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PATTLE DELAMORE PARTNERS LTD

Review and Reporting of Living Earth's Dust Monitoring Programme – July 2020 to June 2021

Living Earth

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Prepared for

Living Earth

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Limitations:

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1.0 Introduction

1.1 Background

Living Earth (LE) operates an organics processing plant and green waste composting facility located at 40 Metro Place, Bromley, Christchurch (shown in Figure 1). LE's air discharges are subject to the conditions attached to air discharge consent CRC080301.1 ("the consent") from Canterbury Regional Council (CRC) to discharge contaminants (odour and dust) to air. While LE operates the composting facility, Christchurch City Council (CCC) holds the consent.

Pattle Delamore Partners (PDP) have been engaged by LE to provide this report to assist in meeting the requirements of dust monitoring and reporting Conditions 33 and 36 of the consent. This report provides a technical review of the LE dust data and monitoring programme and summarises LE's compliance with the relevant consent conditions.

It is important to note at the outset of this report that the 2020-21 dust deposition monitoring period was a very atypical year for the LE site. The company prepared for and began to action a significant transition in operation with the removal of outdoor windrows from the site by January 2022. This has resulted in a year with relatively high dust deposition. However, in longer term result of these changes will be a significant reduction in dust discharged from the site.

1.2 Consent Conditions

The consent conditions relating to dust monitoring and control are listed below. Condition 33 provides details on how dust monitoring, reporting and dust control must be carried out. The objective of this report is to satisfy the reporting requirements of Condition 36.

Condition 33:

"(a) Dust deposition monitoring shall occur in at least two dust gauges sited near to the boundary with Affordable Storage Limited or successor and the boundary with Dogwatch Sanctuary Trust or successor and at least one further control dust gauge. The location of the dust deposition gauges shall be determined by a suitably qualified person and shall be provided in writing to the Canterbury Regional Council. The method of monitoring shall be ISO DIS-4222.2 or a similar method to the satisfaction of the Canterbury Regional Council. Samples shall be collected monthly and the monitoring results shall be included and summarised in the Annual Environmental Report required under Condition 36.

(b) Dust control measures shall be implemented to maintain the rate of dust deposition at the consent holder's boundary, measured in accordance with

Condition 33(a), at less than 4g/m²/30 days above the background concentration measured at the control site. Any exceedance of this trigger level shall be reported to the Canterbury Regional Council, including the likely reasons for exceedance and any remedial action undertaken."

Condition 36:

"The consent holder shall, no later than the 30th of June of each year, provide an Annual Environmental Report to the Canterbury Regional Council setting out all monitoring and reporting results required by conditions of consent and their interpretation by an appropriately qualified person, including dust deposition monitoring and complaints recording undertaken in relation to this consent over the previous period. Where the result of any test or monitoring undertaken in relation to this consent exceeds the relevant limit/trigger level or does not comply with the relevant condition, then the steps that were taken to rectify the non-compliance shall be specified."

1.3 Scope of the Project

The following tasks define the scope of the project and are addressed in this report:

Task 1: Obtain and review the dust deposition data and reports from Fulton Hogan's Atmospheric Dust fall monitoring programme July 2020 to June 2021 for all dust monitoring sites, numbers 1 to 7;

Task 2: Liaise with LE staff to obtain a summary of the composting operations for the 2020-2021 year, and to obtain an update on any changes to operational procedures that occurred in the 2020-2021 year;

Task 3: Obtain wind speed and wind direction data for the period 01 July 2020 to 30 June 2021 (inclusive) from NZ Meteorological Service New Brighton, Christchurch station. Undertake an analysis of wind data to confirm dust monitoring sites 1 and 4 can be used as representative indicators of background dust deposition;

Task 4: Review the LE-supplied estimate of organic dust deposition rate for each month (total deposition minus background) for the downwind sites (site numbers 2, 3, 5, 6 and 7);

Task 5: Identify any exceedances of the 4 g/m^2/30-day consent limit for organic dust at the downwind monitoring sites;

Task 6: Liaise with LE staff to establish likely reasons for any exceedances identified;

Task 7: Liaise with LE staff to establish what, if any remedial action was undertaken in response to any exceedances identified;

Task 8: Review any dust complaints, the relationship to the dust monitoring undertaken, site activities and mitigation; and

Task 9: Produce a report which summarises the key findings of Tasks 1 to 8.

2.0 Summary of Monitored Dust Deposition Data

This section presents a summary of the dust deposition data recorded over the period July 2020 to June 2021 at monitoring sites numbers 1 – 7, shown in Figure 1. The samples were collected by Fulton Hogan Limited from the deposition gauges at the end of each monitoring period[1]. The dates of sample set-up, collection and the total exposure time are shown in Table 1. Each monitoring period lasted approximately one month to provide estimates of dust deposition able to be compared with the guideline of 4 g/m² per 30 days. The sampling at all seven sites was set up and collected on the same day.

