ATTACHMENT A – QUALIFICATIONS AND EXPERIENCE

ATTACHMENT A

Qualifications and Experience

Evidence of Roger Cudmore

QUALIFICATIONS AND EXPERIENCE

I am an experienced air quality & wastewater consulting engineer with 26 years of professional experience working on both New Zealand and international air quality projects. I graduated from the University of Canterbury in 1986 with an honours degree in Chemical & Process Engineering. For many years, I have been routinely engaged by Fonterra, Alliance, Ravensdown, Lowe Corp, Solid Energy and other industries as well as regulatory organisations to provided air quality management advice and expert testimony. This has involved both Environment Court and council hearings since the early days of the Resource Management Act 1991 and with respect to air quality management matters. These have largely involved the consideration of health and nuisance effects of air emissions and their effective mitigation via engineering and management systems and consent conditions. Over the years I have had to worked very closely with professionals in environmental law & planning, human health, toxicology related air quality effects and have gained a wide knowledge of air quality regulation and management in New Zealand and internationally.

My professional affiliations and positions including the following:

- Corporate Member of the Clean Air Society of Australia and New Zealand (**CASANZ**)
- CASANZ Certified Air Quality Professional
- Past NZ Branch Chairman of CASANZ
- Past Chair of the CASANZ Odour Special Interest Group
- Resource Management Law Association of NZ (**RMLA**)
- Leader of the RMLA Air Quality Knowledge Hub

REGULATORY SECTOR

I have undertaken a number of air quality management related projects and acted an expert witness for the regulatory sector since the early 1990s. This has involved audits of consent applications for industrial and commercial processes on behalf of various Regional Councils, airshed air quality modelling, research of literature, and providing expert testimony to the Environment Court on behalf of the Canterbury Regional Council. Examples are listed below.

- **Environment Canterbury (2017):** Audit of odour effects assessment prepared for Canterbury Landscape composting facility, Rangiora.
- **Wellington Regional Council (2015-2017):** Audit of AEE, provide expert evidence regarding odour effects from the Taylor Preston Abattoir, Wellington.
- **Waikato Regional Council (2013):** Audit of AEE for Cresta Mushrooms air discharge consent variation for Waikato Regional Council (2013).

- **Greater Wellington Regional Council and the NZ Environmental Protection Agency (2011).** Audit of air quality effects assessment for the Transmission Gully By-Pass.

- **Canterbury Regional Council (2010):** Investigation of air quality effects research due to urban outdoor burning practices and presentation of expert testimony at plan change hearing.

- **Canterbury Regional Council (2007/08):** Technical lead of airshed modelling of transport, industry and domestic sector emissions for the city of Christchurch.

- **Canterbury Regional Council (2008):** Presentation of expert testimony to the Environment Court in respect to appeals against the Canterbury Natural Resources Regional Plan - Air Section.

- **Auckland Council (2007).** Audit of air quality health risk assessment due to contamination under a super market complex in the North Shore for the

- **Ministry for the Environment (2005):** Audit of dioxin air emission controls employed for the the remediation of the contaminated Mapua site, Tasman District.

- **Ministry for the Environment (2002):** Prepare Technical Report 24 for MfE with respect to Good Practice Odour Management and Assessment tools (MfE Technical Report 24).

- **Ministry for the Environment (2002):** MfE review panel member for the development of the up-dated ambient air quality guidelines (2002) and good practice guide for atmospheric dispersion modelling.

- **Canterbury Regional Council (2001):** Hearings commissioner for an application for air discharges from the Christchurch Airport Engine Testing Facility.

- **Canterbury Regional Council (1997/98):** Preparation of technical reports regarding outside burning practices and odour management to assist in the preparation of the Canterbury Regional Plan - Air Chapter.

- **Canterbury Regional Council (1991- 1997):** Audit of AEE's and provide expert testimony regarding air and odour emissions with respect to Christchurch City Council Boilers, Alpine Dairy Milk Processing - Clandeboye, South Canterbury By-Products, Timaru, Canterbury Malting Ltd - Christchurch, Canterbury Meat Packers - Ashburton.

- **Ministry for the Environment (1991/92):** Prepare report for MfE on use of olfactometry for regulation of environmental odours in NZ: Odour Nuisance Control: Recommendations to the Ministry for the Environment", Agricultural Engineering Institute Report 2496/1, New Zealand (1994).

EXPERT TESTIMONY

With regards to expert testimony provided to the Environment Court or Air Plan Hearing Commissioners, examples include the following:

- Expert air quality evidence to the Court (2018 and 2019) regarding odour and health risk associated with the Taranaki's petroleum exploration and processing industry. ENV-2016-WLG-000071.

- Expert air quality evidence to the Court (2018) regarding odour and dust effects and management associated with the Horowhenua Landfill, Levin. ENV-2016-WLG-000080.

- Expert air quality evidence to the Waikato Regional Council regarding a proposed 360 Megawatt electrical (MWe), Otorohanga. Nova Energy Ltd. (2017)

- Expert air quality evidence to the Court regarding odour and health risk associated with the proposed spray irrigation of treated municipal effluent from the Foxton wastewater treatment plant. ENV-2016-WLG-000026. 2016

- Expert air quality evidence to the Proposed Canterbury Air Regional Plan, Policies and Rules with respect to air quality management. Fonterra and Ravensdown, 2015/16.

- Expert air quality evidence to policies and rules within the Southland Regional Air Plan – Stage 1 ("Proposed Air Plan"). Fonterra, 2015.

- Expert air quality evidence to the Proposed Auckland Unitary Plan Hearings for Topic 035 regarding proposed use of World Health Guidelines for Air Quality. NZ Starch, 2015.

- Expert air quality evidence to the Court regarding reverse sensitivity effects of residential development opposite the Belfast Industrial Zone. Lowe Corporation, 2011.

- Expert air quality evidence to the Court regarding sulphur dioxide (SO_2) effects and associated modelling from an acid manufacturing plant. Ravensdown Fertiliser, 2010.

- Expert evidence to the Court regarding construction dust effects from the construction the extended Marlborough District Hydro-scheme. Main Power, 2009.

- Expert evidence to the Court regarding construction dust effects from the construction Mahinerangi Wind Farm, Dunedin. Trust Power, 2008.

- Expert air quality evidence to the Court regarding the Appealed Canterbury Regional Air Plan. Canterbury Regional Council, 2009.

- Expert air quality testimony to the Court regarding odour effects from an existing mushroom compost. NZ Mushrooms Ltd. 2007.

- Expert air quality testimony to the Court regarding an appeal of the Selwyn District planning rules for intensive piggery expansions. NZ Pork Board vs Selwyn District Council. 2006.

- Expert testimony to the Court regarding nuisance odour effects from a proposed chicken growing operation. Environment Court Decision (Canterbury Regional Council v M & D Rickerby C/2002). For MJ & DT Rickerby. 2002 – 2005.

- Expert air quality evidence to the Court regarding the appeal of the air permit term as granted by Environment Southland (2002). For Alliance Group Limited. 2002.

- Expert evidence to the Court regarding dust nuisance effects from a peat harvesting operation. Environment Court Decision (Ravensdown Growing Media Limited v Southland Regional Council C194/2000). For Ravensdown Growing Media Ltd. 1997 / 98.

- Provided expert evidence to the Court odour nuisance an regarding injunction applied for by Green-McCarghill against the continued operation of the Rosedale Landfill, Northshore City.

- Provided expert evidence given to the Court regarding odour effects from the AFFCO Imlay rendering plant. 1997.

ENVIRONMENTAL IMPACT ASSESSMENT - AIR QUALITY

I have completed numerous environmental impact assessments (**EIAs**) mainly in support of resource consent applications or other similar licenses overseas. The EIAs have covered a wide range of sectors including transport, industrial, manufacturing and mining sectors. These assessments have been largely based on atmospheric modelling of emissions from industrial stack discharges involving common and hazardous pollutants. Industrial activities have involved large coal-fired and gas-fired energy plants (NZ, New Guinea), industrial and municipal incinerators (Singapore), kraft and mechanical pulp & paper mills (NZ), cement manufacture, mineral processing (Armenia Bulgaria, Fiji and NZ), fertiliser, food and manufacturing and other chemical & process industries (NZ).

I have been the technical lead for a number of airshed air quality assessments that account for emissions from the domestic, industry and transport sectors with urban areas. This involved the use and analysis of air emission inventory, airshed modelling and source apportionment investigations. These projects have were undertaken for both regulatory and private sector clients for the Christchurch, Nelson and Dunedin City Airsheds.

PROJECT EXAMPLES

NZ Transport Agency (2019): Technical lead for assessment of ambient dust effects associated with the construction of the northern motorway improvement project expansion (Auckland) and construction of a new bus station at Rosedale including reverse sensitivity effects.

West Connex, Sydney (2018): Technical lead for the assessment of PM_{10}, air toxins and civil aviation plume-rise effects associated ventilation of tunnel air from the Rozelle Interchange, Sydney.

North Power Ltd (2018): Assessment of dust exposure, monitoring programme design and health risk for maintenance crews working on Transpower owned power transmission pylons.

Air New Zealand (2015-2017): Assessment of worker health risk associated with fugitive aircraft engine emissions at Christchurch Airport.

Horowhenua District Council (2016/17): Assessment of regional landfill odour effects and compliance of mitigation with good practice.

AFFCO NZ Ltd (2016/17): Assessment of odour and boiler discharge effects and recommendations for upgrade of odour control systems for rendering and wastewater treatment facility. Provide expert testimony to air discharge hearing, Whanganui.

Veolia New Zealand (2016): Review and recommendations for improved management of biofilter systems and associated air consent conditions for Wellington City's municipal sludge dewatering facility at Carey's Gully, Brooklyn, Wellington.

Z Energy (2015/16): Assessment of health risk and odour effects beyond the boundary of kiwi fruit orchards from standard agrichemical spraying practices in the Bay of Plenty. Based on spray drift modelling and ambient monitoring.

NZ Starch (2015): Provide expert testimony to the Auckland Unitary Plan and Southland Regional Plan hearings with respect the use of Ministry for the Environment and World Health Air Quality Guidelines.

Gelita (NZ) (2015): Assessment of odour effects and recommendations for upgrade of odour control systems for hide storage and gelatine production facility. Provide expert testimony to air discharge hearing, Christchurch.

Nova Energy (2011 - 2016): Air quality impact assessment for 150 MW gas-fired power generation two plants in the Taranaki region (McKee and Junction Road) and a 360 MWe plant in the southern Waikato, Otorohanga.

Alliance Group Ltd (2008 - 2016). Technical lead and presentation for BPO/technology reviews and modelling based assessments of air quality and nuisance effects associated with air discharges from the Alliance Stockburn, Levin, Pukeuri and Lorneville meat processing plants. Processes include coal-fired boilers, rendering, hide processing, wastewater treatment, composting and land irrigation of treated wastewater.

NZ Transport Agency (2014): Technical review of reports regarding validation of the vehicle emission model (VEPM) and for the assessment of air quality effects from the proposed West Belfast By-Pass, Christchurch.

NZ Transport Agency (2014): Team member for the research project, Understanding Vehicle Emission trends in New Zealand.

SembCorp, Singapore (2013 - 2014): Air dispersion modelling based assessment of a proposed 1000 tons/day municipal waste to energy incineration plant for Jurang Island, Singapore.

Exxon Mobil (2013): Review of odour assessments prepared for rehabilitation of old tank farmland at Auckland Port and assisted in resolving an appeal to the Environment Court regarding odour mitigation measures imposed by the Auckland Council.

Solid Energy Renewable Fuels (2005 - 2012): Assessment of waste wood drying and processing for pellet production.

Ravensdown Co-operative Group (2003 - 2011): Completing air quality assessments for fluoride, SO2, PM_{10} and total acidic discharge (H2SO2 equiv) Acidic discharge and fluoride emissions were assessed for potential damage to commercial crops and vegetation. Identified acidic discharges as cause of observed vegetation damage as opposed to the convention view that fluoride was responsible. Specified measures for mitigation of crop effects due to acidic discharges to air.

Oceania Gold (2010): Technical review of pressure oxidation plant emissions modelling for the Macraes Flat site, Otago.

Fonterra Edendale (1997-2010). Provided air consultancy services to the Edendale dairy factory site since late 1990s to support the progressive site expansions including the assessment of existing coal-fired boilers. Work included recommended mitigation strategies to minimise ambient SO2 impacts soot problems, validation of complex dispersion model tools at the site as part of a government funded FRST research programme and prepared annual air quality monitoring reports.

Namosi Joint Venture (2009): Project direction and technical review of an assessment of air quality, dust and greenhouse gases as part of the Waisoi Project Pre-feasibility Stage Environmental and Social Impact Assessment (ESIA) study.

Solid Energy NZ Ltd (2009): Assessment of air quality effects due to a proposed coal mine air shaft emissions from the Huntley Coal Mine.

Trust Power (2008 - 2009): EIA of air quality effects (construction dust) and expert testimony the Regional Council and Environment Court hearings for the Mahinerangi Wind Farm, Otago.

Trust Power (2008 - 2009): Assessment of air quality effects (construction dust) and expert testimony the Environment Court for a large-scale hydropower schemes on the Arnold River (West Coast) and Waiou River Marlborough.

Solid Energy NZ Ltd (2004 - 2008): The assessment of air emissions from domestic heating (including wood pellet fires), industry and the vehicle sectors within a number of South Island Cities including Christchurch, Nelson and Dunedin. Work has included reviewing emission inventories, complex modelling, expert testimony and assistance with successful mediation talks.

New Zealand Industry Group, (2008): Co-authored a technical review recent and historical research investigations that have been cited by the WHO 2005 in developing their recommended guideline for 24-hr SO2.

Fonterra (1997 - 2009): Prepare modelling based assessment of air emissions at the Clandeboye dairy factory using complex modelling of air emissions using TAMP and CALMET and CALPUFF to assess impacts on flat terrain where inversion fumigation events. This was to support the progressive site expansions including new coal fired energy plants and powder plants. Work included recommending emissions mitigation measures, manage the implementation of the site's air quality monitoring programme preparing annual reports to Environment Canterbury. Also included design and installation of a biofilter for treating wastewater tank odours and presentation of expert testimonies to various Regional and District Council Hearing committees.

Genesis Energy (2007 - 2008): New Plymouth: Assessment of air contaminant and dust emissions on human health for a proposed new LNG Terminal including modelling of air discharges from the New Plymouth Power Station (Gasbridge).

Deno Gold Mining Company (2007): Project direction and technical review of baseline survey of ambient dust and contributions from the gold mining and ore processing operation in township of Kapan, Republic of Armenia.

Fonterra / Genesis Energy (2006 - 2007): Site assistance (then NZDG) in applying for a variation to existing air permit conditions for the operation of the gas-fired cogeneration plant at Te Awamutu while allowing for an increased NOx discharge.

Dundee Precious Metals Inc. (2006 - 2007). Project director and technical review for the assessment of fine dust emission rates and potential effects from an existing mine and proposed expansion in Chelopech, Bulgaria.

NZ Refinery Company (2006 - 2007): Assessment of cumulative sulphur dioxide emission impacts using complex modelling due to the New Zealand Oil Refinery at Marsden Point and proposed re-firing of the Marsden B Power station. Submissions to Marsden B consent hearings and the variations to the Northland Regional Plan.

Fonterra (2006): Prepared an assessment of effects reports for boiler discharges at the Marlborough and Brightwater sites (Nelson).

Contact Energy (2005): Combustion emissions assessment and dispersion modelling of air quality effects of a confidential coal-fired power station proposal in the North Island of New Zealand.

Fonterra (2004): Prepared an assessment of effects report to assist with the process plant being re-commissioned and including a new powder plant water scrubber at Morrinsville, Waikato.

NZ Aluminium Smelters, Te Wai Point, (2004): Combustion emissions assessment and dispersion modelling of air quality effects of a confidential coal-fired power station proposal in the North Island of New Zealand.

Fonterra Whareroa, Taranaki (2003 - 2004): Assessed air emissions from a proposed new 250 MW coal-fired co-generation plant. Including the selection of the appropriate site, combustion calculations and emissions quantification, complex modelling of air emissions CALMET / CALPUFF and assessment of mitigation options to minimise particulate and SO2 impacts. Presentation of expert testimony to the Environment Court in regards to CO2 emissions and the potential corrosion effects due to SOx emissions to air.

Holcim New Zealand (2003): Complex modelling and assessment of dioxins, metal and general priority pollutant effects due to kiln emissions and use of alternative fuels.

Tasman Pulp Mill (2000) and Carter Holt Harvey (2003): Management of community wide environmental surveys for both Kinleith and Tasman Pulp Mill sites. Dispersion modelling assessment of pulp mill air emissions.

Carter Holt Harvey Kinleith & Kawerau. (1997, 2001, 2003): Technical expert for mediation talks regarding the appeal of air permit conditions by CHHL for their Kinleith site, as granted by Environment Waikato (Completed 1999).

Oceania Gold NZ (Macraes) (2002): Assessment of pressured oxidation plant emissions technology at the Reefton gold mine site.

New Zealand Industry Group, (2000): Prepared an Odour Management Report that was hosted by MfE's that was the original technical report utilised by the MfE Technical Report no. 24 (2002) and the current MfE odour guidelines (2003).

Kanudi Power Station, Papua New Guinea (1998): Assessment of air quality effects arising from diesel and gas firing.

Weyerhaeuser NZ Inc. (1997 - 1998): Provide air quality assessments for proposed green field site and existing wood processing sites.

Tranz Rail (1997): Preparation of ambient dust impact assessment associated with the Clarence River rock extraction, stockpiling and rail transport for the proposed ferry terminal at Cifford Bay, Seddon. Presentation of expert testimony on ambient effects,

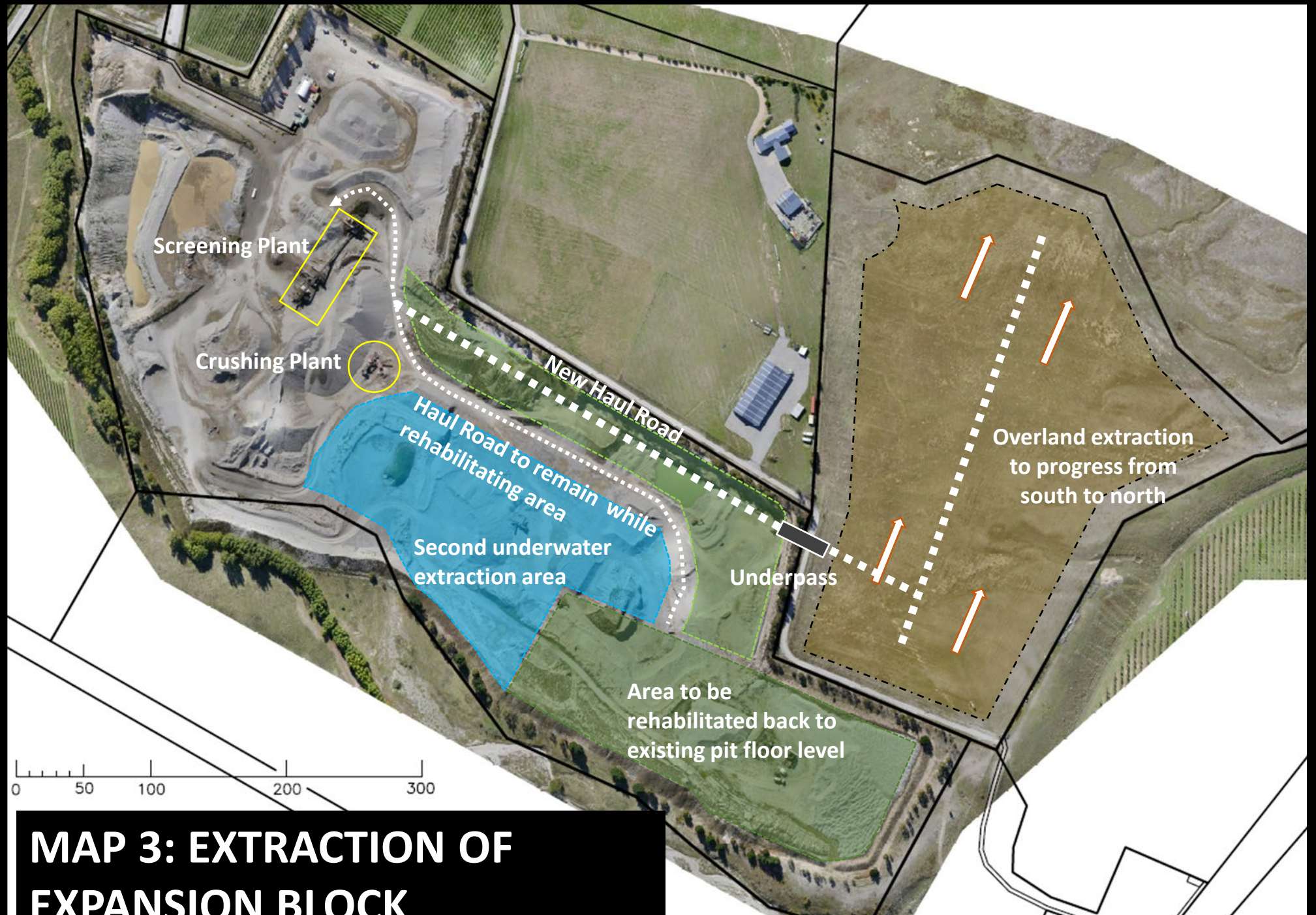
dust mitigation measures and daily dust suppression water demands, at the CRC hearing for resource consent applications.

International Wools Services Ltd (1996): Air dispersion modelling based assessment of the LEMAR sludge incinerator operated at Kaputone Woolscour, Belfast and presentation of evidence to CRC hearing.

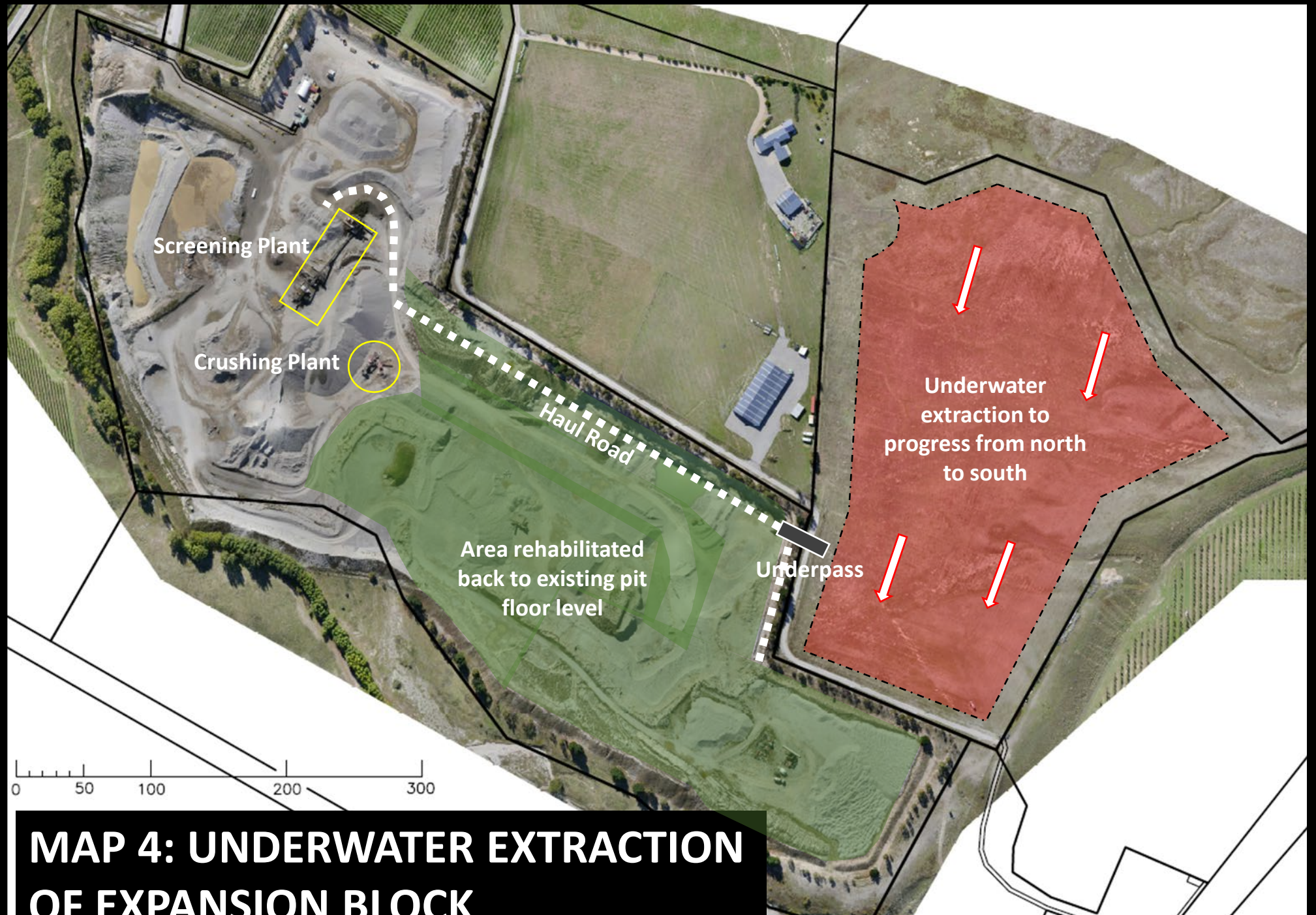
ATTACHMENT B – MINE PLAN

MAP 1: EXISTING LAYOUT

MAP 2: UNDERWATER EXTRACTION

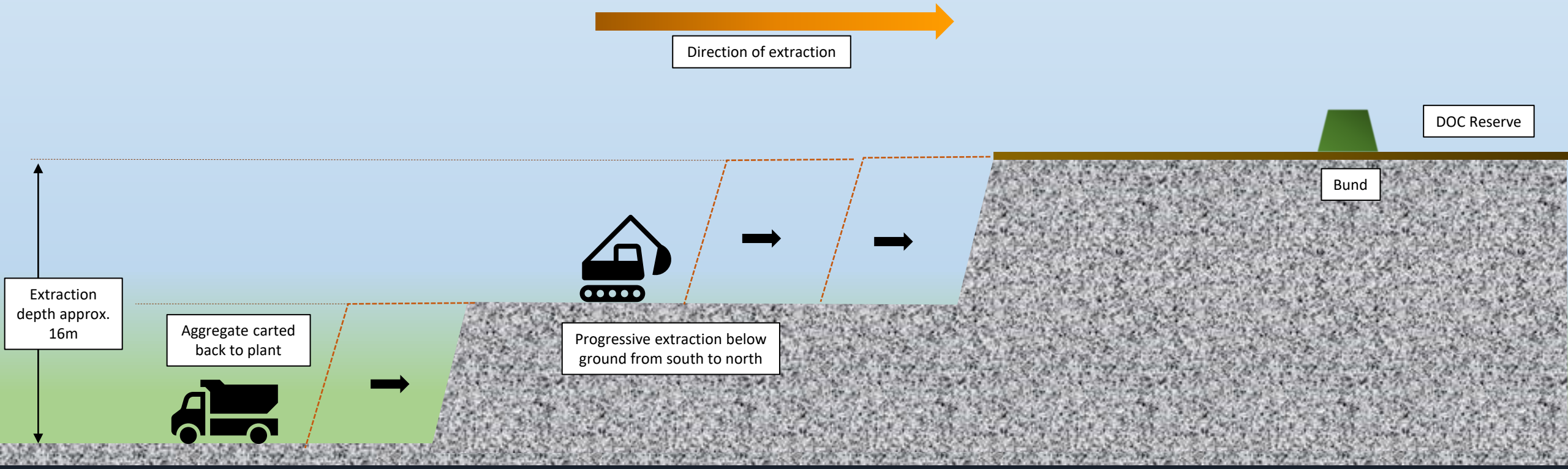


MAP 3: EXTRACTION OF EXPANSION BLOCK

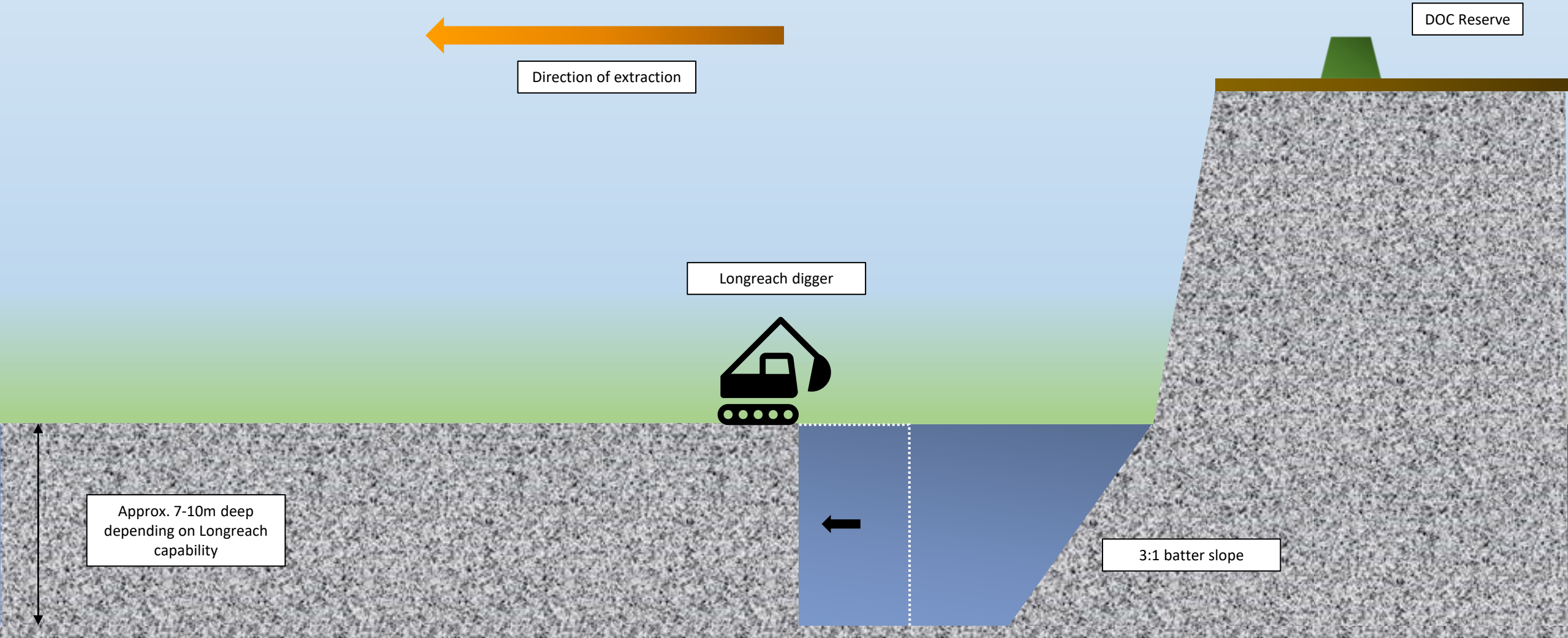


MAP 4: UNDERWATER EXTRACTION OF EXPANSION BLOCK

Above Ground Extraction of Expansion Block



Below Ground Extraction of Expansion Block



ATTACHMENT C – FIGURES AND PHOTOS

Figures from Beca report: Cromwell Quarry - Technical Assessment of Potential Effects of Dust Discharges | 4396863-711958401-22 | 22 October 2020 | 4

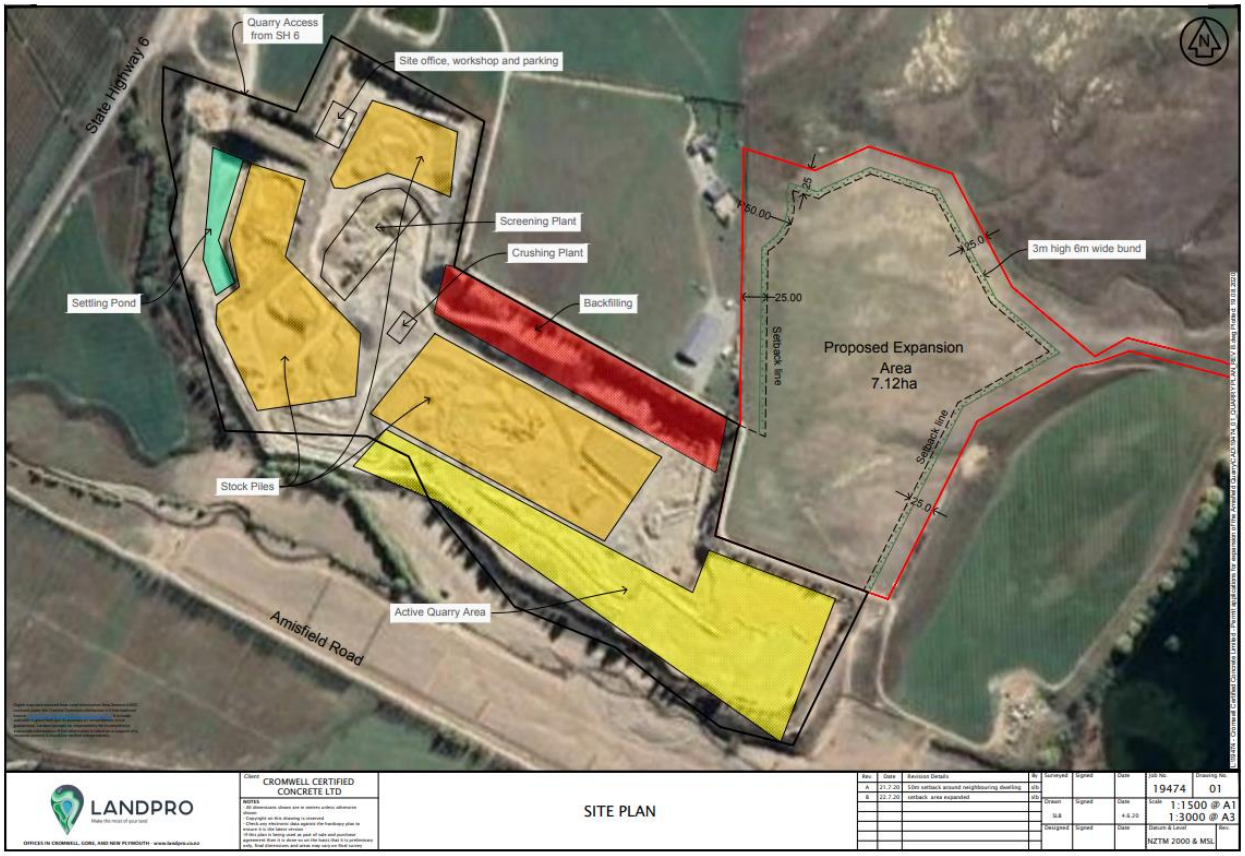


Figure 2-1: Amisfield quarry proposed site plan (Source: Beca, 2020).

