

Before Independent Commissioners Appointed by the Canterbury Regional Council and Selwyn District Council

In the matter of The Resource Management Act 1991

And

In the matter of Applications by **Fulton Hogan Limited** for all resource consents necessary to establish, operate, maintain and close an aggregate quarry (**Roydon Quarry**) between Curraghs, Dawsons, Maddisons and Jones Roads, Templeton

**SUPPLEMENTARY STATEMENT OF ROGER STEVEN CUDMORE
ON BEHALF OF FULTON HOGAN LIMITED**

AIR QUALITY

DATED: 29 JANUARY 2020

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Introduction

1. My name is Roger Steven Cudmore. I have been engaged by Fulton Hogan Limited to provide evidence on air quality management and related impact assessments associated with the proposed Roydon quarry (the Proposal).
2. I have previously provided evidence to the commissions regarding the air quality effects of the Proposal, including:
 - (a) My evidence in chief (dated 23 September 2019);
 - (b) My rebuttal evidence (dated 21 October 2019);
 - (c) My supplementary rebuttal evidence of Louise Wickham's evidence (dated 6 November 2019); and
 - (d) My summary evidence dated 13 November 2019.
3. I have been asked by Fulton Hogan to provide further supplementary evidence to this hearing in response to the following:
 - 3.1 Submitters' comment on the Yaldhurst Study;
 - 3.2 Matters raised by the commissioners during the questioning of Ms Ryan on 11 December, following the presentation of her evidence;
 - 3.3 Potential air quality effects on specific dwellings owned by Brackenridge; and

The Yaldhurst Study

4. Ms Ryan was questioned about the representativeness of ambient conditions that occurred during the Yaldhurst Study (**the Study**) and if these adequately covered worst case dust generating conditions that could occur in the future. I have considered this matter further and have re-examined ambient data during the Yaldhurst Study period (December 2017 to April 2018) against longer term meteorological records from the nearby Christchurch airport monitoring station for these months of the year. I restricted this analysis to the hours of 6 am to 6 pm each day.
5. Table 1 below provides a summary of the range of wind speed and gust speeds and other ambient parameters for the study period during daytime operational hours. These were measured by a 3 m high monitoring site located north of quarries and off West Coast Road. In Table 1 below, the study meteorological data are compared to Christchurch airport

meteorological data records for the same period as well as the last 10 years for the same months of the year and daytime period.

Table 1: Summary of range of meteorological conditions during daytime operational hours*