Table 1: Dates of sample set-up, collection, and exposure time for each monitoring period

Monitoring period	Date of sample set-up	Date of sample collection	Exposure time (days)
Jul-20	23/06/2020	28/07/2020	35
Aug-20	28/07/2020	25/08/2020	28
Sep-20	25/08/2020	22/09/2020	28
Oct-20	22/09/2020	27/10/2020	35
Nov-20	27/10/2020	24/11/2020	28
Dec-20	24/11/2020	14/12/2020	20
Jan-21	14/12/2020	26/01/2021	43
Feb-21	26/01/2021	23/02/2021	28
Mar-21	23/02/2021	23/03/2021	28
Apr-21	23/03/2021	27/04/2021	35
May-21	27/04/2021	25/05/2021	28
Jun-21	25/05/2021	22/06/2021	28

[1] Fulton Hogan Canterbury Laboratory Test monthly test reports on atmospheric dust fall over 30 Days by Andy Howie available on request.

SOURCE:
1. AERIAL IMAGERY SOURCED FROM THE LINZ DATA SERVICE AND LICENCED FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 INTERNATIONAL LICENCE.

FIGURE 1 : LOCATION OF LIVING EARTH AND DUST DEPOSITION MONITORING SITES

SCALE : 1:6,000 (A4)

0 50 100 200

METRES

After collection, each sample was analysed for Total Atmospheric Dust fall (TAD, in g/m²/30-days), which is comprised of Total Suspended Solids (TSS) and Total Dissolved Solids (TDS) deposited in the gauge during the exposure period. The deposition of Total Organic Solids (TOS) (g/m²/30-days) was also analysed; in this report TOS will be referred to as Total Organic Dust Deposition (TODD) and be used as a marker of Living Earth's dust discharge.

The summaries of TAD and TODD data between July 2020 and June 2021 are presented in Figure 2 and Figure 3 below, respectively. It should be noted that the results from January were undertaken for a longer exposure period than 30 days due to the Christmas break and the December samples being taken early.

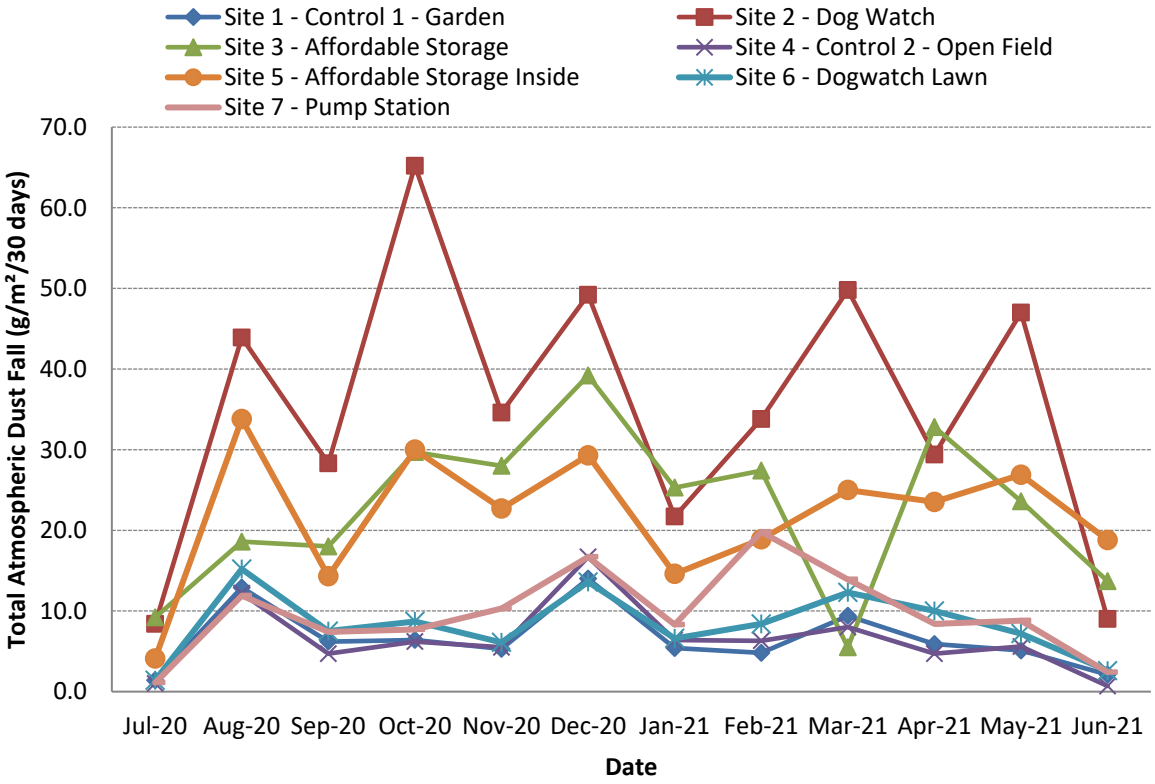


Figure 2: Total Atmospheric Dust fall (g/m²/30-days), July 2020 to June 2021

Compared to the July 2019 to June 2020 reporting year, the total atmospheric dust fall monitored maximum measurements during the July 2020 to June 2021 reporting year has increased significantly. However, the July 2020 to June 2021 reporting year total measurements increased by over 40% compared to the measurements taken in July 2019 to June 2020.