Figure 2-3. Aerial photograph showing the location of the quarry and the immediate neighbours (Source: Beca, 2020).

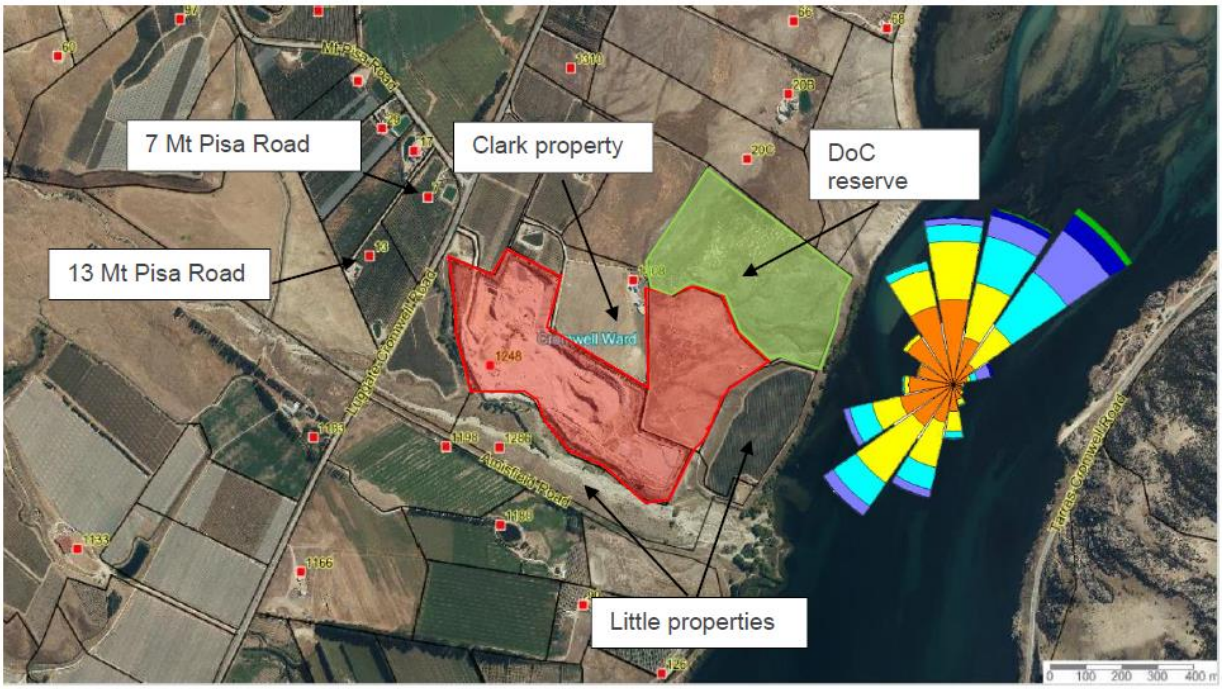


Figure 2-5 Aerial photograph of site overlaid with the Fulton Hogan windrose (Source: Beca, 2020).

Figure 3-1: Photograph of a loader and trucks working on the quarry face (Source: Beca, 2020).

Figure 3-2 Photograph of mobile crushing plant operating on the quarry floor (Source: Beca, 2020).

Figure 3-3: Photograph of screening and washing plant with washed aggregate in the foreground (Source: Beca, 2020).

Figures from Landpro report 20201022_19474_Assessment of Effects, 23 October 2020.

Figure 2: Quarry support facilities (Source: Landpro, 2020).

Figure 18: Approximate location of proposed bunds to mitigate noise effects (Source: Landpro, 2020).

Photographs taken by R Cudmore, Golder (20 July, 2021)

Photo 1:


DOOSAN


CentralPac

ATTACHMENT D – METEOROLOGICAL MODELLING

1 INTRODUCTION

Meteorological inputs were provided by CALMET (see Scire *et al.*, 1999). In the absence of routine atmospheric soundings in the area, upper-air information was incorporated into CALMET using the meteorological component of TAPM (The Air Pollution Model; see Hurley, Physick and Luhar, 2005).

1.1 TAPM Configuration

TAPM is a prognostic model that calculates hourly, three-dimensional fields of meteorological variables such as wind, temperature, and atmospheric turbulence. It was configured as a set of nested grids of points, with successively smaller areas at higher resolution. Each of four grids contained 31 x 31 cells in the horizontal directions, with grid-cell resolution 27 km, 9 km, 3 km, and 1 km, and 25 levels in the vertical. The first (coarsest and largest) grid covered most of the South Island New Zealand; the fourth, finest grid covered an area 31 km x 31 km, centred on the quarry.

TAPM models the large-scale wind fields in three dimensions in hourly steps. In addition to being driven by global meteorological analyses, supplied by its developers (CSIRO), hourly averaged wind data from local surface monitoring sites were assimilated into TAPM, to improve its surface-level wind patterns. Sites included were the monitoring station at Fulton Hogan's Parkburn Quarry (3 km away) and the NIWA-run Cromwell climate station (12 km away). A three-year period has been modelled, 2018 to 2020 inclusive. Note that the Parkburn data were available from mid-2019 only.

Hourly, three-dimensional outputs were extracted from TAPM and processed using the CALTAPM utility to provide upper-air data for CALMET.

1.2 CALMET Configuration

CALMET was run over an area 6 km by 9 km at a horizontal grid resolution of 100 m, at a one-hour time step, to provide a fine-resolution grid of meteorological information for CALPUFF. CALMET incorporates upper-air information from TAPM, interpolates the fields onto the fine-scale grid, and generates terrain-driven flows.

The CALMET model domain is shown in Figure 1. CALMET requires terrain and land use data on the model's regular 100 m grid. Landcover data were obtained from the LRIS portal[1], under the Creative Commons Attribution 4.0 International License. Terrain data were obtained from the LRIS portal, under the Landcare Data Use License[2]. Terrain and land use calculated for the 100 m grid are shown in Figure 2.

Having incorporated the wind data into TAPM, it has not been re-used CALMET. CALMET has been run in a 'no-observation' mode. Other meteorological fields required by CALMET, such as

[1] https://lris.scinfo.org.nz/layer/104400-lcdb-v50-land-cover-database-version-50-mainland-new-zealand/ *Note, this work is licensed under the Creative Commons Attribution 4.0 International License. To view a copy of this license, visit http://creativecommons.org/licenses/by/4.0/ or send a letter to Creative Commons, PO Box 1866, Mountain View, CA 94042, USA.*

[2] Refer to https://lris.scinfo.org.nz/license/landcare-data-use-licence-v1/ for more information.

temperature, humidity, pressure, cloud height and cover, and rainfall rate, are taken from the three-dimensional data supplied by TAPM.

The only key parameter that needs to be selected in CALMET is the terrain radius of influence, *TERRAD*. After testing a range of distances, a value of 3 km was chosen. This ensures the surface wind data from the Fulton Hogan's Parkburn Quarry wind station has influence on the modelled wind fields at the Amisfield site.

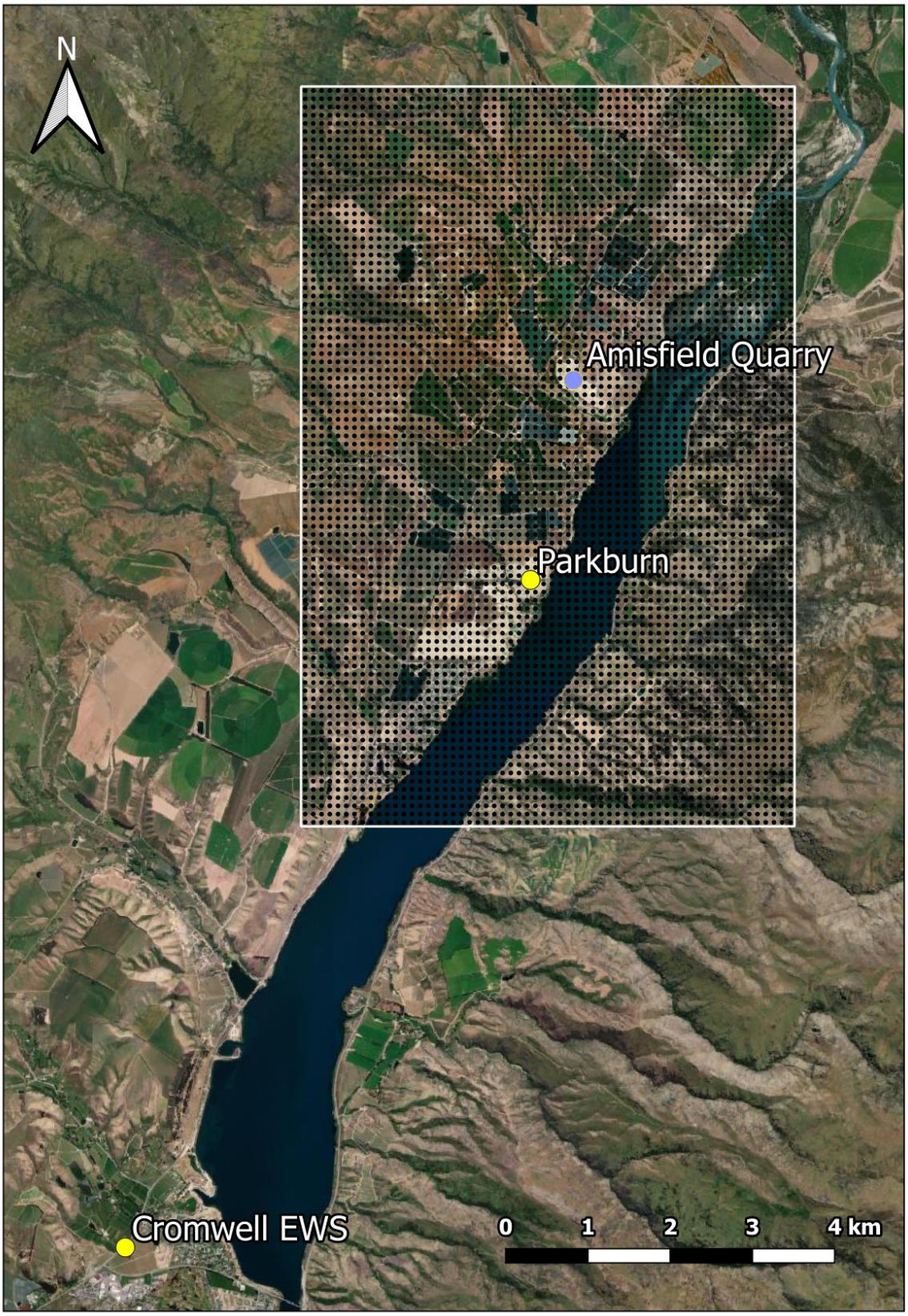


Figure 1: CALMET model domain boundary (white outline), grid points at 100 m spacing (black), and meteorological monitoring stations used by TAPM. Aerial imagery from ESRI.

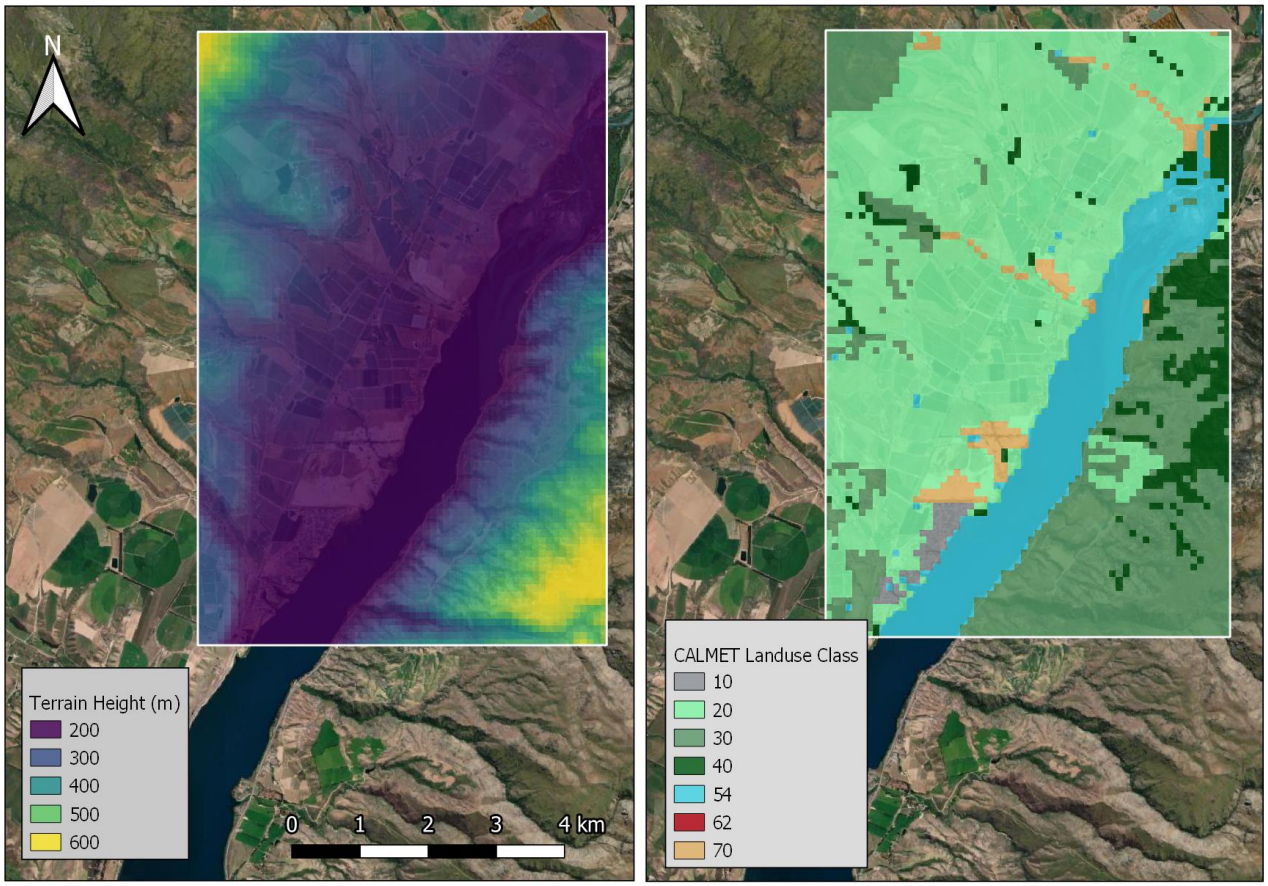


Figure 2: Gridded terrain heights and land use classes, as used by CALMET. CALMET land use classes are urban (10), agriculture (20), rangeland (30), forest (40), water (54), wetlands (62) and barren land (70). Aerial imagery from ESRI.

Wind roses extracted from the CALMET results at the location of the Amisfield quarry are shown in Figure 3. These show a general alignment of the wind direction with the valley direction. Note there is a small change in the distribution of directions in 2020, which has a lower proportion of southerly and southwesterly winds, and a higher proportion of northerlies, with a moderately low wind speed. This is due to the Parkburn monitoring starting in late September 2019, which influences the modelled Amisfield meteorology. The Parkburn site is around 2.5 km from the Amisfield quarry. Prior to the commissioning of the Parkburn site, the modelled meteorology is influenced by inputs from the Cromwell EWS, which is 12 km away.

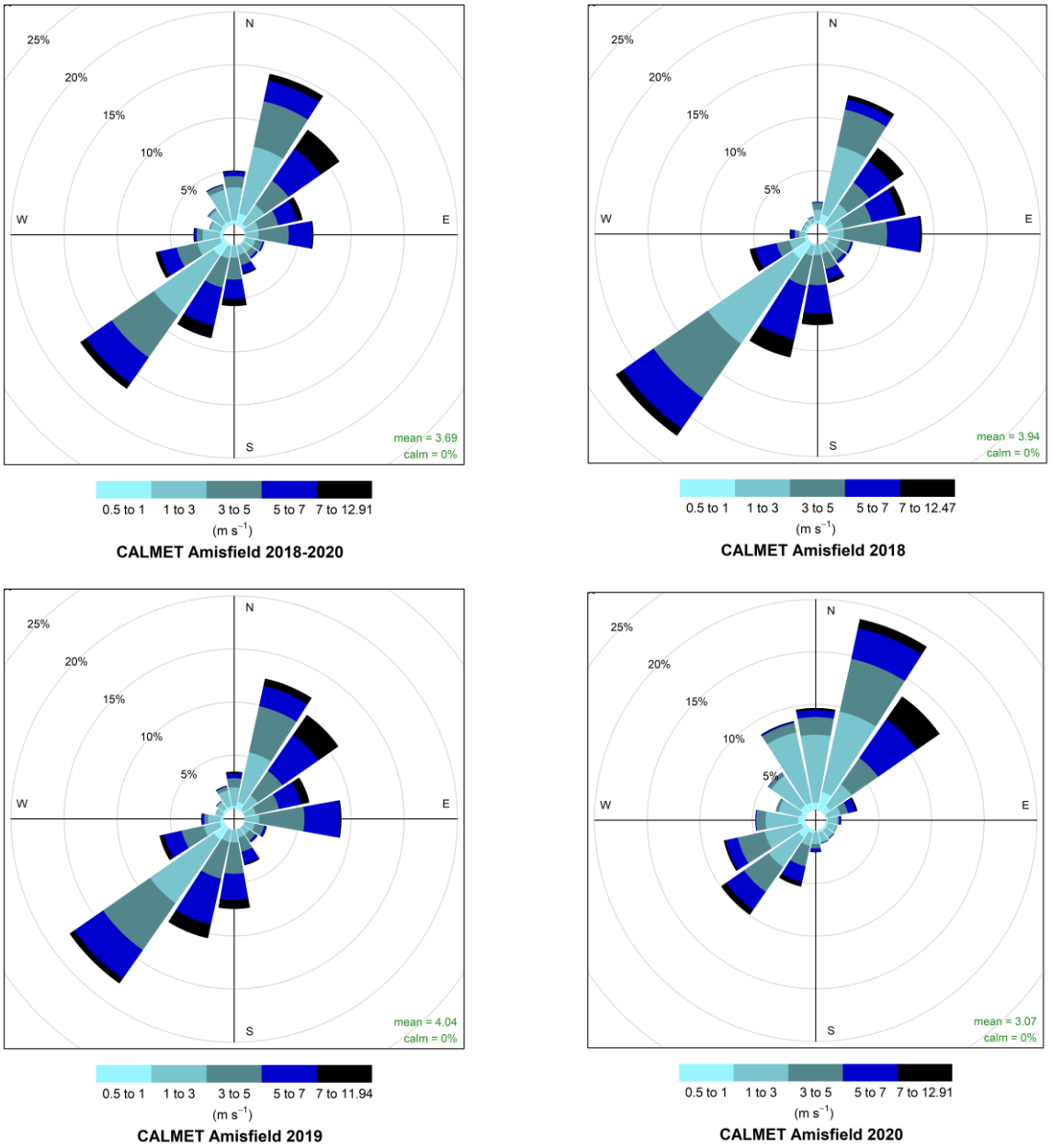


Figure 3: Wind roses extracted from the CALMET model at Amisfield quarry. Top left, 2018-2020; top right 2018; lower left 2019; lower right 2020.

Cook Orchard

Data Comparison

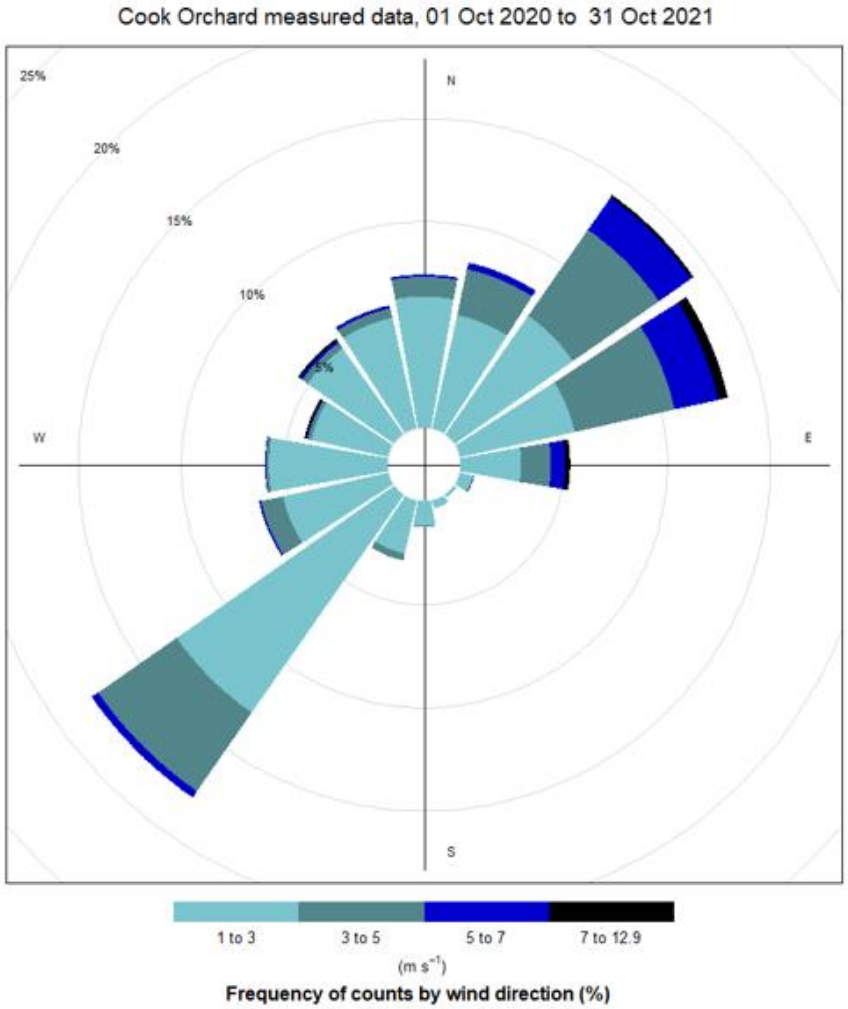
Notes on Harvest Data from Cook Orchard:

- Rainfall, wind speed and wind direction data recorded by a Harvest Monitor operated at Cook Orchard were downloaded from the Harvest website for the period: 01 October 2020 to 31 October 2021.
- Raw data was available at varying intervals, ranging from 1-min to 5-minute intervals over this period. Total daily rainfall were estimated from 1-minute rainfall data on each day.
- Wind direction data from Harvest monitor are available at 22.5-degree intervals.
- Based on instrument specification, wind speed below 1 m/s can have erroneous wind direction readings. Therefore, all wind data where speed is recorded to be less than 1 m/s are excluded from this analysis.

Notes on Cromwell EWS and CALMET data

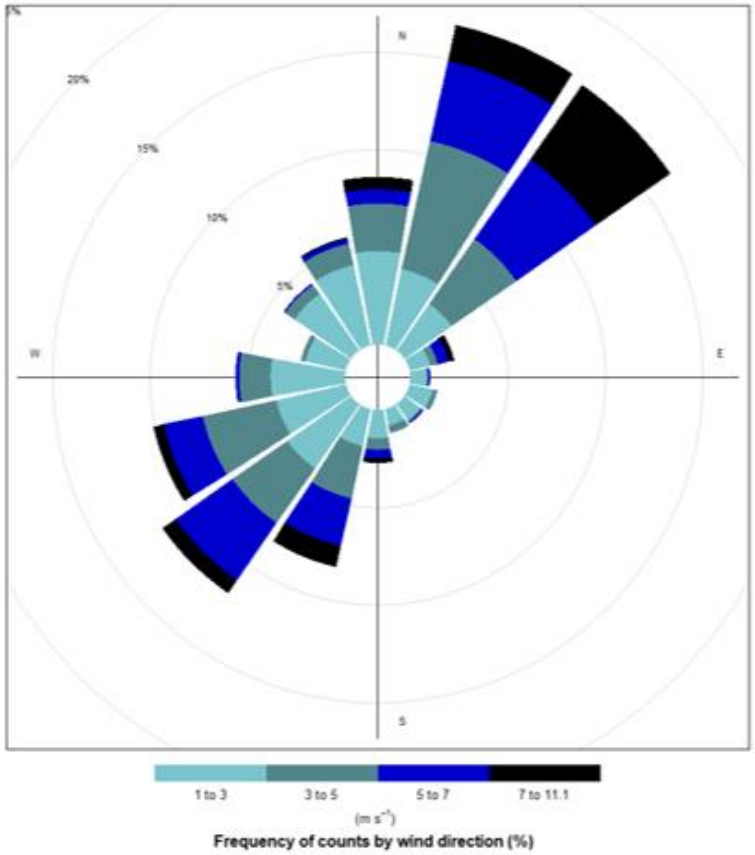
- Daily rainfall data was downloaded for the Cromwell EWS station, from CliFlo (NIWA Climate Database) for the period of 01 October 2020 to 31 October 2021.
- Site-specific hourly wind data was extracted from CALMET model for the years 2018, 2019, 2020.

