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# RESOURCE CONSENT APPLICATIONS FOR PROPOSED LYTTELTON HARBOUR/WHAKARAUPO RECLAMATION ACTIVITIES

# Review of Assessment of Effects on Air Quality

**Submitted to:**
Canterbury Regional Council
PO Box 345
Christchurch

REPORT

**Report Number.** 0978107325

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Golder Associates

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# 1.0 INTRODUCTION

## 1.1 Background

Lyttelton Port Company Ltd (LPC) has applied to Canterbury Regional Council (CRC) for resource consents for activities associated with the proposed reclamation of land at Te Awaparahi Bay, Lyttelton. The proposed reclamation is to provide for port activities, including the expansion and on-going use of the existing coal stockyard facility.

LPC proposes to use material sourced from nearby Gollans Bay Quarry for the reclamation. It also proposes to excavate the hillside adjacent to the existing coal stockyard to obtain material for the reclamation and create additional land for the coal stockyard expansion. Once operational, there will be discharges of coal dust into the air from the coal stockyard facility. Accordingly LPC has applied for the following discharge permits associated with the proposal:

- **CRC101533** – to discharge contaminants (dust) into air arising from the construction of the reclamation, hillside excavation and on-going operation of the coal stockyard facility.
- **CRC101535** – to discharge contaminants (dust) into air arising from quarry activities and the transporting of quarry material at Gollans Bay Quarry.

Golder Associates (NZ) Limited (Golder) was engaged by the CRC to review these resource consent applications in relation to the assessment of effects on air quality and this report summarises the results of the review. This review has been prepared following:

- Lodgement of the resource consent application (with supporting documentation) by LPC in November 2009.
- Initial review of the application and documents.
- Request for further information about the proposed activities and effects.
- Meetings between Golder staff and the applicant to discuss the further information requested.
- Provision of further information by LPC in July 2010.

## 1.2 Scope of Report

This report[1] provides a review of LPC's assessment of the effects on air quality. This report is supplementary to the overview report prepared for all regional council resource consent applications (hereafter referred to as the Officers Report) associated with the proposed reclamation. Full details of the applications are provided in the Officers Report. This report focuses on the assessment of effects on air quality. It includes a review of the proposed mitigation and monitoring in relation to air discharges.

To carry out this review Golder has considered the following documents:

- The Assessment of Environmental Effects (AEE) provided by LPC in November 2009 referenced in this report as LPC (2009).
- (Beca Infrastructure Ltd, 2009) (Appendix 12 to LPC 2009).
- The response to requests for further information submitted by LPC on 30 July 2010.
- Chapter 3 of the Natural Resources Regional Plan (2009).

[1] This report is subject to Golder's report limitations which are provided in Appendix A.

- The Literature Review provided as Appendix 20 of LPC 2009, titled ‘Health Effects of Coal Dust in a Non-Occupational Context’.

Golder has also taken into account issues raised by submitters in relation to the air discharges, as summarised in the Officers Report.

Golder staff, including an air quality scientist, visited the site on 3rd September 2009 to view the existing coal stockyard facility, proposed reclamation area, and Gollans Bay Quarry. On 8 March 2010 Golder staff visited the Lyttelton area with a CRC compliance monitoring officer to view areas where dust effects have been reported to CRC. At this time we met with some residents in the area around the Lyttelton Timeball station who have reported dust effects to CRC, and viewed areas of their properties where dust effects occur.

## 1.3 Qualifications

This report was prepared by Roger Steven Cudmore. Mr Cudmore has been employed by Golder Associates (NZ) Ltd (Golder) as a Principal Air Quality Consultant since 2004. His qualifications are an honours degree in Chemical & Process Engineering, obtained from Canterbury University in 1986. He has 18 years professional experience as an environmental consultant within the fields of wastewater treatment and air quality management.

# 2.0 STATUTORY FRAMEWORK

In considering the effects on air quality this review is guided by the Officers Report and the statutory guidance provided in Chapter 3: Air Quality of the Natural Resources Regional Plan (NRRP) (CRC, 2009) which is partly operative.

Chapter 3 of the NRRP includes objectives and policies for localised effects on air quality which require that localised discharges do not result in significant adverse effects on the environment, including adverse health effects, offensive or objectionable odours, diminished visibility, corrosion and soiling of structures and effects on ecosystems, plants and animals.

The policy for dust effects (Policy AQL6) requires that the discharge to air of dust shall not be corrosive, noxious, dangerous, objectionable or offensive to the extent that it has an adverse effect beyond the site boundary. This policy does recognise and provide for the operation of Lyttelton Harbour/Whakaraupo, while requiring that the adverse effects of the bulk handling of materials at the port are avoided, remedied or mitigated.

# 3.0 ASSESSMENT OF EFFECTS

## 3.1 Introduction

The assessment of air discharge effects includes potential health and nuisance effects due to proposed quarrying activity at Gollans Bay and associated transport of material to the port reclamation, the hillside excavation opposite the existing coal stockyard, and operational and construction effects of the proposed coal stockyard.

There are a number of activities and issues listed above for consideration, however in practice we consider that there is only one substantive air quality issue, that is the potential for coal dust nuisance and health effects on residential properties in Lyttelton due to the operation of the extended coal stockyard. There are concerns and occasional nuisance complaints from the community with respect to the coal dust impacts and potential health effects due to the existing coal stockyard operation.

LPC proposes to increase the area of coal stockpiling from 4.4 hectares (ha) to 12.6 ha by reclaiming land further out into the harbour. This is expected to increase nominal coal storage from 245,000 tonnes to 400,000 tonnes. The extension is expected to allow for a doubling of the existing coal export rate of 2.5 million tonnes per year (tonnes/yr) and require 220 days per year (days/yr) of loading out to ships compared to the current norm of 100 days/yr. Therefore the scale of the operations would increase substantially. Further to this, the new reclaimed area of coal stockyard would be directly upwind of residential properties within the area of the Timeball Station during the most prevalent and strongest winds – that is winds from the East that flow directly up Lyttelton Harbour/Whakaraupo. These residents are already concerned about coal dust impacts from the existing smaller coal stockyard area from which they are more sheltered due to landscape features compared to the proposed reclamation.