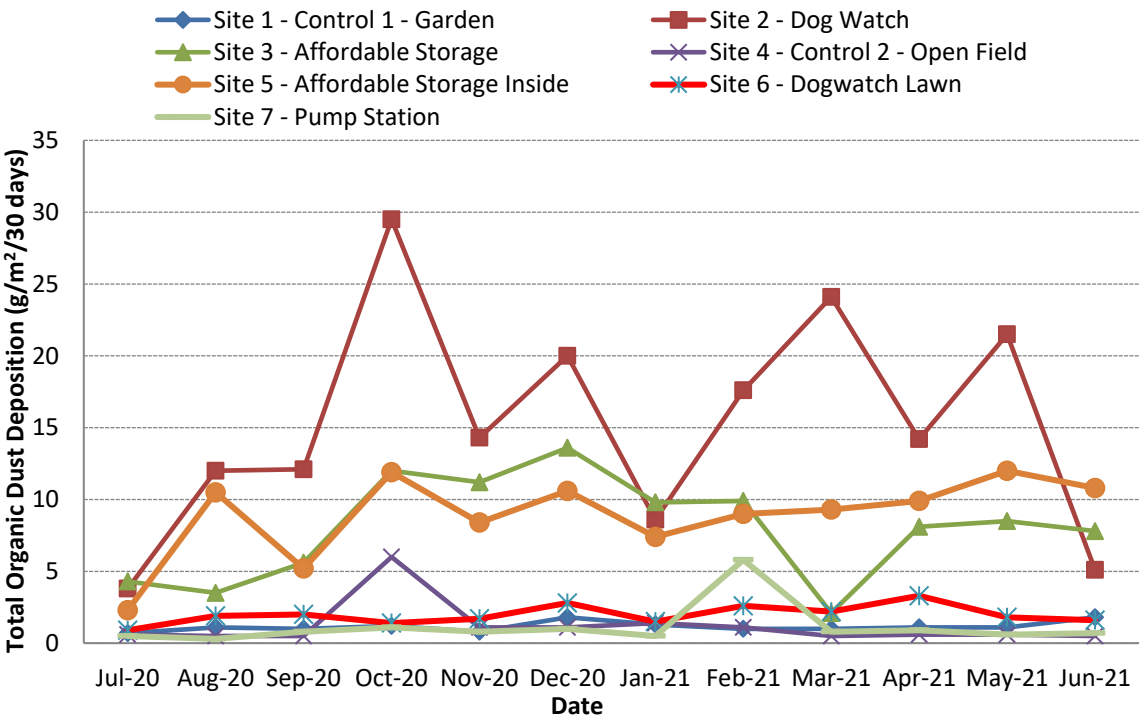


Figure 3: Total Organic Dust Deposition (g/m²/30-days), July 2020 to June 2021

TODD has also increased in the July 2020 to June 2021 monitoring period. More detailed analysis of the TODD data is given in Section 3.0.

3.0 Analysis of Total Organic Dust Deposition Rate

3.1 Overview

To meet the requirement of Condition 33(b) of the consent, Living Earth is required to implement dust control measures to maintain the rate of dust deposition at its boundary at less than 4 g/m²/30-days above the background rate of dust deposition as measured at the control sites. PDP has adopted the approach of Golder Associates (NZ) Limited 2014 dust monitoring report[2] which identified that using TODD as the measure upon which to assess compliance of Condition 33(b) is the most appropriate option of the dust metrics available. TODD is the fraction of the TAD that most closely reflects Living Earth's operations and nature of discharges.

The deposition rate of TODD above background is calculated by subtracting the average background dust deposition rate (measured at control site numbers 1 and 4) from the TODD dust deposition rate measured at the impact sites (numbers 2, 3, 5, 6, and 7).

[2] Golder (2014). Review of Dust Monitoring and Reporting. Report to Living Earth by Golder Associates (NZ) Limited. Report number 1478104304_002, September 2014.

If TODD at the impact site is less than 4 g/m²/30 days before the background is removed, then it is not possible that an exceedance of the consent level occurred for that month. Therefore, only the months with potential exceedances (i.e., total TODD above 4 g/m²/30 days) have been considered for further analysis. The months with potential exceedances are identified in Section 3.2 and further discussed in Section 4.0.

To confirm that the control sites (numbers 1 and 4) have data representative of background concentrations, it is important to check that they are upwind of LE for the majority of each sampling period. The LE impact monitoring sites (numbers 2, 3, 5, 6, and 7) must also be checked to be representative by ensuring the sites were downwind of the LE operations for significant amounts of time during each sampling period. To check the representativeness of the LE monitoring sites for the intended background or impact purposes, an analysis of predominant wind patterns during each monitoring period has been undertaken in Section 3.3 for months identified with potential exceedances of the consent limit.

3.2 Compliance of Total Organic Dust Deposition rate with the Consent Limit

This section presents an assessment of the TODD rates presented against the consent limit for all months and identifies potential and actual exceedances.

An initial evaluation has been undertaken using the TODD results for the five impact sites over the months July 2020 to June 2021 in order to identify which monitored periods have potential exceedances of the dust deposition limit given in Condition 33(b). The method of estimation of impacts from dust generated by activities at the LE site is to subtract the average TODD from the two control sites from the measured TODD at the impact sites. This provides the best estimate of the TODD contribution due to the activities at LE, removing influences from other sites. Figure 3 shows the total TODD from all sites and Figure 4 shows the impact sites following the removal of background TODD.