Windrose for all data at Cook Orchard

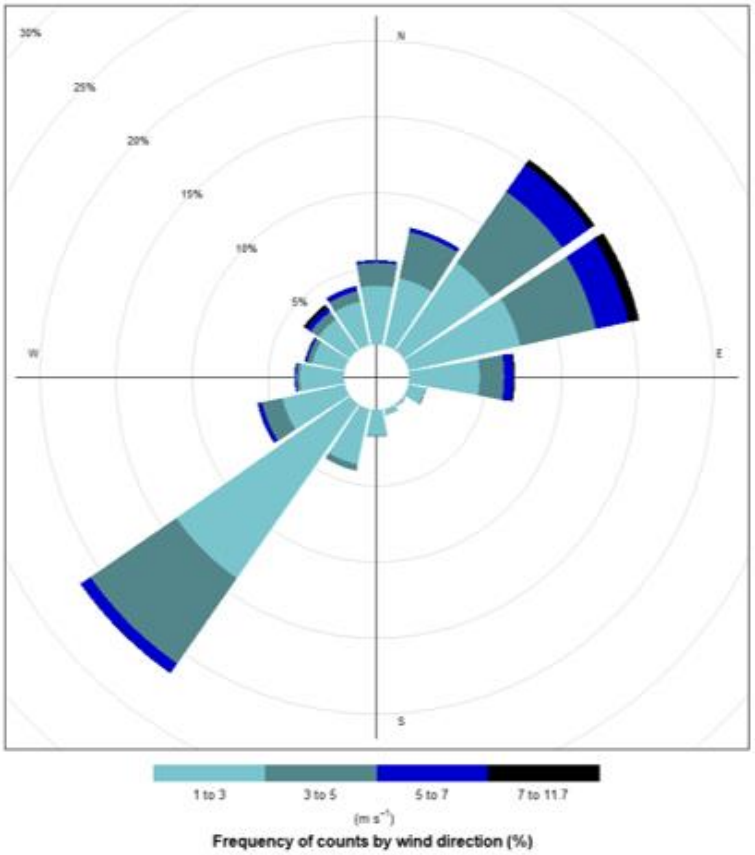


Wind for overlapping period, CALMET vs. Cook Orchard

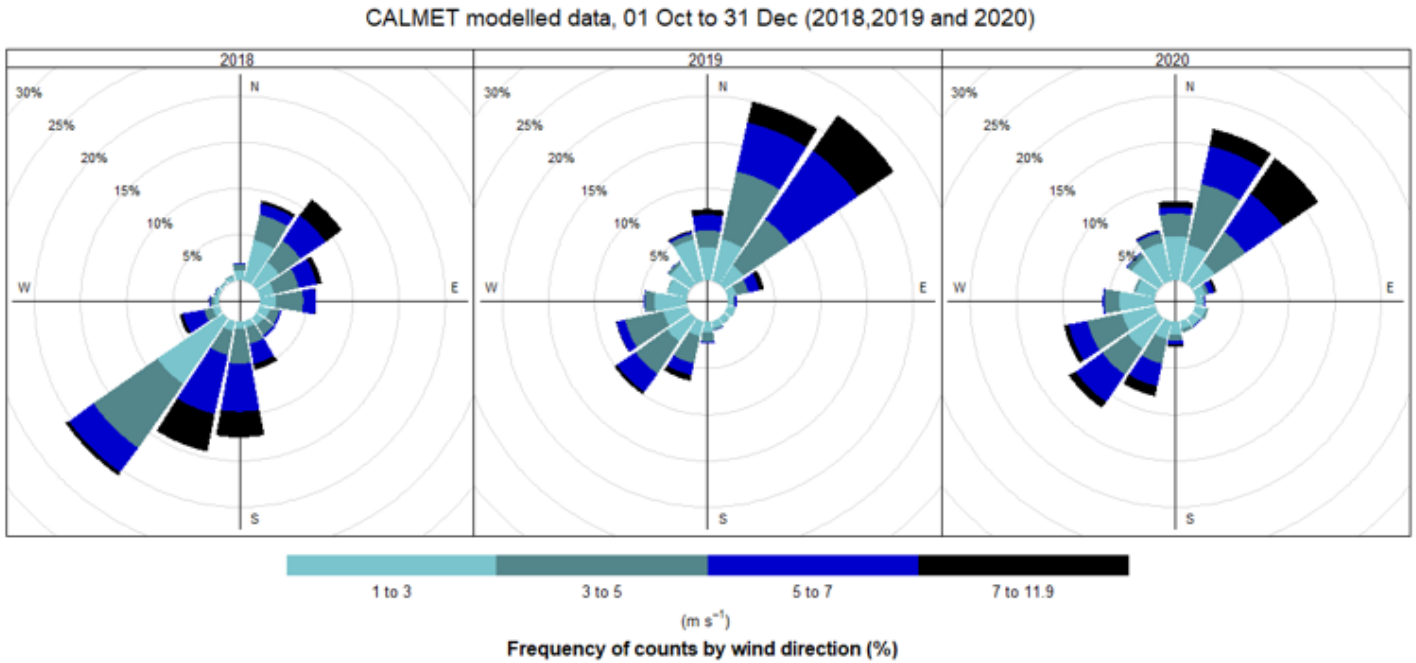
CALMET modelled data, 01 Oct to 31 Dec 2020



Cook Orchard measured data, 01 Oct to 31 Dec 2020

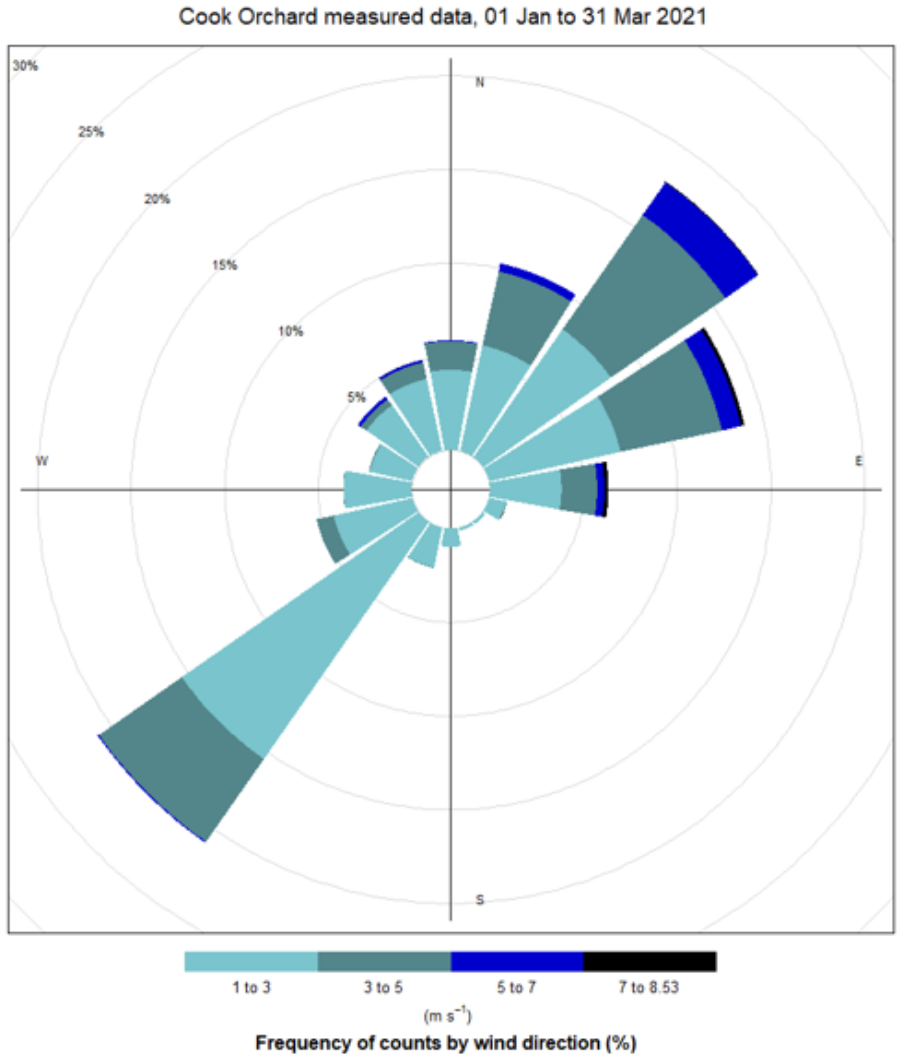


Wind for October to December each modelling year, CALMET data

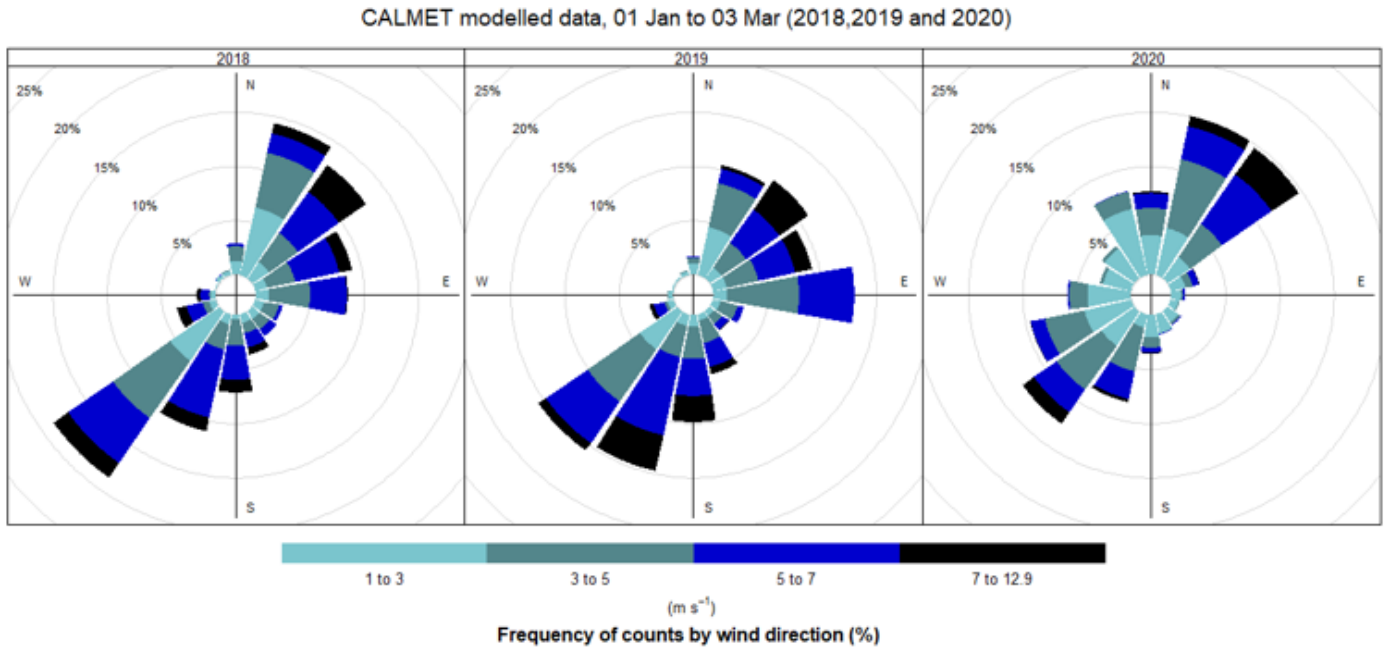


Wind for January 2021 to March 2021, Cook Orchard

CALMET data for same months, different years on following slide



Wind for January to March each modelling year, CALMET data



Time of the year	Calm conditions (% wind speeds <= 1 m/s)	
	Cook Orchard (irregular interval resolution)	CALMET (hourly resolution)
October to December 2020	46.7 %	7.1 %
October to December 2019	-	5.8 %
October to December 2018	-	4.1 %
January to March 2021	49.2 %	-
January to March 2020	-	10.3 %
January to March 2019	-	4.0 %
January to March 2018	-	4.1 %

References

Hurley, P., Physick, W. and Luhar, A. (2005) 'TAPM - A practical approach to prognostic meteorological and air pollution modelling', *Environmental Modelling & Software*, pp. 20:737-752.

Scire, J. *et al.* (1999) *A User's Guide for the CALMET Meteorological Model (Version 5.0)*. Concord, Massachusetts: Earth Tech.

TRC (2011a) *CALPUFF Modeling System - Version 6 User Instructions*. Report prepared by Atmospheric Studies Group, TRC Companies, Inc., April 2011.

TRC (2011b) *Generic Guidance and Optimum Model Settings for the CALPUFF Modeling System for Inclusion into the 'Approved Methods for the Modeling and Assessments of Air Pollutants in NSW, Australia'*. Prepared for NSW Office of Environment and Heritage, Sydney, Australia, March 2011.

ATTACHMENT E – RAINFALL DATA

Data Sources and Assessment

Cromwell EWS is the nearest meteorological station to the site, located approximately 12 km to the southwest of the existing quarry. The monitoring station is operated and maintained by National Institute of Water and Atmospheric Research (NIWA). Ten years of daily rainfall and evaporation (ET) data from January 2010 to December 2020 were downloaded from CliFlo (https://cliflo.niwa.co.nz/), a web system that provides open access to the National Climate Database managed my NIWA.

Summary Plots

Rainfall

Figure 1 shows total monthly rainfall observed over the ten-year period at Cromwell EWS monitoring station. Figure 1 also shows an inset boxplot of total monthly rainfall over ten years at the same monitoring location. The variation in monthly rainfall is observed to be the greatest in 2010 and minimum in 2017. Maximum monthly rainfall was observed in February 2018 and minimum monthly rainfall was observed in May 2020. Maximum annual rainfall was observed in 2018 (544 mm) and minimum annual rainfall was observed in 2017 (278 mm).

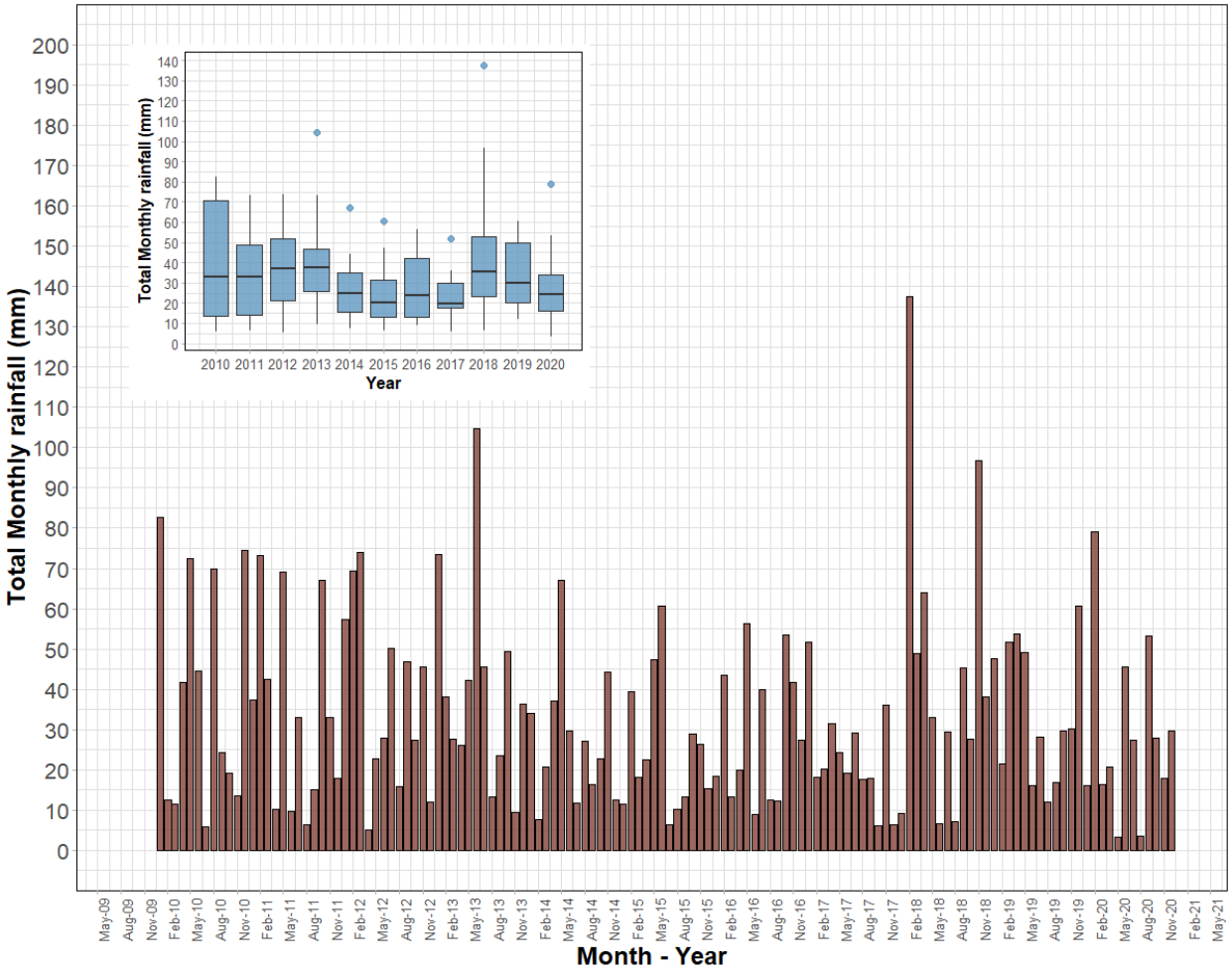


Figure 1: Total monthly rainfall (mm) over ten years (boxplot inset: Range of total monthly rainfall over 10 years).

Wet periods

Net rainfall was estimated by considering the difference in observed rainfall and evaporation on any given day. All days when net rainfall was observed to be above -1 mm were classified as wet days.

Total number of wet days per month have been estimated for each year as shown in Figure 2 and Figure 3. Although there is some inter-annual variability in monthly rainfall across the ten-year period, the number of wet days is generally observed to be higher during the months of May to July. August has been observed to be dry as well as wet in the last ten years with number of wet days observed in the range of 10 to 25 days. In general, net rainfall tends to be lower during the summer months.

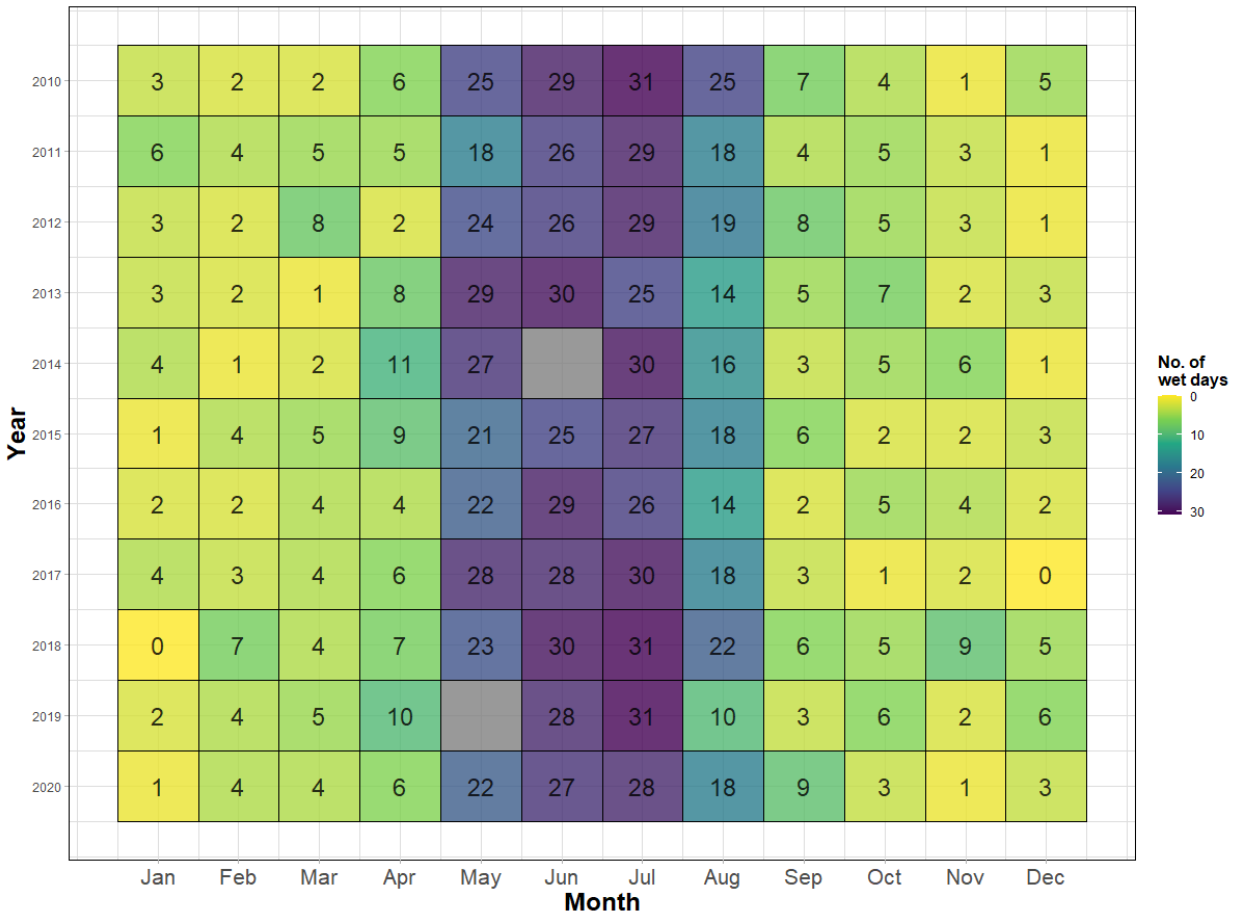


Figure 2: Total number of wet days per month over 10 years as a tile plot.

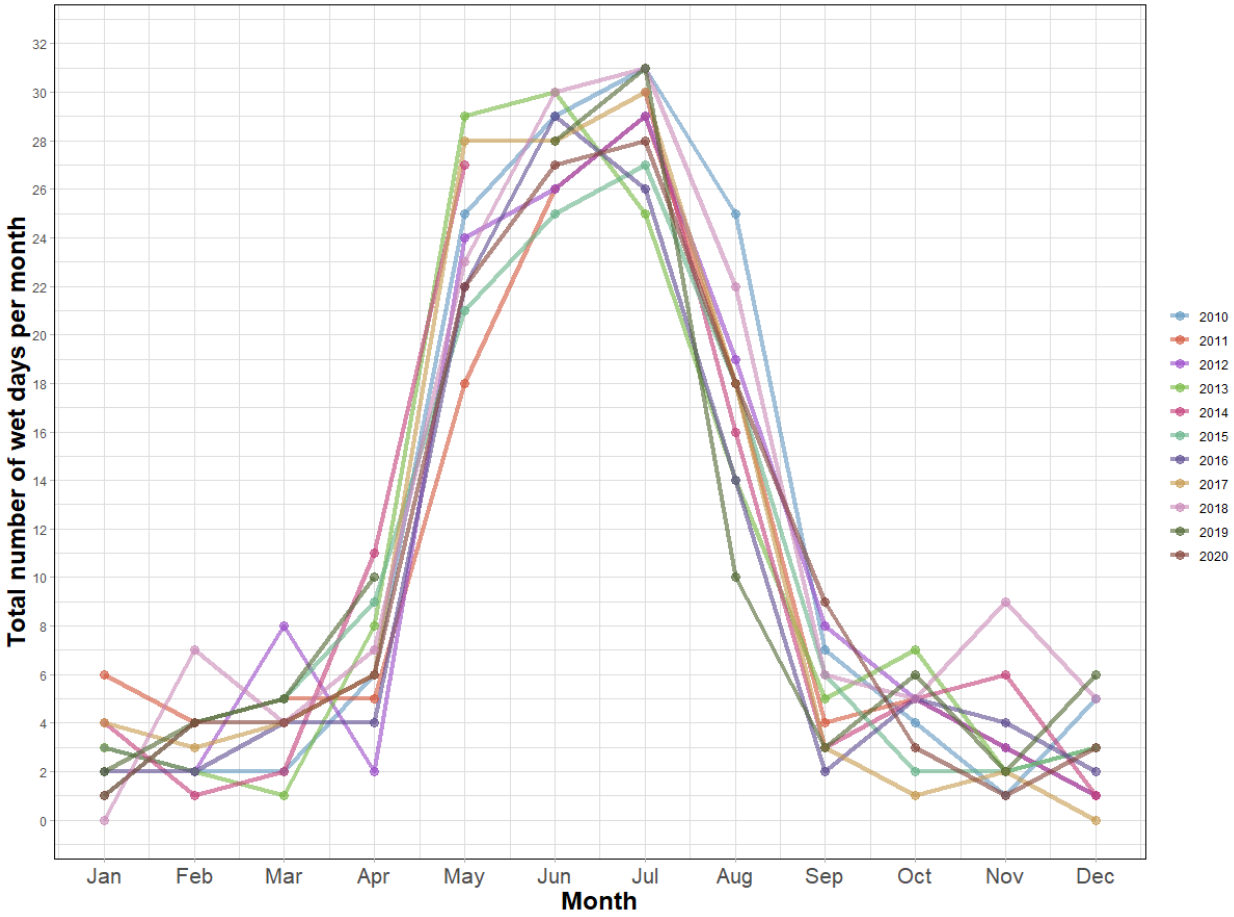


Figure 3: Total number of wet days per month over 10 years as a line plot.

Duration of wet days

Figure 4 and Figure 5 show the duration of wet days since the first wet day was observed as a timeseries and as a boxplot, respectively. In general, the length of a wet period is observed to be higher during the months of May to July. In the last ten years, longest wet period was observed over 80 days, starting in May 2018. Shorter, but more frequent wet periods are also observed to occur more during winter months. The duration of wet days is generally less than five days in summer months.

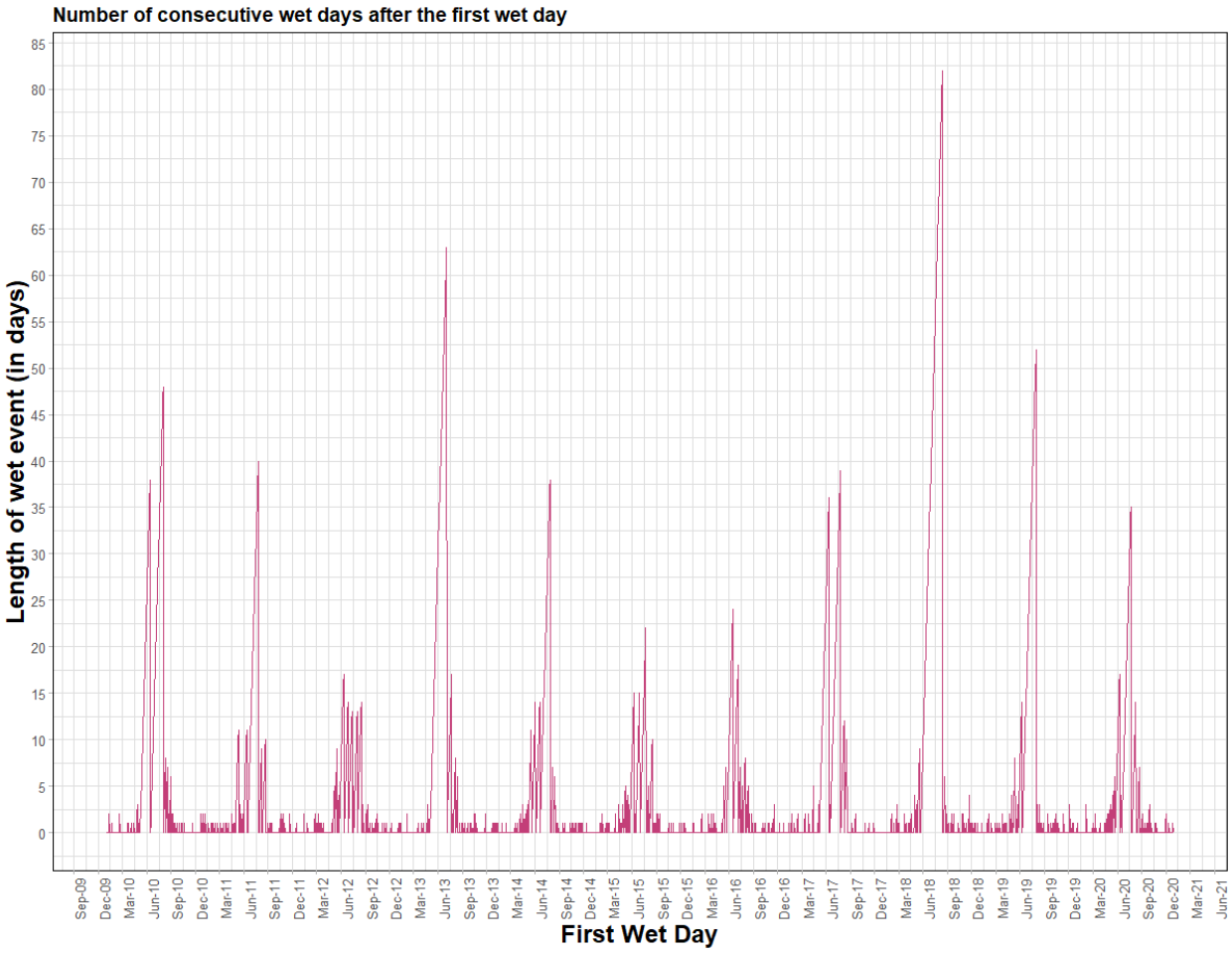


Figure 4: Duration of wet days as timeseries.

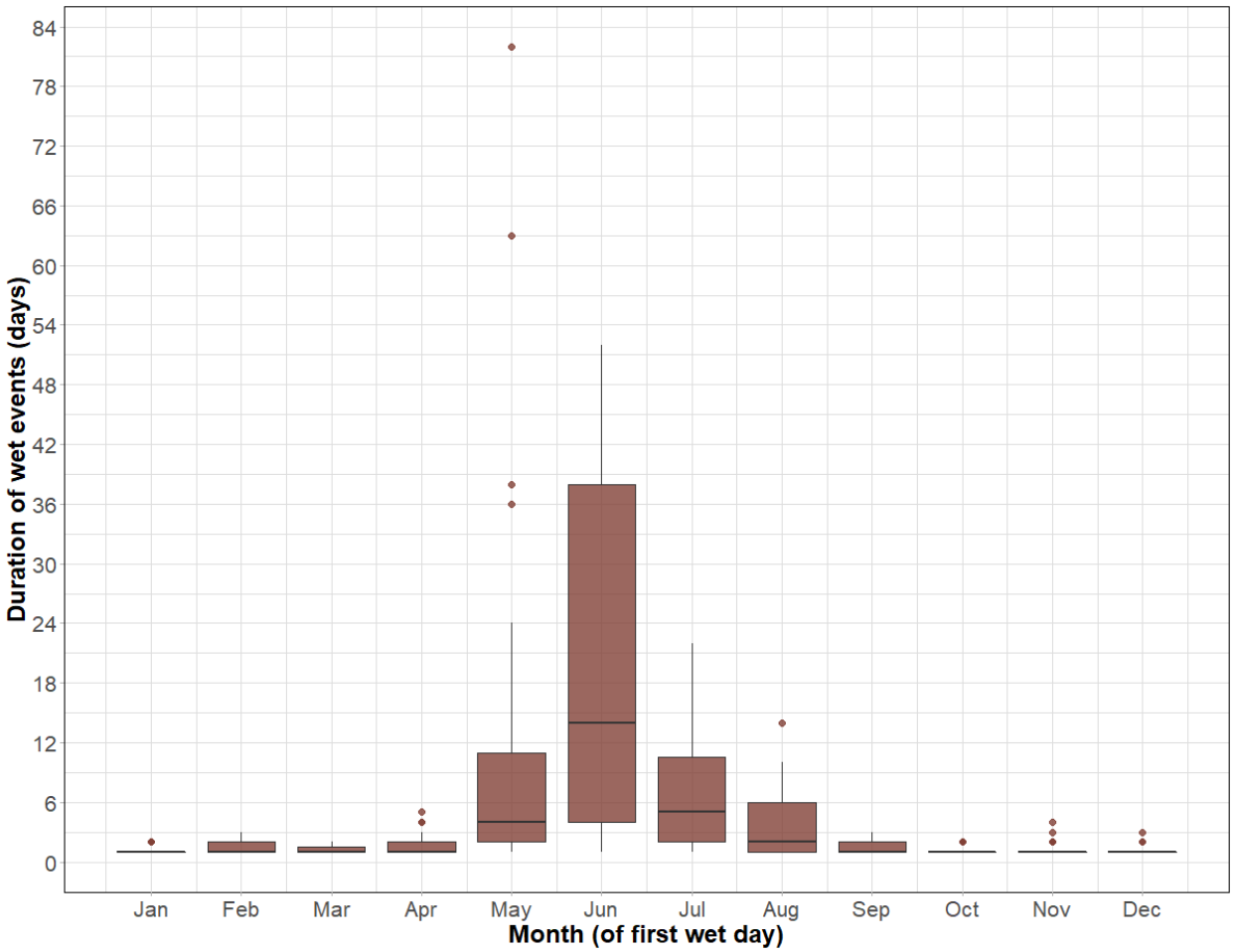


Figure 5: Wet event duration (in days) against the starting month of the event.