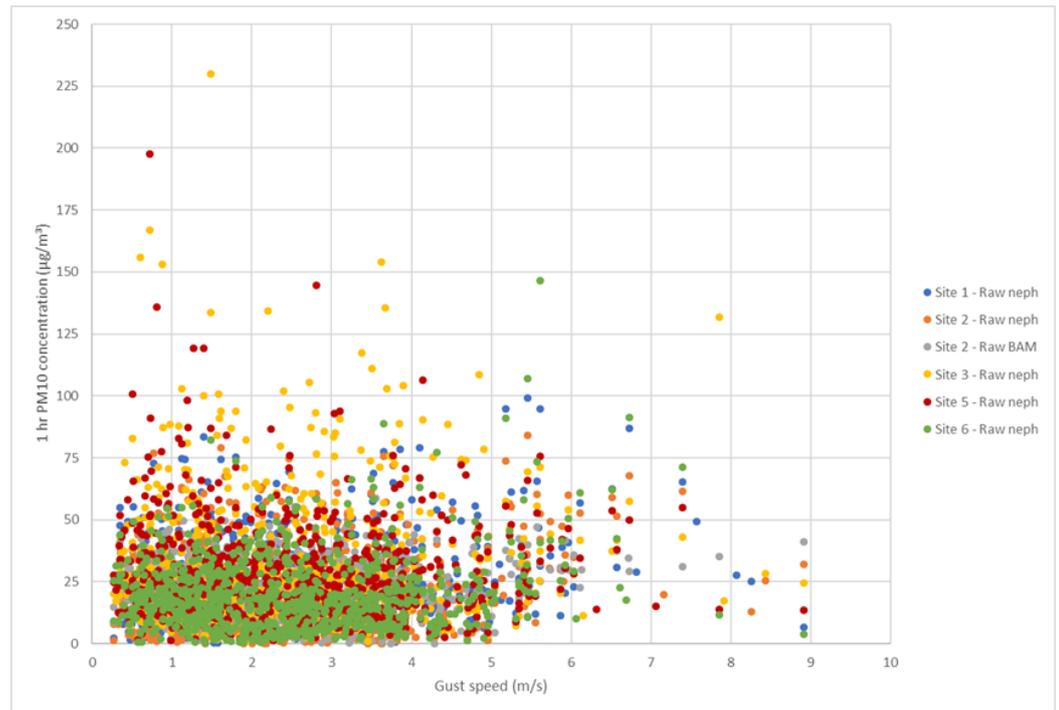
Data source	Hourly average wind speed (m/s)	Hourly gust speed (m/s)	Hourly Temp (°C)	Hourly Pressure (hPa)
Yaldhurst Quarry (December 2017 to April 2018)	0.1 to 5.3, (average 1.6)	0.2 to 8.9 (average 3.0)	-0.9 to 34 (average 17.2)	966 to 1018 (average 1003.3)
Christchurch Airport (December 2017 to April 2018)	0.31 to 14 (average 4.97)	0.82 to 22.3 (average 8)	5.5 to 33.8 (average 19)	975 to 1026.1 (average 1011.3)
Christchurch Airport (December to April from 2010 to 2019, inclusive)	0 to 16.46 (average 4.96)	0 to 27 (average 8)	-2.3 to 35.5 (average 17)	975 to 1040 (average 1014)

Note: The table accounts for meteorological conditions at daytime operational hours (6 am to 6 pm).

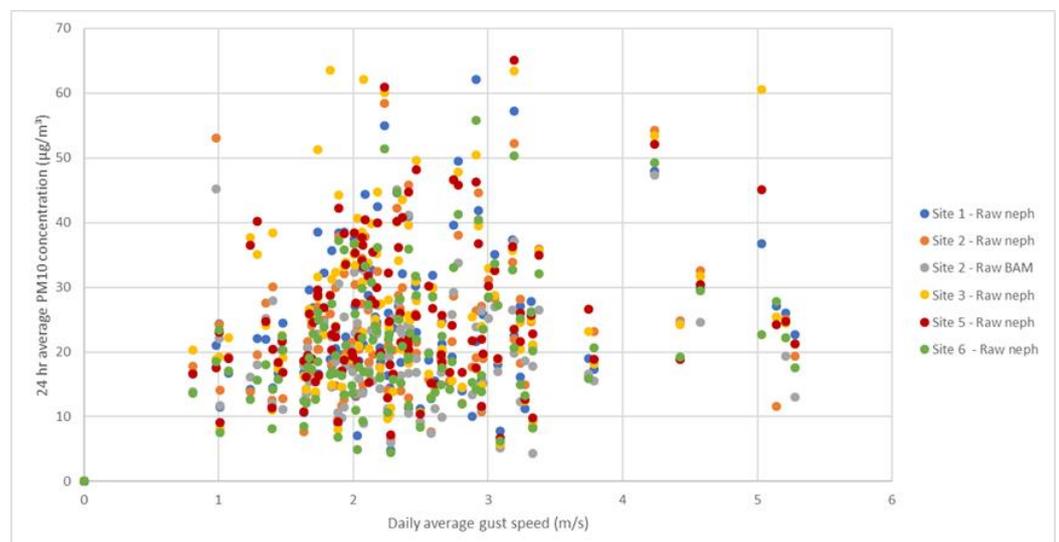
6. Christchurch airport meteorological records during 2017-2018 study period are consistent with the previous 10 years of data for the same times of year and day (therefore encompassing the times of year where the potential for dust is highest). I consider that the lower wind and gust speeds measured at the Yaldhurst site compared to the airport site (shown in Table 1) can be explained by the site's lower met-station mast height compared to the airport met station mast (3 m versus 10 m) and also the sheltering of the site by surrounding tree shelter belts.
7. Therefore, I conclude that the Yaldhurst quarry sites during the study period would have experienced the normal range of wind speeds and temperatures that has occurred historically at these sites during the driest period of the year. Other periods of the year are less prone to dust generation than the December to April period. This includes the normal frequency of strong wind conditions during the dry summer period.
8. The advent of future climate changes may result in more severe wind events, but as explained below, this does not detract from the reliability of the study data set for assessing potential 24 hour PM₁₀ impacts within the Christchurch airshed boundary as a result of the proposed Roydon Quarry.
9. This is because strong wind events do not correspond to worst case off-site PM₁₀ impacts, or even worst-case background levels of PM₁₀ at the Yaldhurst quarry site. The same outcome is very likely to hold for the Proposal.
10. The highest background 24 hour PM₁₀ concentration measured during the study of 47 µg/m³, was associated with a warm day that was dominated by light north east winds (measured on the 15 January 2018 and upwind of the Yaldhurst quarry area). The likely source of this event was working of