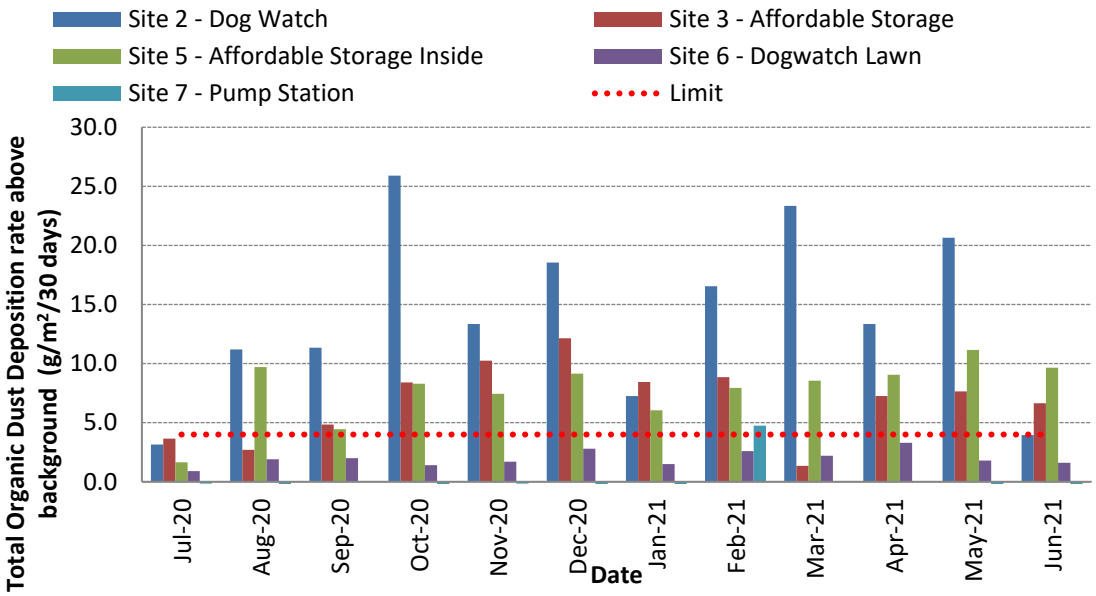


Figure 4: Organic Dust Deposition Rate above background (g/m²/30-days) for impact sites.

It can be seen in Figure 4 that the month of July 2020 does not exceed the consented limit. All remaining months from August 2020 to July 2021 have TODD above 4 g/m²/30-days at least one of the impact sites. Notably impact sites 2 and 3 are placed inside of the LE boundary to measure onsite TODD levels and therefore cannot be considered exceedances beyond the boundary. Impact sites 5, 6 and 7 are outside of the boundary. No exceedances were measured at site 6, however exceedances were measured at impact site 5 in 11 of the 12 months, and impact site 7 in February. Therefore, further analysis is required to evaluate whether theses exceedances of the dust deposition limit are likely to have occurred due to the discharge of dust from LE's activities.

The exceedances shown in Figure 4 are presented in Table 2 where exceedances of the consent limit are denoted by bold text and shaded cells.

Table 2: Organic dust deposition rate above background for relevant monitored periods

Monitoring period	Background (g/m²/30 days)	Organic Dust Deposition Rate Above Background (g/m²/30 days)				
		Onsite Monitors		Offsite Monitors		
		Site 2 - Dog Watch	Site 3 - Affordable Storage	Site 5 - Affordable Storage Inside	Site 6 - Dogwatch Lawn	Site 7 - Pump Station
Jul-20	0.7	3.2	3.7	1.7	0.3	0.0
Aug-20	0.8	**11.2**	2.7	**9.7**	1.1	0.0
Sep-20	0.8	**11.4**	**4.9**	**4.5**	1.3	0.1
Oct-20	3.6	**25.9**	**8.4**	**8.3**	0.0	0.0
Nov-20	1.0	**13.4**	**10.3**	**7.5**	0.8	0.0
Dec-20	1.5	**18.6**	**12.2**	**9.2**	1.4	0.0
Jan-21	1.4	**7.3**	**8.5**	**6.1**	0.2	0.0
Feb-21	1.1	**16.6**	**8.9**	**8.0**	1.6	**4.8**
Mar-21	0.8	**23.4**	1.4	**8.6**	1.5	0.1
Apr-21	0.9	**13.4**	**7.3**	**9.1**	2.5	0.0
May-21	0.9	**20.7**	**7.7**	**11.2**	1.0	0.0
Jun-21	1.2	4.0	**6.7**	**9.7**	0.5	0.0

Notes:

1. *Values that exceed the consent limit of 4 g/m²/30 days above background concentrations are shown in bold.*
2. *Negative values of impact site minus background are reported as zero values.*
3. *The dust deposition gauge was left for an exposure period of 91 days for site 4 and 6 and 63 days for remaining sites due to access to the sites during the COVID-19 lockdown.*

Table 2 and Figure 4 show that there are a total of 32 exceedances of the consent limit (4 g/m²/30-days above background concentration). Further investigation of the exceedances are discussed in the analysis of wind data in Section 3.4 and investigation of exceedances in Section 4.0.

3.3 Summary of CCC and CRC reporting

A summary of CCC and CRC reporting and site activity and dust management for each month when exceedances were observed at the monitoring sites is provided below, notably CRC and the community are advised via the quarterly community liaison group (CLG) meetings where the numbers are also presented.

