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12 June 2019

Simon Hedley
Technical Director - Planning
Lands and Survey (South) Ltd
Level 2, 177 Victoria Street
CHRISTCHURCH 8013

Dear Simon

REQUEST FOR FURTHER INFORMATION - CRC184072; CRC184073; RMA/2019/373

1.0 Introduction

Lands and Survey (South) Ltd have applied for resource consent on behalf of SOL Quarries Ltd to expand their quarry, located at 81 Conservators Road, Yaldhurst.

The purpose of this letter is to provide responses to the questions that have been raised by Environment Canterbury (ECan) and Christchurch City Council (CCC) by way of Section 92 requests for further information.

Additionally, PDP have been asked by Land and Survey (South) Ltd to assess the potential air quality impacts of the currently consented quarry on the property owned by Harewood Gravels Ltd, located to the south of the proposed quarry extension.

2.0 Background information

In order to prepare a response to the requests for further information, PDP reviewed the following documents:

- SOL Quarries Ltd, 81 Conservators Road, Quarry Management Plan, February 2019, Version 9.0;
- Assessment of Air Quality Effects, SOL Quarries – Yaldhurst Expansion, NZAir, 12 February 2019;
- SOL quarry expansion – Clarification on air quality impacts for 113 Conservators Road, NZAir, 18 March 2019;
- High Court of New Zealand Decision, Harewood Gravels Company v Christchurch City Council & Anor (2018), NZHC 3118, 30 November 2018;
- Documents supplied by Simon Hedley detailing:
  - The water cart route.
  - The conceptual Stage 2 quarry development plan.
  - Stage 2 quarry bund details.

- Good Practice Guide for Assessing and Managing Dust, MfE, 2016
- Guidance on the Assessment of Mineral Dust Impacts for Planning, IAQM, 2016

3.0 Quarry site visit

In order to become familiar with the site, quarry operation and surroundings, a site visit was undertaken on the 9 of May 2019 hosted by the former SOL General Manager, Simon Hedley, now of Land and Survey (South) Ltd.

The general impression from the site visit was of a well-run quarry with a good appreciation of the potential for dust generation and who were actively implementing dust mitigation measures. Although the day of the visit was low risk from a dust generation perspective (overcast, little to no wind with some light showers developing later in the visit), it was evident that the water cart has dampened down both the haul and internal roads.

Other key points that were noted relevant to impacts of air quality are summarised as follows:

- Quarry development was started in 2016
- Consents conditions were varied in April 2018
- Quarry operating hours
  - 7am – 6pm Monday to Friday (11 hrs)
  - 7am – 12pm Saturday (5 hrs)
- Heavy truck haul road
  - 1.25 km long
  - Was historically a source of dust especially tracked dust onto Guys Road
  - 15 km per hr speed limit. Monitored by speed camera
  - Entrance has been sealed with asphalt to reduce truck damage to surface
  - Entrance swept by Waste Co 5 days a week to remove any dust deposited at the entrance that could cause a nuisance effect
  - 2 judder bars have been installed near the entrance onto Guys Road to help dislodge any dust prior to trucks turning onto Guys Road
  - The first 250 m from Guys Road is chip sealed (not applied with water for dust suppression)
  - The remaining haul road surface is covered with chipped aged asphalt which has lower dust generation propensity than gravel. Water is only applied for dust suppression once a day for dust suppression when required due to the low dust generation propensity
  - The east/west portion is lined with k-line sprinklers in 100m sections that can be used to dampen down if required. This is used as a backup if the watercarts cannot be operated for some reason
- Light access road
  - 15 km/hr speed limit. Monitored by speed camera
- A water cart is used as required for dust suppression
  - Primary water cart holds approximately 9,500 litres

- Backup water cart holds approximately 4,900 litres
- There is also a small pull behind cart
- The primary water cart can complete two loops of the haul roads before refilling which takes approximately 1 ½ hrs
- Water carts run for the full operational day in all seasons when conditions require it (more so in summer)
- When required water suppression begins at 6.30am before the quarry starts operation at 7.00am
- In addition to the water cart there is a sprinkler system, involving a main-line and 100 metre laterals with sprinkler pods at 15-metres intervals on the heavy haul road. Sprinklers were also evident on the vegetated topsoil stockpiles.

⁘ Water storage tanks
- Filled from an onsite bore
- 100,000 litres
- 30,000 litres

⁘ Soil stockpiles
- Watered with k-line irrigators until vegetation established

⁘ Met station with a 10 m tower located at western end of the site

⁘ Quarry operation
- Cleanfill
  - Cleanfill dumped near face of cleanfill area
  - Clean fill moved into face of clean fill area by bulldozer (Cat D7)
  - Cleanfill site surface being rehabilitated with planting grass. Currently still pretty much unconsolidated.
  - Truck trays washed down after dumping cleanfill and before loading with aggregate
- Gravel extraction and stockpiling
  - Top 8m dug out from bottom of working face by loader
  - Moved to processing plant by loader.
  - Bottom 2m removed by digger (the working surface of the pit is compacted by operating machinery over time)
- Two processing plants used onsite, each consisting of:
  - Jaw crusher– removes largest gravel
  - Screen – disaggregates raw material into size fractions
  - Cone crusher – crushes gravel into finished product
- Finest product 8-9 mm
- Can't use water on the finished product stockpiles as this will separate the size fractions

  - Raw gravels are damp on removal from the quarry face and appear not to generate any dust
  - Main dust producing activities are the crushing plant, the wheels of the loaders and the loading of trucks with product
  - Dust generating activities onsite must cease when the average wind speed exceeds 10 m/s

- New consent
  - 20 yr duration with an 8 yr lapse period (12 years of operation)
  - 12 yrs of operation will consist of 8yrs quarrying and 4 years rehabilitation
- Real time dust monitoring planned at the eastern end of the property closest to houses

4.0 Proposed stage 2 quarry operation

Figure 1 below shows the proposed Stage 2 quarry. With reference to **Figure 1**, it is proposed to operate the Stage 2 quarry in the following manner:

1. The existing quarry will continue operation in the direction of the grey arrows up to the boundary of the existing quarry.
2. Backfilling of the quarry pit with cleanfill and the associated site rehabilitation will continue behind the quarrying operations, in the direction of the blue arrows.
3. Initial quarrying of Stage 2 will be carried out at the western end of Stage 2 creating an area that will be used for the processing and stockpiling of product for the duration of the operation of the Stage 2 quarry. The initial quarry face is shown as a line in **Figure 1.**
4. The quarry's two crushing plants will not be located any closer than 350 m from the nearest property boundary (not owned by ECan) effectively constraining them to the western end of the Stage 2 quarry (see **Figure 1**)
5. Trucks coming onto site will generally be bringing a load of cleanfill for backfilling the mined-out portions of the quarry. Consequently, the route of the haul road will change as the quarry progresses however all loading of product will occur in the bottom of the quarry pit at the western end of the quarry adjacent to the two processing plant and product stockpiles (approximately 10-metres below natural ground level). The haul road will pass the Quarry Office and Weigh Bridge in both directions, before exiting on the Heavy Vehicle Road.
6. The gravels will be removed from the bottom of the quarry face (i.e. at the bottom of the pit) by front end loader and transported by front end loader back to the crushing plants.

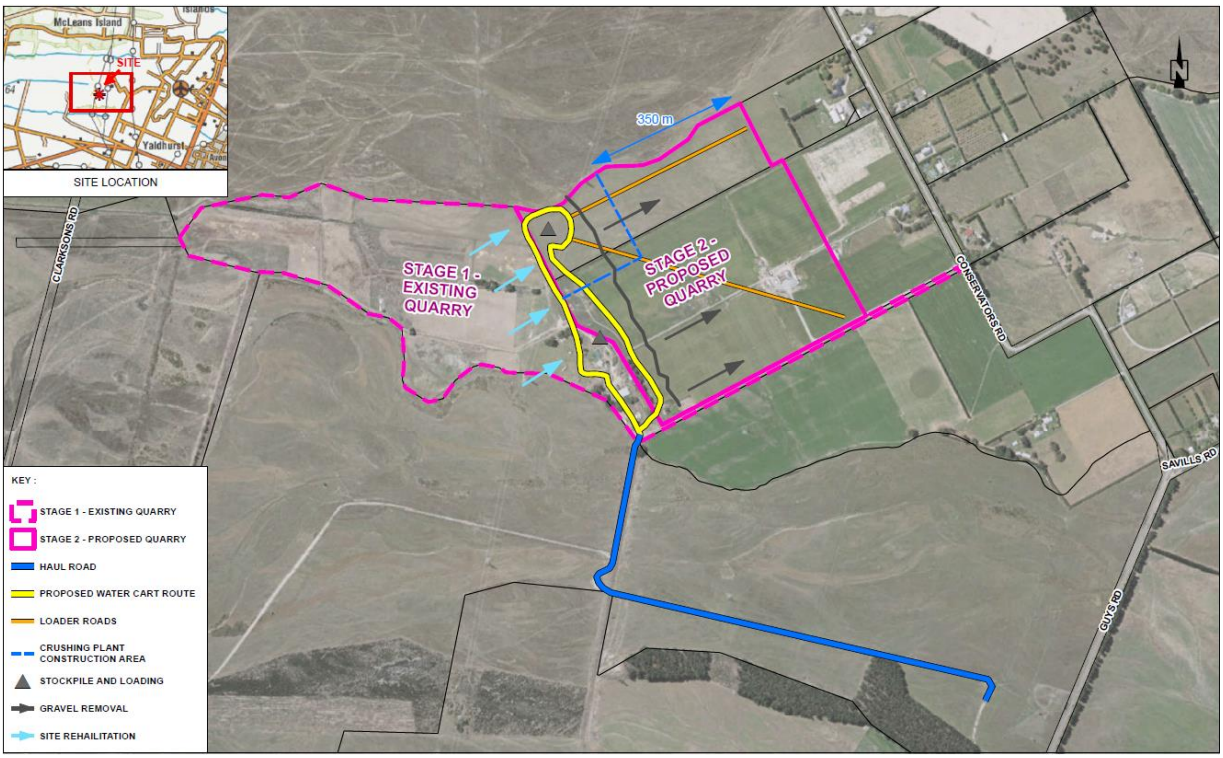

Figure 1: Proposed Dust Management Plan

5.0 Section 92 further information request responses

In the following sections the various Section 92 requests for further information are addressed. The wording of the request is in ***bold italics*** while the response is in normal text.

6.0 ECan Request – Air Quality Impacts at 113 Conservators Road.

1. ***Residence at 113 Conservators Road.***

   Information has been provided seeking to clarify the air quality impacts on the site at 113 Conservators Road, Yaldhurst. This has been reviewed by the Air Quality Expert and it is considered to further information is required to understand this.

   Please provide a more detailed assessment of the potential exposure of the residence at 113 Conservators Road, Yaldhurst to potential dust events from the proposed quarry activity. This assessment should include consideration of any additional mitigation measures to address potential impacts, particularly when quarry operations come within 250 metres of that residence.

6.1 Overview

The residence at 113 Conservators Road, Yaldhurst has been identified for further assessment of exposure to potential dust events from the proposed quarry activity. The assessment considers the FIDOL factors (frequency, intensity, duration, offensiveness, location) influencing dust events at this site and the ability of proposed mitigation measures to reduce these potential impacts. Consideration will also be given to the

Source-Pathway-Receptor concept as described in the Institute of Air Quality Management (IAQM) guidelines[1].

Dust events from the proposed quarry activity will be directly affected by the local meteorological conditions. The likely impact of the quarrying activity on neighbouring properties can be assessed by considering conditions in the vicinity of the site.

The onsite meteorological station wind data was initially accessed and assessed for suitability for use in this air quality assessment. Unfortunately, the meteorological data had not been recorded during the hours of darkness. Further investigation determined that the solar power supply was faulty and, while operational data was being supplied during daylight hours, no data was being recorded during the night. As such the dataset was unsuitable for the required analysis.

The Christchurch Aero weather station data was instead used for this analysis. This weather station is located at Christchurch Airport, approximately 3 km east from the proposed quarry site. Given the proximity of the SOL Quarry to the airport weather station and the lack of any topographical features between the two locations, PDP consider the airport site will provide data that is representative of the wind conditions experienced at the SOL Quarry site. Hourly average surface wind data and daily rainfall and evapotranspiration figures for the past five years from this site have been used to conduct an analysis of local meteorological conditions.

6.2 Frequency

6.2.1 Overall wind conditions

Figure 2 shows a wind rose for Christchurch Aero between 2014 and 2019. The predominant winds blow from the northeast. The average wind speed for this period is 3.97 m/s. The overall frequency of winds above 5 m/s is 33.3%.

[1] *Guidance on the Assessment of Mineral Dust Impacts for Planning*, Institute of Air Quality Management, May 2016 (v1.1)

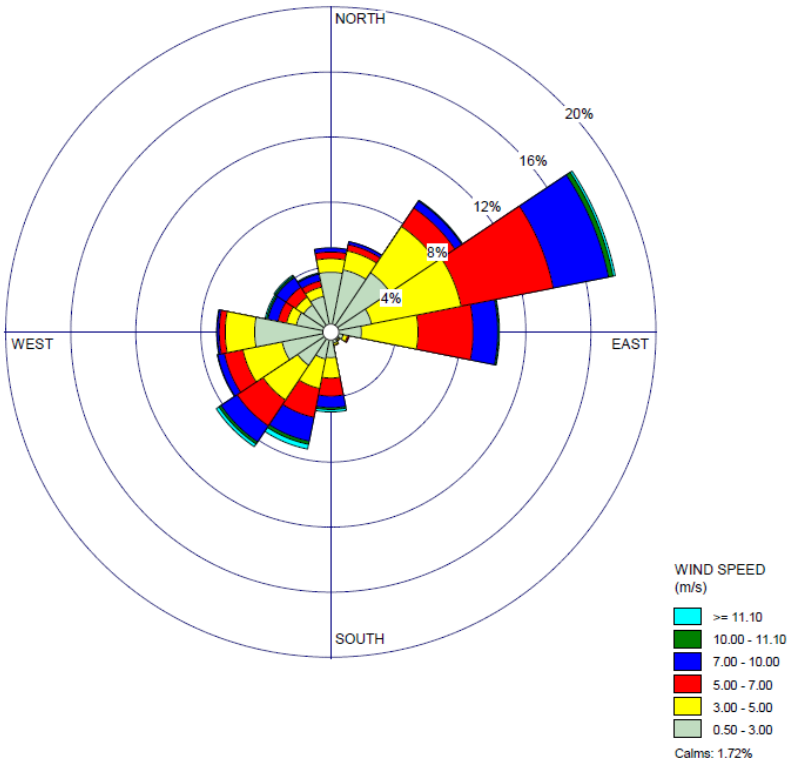

Figure 2: Wind rose for Christchurch Aero Data (2014-2019)

6.2.2 Calculation of wet and dry surface conditions

Rainfall has a significant influence on whether dust emissions will occur because a wet or damp ground surface will not generate dust emissions. For calculation of whether a day had wet or dry ground conditions, a day when wet ground conditions occurred was defined as one where the daily evaporation (Penman ET) exceeded the daily rainfall by no more than 1 mm. This allows for some minimal moisture storage within the surface layer. A day with dry ground conditions and thus a potential for dust generation was then taken as any day when wet ground conditions had not occurred.