farmland, which I discuss in paragraph 25 of my evidence in chief (dated 23 September 2019). Furthermore, the highest background 24 hour concentration recorded at the Roydon control site of $45 \mu\text{g}/\text{m}^3$, was confirmed to occur when ploughing of farmland was occurring.

11. The figure below provides plots of *maximum hourly wind gust speed* (m/s) versus measured *hourly PM_{10} concentrations* (measured downwind) at key monitoring sites during the study.



12. This next figure is similar to the above, but instead plots *average daily wind gust speed* (m/s) versus measured *24 hour PM_{10} concentrations* at key monitoring sites during the study.



13. These two figures above highlight that during the study period, higher wind gust speeds within an hour, or the average gust speeds for a particular day, did not correspond to higher downwind hourly, or 24 hourly PM₁₀ concentrations. While on some days, hourly results indicate increasing hourly PM₁₀ levels with increasing wind speed, the overall results do not produce this relationship.
14. The actual gust speeds within the quarry area itself would have been much higher than indicated on the above figures (based on airport wind records at the time that are more reliable regarding the actual wind speed) for a corresponding measured PM₁₀ concentration, but the flat response in measured concentrations with increasing wind speed would be unchanged.
15. Part of the reason for higher wind speeds not relating to higher PM₁₀ concentrations, is that the main sources of PM₁₀ emission are related to vehicle movements and processing of aggregate rather than wind erosion of dust from unpaved areas. These main sources of PM₁₀ emission (not related to erosion) would cause worst case offsite PM₁₀ impacts during low to moderate wind conditions, rather than the higher wind speeds – this is because higher wind speeds will cause the dispersing dust emissions to dilute rapidly with distance from the source.
16. Table 1 of the 9 December 2019 air quality joint witness statement (**JWS**) further demonstrates that wind erosion is expected to be a relatively minor source of PM₁₀ at the Roydon quarry compared to other sources that are influenced by wind speed.
17. Another important factor is that the Roydon quarry design would drastically minimise the inventory of PM₁₀ which would be available for strong wind events to erode and discharge to air over a number of hours. In particular the use of sealed roads, the conveyor as the primary means to transfer excavated materials, and reject gravel for low use internal access routes would drastically reduce the generation of a PM₁₀ inventory over time (due to abrasive tyre forces), compared to conventional quarry sites.
18. It appears most likely that lighter wind conditions on warm dry days create the greater potential for worst-case off-site PM₁₀ concentrations and these were fully represented within meteorological conditions experienced during the study.