- **August 2020:** The exceedance monitored at site 2 and site 5 were 180% and 143% higher than the consent limit, respectively.
- **September 2020:** The exceedance monitored at site 2, site 3 and site 5 were 184%, 21% and 11% higher than the consent limit, respectively.
- **October 2020:** The exceedance monitored at site 2, site 3 and site 5 were 548%, 110% and 108% higher than the consent limit, respectively.
- **November 2020:** The exceedance monitored at site 2, site 3 and site 5 were 234%, 156% and 86% higher than the consent limit, respectively.
- **December 2020:** The exceedance monitored at site 2, site 3 and site 5 were 364%, 204% and 129% higher than the consent limit, respectively.
- **January 2021:** The exceedance monitored at site 2, site 3 and site 5 were 81%, 111% and 51% higher than the consent limit, respectively.
- **February 2021:** The exceedance monitored at site 2, site 3 and site 5 were 314%, 121% and 99% higher than the consent limit, respectively.
- **March 2021:** The exceedance monitored at site 2 and site 5 were 484%, and 114% higher than the consent limit, respectively.
- **April 2021:** The exceedance monitored at site 2, site 3 and site 5 were 234%, 81% and 126% higher than the consent limit, respectively.
- **May 2021:** The exceedance monitored at site 2, site 3 and site 5 were 416%, 91% and 179% higher than the consent limit, respectively.
- **June 2021:** The exceedance monitored at site 3 and site 5 were 66% and 141% higher than the consent limit, respectively.

In summary, exceedances were measured on 10 instances at site 2 during August to May, 9 instances at site 3 during September to February and April to June, 11 instances at site 5 August to June, and on one instance at site 7 in February. Both site 2 and 3 are onsite monitors, before boundary control measures. Site 5 is offsite, immediately next to the boundary within the Dogwatch property (lawn) and site 7 is 650 m from the LE boundary at the pump station. All exceedances were reported to CCC and the site 5 and 7 exceedances was reported to CRC following results in June.

3.4 Analysis of Wind Data – Influence on Control and Impact Sites

To confirm that the control sites (1 and 4) and the impact sites (2, 3, 5, 6 and 7) provide data that is appropriate for assessment of compliance with condition 33(b), wind data was obtained from the MetService meteorological station located at New Brighton Pier. Data from the onsite meteorological station is also available for this monitoring period. However, this data is not easily averaged and formatted to enable the generation of monthly and annual wind roses.

The MetService data is much better suited for the purpose of generating annual and monthly windroses. The New Brighton Pier Automated Weather Station (AWS) station is located just over 4 km away, in a northeast direction from the LE facility. Given the proximity of the LE site to the New Brighton Pier AWS station and the lack of any topographical features between the two locations, PDP consider the station is likely to provide data that is representative of the wind conditions experienced at the LE site.

Frequencies of wind speed and wind direction were checked for each monitored period. Based on the wind data, it was concluded that sites 1 and 4 could be considered as representative control sites (i.e., upwind of LE for the majority of time).

The remaining sites could be considered as impact sites (i.e., downwind of LE for a relatively large number of hours). Figure 5 shows the wind rose for the period from July 2020 to June 2021. The annual wind rose demonstrates that the predominant wind direction is from the east and east north-east, with a slightly lower frequency of generally lower speed west north-west winds also common. This suggests sites 2, 3, 5, 6 and 7 are appropriately located to be downwind of the LE activities for the predominant wind direction.

The annual wind rose is of a similar character to those presented in previous monitoring ports for LE[3]. The previous reports have also noted the predominant wind direction is from the east (or north-east) and there is also a significant frequency of winds from the west, which is similar to this year's observations. The wind is rarely from the direct south, so monitoring sites 1 and 4 to the north of the LE facility should not be significantly impacted by onsite activities, however this year some months did observe more south-west winds as demonstrated in Appendix A. The south direction is the least predominant wind direction and in general the annual wind rose supports their use as representative sites for measurement of background levels of dust.

[3] Pattle Delamore Partners (2020). *Review and Reporting of Living Earth's Dust Monitoring Programme – July 2019 to June 2020* .