Having considered the potential nuisance and health effects due to air discharges from the activities outlined above, the report will comment upon the monitoring and mitigation measures that have been proposed by LPC.

## 3.2 Construction and Quarrying Effects on Air Quality

### 3.2.1 Discharge sources

The application considers four main areas where construction-phase discharges would occur:

1) Rock extraction and processing at the Gollans Bay Quarry. Approximately 5,000 cubic metres per day ($m^3$/day) may be extracted, following stripping of loess overburden. Extraction would involve blasting, and the overburden would be stockpiled at the quarry. During the reclamation project, the quarry may operate for 24 hours per day, 7 days per week.

2) Vehicle movements on the haul road between Gollans Bay and the reclamation area. The route will lie along the Old Sumner Road, then down to the reclamation area via a new connection.

3) Rock extraction and processing at Te Awaparahi Bay, behind the coal stockpile. Approximately 5,000 $m^3$/day of rock and loess may be excavated, up to a total maximum of approximately 770,000 $m^3$.

4) The reclamation area itself, which has an area of 10 ha and will require approximately 1,500,000 $m^3$ of fill. Construction is expected to occur 24 hours per day, 7 days per week, during the reclamation period.

The application identifies the following activities, any or all of which might occur at each of the four main sources of construction main phase discharges:

- Blasting.
- Excavation including overburden stripping.
- Vehicle movements on unpaved sources.
- Loading and unloading.
- Exposed surfaces such as stockpiles and yards.
- Crushing and screening.
- Vehicle engine emissions.

Dust and particulate matter from these activities is considered by the applicant to be the most significant discharge. Of these sources, blasting and vehicle engine emissions are not assessed further in the application, as they are considered likely to lead to insignificant adverse effects at sensitive receptors. We agree with this.

### 3.2.2 Health effects

The application only considers the potential adverse nuisance effects of these discharges (i.e. dust discharge and deposition). This implies that adverse health effects are considered unlikely to occur as a result of the construction phase. We agree that this is likely to be the case, and that the application has focussed appropriately on potential nuisance effects resulting from these activities.

### 3.2.3 Nuisance effects

In general, the applicant considers that the adverse effects from these activities are likely to be minor. A number of dust mitigation methods are proposed, and dust management plans (DMPs) have been prepared for both the Te Awaparahi Bay and Gollans Bay quarry areas. The Te Awaparahi Bay DMP also includes the reclamation area. We agree that the proposed dust mitigation measures are good practice for dust mitigation.

With regard to the excavation at Te Awaparahi Bay, the applicant expects that dust effects at sensitive receptors will be minor, as long as effective mitigation is undertaken and potential dust emissions are monitored. The application also states that adverse effects could occur as a result of dust discharges from the reclamation area, as it is more exposed to the wind than other parts of the operation. Mitigation practices are set out in the AEE and draft DMP, and we agree that these proposed measures are consistent with good practice. In addition, the applicant proposes to monitor dust-generating activities when the wind speed exceeds 5 m/s. However, it is noted that the draft DMP does not include a response strategy in the event that dust discharges create a nuisance beyond the site boundary during such times.

With regard to quarrying at Gollans Bay, the application considers that the quarry and haul road are sufficiently far from sensitive receptors that effects on them should be minor provided that best-practice mitigation is used. The mitigation measures are set out in the Gollans Bay draft DMP, and we consider them to be appropriate. The Gollans Bay draft DMP also includes proposed monitoring, similar to that proposed in the Te Awaparahi draft DMP, and it is noted again that no response strategy is included.

Overall, we agree with the conclusion of the assessment, that the adverse effects resulting from these discharges are likely to be minor, provided good practice dust mitigation measures are implemented should there be any sign of visual dust impact on sensitive receptors. It is recommended that conditions be attached to the resource consent, if it is granted, that reflect the mitigation proposals set out in the application documents.

## 3.3 Operational Effects of Coal Stockyard Activities on Air Quality

### 3.3.1 Health effects

#### *3.3.1.1 Introduction*

In this section, the applicant's assessment of coal dust health effects is summarised and our review of this is provided.

#### 3.3.1.2 Summary of the applicant's assessment

The application concludes that potential adverse health effects resulting from the discharge of respirable particulate matter ($PM_{10}$) are likely to be minor, both under the existing situation and the expansion scenario. This is based on consideration of measured 24-hour average $PM_{10}$ and total suspended particulate matter (TSP) concentrations. $PM_{10}$ was measured by the CRC during June 2004, and no exceedances of the National Environmental Standard (NES) value of 50 µg/m$^3$ were observed. TSP concentrations were measured by the applicant at the Timeball Station during January to March 2009, and although the $PM_{10}$ fraction is not reported in the application, only one exceedance of the $PM_{10}$ NES was measured, suggesting that $PM_{10}$ concentrations would all have fallen within the NES value during the monitoring period. These limited monitoring data do suggest that exceedances of the NES for $PM_{10}$ are unlikely. However, they only cover approximately a quarter of a year.

The Timeball Station TSP monitoring indicates that concentrations appear to be influenced by the coal stockpile area, such that when the data are filtered for wind direction, winds blowing from the coal stockpile toward the monitor result in higher TSP values than those from other directions. In addition, TSP concentrations tend to increase when wind speeds exceed 5 metres per second (m/s), and also when loading or unloading activities are taking place at the coal stockpile. When the wind is blowing from the coal stockpile, measured 1-hour average TSP concentrations exceed 100 µg/m$^3$ on a number of occasions, and twice approach 200 µg/m$^3$.