19. Therefore, while occasional wind conditions in the future could possibly be stronger than those which occurred during the study, this is not a significant deficiency in the study dataset – the study period clearly covered a full range of wind conditions at the site including those that typically cause the highest off-site concentrations of PM₁₀. Therefore, I consider that worst case conditions as well as strong wind events would have been adequately captured during the study. Furthermore, the advent of stronger wind events in the future is not a significant concern with respect to the ability of the Proposal to meet the requirements of section 17(1) of the NES.
20. As such the study data set provides a representative range of ambient PM₁₀ impacts from the Yaldhurst quarries. This dataset therefore provide a reliable basis to assess the Proposal's ability to comply with Regulation 17(1) of the NES.
21. Irrespective of my above views on worst case conditions for the Proposal (in terms of PM₁₀ effects off-site), I consider that where there are large inventories of built-up PM₁₀ (e.g. silt deposits within riverbeds, quarries, road surfaces) that higher wind speeds and dry conditions are likely to cause relatively high PM₁₀ emissions and effects downwind.
22. Also, I consider that the low to moderate wind speeds (that cause worst-case PM₁₀ impacts) are not likely to cause worse case impacts for larger particulates (TSP) – that is the fraction which readily forms visible deposits on surfaces. Instead, this form of dust nuisance is likely to be associated with stronger winds which are necessary to mobilise these heavier particles. The study did not monitor this fraction, but only PM₁₀ which does not settle readily.
23. Submitters have expressed concern that the study was not scientific or transparent. However, with respect to ambient PM₁₀ impacts from the quarrying of alluvial gravels, I consider the study was undertaken using appropriate locations and robust continuous monitoring methods. I am not aware of any similar available documented studies world-wide of ambient PM₁₀ impacts resulting from alluvial gravel quarry activities, which are as transparent, or as comprehensive as this study. I doubt very much that any similar studies exist which are as comprehensive in terms of quantifying the ambient PM₁₀ effects off site.
24. While the study was limited to a 4-month summer period, this period captured a typical range of meteorological conditions that occurred historically.

Furthermore, it is clear that the frequent occurrence of low to moderate wind conditions on warm summer days were captured by the study and these appear to be associated with worst case conditions for incremental ambient PM₁₀ effects off site.

25. Whilst climate change can be expected to cause longer drought periods, more extreme flooding events and possibly more frequent and severe northwest winds in Canterbury, it would be incorrect to assume that the outcome would be an increased potential for increasing worst-case daily average PM₁₀ impacts from the Proposal. There is clearly a science-based reason for this outcome that I explained above.
26. Ms Ryan was also asked if the Roydon site was in fact a good control site for the study. Specifically, would the study site at Yaldhurst have caused the high levels of PM₁₀ measured at the Roydon site in January 2018 (45 µg/m³ 24 hour average). I concur with Ms Ryan, that a similarly high value measured at the study site was from a source to the north of the site. Ms Ryan suggested river-bed related emissions as a possibility - my view on the source is discussed in paragraph 9.
27. Finally, with respect to concerns regarding rainfall during the study, I reiterate my view that the high rainfall event that occurred during the study (due to Cyclone Gita hitting New Zealand in 2018) is not likely to have resulted in atypically low ambient PM₁₀ levels compared to other years. It is very likely that the prevalence of dry conditions within the quarries during the study would have been typical of other summer periods at the site – there is no science based rationale for arguing otherwise in my view. I refer the commissioners to paragraphs 34 to 36 of my supplementary rebuttal evidence of Louise Wickham's evidence (dated 6 November 2019).

Other Relevant Studies

28. Ms Ryan was questioned about the significance of other relatively recent studies (focused on RCS) that have been raised by submitters. I have reviewed the short term RCS exposure study that was commissioned by the Canterbury Regional Council and the results reported by Chemsafety.^{1,2,3.}

¹ Chemsafety, (2017). *Quarry Dust Residential Exposure Assessment. 1 – 25 August 2017*. Prepared for Environment Canterbury by Bridgett Jennings and Sam McGee. Christchurch. October. Report 10 version 1 Public copy.

² Chemsafety, (2018). *Quarry Dust Residential Exposure Assessment – Post Cleaning. 25 & 27 January 2018*. Prepared for Environment Canterbury by Bridgett Jennings and Sam McGee. Christchurch. March. Report 5 version 2 Public copy.