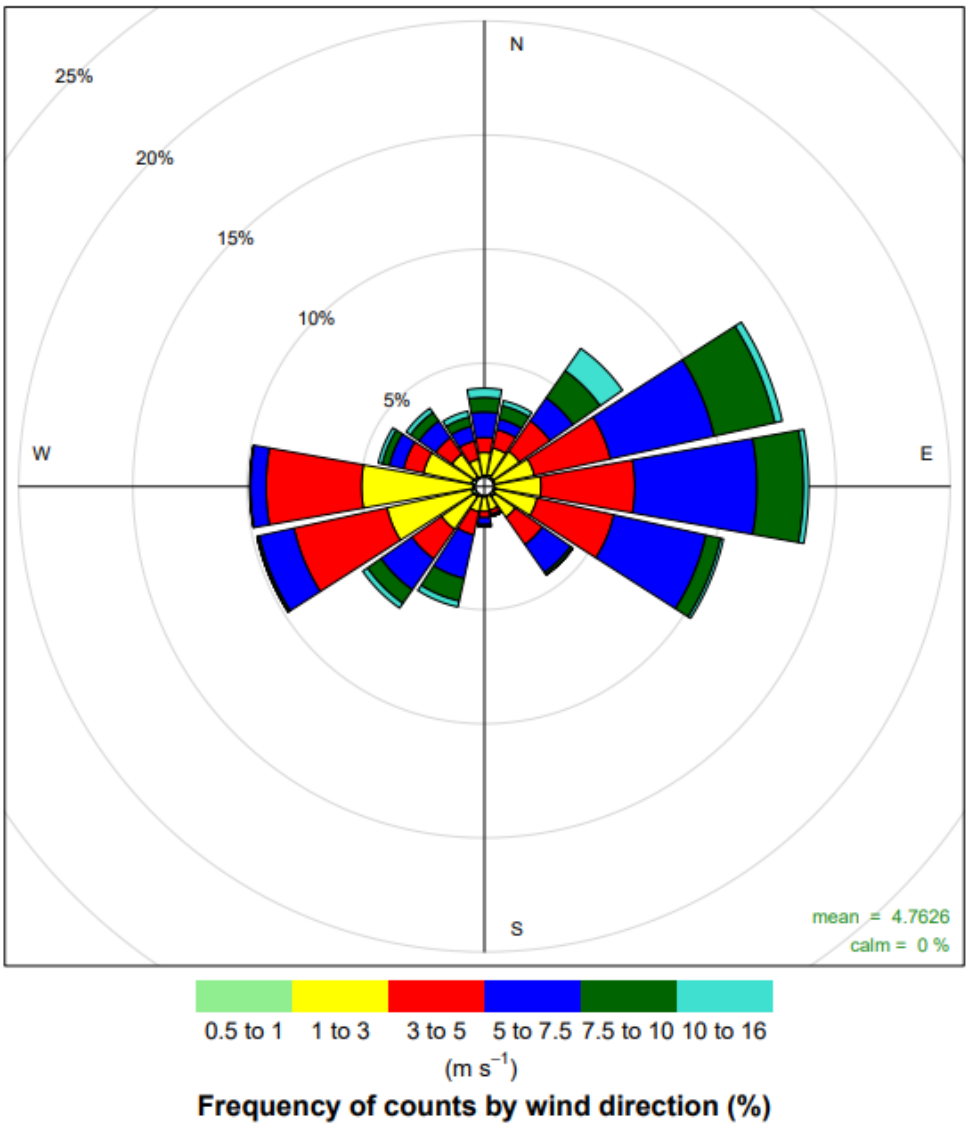


Figure 5: New Brighton Pier AWS (MetService station) wind rose, 1 July 2020 to 30 June 2021

Monthly wind roses for the monitoring period were constructed and are shown in Appendix A. There is variation in the distribution of wind speeds and directions between months when compared with each other and against the annual average. These variations can affect TAD and TODD levels at monitoring sites as they will be downwind from different dust sources at different times of the year.

In Table 3, wind directions are compared with monthly dust deposition rates at monitoring sites for the 11 months identified as having exceedances in Section 3.2.

Table 3: Summary of wind patterns and dust levels				
Period	**General wind patterns[1 2 3] (see Appendix B for wind roses)**	**TODD levels at impact monitoring sites**	**Hours exceedance site is downwind during moderate/strong[4] winds**	**Max gust when downwind (m/s)**
August (23/06/2020 to 28/07/2020)	High frequency from ESE (moderate winds) Moderate frequency from W, WSW and E (moderate winds) Low frequency from SE, ENE (moderate winds) and NE (high winds)	Site 2 at 11.2 g/m²/30 days, Site 5 at 9.7 g/m²/30 days (other sites less than 4 g/m²/30 days)	185(27%)	15.7
September (28/07/2020 to 25/08/2020)	Moderate frequency from W and ESE (moderate winds) Low frequency from ENE, E, SE, SW, WSW (moderate winds), WNW and NW (high winds)	Site 2 at 11.4 g/m²/30 days, Site 3 at 4.9 g/m²/30 days, Site 5 at 4.5 g/m²/30 days (other sites less than 4 g/m²/30 days)	95(14%)	12
October (25/08/2020 to 22/09/2020)	High frequency from E (high to moderate winds) Moderate frequency from NEN and ESE (high winds) Low frequency from N, NE, SE, SW, WSW, W and NW (high winds)	Site 2 at 25.9 g/m²/30 days, Site 3 at 8.4 g/m²/30 days, Site 5 at 8.3 g/m²/30 days (other sites less than 4 g/m²/30 days)	233(27%)	20.3
November (22/09/2020 to 27/10/2020)	High frequency from ENE (high to moderate winds) Moderate frequency from E and ESE (moderate winds) Low frequency from N, SWS, SW (high winds), WSW and W (moderate winds)	Site 2 at 13.4 g/m²/30 days, Site 3 at 10.3 g/m²/30 days, Site 5 at 7.5 g/m²/30 days (other sites less than 4 g/m²/30 days)	196(31%)	14.8
December (27/10/2020 to 24/11/2020)	High frequency from ENE (high to moderate winds) Moderate frequency from E and ESE (moderate winds) Low frequency from N, SWS, SW (high winds), WSW and W (moderate winds)	Site 2 at 18.6 g/m²/30 days, Site 3 at 12.2 g/m²/30 days, Site 5 at 9.2 g/m²/30 days (other sites less than 4 g/m²/30 days)	171(35%)	16.2
January	High frequency from ENE and E (moderate winds)	Site 2 at 7.3 g/m²/30 days,	341(38%)	20.1