The application goes on to state that *"The frequency of occurrence of local maximum $PM_{10}$ concentrations is not relevant provided the peak concentrations do not exceed the relevant NES criteria"* (AEE document, page 72). In conclusion, it states that dispersion modelling indicates that $PM_{10}$ concentrations should decrease following the proposed expansion, and concludes that the resulting potential for adverse health effects is minor.

#### 3.3.1.3 Review of the applicant's assessment

The principal conclusion made by the application is that existing 24-hour average $PM_{10}$ concentrations appear to be well within the NES for $PM_{10}$ and that those following the expansion are also likely to be, and therefore the potential for adverse health effects is minor. This conclusion is based on the compliance with the current regulatory benchmark for $PM_{10}$. However this does not address, or ensure protection from, the potential for health effects resulting from short-term exposures to relatively high concentrations of coal dust whose size fraction is not well defined by the application. The dispersion modelling used to assess the effects of the proposed expansion will be discussed later in this report.

Given that the TSP monitor is located some distance from the stockyard area and approximately 100 m higher on elevated terrain, it is possible that much of the stockyard-derived material could be within the $PM_{10}$ size fraction. Given this, then much of the short-term exposure could be to coarse respirable particles. This is because the fine fraction of $PM_{10}$ that is, $PM_{2.5}$ size fraction, is more typically derived from combustion processes rather than physical attrition.

It is considered that the short-term peak concentrations of coal dust are relevant to the assessment of effects. In this case, the short-term measured concentrations are substantial on occasion during the short period of monitoring that has been undertaken. It is considered that the potential short term health effects of coal dust require further consideration, which should include an analysis of the actual size fraction of the measured coal particulate. Compliance with the NES target for $PM_{10}$ does not necessarily provide protection to high short term coal dust impacts. This coal dust is likely to be a more fine fraction and therefore more likely to penetrate an individual's respiratory system. It is therefore recommended that the potential health effects of short term high exposures of coal dust near the Timeball Station be further considered. In doing so, this should account for the particle size distribution of suspended short term dust peaks, and the magnitude and duration of these.

## 3.3.2 Nuisance Effects

### *3.3.2.1 Introduction*

In this section, the applicant assessment of coal dust nuisance effects is summarised and our review of this is provided.

### *3.3.2.2 Summary of the applicant's assessment*

The general approach of the nuisance assessment was via the following steps:

1) Estimate dust emission rates in grams per second (g/s) for current and future stockyard scenarios.
2) Use estimated emissions as inputs to dispersion modelling to calculate ambient impacts for current and future scenarios (concentrations in micrograms per cubic metre (µg/m$^3$) and deposition rates in milligrams per square metre per day (mg/m$^2$/day)).
3) Compare modelling predictions to ambient monitoring data (µg/m$^3$ and mg/m$^2$/day) to assess modelling realism.
4) Compare relative change (%) in predicted impacts from current and future scenarios so to evaluate relative change in nuisance potential.

In summary, the coal dust emission assumptions established in step (1) above are used to predict (via dispersion modelling) the relative difference in "peak" and "long term" average coal dust deposition rates (mg/m$^2$/day) and ambient concentrations (µg/m$^3$) for the existing and future operating scenarios. The comparison of modelled results for the existing and extended coal stockyard operation allows for the relative change in effects to be estimated which helps to overcome problems with consistent errors inherent within the equations. Therefore the dust nuisance assessment is based on the dispersion modelling of the relative change in coal dust deposition and coal dust concentrations in the air.

The resultant average and peak dust emission results (g/s) that were estimated (using empirical equations developed for Australian coal mines) for the existing and future stockyard operation were very similar to each other, despite the large increase of stock piling area and the scale of the operation approximately doubling. This was a result of more effective control / minimisation of dust emissions when undertaking stockyard activities such as stockpiling, unloading coal, reclaiming coal from piles and loading coal out to ships.

A key measure that was used by the applicant to justify significant improvements in the control of coal dust emission to air (per unit length of conveyor, per conveyor transfer point etc) is the proposed increased use of surface watering systems to enhance dust suppression.

A higher degree of enclosure for coal transfer equipment was also a factor. However, the majority of dust emissions to air were calculated to result from bulldozer / front end loader operation and wind erosion of dust from the coal stock piles. Watering of surfaces is the key mitigation measure for these main sources of coal dust. From the calculated emissions it was concluded by the applicant that long term average dust emissions would only increase moderately. This moderate increase was assumed to occur over a larger stockyard area, which mitigated the predicted dust impacts in the area of the Timeball Station.

The assessment also concluded that the short-term peak coal dust emissions (daily or sub-daily) would decrease despite the expansion, due to the increased control that was assumed by the increased use of water and to a lesser extent the more effective enclosing of coal transfer systems.

In summary the future potential for nuisance effects were assessed using a dispersion modelling process based on assumed dust emissions that relied upon specified levels of increased dust control. Like many modelling assessments, ambient monitoring data (dust deposition rates and ambient concentrations) were compared to the modelling results, so to evaluate the model's ability to predict a representative spatial pattern of effects - that is ambient impacts and ultimately the relative potential for nuisance effects.

Another key point is that the assessment of nuisance potential for the extended stockyard operation was based on the relative change in predicted short-term ambient impacts of coal dust. From this predicted relative change of peak ambient impacts, the assessment concluded that dust nuisance effects would reduce as a result of the expansion. This was because the peak dust impacts were predicted to decrease at residential houses (by approximately 40%). This conclusion was based on the underpinning assumption that "peak" dust deposition rates are the key driver of dust nuisance potential. As discussed later, this assumption is considered to be incorrect in terms of both time frame and the parameter itself.