The percentage of dry days per month was calculated using data from the Christchurch Aero weather station for the same period as the analysed wind data above (2014-2019). The monthly frequency of dry days is shown in **Figure 3**. This shows that there are the highest number of dry days in the early spring, summer and late autumn months of September to March, and fewer days expected with dry ground conditions in the April to August period. The classification of dry and wet days was cross-referenced with the surface wind data for the same date range to allow targeted analysis of dry days with wind speeds above specific values. These conditions are considered the highest risk for occurrence of potential dust events.

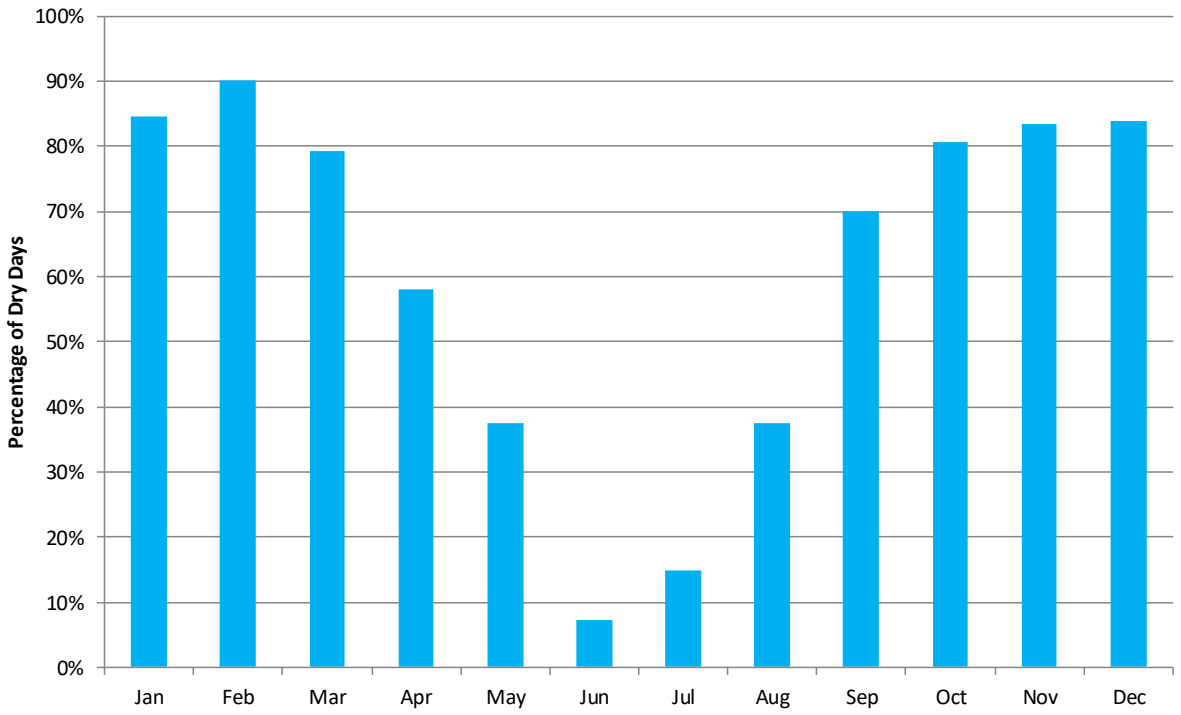

Figure 3: Dry surface days per month for Christchurch Aero (2014-2019)

6.2.3 Assessment of high risk conditions for the sensitive receptor at 113 Conservators Road

Figure 4 shows the location of 113 Conservators Road and the corresponding downwind impact arc relative to the current and proposed operations (including the heavy truck haul road). The residential sensitive receptor at 113 Conservators Road is located to the northeast of the proposed quarry site as shown in **Figure 4**. The downwind impact arc is also shown which indicates the wind directions considered when analysing which winds cause the sensitive receptor to be downwind from the proposed quarrying activities. Wind directions blowing from between 180 and 260 were used for wind analysis calculations when considering this receptor.

Table 1 shows the frequency with which the sensitive receptor identified at 113 Conservators Road is downwind from the proposed quarry. The IAQM guidelines for frequency are based upon the percentage frequency of winds > 5 m/s from the direction of the dust source on dry days. The sensitive receptor at 113 Conservators Road is classified as 'Moderately frequent' under the criteria defined in IAQM (between 5% and 12%).

Table 2 shows the breakdown for the frequency of winds for the complete years of 2016, 2017 and 2018. There is low variability in the annual frequency of winds in these years indicating likely predictability of wind behaviour in future years.

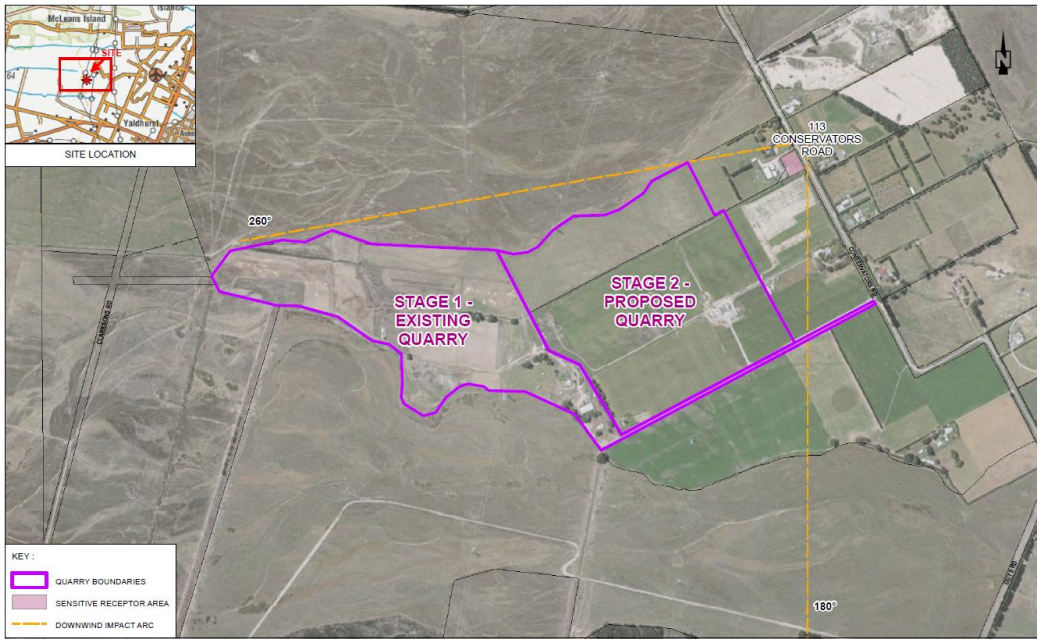

Figure 4: Downwind impact arc for 113 Conservators Road

Table 1: 113 Conservators Road - Frequency that sensitive receptor is downwind from source			
Sensitive Receptor	**113 Conservators Road**		
	%	**Number of hours/year**	**Number of days/year**
Frequency that sensitive receptor is downwind	30	2596	108
Time downwind with wind speeds above 5 m/s	11	955	40
Time downwind with wind speeds above 5 m/s on dry days	5	450	19

Table 2: 113 Conservators Road - Variation in high-risk conditions						
Sensitive Receptor	**113 Conservators Road**					
	2016		**2017**		**2018**	
	%	**Hours/year**	**%**	**Hours/year**	**%**	**Hours/year**
Frequency that sensitive receptor is downwind	28	2466	31	2691	31	2713
Time downwind with wind speeds above 5 m/s	10	877	12	1029	10	860

Table 2: 113 Conservators Road - Variation in high-risk conditions						
Sensitive Receptor	**113 Conservators Road**					
	2016		**2017**		**2018**	
	%	**Hours/year**	**%**	**Hours/year**	**%**	**Hours/year**
Time downwind with wind speeds above 5 m/s on dry days	5	412	5	447	4	334

Table 3 shows seasonal variation in frequency of winds towards the sensitive receptor. The most significant impact is likely when wind speeds are above 5 m/s on dry days. The highest incidence of these winds occurs during the summer months (December – February) but the frequency during this time still falls within the overall IAQM classification of 'Moderately frequent' given above.

The directional component of these seasonal winds is shown in the wind roses in **Figure 5**. Winds that would be likely to impact the sensitive receptor at 113 Conservators Road are those blowing from directions in the southwest quadrant. The highest proportion of winds from this direction occurs during the winter which coincides with the lowest frequency of dry days. The lowest proportion of winds from this direction occurs during the summer when the frequency of dry days is highest.

Table 3: 113 Conservators Road – Seasonal variation of high-risk conditions								
Sensitive Receptor	**113 Conservators Road**							
	Summer		**Autumn**		**Winter**		**Spring**	
	%	**Hours/ season**	**%**	**Hours/ season**	**%**	**Hours/ season**	**%**	**Hours/ season**
Frequency that sensitive receptor is downwind	25	536	30	663	35	762	29	635
Time downwind with wind speeds above 5 m/s	11	241	11	236	10	219	12	259
Time downwind with wind speeds above 5 m/s on dry days	8	170	4	99	1	31	7	150

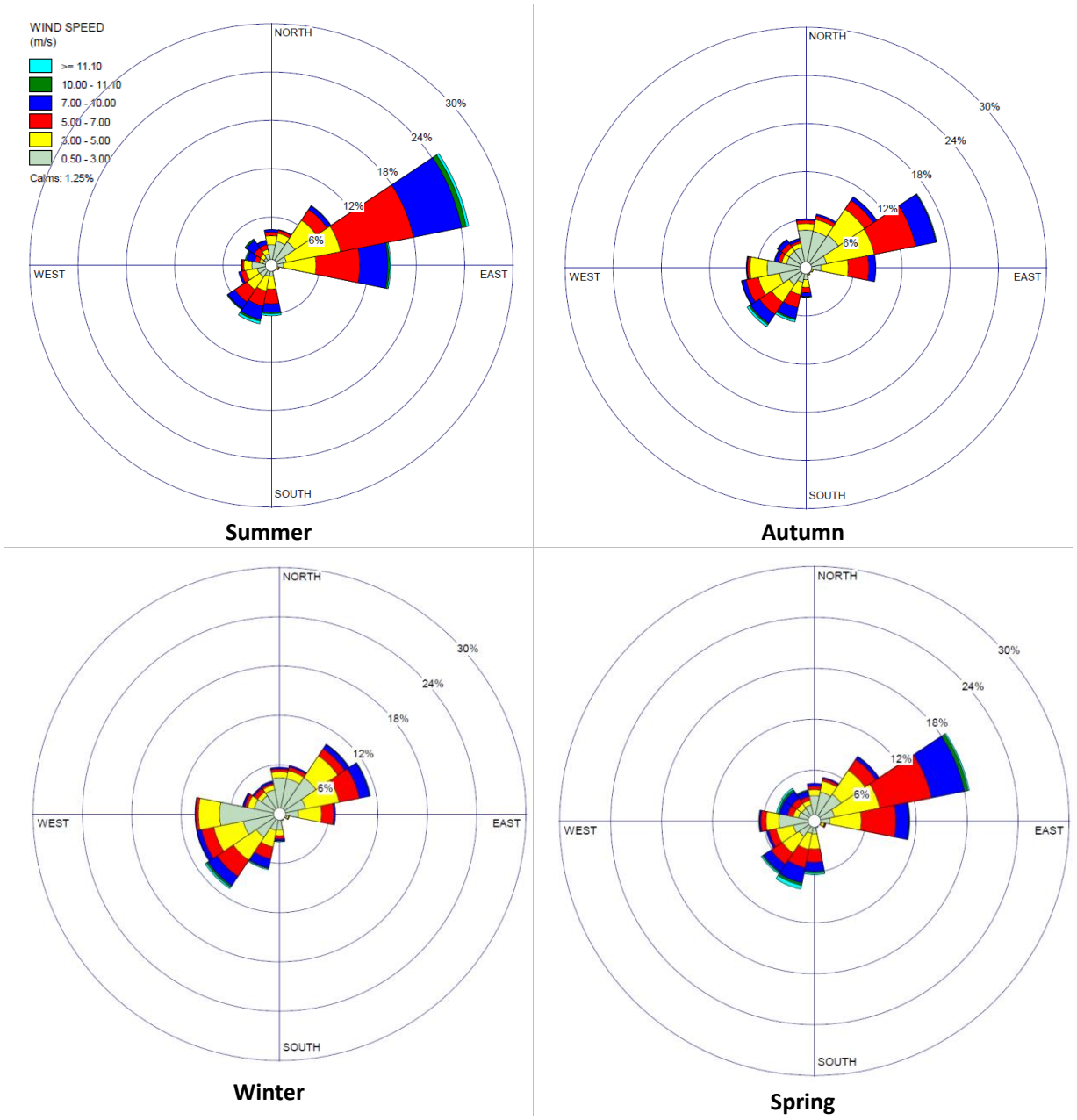

Figure 5: Seasonal wind roses for Christchurch Aero (2014-2019)

The frequency of wind speeds >5 m/s on dry day blowing towards the receptor at 113 Conservators Road is shown in **Figure 6**. This shows that for an average summer day, the likelihood of strong winds causing the receptor to be downwind from the proposed quarry is highest during the late morning to early afternoon. The quarry operates from 7.00 am until 6.00 pm on weekdays (shown by the green box in **Figure 6**) so these high risk winds are likely to occur during operating hours. This information can be used to plan the application of water to ensure that sufficient water volumes are available for periods of higher risk of potential dust events.