Table 3: Summary of wind patterns and dust levels

Period	General wind patterns[1 2 3] (see Appendix B for wind roses)	TODD levels at impact monitoring sites	Hours exceedance site is downwind during moderate/strong[4] winds	Max gust when downwind (m/s)
(24/11/2020 to 14/12/2020)	Moderate frequency from ESE (moderate winds) Low frequency from WSW and W (moderate winds)	Site 3 at 8.5 g/m²/30 days, Site 5 at 6.1 g/m²/30 days (other sites less than 4 g/m²/30 days)		
February (14/12/2020 to 26/01/2021)	High frequency from ENE and E (high to moderate winds) Low frequency from NE (high winds), ESE, SWS, SW, WSW and W (moderate winds)	Site 2 at 16.6 g/m²/30 days, Site 3 at 8.9 g/m²/30 days, Site 5 at 8.0 g/m²/30 days, Site 7 at 4.8 g/m²/30 days (other sites less than 4 g/m²/30 days)	227(33%)	14.5
March (26/01/2021 to 23/02/2021)	High frequency from ENE and E (high winds) Moderate frequency from ENE (high winds) Low frequency from N, NEN (high winds), ESE, SWS, WSW, W (moderate winds)	Site 2 at 23.4 g/m²/30 days, Site 5 at 8.6 g/m²/30 days (other sites less than 4 g/m²/30 days)	198(29%)	17.8
April (23/02/2021 to 23/03/2021)	Moderate frequency from ENE, E, ESE (high winds) Low frequency from NE (high winds), SE, SW, WSW, W (moderate winds)	Site 2 at 13.4 g/m²/30 days, Site 3 at 7.3 g/m²/30 days, Site 5 at 9.1 g/m²/30 days (other sites less than 4 g/m²/30 days)	179(21%)	20.7
May (23/03/2021 to 27/04/2021)	High frequency from W (moderate winds) Moderate frequency from NE (high winds), SW and WSW (moderate winds) Low frequency from N (high winds), E, ESE, SWS, SW, WSW and W (moderate winds)	Site 2 at 20.7 g/m²/30 days, Site 3 at 7.7 g/m²/30 days, Site 5 at 11.2 g/m²/30 days (other sites less than 4 g/m²/30 days)	52(16%)	17.1
June	High frequency from W and WSW (moderate winds) Moderate frequency from ESE (moderates winds)	Site 3 at 6.7 g/m²/30 days, Site 5 at 9.7 g/m²/30 days	41(9%)	15.3

Table 3: Summary of wind patterns and dust levels				
Period	**General wind patterns[1 2 3] (see Appendix B for wind roses)**	**TODD levels at impact monitoring sites**	**Hours exceedance site is downwind during moderate/strong[4] winds**	**Max gust when downwind (m/s)**
(27/04/2021 to 25/05/2021)	Low frequency from SW (moderate winds) Low frequency from N (high winds), E, ESE, SWS, SW, WSW and W (moderate winds)	(other sites less than 4 g/m²/30 days)		

Notes:
1. Comments on wind strength are indicative only and refer to the more commonly occurring wind speeds each month.
2. High, moderate and low frequency winds have been categorised as >15%, 10 – 15%, and 5 – 10% respectively.
3. 'Moderate' winds refers to a speed range of 5 m/s to 10 m/s; 'strong' refers to winds above 10 m/s.
4. Wind roses corresponding to periods of monitoring are documented in Appendix B.

Similar to other monitoring years, the most frequent winds are generally from an easterly direction. For two months during autumn and winter (May and June), the frequency of winds from a westerly direction are greater than that of easterly winds. However, in May the wind speed is generally higher in the winds from an easterly direction than in the westerly winds. The impact sites (2, 3, 5, 6 and 7) are all located in a westerly direction relative to the LE operation. This means that winds from an easterly direction would increase the likelihood of dust being carried towards the impact sites. The presence of less frequent but stronger winds from an easterly direction in one monitoring period when exceedances were observed (May and June) indicates that the exceedances may have been due to activity on the LE site, despite the impact sites being upwind from the LE site under the prevailing (most common) wind direction.

Measured high dust deposition rates were generally higher from August 2020 through to June 2021. During these months, except for May and June 2021, the prevailing winds were blowing from an easterly direction. These winds would result in the impact sites being downwind of the LE site.

Dust deposition is generally lower at sites 6 and 7 than it is at the other impact sites. These sites are further away from the boundary of the LE site than sites 2, 3 and 5. Stronger wind speeds would be required to transport the dust to these further away monitoring sites 6 and 7. The increase in dust deposition at the LE boundary is representative of the localised effects of the LE activities onsite. Despite this there is one exceedance at the pump station 650 m from the LE boundary in February.

All monitored sites had decreased dust deposition in the winter season (June –July) compared to other months in the monitored period. This is likely to have been due to wet weather conditions and wind speed and frequency decreasing the potential for dust generation and transport. The wind roses for June to July show prevailing winds from a westerly direction during these lower dust deposition monitoring periods.