It was generally concluded by the applicant that the comparison of ambient monitoring data to model-predictions of dust deposition rates indicated that estimated dust emission rates and the model itself were able to reliably predict relative changes in ambient dust deposition rates and suspended coal dust concentrations as a result of the proposed stockyard extension and upgrade.

### *3.3.2.3 Summary of main findings of review of the applicant's assessment*

The applicant's main conclusion regarding the adverse effects of these discharges is provided above. For the reasons discussed below, we consider that this conclusion is incorrect and that the model setup used for the assessment is unreliable in its predictions of relative changes in ambient impacts that are likely to occur as a result of the coal yard extension.

The underpinning assumptions that allowed for the assessment's conclusion of reduced nuisance are that:

- Dust deposition rates are the primary driver of nuisance effect.
- The relatively infrequent peak deposition events drive the severity of the nuisance overall.

As already indicated, this review concludes that these assumptions are incorrect.

Notwithstanding the above, the assessment does not address the significance of existing nuisance effects and whether or not these breach the objectionable effects threshold. It is our view that existing dust effects are objectionable at some residential dwellings. The assessment does not conclude, or comment on whether the predicted reduction in potential nuisance for the extended coal stockyard operation is likely to result in future effects being less than the objectionable effects threshold. These are significant omissions that preclude the assessment from being able to provide a reliable indication with regard to the likely significance of future dust nuisance effects. The existing severity of coal dust nuisance effects at impacted locations indicates that nominal emissions from the stockyard area need to reduce by approximately an order of magnitude (i.e. 80% or more) to make a noticeable reduction in effects, to a level whereby they are not objectionable. A reduction in existing emissions in the order of 40% is not likely to achieve this outcome.

In the following section a review of the applicant's assessment is provided.

### *3.3.2.4 Review of the applicant's assessment*

This section provides a summary of conclusions from our review of the applicant's assessment of potential coal dust nuisance effects following the proposed expansion of the coal stockyard. The main conclusions are summarised as follows:

1) The assessment of potential coal dust nuisance effects is not robust and is based on flawed underpinning assumptions.
2) There is insufficient knowledge regarding the degree of emissions reduction necessary to ensure that the main source(s) of coal dust emission do not cause objectionable effects within the nearest residential area both currently and following the proposed extension.
3) The extent of dust emissions reductions necessary to avoid objectionable effects is likely to be far greater than the reductions assumed by the assessment. Further these assumed improvements in

mitigation performance are at best, only ball-park estimations given the absence of a detailed benchmarking of the existing mitigation procedures, engineered controls and water application rates, and the same for the extended stockyard operation.

4) There is a real prospect that existing nuisance effects would become more severe and that the zone of nuisance effects would increase as a result of the extended coal stockyard operation.

5) Finally, it is concluded that the relative changes in dust deposition rates (peak and averages) and predicted changes in ambient TSP concentrations for the operations of the extended stockyard do not indicate a reduction in the primary dust nuisance effect on residential properties in the vicinity of the Timeball Station.

The rationale for these conclusions is expanded below.

As stated above, it is concluded that the coal dust nuisance assessment is not robust and is based on unsubstantiated underpinning assumptions. The reasons for this view can be broken down into issues surrounding the appropriate use of modelling tools for assessing nuisance effects, understanding the actual driver of nuisance effects, benchmarking the modelling outputs against existing effects and the reliability of meteorology and emission inputs to the dispersion model.

The modelling approach used for the assessment is not directly linked to the actual nuisance effects of coal dust impacting on washing, vegetation, buildings and internal living areas being visually degraded by coal dust soiling. The assessment approach did not consider whether existing effects are objectionable or otherwise. Therefore modelling relative changes in this case was unable to address the issue of whether future effects will meet the requirements of the relevant regional plan (Chapter 3 of the NRRP: Air Quality) regarding objectionable effects.

The modelling-based assessment has focused upon dust deposition rates and guidelines – the latter were largely derived from those relevant to sediment type dust and which provide a poor indication of the degree of actual nuisance being experienced. The modelling assessment in this case lacked a substantive benchmarking of modelled impacts against the spatial variation of observable coal dust nuisance effects. It also lacked any assessment to confirm that the modelling of dust deposition provides an effective indicator of nuisance potential and if so, what a reliable guideline value is that protects against objectionable effects in this instance.

Consequently, no modelling impact criteria were established for which compliance would indicate effects to be below the objectionable / otherwise threshold. Instead, the past criterion for dust deposition rates of 80 mg/m$^2$/day has been promoted despite modelling and monitoring data clearly showing that the worst-impacted dwellings are exposed to deposition rates that readily meet this numeric guideline value. An investigation of actual nuisance effects of these properties, which are located in the Timeball Station area, highlights that objectionable effects are occurring in our opinion, despite routine compliance with the numerical criterion. Therefore it is our view that exposure to much lower deposition rates than 80 mg/m$^2$/day is likely to cause objectionable effects.

Part of the reason why the deposition guideline of 80 mg/m$^2$/day is not protective against objectionable effects is the nature of coal dust compared to sediment type dust typical of quarrying activities. Firstly, it is dark and secondly it is relatively fine. In addition, in this case, the most-impacted dwellings are located on much higher ground than the source of the dust (i.e. ~ 100 metres (m) higher than the stockyard area). Therefore, only the fine fraction of coal dust emission, that is sufficiently fine to rise with air currents, will impact on these dwellings. As a result, this nuisance coal dust does not readily settle in the way quarry dust would, otherwise it would never impact on terrain that is in the order of 100 m above the source. The dust does not settle in the normal sense, but instead it is removed from the bulk air stream when impacting on vegetation, buildings etc. Instead, the mechanism for settling inside houses is likely to be the result of normal diffusion into enclosed spaces, in the same way as any ambient gaseous pollutant. Once trapped in an enclosed space (e.g. a living room) much of this fine dust will ultimately deposit onto surfaces because there is effectively quiescent conditions. The result is a relatively high visual soiling effect as a consequence of particulate colour and its fineness. Normal atmospheric dust also impacts and accumulates within buildings through the same process but has a far lesser visual impact because of its lighter colour.