Cook Orchard

Data Comparison

Notes on Harvest Data from Cook Orchard:

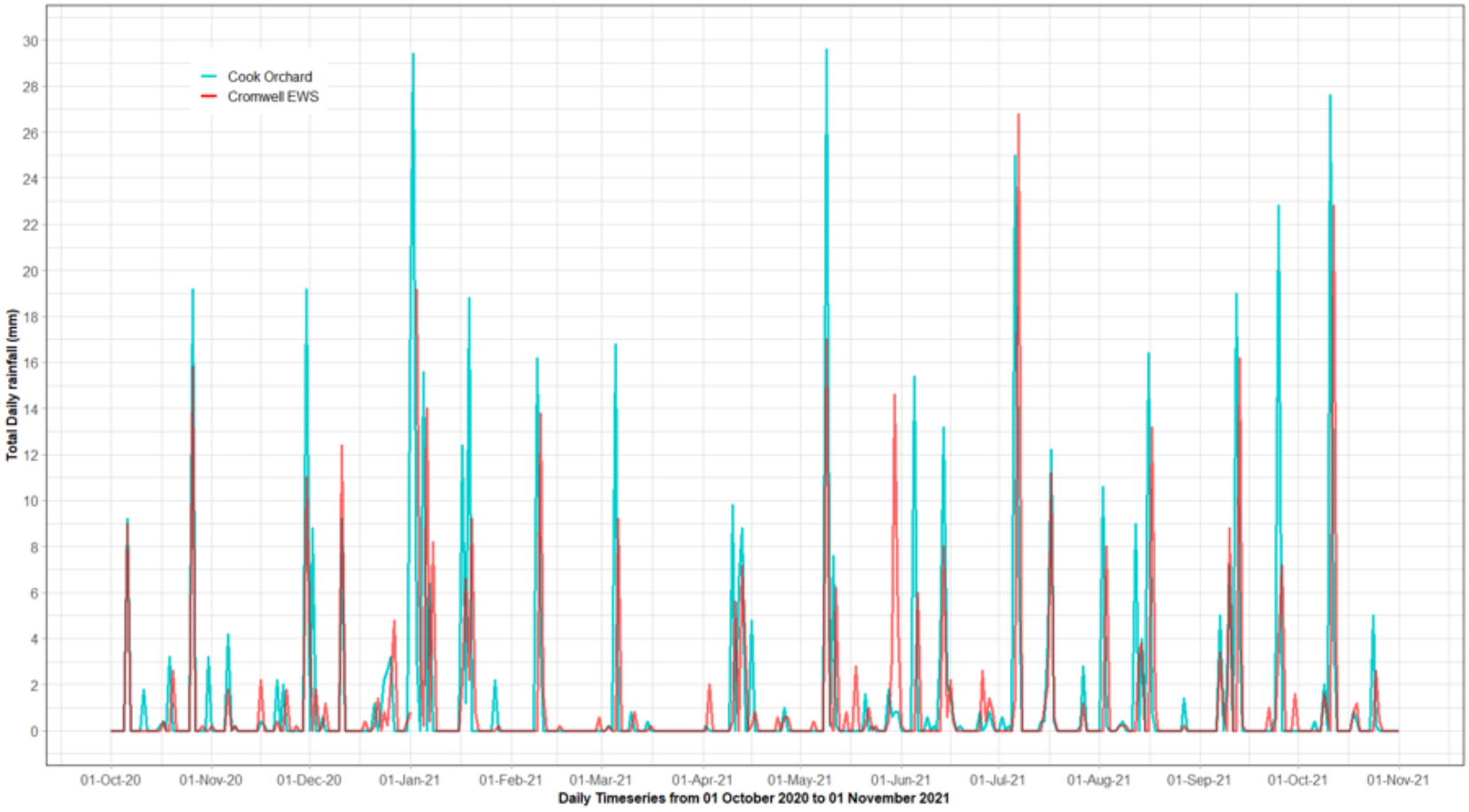
- Rainfall, wind speed and wind direction data recorded by a Harvest Monitor operated at Cook Orchard were downloaded from the Harvest website for the period: 01 October 2020 to 31 October 2021.
- Raw data was available at varying intervals, ranging from 1-min to 5-minute intervals over this period. Total daily rainfall were estimated from 1-minute rainfall data on each day.
- Wind direction data from Harvest monitor are available at 22.5-degree intervals.
- Based on instrument specification, wind speed below 1 m/s can have erroneous wind direction readings. Therefore, all wind data where speed is recorded to be less than 1 m/s are excluded from this analysis.

Notes on Cromwell EWS and CALMET data

- Daily rainfall data was downloaded for the Cromwell EWS station, from CliFlo (NIWA Climate Database) for the period of 01 October 2020 to 31 October 2021.
- Site-specific hourly wind data was extracted from CALMET model for the years 2018, 2019, 2020.

Daily Rainfall, 01 October 2020 to 31 October 2021

Calculated total daily rainfall at Cook Orchard (from 1 to 5-min data) and downloaded daily rainfall for Cromwell EWS from CliFlo (NIWA Climate Database)



ATTACHMENT F – HAUL ROAD DUST IMPACT MODELLING

General

This attachment summarises the approach used for modelling *uncontrolled* dust (TSP, PM_{10} and $PM_{2.5}$) emissions due to future movements of trucks when hauling excavated pit run material (at 200,000 m^3/annum) from the northern end of Amisfield quarry's new expansion area.

The dispersion model, CALPUFF (see TRC (2011a) and TRC (2011b) for technical information and guidance on CALPUFF) was used to predict particulate deposition and ambient concentrations due to truck wheel generated emissions from the haul road.

The aim of this modelling was to establish indicate magnitude of particulate impacts due to truck movements on the new expansion area's haul road, when uncontrolled and assuming accepted US EPA factors for uncontrolled haul road emissions. The development of the site specific three-dimensional meteorological file (covering 3 consecutive years of hourly data), which is an essential input to the CALPUFF dispersion model, is documented in Attachment D of evidence presented by R S Cudmore.

Location of Haul Road and Active Exposed Areas

Cromwell Certified Concrete (CCC) existing quarry and the proposed expansion area are shown in Figure 1. This highlights in purple, areas of the existing quarry and expansion area, assumed to have continuous heavy vehicle movements. It also highlights the location of the haul road linking the excavation area and the central processing plant (located within the existing quarry).

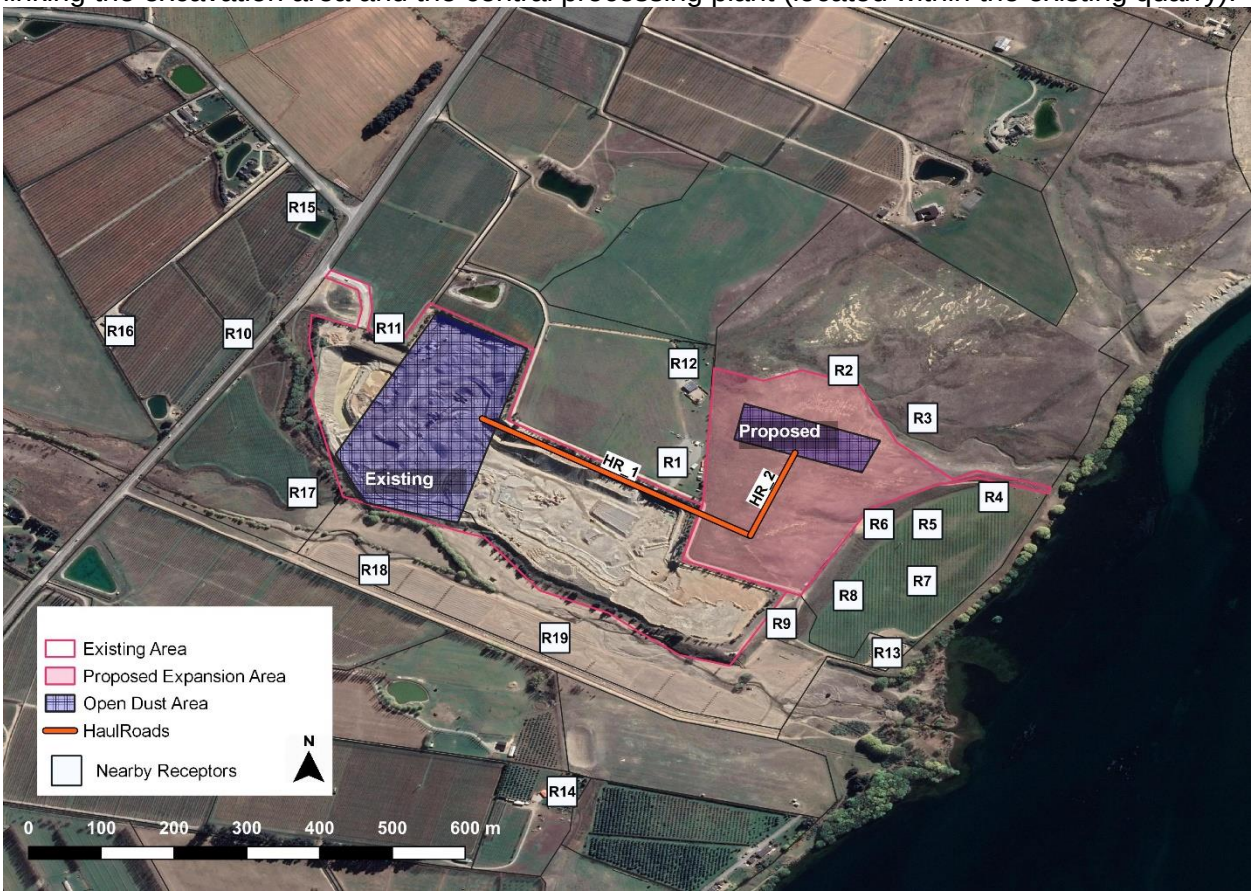


Figure 1: Site location, dust sources and nearby sensitive receptors.

Surrounding Houses and Orchards

Nearby activities, both residential and non-residential have been identified in Figure 1. Five residential dwellings have been identified within 500 m of the site. The identified non-residential sensitive areas include department of conservation reserve, cherry orchards, vineyards, and a storage shed; all within 1 km of the site. Discrete receptors (R1 to R16) were specified within the CALPUFF setup, so that dust impacts values were predicted for a range of relevant sensitive landuse locations. Further details of these receptor locations are provided in Table 1.

Table 1: Receptor IDs versus details.

ID	Name	Category	Details
R1	Clark storage sheds	Non-residential	A storage shed business – located approximately 35 m north of the northern boundary of the existing quarry and approximately 20 m west of the western boundary of the proposed expansion area.
R2	Department of Conservation (DoC) reserve	Non-residential	Land boarders the northern extent of the proposed expansion area (25 m).
R3	Department of Conservation (DoC) reserve	Non-residential	Land boarders the northern extent of the proposed expansion area (25 m).
R4	Little's cherry orchard	Non-residential	Cherry orchard on a lower river terrace, 50 m to the east of the proposed expansion area.
R5	Little's cherry orchard	Non-residential	Cherry orchard on a lower river terrace, 60 m to the south-east of the proposed expansion area.
R7	Little's cherry orchard	Non-residential	Cherry orchard on a lower river terrace, 170 m to the east of the proposed expansion area.
R8	Little's cherry orchard	Non-residential	Cherry orchard on a lower river terrace, 60 m to the east of the proposed expansion area.
R6	Building Platforms – Little's cherry orchard	Residential	Consented building platform to the east of the proposed expansion area and 40 m away
R9	Building Platforms – Little's cherry orchard	Residential	Consented building platform to the east of the existing quarry and 40 m away
R10	Vineyard off Mt Pisa Road	Non-residential	Approximately 100 m to the west of the quarry across Luggate-Cromwell Highway.
R11	Established vineyard	Non-residential	Approximately 20 m to the north of the existing quarry.
R12	Clark residential dwelling	Residential	Approximately 200 m north of the northern boundary of the existing quarry and approximately 60 m to the west of the the proposed expansion area.

R13	Workers' accommodation	Residential	Approximately 160 m east of the existing quarry and 140 m southeast of the southern boundary of the proposed expansion area.
R14	90 Smiths Way	Residential	Approximately 320 m to the south of the southern boundary of the existing quarry and to the south of Amisfield Road.
R15	Dwelling off Mt Pisa Road	Residential	Approximately 100 m to the northwest of the quarry entrance at 7 Mt Pisa Road.
R16	Dwelling off Mt Pisa Road	Residential	Approximately 250 m west of the western extent of the working area of the existing quarry.
R17	Cook cherry orchard	Non-residential	Approximately 50 m to southwest of the existing quarry.
R18	Little cherry orchard (being established in 2021)	Non-residential	Two receptors identified on the established vineyard approximately 70 m south of the site.
R19	Little cherry orchard (being established in 2021)	Non-residential	Two receptors identified on the established vineyard approximately 70 m south of the site.

Assessment Approach

Introduction

A dispersion modelling assessment was undertaken to quantify the PM_{10} and TSP ground level concentrations (GLCs) as well as TSP deposition from haul road emissions. An analytical approach was also undertaken for assessing potential dust impacts from active exposed areas (purple areas in Figure 1) in dry windy conditions.

While this attachment provides details on the haul roads modelling, the assessment approach, for analysing dry windy conditions, along with the results are provided in Attachment G.

Haul Roads Modelling

Haul road emission calculation

Truck/vehicle movements on unpaved roads, especially the trucks hauling excavated aggregate to the central processing plant and returning to the extraction area can discharge dust into the air. Dispersion modelling system was used to predict the resulting concentrations and deposition of dust from haul road discharges.

Emission factors and empirical formulae to estimate emission rates from unpaved roads at industrial sites have been provided in AP-42 13.2.2 guideline[1] (AP42 guideline). Using equation 1a from the AP42 guideline, emission rates from unpaved haul roads at the site were estimated for $PM_{2.5}$, PM_{10} and PM_{30}.

Equation 1a shows that the emission factor associated with $PM_{2.5}$, PM_{10} and PM_{30} vary with vehicle weight (W), silt content (s) of the road surface material and total vehicle kilometres travelled (VKT). The following assumptions were made to estimate size-specific emission factors:

- Truck movement in peak hour, 6.25 trucks per hour (covers both directions);
- W, Average vehicle weight calculated from tare weight of 30 T and loaded truck weight of 55 T;
- s, 5 % silt in haul road surface material.

Two unpaved haul road segments, as seen in Figure 1, were assumed to discharge dust during operational daytime hours and therefore, particulate emission rates have been estimated for these two road segments. HR_1 was assumed to be 436 m long going from the central processing plant to the proposed expansion area (east-west segment). HR_2 was assumed to be 218 m long running north-south on the proposed expansion area. Table 2 shows the emission rate estimates derived from equation 1a from AP42 13.2.2 guideline.

[1] https://www3.epa.gov/ttnchie1/ap42/ch13/final/c13s0202.pdf

Table 2: Emission Rates for vehicle movement on unpaved roads[1]

PM	k (g/VKT)	a	b	W (T)	s (%)	Emission Factor (g/VKT)	Number of trucks (N)	Distance Travelled (m)		**Emission Rate (kg/hour)**	
								HR_1	HR_2	**HR_1**	**HR_2**
$PM_{2.5}$	42.29	0.9	0.45	39	5	56.63	6.25	436	218	0.17	0.09
PM_{10}	422.85	0.9	0.45	39	5	566.28	6.25	436	218	1.74	0.87
PM_{30}	1381.31	0.7	0.45	39	5	2203.84	6.25	436	218	6.75	3.38

Size Distribution Analysis

The default geometric mean and standard deviation of $PM_{2.5}$ and PM_{10} within CALPUFF modelling system represent a particle size distribution where majority of PM_{10} is within $PM_{2.5}$. However, dust from unpaved roads is expected to be dominantly in the coarser size fraction. Particulate discharges from haul roads that are less than 1 µm in size are expected to be negligible. The emission factors distribution from PM_1 to PM_{30} are shown in Figure 2. The profile suggests that for every vehicle kilometre travelled (VKT) on unpaved surfaces, PM_{30} discharge is considerably higher than the smaller size fractions.

Therefore, the default CALPUFF values of geometric mean diameter, standard deviation of $PM_{2.5}$ and PM_{10} size fractions were changed to be more consistent with published emission factor data and also to reflect our definition of the three particle size ranges/categories as summarised below.

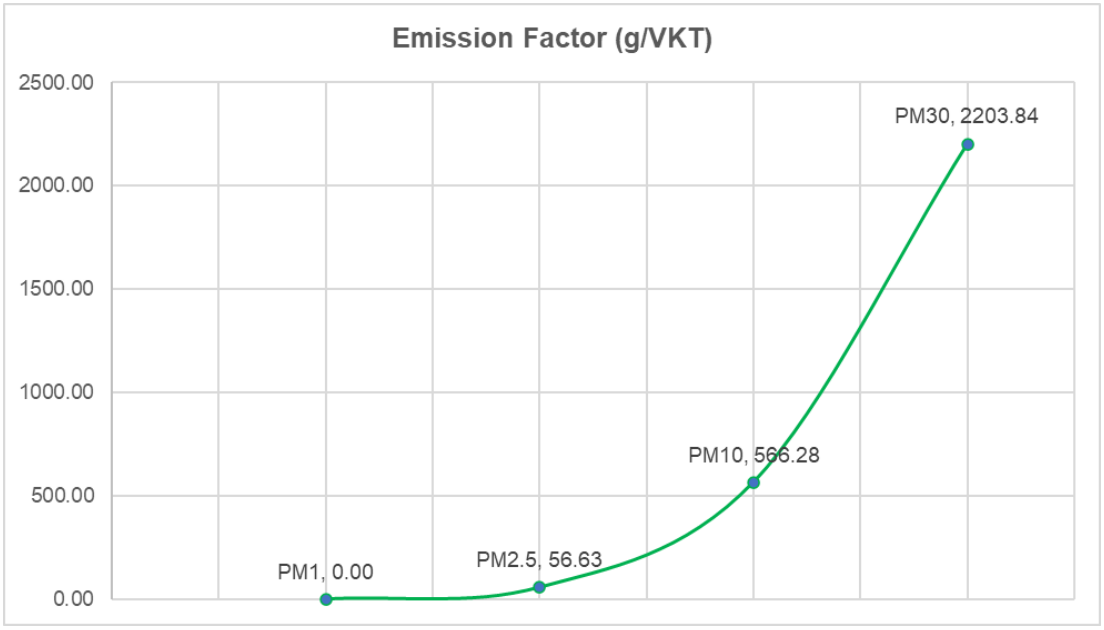


Figure 2: Particulate emission factors estimated for unpaved roads at industrial sites (AP42 guideline method).

For relatively better representation of particle size distribution of coarser particle discharges within CALPUFF, geometric mean and standard deviation were estimated for the following size categories:

- PM_1 to $PM_{2.5}$: 1 to 2.5 µm
- $PM_{2.5}$ to PM_{10}: 2.5 to 10 µm
- PM_{10} to PM_{30}: 10 to 30 µm

To estimate geometric mean and standard deviation, a uniform distribution of numbers was generated within each size category above. All sizes at 0.1 µm interval between the two end points of each of the size categories were considered to have a similar likelihood of occurrence. A sample geometric mean and standard deviation was estimated for these three uniform distributions within each size category. Table 3 shows the resulting values of geometric mean and standard deviation derived from this approach.

However, the number of points within each category generated at 0.1 µm intervals are different. Therefore, a sensitivity test was also undertaken to look at the impact of number of sample points on geometric mean and standard deviation of each of the distributions. For a particular size category, an algorithm was run to create 5000 sampling groups of random numbers and of random sizes. Sampling group sizes ranged from 10 to 10000. Geometric mean and standard deviation were calculated for each sampling group. Figure 3 shows the geometric mean results from 5000 runs per size category. The black horizontal lines show the sampling mean used in the CALPUFF model for each size category. Therefore, the geometric mean and standard deviation used for dispersion modelling in this assessment are considered likely to be representative of the uniform distribution that is assumed within each of the size categories.

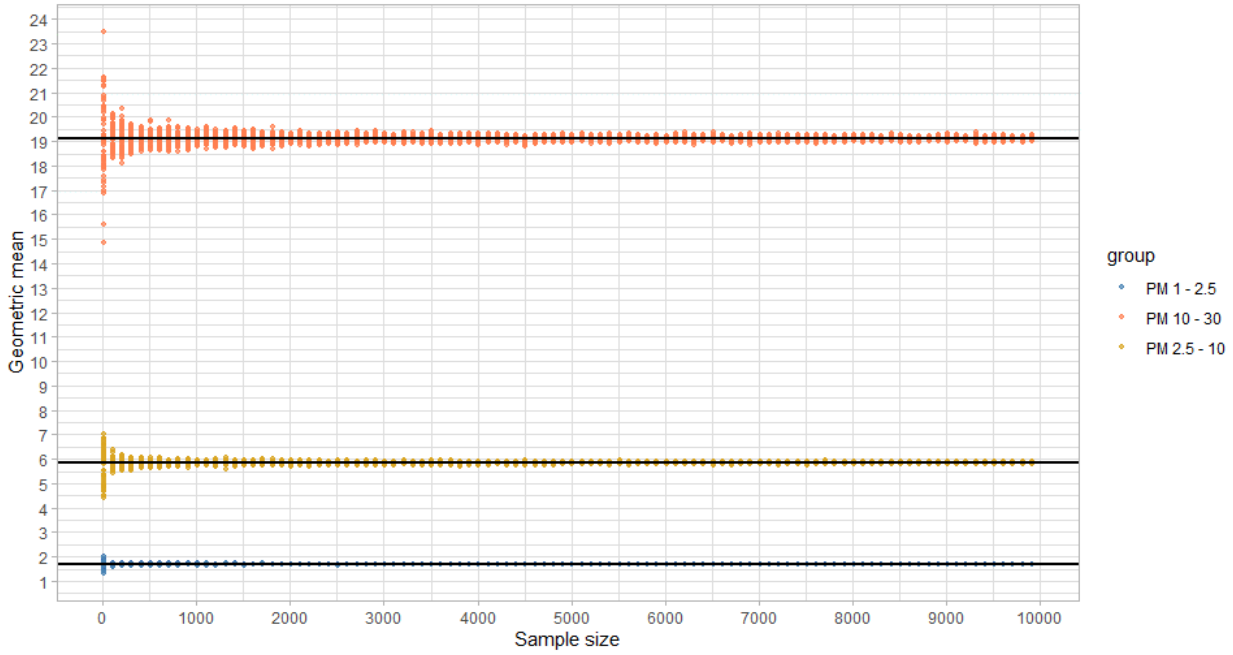


Figure 3: Geometric Mean of each size category against number of sampled points.

CALPUFF assumes specific gravity of particulate matter as 1, but sediment particles have higher specific gravity of approximately 2.8. To account for the higher density of sediment, the calculated geometric mean diameter of particles within each group were scaled up by a factor of 1.4 (i.e., 40 % increase), which increase the volume (and therefore weight of particles with SG set at 1.0) by a factor of 2.8.

Summary of Modelled Species

Emission rates for three size categories were estimated by taking the difference of emission rates between the end points of each size category. For the size range PM_1 to $PM_{2.5}$, the emission rate for $PM_{2.5}$ was used.

Geometric mean, standard deviation and emission rates of all size categories used in CALPUFF are provided in Table 3.

Table 3: Size category and emission rates used in the model.

Size Category	**Geometric Mean**	**Geometric Standard Deviation**	**Emission Rate (kg/hour)**	
			HR_1	**HR_2**
PM_1 to $PM_{2.5}$	2.36	1.33	0.17	0.09
$PM_{2.5}$ to PM_{10}	8.16	1.48	1.56	0.78
PM_{10} to PM_{30}	26.75	1.36	5.02	2.51

Model Configuration

The air dispersion modelling system was developed using the CALPUFF air dispersion model and the CALMET meteorological pre-processor. CALMET was used to develop a three-year site-specific meteorological data set from 2018 to 2020. Details of CALMET modelling are provided in **Attachment E** to the evidence of R Cudmore.

CALPUFF, version 7.2.1, was used to predict the ground level concentrations as well as dry deposition rates of all three size categories at the nearby receptors as shown in Figure 1.

Two line-volume sources were set as shown in Figure 1 and as follows:

- **HR_1**: 436 m long east to west haul road going from the central processing plant up to the proposed expansion area;
- **HR_2**: 218 m long north to south haul road on the proposed expansion area.

The in-built haul road volume source calculator was used to estimate the number of volume sources and other CALPUFF parameters such as initial sigma and plume release height. The required inputs in haul road calculator, vehicle height and width were set to 4.3 m and 2.55 m, respectively as provided by NZTA for heavy rigid vehicles[2].

[2] https://www.nzta.govt.nz/vehicles/vehicle-types/vehicle-classes-and-standards/vehicle-dimensions-and-mass/heavy-rigid-vehicles/

The particle size categories as mentioned in Table 3 were modelled in CALPUFF as separate species with their own specific emission rates, geometric mean and standard deviation. Emission factors were applied only for operating hours (Mon – Sat, 7 am to 7 pm).

The model was set to predict ground level concentrations (GLCs) and dry deposition over 2 km by 2 km sampling grid of receptors at 50 m grid spacing, centred on the site. Additionally, nearby receptor locations as shown in Figure 1 and points located approximately every 20 m along the site's property boundary were also included in the modelling as discrete receptors. The model was run into multiple batches for three years and results were combined using APPEND.

Post Processing of Model Results

POSTUTIL was used to sum the predicted hourly concentration and dry deposition of three size categories into two final categories:

- **TSP (total suspended particles)**: PM_1 – $PM_{2.5}$, $PM_{2.5}$ – PM_{10} and PM_{10} – PM_{30}
- **PM_{10} (size fraction <10 µm)**: PM_1 – $PM_{2.5}$ and $PM_{2.5}$ – PM_{10}

Concentration and dry deposition hourly timeseries for all TSP and PM_{10} were extracted for each nearby receptor location specified in Figure 1.

Concentration and deposition data were combined with daily rainfall and evaporation-transpiration (ET) data for the years 2018 to 2020. More information on rainfall and ET data is provided in Attachment D. Net rainfall was estimated by considering the difference in observed rainfall and evaporation on any given day. All days when net rainfall was observed to be above -1 were classified as wet days. Dust discharges from haul roads on wet days are assumed to be zero. Therefore, TSP and PM_{10} concentration and deposition resulting from site discharges were set to zero on wet days.

Following all the post processing, TSP and PM_{10} predicted concentration and dry deposition resulting from truck movement on unpaved haul roads were assessed only during operational hours and on dry days.

The haul road modelling results section provides summary of predicted TSP and PM_{10} concentrations and TSP deposition at the following levels:

- Statistics derived from 24-hour average concentration of TSP and total deposited TSP[3]
- Statistics derived from 3-hour rolling average concentration of TSP and total deposited TSP
- Statistics derived from 8-hour rolling average concentration of TSP and total deposited TSP
- Statistics derived from 24-hour and annual average concentration of PM_{10}

[3] Deposition rate outputs from modelling are converted from µg/m^2/s to mg/m^2. Total deposited TSP is calculated by looking at the sum of TSP deposition over the assessed time-period (24-hour, 3-hour or 8-hour).

CALPUFF Modelling Results

TSP deposition and concentration results

Figure 4 provides a plot of predicted total TSP deposition at all receptor locations due to discharges from vehicle movement on haul roads on site, summarised over a 24-hour midnight-to-midnight period for all dry days observed between 2018 and 2020. Similarly, Figure 5 provides a summary plot of predicted 24-hour average TSP concentration at all receptor locations.

The boxplot shows the overall distribution of predicted 24-hour total TSP deposition or average concentration at each receptor and the cloud of pink dots show every 24-hour predicted value at each receptor location. The whiskers of the boxplot go from 5th percentile to 95th percentile. The box shows middle range of the distribution from 25th to 75th percentile predicted deposition values.

