertainty for estimating rail emissions |
| *An analysis of the health impacts from PM and $NO_X$ emissions resulting from train operations in the Alameda Corridor, CA*<br><br>(Sangkapichai et al., 2010) | Sangkapichai et al (2010)<br>University of California Transportation Center, UCTC Research Paper No. UCTC-FR-2010-10 | Estimate the health impacts of exposure to PM and $NO_x$ emitted by train operators in the Alameda Corridor | Linked a pollutant dispersion model (CalPUFF) to a benefits assessment model (BenMAP) to identify population impacts of PM and $NO_X$ emissions from switching and line haul train operations; followed by 2 scenarios to assess benefits of changing to USA Tier 2 to Tier 3 locomotives | Mortality from PM accounts for largest health impacts, with health costs of $40M annually<br>Switch to Tier 2 locomotive would save half of the annual health costs but switch from Tier 2 to Tier 3 benefits much smaller<br>Limits: gaps in available health data |
| *Development of an Exposure Model for Diesel Locomotive Emissions near the Alameda Corridor* | Rahai (2008)<br>Center for Energy and Environmental Research and Services, | Develop model to assess exposure risks of PM concentration | Approximate $PM_{2.5}$ concentration for diesel locomotive emissions was obtained using a TSI DustTrak aerosol monitor; and wind speed and direction using a Young model 85000 2-axis anemometer. Measurements were carried out at different distances from the railroad from -4.6M (other side of railway) to 90M, with readings taken on | Results indicate between10-15% increase in PM concentration from the passage of the diesel locomotives.<br>Instrumentation used meant not able to distinguish small particles and |

| Title<br>Date/ Stage /<br>Jurisdiction | Author | Focus/<br>Questions addressing | Methods | Results/<br>Conclusions |
|---|---|---|---|---|
| (Rahai, 2008) | California State University | | different days. | fractions |

Note: The information is the table is compiled from information reviewed and will continue to be updated through the Review. It is suggested that the reader consult the original source for more information and not rely solely on the information presented in the table.

# APPENDIX 5 FUTURE STUDY CHARACTERISTICS

**Table 4: Future study characteristics**

| Criteria to be met | Description |
|---|---|
| Ambient, baseline and signature measurements | For $PM_{10}$ and $PM_{2.5}$<br>• Ambient: measurements of the ambient levels, as determined by a nearby monitor<br>• Baseline: monitoring within the corridor whilst there are no trains to determine the baseline disturbance at the corridor. This can be used to compare any effect that trains (irrespective of type) have as they pass and also if the corridor has a higher ambient level when compared to outside of the corridor<br>• Signature: measurements during train movements |
| Train parameters | Ability to identify each train type (all types: coal loaded and unloaded, freight and passenger), it's speed, length, number of diesel locomotives, number of wagons, etc. |
| Meteorological conditions | Accurate and preferable co-located meteorological monitoring should be conducted. This includes, but is not limited to, wind speed and direction, humidity, precipitation, etc. |
| Particle characterisation | Particle characterisation will determine the composition of particulate matter ($PM_{10}$ and $PM_{2.5}$) and could indicate the sources of particulate matter. |
| Multiple monitoring locations | Locational considerations and conflicting factors include:<br>• Prevailing wind directions<br>• Topographic features, such as valleys, that prevent lateral atmospheric mixing that can lead to higher/lower air pollutant conditions<br>• Other sources of contamination, such as roads and vegetation (particularly large trees)<br>• Conflicting coal sources, such as coal-fired power plants<br>Most common method is to place monitors, at varying distances, along a vector approximately perpendicular to the source (Karner et al., 2010)<br>Multiple monitoring sites aids in reducing the errors associated with conflicting factors:<br>• Limits factors such as site specific or other sources of particulate matter (this is incorporated in the NEPM and AU/NZS standards for air quality monitoring)<br>• Increases data coverage (If data coverage < 100 % is planned, consistent durations should be used for the sampling and the non-sampling periods, i.e. sampling for time x across all points, rather than sampling for time x, time y, etc. across different points)(Brown & Woods, 2014).<br>Multiple monitoring locations also adds to the robustness of data, allowing for comparative analysis and increased data |
| Multiple monitors at each site, set at varied distances from the source | Studies on road emissions have concluded that particulate pollution decreases exponentially as distance increases from the road (source), with a return to 'background' conditions between 200-500m (Baldauf et al., 2009). Furthermore, distance-decay gradients of $PM_{2.5}$ were also demonstrated to extend to distances of 500m on the downwind side at night-time (Zhu, Kuhn, Mayo, & Hinds, 2006).<br>Vehicle-induced turbulence (VIT) can influence nearby monitors, regardless of their position upwind or downwind. A study by Venkatram et al. indicated that this could be as far as 50 m (Venkatram, Isakov, Thoma, & Baldauf, 2007).<br>The recommendation for future studies is to place a monitor 10-20m from the source (according to Baldauf et al. 2009) and further monitors between 50-500m. It must be noted, the primary assumption with this methodology is that there is no source or sink between the monitoring sites (Baldauf et al., 2009; Longley, Somervell, & Gray, 2014). |
| Paired monitors, located on both sides of the source | This is an important requirement for two reasons:<br>1) if the wind shifts, a monitor will capture any emissions originating upwind; and,<br>2) comparative measurements; a monitor will always be upwind/downwind<br>It must be mentioned that most studies rely on wind from a prior meteorological data to determine prevailing wind directions in order to set up monitoring studies, and in the case of dispersion studies, usually only have one monitor on the |