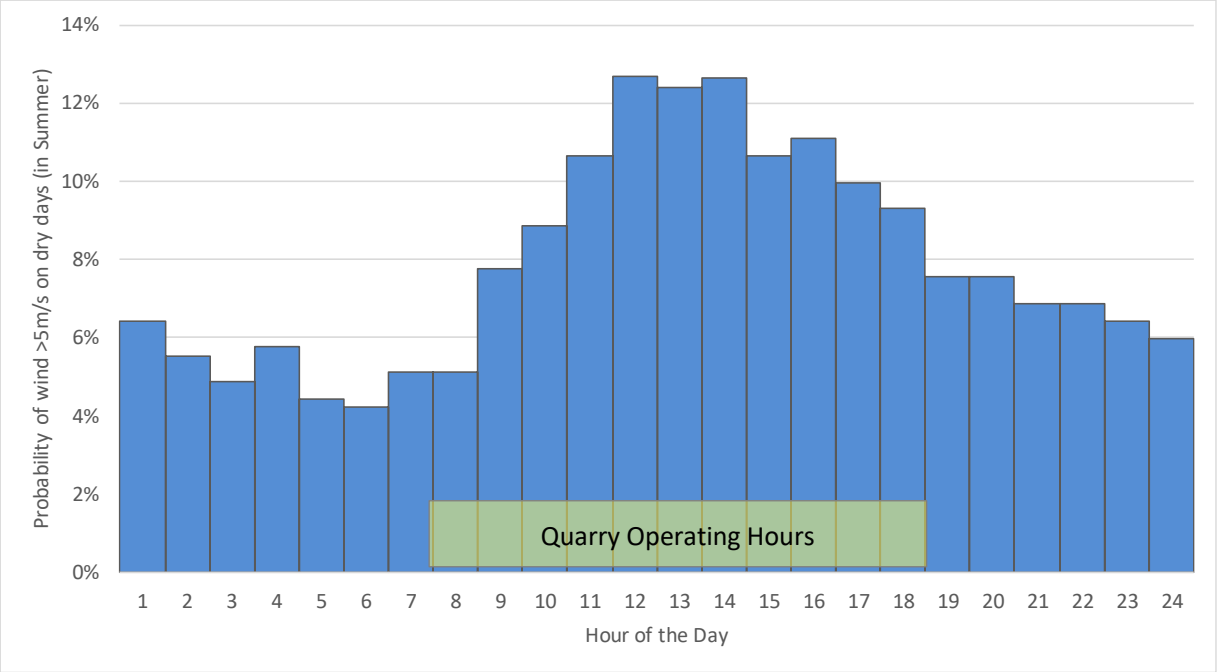

Figure 6: Frequency of wind speeds >5 m/s on dry days blowing towards 113 Conservators Road in summer

The sensitive receptor located at 113 Conservators Road is not located downwind of the prevailing wind direction experienced at the proposed quarry site. Strong winds on dry days in a direction from some area of the quarry site towards the sensitive receptor occur with around 5% frequency in an average year. The highest incidence of strong winds on dry days is anticipated during the summer months (Dec-Feb), particularly during the late morning to early afternoon when the probability of dry winds >5 m/s is around 10-13%. The IAQM classification of winds from the proposed quarry site towards the sensitive receptor is 'Moderately frequent'. It is noted that mitigation measures are to be implemented as part of the Quarry Management Plan to reduce the potential for dust events during times of strong dry winds.

6.3 Intensity

The property at 113 Conservators Road is recognised as a 'human receptor' in the IAQM guidelines and is classified as 'highly sensitive' due to its use as a residential dwelling.

6.3.1 Pathway effectiveness

The IAQM guidelines state that the distance between the dust source and the sensitive receptor is the primary factor influencing the pathway, with adjustments made depending upon the orientation of the receptor with respect to the prevailing wind and the topography, terrain and physical features of the site. The site at 113 Conservators Road is not downwind from the prevailing wind and there are no topographical features of the site that are likely to significantly alter the local dispersion and dilution behaviours of dust emissions.

The receptor is over 200 m from the closest boundary of the proposed quarry so is classified by the IAQM guidelines as a 'Distant' receptor (between 200 m and 400 m from the dust source). This can then be combined with the 'Moderately frequent' classification of winds for the receptor location using the matrix shown in **Table 4**, this gives an overall pathway effectiveness rating of 'Ineffective'.

Table 4: Pathway Effectiveness

		Frequency of Potentially Dusty Winds			
		Infrequent	**Moderately Frequent**	**Frequent**	**Very Frequent**
Receptor Distance	**Close**	Ineffective	Moderately Effective	Highly Effective	Highly Effective
	Intermediate	Ineffective	Moderately Effective	Moderately Effective	Highly Effective
	Distant	Ineffective	Ineffective	Moderately Effective	Moderately Effective

The 'Ineffective' pathway classification can be combined with the Residual Source Emission type to estimate the Dust Impact Risk.

6.3.2 Residual Source Emission (RSE) determination

According to the key factors for assessing RSEs listed in Section 5.1 of the IAQM guidelines, the characteristics of the proposed site (summarised from the NZ Air Assessment of Air Quality Effects[2]) are:

- The proposed site is zoned as Rural Waimakariri Zone in the Christchurch District Plan. The boundary is shared with rural residential lifestyle blocks (to the northeast) and pasture;
- The existing operations on the proposed development site are undertaken by Ready Lawn Industries and involve various soil disturbance activities;
- The scale of operations will remain unchanged from that of the existing quarry and a staged quarrying operation has been proposed (as described in Section 4.0);
- There will be up to two aggregate processing and screening plants which will be set back a minimum of 350 m from the nearest rural residential boundary to the site;
- The mineral type is described in Section 6.5;
- The maximum processing rate will be 600 t/hr;
- The methods of working will be:
  - Topsoil stripped (area not generally exceeding 2 hectares);
  - Benched excavation to desired pit depth (likely 10 m below ground level (bgl));
  - Haul trucks enter site via heavy vehicle access point and weighbridge;
  - Clean fill will be dumped at dedicated backfill area;
  - Aggregate will be loaded at the pit floor;
  - Filled trucks will exit the site via the weighbridge and heavy vehicle access road;
  - Machinery on-site will include:
    - Up to five loaders;
    - One excavator;

[2] *Assessment of Air Quality Effects, SOL Quarries – Yaldhurst Expansion,* NZ Air, February 2019

  - One bulldozer;
  - Up to two crushing and screening plants (jaw crusher, cone crusher, powerscreen);
  - One water cart.

∵ Material handling will be:

- Topsoil used for bund formation or stockpiled;
- Excavated material will be either directly loaded to haul trucks, stockpiled for future load out or transported to onsite aggregate processing plant;
- Haul trucks entering site will either be empty or carrying clean fill;
- Clean fill will be dumped in dedicated backfill area for rehabilitation;
- When sections have been backfilled to the required level, rehabilitation with topsoil and re-grassing will be completed;
- On-site processing will primarily be used to form crusher dust, CAP20, CAP40, TNZ M4-40, and CAP65.

∵ Storage in the form of stockpiles in the quarry pit is proposed and these will be managed to a maximum of 15,000 m^3 in each stockpile.

∵ Access to the site will be via the existing heavy vehicle access route from Guys Road and the existing light vehicle access route from Conservators Road. There is a limit of 300 heavy vehicle movements and 30 light vehicle movements per day.

∵ Various mitigation measures are planned for the operation of the proposed quarry including:

- Installing two judder bars near the Guys Road entrance to help dislodge dust;
- Chip sealing of the first 250 m of the haul road;
- The use of a water cart or k-line sprinklers to suppress dust when conditions require;
- Sealing the Guys Road entrance with asphalt to reduce truck damage to the surface;
- Surfacing the haul road with crushed used asphalt which has lower dust generation propensity than gravel;
- The entrance at Guys Road is swept by Waste Co 5 days a week to remove any dust deposited at the entrance that could cause a nuisance effect;
- Site traffic movements are restricted to 15 kph;
- Potentially dusty activities (crusher/screening operation without watering, topsoil stripping/spreading, formation of bunds/stockpiles) will be stopped when wind speeds exceed 10 m/s;
- Real-time monitoring of PM_{10} to inform use of dust mitigation measures and provide feedback on their effectiveness;
- Stockpiles will be located at the western end of the quarry pit to ensure large buffer distances to residential dwellings; and
- The crushing plant and loading activities will be located at the western end of the proposed site to maximise the buffer distances to residential dwellings.

The IAQM guidelines break down site activities into seven categories and offer guidance parameters for determination of whether activities in each category are likely to be classified as 'Small', 'Medium', or 'Large' RSEs. These categories are assessed with regards to the proposed quarry activities below:

- Site preparation/restoration: the anticipated working area of 2 hectares and bund height of up to 3 metres are classified as 'Small'. The possibility for more than five heavy plant units operating simultaneously would be classified as 'Medium' but this risk is mitigated through the operation of a water cart for wetting of haul routes during quarry operating hours. The material movement for bund construction may exceed the 'Small' classification of 20,000 m^3 so overall this category has a 'Medium' RSE classification.
- Mineral extraction: a small working area of approximately 2 hectares is anticipated but the proposed operating hours and extraction rate of 600 t/hr lead to an anticipated extraction rate of over 1,000,000 tpa which is considered large. It has been noted that the raw gravels are damp on removal from the quarry face so overall this category has been classified as 'Medium'.
- Materials handling: it is proposed to limit material loading to the western end of the proposed quarry which will ensure that there is a minimum of 350 m between the loading activities and the closest privately-owned adjoining property boundary. It is not possible to wet the processed product as this would separate the size fraction so there is potential for low moisture content leading to elevated risk of dust. A distance of over 100 m from a site boundary is classified as a 'Small' RSE so the extended separation distance of 350 m is considered to mitigate the potential for elevated dust as a result of low moisture content having an impact at the site boundary. For this reason, this category has been classified as 'Small'.
- On-site transportation: More than 250 daily movements on unpaved surfaces is considered a 'Large' RSE. However, the dust potential of the haul road has been lowered through the addition of used asphalt to the surface and a water cart is utilised to wet the roads to reduce the risk of dust events. Speed is also restricted to 15 kph (lower than the 'Small' suggestion of 15 mph). These mitigation measures are considered to reduce the overall RSE for this category to 'Medium'.
- Mineral processing: the proposed activity incorporates a high processing volume of material with a combination of processes undertaken at the plant. Although the raw material is likely to be damp, there is potential for low moisture content in the product leading to high dust potential. Although mitigation measures have been undertaken to distance this activity from the nearby sensitive receptors, they are not considered for this RSE classification as their impact has already been included in the assessment of pathway effectiveness. However, it is proposed to stop crushing and loading activities if wind speeds reach above 10 m/s due to their high potential for dust propagation. Overall, this category has been classified as a 'Medium' RSE.
- Stockpiles/exposed surfaces: The total area of proposed stockpiles is considered small. The proposed production rate is considered high but there are mitigation measures that address the risks of stockpiling included in the proposed activities and Quarry Management Plan (QMP). The QMP states that extended stockpiles should be seeded as soon as practicable to ensure stabilisation and that the temporary stockpiles will be located within the quarry void. Due to these mitigation measures, this category has been classified as a 'Medium' RSE.
- Off-site transportation: the potential for 300 heavy duty vehicle movements and an unsurfaced haul road would lead to a 'Large' RSE classification. The wetting of the haul road using the water cart, the addition of used asphalt to reduce dust, and the chip sealing of 250 m of access road to the site boundary are all mitigation measures that act to reduce this emission. Judder bars to reduce material tracking off-site and sweeping of the entrance road five days per week also

contribute to the mitigation of this emission source. Overall, this category has been classified as a 'Medium' RSE.

The highest RSE is the 'Medium' classification identified for the site preparation/restoration, mineral extraction, on-site transportation, mineral processing, stockpiles/exposed surfaces, and off-site transportation categories. Combining the 'Ineffective' pathway and 'Medium' RSE values using **Table 5** gives an overall Dust Impact Risk of 'Negligible Risk' for the proposed quarry activities on the sensitive receptor located at 113 Conservators Road.

Table 5: Estimation of Dust Impact Risk

		Residual Source Emissions		
		Small	**Medium**	**Large**
Pathway Effectiveness	**Highly Effective Pathway**	Low Risk	Medium Risk	High Risk
	Moderately Effective Pathway	Negligible Risk	Low Risk	Medium Risk
	Ineffective Pathway	Negligible Risk	Negligible Risk	Low Risk

Using the IAQM approach for assessing dust risk impact suggests that the intensity of any impact on 113 Conservators Road from the dust discharged from the proposed activity will be low.

6.4 Duration

The duration of potential dust events is determined by the duration of the quarrying activities and the duration of strong wind events when the dust emissions may be elevated.

Figure 7 shows the annual frequency and duration of high-risk wind conditions (an average hourly wind speed above 5 m/s blowing from the extraction areas towards the sensitive receptor at 113 Conservators Road on dry days). The frequency of events rapidly declines with increasing duration. Theoretical exposure to an event greater than 12 hours in duration is predicted to occur 4 times per year.

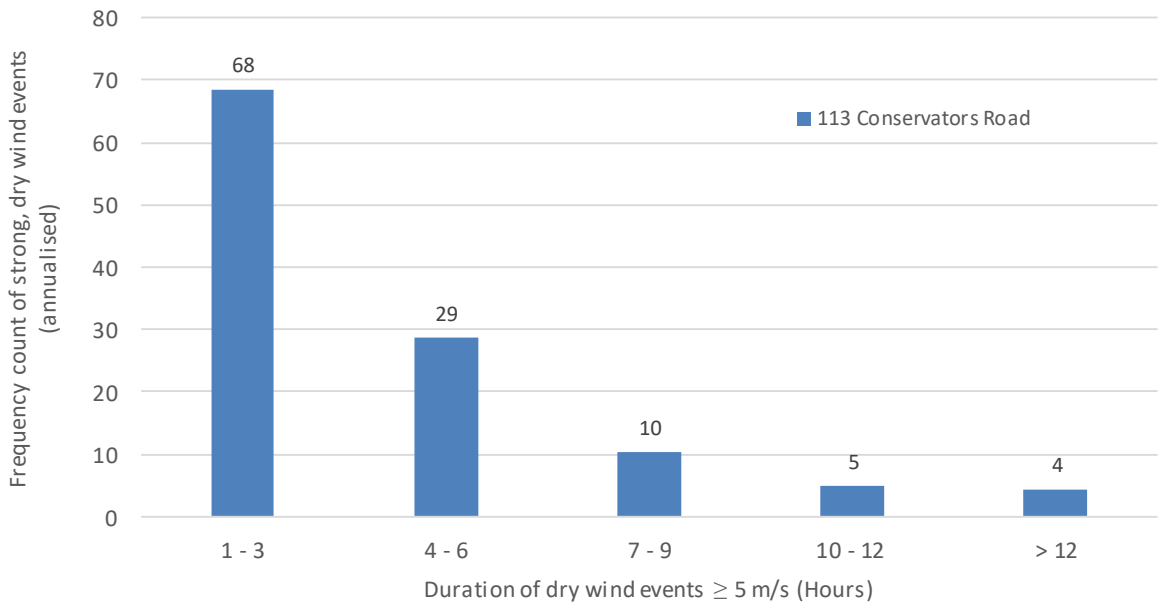

Figure 7: Annual frequency and duration of high-risk wind conditions blowing from the extraction areas towards the sensitive receptor at 113 Conservators Road

6.5 Offensiveness

There are two main dust type sources from the quarry; stripped overburden soil stockpiles, and the crushed aggregate product itself.

The dust from the stripped overburden is light brown in colour, is inert in nature, and would only potentially cause a nuisance effect if it settles on surfaces. This dust would be the same composition as that from the ready lawn operation currently operating on the area proposed for the Stage 2 quarry.

Dust from the crushing of the aggregate used in New Zealand is predominantly greywacke which can contain a small portion of quartz (generally in veins) which has a high silica content. Respirable silica is primarily released from the cutting, crushing or processing of aggregates containing silica. As part of the ECan's Yaldhurst Air Quality Monitoring study[3] Respirable Crystalline Silica (RCS) was monitored at 7 locations around the quarries (20 samples in total). Only 2 of the samples (both from the same location) returned results above the detection limit of 20 µg per filter. The location where RCS was detected was 50 m to the south east of the quarry and the average RCS concentration was 0.4 µg/m^3. The chronic reference exposure level for RCS is 3 µg/m^3 as an annual average.

Based on the ECan air quality monitoring study, the dust generated from the aggregate crushing plant can be regarded as inert in nature and, like the dust from the stripped overburden, is light brown in colour and would only potentially cause a nuisance effect if it settles on surfaces.