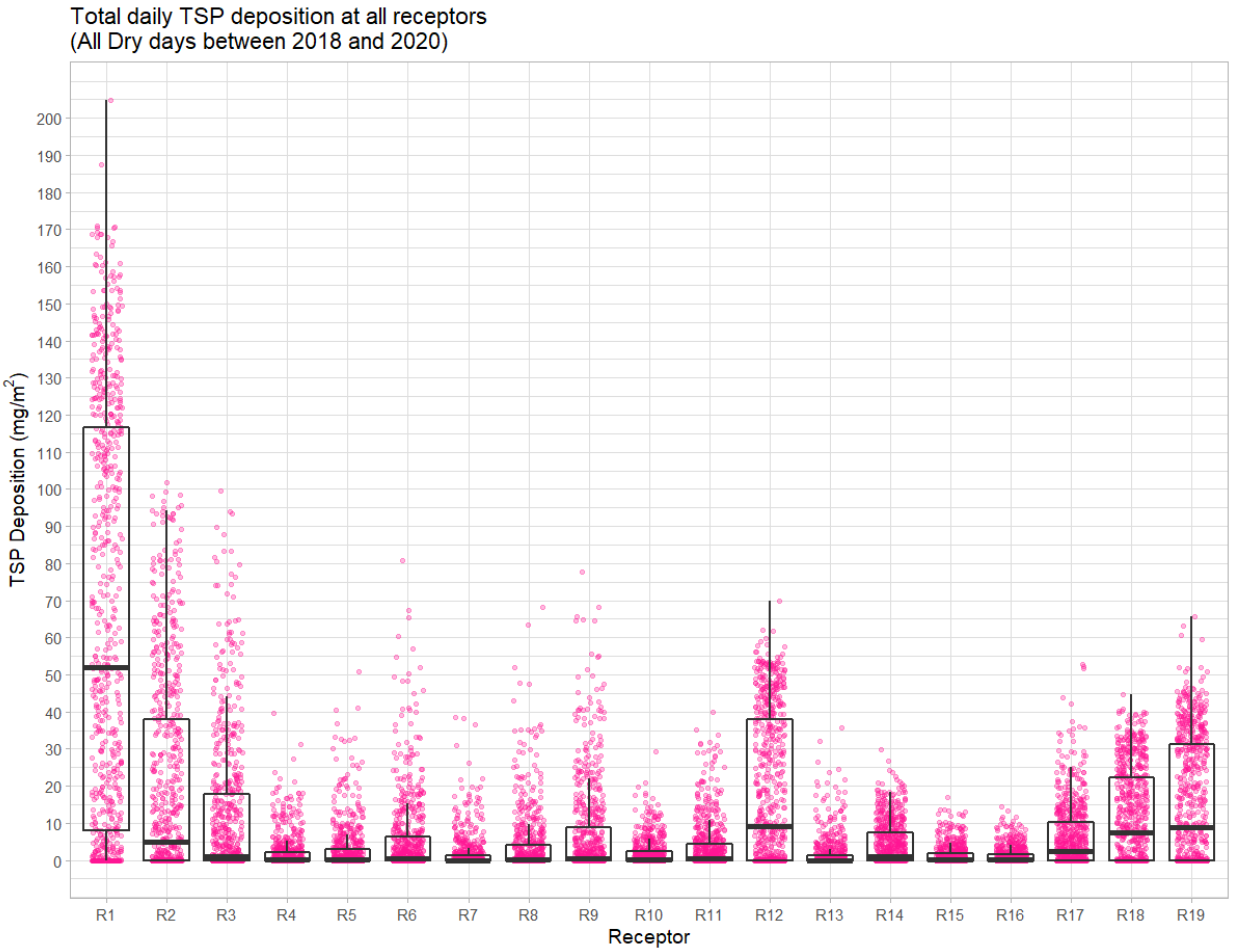


Figure 4: Total TSP deposition at each receptor location (over 24 hours).

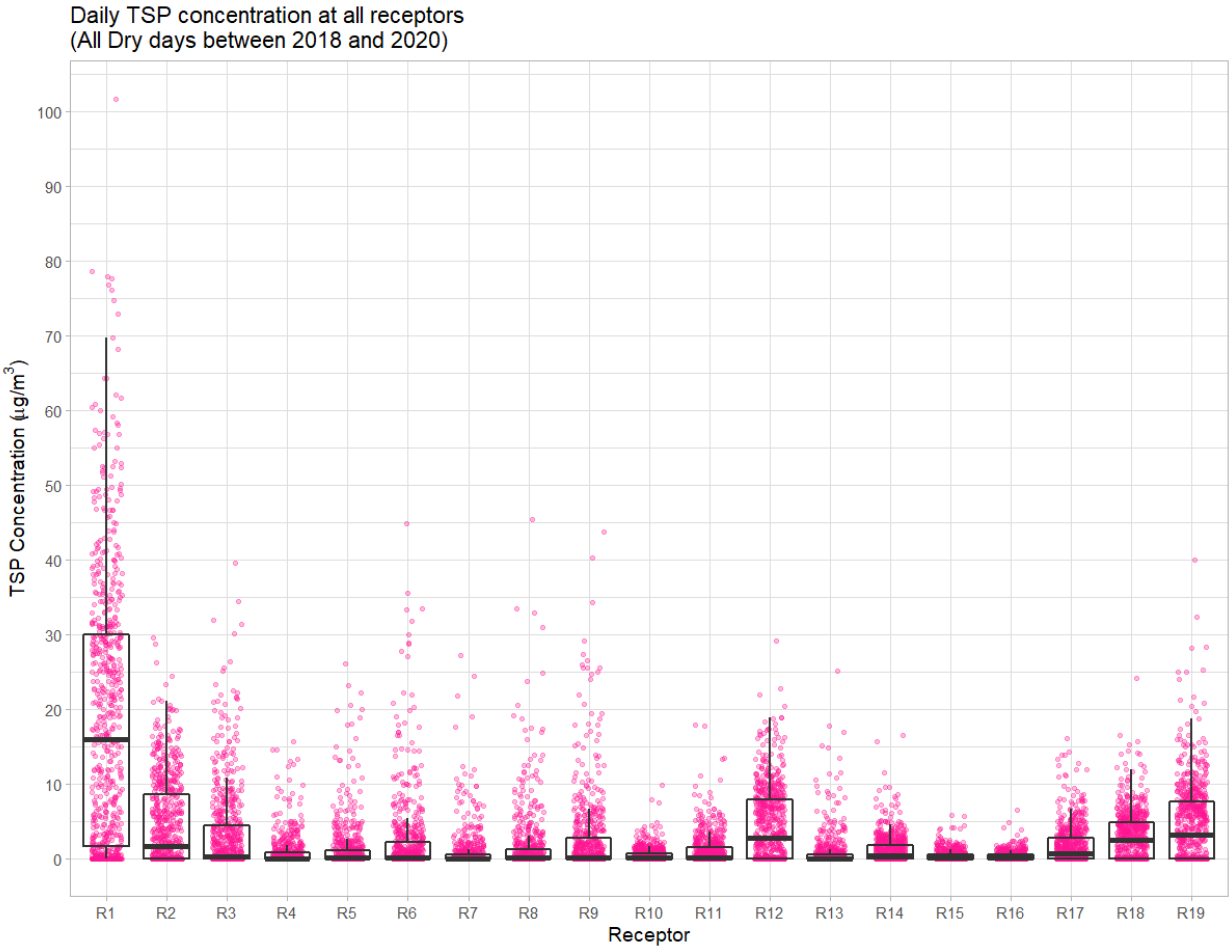


Figure 5: 24-hour average TSP concentration at each receptor location.

Table 4 to Table 6 present the summary of total TSP deposition and average TSP concentration predicted at each receptor location at 24-hour, rolling-8-hour and lastly hourly time resolution respectively. The 8-hour and hourly summaries provide insights into short-term impacts from haul road emissions on dry days.

Table 4:Summary of predicted TSP Impacts from trucks movements on haul roads summed over 24-hours.

Receptor	24-hour TSP deposition rate (mg/m^2)				24-hour TSP Concentration (µg/m^3)			
	Max.	95th	90th	80th	Max.	95th	90th	80th
R1	204.9	145.3	130.3	105.4	101.7	46.8	36.7	27.3
R2	101.8	69.6	54.4	26.8	29.6	14.2	11.2	6.2
R3	99.5	45.5	29.4	11.7	39.6	12.1	7.6	3.0
R4	39.7	9.4	3.9	1.1	15.6	3.3	1.6	0.4
R5	50.9	11.7	6.0	1.5	26.1	4.6	2.2	0.5
R6	80.9	20.2	12.9	3.9	44.8	8.0	4.1	1.1
R7	38.6	7.5	3.3	0.7	27.2	3.1	1.3	0.2
R8	68.2	15.4	8.1	1.9	45.3	6.1	2.6	0.6

R9	77.6	26.9	16.2	4.8	43.8	8.2	5.0	1.6
R10	29.3	7.5	4.5	1.4	9.9	1.8	1.2	0.4
R11	39.9	14.0	7.9	2.8	17.8	3.9	2.3	1.0
R12	69.8	50.9	45.5	30.9	29.2	11.4	9.4	6.8
R13	35.7	6.9	3.4	0.6	25.0	2.8	1.2	0.2
R14	29.9	14.4	10.9	5.6	16.4	3.5	2.6	1.4
R15	17.0	5.7	3.2	1.0	5.8	1.4	0.8	0.3
R16	14.4	5.0	2.9	1.0	6.5	1.2	0.8	0.3
R17	52.8	20.1	14.2	7.2	16.1	5.5	3.8	2.0
R18	44.7	32.4	28.1	17.9	24.1	7.3	5.8	4.3
R19	65.7	41.2	36.5	26.6	40.0	11.7	9.2	6.7

Table 5: Summary of predicted TSP Impacts from trucks movements on haul roads over ROLLING 8-hours.

Receptor	**8-hour TSP deposition rate (mg/m^2)**				**8-hour TSP Concentration (µg/m^3)**			
	Max.	**95th**	**90th**	**80th**	**Max.**	**95th**	**90th**	**80th**
R1	144.3	76.2	54.7	25.3	218.8	64.3	45.8	21.0
R2	71.3	31.7	17.1	2.5	77.6	19.7	11.8	2.2
R3	69.5	18.3	8.5	0.2	83.9	13.5	6.5	0.2
R4	29.2	2.7	0.7	0.0	41.5	2.7	0.7	0.0
R5	42.7	3.9	0.9	0.0	69.5	4.0	0.9	0.0
R6	66.6	8.0	2.4	0.1	109.0	8.0	2.2	0.1
R7	38.6	1.9	0.4	0.0	73.3	2.4	0.4	0.0
R8	53.9	5.4	1.3	0.0	98.5	5.3	1.3	0.0
R9	54.6	10.8	3.3	0.2	102.7	10.1	3.5	0.1
R10	29.3	2.7	0.8	0.0	27.9	2.2	0.8	0.0
R11	35.3	5.2	1.6	0.1	53.4	4.8	1.6	0.1
R12	50.0	25.8	17.2	5.1	59.8	16.6	11.5	4.1
R13	28.4	2.1	0.4	0.0	53.3	2.2	0.4	0.0
R14	20.3	6.6	3.7	0.5	34.6	4.8	2.6	0.4
R15	13.3	2.1	0.6	0.0	17.4	1.6	0.6	0.0
R16	12.1	1.9	0.6	0.0	17.7	1.5	0.5	0.0
R17	38.2	9.2	4.8	0.9	42.0	7.4	3.9	0.7
R18	31.5	16.0	10.5	3.4	47.7	10.5	7.4	2.9
R19	43.7	21.7	14.6	4.4	76.0	16.8	11.8	4.5

Table 6: Summary of predicted TSP Impacts from trucks movements on haul roads (hourly).

Receptor	1-hour total TSP deposition rate (mg/m^2)				1-hour TSP Concentration ($\mu g/m^3$)			
	Max.	95th	90th	80th	Max.	95th	90th	80th
R1	50.3	12.3	8.9	0.3	804.4	73.9	48.1	1.5
R2	23.7	5.3	0.6	0.0	382.0	25.0	4.0	0.0
R3	20.5	1.8	0.1	0.0	331.3	9.0	0.4	0.0
R4	14.2	0.1	0.0	0.0	224.8	0.5	0.0	0.0
R5	22.1	0.1	0.0	0.0	339.8	0.6	0.0	0.0
R6	28.7	0.3	0.0	0.0	445.9	1.9	0.1	0.0
R7	18.4	0.0	0.0	0.0	293.9	0.3	0.0	0.0
R8	22.2	0.1	0.0	0.0	357.5	1.0	0.0	0.0
R9	23.0	0.5	0.0	0.0	355.1	3.9	0.2	0.0
R10	12.6	0.1	0.0	0.0	131.1	0.8	0.0	0.0
R11	15.6	0.2	0.0	0.0	232.1	1.9	0.1	0.0
R12	13.9	4.3	2.9	0.0	226.0	19.0	12.7	0.0
R13	13.3	0.0	0.0	0.0	212.7	0.3	0.0	0.0
R14	6.5	0.9	0.1	0.0	121.4	4.6	0.8	0.0
R15	6.5	0.1	0.0	0.0	113.8	0.6	0.0	0.0
R16	5.0	0.1	0.0	0.0	92.1	0.6	0.0	0.0
R17	10.8	1.1	0.2	0.0	198.2	7.5	1.0	0.0
R18	10.8	2.8	1.3	0.0	198.2	13.1	7.7	0.0
R19	15.3	3.6	1.9	0.0	265.0	19.7	12.1	0.0

PM_{10} concentration results

Figure 6 shows midnight-to-midnight 24-hour average concentrations at each receptor location in the same manner as TSP deposition and concentration plots for all dry days between 2018 and 2020. The red line on the figure shows the National Environmental Standards for Air Quality (NESAQ) criteria for 24-hour PM_{10} concentrations.

Table 7 provides the top three predicted 24-hour average PM_{10} concentrations at each receptor location to assess the intensity of worst-case PM_{10} impacts from the truck movements on haul roads on dry days. The table also reports the predicted annual average PM_{10} concentrations at each receptor location.

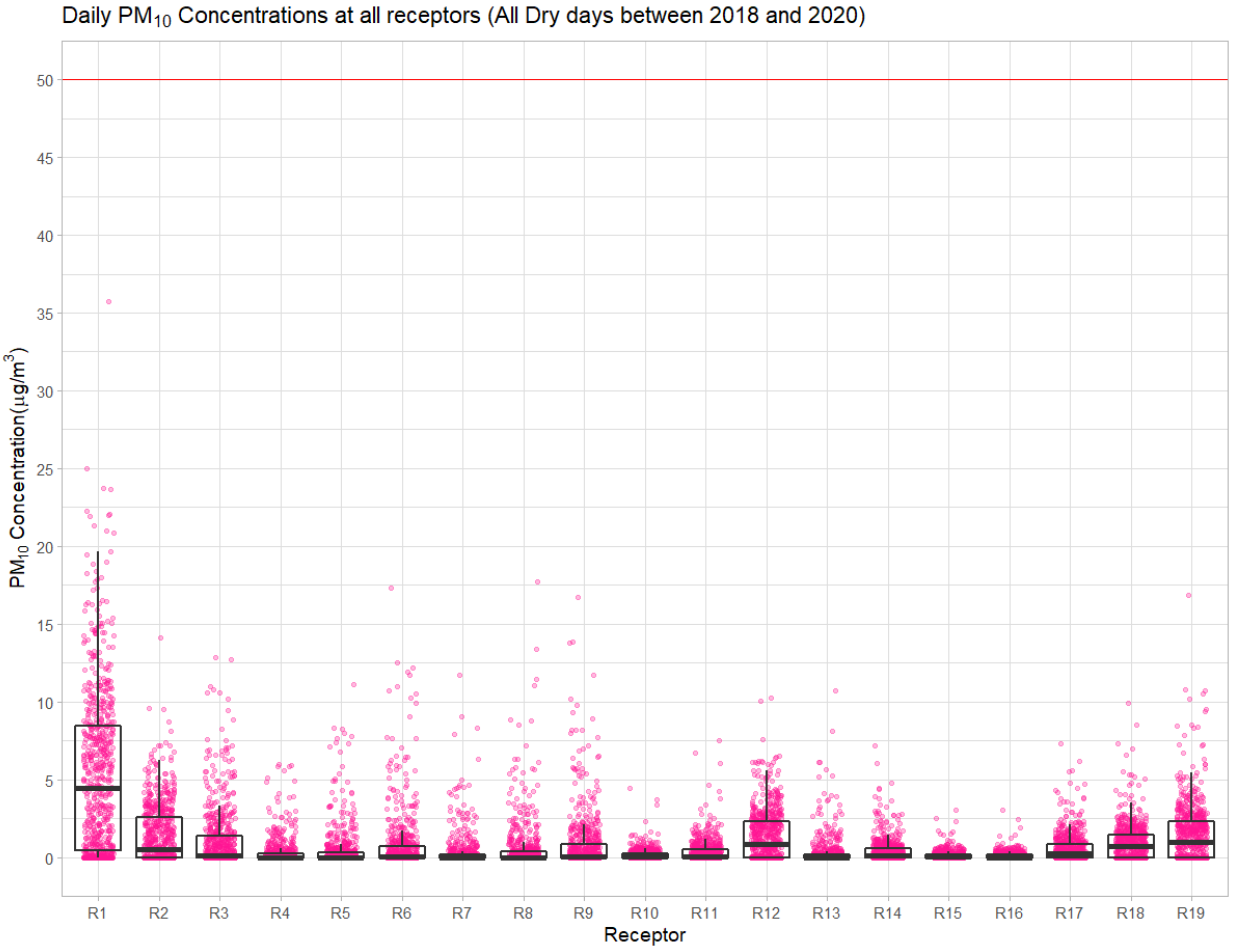


Figure 6: 24-hour average PM_{10} concentration at each receptor location.

Table 7: Summary of predicted PM_{10} ground level concentrations from trucks movements on haul roads.

Receptor	24-hour PM_{10} Concentration (µg/m^3)			Annual PM_{10} Concentration (µg/m^3)		
	Max.	2nd	3rd	Max.	2nd	3rd
R1	35.7	25.0	23.7	3.6	3.5	3.0
R2	14.2	9.6	9.5	1.0	1.0	0.7
R3	12.8	12.7	11.0	0.9	0.7	0.5
R4	6.0	5.9	5.9	0.4	0.2	0.1
R5	11.1	8.3	8.3	0.6	0.2	0.2
R6	17.4	12.5	12.2	0.9	0.3	0.3
R7	11.7	9.1	8.3	0.5	0.1	0.1
R8	17.8	13.4	11.5	0.8	0.2	0.2
R9	16.7	13.8	13.8	1.1	0.3	0.2
R10	4.4	3.7	3.4	0.1	0.1	0.1
R11	7.5	6.8	6.0	0.3	0.2	0.2
R12	10.3	10.1	7.6	0.9	0.9	0.8
R13	10.7	8.1	6.1	0.4	0.1	0.1

R14	7.2	6.0	4.8	0.5	0.2	0.2
R15	3.0	2.5	2.3	0.1	0.1	0.1
R16	3.1	2.5	1.9	0.1	0.1	0.1
R17	7.3	6.2	5.6	0.4	0.4	0.3
R18	9.9	8.5	7.3	0.7	0.6	0.5
R19	16.8	10.8	10.7	1.3	0.7	0.7

ATTACHMENT G – DRY WINDY CONDITIONS ANALYSIS

General

Strong winds, especially in dry conditions can mobilise the dust from active exposed areas of Cromwell Certified Concrete (CCC) quarry and blow them in the prevalent wind direction. The receptors that end up being downwind of the active exposed areas in dry windy conditions are likely to be exposed to the dust discharges from the site.

This attachment provides details on an analytical assessment undertaken to assess the potential dust impacts from the site in dry windy conditions at various locations around the site.

Location of Open Dust Areas

Cromwell Certified Concrete (CCC) existing quarry and the proposed expansion area are shown in Figure 1. This highlights in purple, areas of the existing quarry and expansion area, assumed to have continuous heavy vehicle movements.

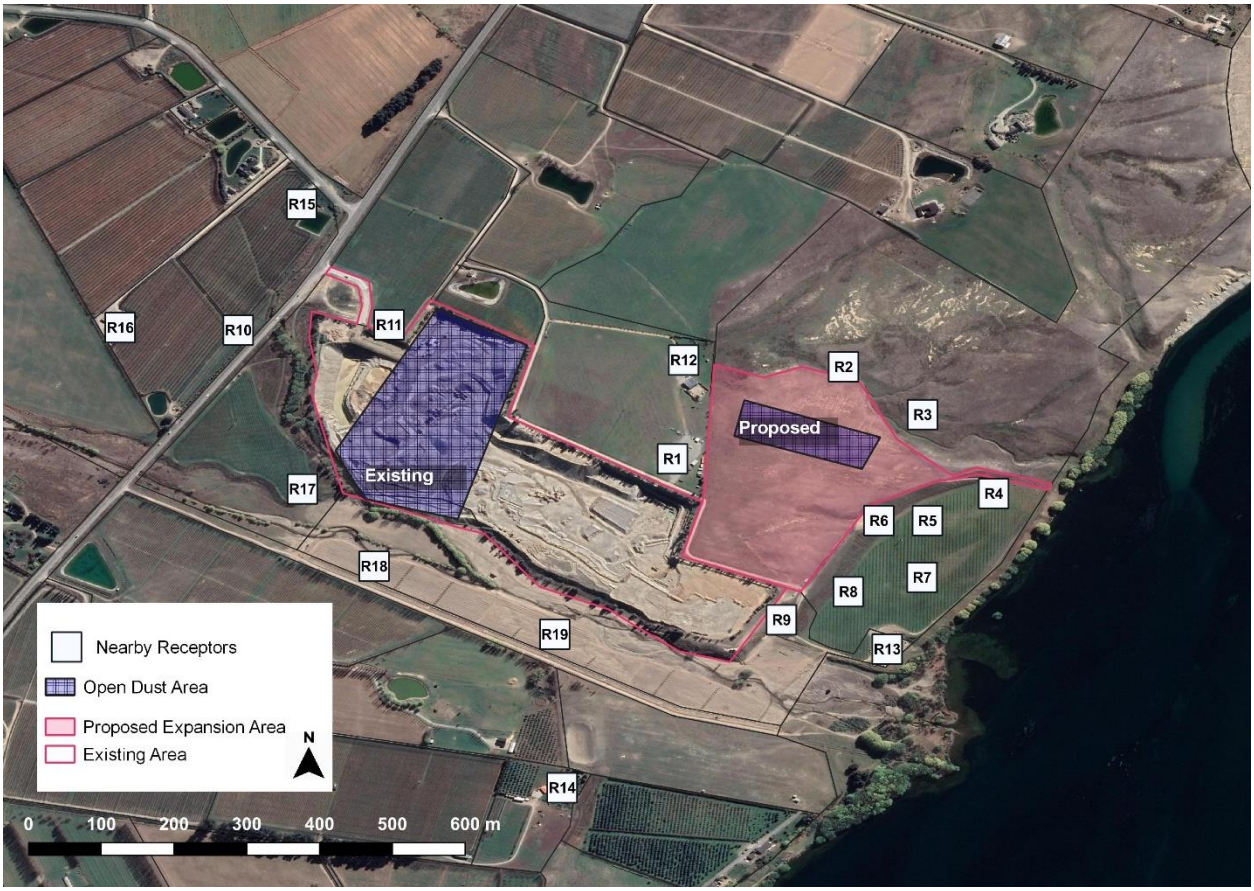


Figure 1: Site location, active exposed areas and nearby sensitive receptors.

Distance and Downwind Angles to Nearby Receptors

Nearby activities, both residential and non-residential have been identified in Figure 1. More details of each of the receptors are provided in Attachment F of the evidence presented by R S Cudmore.

The distance to each of the active exposed areas identified in Figure 1 as purple areas, along with wind directions for which each identified receptor is likely to be downwind of either of the active exposed areas on existing or proposed quarry are provided in Table 1: Receptor-to-source downwind angles and distances..

Table 1: Receptor-to-source downwind angles and distances.

	Existing open dust area			Proposed open dust area		
	Downwind angles		Distance	Downwind angles		Distance
ID	From (^{0})	To (^{0})	(m)	From (^{0})	To (^{0})	(m)
R1	246	315	255	38	92	97
R2	238	279	441	157	242	110
R3	250	284	565	216	274	73
R4	264	292	702	282	302	187
R5	268	299	628	299	335	136
R6	268	302	575	307	358	104
R7	277	307	651	314	345	228
R8	282	315	560	336	4	241
R9	290	324	543	351	18	309
R10	79	149	227	98	105	716
R11	62	194	45	104	112	515
R12	223	284	219	116	152	115
R13	289	317	648	330	356	354
R14	331	354	544	16	31	727
R15	129	172	277	117	124	724
R16	82	132	375	97	102	877
R17	30	103	88	72	84	608
R18	348	53	125	55	72	570
R19	312	353	260	27	50	450

Assessment Approach

Data sources

Site-specific hourly wind speed and direction data was extracted from CALMET dataset for the years 2018, 2019 and 2020. More details on CALMET meteorological modelling are provided in Attachment D of the evidence presented by R S Cudmore.

Daily rainfall and Evapotranspiration (ET) data were obtained from Cromwell EWS station managed by NIWA. More details on the source of this data are provided in Attachment E of the evidence presented by R S Cudmore.

Identification of dry windy conditions when receptors are downwind

A combination of modelled wind data and observed rainfall and ET data was used to identify dry windy periods for the years 2018, 2019 and 2020.

- **Dry day**: Net rainfall was estimated by considering the difference in observed rainfall and evaporation on any given day. Any day when net rainfall is less than 0 is classified as *dry day* and all days with net rainfall greater than 0 were classified as wet days (see Attachment E to the evidence of R S Cudmore for further details).
- **Windy periods**: All hours when the wind speeds are greater than 6 m/s are classified as *windy hours*. To account for the variations in wind speeds, if the wind speed dipped below 6 m/s for one hour, the hour was still classified as a *windy hour*.

Downwind periods were flagged using modelling wind direction ranges for which a receptor is expected to be *downwind* of either of the two active dust sources are provided in Table 1. A 2-degree buffer at both minimum and maximum bearings was applied to get a conservative range of downwind angles for each receptor.

Hours when the receptor location was *downwind* of either of the two sources in *dry windy* conditions are summarised in the following sections to assess the potential of dust impacts from the site at these locations.

Results

Percentage time of dry windy conditions and receptor downwind

Percentage of time a receptor is downwind of either or both active exposed areas in dry windy conditions was derived at a seasonal level. This statistic is useful in assessing the overall frequency of dust episodes at each receptor location in the long-term. The results of each receptor are provided in Table 2. These are discussed in detail in the evidence presented by R S Cudmore.

Table 2: Percentage of dry windy condition when receptor is downwind.

Receptor	Autumn (%)	Spring (%)	Summer (%)	Winter (%)
R1	**4.9**	**7.6**	**7**	1
R2	**4.6**	**6.6**	**9.4**	1.5
R3	1.8	2.2	2.5	0.4
R4	0.1	0	0	0
R5	0.1	0	0	0
R6	0.1	0.3	0.3	0.1
R7	0	0.1	0.1	0.1
R8	0	0.4	0.5	0.1
R9	0.1	1	1.1	0.1
R10	0.8	0.6	1.1	0.1
R11	3.4	3.6	**6.5**	0.8
R12	1.4	1.8	2.1	0.2

R13	0	0.2	0.2	0.1
R14	0.4	2.9	2.7	0.3
R15	0.4	0.8	1.9	0.1
R16	0.7	0.5	0.7	0.1
R17	**4.9**	**9.6**	**8.5**	1.2
R18	**4.3**	**10.7**	**9.5**	1.3
R19	2.8	**8**	**6.3**	1

Duration of dry windy conditions

Duration of dry windy conditions were estimated based on total number of consecutive dry windy hours when the receptors were downwind of either or both active exposed areas of the site. The duration of all events was summarised by season for each receptor and are presented in Figure 2.

For each season, the boxplot shows the overall distribution of duration of dry windy conditions when the receptors are downwind, and the cloud of pink dots show the duration of each event. The whiskers of the boxplot go from 5th percentile to 95th percentile. The box shows middle range of the duration of events from 25th to 75th percentile that are most typically observed at each receptor location. Some receptors are seen to have fewer events of long durations while some are observed to have more events of short durations. The results are discussed in further detail in the evidence presented by R S Cudmore.

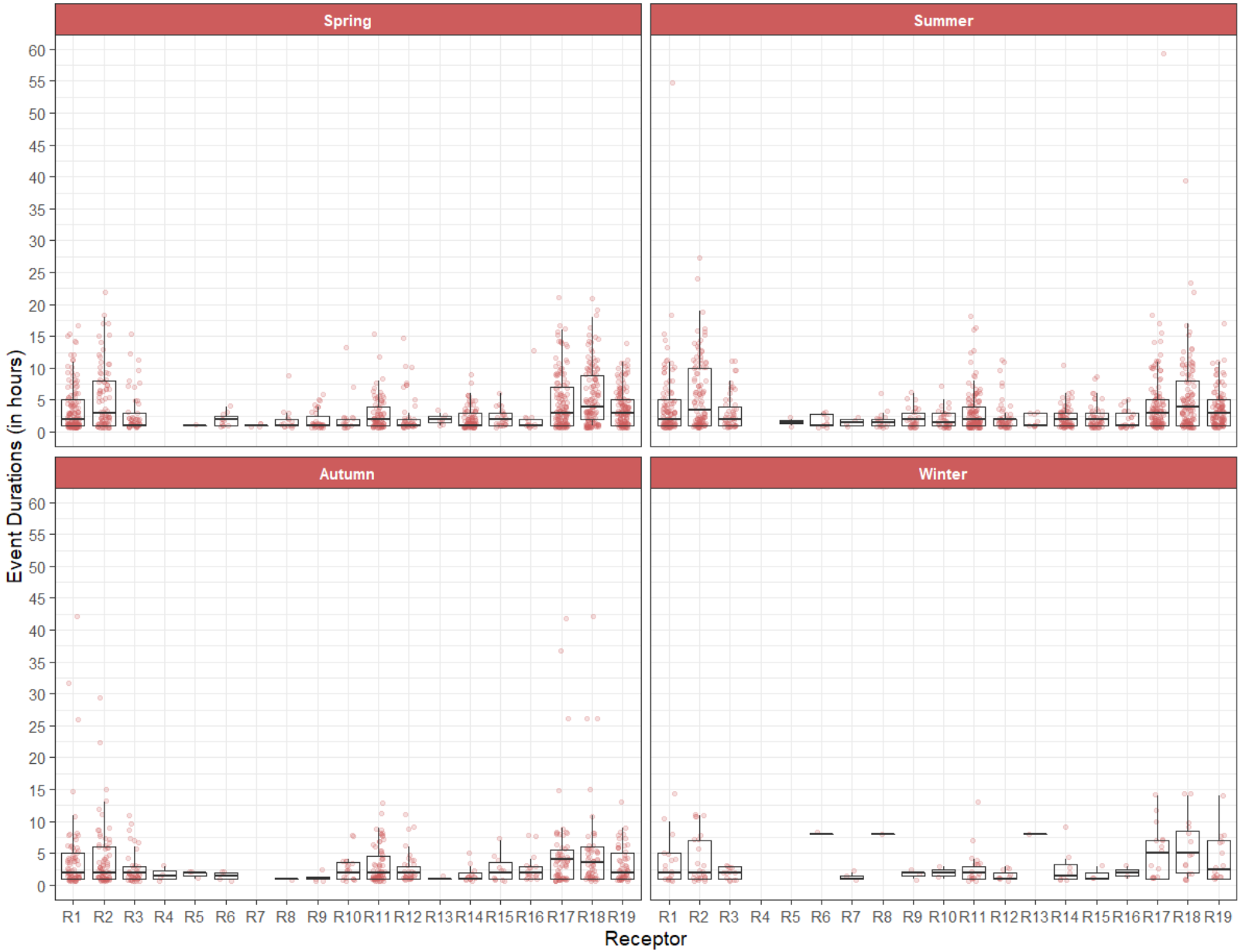


Figure 2: Duration of events of dry windy conditions at each receptor when downwind of the site active exposed areas (in hours).