These studies were discussed in paragraphs 77 and 78 of Ms Wickham's evidence dated 17 October 2019.

29. These reports are based on personal monitoring of individuals when residents were within and around their private properties. I understand these are the studies which Ms Ryan had discounted based on the international peer review findings of these being inconclusive.
30. The reports indicate that monitoring occurred on 1 - 25 August 2017, 25 - 27 January 2018 and 9 - 27 March 2018. Therefore, mostly overlapping in time with the Yaldhurst quarry study.
31. The reports do not fully document location of properties or the activities and movements of individuals during the monitoring. Although, it was reported for the January 2018 monitoring that the individual did some office/computer work, tidied up their garage, did some sweeping, and some gardening activities. Also, from Ms Wickham's evidence it is apparent that some of the properties were probably located off the West Coast Road – this runs along the northern boundary of the quarry sites.
32. I refer the commissioners to my comments in paragraph 9 regarding high background ambient PM₁₀ on the 15 January 2018. This appears to have resulted from an agricultural activity north of the Yaldhurst quarry area. I consider it reasonable to assume that properties off the West Coast Road can be exposed to quarry derived dust during cold southerlies and dust from surrounding agricultural land during warm north easterlies - that are frequent in summer.
33. As such, I agree with the international peer review that the results of these studies are inconclusive. I do not consider the source of measured RCS could be reliably established from the study design, or if the elevated short-term exposures to RCS that were measured at a few properties are atypical, or not, of normal exposure to RCS that occurs during activities such as vacuuming and sweeping.

PM₁₀ Emission Calculations

34. Ms Ryan was asked if the emission reduction factors that I have used in my calculations - as result of using reject gravel material for access roads (84%)

³ Chemsafety, (2018b). *Quarry Dust Residential Exposure Assessment 9 – 27 March 2018*. Prepared for Environment Canterbury by Bridgett Jennings and Sam McGee. Christchurch. May. Report 9 version 2 Public copy.

and water suppression (70%) - were accepted. Furthermore, if the overall reduction by 95% was based in science.

35. I have reflected on those figures and confirm that, in my view, they are conservative assumptions and their scientific basis is embodied within accepted emission factor equations. Because the silt content of reject gravel material is very low, it is reasonable to increase the 84% reduction factor for use of this material, to 99% assuming there is regular replenishment of access roads with fresh material. With regular replenishment, the need for watering of access roads can effectively be eliminated and any PM₁₀ emissions will be insignificant. Nonetheless, all of my calculations have been done on the more conservative basis of an 84% reduction.
36. Ms Ryan was questioned regarding the differences in PM₁₀ emission estimates between myself and Ms Wickham. In particular, if the decision to operate the mobile crusher no closer than 500 m of the airshed boundary means that Ms Wickham's assumption of greater travel distances for trucks was likely to be more valid. I consider, if anything, that operation of the mobile crushing plant at or beyond 500 m of the airshed boundary, further ensures that my assumption of return travel distances being 250 m is correct. My experience is that mobile crushing plant are only operated adjacent or very close to the area where aggregates are excavated from (around 100 m or less) and typically are fed directly from the loader that is excavating aggregates. I consider that situations whereby trucks would be used at the site to transport excavated aggregate to the mobile crushing plant for return distances greater than 250 m would be rare.
37. From the 2nd JWS it can be seen that one of the main reasons for Ms Wickham's higher emission estimates compared to mine are also due to her (and Mr Kirby) not accepting my use of the reduction factors to achieve a conservative 95% reduction in PM₁₀ from access road, as discussed above in paragraph 33. Nor does she accept the use of the 70% reduction when applied to aggregate unloading operations. These are outlined in Appendix A of the 9 December JWS.
38. Ms Ryan was questioned regarding the robustness of the long-term exposure limit for RCS of 3 µg/m³ (annual average). The question was whether the long travel distance of fine particulate (such as from the Australian bush fires) and cumulative exposure to these particles mean that the criterion is not robust, or not. The simple answer is that the travel distance and persistence

of PM₁₀ and its much finer sub fractions within the atmosphere, are what create the concentrations that are regulated.