The second reason why the 80 mg/m$^2$/day guideline does not appear to be protective against objectionable coal dust effects is because the key driver of nuisance in this instance is the horizontal mass flux or impact of coal dust and not its atmospheric deposition rate due to gravity – the two are not directly proportional. The horizontal mass flux of coal dust is more directly related to its ambient concentration. It is likely that minimal coal dust deposition can still be associated with significant visual soiling of surfaces as a result of direct impaction of the dust (i.e. the horizontal mass flux), as opposed to it gravity settling (i.e. the deposition mass flux) from above. This is evident from vegetation impacts, where small trees near the Timeball Station are black from coal dust on the side facing the stockyard and relatively clean on the lee side. It is also evident from the fact that this coal dust impacts 100 m above its point of release – it has minimal propensity to deposit vertically.

As a consequence of the above, running a dispersion model to simulate the gravity settling of coal dust, or even directly monitoring this deposition mass flux (mg/m$^2$/day) with dust collection pots produces deposition values (mg/m$^2$/day) of dust settlement primarily due to gravity that are not directly linked to the actual mechanism that drives coal dust nuisance effects. Therefore, identifying a dust deposition rate that protects against objectionable effects is not likely to be practical or reliable. Monitoring of deposition rates may well provide an indication in trends in coal dust mitigation, but as a means of reliably indicating the potential for dust nuisance effects, and the extent to which these may be objectionable, this parameter is not relevant or appropriate, as it is based on a physical process (i.e. gravity settling) that is not the primary driver of nuisance. Therefore, its magnitude cannot be used to reliably infer nuisance even in relative terms.

Another underpinning assumption of the assessment that is highly doubtful in our opinion is that 'peak' deposition rates, or peak ambient coal TSP concentrations are the primary drivers of the nuisance effects. The main conclusion of the assessment, that potential nuisance will decrease, hinges on this assumption. However, there is considerable evidence that it is not correct. It is considered that the persistent impact of coal dust is the primary issue, and that nuisance potential can only reduce significantly by avoiding dust impacts for the vast majority of time and only allowing for the odd peak event. The primary mechanism for nuisance effects, which is the horizontal impaction of fine suspended coal particulates and then the entrainment / deposition within enclosed spaces, clearly points to average day to day exposure levels being the key issue to address if current nuisance effects are to be addressed effectively. Infrequent peak impacts of ambient dust are very likely to be a secondary driver of the nuisance that has been experienced by some residential property occupants in the vicinity of the Timeball Station.

Given that the prediction of ambient coal TSP levels is more appropriate for indicating dust nuisance in this instance, it is essential to know whether or not the dispersion modelling setup that has been used can reliably predict the variation of this ambient parameter throughout the residential area, and therefore to assess the model's ability to reliably assess future nuisance potential. The modelled deposition rates and ambient coal dust TSP contours reported by the assessment predict very similar ambient impacts for areas near the Timeball Station and those further away on Forster Terrace. Therefore the actual nuisance impact zone is not shown up by the modelling as being different from areas known to have far less nuisance effects. This provides a clear indication that the dispersion model, as used, does not simulate the trajectory of coal dust emissions in a manner that is representative of what occurs within the sensitive residential areas of Lyttelton. Therefore it is doubtful that the modelling can reliably assess the potential for dust nuisance (via TSP predictions) within residential areas near and further from the Timeball Station.

It is acknowledged that the modelling has shown high dust impacts to occur opposite and close to the coal stockyard at similar elevations to it, and that it predicts much lower impacts further away on raised terrain at the Timeball Station. However, even the most unsophisticated dispersion models would show this trend, and it is not a strong basis to assume the model produces representative impact distributions. The modelling should predict relatively higher impacts within the known nuisance zone near the Timeball Station, and then show that these reduce in line with this established zone. However, the modelling does not appear to have the resolution to predict impact contours that are representative of the existing pattern of nuisance that is known to occur within the residential areas situated along the eastern ridge of Lyttelton.

Our review of the modelling and especially the development of the complex meteorological data set, has identified concerns with methods used that may partly explain the non-representative predictions from the modelling. However, even using a revised and improved set up for modelling, the complexity of the terrain is such that the CALPUFF / CALMET modelling system appears to be unable to simulate dust dispersion patterns that are representative of what actually occurs.

Putting aside the representativeness of modelled impacts, it is also important to consider the dust emission assumptions that ultimately determine if nuisance effects will improve or worsen. In this respect the use of empirical equations has probably produced emission rates from different sources that are reasonable in relative terms. For example, the erosion of dust from the stockpiles and its generation from front end loader / bulldozer operations are predicted to be the dominant source of dust for both existing and future scenarios. Intuitively this seems reasonable. Having said this, it cannot be assumed that the calculated relative difference in dust emissions between the existing and extended coal stockyard are reliable. There are several reasons for this, including the assumptions regarding the true extent of improved dust control for the extended stockyard, uncertainty within the variation of the wind speed distribution throughout the stockyard and unaccounted-for coal dust emission due to heavy equipment movements.

Firstly, the extent of reduced dust emissions for the extended coal stockyard relies on significant improvements due to water systems that are based on a judgement for the main sources – that includes stockpile erosion and operation of large mobile equipment (bulldozers and front end loader activity). Furthermore, some of the existing sources of dust (such as load out conveyors) are assumed to have dust emissions reduced by a factor of three due to upgraded mitigation. It is considered that mitigation design details are necessary for such assumptions to be reliable. However the AEE report confirms that the exact measures cannot be specified until detailed design is performed.