Based on the discussion above, it is concluded that the dust is inert in nature, is light in colour, and therefore in itself is of low offensiveness.

An ecological assessment of the adjacent Christchurch City Council grassland to the north of SOL Quarries[4] concluded that dust from the quarrying operations does not settle on the grassland.

[3] Yaldhurst Air Quality Monitoring, Summary Report: 22 December – 21 April 2018, Mote, 19 June 2018, p47,
[4] An ecological assessment of the Christchurch City Council grassland reserve adjacent to SOL Quarries on Conservators Road, McLeans Island, Wildland Consultants Ltd, 2019

6.6 Location

The sensitive receptor located at 113 Conservators Road is the closest of a number of rural-residential properties located in the vicinity of the proposed quarry site along Conservators Road. The surrounding area is zoned as Rural Waimakariri within the Christchurch City Council District Plan. This zoning lists quarrying activity located 250 m or more from a residential zone or Specific Purpose (School) Zone boundary as a Discretionary activity. The Rural Waimakariri zoning extends beyond 250 m from the proposed site boundary in the direction of existing nearby residences. The non-residential pasture land adjoining the quarry site on the northern boundary is zoned as Open Space Natural.

The downwind impact arc for the sensitive receptor at 113 Conservators Road has been defined as 180-260 from the receptor, including almost the entire southwest quadrant. The distance from the receptor to the boundary of the proposed quarry site is over 200 m and the proposal includes plans to ensure that the crushing plant which is associated with the highest potential dust risk is located a minimum of 350 m from the receptor, at the western end of the proposed site.

Due to the rural zoning of the surroundings, the receiving environment is likely to have more existing natural dust sources than a residentially zoned area so the environment can be considered less sensitive to minor nuisance dust impacts. However, the property at 113 Conservators Road is a residential dwelling so is considered a high sensitivity receptor for the purposes of assessment for magnitude of dust effects.

6.7 Overall Finding of Dust Amenity Assessment

The sensitive receptor located at 113 Conservators Road is not located downwind from the prevailing wind direction experienced at the proposed quarry site. Strong winds on dry days in a direction from some area of the quarry site towards the sensitive receptor occur with around 5% frequency in an average year with the highest frequency expected in summer months. Wind directions blowing from between 180 and 260 were used for wind analysis calculations when considering this receptor.

Strong wind events on dry days are more commonly of a short duration, with a few longer duration events expected each year.

The only offensiveness identified was the potential for nuisance if any of the dust settles on surfaces at neighbouring properties.

The distance from the receptor to the boundary of the proposed quarry site is over 200 m and the proposal includes plans to ensure that the crushing plant which is associated with the highest potential dust risk is located a minimum of 350 m from the receptor, at the western end of the proposed site. Due to the rural zoning of the surroundings, the receiving environment is likely to have more existing natural dust sources than a residentially zoned area so the environment can be considered less sensitive to minor nuisance dust impacts.

The property at 113 Conservators Road is recognised as a ‘human receptor’ in the IAQM guidelines and is classified as ‘highly sensitive’ due to its use as a residential dwelling. The receptor is over 200 m from the closest boundary of the proposed quarry so is classified by the IAQM guidelines as a ‘Distant’ receptor. The wind frequency and receptor distance combine to give an overall pathway effectiveness rating of ‘Ineffective’. The highest Residual Source Emission is the ‘Medium’ classification identified for various site activities. Combining this with the ‘Ineffective’ pathway gives an overall Dust Impact Risk of ‘Negligible Risk’ for the sensitive receptor.

Table 6 can be used to combine the ‘Negligible Risk’ Dust Impact Risk value with the ‘High’ receptor sensitivity classification to assess the Magnitude of Dust Effects. This gives an overall result of ‘Negligible Effect’ for the proposed quarry activities on the sensitive receptor located at 113 Conservators Road.

Table 6: Descriptors for Magnitude of Dust Effects				
		Receptor Sensitivity		
		Low	**Medium**	**High**
Dust Impact Risk	High Risk	Slight Adverse Effect	Moderate Adverse Effect	Substantial Adverse Effect
	Medium Risk	Negligible Effect	Slight Adverse Effect	Moderate Adverse Effect
	Low Risk	Negligible Effect	Negligible Effect	Slight Adverse Effect
	Negligible Risk	Negligible Effect	Negligible Effect	Negligible Effect

7.0 Air Quality Impacts on the Harewood Gravels Property

Harewood Gravels are the owners of the property immediately to the south of SOL Quarries light vehicle access road off Conservators Road (see **Figure 8**).

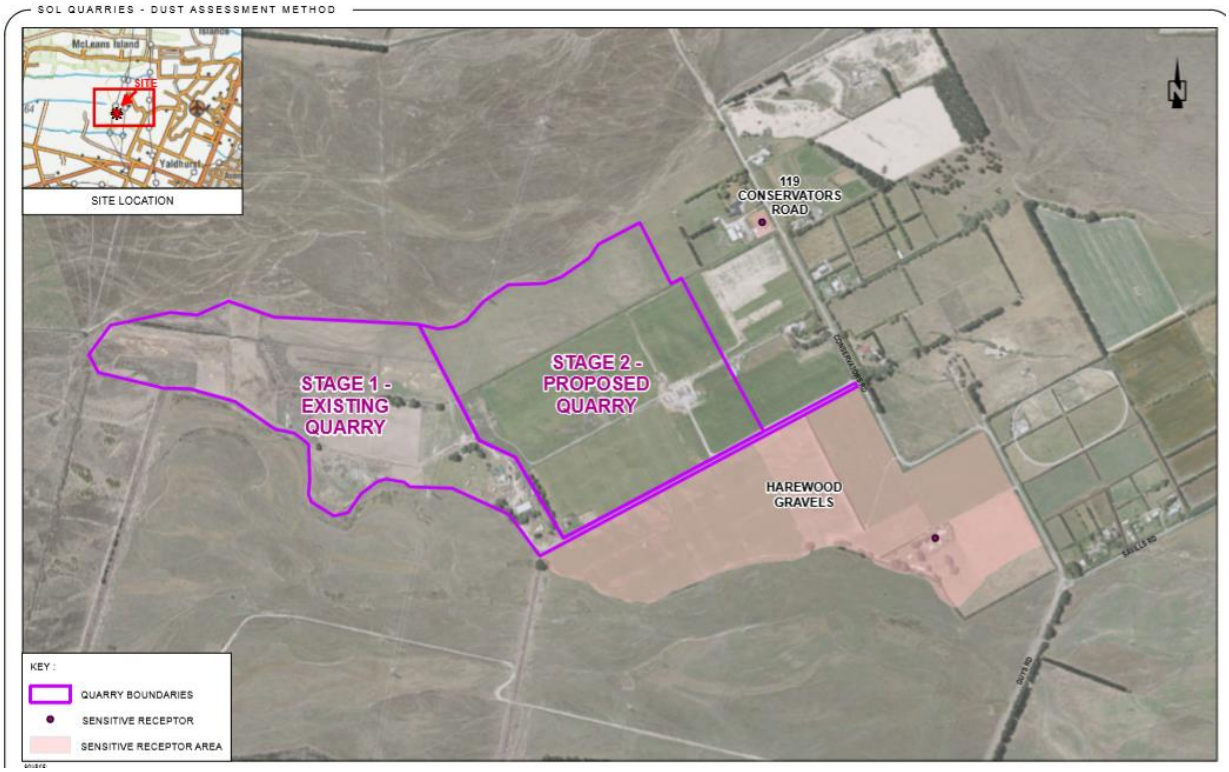

Figure 8: Boundary of Harewood Gravels site

The property was observed during the site visit undertaken to SOL Quarries on the 9 May 2019 as being used for dry stock grazing. There is a residence and associated farm buildings on the property which are accessed from Conservators Road. The residence is located a minimum of approximately 375 m South South East from the closest point on SOL Quarries' light vehicle access road and approximately 575 m North North East from the closest point on SOL Quarries' heavy haul road. The distance to the closest part of SOL Quarries current consented quarry operations is approximately 850 m due west.

The dwelling on the Harewood Gravels site is considered as the sensitive receptor for the purposes of this assessment. The assessment will consider the FIDOL factors (frequency, intensity, duration, offensiveness, location) influencing dust events at this site and the ability of proposed mitigation measures to reduce these potential impacts. Consideration will also be given to the Source-Pathway-Receptor concept as described in the Institute of Air Quality Management (IAQM) guidelines[5].

Dust events from the proposed quarry activity will be directly affected by the local meteorological conditions. The likely impact of the quarrying activity on neighbouring properties can be assessed by considering meteorological conditions in the vicinity of the site.

The onsite meteorological station wind data was initially accessed and assessed for suitability for use in this air quality assessment. Unfortunately, the meteorological data had not been recorded during the hours of darkness. Further investigation determined that the solar power supply was faulty and, while operational data was being supplied during daylight hours, no data was being recorded during the night. As such the dataset was unsuitable for the required analysis.

The Christchurch Aero weather station data was instead used for this analysis. This weather station is located at Christchurch Airport, approximately 3 km east from the proposed quarry site. Given the proximity of the SOL Quarry to the airport weather station and the lack of any topographical features between the two locations, PDP consider the airport site will provide data that is representative of the wind conditions experienced at the SOL Quarry site. Hourly average surface wind data and daily rainfall and evapotranspiration figures for the past five years from this site have been used to conduct an analysis of local meteorological conditions.

The following sections of this report address each of the FIDOL factors. A summary of the air quality assessment based on the FIDOL factors is presented at the end of this section (see **Section 5.6**).

7.1 Frequency

7.1.1 Overall wind conditions

Figure 9 shows a wind rose for Christchurch Aero between 2014 and 2019. The predominant winds blow from the northeast. The average wind speed for this period is 3.97 m/s. The overall frequency of winds above 5 m/s is 33.3%.

[5] *Guidance on the Assessment of Mineral Dust Impacts for Planning*, Institute of Air Quality Management, May 2016 (v1.1)

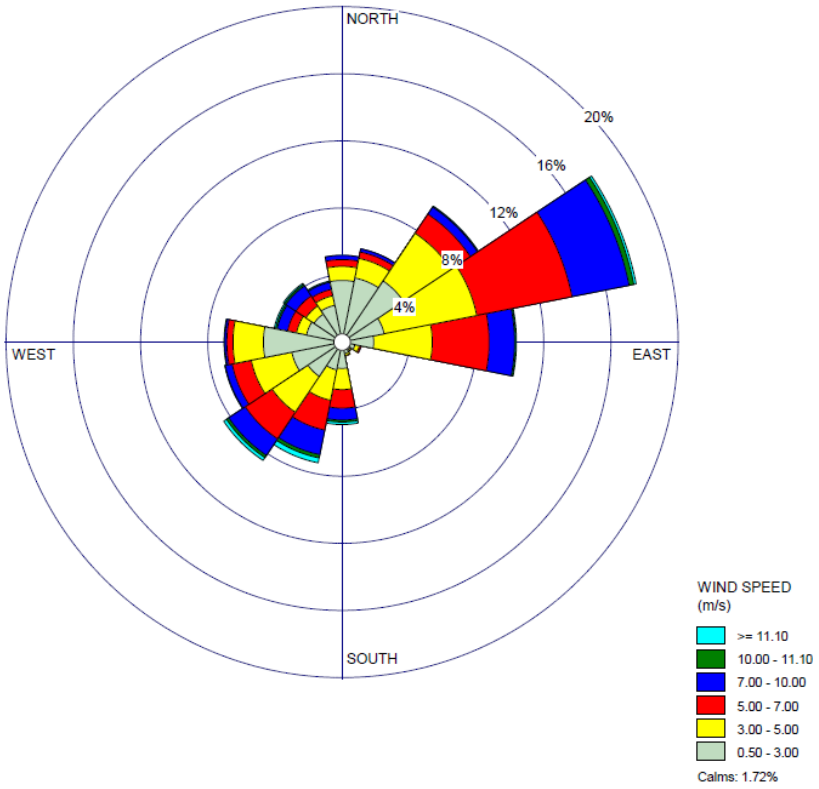

Figure 9: Wind rose for Christchurch Aero Data (2014-2019) (blowing from)

7.1.2 Calculation of wet and dry surface conditions

Rainfall has a significant influence on whether dust emissions will occur because a wet or damp ground surface will not generate dust emissions. For calculation of whether a day had wet or dry ground conditions, a day when wet ground conditions occurred was defined as one where the daily evaporation (Penman ET) exceeded the daily rainfall by no more than 1 mm. This allows for some minimal moisture storage within the surface layer. A day with dry ground conditions and thus a potential for dust generation was then taken as any day when wet ground conditions had not occurred.

The percentage of dry days per month was calculated using data from the Christchurch Aero weather station for the same period as the analysed win data above (2014-2019). The monthly frequency of dry days is shown in **Figure 10**. This shows that there are the highest number of dry days in the early spring, summer and late autumn months of September to March, and fewer days expected with dry ground conditions in the April to August period. The classification of dry and wet days was cross-referenced with the surface wind data for the same date range to allow targeted analysis of dry days with wind speeds above specific values. These conditions are considered the highest risk for occurrence of potential dust events.

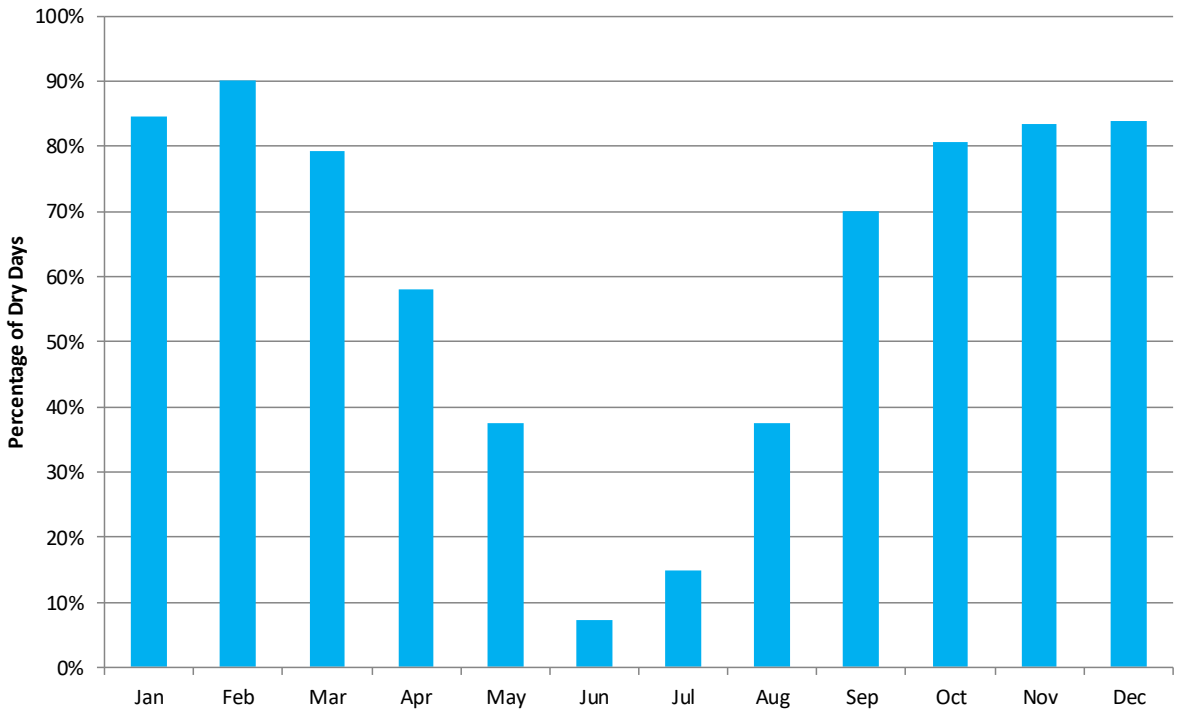

Figure 10: Dry surface days per month for Christchurch Aero (2014-2019)

7.1.3 Assessment of high risk conditions for the sensitive receptor at Harewood Gravels

Figure 11 shows the location of the residential buildings at Harewood Gravels and the corresponding downwind impact arc relative to the current and proposed operations.