Duration in between events

Building on the calculation of duration of events of dry windy conditions when receptor is downwind, duration in between events was also derived for each receptor location. Figure 3 shows all duration in between dry, windy and downwind events at all receptor location summarised seasonally in the similar manner as for duration of events.

In contrast to duration of events, if the events are more frequent, the number of hours in between the events would be small. If events occur occasionally, the number of hours in between the episodes is expected to be relatively larger.

Figure 4 shows the same information as Figure 3, but for selected receptors that are expected to be the most impacted locations in dry windy conditions due to longer periods of being downwind of the site. The results are discussed in detail in the evidence presented by R S Cudmore.

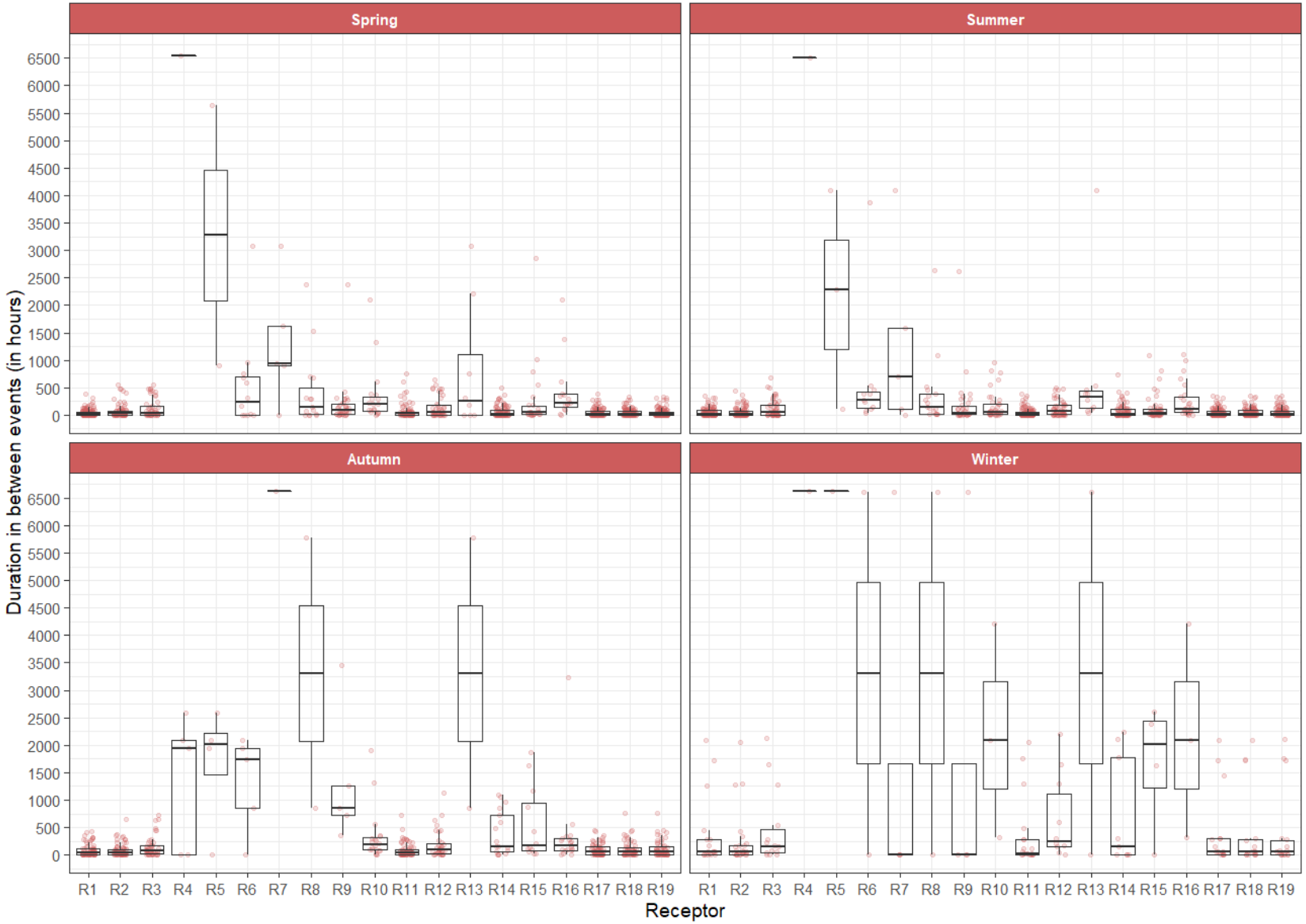


Figure 3: Duration in between events of dry windy conditions at each receptor when downwind of the site active exposed areas (in hours) – All Receptors.

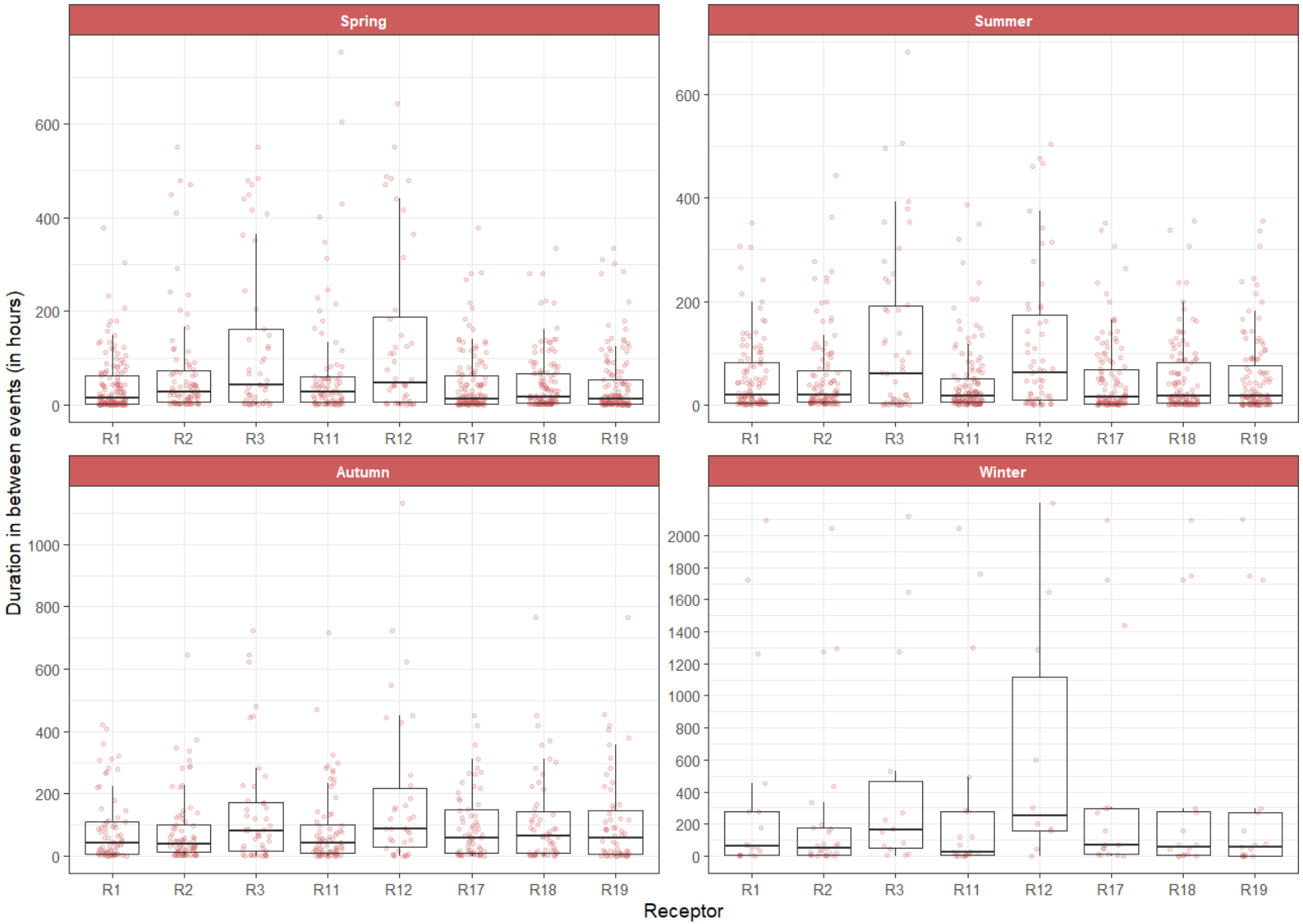


Figure 4: Duration in between events of dry windy conditions at each receptor when downwind of the site active exposed areas (in hours) - Most impacted receptor.

Timeseries Plots for ALL Receptors

Timeseries plots from 2018 to 2020, were generated to provide a visual summary of dry windy conditions when receptors are downwind of either or both the active exposed areas. These are provided in the following figures where the green lines are shown as wind speed is greater than or equal to 6 m/s in dry conditions when the respective receptor is downwind, and white spaces in between show the duration in between two potential dust erosion episodes.

Dry windy hours when R1 is downwind

Dry windy hours when R2 is downwind

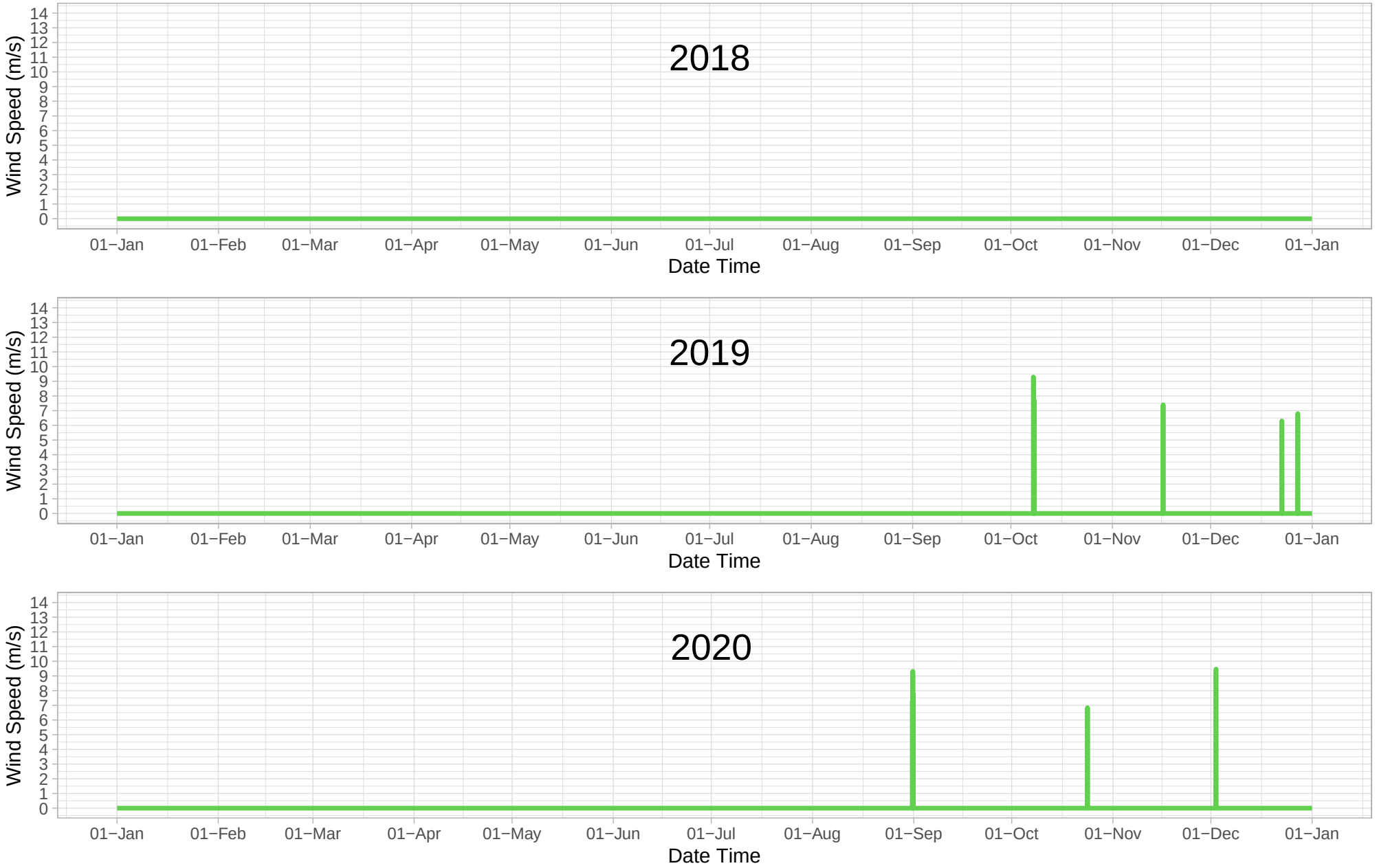
Dry windy hours when R3 is downwind

Dry windy hours when R4 is downwind

Dry windy hours when R5 is downwind

Dry windy hours when R6 is downwind

Dry windy hours when R7 is downwind

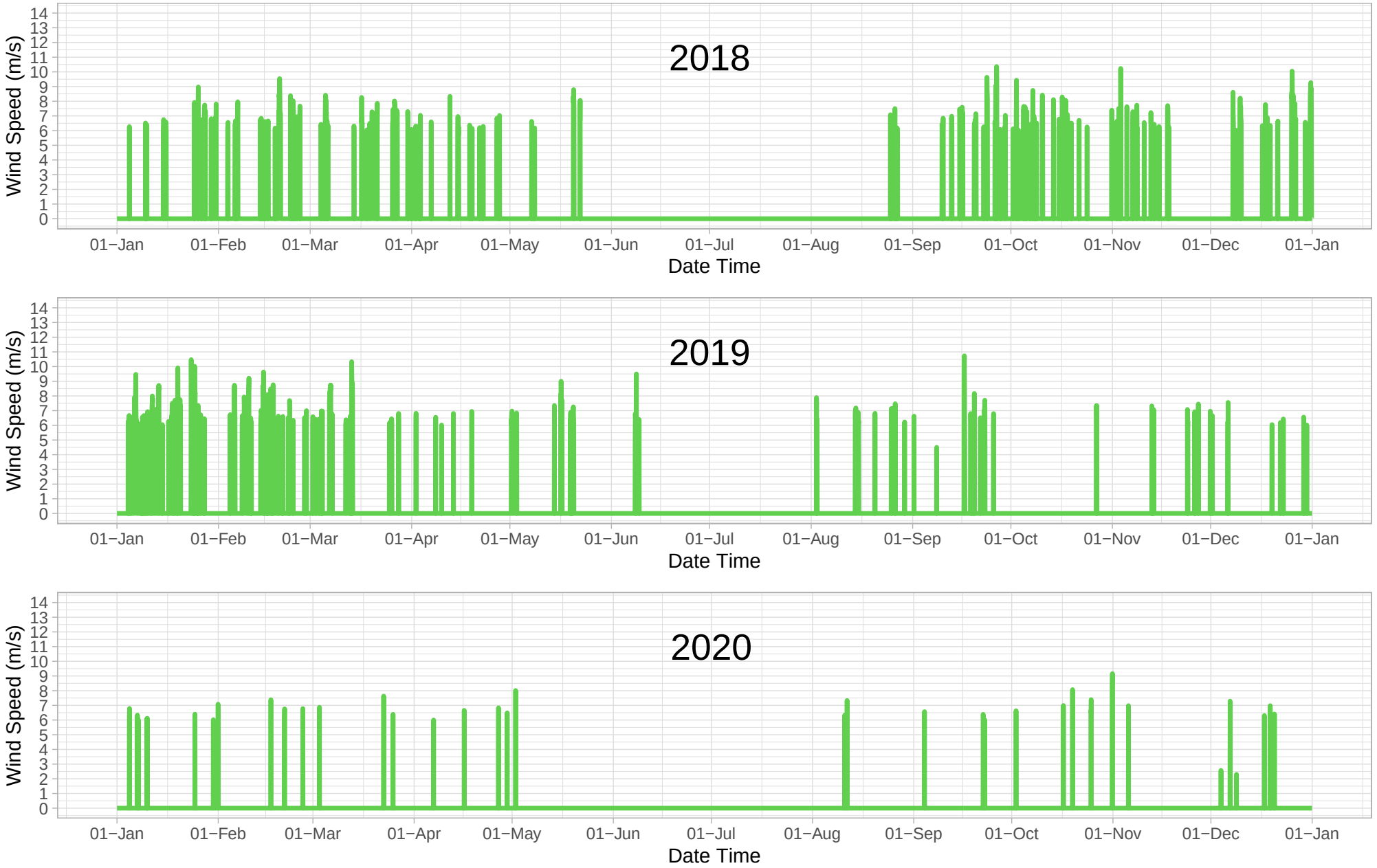


Dry windy hours when R8 is downwind

Dry windy hours when R9 is downwind

Dry windy hours when R10 is downwind

Dry windy hours when R11 is downwind



Dry windy hours when R12 is downwind

Dry windy hours when R13 is downwind

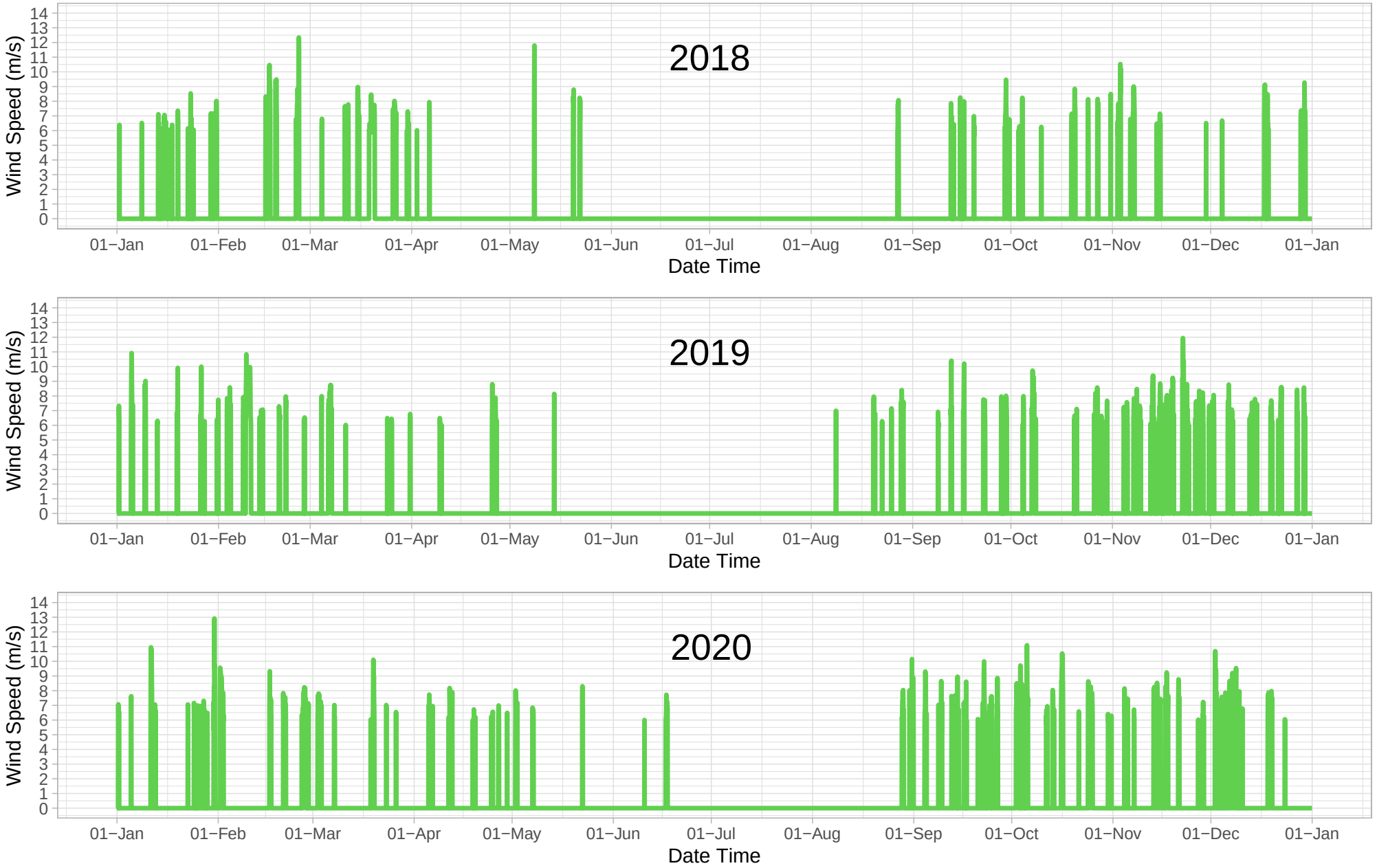
Dry windy hours when R14 is downwind

Dry windy hours when R15 is downwind

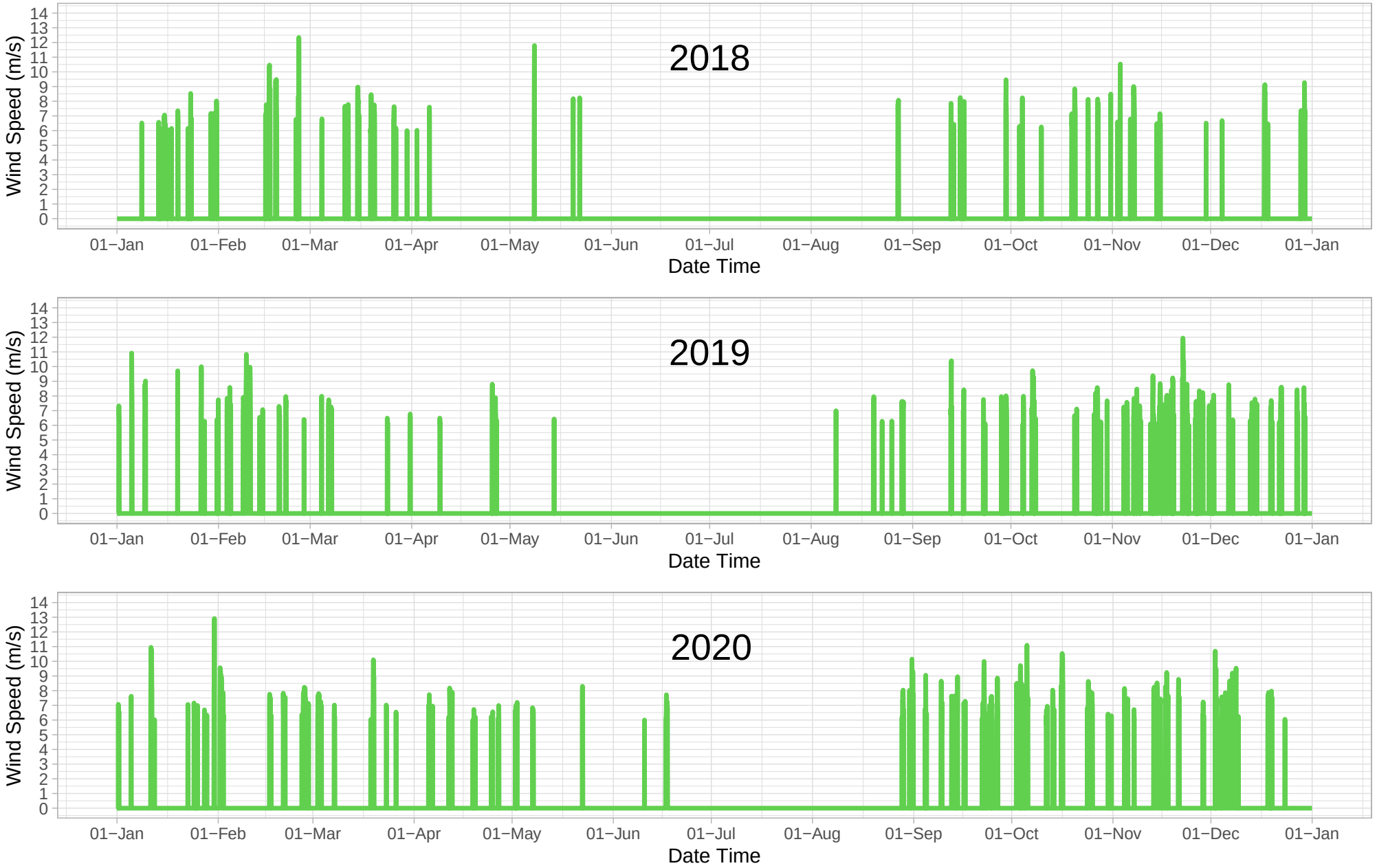
Dry windy hours when R16 is downwind

Dry windy hours when R17 is downwind

Dry windy hours when R18 is downwind



Dry windy hours when R19 is downwind



ATTACHMENT H – DRAFT AIR DISCHARGE PERMIT CONDITIONS

RM20.360.03: Air Discharge Consent (Discretionary activity) Draft Conditions

DISCHARGE PERMIT

Pursuant to Section 104B of the Resource Management Act 1991, the Otago Regional Council grants consent to:

Name: Cromwell Certified Concrete Limited

Address: 810 Great South Road, Penrose, Auckland 1061

Activity: To discharge contaminants to air for the purpose of operating an alluvial quarry

Term: 25 years

Location of consent activity: 1248 Luggate-Cromwell Road (State Highway 6)

Legal Description of consent location: Lots 3, 5 and 8 DP 301379

General Conditions

1 If this consent is not given effect to within a period of five years from the date of commencement of this consent, this consent shall lapse under Section 125 of the Resource Management Act 1991. The consent shall attach to the land to which it relates.

2 Aggregate extracted from the site must not exceed 200,000 cubic metres in any 12-month period.

3 The discharge shall not cause dust or the deposition of particulate matter that causes an objectionable or offensive effect beyond the boundary of the site.

4 The Quarry Manager or another nominated person, must be available at all times (including outside quarry operation hours) to respond to dust emission complaints and issues in accordance with measures described in the Dust Management Plan (DMP).

5 The maximum area of unconsolidated land comprising of the excavation area, backfilling areas and rehabilitation area shall not exceed two hectares.

Advice Note: The maximum area of unconsolidated land does not include the haul roads, processing area, stockpiles, portacoms or workshop.

Dust Management Plan (DMP)

6 At least 20 working days prior to the commencement of quarry activities, the Consent Holder must prepare a Dust Management Plan (DMP) for the certification of the Consent Authority.

7 Works must not commence until the Consent Holder has received written certification of the DMP. Notwithstanding this, the works may proceed if the Consent Holder has not received a response from the Consent Authority within 10 working days of the date of the submission of the DMP.

8 The DMP must include, but not be limited to:

(a) A description of the purpose of the DMP;
(b) A description of the dust sources on site;
(c) A description of the receiving environment and identification of sensitive receptors within 250 metres of site boundaries;

(d) The methods (including dust reduction through design methodologies), which will be employed as necessary to ensure compliance with the conditions of this consent;
(e) A description of site rehabilitation methodology and associated dust control measures;
(f) A description of particulate matter and wind monitoring requirements including:

  (i) The location of the wind monitoring station;
  (ii) The location of permanent and mobile particulate matter monitors between active work areas within the quarry and sensitive off-site activities;
  (iii) Details of wind speed trigger levels as set out in Condition 9 and associated alarm system. This shall account for the concurrent wind direction as measured in accordance with Conditions 14 and 15;
  (iv) Details of the particulate matter trigger levels as set out in Condition 9 and associated alarm system; and
  (v) Monitoring instrumentation methodology, setup requirements, maintenance and calibration procedures;

(g) A description of procedures for responding to dust and wind condition-based trigger levels and associated follow up investigations, actions and recording of findings;
(h) A system for training employees and contractors to make them aware of the requirements of the DMP;
(i) Names and contact details of staff responsible for implementing and reviewing the DMP in order to achieve the requirements of this consent, and procedures, processes and methods for managing dust outside of standard operating hours;
(j) A method for recording and responding to complaints from the public;
(k) A maintenance and calibration schedule for meteorological and particulate matter monitoring instruments;
(l) Contingency measures for responding to dust suppression equipment malfunction or failures, including wind and particulate matter monitoring instruments.
(m) Separate Standard Operating Procedures (SOPs) dedicated to the management of potential dust discharges from specific sources, including but not limited to:

  (i) Stockpiles;
  (ii) Site roads – sealed and unsealed;
  (iii) Triggers for the increased use of ~~water for~~ dust suppression methods;
  (iv) The use of dust suppressants in conjunction with water;
  (v) Aggregate excavation and backfilling areas;
  (vi) Topsoil and overburden stripping and stockpiling;
  (vii) Bund construction, maintenance and the recontouring of slopes during rehabilitation;
  (viii) Any automated dust suppression for areas prone to dust erosion that can be activated outside of working hours;
  (ix) Location and calibration of ambient particulate concentration and meteorological monitoring equipment;

(n) Environmental information management for recording, quality assurance, archiving and reporting all data required for dust management of the site.

Advice Note: For the purpose of this consent, sensitive receptor means:

a) Residential dwellings and associated private property, including the area within 20m of the façade of an occupied dwelling;
b) Public roads;
c) Areas of significant indigenous vegetation and significant habitats of indigenous fauna; and

d) Commercially important or sensitive plants, crops or farming systems

Trigger Levels and Dust Mitigation

Trigger Levels

9 Quarry activities (except dust suppression measures) within 250 metres of a sensitive receptor location must not be undertaken when:

(a) Wind speed reaches or exceeds 7 m/s (10 min average); and
(b) Quarry activities would be directly upwind of a sensitive receptor (10-minute average wind direction).
(c) Less than 1 mm of rain has fallen during the preceding 12 hours.