The substantial improvements in dust emission control assumed by the AEE report for the extended stockyard over and above what currently occurs can only be reliably substantiated when the engineering detail of the new and the existing systems can be confirmed. Furthermore, the reductions in dust emissions assumed for the up-graded watering systems are difficult to verify without detailed operational and design information regarding the existing and proposed water spray systems.

The second area of uncertainty within the relative dust emission estimates (existing compared to future) is due to the assumption that the long term average wind-speed distribution at the existing stockyard will be relatively unchanged within the new area that extends out into the harbour. The CALMET wind field modelling predictions show little variation in wind speed distributions for existing and extended stockyard locations. This seems unlikely as the extension moves the stockyard a significant distance out into the bulk air stream of the harbour. Instead, it is expected that the average wind speeds within the extended stockyard area would be significantly higher than those experienced within the existing yard. These winds would place sensitive areas more directly downwind of the stockyard, with less natural sheltering. Consequently the reductions assumed for dust emissions (that are likely to be dominated by wind erosion and coal excavation activities) may well be optimistic and the generation of coal dust from the extended coal yard may increase with respect to existing levels.

The third area of uncertainty in predicting the relative change in existing versus future emissions arises because the dust emissions due to the movements of front end loaders appear to have been overlooked. Heavy vehicle movements over dust laden surfaces at sites such as quarries and construction sites are often the dominant source of dust emissions. The equations that estimate the rates of discharge from this source of dust account for the distances travelled (VKTs) and vehicle weights. These calculations are not included within the assessment. Instead the equations used for front end loaders only estimate the dust generated due to loading and dumping of coal within the stockpile area – not the vehicle movement itself. Therefore, the fine dust that is generated by the grinding action of front end loader tyres over surfaces (paved or otherwise) is not accounted for in either the existing or future coal yard scenarios. This source of dust could be significant during north easterly winds that are associated with existing and future coal dust impacts within the area surrounding the Timeball Station. Their exclusion from the assessment creates some additional uncertainty regarding the relative change in dust emissions with extension.

#### 3.3.2.5 Summary and conclusions regarding nuisance effects

The application contains a great deal of useful information regarding site activities, existing monitoring methods, and monitoring results. The application therefore provides a comprehensive overall picture of the existing situation, but without providing a clear indication of how this relates to actual and potential adverse effects.

From the review of the modelling based assessment of dust nuisance potential as provided by the applicant, it is concluded that there are substantial short comings making its predictions unreliable and probably understating the risk of nuisance effects being exacerbated by the coal stock yard expansion. This is primarily a result of the monitoring and modelling dust deposition to assess nuisance potential, when deposition via gravity settling is not the primary driver of nuisance effects in this case. The concerns with the assessment are compounded by the modelling assessment approach not being thoroughly bench marked against existing nuisance effects, or these being investigated and assessed against the objectionable standard. Furthermore the inputs to the modelling assessment themselves and the modelling process is considered to provide an unreliable indication of the relative changes in ambient dust levels that are likely to occur as a result of the proposed expansion and therefore the changes in the potential for ongoing nuisance effects.

It is concluded that existing coal dust effects are likely to be objectionable and further that the reduction in coal dust exposure levels necessary to avoid objectionable effects is likely to be in the order of 80% or higher. Reductions much less than this are not likely to result in a significant change in the perceived nuisance given the logarithm relationship between concentrations and perceived nuisance effects.

It is concluded that the assessment to date has assumed optimistic emission reductions that themselves appear inadequate to avoid objectionable effects from coal dust.

# 4.0 MITIGATION AND MONITORING

## 4.1 Introduction

The information provided on mitigation and monitoring is discussed in this section. This is considered to be critical to this application as it is concluded from the assessment that what is proposed, and the level of emissions control, is not sufficient to avoid objectionable effects. This means that existing impacts could easily be exacerbated and impact upon a far wider area of Lyttelton unless current mitigation performance is improved drastically such that existing emissions per unit area of stockyard are reduced in the order of at least 80%.

Therefore it is considered that the details of coal dust mitigation and measures and understanding the extent of improvements to even contain the existing zone of objectionable effects, are critical considerations for ascertaining the potential effects of coal dust from the expanded operation.

## 4.2 Mitigation

### 4.2.1 Introduction

The key question for this proposal is whether or not LPC can implement mitigation that effectively limits dust nuisance effects to an acceptably low level, and which is practical and economically viable to implement. As an initial comment, it must be stated that this key question cannot be answered based on the assessment presented to date, as there is insufficient reliable information regarding the relative contribution of dust from various sources, under what conditions and ultimately the extent of reductions needed to only cause an acceptable level of residual effect, or else avoid objectionable effects. As well as auditing the application, the following discussions attempt to provide a possible solution.

### 4.2.2 Mitigation proposed by the applicant

Detailed mitigation measures are not provided in detail by the application or supporting dust assessment. Instead, the concepts and approaches are summarised. The proposed approach is to not commit to specific engineering systems (mitigation works), water application rates etc, but instead the applicant proposes a management plan process which monitors effects and from the findings of this, the mitigation works will be progressively installed. The AEE lists principal mitigation measures that will be used, but goes on to state that exact measures cannot be determined until detailed design is completed. The pro-active monitoring of dust effects and impacts and responding to this information through implementing necessary mitigation is supported. But it is concluded from the existing situation, that existing monitoring and the application of good practice dust mitigation measures has not avoided the long term imposition of objectionable coal dust impacts.

### 4.2.3 Recommended mitigation

While the general monitoring and pro-active mitigation process is a good practice and is recommended, this nevertheless needs to be supported by the following:

1) Implementation of an approach for monitoring dust nuisance effects and ensuring that objectionable effects are readily identified and can be correlated to relevant ambient parameters and site activities such that credible nuisance criteria can be defined for the coal dust impacts.