The downwind impact arc for this receptor indicates that wind directions blowing from 270 to 320 were used for wind analysis calculations.

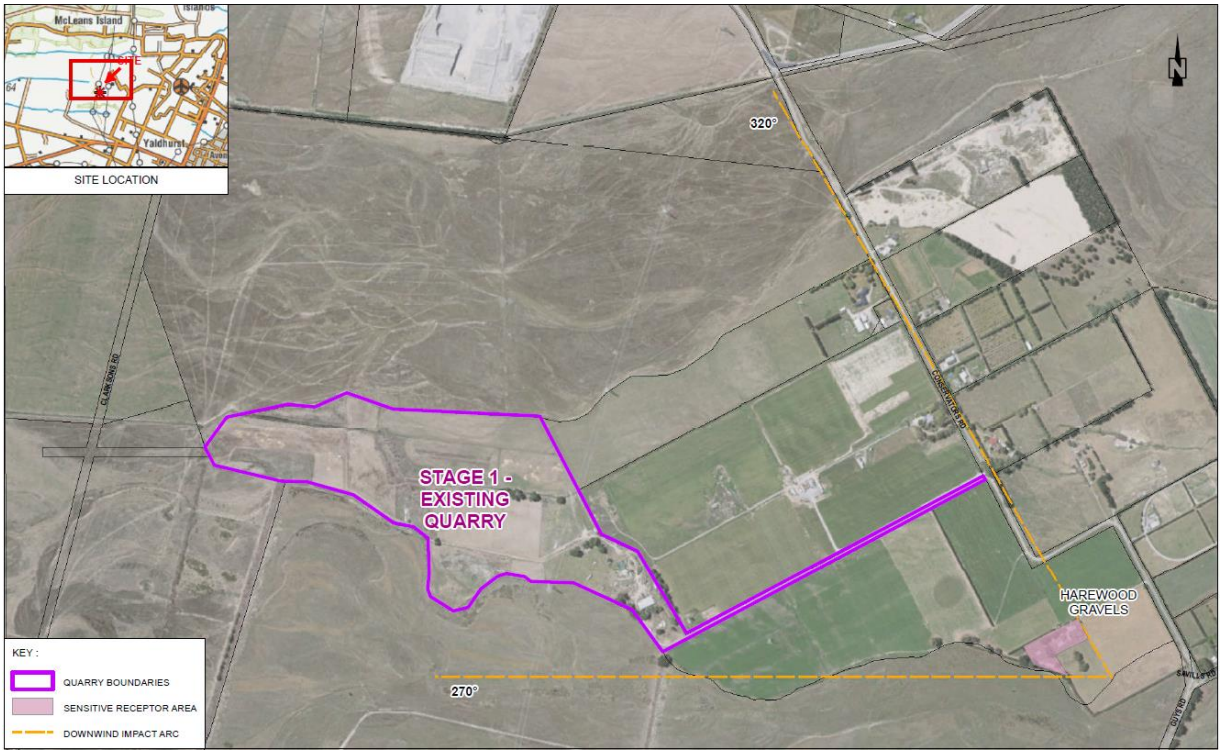

Figure 11: Downwind impact arc for Harewood Gravels

Table 7 shows the frequency with which the sensitive receptor identified at Harewood Gravels is downwind from the existing quarry. Using the IAQM guidelines classification for frequency, the sensitive receptor at Harewood Gravels is classified as 'Infrequent' (less than 5%).

Table 7: Harewood Gravels - Frequency that sensitive receptor is downwind from source

Sensitive Receptor	Harewood Gravels		
	%	Number of hours/year	Number of days/year
Frequency that sensitive receptor is downwind	13	1124	47
Time downwind with wind speeds above 5 m/s	3	299	12
Time downwind with wind speeds above 5 m/s on dry days	3	248	10

Table 8 shows the breakdown for the frequency of winds for the complete years of 2016, 2017 and 2018. There is low variability in the annual frequency of winds in these years indicating likely predictability of wind behaviour in future years.

Table 8: Harewood Gravels - Variation in high-risk conditions						
Sensitive Receptor	**Harewood Gravels**					
	2016		**2017**		**2018**	
	%	**Hours/year**	**%**	**Hours/year**	**%**	**Hours/year**
Frequency that sensitive receptor is downwind	12	843	13	940	13	905
Time downwind with wind speeds above 5 m/s	3	280	3	283	3	227
Time downwind with wind speeds above 5 m/s on dry days	3	230	3	239	2	168

Table 9 shows the seasonal variation in frequency of winds towards the receptor. The most significant impact is likely when wind speeds are above 5 m/s on dry days. The highest incidence of these winds occurs during spring (September-November) but the frequency during this time still falls within the overall IAQM classification of 'Infrequent' given above. (Note: The actual frequency during spring is 4.8% but the value shown in the table is rounded to 5%.)

Table 9: Harewood Gravels – Seasonal variation of high-risk conditions								
Sensitive Receptor	**Harewood Gravels**							
	Summer		**Autumn**		**Winter**		**Spring**	
	%	**Hours/ season**	**%**	**Hours/ season**	**%**	**Hours/ season**	**%**	**Hours/ season**
Frequency that sensitive receptor is downwind	10	212	13	279	15	336	14	297
Time downwind with wind speeds above 5 m/s	4	96	3	56	2	38	5	109
Time downwind with wind speeds above 5 m/s on dry days	4	95	2	37	0.5	10	5	105

The directional component of these seasonal winds is shown in the wind roses in **Figure 12**. Winds that would be likely to impact the sensitive receptor at Harewood Gravels are those blowing from directions in the northwest quadrant. Winds from this direction are relatively infrequent but the highest proportion occurs during the winter which coincides with the lowest frequency of dry days. The lowest proportion of winds from this direction occurs during the summer when the frequency of dry days is highest.

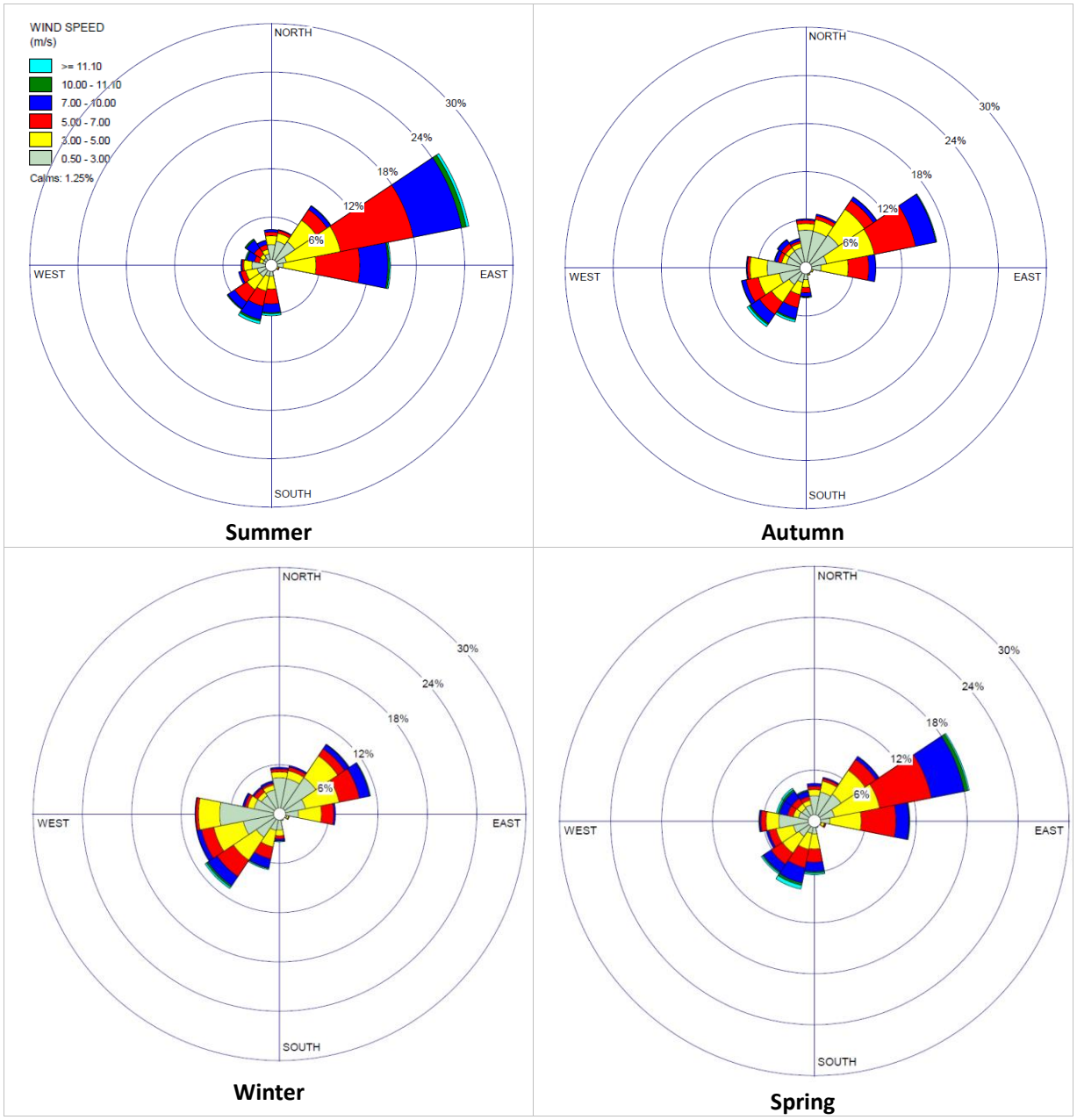

Figure 12: Seasonal wind roses for Christchurch Aero (2014-2019)

The frequency of wind speeds >5 m/s on dry days blowing towards the receptor at Harewood Gravels during spring is shown in **Figure 13**. This shows that for an average spring day, the likelihood of strong winds causing the receptor to be downwind from the proposed quarry is highest during the afternoon to early evening. The quarry operates from 7.00 am until 6.00 pm on weekdays (shown by the yellow box in **Figure 13**) so the majority of these winds are likely to occur during operating hours. This information can be used to plan the application of water to ensure that sufficient water volumes are available for periods of higher risk of potential dust events.

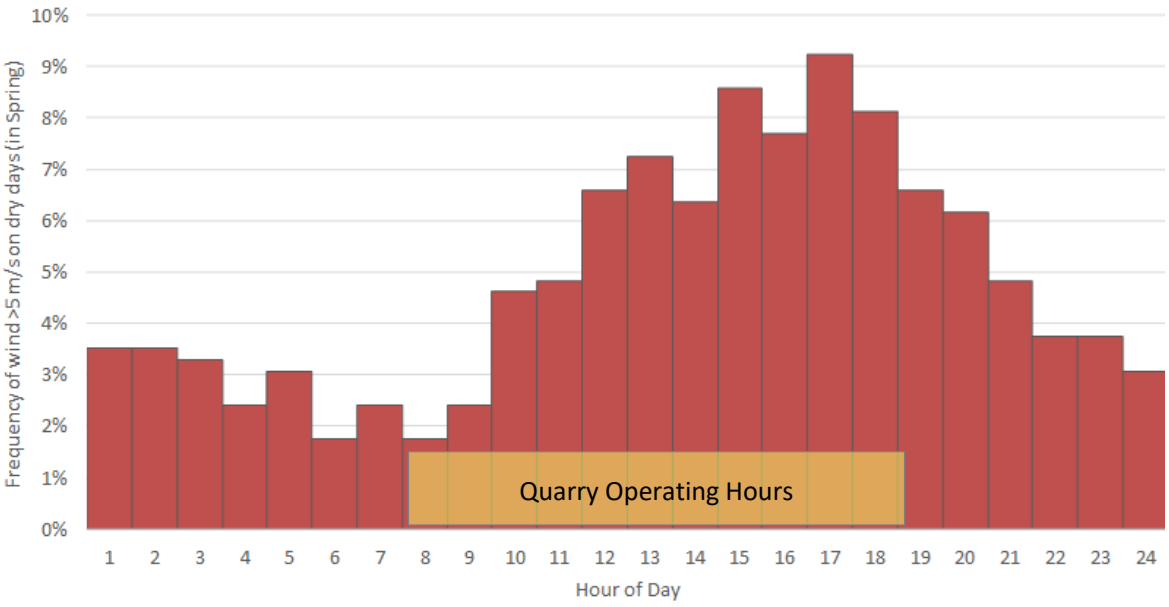

Figure 13: Frequency of wind speeds >5 m/s on dry days blowing towards Harewood Gravels in spring

The sensitive receptor located at Harewood Gravels is not located downwind from the prevailing wind direction (North East) experienced at the proposed quarry site. Strong winds on dry days in a direction from some area of the quarry site towards the sensitive receptor occur with around 3% frequency in an average year. The highest incidence of strong winds on dry days is anticipated during the spring (Sep-Nov). The highest probability of strong winds on dry spring days is during the afternoon to early evening when the probability of dry winds >5 m/s is around 7-9%. The IAQM classification of winds from the proposed quarry site towards the sensitive receptor is 'Infrequent'. It is noted that mitigation measures are to be implemented as part of the Quarry Management Plan to reduce the potential for dust events during times of strong dry winds.

7.2 Intensity

The residential dwelling at Harewood Gravels is located to the southeast of the proposed quarry site. The residential dwelling is recognised as a 'human receptor' in the IAQM guidelines and is classified as 'highly sensitive'.

7.2.1 Pathway effectiveness

The IAQM guidelines state that the distance between the dust source and the sensitive receptor is the primary factor influencing the pathway, with adjustments made depending upon the orientation of the receptor with respect to the prevailing wind and the topography, terrain and physical features of the site. The residence at Harewood Gravels is not downwind from the prevailing wind and there are no topographical features of the site that are likely to significantly alter the local dispersion and dilution behaviours of dust emissions.

As the receptor is approximately 350 m from the closest boundary of the existing quarry, it is classified by the IAQM guidelines as a 'Distant' receptor (between 200 m and 400 m from dust source). This can then be combined with the 'Infrequent' classification of winds for the receptor location using the matrix shown in **Table 10**, this gives an overall pathway effectiveness rating of 'Ineffective'.