10 Any quarry activities (except dust suppression measures), which are upwind of any real-time dust monitor (as specified in Conditions 17 to 22), must cease when the monitor records PM_{10} concentrations, which are ≥ 150 micrograms per cubic metre ($\mu g/m^3$), as a 1-hour average, which is updated every ten minutes. The quarry activities shall only recommence following the implementation of effective dust mitigation which achieves compliance with Condition 10.

11 If at any time, including outside normal operating hours, visible dust is blowing beyond the site boundary the Consent Holder must:

(a) Immediately investigate, identify and cease all quarry activities (except dust suppression measures and vehicle movements along the site access road), which are causing the visible dust blowing beyond the site boundary;
(b) Confirm that automated dust suppression water systems are working and immediately implement additional dust suppression measures, which target the identified areas causing the dust event;
(c) Only resume quarry activities (other than dust suppression) once there is no longer visible dust blowing beyond the site boundaries and there are no breaches of Conditions 9 and 10; and
(d) Notify the Consent Authority as soon as practicable, detailing the cause of the dust event (including any off-site sources) and the dust suppression actions undertaken.

12 If the investigation required under condition 11(a) determines the source of dust is localised to the excavation area only and is only impacting on areas downwind of this source, then activities within the central processing area, including sales of product can continue. This is contingent on all activities within the existing processing and load out area to be not causing visible dust blowing beyond the site boundary and their downwind real time PM_{10} monitors not reaching or exceeding the trigger in condition 10.

Mitigation Measures

13 The Consent Holder must take all reasonably practicable measures to minimise the discharge of dust from quarry activities, including but not limited to:

(a) Assessing weather and ground conditions (wind and dryness) at the start of each day and ensure that applicable dust mitigation measures and methods are ready for use prior to commencing quarry activities;
(b) Taking wind direction and speed into account in planning quarry activities to minimise the risk of dust dispersion towards any residential dwellings that are within 250 metres of the site boundary;

(c) Water suppression such as using water carts or fixed sprinklers will be applied as required to dampen down unpaved areas and stockpiles, which are prone to generate dust. This must occur during dry weather, irrespective of wind speed;
(d) Carrying out topsoil and overburden stripping and land rehabilitation during winter months when ground conditions are damp and winds are below 7 m/s (10 minute average);
(e) Pre-dampening topsoil and overburden, if necessary, with a water cart or sprinklers prior to its stripping and removal.
(f) Constructing and maintaining unsealed internal haul roads so that their surfaces consist of a crushed clean aggregate layer that is free of potholes;
(g) Minimising drop heights when loading trucks and when moving material;
(h) Operating fixed and mobile crushing plant in conjunction with water dust suppression (either sprays or high-pressure fogging system) as necessary to avoid the dust trigger level, as specified in Condition 15, being reached or exceeded;
(i) Undertaking routine onsite and offsite inspections of visible dust emissions and deposited dust throughout each day of quarry activities and electronically logging findings and any dust suppression actions, and to make the results of the inspections available to the Consent Authority when requested;
(j) Maintaining an adequate supply of water and equipment on site for the purpose of dust suppression at all times;
(k) Imposing a speed restriction on all internal haul and access roads to 30 kilometres per hour if these are either sealed or constructed from crushed clean aggregate;
(l) Sealing the first 50m of the access road from the entrance off Luggate-Cromwell Highway to the site;
(m) Application of water via watercart or fixed irrigation of dust suppression water onto any section of the external access road shall only be used as a contingency/back up measure.

Meteorological Monitoring

14 Prior to exercising this consent, the Consent Holder shall install a meteorological monitoring station at the location described in the DMP. The meteorological monitoring station shall be capable of continuously monitoring:

(a) Wind speed and direction at a height of 6 m above the natural ground level; and
(b) Temperature.

15 The meteorological monitoring instruments shall:

(a) Measure wind speed as 1-minute scalar averages with maximum resolution of 0.1 metres per second (m/s), have an accuracy of at least within +/-0.2 m/s, and a stall speed no greater than 0.5 m/s;
(b) Measure wind direction as 1-minute vector averages with maximum resolution of 1.0 degree and accuracy of at least within +/- 1.0 degree, and a stall speed no greater than 0.5 m/s;
(c) Measure screened temperature with accuracy of +/- 0.5 degree;
(d) Located on the subject property in accordance with AS/NZS 3580:14-2014 (Methods for sampling and analysis of ambient air – Part 14 Meteorological monitoring for ambient air quality monitoring applications). If the monitoring station cannot be located in accordance with AS/NZS 3580:14-2014 an alternative location shall be agreed in writing with the Consent Authority;

(e) Maintain a data and time stamped electronic record for at least 36 months of meteorological monitoring results, recorded as rolling 10-minute averages, which are up-dated every one-minute in real-time.
(f) An alarm to the Quarry Manager (for example via mobile phone) must be provided if the rolling average wind speed and downwind trigger levels in Condition 9 are reached or exceeded.
(g) Maintained and calibrated in accordance with the manufacturer's specifications.

16 All meteorological monitoring data shall be made available to the Consent Authority on request.

Particulate Matter Monitoring

17 Prior to exercising of this consent, the consent holder shall operate and maintain one permanent real-time dust management monitor for continuous monitoring of ambient 10-minute average PM_{10} concentrations, which is installed and operated at a fixed location at the existing quarry's southwest boundary and in accordance with the DMP.

Advice Note: The permanently located real-time dust management monitor shall be an accepted method for general dust management/monitoring purposes, and does not need to be a certified US EPA, or National Environmental Standards for Air Quality (NESAQ) compliant method.

18 The permanent monitor shall be installed, operated, maintained and calibrated in accordance with the AS/NZS 3580.12.1:2015 *Methods for sampling and analysis of ambient air - Determination of light scattering - Integrating nephelometer method*, or else an equivalent, or superior standard which is approved by the Consent Authority;

19 Prior to the exercising of this consent, the consent holder shall operate and maintain two mobile real-time dust management monitors for continuous monitoring of ambient ten-minute average PM_{10} concentrations, whose location changes for different stages of the quarry development and in accordance with the DMP.

20 The mobile real-time dust management monitors can be equivalent to that used for the permanently located dust monitor, or else be a lower cost method, on the basis that this can be effectively calibrated against the permanent dust monitor.

21 The two mobile dust monitors shall be positioned at different site boundary locations, such that real-time dust monitoring is undertaken at locations, which are between active dust sources and downwind sensitive receptor locations, when the latter are within 250 m of the dust source, as described in the DMP.

22 Other general requirement for all three dust monitors includes the following:

(a) Sited in general accordance with AS/NZS 3580.1.1:2016 Methods for sampling and analysis of air - Guide to siting air monitoring equipment;
(b) Have a GPS location service (or similar technology) which enables their locations to be remotely monitored and recorded.
(c) Able to provide and record the results continuously using an electronic data logging system with an averaging time for each parameter of not more than one minutes;
(d) Able to record monitoring PM_{10} concentrations in real-time as rolling 1-hour averages, updated every 10-minutes in an appropriate electronic format;
(e) Fitted with an alarm system that is able to send warnings and alerts to the Quarry Manager or other nominated person; and
(f) Maintained in accordance with the manufacturer's specifications.

Bund Formation

23 When constructing the bunds, the following controls apply:

(a) Wherever possible the bunds shall be constructed during winter months (1st May to 1st September);
(b) Maintain a buffer distance of 250 m when wind speeds are above 7 m/s (10 minute average) in a direction towards the nearest sensitive locations;
(c) Material to be excavated must be thoroughly wetted using a water cart, if not already damp, ahead of excavation and wetted thoroughly thereafter;
(d) Wind monitoring must be carried out and dust generating activities shall cease when the wind is blowing towards sensitive locations and the wind speeds exceed 7 m/s (10 minute average) in accordance with Condition 9;
(e) Vegetated cover shall be established as soon as practicable and maintained to ensure healthy cover during dry months.

Complaints Register

24 The Consent Holder shall maintain a Complaints Register for any complaints received. The Complaints Register must include:

(a) The date and time the complaint was received;
(b) The nature and location of where the complaint has originated, if provided;
(c) A summary of the complaint;
(d) Particulate matter and wind conditions at the time the when the dust was observed by the complainant; and
(e) Any corrective action undertaken by the Consent Holder to avoid, remedy or mitigate the issue raised.

25 The Complaints Register must be provided to the Consent Authority on request.

Review

26 The Consent Authority may, in accordance with Sections 128 and 129 of the Resource Management Act 1991, serve notice on the consent holder of its intention to review the conditions of this consent within 3 months of each anniversary of the commencement of this consent for the purpose of:

(a) To deal with any adverse effect on the environment which may arise from the exercise of the consent that was not foreseen at the time of granting of the consent, and which is therefore more appropriate to deal with at a later stage; and/or
(b) To require the Consent Holder to adopt the best practicable option to reduce any adverse effects on the environment resulting from the activity; and/or
(c) Ensuring the conditions of this consent are consistent with any National Environmental Standard or National Planning Standard.

ATTACHMENT I – DRAFT DUST MANAGEMENT PLAN

GOLDER
MEMBER OF WSP

REPORT

Dust Management Plan

Amisfield Quarry

Submitted to:

Cromwell Certified Concrete Limited

1248 Luggate-Cromwell Rd, Mount Pisa, Cromwell, Central Otago, New Zealand

Submitted by:

Golder Associates (NZ) Limited

Level 1, 214 Durham Street, Christchurch 8011

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21480092-001-R-Rev0

November 2021

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APPENDICES

1.0 INTRODUCTION

Cromwell Certified Concrete Ltd (CCCL) operates the Amisfield Quarry located on predominantly flat land off Luggate Cromwell Road (State Highway 6), Central Otago.

CCCL plan to expand the annual production of aggregate at the site from 70,000 to 200,000m^3 per year. This expanded production exceeds the permitted extraction rate of 100,000m^3 per year and requires consent under Rule 16.3.5.3 of the Regional Plan: Air for Otago (Air Plan). The operating area of the expanded quarry is approximately 27ha.

This DMP has been written with reference to the Ministry for the Environment (MfE) "Good Practice Guide for Assessing and Managing Dust" (MfE 2016)[1]. The matters listed above cover those that are listed in xxxxxx of the regional air plan.

Purpose

The purpose of this Dust Management Plan (DMP)[2] is to provide a framework for managing dust emissions from the expanded quarry so that potential adverse effects at or beyond the site boundary are avoided or mitigated. To achieve that, this DMP includes the following:

- A description of the site location and sensitive receptor locations
- A summary of site activities
- Identification of the potential dust generating sources and associated qualitative dust risk assessment
- Dust mitigation measures
- Dust and meteorological monitoring
- Ambient dust and wind speed trigger levels
- Responses to dust trigger levels
- Complaint recording and response
- Training of personnel necessary for the DMP to be implemented
- Record keeping
- Roles and responsibilities of staff in relation to the DMP
- Contingencies
- Update of the DMP

Resource Consent

The quarry activities are subject to the conditions included in Consent xxx, granted by Otago Regional Council on xx/2021. A copy of Consent xxx is attached as Appendix B.

[1] Ministry for the Environment. 2016. Good Practice Guide for Assessing and Managing Dust. Wellington.

[2] Your attention is drawn to the document, "Report Limitations", as attached in Appendix A.

2.0 SITE AND SURROUNDING SENSITIVE RECEPTOR LOCATIONS

The proposed expanded quarry area and neighbouring activities are show in Figure 1. This shows the established existing quarry area and new expansion to the east. All the area surrounding the quarry is zoned Rural in the Central Otago District Plan. The area surrounding the existing quarry is dominated by vineyards and orchards in all directions from the quarry, except to the north of the site, which is animal grazing land.

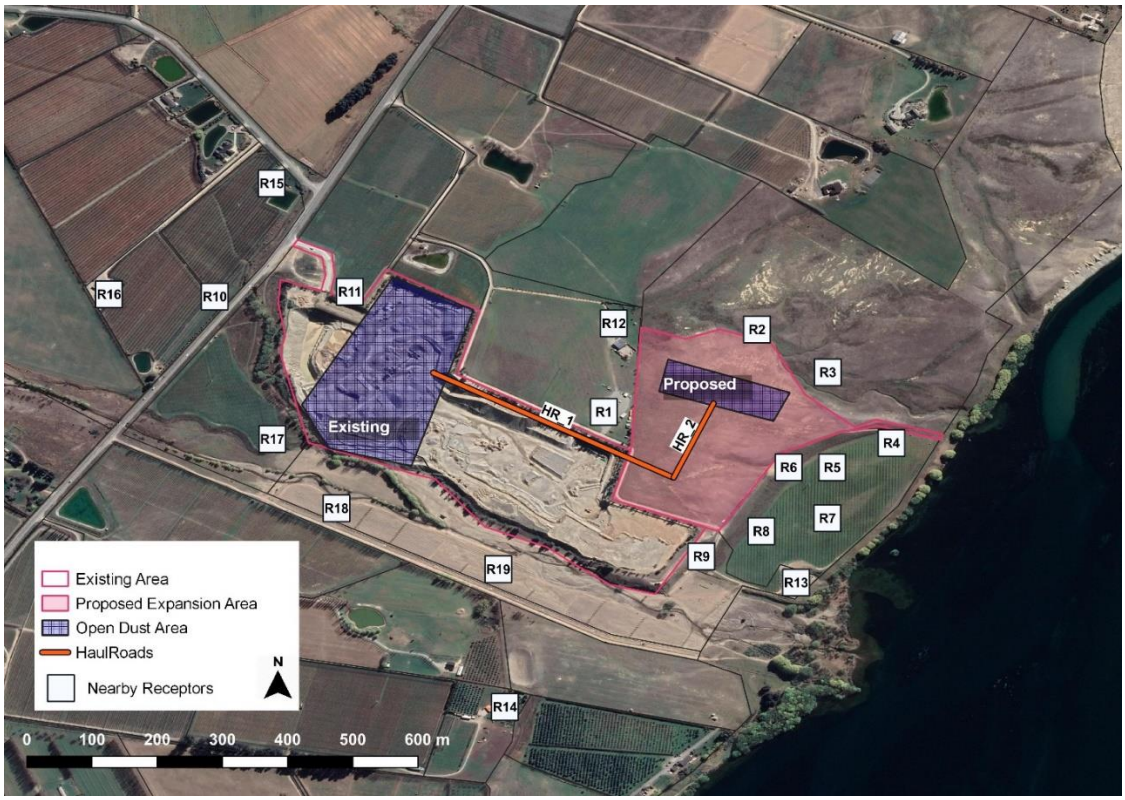

Figure 1: Site location and surrounding activities.

Figure 1 details a number of receptor locations R1 to R19 (which are described below in Table 1) and shows the approximately location of internal haul roads (HR_1) and HR_2. The blue cross hatch area within the existing quarry indicates the approximately active area where aggregate processing, stockpiles, site offices and vehicle movements will mainly. The blue cross hatched area in the proposed expansion area shows a typical active area associated with future excavation of aggregate – this area will move over time as the quarry is mined.

Residential dwellings in Figure 1 are highlighted by receptors R10, R12, R14, R15 and R16. Whereas, worker accommodation buildings are highlight by R6, R9 and R13.

Surrounding cherry orchards are highlighted by receptors R4 to R9, R13, R17 to R19.

Surrounding vineyards are highlighted by receptors R10, R11, R14, R15, and R16. There are other vineyards approximately 300 m to the north and south of the quarry boundary.

A commercial storage shed business (shown in Figure 1 as receptor location R1) is operated on the rural property, respectively to the north and west of the existing quarry and new expansion areas.

To the north of the proposed expansion area is a Department of Conservation (DoC) reserve land (receptors R2 and R3) in which several rare plants are found.

Table 1: Description of off-site receptor locations as detailed in Figure 1

ID	Name	Category	Details
R1	Clark storage sheds	Non-residential	A storage shed business – located approximately 35 m north of the northern boundary of the existing quarry and approximately 20 m west of the western boundary of the proposed expansion area.
R2	Department of Conservation (DoC) reserve	Non-residential	Receptors to the north of the proposed expansion area placed within 100 m.
R3	Department of Conservation (DoC) reserve	Non-residential	Receptors to the north of the proposed expansion area placed within 100 m.
R4	Little's cherry orchard	Non-residential	Multiple receptors identified on cherry orchard on a lower river terrace to the east of the proposed expansion area and to the south of the existing quarry.
R5	Little's cherry orchard	Non-residential	Multiple receptors identified on cherry orchard on a lower river terrace to the east of the proposed expansion area and to the south of the existing quarry.
R7	Little's cherry orchard	Non-residential	Multiple receptors identified on cherry orchard on a lower river terrace to the east of the proposed expansion area and to the south of the existing quarry.
R8	Little's cherry orchard	Non-residential	Multiple receptors identified on cherry orchard on a lower river terrace to the east of the proposed expansion area and to the south of the existing quarry.
R6	Building Platforms – Little's cherry orchard	Residential	Consented building platform to the east of the proposed expansion area and 40 m away
R9	Building Platforms – Little's cherry orchard	Residential	Consented building platform to the east of the existing quarry and 40 m away
R10	Dwelling off Mt Pisa Road	Residential	Approximately 100 m to the west of the quarry across Luggate-Cromwell Highway.
R11	Established vineyard	Non-residential	Approximately 20 m to the north of the existing quarry
R12	Clark residential dwelling	Residential	Approximately 200 m north of the northern boundary of the existing quarry and approximately 35 m to the west of the boundary with the proposed expansion area.
R13	Workers' accommodation	Residential	Approximately 160 m east of the existing quarry and 140 m southeast of the southern boundary of the proposed expansion area.
R14	90 Smiths Way	Residential	Approximately 340 m to the south of the southern boundary of the existing quarry and to the south of Amisfield Road.
R15	Dwelling off Mt Pisa Road	Residential	Approximately 100 m to the northwest of the quarry entrance at 7 Mt Pisa Road.
R16	Dwelling off Mt Pisa Road	Residential	Approximately 250 m west of the western extent of the working area of the existing quarry.
R17	Cook cherry orchard	Non-residential	Approximately 50 m to southwest of the existing quarry.
R18	Little cherry orchard (being established in 2021)	Non-residential	Two receptors identified on the established vineyard approximately 70 m south of the site.
R19	Little cherry orchard (being established in 2021)	Non-residential	Two receptors identified on the established vineyard approximately 70 m south of the site.

3.0 SITE CLIMATE

Rainfall is relatively high during the winter months, and then low during spring, summer and autumn. Therefore, outside of winter months, dust suppression and management measures will need to be implemented. Figure 2 summarises 10 years rainfall data from Cromwell EWS is the nearest public meteorological station to the site, located approximately 12 km to the southwest of the existing quarry. The monitoring station is operated and maintained by National Institute of Water and Atmospheric Research (NIWA).

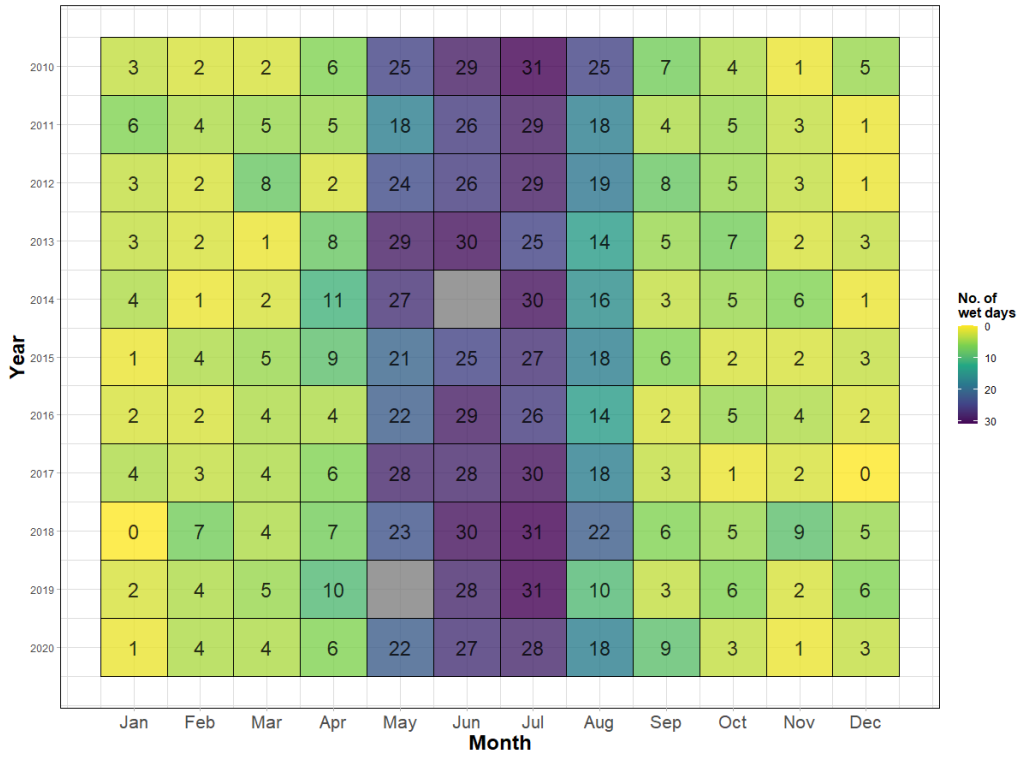

Figure 2: Total number of wet days per month over 10 years as a tile plot.

Figure 3 shows a wind rose (summary of the distribution of wind speeds and directions) for the site, extracted from the modelled site-specific meteorological data at the site for 2018, 2019 and 2020[3].

The arms of the wind rose indicate the direction the wind is blowing from and show that the wind at the site is dominated by south-westerly and north-easterly winds. This means that sensitive locations to the southwest of the site are at most risk from dust sources from within the central processing area, including stockpiles and the loadout and transport of aggregates from the site.

Sensitive receptors to the north and northwest of the site have the 2nd highest dust risk (after those to the southwest), due to dry southerly conditions. Wind speeds greater than a 1-hour average of 6 metres per second (m/s) are generally necessary for dust to be entrained from exposed surfaces.

[3] Meteorological data was generated using CALMET (see Scire, J. et al. (1999) A User's Guide for the CALMET Meteorological Model (Version 5.0). Concord, Massachusetts: Earth Tech.). This used upper-air information was incorporated into CALMET which was generated using the meteorological component of TAPM (As described by Hurley, P., Physick, W. and Luhar, A. (2005) 'TAPM - A practical approach to prognostic meteorological and air pollution modelling', Environmental Modelling & Software, pp. 20:737-752.

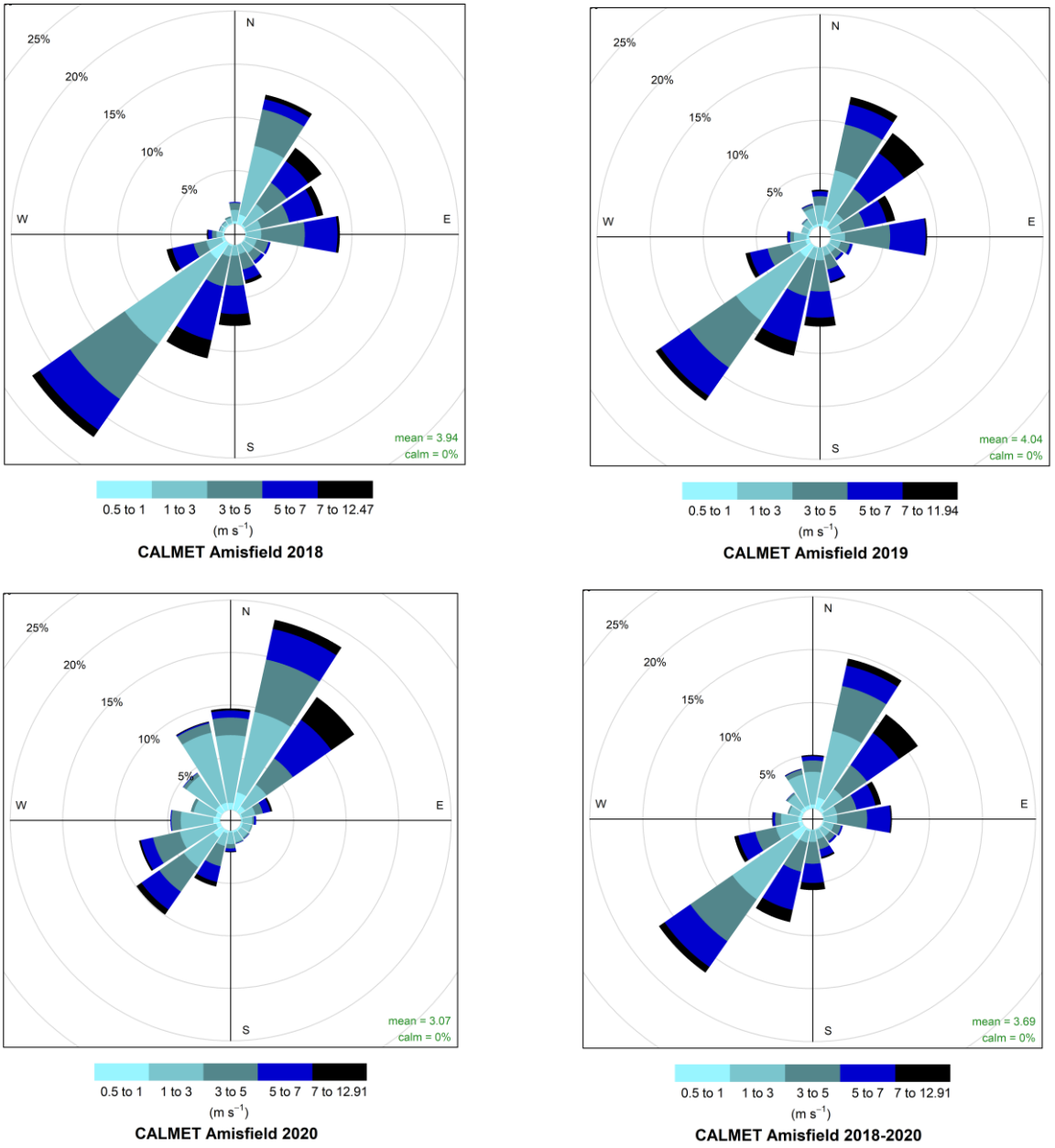

Figure 3: Modelled on-site wind rose for 2018 to 2019.

4.0 SITE ACTIVITIES

4.1 Introduction

This section briefly describes the nature of the activities to be undertaken at the site. The site will be developed in stages from east to west.

4.2 Site Preparation and Bunding

Prior to quarrying commencing in the new expansion area, approximately 200 mm layer of topsoil/subsoil overburden material will be removed from total area of 8 ha, stockpiled and used to construct bunds along the site boundary.

Removal of overburden material will be undertaken using an excavator and either dump trucks or road trucks, in combination with a loader.

Some topsoil may also be brought to the site to enable the establishment of new site bunds. Bunds will be established directly adjacent to expansion area site boundary.

4.3 Extraction and Aggregate Transportation

Once an area has been prepared for quarrying, extraction of aggregates will commence. Quarrying operations will move in stages as the quarry develops and will typically involve the use of a single loader and other machinery as required for the efficient extraction of the resource. The new quarry expansion pit will be a progression from the existing quarry in a north direction with maximum area of 2 ha open for aggregate extraction at any one time.

It is proposed that only one loader will be used on site, the aggregate will be placed into haul trucks, transporting the aggregate to the processing site.

The existing haul road will be used to transport aggregate from the existing quarry site to the screening and washing plant. The location of the haul road for the expansion area will be approximately located as shown in Figure 1.

Taking into account retention of a 25 m setback from the site boundaries (north and south) and a 50 m setback from dwellings, extraction of approximately 200,000 bank cubic metres (BCM[4]) of pit run gravel will be available to be quarried from the site.

4.4 Rehabilitation

Rehabilitation will occur progressively once areas of extraction have been completed. It will primarily involve xxxxxxx.

4.5 Open Areas

CCCL proposes to have an open area of 14 ha at a time, including extraction area, main haul and other internal access roads, rehabilitation, screening/crushing, stockpiling and load out. Table 2 defines the

[4] BCM represents the contents of a cubic metre of pit run material in place, prior to extraction.

estimated open areas and sub areas which are likely to be active sources of dust, which will require dust suppression measures (i.e., both design and the occasional active measures).

Table 2: Estimated open areas requiring dust suppression.

Purpose	Nominal Area (ha)	Active area for dust suppression	Comments
Excavation & truck loading (active quarry area)	2	1	The active area at the quarrying face is expected to be within 1 ha.
Screening, crushing and stockpiling/load out area	8	3	The active dust generating areas around processing plant and stockpile are 3 ha of loader and truck access roads.
Rehabilitation area	1	1	The active un-remediated area (1ha)
Main haul road (excavation to screening plant)	2	2	Main haul roads assumed to be constructed from clean aggregate.
Site access for aggregate sales	1	1	Consisting of sealed and clean aggregate covered sections
Total open area (max)	**14**	**8**	Maximum dust generating area.

5.0 DUST SOURCE DESCRIPTION AND RISK RATING

5.1 Introduction

This section provides a brief description of each specific dust source at the site, together with a qualitative assessment of the risk of a dust impact from that source type.

5.2 Summary of Dust Sources

Vehicle movements: Vehicle movements over dry unpaved surfaces, both within and when entering and leaving the site, are often the most significant source of dust discharge from aggregate quarrying activities. Dust discharge can also result from trucks leaving the site when carrying dry dusty material, and from movement of trucks on unpaved roadways. The mechanical action of the truck wheels results in the ongoing generation of fine dust, which is entrained by either strong wind, or truck movement induced turbulence irrespective of wind conditions. The generation of dust from truck movements is related to the truck weight, truck speed, the silt and the moisture content of the unpaved surface.

Overburden removal, bund formation and rehabilitation: Overburden removal, the forming of bunds and subsequent site rehabilitation can give rise to dust emissions during dry weather and strong winds, especially if the ground surface and overburden material is dry. Consequently, these activities are best undertaken during winter months when ground conditions are wet, and with the additional contingency measure of pre-watering.

Stockpiles: Dust can be discharged crusher dust and sand stockpiles due to wind erosion, especially when they are disrupted by the addition or removal of material. However coarse aggregate stockpiles have a low potential to produce any dust from wind action or when handling.

Pit run excavation: Excavation of pit run aggregates is not a significant source of dust as the in-situ material is typically damp. Dust emissions can occur from aggregate excavation if the surface of the working face has dried significantly, although this is usually limited to the initial disturbance of any dried outer layer of the extraction face. Loading of the excavated material onto trucks can also be a source of dust, if the excavated pit run material is dry.