2) Understanding of the dust generation processes and what site activities are mainly responsible for causing fine dust impacts under most north easterly wind conditions and that are causing continual / gradual soiling of surfaces.

3) The reasonable estimation of daily water quantities for application ($m^3$/day/ha) and the likely extent of physical enclosures necessary to effectively contain these sources so to avoid objectionable effects.

Achieving steps (1) and (2) to a reasonable extent is important for allowing the applicant to reliably estimate the costs and feasibility of mitigation measures that are like to be necessary to avoid objectionable effects due to coal dust impacts at residential dwellings. We consider that the information within the assessment does not allow this to be understood for the existing, or the extended stockyard operation.

Step (1) above is the critical step and should be designed to provide data that allows for an adequate understanding of the relative importance of different dust generation processes and site activities (Step 2) and therefore ensure that the economic feasibility and practicality of achieving an acceptable level of coal dust effect can be estimated with reasonable confidence.

The proposed monitoring and subsequent investigations achieving (2) and (3) above are discussed in the following sections.

A list of mitigation measures that can be implemented at the coal stockyard is provided in Section 10.3 of the AEE. This is very general, and more specific measures are listed below as options that may be required to avoid objectionable dust effects at residential properties. This list is not exhaustive of all options but provides a reasonable selection of increasingly expensive yet effective dust control measures.

**Stockpiles**

- Ability to apply 10 mm/day depth of water to surface areas including stockpiles, front end loader access routes and any surface covered with coal dust using solid set water spray system and mobile water cart.
- Use of chemical polymers to assist dust suppression.
- Water sprays on coal receiving and load-out hoppers.

- Water sprays on the bucket reclaimer, automatic stacker and ship loading machinery.
- Paving of front end loader access routes and limiting speeds.
- Enclosure of reclaim hoppers, ventilation of enclosure air to bag-house filtering system.
- Partial enclosure of coal stockpiles, excluding those accessed by bucket wheel reclaimer and ventilation of building air to bag-house filtering system.
- Full enclosure of coal stockpiles and ventilation of building air to bag-house filtering system.

**Conveyors**

- Partial or full enclosure of conveyors.
- Partial enclosure of conveyor transfer points.
- Conveyor belt washing and / or water spray systems.
- Water sprays at transfer points.
- Underground conveyor system.
- Conveyor belt scrapers and cleaning systems.

It is noted that the assessment discussed full enclosure of the stockyard area and commented that it would be impractical to enclose an area of 20 ha. It is agreed that this area seems very large and even without detailed economic information, it is clear that such a building would be very expensive to construct and maintain. However, there are lesser options not listed within the assessment. These include only enclosing the stockpiles themselves, or partial enclosure of some stockpiles, and/or load out hoppers. These options may prove to be necessary to avoid objectionable coal dust effects and they would involve significantly less cost than full enclosure of the entire stockyard area.

## 4.3 Monitoring

### 4.3.1 Introduction

In this section, general monitoring is discussed and recommended, should consent be granted. This is followed by a specific monitoring and investigation programme that is recommended for step (1) above in order to allow for the better understanding of source contributions, and the reductions in dust and associated mitigation likely to be required to not cause objectionable dust effects. This process could be embodied into a management plan, but given the existing and potential dust impacts, it would be preferable that a clear understanding is obtained of the likely extent of mitigation measures necessary to avoid objectionable effects. This should then form the basis of the management plan, rather than relying on an evolving management plan to establish this over time. The role of the dust management plan can then be to monitor the extent of any ongoing dust effects, review the performance of these measures and hopefully confirm their adequacy, and help point to refinements, rather than requiring wholesale changes to achieve acceptable dust effects as time goes by.

### 4.3.2 Monitoring proposed by the applicant

The assessment recommends the continued monitoring of dust deposition via the monitoring standard ISO DIS 4222.2, which is seen as an improvement over the existing use of an Australian based method. We recommend that only limited dust deposition monitoring be continued, especially in residential areas. Instead, it is recommended that a more appropriate method be used whose results are more directly related to the extent of nuisance effect. The proposed reduction in the number of dust monitoring sites is considered reasonable, as there are currently more sites than are necessary to reliably indicate long term trends. The following section discusses recommended monitoring methods and programme for establishing dust mitigation requirements.

### 4.3.3 Recommended monitoring methods

Given the discussion and conclusions regarding the mechanism for coal dust nuisance in residential areas, continuous monitoring of ambient dust concentrations (TSP) and impaction by gravimetric methods are required in place of deposition monitoring.

The continuous TSP monitoring method has been utilised for the assessment, but to an extent that was too limited to allow for comprehensive relationships to be established between concurrent site activities, environmental conditions, ambient TSP concentrations and reported adverse effects. However this type of monitoring is an essential component of any overall programme that hopes to establish the significance of individual dust nuisance sources and associated mitigation requirements to avoid objectionable dust effects.

The continuous TSP monitoring implemented by LPC is summarised in Appendix 3 of the AEE report. This used the Beta Attenuation Monitoring (BAM) method, which is a certified method under the Ministry for the Environment National Environmental Standards for Air Quality with regard to the measurement of $PM_{10}$. It is likely that a non-certified and less expensive method would suffice given the aim is to monitor nuisance potential and the effectiveness of mitigation. Examples include the light scattering based methods used by the DustTack™ or GRIMM devices that are often used downwind of mining and quarrying sites. Irrespective of the method used, the key factors influencing the optimal choice (apart from cost) include the ability to analyse collected samples for composition and size range and most importantly the ability to correlate short term ambient concentration fluctuations to changes in wind conditions and site activities.