Table 10: Pathway Effectiveness					
		Frequency of Potentially Dusty Winds			
		Infrequent	**Moderately Frequent**	**Frequent**	**Very Frequent**
Receptor Distance	**Close**	Ineffective	Moderately Effective	Highly Effective	Highly Effective
	Intermediate	Ineffective	Moderately Effective	Moderately Effective	Highly Effective
	Distant	Ineffective	Ineffective	Moderately Effective	Moderately Effective

The 'Ineffective' pathway classification can be combined with the Residual Source Emission type to estimate the Dust Impact Risk.

7.2.2 Residual Source Emission (RSE) determination

According to the key factors for assessing RSEs listed in Section 5.1 of the IAQM guidelines, the characteristics of the proposed site (summarised from the NZ Air Assessment of Air Quality Effects[6]) are:

- The proposed site is zoned as Rural in the Christchurch District Plan. The boundary is shared with rural residential lifestyle blocks (to the northeast) and pasture;
- The existing operations on the proposed development site are undertaken by Readylawn Industries and involve various soil disturbance activities;
- The scale of operations will remain unchanged from that of the existing quarry and a staged quarrying operation has been proposed (as described in Section 4.0);
- There will be up to two aggregate processing and screening plants which will be set back a minimum of 350 m from the nearest rural residential boundary to the site;
- The mineral type is described in **Section 7.4**;
- The maximum processing rate will be 600 t/hr;
- The methods of working will be:
  - Topsoil stripped (area not generally exceeding 2 hectares);
  - Benched excavation to desired pit depth (likely 10 m below ground level (bgl));
  - Haul trucks enter site via heavy vehicle access point and weighbridge;
  - Clean fill will be dumped at dedicated backfill area;
  - Aggregate will be loaded at the pit floor;
  - Filled trucks will exit the site via the weighbridge and heavy vehicle access road;
  - Machinery on-site will include:
    - Up to five loaders;
    - One excavator;
    - One bulldozer;

[6] *Assessment of Air Quality Effects, SOL Quarries – Yaldhurst Expansion,* NZ Air, February 2019

  - Up to two crushing and screening plants (jaw crusher, cone crusher, powerscreen);
  - One water cart.

- Material handling will be:
  - Topsoil used for bund formation or stockpiled;
  - excavated material will be either directly loaded to haul trucks, stockpiled for future load out or transported to onsite aggregate processing plant;
  - Haul trucks entering site will either be empty or carrying clean fill;
  - Clean fill will be dumped in dedicated backfill area for rehabilitation;
  - When sections have been backfilled to the required level, rehabilitation with topsoil and re-grassing will be completed;
  - On-site processing will primarily be used to form crusher dust, CAP20, CAP40, TNZ M4-40, and CAP65.
- Storage in the form of stockpiles in the quarry pit is proposed and these will be managed to a maximum of 15,000 m^3 of each product.
- Access to the site will be via the existing heavy vehicle access route from Guys Road and the existing light vehicle access route from Conservators Road. There is a limit of 300 heavy vehicle movements and 30 light vehicle movements per day.
- Various mitigation measures are planned for the operation of the proposed quarry including:
  - Installing two judder bars near the Guys Road entrance to help dislodge dust;
  - Chip sealing of the first 250 m of the haul road;
  - The use of a water cart or k-line sprinklers to suppress dust when conditions require;
  - Sealing the Guys Road entrance with asphalt to reduce truck damage to the surface;
  - Surfacing the haul road with crushed used asphalt which has lower dust generation propensity than gravel;
  - The entrance at Guys Road is swept by Wasteco 5 days a week to remove any dust deposited at the entrance that could cause a nuisance effect;
  - Site traffic movements are restricted to 15 kph;
  - Potentially dusty activities (crusher/screening operation without watering, topsoil stripping/spreading, formation of bunds/stockpiles) will be stopped when wind speeds exceed 10 m/s;
  - Real-time monitoring of PM_{10} to inform use of dust mitigation measures and provide feedback on their effectiveness;
  - Stockpiles will be located at the western end of the quarry pit to ensure large buffer distances to residential dwellings; and
  - The crushing plant and loading activities will be located at the western end of the proposed site to maximise the buffer distances to residential dwellings.

The IAQM guidelines break down site activities into seven categories and offer guidance parameters for determination of whether activities in each category are likely to be classified as 'Small', 'Medium', or 'Large' RSEs. These categories are assessed with regards to the proposed quarry activities below:

- Site preparation/restoration: the anticipated working area of 2 hectares and bund height of up to 3 metres are classified as 'Small'. The possibility for more than five heavy plant units operating simultaneously would be classified as 'Medium' but this risk is mitigated through the operation of a water cart for wetting of haul routes during quarry operating hours. The material movement for bund construction may exceed the 'Small' classification of 20,000 m^3 so overall this category has a 'Medium' RSE classification.
- Mineral extraction: a small working area of approximately 2 hectares is anticipated but the proposed operating hours and extraction rate of 600 t/hr lead to an anticipated extraction rate of over 1,000,000 tpa which is considered large. It has been noted that the raw gravels are damp on removal from the quarry face so overall this category has been classified as 'Medium'.
- Materials handling: it is proposed to limit material loading to the western end of the proposed quarry which will ensure that there is a minimum of 350 m between the loading activities and the closest privately-owned adjoining property boundary. It is not possible to wet the processed product as this would separate the size fraction so there is potential for low moisture content leading to elevated risk of dust. A distance of over 100 m from a site boundary is classified as a 'Small' RSE so the extended separation distance of 350 m is considered to mitigate the potential for elevated dust as a result of low moisture content having an impact at the site boundary. For this reason, this category has been classified as 'Small'.
- On-site transportation: More than 250 daily movements on unpaved surfaces is considered a 'Large' RSE. However, the dust potential of the haul road has been lowered through the addition of used asphalt to the surface and a water cart is utilised to wet the roads to reduce the risk of dust events. Speed is also restricted to 15 kph (lower than the 'Small' suggestion of 15 mph). These mitigation measures are considered to reduce the overall RSE for this category to 'Medium'.
- Mineral processing: the proposed activity incorporates a high processing volume of material with a combination of processes undertaken at the plant. Although the raw material is likely to be damp, there is potential for low moisture content in the product leading to high dust potential. Although mitigation measures have been undertaken to distance this activity from the nearby sensitive receptors, they are not considered for this RSE classification as their impact has already been included in the assessment of pathway effectiveness. However, it is proposed to stop crushing and loading activities if wind speeds reach above 10 m/s due to their high potential for dust propagation. Overall, this category has been classified as a 'Medium' RSE.
- Stockpiles/exposed surfaces: The total area of proposed stockpiles is considered small. The proposed production rate is considered high but there are mitigation measures that address the risks of stockpiling included in the proposed activities and Quarry Management Plan (QMP). The QMP states that extended stockpiles should be seeded as soon as practicable to ensure stabilisation and that the temporary stockpiles will be located within the quarry void. Due to these mitigation measures, this category has been classified as a 'Medium' RSE.
- Off-site transportation: the potential for 300 heavy duty vehicle movements and an unsurfaced haul road would lead to a 'Large' RSE classification. The wetting of the haul road using the water cart, the addition of used asphalt to reduce dust, and the chip sealing of 250 m of access road to the site boundary are all mitigation measures that act to reduce this emission. Judder bars to reduce material tracking off-site and sweeping of the entrance road five days per week also

contribute to the mitigation of this emission source. Overall, this category has been classified as a 'Medium' RSE.

The highest RSE is the 'Medium' classification identified for the site preparation/restoration, mineral extraction, on-site transportation, mineral processing, stockpiles/exposed surfaces, and off-site transportation categories. Combining the 'Ineffective' pathway and 'Medium' RSE values using **Table 11** gives an overall Dust Impact Risk of 'Negligible Risk' for the proposed quarry activities on the sensitive receptor located at Harewood Gravels.

Table 11: Estimation of Dust Impact Risk

		Residual Source Emissions		
		Small	**Medium**	**Large**
Pathway Effectiveness	**Highly Effective Pathway**	Low Risk	Medium Risk	High Risk
	Moderately Effective Pathway	Negligible Risk	Low Risk	Medium Risk
	Ineffective Pathway	Negligible Risk	Negligible Risk	Low Risk

Using the IAQM approach for assessing dust risk impact suggests that the intensity of any impact on the sensitive receptor located at Harewood Gravels from the dust discharged from the proposed activity will be negligible.

7.3 Duration

The duration of potential dust events is determined by the duration of the quarrying activities and the duration of strong wind events when the dust emissions may be elevated.

Figure 14 shows the annual frequency and duration of dry day wind events with an average hourly wind speed above 5 m/s blowing from the extraction areas towards the sensitive receptor (residence) at Harewood Gravels. The frequency of events rapidly declines with increasing duration. Theoretical exposure to an event greater than 12 hours in duration is predicted to occur less than once per year.

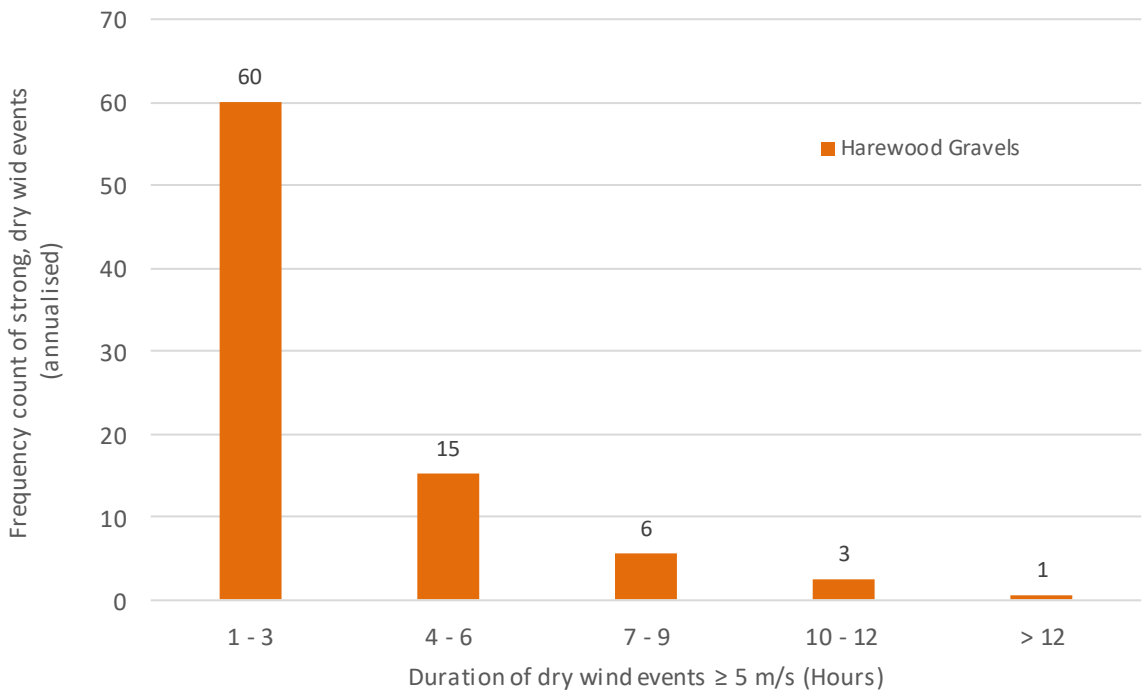

Figure 14: Duration and frequency (annualised) of strong wind events (hourly average wind speed ≥ 5 m/s) blowing from proposed extraction areas towards Harewood Gravels

7.4 Offensiveness

There are two main dust type sources from the quarry; stripped overburden soil stockpiles, and the crushed aggregate product itself.

The dust from the stripped overburden is light brown in colour, is inert in nature, and would only potentially cause a nuisance effect if it settles on surfaces. This dust would be the same composition as that from the ready lawn operation currently operating on the area proposed for the Stage 2 quarry.

Dust from the crushing of the aggregate used in New Zealand is predominantly greywacke which can contain a small portion of quartz (generally in veins) which has a high silica content. Respirable silica is primarily released from the cutting, crushing or processing of aggregates containing silica. As part of the ECan's Yaldhurst Air Quality Monitoring study[7] Respirable Crystalline Silica (RCS) was monitored at 7 locations around the quarries (20 samples in total). Only 2 of the samples (both from the same location) returned results above the detection limit of 20 µg per filter. The location where RCS was detected was 50m to the south east of the quarry and the average RCS concentration was 0.4 µg/m^3. The chronic reference exposure level for RCS is 3 µg/m^3 as an annual average.

Based on the ECan air quality monitoring study, the dust generated from the aggregate crushing plant can be regarded as inert in nature and, like the dust from the stripped overburden, is light brown in colour and would only potentially cause a nuisance effect if it settles on surfaces.

As discussed in the NZAir Assessment of Air Quality Effects of the quarry expansion, the product crushing and processing on-site will be well separated from the nearest off-site receptors and have a number of mitigation measures employed to limit the emissions of dust.

[7] Yaldhurst Air Quality Monitoring, Summary Report: 22 December – 21 April 2018, Mote, 19 June 2018, p47,

Based on the discussion above, it is concluded that the dust is inert in nature, is light in colour, and therefore in itself is of low offensiveness.

An ecological assessment of the adjacent Christchurch City Council grassland to the north of SOL Quarries[8] concluded that dust from the quarrying operations does not settle on the grassland.

7.5 Location

The surrounding area the sensitive receptor located at Harewood Gravels is zoned as Rural Waimakariri within the Christchurch City Council District Plan. This zoning lists quarrying activity located 250 m or more from a residential zone or Specific Purpose (School) Zone boundary as a discretionary activity. The Rural Waimakariri zoning extends beyond 250 m from the proposed site boundary in the direction of existing nearby residences. The non-residential pasture land adjoining the quarry site on the northern boundary is zoned as Open Space Natural.

The downwind impact arc for the sensitive receptor at Harewood Gravels has been defined as 270-320 from the dwelling, including over half of the northwest quadrant. The distance from the dwelling to the nearest boundary of the proposed quarry site is over 350 m and the proposal includes plans to ensure that the crushing plant which is associated with the highest potential dust risk is located a minimum of 350 m from the boundary of the Harewood Gravels property. The dwelling is therefore located a minimum of 700 m from the closest crushing plant location.

Due to the rural zoning of the surroundings, the receiving environment is likely to have more existing natural dust sources than a residentially zoned area so the environment can be considered less sensitive to minor nuisance dust impacts. However, as outlined above, Harewood Gravels site includes a residential dwelling which it is considered a high sensitivity receptor for the purposes of assessment for magnitude of dust effects.

7.6 Overall Finding of Air Quality Assessment

The sensitive receptor located at Harewood Gravels is not located downwind from the prevailing wind direction experienced at the proposed quarry site. Strong winds on dry days in a direction from some area of the quarry site towards the sensitive receptor occur with around 3% frequency in an average year with the highest frequency expected in the spring. Wind directions blowing from between 270 and 320 were used for wind analysis calculations when considering this receptor.

Strong wind events on dry days are more commonly of a short duration, with fewer longer duration events expected each year.

The only offensiveness identified was the potential for nuisance if any of the dust settles on surfaces at neighbouring properties.