| Criteria to be met | Description |
|---|---|
| | upwind side as a comparative reference. This is only successfully when used in conjunction with co-located meteorological units to confirm wind direction (Karner et al., 2010). |
| Data robustness | A number of criteria, termed Data Quality Objectives (DQOs), must be fulfilled to be compared against legislative limits in Europe (Brown & Woods, 2014). This study concluded that the term ‘data coverage’, which is the percentage of a relevant reference period for which valid measurements are available, is more suitable for DQOs than time coverage (proportion of the year for which measurements were originally planned) and data capture (proportion of valid measurements obtained within the measurement period defined by time coverage). Furthermore, they suggested that this removes the requirement for studies to be at least a year in length, and could focus on the relevant concentration cycles of the pollutants studied. |
| Inclusion / exclusion justification | The scope of the work has to be specifically stated, with the reasons for exclusion of data clearly articulated: for example, in previous studies trains have been excluded if they are closely associated with another train travelling in the opposing direction due to potential conflicting results.<br>This includes justification for the choice of site, and possible conflicting factors of particulate matter. |
| Types and calibration of monitors | There are a variety of monitor manufacturers and models that use different methods for measuring air quality parameters, such as $PM_{10}$ and $PM_{2.5}$. The monitors used for the study must be appropriate to the variable being measured. Experimental design reviews have indicated that for particulate matter a combination of 24-hour sampling (mass measurement via filter-based gravimetric analysis) and continuous PM sampling should be used, as each method has limitations: for example, diurnal variation is missed in the 24-hour sampling whilst some continuous PM sampling use an optical measurement that reduces its accuracy for determining the quantity of smaller particles (Baldauf et al., 2009). Ideally, all monitors would comply with the AU/NZS standards and be calibrated against a NEPM-compliant monitor. |
| Dispersion modelling | Air quality modelling is the mathematical prediction of ambient concentrations of air pollution, based on measured inputs, and is inextricably linked to monitoring. Dispersion modelling is the most relevant to fugitive dust emission from rail corridor, with both railways and roads classified as a line emission source. Irrespective of the models, numerous studies have indicated the need to include model-to-monitor comparisons to confirm predictions of dispersion made by these models (Venkatram et al., 2007). |

# APPENDIX 6 REGULATION OF AIR QUALITY AND THE RAIL CORRIDOR

**Regulation of air quality**

Air quality standards are established in Australia at a national level through Federal, State and Territory Environment Ministers, having regard to international standards and agreements, and are given effect through jurisdictional legislation and policies (Figure 2).

In NSW, the Environment Protection Authority (EPA) has regulatory responsibility for issues and activities affecting environmental outcomes, which may be addressed through licensing; compliance, investigation and enforcement actions; research and special initiatives.