Given the above, it is concluded that the TSP monitoring approach utilised for the assessment was appropriate although was too limited in its application and use in this instance. Secondly this form of monitoring is recommended for ongoing monitoring of nuisance potential and the effectiveness of mitigation measures, although a less expensive technology than a BAM is like to suffice and should be considered.

With regard to gravimetric monitoring of dust impacts, it is recommended that the existing deposition monitoring is scaled back to a level sufficient to allow for historical comparisons at several sites. Otherwise the information is of little use. We recommend the gravimetric monitoring of dust that impacts horizontally, using multi-direction gauges such as those that conform to the British Standard BS1747Pt5 Directional Dust Gauge, (also known as the CERL Gauge). Note there is a common misconception that these gauges measure dust deposition whereas in fact they measure dust flux. This flux is the vector product of TSP concentration ($\mu g/m^3$) and the horizontal wind speed (velocity). Therefore it has the same units as for dust deposition, which can cause confusion. However, the results obtained by the directional gauge are not the same as those obtained from dust deposition. An estimated conversion between the two would require knowledge of particle size, particle concentration and wind velocity components, most of which are not known. The requirement of these parameters may help clarify to the reader that there is not a simple constant relationship between dust impaction results over time and dust deposition results, which further demonstrates that attempts to correlate dust deposition to nuisance potential is not a sound approach.

### 4.3.4 Recommended monitoring programme

Section 4.1 of this report recommends a list of mitigation options that may or may not be required to avoid objectionable coal dust effects, or at least contain the current level of impact to within the existing impact zone around the Timeball Station. To reliably establish which sources are likely to need improved mitigation compared with what is currently achieved, and which mitigation measures listed in the Section 4.1 are likely to be required, requires further investigation. To be effective, it is recommended that this investigation simultaneously assesses site, environmental and effects information by monitoring the following:

1) Ambient TSP near the Timeball Station and a more moderately impacted site.
2) Dust impaction gauges (BS1747Pt5 - Directional Dust Gauge) alongside the continuous TSP monitor and throughout the residential areas where there are high, moderate, and low dust effects.
3) Diary records of dust impacts on washing and inside buildings for high, moderate and low impacted areas.
4) Wind speed, direction, rainfall, solar radiation monitoring near the coal stockpiles.
5) Accurate logging of times for loading out, stockpile forming, no activity etc at the coal stockpile.

Undertaking the above monitoring concurrently for at least one full summer / autumn period is likely to provide sufficient data for analysis to produce a clearer link between site activities and the potential for ambient dust impacts. The monitoring of effects needs to go beyond a laboratory based test result, and include more direct assessments of dust impacts on surfaces around residential properties and within dwellings. A dust diary programme is a good starting point for this, and could provide a more systematic grading of nuisance effects from one property to another that can then be compared to the measure dust impaction and monitored TSP levels. For example, a diary programme could record the number of days of washing impacts, modified behaviour, relative grading of coal dust deposition within household surfaces, etc. Currently there is large disconnect between the routine monitoring of dust deposition and the severity of nuisance effects being caused as the former is not a strong indicator of the potential for nuisance.

Being able to link the severity of effects to dust and / or TSP levels would be a significant step forward as it would provide the basis to confirm if the 80 $mg/m^2/day$ guideline provides adequate protection from objectionable effects when applied to dust impaction, and if not, then what a more reliable value may be.

### 4.3.5 Summary

Although it may well be the case that mitigation measures can be implemented to achieve an acceptable outcome, whether this can be achieved economically is still unclear and would require a more systematic investigation. This would generally require the analysis of continuous TSP impacts, weather data and site activity information, combined with an effective recording of visual dust effects to all be collated and analysed. This should establish more reliable estimates of source dust contributions as well as the level of impact that is likely to avoid objectionable dust effects. This is considered necessary to establish with confidence whether or not it would be practical and economically viable to implement mitigation measures which achieve acceptable coal dust effects.

## 5.0 CONCLUSIONS

From our review of the assessment of air emissions from the proposed construction and operation of the extended coal stockyard at Lyttelton Harbour/Whakaraupo, the following conclusions have been reached.

Construction and quarrying-related air emissions should have a minor potential to cause nuisance or health effects, and standard dust mitigation measures via surface-wetting with water would be effective mitigation effects if this was at all necessary.

Operational dust effects from the existing coal stockyard are likely to be objectionable at residential properties within the vicinity of the Lyttelton Timeball Station. Furthermore, the reductions in emissions assumed by the applicant’s assessment are not likely to reduce existing nuisance effects.

The level of reduction required in existing dust emissions to avoid objectionable effects is estimated to be an order of magnitude or better – that is 80% reduction or even higher from what is achieved via existing water suppression based mitigation.

The large increase in the stockpiling area and its location further out into the harbour is likely to make the task of dust mitigation more difficult because the reclaimed area for stockpiling is likely to be exposed to stronger winds while being more directly upwind of residential areas during the most prevalent and strong wind conditions.

The assumption regarding the relative improvements in existing dust emission mitigation compared to that for the extended stockyard is not reliable and an exacerbation of existing dust effects and an increase in the nuisance zone is a significant risk of the proposal.

The assessment provides only limited information regarding dust mitigation which is the key consideration for this application. In particular it is concluded that the feasibility for LPC to implement dust mitigation measures which are practical and economic and which are sufficient to avoid objectionable effects, cannot be reliably established from the information provided by the assessment. A more systematic monitoring programme that attempts to link site activities, appropriate ambient nuisance parameters and actual effects is recommended to provide much greater certainty and an answer to the questions as to what type and extent of mitigation is likely to be required.

## 6.0 REFERENCES

Beca Infrastructure Ltd, 2009. Lyttelton Port Company Ltd Coal Stockyard Expansion – Assessment of Effects of Discharges to Air.

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# APPENDIX A

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