39. However the validity of the safe annual exposure concentration has nothing to do with the particle's previous life time within the atmosphere - the fact that particles can persist within the atmosphere and transport for thousands of kilometres just makes the background level higher and achieving the cumulative concentration limit more difficult. Ms Wagenaar can further explain as necessary, but in my view, the robustness of the annual RCS criterion has no relationship to the extent of particle transport distances.
40. Ms Ryan was also questioned about the assumption of 50% of the total extracted aggregate being crushed, if this was critical to the emission calculations and requiring an associated consent condition. In my opinion this is not actually the most critical assumption regarding the assessed PM₁₀ emissions from the processing plant, but I agree it was one of the assumptions. Instead, the restriction on processed product types (nothing finer than AP20) is the critical assumption that markedly affects the annual PM₁₀ emissions from the processing plant and therefore the site overall.

Potential Effects upon Brackenridge Properties

41. I have been asked to provide comment on the potential for air quality related effects from the proposal upon two houses in Templeton that are owned by Brackenridge Estates. I am aware of the locations of these houses and confirm that they are more than 700 m from the Roydon Quarry site and within the Templeton township.
42. In the first JWS (dated 14 November) I and fellow air quality experts agreed that there would be "negligible health effects due to PM₁₀ at the Templeton township (700 m from proposal boundary)". My view on health effects follows on from my view that air quality effects of the Proposal in Templeton are likely to be negligible. I have not changed my position on this matter and the assessment of negligible health effects applies to the people living at the aforementioned residential properties.

Reduction Factor

43. Ms Ryan was questioned on her analysis of the range of reduction factors that could apply to the incremental PM₁₀ impacts at Yaldhurst so to assess the likely effects from the Proposal. I agree with Ms Ryan's approach of inferring the reduction factor directly from the emissions reduction factor that,

in turn, is inferred from Table 1 of the 9 December JWS. I have followed the same approach as Ms Ryan for my assessment of the reduction factor.

44. I clarify that I have never intended to state – in evidence or the JWSs – that the reduction factor is exactly 10. From the outset I surmised that a reduction of at least 10 would be required to satisfy Regulation 17 of the NES. I then proceeded to analyse what reduction factor could be reasonably calculated for Roydon. My conclusion and subsequent evidence was that a reduction factor of at least 10 could appropriately be applied. In reality, the proportional reduction factor I derive from dividing the Yaldhurst PM₁₀ emission estimates by the Roydon PM₁₀ emission estimates, far exceeds 10 in both my primary evidence and my later calculations in the second JWS.
45. My and Ms Ryan's approach differs from the method Ms Wickham, and to some extent Mr Kirkby, used to arrive at an overall reduction factor.
46. Ms Wickham and Mr Kirkby produce an overall estimated reduction factor by introducing a further arbitrary reduction to their estimated PM₁₀ emissions-based reduction factor (Roydon versus Yaldhurst quarries). Their additional reduction to their emissions-based reduction factor second has no scientific/engineering basis –I cannot understand the basis for it and in my view it is not justified.
47. The arbitrariness of this approach is highlighted by Ms Wickham original recommendation of a 5 to 7 overall reduction, based on a 5 tonne/year PM₁₀ emission estimate for the Proposal. An unaltered overall reduction factor is recommended by Ms Wickham in the December JWS despite her estimated annual PM₁₀ emission for the Proposal reducing down to 2.9 tonne.
48. Therefore, in my opinion the overall reduction factors recommended by Ms Wickham have a significant level of arbitrariness, which maintains her position that regulation 17(1) of the NES cannot be complied with – despite her estimated emissions of PM₁₀ from Roydon decreasing by around 40%. In my view this degree of arbitrariness is no appropriate, particularly when the outcome is to trigger decline of consent or an offset being designed.

Roger Cudmore

29 January 2020