The distance from the receptor to the boundary of the proposed quarry site is over 350 m and the proposal includes plans to ensure that the crushing plant which is associated with the highest potential dust risk is located a minimum of 350 m from the property boundary. Due to the rural zoning of the surroundings, the receiving environment is likely to have more existing natural dust sources than a residentially zoned area so the environment can be considered less sensitive to minor nuisance dust impacts.

[8] An ecological assessment of the Christchurch City Council grassland reserve adjacent to SOL Quarries on Conservators Road, McLeans Island, Wildland Consultants Ltd, 2019

The residential property at Harewood Gravels is recognised as a 'human receptor' in the IAQM guidelines and is classified as 'highly sensitive' due to its use as a residential dwelling. The receptor is over 200 m from the closest boundary of the proposed quarry so is classified by the IAQM guidelines as a 'Distant' receptor. The wind frequency and receptor distance combine to give an overall pathway effectiveness rating of 'Ineffective'. The highest Residual Source Emission is the 'Medium' classification identified for various site activities. Combining this with the 'Ineffective' pathway gives an overall Dust Impact Risk of 'Negligible Risk' for the sensitive receptor.

Table 12 can be used to combine the 'Negligible Risk' Dust Impact Risk value with the 'High' receptor sensitivity classification to assess the Magnitude of Dust Effects. This gives an overall result of 'Negligible Effect' for the proposed quarry activities on the sensitive receptor located at Harewood Gravels.

Table 12: Descriptors for Magnitude of Dust Effects

		Receptor Sensitivity		
		Low	**Medium**	**High**
Dust Impact Risk	High Risk	Slight Adverse Effect	Moderate Adverse Effect	Substantial Adverse Effect
	Medium Risk	Negligible Effect	Slight Adverse Effect	Moderate Adverse Effect
	Low Risk	Negligible Effect	Negligible Effect	Slight Adverse Effect
	Negligible Risk	Negligible Effect	Negligible Effect	Negligible Effect

To ensure that the actual dust impacts are no greater than those assessed in this report, the Stage 2 SOL Quarries development have a comprehensive dust mitigation programme and SOL Quarries will implement a real time dust monitoring programme to allow the proactive management of dust during high risk wind conditions.

8.0 ECan Request - Dust Control

The main mitigation measure for the proposed quarry is proposed to be the application of water to suppress dust. Therefore, ensuring that there is sufficient water available for this purpose is important. The air quality assessment calculates that 27 m^3 of water will be required per hour during peak dry conditions. It is noted by our Air Quality Scientist, during prolonged dry weather, the application of water could reasonably be expected to occur for all hours of operation and for several consecutive days in a row. Given this, hourly water consumption and an 11-hour operating day, a peak daily water consumption of approximately 300 m^3 would be required. This is in excess of the site's water take (100m^3) and available storage (100 m^3).

Our Air Quality Scientist agrees that applying one litre of water per square metre of exposed surfaces per hour is conservative. Irrespective of this, the air quality assessment should assess the effectiveness of dust suppression in light of the limited volume of water available on a daily basis.

i. Based on the above, please clarify what is considered to be a more reasonable water application and provide an updated assessment regarding the use of water for dust suppression. In this consideration, please include water that will be consumed during

operation of the processing plant and for the irrigation of the bunds, if required, in order to establish and maintain grass growth needed to minimise dust emissions from the bund.

SOL Quarries Ltd supplied PDP with the ECan complaints register which was requested on the 14 May 2019. It contains complaints from when the quarry began operations on the 13 June 2016 i.e. a period of 35 months. There are 53 complaints recorded in the register with 5 of these recorded as having been substantiated (the latest complaint on the 1 April 2019 has not been assessed yet). In each substantiated case SOL Quarries Ltd is recorded as being compliant with their resource consent conditions. Of the 5 substantiated complaints, 4 related to dust generated by truck movements on the heavy truck haul road and the tracking of dust onto Guys Road at the entrance of the haul road.

PDP have discussed operational dust suppression activities with SOL Quarries and reviewed the recent (6 months) water use.

PDP understands that the following actions have been taken to address dust issues from the heavy truck haul road:

- Sealing the Guys Road entrance with asphalt reduce truck damage to the surface;
- Installing judder bars to help dislodge dust;
- Chip sealing of the first 250m of the haul road;
- Surfacing the haul road with crushed used asphalt which has lower dust generation propensity than gravel;
- The entrance swept by Waste Co 5 days a week to remove any dust deposited at the entrance that could cause a nuisance effect; and
- The use of a watercart or k-line sprinklers to suppress dust when conditions require.

PDP have estimated the current area to which water dust suppression is applied to be 1.48 ha (see below). SOL Quarries have informed PDP that the maximum daily water use in the past six months has been 72 m^3 which equates to an average water application rate of 0.45 litres per m^2 per hour assuming water suppression was used over the maximum 11 hr working day. This is roughly half the figure stated in the Good Practice Guide for the Management of Dust of 1 litre per m^2 per hour however this figure is stated as being conservative.

It can be reasonably be assumed that the area requiring dust suppression will remain much the same for the Stage 2 quarry as the equipment used and extraction rates will remain the same as they currently are.

The maximum required water requirements of 72 m^3 per day is within the available 100 m^3 per day allowing at least 28 m^3 for additional dust suppression and dust suppression of topsoil stockpiles and bunds until vegetation is established.

Given that the maximum daily volume of water used for dust suppression over the past few months is 72 m^3, PDP suggest that SOL Quarries' dust management approach be modified to ensure that the entire 100 m^3 of available water is used for dust suppression during conditions that warrant it. Doing this would increase the intensity of water application from 0.65 litres per m^2 per hour to 0.90 litres per m^2 per hour.

Based on the wind speed data analysis above (see **Figure 6**) PDP also suggests that SOL Quarries' dust management approach could be amended to focus water application for dust suppression to the hours when wind speeds are greater than 5 m/s i.e. in the 6 hours in the afternoon. If the full 100 m^3 of available water were used for dust suppression during this time, this would increase the potential intensity of water

application from 0.65 litres per m^2 per hour to 1.60 litres per m^2 per hour or allow additional dust suppression on other areas of the quarry.

If required, additional water may be sourced from the stock water race which runs through the site to provide additional dust suppression capability although this is likely to require additional personal to operate another water cart.

ii. In regard to the surface area that will require dust suppression, please provide clarification on the following matters:

a. The length of the main haul road is stated to approximately 1,700 metres. However, based on Google Maps, it may be larger than this even when allowing for a 250- metre sealed section.

With reference to **Figure 1**, the main haul road length has been measured as being 1.3 km in length from the end of the chip sealed entrance to the weigh bridge. In order to minimise the dust creation potential and consequently reduce dust suppression water demand, the main haul road has been surfaced with crushed used asphalt which has lower dust generation propensity than gravel.

In addition to the main haul road there is an internal haul road which has been measured as being approximately 1.3 km in length.

b. The width of the haul road is assumed to be four metres allow for the safe passing of trucks.

This is correct.

c. An active quarry area of 2 hectares is assumed in the calculations and this seems reasonable. However, for the purpose of calculating water consumption, it may be overly conservative in order to account for frequently trafficked areas and stockpiles.

Discussion with SOL Quarries indicates that not the whole open quarry area of 2 ha is dust suppressed with water when required but rather only the active trafficked areas used by loaders and trucks.

Stockpiles cannot be dust suppressed as this will lead to separation of the product. The minimum product size is 8-9 mm.

PDP have estimated the area that currently has water applied to it for dust suppression as follows:

- Heavy haul road — 1.3 km x 4 m = 5,200 m^2 (Note: only currently has dust suppression water applied once a day when required).
- Internal haul road — 1.3 km x 4 m = 5,200 m^2
- Pit bottom load paths — 1.1 km x 4 m = 4,400 m^2
- Total — 14,800 m^2 or 1.48 ha

iii. Based on the above clarifications and the potential lack of water for dust suppression, please provide a revised assessment of effects of dust discharges from:

a. An unmitigated processing plant and vehicles travelling along haul roads, which will generate dust regardless of wind speed; or

See assessment above for 113 Conservators Road.

b. A revised methodology on how air quality effects from an unmitigated processing plant and vehicles travelling along haul roads can be avoided, remedied or mitigated. However, it is considered this is reasonably narrow and would not necessarily.

A revised methodology of how air quality effects can be avoided, remedied or mitigated is as follows:

The original dust mitigation employed on the quarry haul road was as follows:

- Installing judder bars to help dislodge dust;
- Chip sealing of the first 100m of the haul road;
- The entrance swept by Waste Co 2 days a week to remove any dust deposited at the entrance that could cause a nuisance effect; and
- The use of a watercart or k-line sprinklers to suppress dust when conditions require.

As discussed above, SOL Quarries have already taken additional steps to mitigate the potential for nuisance dust arising from vehicles travelling along haul roads by:

- Sealing the Guys Road entrance with asphalt reduce truck damage to the surface;
- Chip sealing an additional 150 m of the haul road (the first 250 m is now chip sealed);
- Surfacing the haul road with crushed used asphalt which has lower dust generation propensity than gravel; and
- Increasing the frequency with which the heavy truck haul road is swept to remove dust from the entrance off Guys Road.
  - Late 2016 2 days per week
  - August 2017 Increased to 3 days per week
  - January 2018 Increased to 5 days per week

In addition, a second 30,000 litre water tank providing combined water storage of 130,000 litres has been installed onsite. Both on-site water tanks are trickle-fed from an on-site bore. The water supply is metered and does not exceed the 100 m^3 per day "permitted activity" volume. Consequently, 130 m^3 of water is now available for dust suppression. If full dust suppression was required for more than one day, only 100m^3 would be available for the second day as per the permitted activity volume limit.

As discussed in Section 42 c. of the Section 42A Officer's Report9, "The soils on the site are relatively damp, which generally prevents the generation of excessive amounts of dust generated on the working areas of the site". PDP during their site visit also observed the working face of the quarry to be damp and not a source of operational dust.

It is not proposed to fit any dust suppression to the crushing plants themselves. Instead SOL Quarries Ltd is also proposing that crushing units will be located no closer than 350 metres from the boundary of the quarry. This provides a large buffer distance between the crushing plants and the nearest sensitive receptor in order to mitigate the effects of any dust generated.

As discussed below in Section 8 - Proposed Air Quality Monitoring, SOL Quarries Ltd have recently purchased a real time dust monitor which will be installed on the northeast boundary of the site. Real

[9] Application CRL184072 and CRC184073 By SOL Quarries Limited to Change Conditions of Resource Consents CRC 155098 and CRC155099, Section 42A Officer's Report, Nick Reuther, 31 May 2018.

time feedback from this monitor will allow operational dust effects to be identified and enable water dust suppression applications to be focussed on areas causing concern.

iv. A description of the mitigation measures for minimising dust should overburden removal and bund formation need to occur outside of winter months when ground conditions are dry.

The bunds that will surround the Stage 2 quarry will be formed prior to operations beginning and as such can be programmed to occur during the winter period when dust related issues are reduced.

Should overburden removal and bund formation occur outside of the winter months, the following mitigation measures will be employed:

- Removed using a scraper to minimise dust generation;
- Use of k-line sprinklers to keep topsoil stockpiles and bunds damped down until vegetation establishes itself (as is currently done now on overburden stockpiles);

Vegetation should be able to be quickly established eliminating stockpiles and bunds as ongoing dust sources.

9.0 ECan Request - Proposed Air Quality Monitoring

The Air Quality Assessment indicates that monthly PM_{10} and Total Suspended Particulate (TSP) monitoring will be undertaken on the northeast boundary of the site to demonstrate the effectiveness of the control and mitigation measures. It is stated that detail of this is provided within the 'Draft Dust Management Plan'. However, no details of this have been provided. Please provide:

i. A description of the monitoring programme that will be used on site. This should take into account the Canterbury Regional Council's current monitoring requirements for gravel quarries within the Christchurch area operating near to residences.

ii. Justification as to why it is considered that the proposed monitoring frequency of one month is appropriate.

Environment Canterbury have determined that gravel quarries in the Yaldhurst area that are within 500 metres of someone's home are required to:

- Install an air quality monitoring site on their boundaries;
- Measure PM_{10}; and
- Measure windspeed and wind direction.

SOL will implement a particulate and meteorological monitoring programme with the objectives of:

- Meeting the ECan's requirements for air quality monitoring (as defined above);
- As far as practical meeting the requirements of New Zealand's National Environmental Monitoring Standards (NMES) for:
  - Rainfall; and
  - Meteorological Structures.

- As far as practical meeting the requirements of the relevant Standards Australia and Standards New Zealand:
  - AS/NZS 3580.1.1:2016. Methods for Sampling and Analysis of Ambient Air: Part 1.1: Guide to Siting Air Monitoring Equipment; and
  - AS/NZS 3580.12.1:2015 guidelines. Methods for sampling and analysis of ambient air - Determination of light scattering - Integrating nephelometer method.
- Meeting the recommendations of the Ministry for the Environment's good practice guidance on the monitoring of air quality and dust; and
- Providing real-time environmental information to enable SOL to proactively manage their dust mitigation procedures.

One of the key elements of SOL Quarries' air quality monitoring programme is a 10 m high meteorological mast carrying windspeed, wind direction, temperature and relative humidity sensors. A rain gauge is installed alongside the meteorological mast. The meteorological mast has been installed on site and is located on the western boundary of the site. Because of the surrounding flat terrain while it is located on the western end of the site the instruments will provide data that is representative of conditions being experienced across the entire site. The metrological sensors on the mast are currently not fully functional but a complete maintenance service and re-calibration is scheduled for the site in the near future. The data from the meteorological site is telemetered via a cellular network to Harvest.com where it is available for real-time viewing and analysis on that website.

The second key element to SOL Quarries' air quality monitoring programme will be a PM_{10} monitor. The PM_{10} monitor is likely to be a nephelometer (light scattering) instrument which provides real-time PM_{10} measurements which along with the meteorological data be telemetered to the Harvest website. The PM_{10} monitor will be set up on a steel frame and be powered by batteries which are recharged by solar panels. This configuration allows the PM_{10} monitor to be quickly and easily relocated (within say 2 hours) to capture PM_{10} concentrations when the wind is blowing toward nearby sensitive receptors.

Figure 17 shows the location of the meteorological mast (blue circle) and an indicative area (red circle) within which the PM_{10} monitor is most likely to be operated to capture PM_{10} concentrations**. Figure 17** shows a photo of the PM_{10} monitor set up.