Activities that require an Environment Protection License (EPL), including activities affecting air quality, are set out in Schedule 1 of the Protection of the Environment Operations Act 1997 (NSW) (the POEO Act). Scheduled activities may be premises or not premises-based. EPLs set out requirements for how activities are conducted and include conditions relating to pollution prevention; permissible levels of emissions, noise and other pollutants; hours of operations; incident management; monitoring and reporting. The NSW EPL system is based on an outcome, load and risk based approach with an emphasis on best practice. Pollution Studies and Pollution Reduction Programs (PRPs) are frequently used as part of the licensing regime to assess and respond to significant issues and management practices. The EPA is required to review each EPL at least once every five years.

**National Environment Protection (Ambient Air Quality) Measure (AAQ NEPM)**

The AAQ NEPM sets out a number of requirements for monitoring stations that form part of the national network to ensure data from around Australia is captured and reported in a consistent, equivalent and reliable manner. This includes for example, the number and location of monitoring stations that are included in the national reporting process, the methods for assessing concentrations of different pollutant types, and standards for and calibration of instrumentation. AAQ NEPM stations must meet specific standards e.g. be located in accordance with the requirements for Australian Standard AS2922-1987 (Ambient Air-Guide for Siting of Sampling Units) and accredited by the National Association of Testing Authorities (NATA). Some stations are required to be nominated as 'trend' stations to monitor and assess long term changes in ambient air quality and must be located in the one place for at least one decade.

Because they are intended to capture representative general air quality in major population centres, the AAQ NEPM monitoring stations are not located in 'hot spots' near roads or other significant sources of pollutants.

**Licensing of railway system activities**

Railway system activities in NSW are captured in Schedule 1 Clause 33 of the POEO Act and are defined as including at 1(b) *the operation of rolling stock on track,* rolling stock at cl 4 *is taken to be operated by the occupier of the land on which the track is situated*. 'Track' is defined as forming part of or consisting of a network of more than 30 km. There are also a range of exclusions set out at cl (33)(2), some of which are covered through other provisions (e.g. cl 10 - coal works which includes storing, loading or handling coal).

From a supply chain perspective, the effect of the current definition is that primary responsibility for environmental performance vests with the network (track) operators, with rolling stock operators (carriers) captured through secondary (contractual) arrangements between them and the network operator.

In August 2014, the EPA released a Position paper as part of a review of the regulation of railway systems activities under the POEO Act. The paper noted serious limitations with the current framework, including inefficiencies and enforceability of environmental obligations through secondary and essentially commercial arrangements (NSW EPA, 2014b). The paper proposed a number of solutions, the preferred alternate strategy being a requirement for rolling stock operators as well as railway system operators to hold an EPL. In February 2015 the EPA released a paper summarising responses to the discussion paper and indicating its intent to amend the POEO Act to implement the preferred option. At the time of release of this report an exposure draft Amendment had not yet been released.

**Regulation of diesel locomotives**
Diesel fuelled locomotives are recognised as important contributors to fine particulate emissions. Unlike the US and Europe, currently there are no Australian standards in place to address locomotive emissions. Following the release of the Air Emissions Inventory for the Greater Metropolitan Region in NSW (NSW EPA, 2012), the EPA commissioned a detailed scoping study on locomotive emissions (ENVIRON, 2013).

Nine emission reduction measures were assessed for cost and reduction in nitrous oxide ($NO_{x)}$ as well as $PM_{10}$) and annual health benefits. Measures included introduction of national standards, accelerated replacement and retrofitting of the existing fleet, fuel efficiency and driver advice measures. Measures recommended for further national consideration included introduction of emission standards (equivalent to USA), support for fuel efficiency measures and incentives to operators to upgrade. State level measures recommended for further consideration include fuel efficiency measures, accelerated replacement of old (25+ years) vehicles (including high utilisation locomotives such as coal and freight haul) and accelerated overhaul of other existing locomotives. Shorter term (one-five year) state level options included extension and targeting of clean technology and energy efficiency programs, collection and publication of fuel efficiency and performance data and use of both PRPs by the regulator and contractual agreements between network and rolling stock operators to accelerate upgrades and improve performance (e.g. emissions, maintenance and fuel efficiency practices). In 2014 the EPA released a paper summarising responses to the scoping paper with comments (EPA, 2014). At this point details of further action by the EPA have not been publicly released.