Feeder Bin: Dust can be discharged from excavated pit run material as it is placed into the screening plant's feeder bin, or stockpiled when the material is dried. However, this is not generally a substantial source as freshly excavated material is relatively damp.

Open areas: Up to 14 ha of the site will be open at any time, but only a 8 ha sub set to of this area will be a potentially active dust generating source due to either vehicle movements, and/or strong dry wind conditions.

5.3 Frequency of dry windy conditions

Most of the time (approximately 90 %), winds are relatively light (less than 7 m/s). During these conditions, the adoption of standard dust mitigation measures can be effective in controlling dust emissions. However, during moderate to strong winds on dry days, surfaces will dry rapidly, and entrainment of un-suppressed dust sources can occur. For this reason, the focus for assessing the frequency of exposure is on dry days when winds are Strong (>7 m/s). These strong, dry winds are predominantly from the northeast and southwest directions.

Sensitive locations within 250 m to the north and south of the existing or new expansion quarry area would be downwind in the order of 10 % of the time during summer. Whereas sensitive locations within 250 m to the east

and west of the existing or new expansion quarry area would be downwind in the order of 1% to 2 % of the time during summer.

5.4 Risk Assessment Table

The risk assessment is included in Table 3. The risk assessment assumes no mitigation and provides an indication of the potential for each source to create a nuisance. Mitigation and management measures are addressed in the following sections. "Probability" is the overall likelihood of a discharge occurring from the source, and "consequence" is an assessment of seriousness should the discharge occur. These factors together are used to estimate the overall risk from the source, and this informs the required mitigation and management practices in Section 0.

Table 3: Site dust source risk assessment.

Dust Source	Probability	Consequence	Overall risk rating
Incoming/Outgoing Trucks	M	M	M
Loader/Truck Movements - Central Process Area	H	H	H
Extraction of Pit Run	L	M	L
Loading/Unloading Pit Run	L	M	L
Main Haul Roads	H	H	H
Screening & Washing Plant	L	M	L
Coarse Aggregate Stockpiles/ Load Out	L	L	L
Crushing Plant	M	M	M
Crusher Dust/Sand Stockpiles/ Load Out	H	H	H
Transport of coarse aggregates	L	L	L
Transport of dry crusher dust/sand	H	H	H
Overburden removal, bund formation and rehabilitation	H	H	H
Active Open Areas	H	H	H
Non-Active Open Areas	L	H	M

Notes: "H" = high, "M" = medium, "L" = low.

6.0 MITIGATION AND MANAGEMENT PRACTICES

6.1 Summary of Control and Management Methods

Table 4 summarises the control and management measures to be implemented at the site. Specific methods used for controlling dust at each source are documented as standard operating procedures (Environmental Management Plan Operational Summaries) which are contained in Appendix [**XX – to be appended should resource consent be granted].**

6.2 Contingencies

Relevant contingency measures, in addition to those wind and PM_{10} monitoring trigger requirements to cease dust generating activities, are summarised below:

- Reduced groundwater take. Should the ability to take water authorised under xxxxxx (or any subsequent permit) cease, or reduce at any time, the consent holder shall assess alternative supply and/or dust mitigation options and subsequently assess the need to temporarily cease some or all parts of site operations, until such time that these activities can be resumed without causing adverse dust impacts offsite.
- Breakdown/Failure of water suppression systems. As this is a key control measure, cease dust generating activities until the systems can be restored, or use a water truck deployed to suppress dust.
- Failure or poor performance of meteorological and particulate matter monitoring equipment. The supplier contract should account for this with the ability to have replacement equipment on site, or the existing equipment repaired within a specified time frame of not more than 48 hours.
- Stabilisation materials. Adequate supplies of clean aggregate, chemical stabilisers, solid covers etc., must be available on site or easily and quickly obtainable in order to provide suppression to open areas at short notice. Backup suppliers should be arranged before site activities commence.
- Dust impacts occurring out of hours. A 24-hour contact must be available to respond to complaints, meteorological and PM_{10} monitoring trigger alarms and institute response measures as necessary.

7.0 DUST MITIGATION & MONITORING

7.1 Site Inspections

Site inspections of visible dust emissions (this may be through video monitoring systems or staff directly) will be carried out routinely throughout each day of operation (and findings and mitigation actions logged electronically (see Section 9.2 for further information on daily logs).

The inspections are to ensure that control measures are effective. They also assist in the analysis of dust events and for investigating and responding to complaints. The specific procedures for carrying out daily site inspections are outlined below:

- Site staff will keep a routine watch for visible dust plumes.

  Note: Video monitoring may be used.
- If visible dust plumes from the site are transgressing beyond the site boundary, the following details must be recorded:
  - the source of the visible dust emissions;

- the level (extent) of the visible dust emissions based on the following:
  1) minor visible emissions (<5 m beyond the boundary)
  2) moderate visible emissions (<30 m beyond the boundary)
  3) major visible emissions (>30 m beyond the boundary);
- the person responsible for investigation and response.
- a brief description of the colour and opacity of the visible dust emissions (e.g., dim brown, hazy grey, dense black etc.);
- the date, time and general weather conditions (wind speed/direction, temperature etc);
- the possible causes of the incident, corrective and preventive actions taken; and

- The control and mitigation measures listed in Table 4 apply at all times and are to be carried out as necessary to prevent or remedy any visible dust emissions beyond the site boundary. If the level of visible dust emissions extends beyond the boundary, the duty or site manager must be notified for further action.
- When notified for further action, the Quarry manager, or delegate person will investigate the situation and take necessary measures to ensure dust levels do not give rise to adverse off-site impacts. Such actions will also be recorded in the daily log (see Section xxxx for more details).

7.2 Key Dust Mitigation Measures

Table 4 provides a comprehensive summary of the key dust mitigation actions , which would be applied to various dust sources, as necessary to ensure ambient dust levels are low and well below trigger values specified in Section 7.4 .

Table 4: Summary of mitigation and management measures, and staff responsibility.

Dust source	Control and management methods	Staff responsible
General Measures	■ Ensure that sufficient water and distribution equipment (20,000 L watercart with water canon) are available and ready to use for dust control. ■ Stabilise all inactive exposed areas of quarry floor (i.e., bare land that is not vegetated) if these are to remain unused for one month or more (if natural crusting is insufficient). ■ If the area of exposed quarry floor is inactive and is planned to be left undisturbed for a long period of time, then apply a layer of suitable dust suppression agent or, alternatively, stabilised with mulch, bark or clean aggregate. This will minimise the potential for dust emissions due to wind erosion as well as the need for water application over these inactive areas during dry, windy conditions. ■ Bunds are to be mulched and vegetated (using ground cover species accepted by DoC and Iwi) as soon as practicable and the cover maintained. During dry weather, the regular application of water to suppress dust and promote growth will be required. ■ Assess weather and ground conditions (dryness and wind) at the start of each day and ensure that applicable mitigation measures and methods are ready for use. If it is a dry day (i.e., there has been no rain in the last 24 hours and ground conditions are visibly dry) and wind speed is (or is forecast to be during that day) above 7 m/s: a) Use a water suppression system (for example water cart, or sprinklers, or water-misting system) at the start of the day to dampen down exposed surfaces within the site, including those that are not active if these have a dried-out layer of exposed soil (e.g., they have not been re-grassed or covered with a layer of dust suppressant or pea gravel); b) Use of suppression systems throughout the day as necessary, particularly for the haul roads, feeder bin, and working face area. ■ Regularly assess (at least twice daily) visible dust emissions and respond accordingly – this may be achieved using a video recording system that targets key areas of the operation (as detailed in Section 7.1). ■ At any time, including outside normal operating hours, if visible dust is blowing beyond the site boundary or if ambient dust monitoring trigger levels are reached (as per the monitoring programmes described in Sections 7.3 and, respectively) and irrespective of it being a dry, windy day: a) Cease activity(s) which are the cause of the dust beyond the boundary, or ambient trigger being reached; b) Continue all dust suppression activities;	Site Manager or delegated person

Dust source	Control and management methods	Staff responsible
	c) Respond with appropriate corrective and preventive actions. Note, this may include immediate watering of both active and possibly inactive open surfaces, even if dust generating activities have been ceased. d) Only resume the activity(s) (other than dust suppression) once the appropriate mitigation measures are in place to prevent visible dust blowing beyond the site boundary. ■ Monitor wind meteorological conditions and particulate matter concentrations as discussed in Sections 7.3 and 7.4, and respond accordingly if the applicable trigger conditions are exceeded. ■ Ensure a 24-hour contact is available, with details posted in clear view at the site entrance.	
"High risk" activities		
Haul Roads	■ Maintain the unpaved section of the site's access road with clean aggregate material ■ Apply clean aggregate material and/or water (which can be mixed with dust suppressing polymers e.g., using Haul loc™)[5] to the main site haul roads, when these produce visible dust plumes, which can drift off-site (irrespective of wind speed conditions).	
Site Access Roads	■ Maintain the first 100 metres of the site's access road from the State Highway 6 in a sealed and clean state. ■ Maintain the unpaved section of the site access road with clean aggregate material. ■ Limit vehicle speeds on site to 30 kilometres per hour and clearly signpost this limit on all internal roads. ■ Apply water (which can be mixed with dust suppressing polymers e.g., using Haul loc™)[6] only as a contingency to the use of clean gravel surface maintenance for site access roads, as necessary to avoid visible dust plumes which can drift off-site (irrespective of wind speed conditions). ■ Maintaining unsealed haul roads and site access roads by grading; and regularly removing deposited debris from the sealed entrance road to the quarry.	Site Manager or delegated person

[5] Haul loc ™ is is a liquid polymer that is added to dust suppression water to improve dust suppression effectiveness by binding fine dust particles together and forming a surface crust. Haul-Loc is therefore applied using existing site water trucks, tankers, or sprinklers.

[6] Haul loc ™ is is a liquid polymer that is added to dust suppression water to improve dust suppression effectiveness by binding fine dust particles together and forming a surface crust. Haul-Loc is therefore applied using existing site water trucks, tankers, or sprinklers.

Dust source	Control and management methods	Staff responsible
Overburden removal, bund formation and rehabilitation activities	■ Undertake overburden stripping and bund formation primarily during winter months, or otherwise during wet ground conditions. ■ If necessary, pre-dampen the land to be stripped during dry days to minimise the potential for dust from overburden stripping. ■ Apply water as required to ensure that any exposed earth on the bund or stockpiles is dampened or a crust formed to minimise dust during strong wind conditions until the grass cover is established. ■ Pre-plan and verify weather forecast prior to bund formation to avoid these works when strong winds are expected and when the ground surface is particularly dry. ■ Once bund has been formed, prioritise mulching/vegetation to established ground cover as soon as practicable. ■ Ensure polymer-based dust suppressants are available during bund formation activities so that, if in exceptional circumstances bund formation does take place during very dry weather, it may also be applied as necessary to prevent dust emissions.	Environmental Manager or delegated person
Active open areas	■ Restrict unpaved active areas to 2 ha at the excavation area and 3 ha around the central processing/stockpiling/loadout areas. ■ Apply dust suppression water to these areas as necessary to restrict dust emissions	Site Manager or delegated person
Fine chip, overburden and sand stockpiles	■ Limit stockpiling within the site boundary to materials that are raw feed or to be used for rehabilitation. It is noted, these materials will be left undisturbed for most of the time. Any stockpile volumes of raw feed will be less than 1000 tonne and not located within 100 m of a sensitive activity ■ During the quarry's operational life, cover or grass topsoil and overburden stockpiled materials in order to prevent wind-blown erosion losses. ■ Use polymer-based suppressants (such as Rubble Loc™)[7] can be mixed with water when spraying/sprinkling to dampen stockpiles of fine chip, natural sand, crusher dust or similar materials during dry windy conditions.	Site Manager or delegated person

[7] Rubble loc™ is a similar product to Haul-loc and is used as required across the site (for example prior to long weekends or before forecasting high winds). Rubble-loc is designed for use on dynamic sites such as quarries with material stockpiles. The product is designedto provide long term dust treatment.

Dust source	Control and management methods	Staff responsible
"Moderate risk" activities		
Non active open areas	■ Non active open areas which are undisturbed for longer than one month are to be stabilised clean aggregate, polymer-based suppressants, or other appropriate solutions with equivalent effectiveness to avoid these being significant sources of dust erosion.	Site Manager or delegated person
Aggregate excavation and loading	■ Minimise drop heights when loading trucks or feeder bins at the screening plant. ■ Cover or dampen loads of fine chip or sand type materials prior to leaving the site ■ Dampen the working face, as necessary to avoid dust plumes crossing the site boundary during truck loading operations ■ No blasting of ground prior to excavation activities	Site Manager or delegated person
Crushing	■ Crushing of wet aggregate at the mobile crusher plant produces a low/moderate level of dust due to aggregate being in a wet state and the application of further water during crushing. Water sprays are to be used to avoid visible plumes, or ambient trigger levels to be reached or exceeded.	
"Low risk" activities		
Coarse Product Stockpiles	■ Limit stockpiling within the site boundary to materials that are raw feed or to be used for rehabilitation. It is noted, these materials will be left undisturbed for most of the time. Any stockpile volumes of raw feed will be less than 1000 tonne and not located within 100 m of a sensitive activity ■ During the quarry's operational life, cover or grass topsoil and overburden stockpiled materials in order to prevent wind-blown erosion losses. ■ Use polymer-based suppressants (such as Rubble Loc™)[8] can be mixed with water when spraying/sprinkling to dampen stockpiles of fine chip, natural sand, crusher dust or similar materials during dry windy conditions.	Site Manager or delegated person
Screening and washing of mined aggregate	■ Water sprays will be used throughout the screening and washing stage to control the moisture content of the materials and therefore this process results in minimal dust production.	

[8] Rubble loc™ is a similar product to Haul-loc and is used as required across the site (for example prior to long weekends or before forecasting high winds). Rubble-loc is designed for use on dynamic sites such as quarries with material stockpiles. The product is designedto provide long term dust treatment.

7.3 Meteorological Monitoring

Wind direction and speed need to be continuously monitored to enable the triggering of additional dust mitigation when necessary to avoid adverse dust effects.

7.3.1 Instrument requirements

The station must have instruments capable of continuously monitoring:

a) Wind speed as 1-minute scalar averages with maximum resolution of 0.1 metres per second (m/s), accuracy of at least within +/-0.2 m/s, and a stall speed no greater than 0.5 m/s;

b) Wind direction as 1-minute vector averages with maximum resolution of 1.0 degree and accuracy of within +/- 1.0 degree, and a stall speed no greater than 0.5 m/s;

c) Screened temperature with accuracy of +/- 0.5 degrees;

d) Humidity (%RH) with accuracy of +/- 5 percent; and

e) All monitoring instruments shall be routinely checked to ensure it is functioning properly and calibrated at a frequency and according to manufacturer's specifications. A record of when maintenance is undertaken, the type of maintenance and who undertook it must be kept. This record must be provided to the ORC Manager on request.

7.3.2 Installation requirements

The monitoring station installation shall:

a) Be in place and operational for the duration of site activities and maintained in accordance with the manufacturer's specifications.

b) Be located on either neighbouring property which are adjacent to the property boundary, or one the subject property in accordance with AS/NZS 3580:14-2014 (*Methods for sampling and analysis of ambient air – Part 14: Meteorological monitoring for ambient air quality monitoring applications*). If the monitoring station cannot be located in accordance with AS/NZS 3580:14-2014 an alternative location shall be agreed in writing with the Council;

c) Have a mast height enabling monitoring instruments to be least 6 metres above natural ground level immediately adjacent to the western side of the quarry, or else at least four metres above the site's bund, if located at the property boundary, and/or on the quarry's bund system;

d) Fitted with an alarm system capable of informing site staff if the 10-minute scalar average wind speed-direction trigger levels are exceeded for specified downwind receptors and associated downwind direction range. The alarm can be via mobile phone.

7.3.3 Data recording/reporting requirements

A meteorological monitoring station shall:

a) Monitor and continuously record in electronic format, date and time stamped 10-minute rolling average *vector average* wind direction, and 10-minute *scale average* wind speed and screened ambient temperature values, which are updated once per minute;

b) Maintain at least a 36-month continuous record of 10-minute averaged data specified in (a), in the form of an electronic record and this shall be provided to the ORC on request; and

c) Automatically send alerts of trigger levels being reached or exceeded to the Site Manager or delegated authority via text message.

7.3.4 Wind-speed direction trigger and response

Any quarry activity (except dust suppression measures) within 250 m of a sensitive receptor location must cease when:

> *The wind direction (10-minute vector average) places the quarry activity upwind of the sensitive receptor(s) and the 10-minute average wind speed reaches or exceeds 7 m/s, and during dry weather conditions. Dry weather conditions are defined as: when there has been less than 1 mm of rain over the preceding 12 hours.*

If the wind speed trigger level, and/or PM_{10} trigger levels specified in Section 7.4.4 are exceeded, then the following additional measures are to be taken:

- Hourly visual monitoring for dust beyond the site boundary, and cessation of activities if this is noted.
- Mandatory water application on active on-site roadways and excavation/deposition locations.
- Minimise vehicle movements on unsealed roadways.

A record is to be kept of all trigger breach events. The record should include:

- The duration of the event.
- A summary of the wind speeds recorded (maximum and average).
- The response to the event.
- Response, including any dust effects that occurred beyond the site boundary.

A sample daily log form, including fields for recording wind monitoring trigger exceedances is included in Appendix B.

7.4 Particulate Matter Monitoring

Prior to the commencement of quarrying activities, at least two mobile and one permanently located continuous dust monitor shall be installed at locations along the quarry site boundary.

7.4.1 Instrument requirements

The continuous dust monitors shall be based on light-scattering based technology (this includes nephelometer type instruments) to measure and log ambient PM_{10} concentrations in real-time.

The permanently located dust monitor must be of a type that is suitable for dust management and be able to maintain a stable calibration K-factor but does not need to meet the standard for US EPA certification, or NESAQ compliance monitoring for ambient PM_{10}.

The dust monitors must all be able to monitor and electronically log ambient PM_{10} concentrations as rolling 1-hour average, which is updated every ten minutes.

7.4.2 Installation requirements

The mobile dust monitors shall:

a) Be located such that one monitor is positioned along the western or eastern property boundary and the second is positioned along the northern or southern property boundary. The appropriate boundary will depend on the quarry development stage. However, the mobile dust monitor locations

should ensure that a dust monitoring occurs between any active dust generating area and any residential building that is ≤ 250 m from these active dust sources.

The permanently located dust monitor shall:

b) Be located along the southern property boundary and be generally downwind of the central processing area during prevalent north easterly winds.

All dust monitors shall:

c) Be sited in general accordance with AS/NZS 3580.1.1:2016 Methods for sampling and analysis of air - Guide to siting air monitoring equipment;

d) Shall have a GPS location service (or similar technology) which enables their locations to be remotely monitored and recorded.

e) Be fitted with an alarm system that, when PM_{10} concentrations exceed the specified trigger level, sends a warning to the Site Manager or other nominated person who has the responsibility for managing dust effects on the site.

f) Be calibrated and maintained in accordance with the manufacturer's specifications.

7.4.3 Data recording/reporting requirements

The continuous dust monitors shall:

a) Monitor and continuously record in electronic format, date and time stamped 1-hour rolling average PM_{10} concentrations, which are updated once per 10-minutes;

b) Retain 1-hour averaged PM_{10} concentration data in the form of an electronic record and copies shall be provided to the ORC on request; and

c) Automatically send alerts of dust trigger levels being reached or exceeded to the Site Manager or delegated authority via text message.

7.4.4 Dust concentration trigger and responses

Any quarry activity which is generally upwind of a real-time dust monitor, which is located at the site boundary (except dust suppression measures) must cease when:

The dust monitor records particulate concentrations, which reach or exceed a PM_{10} concentration of 150 micrograms per cubic metre ($\mu g/m^3$), as a 1-hour average updated every ten minutes.

The Site Manager or other nominated person shall be available at all times to take immediate action as might be necessary to reduce site dust emissions from the quarry in response to visible, or report dust impacts, or when a dust limit trigger value is reached or exceeded.

If at any time, including outside normal operating hours, visible dust is blowing beyond the site boundary, or if the PM_{10} monitoring trigger is breached, the Site Manager or delegated authority must:

a) Confirm if any CCCL operated quarry activities are upwind of monitor or not, if they are then

b) Confirm the activity(s) causing the dust event; then:

   i. Cease the quarrying activity(s) upwind of the monitor(s) and any other activities causing visible dust plumes to extend beyond the site boundary;

ii. Continue all dust suppression activities including any additional measures that can be applied the upwind source(s) of the dust;

iii. Only resume quarry activities (other than dust suppression) once there is no longer visible dust blowing beyond the site boundaries and when the monitoring trigger) is no longer exceeded; and

iv. Notify the ORC Manager within one working day of the dust event, including its cause and the dust suppression actions undertaken.

c) The Consent Holder shall maintain a record of any exceedance of a trigger value, and which related to quarrying activities from the site, and any responses or investigative actions taken.

A sample daily log form, including fields for recording trigger exceedances is included in Appendix B.

8.0 COMPLAINT RESPONSE AND RECORDING

8.1 Introduction

Complaints may be referred by one or more of the Otago Regional Council, a member of the public or a member of the site team. The Quarry Manager is responsible for ensuring suitably qualified personnel are available to respond to complaints at all times. It is the responsibility of the Quarry Manager (or the Site Foreman in the Manager's absence) to respond to and follow up all complaints regarding dust.

A Complaints Register will be maintained by the Quarry Manager and forwarded to the Consents Compliance Manager at the Otago Regional Council on request.

8.2 Receiving and Responding to a Complaint

A complaint is likely to be received from a member of the public via the following:

- Direct call to XXXXX.
- Complainant attends the site in person.
- Written or email correspondence.
- Complaint received via ORC or Clutha District Council.

In all circumstances, the correct information needs to be recorded by the person receiving the complaint in order to help investigate the cause of the complaint and ensure appropriate mitigation has or will be undertaken.

Whenever possible, the following guide should be followed when a complaint is received:

- Immediately suspend contact with the complainant if there is risk of injury or abuse.

- Advise that an investigation process will be carried out to determine the likely cause of their concern and ensure appropriate mitigation has or will be undertaken promptly.
- Record the details provided by the complainant about the incident on a complaint form (see Appendix C).
- Investigate the likely cause of the complaint – including immediate visual inspections of the site and note all dust generating activities taking place and the mitigation methods being employed, as well as consideration of the process (e.g., if there are any abnormalities) and meteorological conditions.
- Liaise with relevant site staff and if necessary, undertake any additional dust mitigation measures as soon as practicable.
- Follow up with the complainant via a visit the area from where their complaint originated to ascertain if dust is still a problem (as soon as possible i.e., within 2 hours, where practicable). following the investigation to check whether their concerns have been addressed.

8.3 Recording and Investigating Complaints

A record shall be kept of all complaints received in relation to site activities. A complaint investigation form is provided in Appendix C, which can be used to record the details of the complaint and any subsequent investigation and actions taken.

A copy of the completed complaint form is to be filed in the appropriate folder in the site office following completion of the investigation and within 24 hours of receiving the complaint. The folder with the record of all complaints is to be available for inspection when required by ZZZ and/or YYY staff.

The complaint investigation form includes spaces to enter information that must be recorded including:

- Name and location/address and telephone number of complainant when dust is detected (if provided).
- Date and time of the dust event and other information about the incident as described by the complainant.
- Details of who received the complaint and how it was received.
- Weather conditions as recorded by the site weather station, including wind direction and speed at the site at the time of the complaint and when assessments were made. Describe windspeed via the Beaufort Scale[9]
- Details of any observed dust emissions coming from the site by the person investigating the complaint.
- Identification of the possible cause of the complaint following the investigation.
- Details of the corrective action taken at the time to resolve the incident.
- Details of the preventative actions to be taken to ensure the likelihood of such events occurring in the future are minimised.

[9] The Beaufort Scale is a system for estimating wind strength based on its effects on the physical environment. xxxxx

An investigation of the complaint will require the site manager or delegated staff member to go around the whole site and make visual observations about activities occurring on site. This may also include going to the location where the complainant observed the impact.

At all times during the complaint investigation, appropriate health and safety procedures must be followed.

9.0 RECORD KEEPING AND DOCUMENT MAINTENANCE

9.1 Overview

Record keeping requirements are outlined in Table 5. These records will be kept by the consent holder and made available to the ORC's RMA Compliance and Monitoring Manager on request.

Table 5: Record keeping requirements.

Records	Responsibility	Location
Daily log	Site Manager or delegated person	Site office
Complaint records	Site Manager or delegated person	Site office
Environmental incident reports or monitoring trigger events	Site Manager or delegated person	Site office
Revisions to the DMP and relevant sub-plans	Site Manager or delegated person	Site office

9.2 Daily Log

Site activities can be affected by factors such as weather conditions and equipment malfunction, which can contribute to an increase in dust emissions. Control and mitigation measures are to be carried out on the site to prevent such effects, and inspections and monitoring data will be used to assess the level of dust emissions both on the site and beyond its boundary. Recording relevant inspection results, as well as the conditions of external and internal factors, can help to assess if control measures are being effective and to define appropriate corrective or preventive actions in case any adverse effects occur.

The following information will be recorded electronically in a daily log or equivalent system (an example of the type of detail that may comprise the daily log is provided in Appendix B of this DMP):

- Records of PM_{10} monitoring exceedances of the trigger levels specified by this DMP, including the time and value of the PM_{10} exceedance.
- Dust control equipment malfunctions and any remedial action(s) taken.
- Results of the daily site inspections of visible dust emissions (refer Section 7.1). The inspections will be carried out on days when the site is operating, at the most appropriate time and location for the conditions presented.
- General weather conditions during the day (i.e., windy, calm, warm, rain etc.).
- The frequency of water sprinkling/spraying system use.

10.0 INDUCTION AND TRAINING

It is the responsibility of the Quarry Manager to implement an induction and on-going training programme for all staff and contractors. The purpose of this programme is to make all personnel working on site aware of, and understand, the purpose and requirements of the AQMP, the air discharge consent conditions and the ramifications of a failure to comply with these requirements.

The training programme for all staff and contractors will include at least the following aspects:

- Responsibilities for carrying out the work on site in a manner which does not result in adverse effects on the environment and local residents and in accordance with resource consent conditions;
- The potential legal ramifications of adverse environmental effects occurring as a result of the project and non-compliance with resource consent conditions;
- The minimum requirements for dust control for all activities on site;
- The requirements to monitor weather and visually inspect the site for dust discharges, assess the adequacy of dust control methods and implement additional dust control methods when required;
- The actions to be taken in an extreme dust and weather event;
- The actions to be taken if a complaint is received from the public or consent authority.

Additional training will be provided to water cart operators, in assessing whether sufficient water has been applied for effective dust suppression.

Staff and contractors will be regularly updated on any changes or amendments to the AQMP or improvements in site air quality management procedures.

11.0 ROLES AND RESPONSIBILITIES

The key management roles in relation to environmental management of the site are outlined in Table 6.

Table 6: Environmental management responsibilities.

Role	Responsibilities
Consent holder	■ Compliance with the RMA and air discharge permit.
Quarry Manager, supported by Site Foreman or delegated person	■ Overall responsibility for site compliance with the air discharge permit. ■ Reviewing and reporting on environmental performance regarding odour and dust. ■ Inspection of activities to assess compliance with the DMP. ■ On-site compliance with the DMP. ■ Annual review and update of DMP ■ Maintain Daily Logs and Complaint Records and Responses ■ Training of all staff including subcontractors regarding the use of the DMP and dust mitigation procedures ■ Auditing to assess that compliance with the DMP is being met. ■ Consent compliance monitoring and reporting back to consent holder.
Site Foreman	■ The Site Foreman will be responsible for all site related air discharge management procedures when the Quarry Manager is not on site.
Contractors	■ All contractors working on site are responsible for ensuring that their activities comply with the requirements of this AQMP and the directions of the Quarry Manager (or the Site Foreman in the Manager's absence).

Contact Details

The contact details for those with key responsibilities in the implementation of this DMP are provided in Appendix D, including after-hours contact details in case of any emergency or problems.

12.0 DMP AUDITING AND REVIEW

This DMP may require review and amendment during the life of the site operation to reflect changes to activities, risks, mitigation measures, responsibilities and management processes.

The ability to make changes to the DMP is an important aspect of continually improving the effectiveness of the DMP. Modification will be required once the resource consents are obtained, and detailed design and construction methods finalised.

Procedures for auditing and review will be undertaken by the site. These procedures will be used to provide an independent appraisal of the site's performance in relation to the objectives of the DMP.

The results of this review process will enable management to assess suitability, adequateness and effectiveness of site operations from an environmental perspective.

13.0 CONSENT MONITORING

Council officers may visit the site on an 'ad hoc' basis, to undertake site inspections and assess compliance with consent conditions. Site staff will be available to assist council officers during these inspections and provide any information required to be provided as per consent conditions. In particular, any information or records required to be available by any resource consents held by ORC and/or CDC will be kept on site and will be readily available upon request.

A full internal audit of the site operations is to be carried out by management to assess compliance with the DMP and the air discharge permit on a yearly basis.

All documentation relating to this DMP shall be appropriately filed for auditing and review purposes.

14.0 DMP REVIEW

This DMP shall be reviewed and updated as appropriate at least once every two years. Any amendments shall be:

a) For the purpose of improving efficacy of the mitigation, and shall not result in reduced discharge quality;

b) Consistent with the conditions of this resource consent; and

c) Submitted in writing to XXXXXX, Attention: xxxxxxxxxxxxxx, for certification in accordance with Condition (xx) of xxxx prior to any amendment being implemented.

The review will take into consideration:

- Site personnel comments.
- Audit findings and recommendations.
- Environmental monitoring records.
- Environmental complaints, incidents and emergencies.
- Details of corrective and preventative actions.
- Changes to organisational structure.
- Ongoing compliance with objectives, conditions and targets.
- Possible changes in legislation and standards.
- Improvements to site and any developments of industry codes of practices

The review process will include looking at the environmental controls and procedures to make sure they are still applicable to the activities being carried out. Reasons for making changes to the DMP will be documented.

A copy of the original DMP document and subsequent versions will be kept for the Project records and marked as obsolete.

Each new/updated version of the DMP will be issued with a version number and date to eliminate obsolete DMP documentation being used. XXXXX will ensure the ZZZ and YYY is always provided with a copy of the most recent version of the DMP.