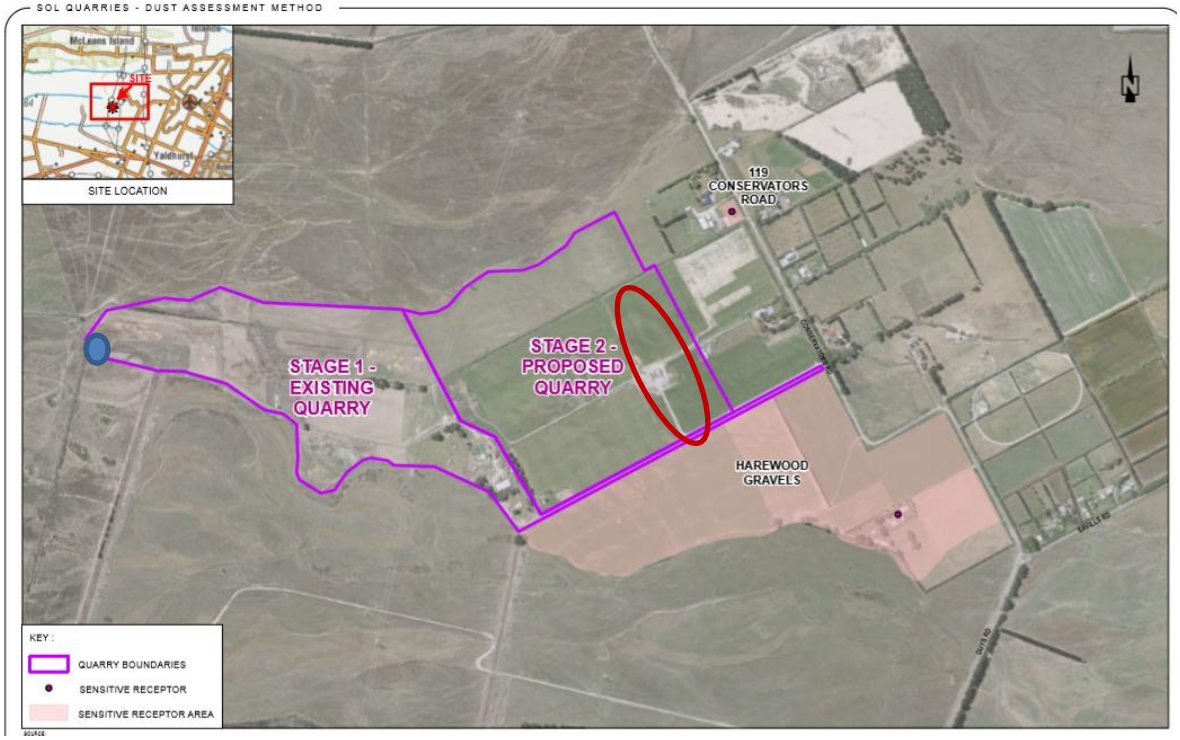

Figure 15. Location of the meteorological monitoring site (blue circle) and indicative area for the PM_{10} monitoring (red circle).

Figure 16: PM_{10} monitoring instrument, batteries and solar panels installed on a mobile steel pellet.

The real time meteorological and PM_{10} data will be used by the site staff to proactively manage dust emissions. Wind and PM_{10} trigger levels will be established above which additional dust mitigation will be implemented and/or dust generating activities halted. The PM_{10} monitoring system will be capable of sending text and email alerts to site staff. Details of how the meteorological and PM_{10} monitoring systems will be used to manage dust emissions, including the establishment of mitigation trigger levels will be detailed in the site's Dust Management Plan.

Once established, the meteorological and PM_{10} monitoring programme will be operated on a continuous and permanent basis at the quarry. Hence the actual proposed monitoring frequency is continuous rather than monthly.

10.0 CCC Request – Existing Dust Levels

Please provide details of the existing dust levels at the nearest residential properties. This will require dust monitoring on a number of days with different weather and wind conditions.

This information is required after taking into account the Harewood Gravels Environment Court decision, where they state that a comprehensive description of the existing dust environment should have been provided (see paragraph 230). The decision also states, "We do not consider the identification of sensitive receptors (i.e. residents) and sources of dust in the locality sufficient in this case to establish the background level of dust".

Given the limited time frame for responding to this request for further information, monitoring of existing dust levels at the nearest residential properties is not possible. It is however possible to use the extensive dust monitoring undertaken by ECan as part of their air quality study around quarries at Yaldhurst[10] to estimate the likely existing dust levels at the nearest residential properties to the current SOL Quarries' operations.

A total of 10 monitoring sites were setup around the quarrying operations as part of the study including 2 sites located well away from the quarrying operations to give "background" dust concentrations. The monitoring study ran during the summer period from 22 December 2017 until the 21 April 2018.

The monitoring site that best represents the location of residences relative to the quarrying operations is "Site 1" which was located ~200m due east of a quarry.

The closest residence to the boundary of the current SOL Quarries' operations is 83 Conservators Road located ~700 m east north east of the closest boundary.

The 1hr average PM_{10} concentrations at Site 1 are shown below in **Figure 17** which had been reproduced from the Mote report (originally Figure 5 on page 13).

It can be seen from **Figure 17** that the MfE 1-hour dust nuisance trigger value of 150 $\mu g/m^3$ was exceeded twice on Saturday the 7 April 2018. These exceedances occurred at 8.00pm-9.00pm and from 9.00pm-10.00pm New Zealand Standard Time. Both these periods are outside the operating hours of the quarries and occurred when a northly wind was blowing i.e. not from the direction of the quarries.

The 1-hour average PM_{10} concentrations were typically between 0-50 $\mu g/m^3$ with some periods of up to 100 $\mu g/m^3$.

[10] "Yaldhurst Air Quality Monitoring: Summary Report 22 December -21 April 2018", Mote Ltd, 19 June 2018.

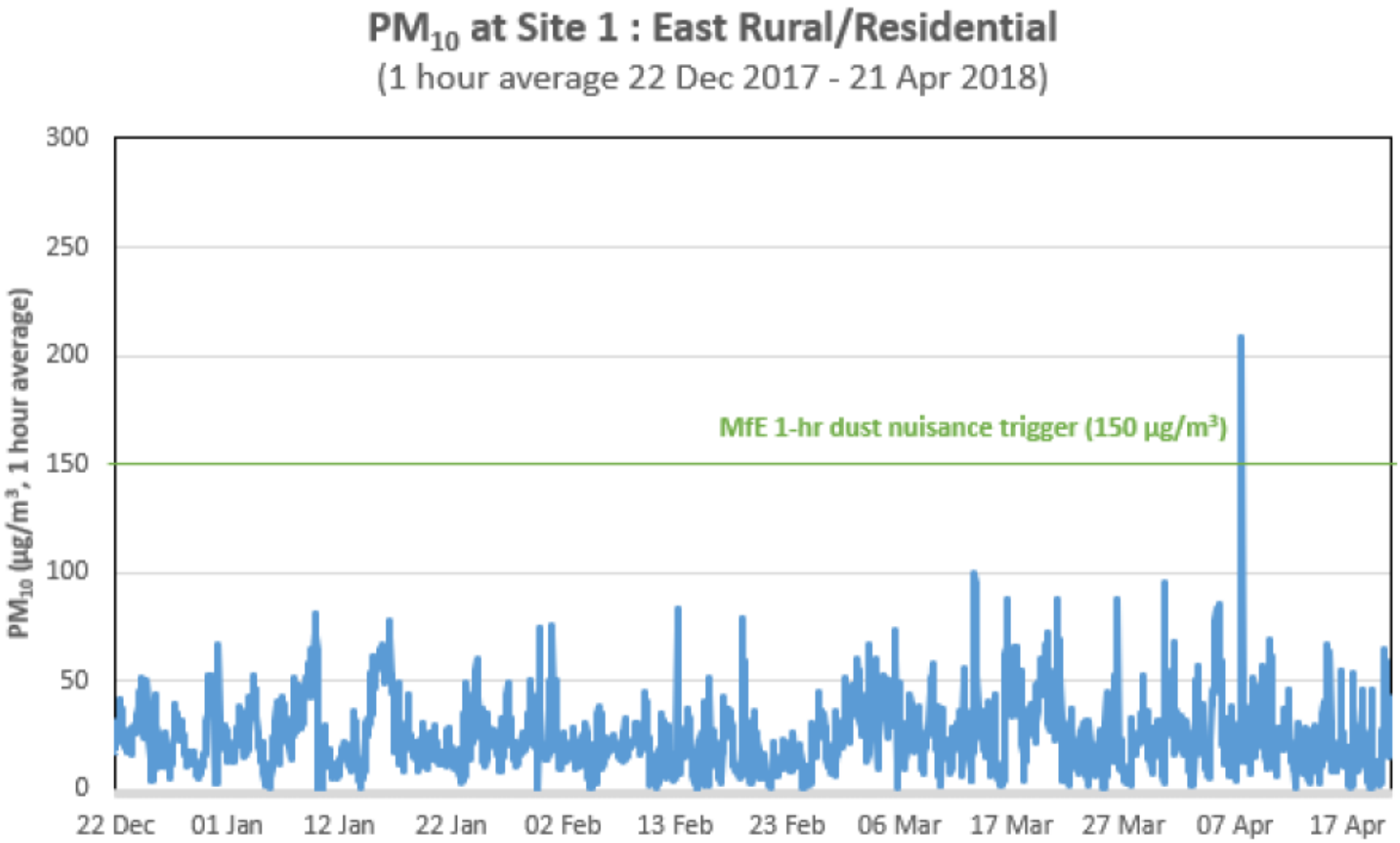

Figure 17: 1-hour average PM10 concentrations at Site 1

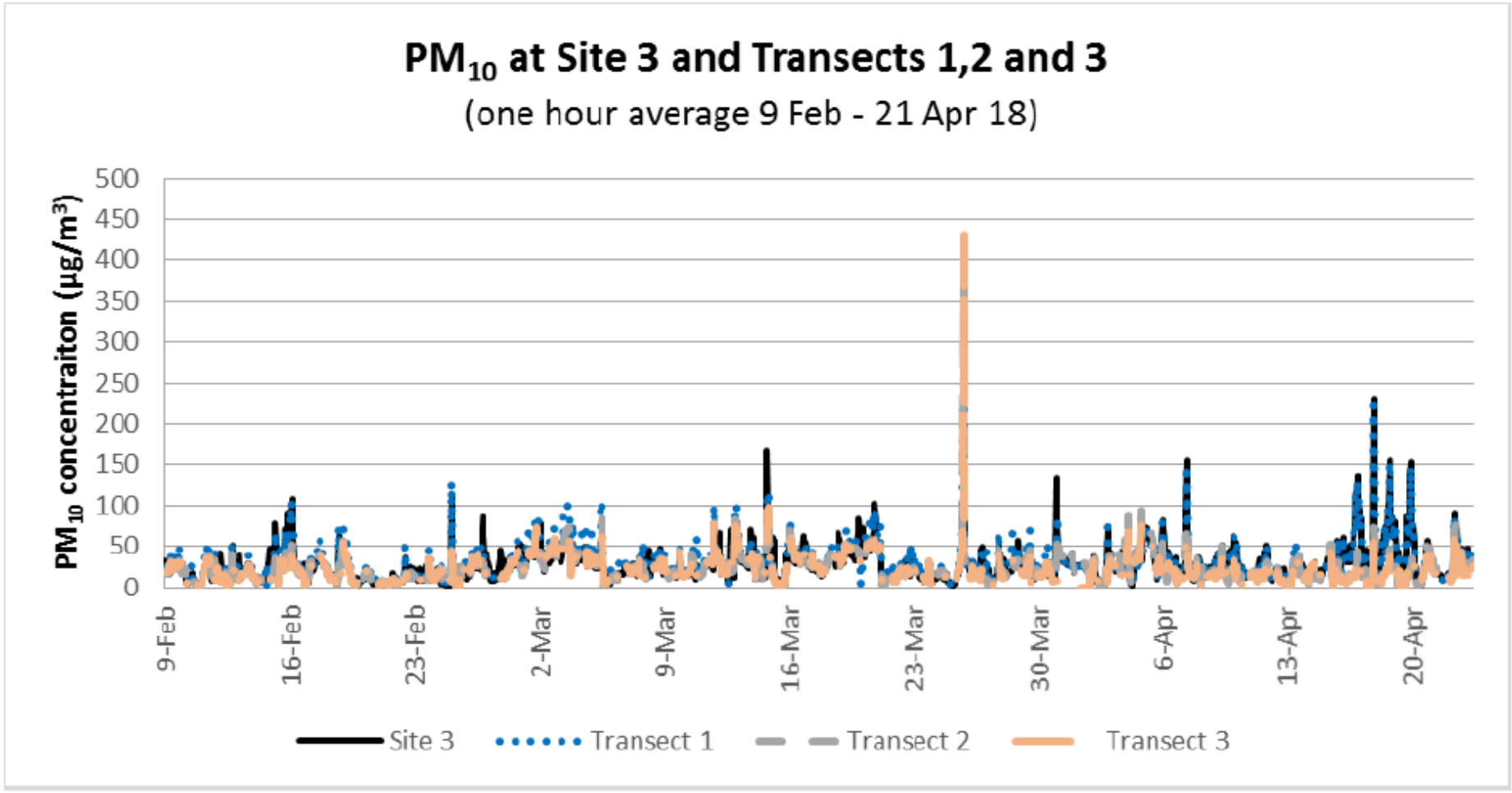

Figure 18: 1-hour average PM10 concentrations at Site 1

Monitoring Site 9 (Transect 3) is located ~650 m south east from the boundary of the quarrying operations and is at a similar distance from quarrying operations as the closest residence SOL Quarries current operations.

The 1-hour average PM_{10} concentrations at Sites 3, 7, 8 &9 (Site 3, Transects 1, 2 &3) are shown below in **Figure 18** which had been reproduced from the Mote report (originally Figure 33 on page 34).

Similar to Site 1, the Site 9 (Transect 3) 1-hour average PM_{10} concentrations were typically between 0-50 $\mu g/m^3$ with some periods of up to 100 $\mu g/m^3$. The apparent exceedance of the MfE 1-hour dust nuisance trigger value of 150 $\mu g/m^3$ around the 26 March 2018 was not discussed at all in the report text unlike the northwest wind gust on the 25 February and those on the 18th and 19th of April 2018. It is concluded that the wind on the 26 March 2018 was not from the direction of the quarries and therefor the exceedance of the MfE 1-hour dust nuisance trigger value was not due to quarrying operations. A review of Christchurch airport wind data on the 26 March 2018 supports this with winds occurring from the north east and southerly directions.

From the above discussion it is reasonable to conclude that the background levels of dust at the nearest residential properties is likely to be between 0-50 $\mu g/m^3$ with some periods of up to 100 $\mu g/m^3$ with occasional concentrations above the MfE 1-hour dust nuisance trigger value of 150 $\mu g/m^3$ that are not related to quarrying activities in the proximity of the residence.

In PDP's assessment, the background air quality is good the majority of the time but will occasionally experience non quarrying related dust events exceeding the MfE 1-hour dust nuisance trigger value due to high velocity northwest winds.

11.0 Limitations

This report has been prepared by Pattle Delamore Partners Limited (PDP) on the basis of information provided by Lands and Survey (South) Ltd and others (not directly contracted by PDP for the work), including NZAir. PDP has not independently verified the provided information and has relied upon it being accurate and sufficient for use by PDP in preparing the report. PDP accepts no responsibility for errors or omissions in, or the currency or sufficiency of, the provided information.

This report has been prepared by PDP on the specific instructions of Lands and Survey (South) Ltd for the limited purposes described in the report. PDP accepts no liability if the report is used for a different purpose or if it is used or relied on by any other person. Any such use or reliance will be solely at their own risk.

Yours sincerely

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