**Figure 2**: **Australian and NSW regulatory framework for air quality and emissions**

## Federal

**National Environment Protection Council Act 1994**
Allows the National Environment Protection Council
(Federal & State/Territory Governments)
to make National Environment Protection Measures (NEPMs)

**National Clean Air Agreement** (proposed)
Commitment by Environment Ministers to develop by mid-2016 to address key challenges
*Working towards a National Clean Air Agreement discussion paper Feb 2015*

**Four measures directly relate to air quality**

- Ambient Air Quality (AAQ) NEPM – criteria pollutants that are regulated and used as indicators of air quality: carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO2), Ozone (O3), sulfur dioxide (SO2), particulate matter (PM)
- Diesel Vehicle Emissions NEPM
- Air Toxics NEPM – hazardous air pollutants - no mandatory standards; requirement to monitor & report e.g. benzene, toluene
- National Pollutant Inventory (NPI) NEPM – data set on 93 substances (including PM); requirement to report if facility type listed (e.g. rail yard operations); manuals for how facilities estimate (e.g. sampling direct measurement),

## New South Wales

**Protection of the Environment Operations Act 1997 (NSW)**

Statutory framework for managing air quality and emissions
Describes environment protection goals, guidelines, standards, policies, offences and powers
Provision to license activities and ability to make particular conditions e.g. requiring pollution studies or reduction programs

**POEO (General) Regulation 2009**

Provides for a load based licensing scheme, which includes economic incentives for EPA licensed premises to reduce water and air pollution and environmental monitoring including air quality

**POEO (Clean Air) Regulation 2002 NSW** (updated 2010)

Prescribed standards (maximum limits) of concentration for air impurities to control emissions from a range of sources including industry, wood heaters, vehicles and fuels & test methods (as set out in Schedules)

**Approved Methods for the Sampling and Analysis of Air Pollutants in NSW** (AMSAAP) **–** prescribed methods for testing and monitoring

**Environmental Protection Licence**

Requirement to hold EPL in premises where scheduled activities undertaken, including conditions for pollution prevention, monitoring and reporting.

**Air Quality Monitoring Network**
Run by Office of Environment & Heritage NSW
Originally Greater Sydney; in 2010 extended to the Upper Hunter (UHAQMN) and subsequently Newcastle (NLAQMN)

**POEO (General) Amendment (Upper Hunter Air Quality Monitoring Network) Regulation 2013**
Provides for ongoing funding of the UHAQMN, including requirement for coal mining & electricity generator license holders (EPLs) in Upper Hunter to pay a levy towards the network & how calculated; requirement for EPL holders to provide data & for EPA to make data available

**POEO (General) Amendment (Newcastle Air Monitoring) Regulation 2015**

Provides for funding of the Newcastle network established in 2014, including requirement for license holders (EPLs) to pay a levy towards the network & how calculated; requirement for EPL holders to provide data & for EPA to make data available

# APPENDIX 7 SITE VISITS, STAKEHOLDER MEETINGS AND TELECONFERENCES, AND SUBMISSIONS

**Table 5: Site visits**

| Date | Location | Present |
|---|---|---|
| 08/10/15 | Various sites across the city of Newcastle and Sandgate | EPA representative |
| 16/11/15 | Kooragang Island, Aurizon Hexham Train Support Facility | PWCS representatives, Aurizon representatives |

**Table 6: Stakeholder meetings & teleconferences**

| Date | Type | Stakeholder Group/s |
|---|---|---|
| 18/09/15 | Meeting | EPA (Members from Reform and Policy, Air Policy, Compliance and Assurance, Infrastructure and the Hunter Region.) |
| 02/10/15 | Teleconference | EPA (Members from Hunter Region) |
| 08/10/15 | Meeting | Correct Planning and Consultation for Mayfield group (CPCFM) |
| 13/10/15 | Teleconference | Environmental Justice Australia |
| 03/11/15 | Meeting | NSW Minerals Council, Glencore Coal Assets, Centennial Coal, Aurizon, Pacific National, ARTC, PWCS |
| 03/11/15 | Meeting | Professor Louise Ryan, UTS |
| 16/11/15 | Meeting | Concerned community members from CPCFM and CTAG |

**Table 7: Submissions**

| Ref: | Name | Organisation |
|---|---|---|
| SUB0001 | Nick Higginbotham, PhD | |
| SUB0002 | NSW Minerals Council | NSW Minerals Council |
| SUB0003 | Mr Rick Banyard | |