There was high dust deposition recorded for the remainder of the year in August 2020 to May 2021. This is likely to have been due to dry weather conditions and high wind speed increasing the potential for dust generation and transport. The wind roses for August, and October to April show prevailing winds from an easterly direction during these higher dust deposition monitoring periods. September and May are exceptions to this trend where the frequency of winds from the east are not as high, however these months still have periods of winds of significant wind speed from the east. This supports the hypothesis that higher wind speeds may have contributed to the increased dust deposition measured.

The Dogwatch monitoring site (site 2) which is located inside LE's site boundary generally had the highest dust deposition rates of the impact sites.

This site is located in a corner of the LE site directly adjacent to the LE activities so is effectively downwind from the site activities (prior to boundary controls) for winds blowing from west north-west right through to south south-west. It is also very close to the LE boundary so dust can be deposited as a result of slower wind speeds than those required to impact the more distant monitoring sites.

It is noted there are abnormally high results recorded this year from August 2020 through to June 2021 (11 of the 12 monitoring months) this year which showed significant exceedances above 4 g/m²/30 days. Impact sites 2 and 3 which are inside the side boundaries had 10 and 9 exceedances in the 12 monitoring months respectively. The maximum exceedances at sites 2 and 3 were 25.9 g/m²/30 days in October and 12.2 g/m²/30 days in December respectively. In addition, impact site 5 which is outside the site boundaries where mitigation should have reduced dust deposition exceeded the consent limit 11 out of 12 months with a maximum exceedance of 11.2 g/m²/30 days in May 2021. All of these exceedances surpassed the consent limit of 4 g/m²/30 days by approximately 3 times or more.

Impact site 7 at the pump station also had one exceedance of 4.8 g/m²/30 days in February 2021. This is unexpected due to the distance away from LE activities the impact site 7 is. While some of the wind roses within this monitoring period show higher frequencies and speeds of easterly winds, the general wind trends from the July 2020 to June 2021 monitoring period are not significantly different to other years wind data. There are no obvious sources of organic dust from the western commercial area along Dyers Road which may cause more deposition at the impact sites from previous years.

4.0 Investigation of Dust Deposition Exceedances

4.1 Introduction

Condition 33(b) of the resource consent requires the consent holder to report on the likely reasons for any exceedances that occur and any remedial action taken. This section of the report examines potential reasons or causes of exceedances which occurred during the eleven months listed in Section 3.2 and reports on remedial action taken by LE at the time.

4.2 Potential Causes of Exceedances

Dust deposition exceedances were observed at sites 2, 3, 5 and 7.

It is anticipated that sites within or on the boundary of the LE site (i.e., sites 2, 3 and 5) would experience higher TODD rates than the more distant sites (i.e., sites 6 and 7). This is consistent for the monitoring results of July 2020 to June 2021 and previous years monitoring results.

There were 21 more TODD exceedances in the 2020-2021 monitoring year in comparison to the 2019-2020 monitoring year.

As outlined in the previous year's reports, related studies confirm that relative humidity and rainfall show significant negative association with dust fall level (Giri et al[4], Naddafi et al[5], Yassen[6]). The positive association between wind speed and dust fall is also reported.

To investigate probable causes of the exceedances, PDP have reviewed relative humidity, wind speed and direction data obtained from New Brighton Pier weather station from July 2020 to June 2021. Precipitation monitored at the Christchurch Airport and Christchurch Kyle Street weather station from 2020 to 2021 was also considered.

- **Wind speeds and directions:**

  Through the summer months of December to February wind direction and speed were similar to the previous year. In autumn (March, April and May) wind speed and direction was similar however wind frequency and speed from the east were lower in April 2021 than April 2020, but higher in May 2021 than May 2021. In May 2021 there was a high frequency of high wind (>10 m/s) from the northeast. The winter season (June to August) was very similar to the previous season in wind speed and frequency, and the spring season (September to November) had similar wind speeds to the previous monitoring year but a higher frequency of easterly winds. Average windspeed in the previous 2019 – 2020 period was slightly higher at 4.9 m/s than this year's 2020 -2021 monitoring period which was 4.8 m/s. In summary there appears to be a similar annual frequency of north and east winds to previous years, and there does not appear to be a significant amount of higher wind speeds or frequencies which has potential to result in higher potential for dust in the current monitoring period than in 2019-2020.

- **Precipitation level:**

  Average rainfall data from Christchurch Aero - 4843 indicates rainfall in the 2020 – 2021 period had more monthly variation than the 2019-2020 period. Rainfall in May was significantly higher than previous years, but rainfall from July to November 2020 was lower compared to the 2019 – 2020 period. Notably rainfall in February and March 2021 was significantly low compared to the previous year's data of 2017 to 2020. While the summer drought was significant in early 2021 with extremely low rainfall, this period of low rainfall did not last as long as the previous year's summer drought. Average monthly rainfall for the Christchurch Aero station is presented in Figure 6.

  The total rainfall in the 2020 to 2021 period is 21% less than the total rainfall in the 2019 to 2020 monitoring period. In summary, the lower overall

[4] D.Giri, V.Krishna Murthy, and P.R. Adhikary, The influence of meterological conditions on PM_{10} concentrations in Kathmandu Valley. International Journal of Environmental Research, vol. 2, no. 1, pp. 49-60, 2008.
[5] K.Nabizadeh, Z.Soltanianzadeh, and M.H.Ehrapoosh, Evaluation of dust fall in arid air of Yazd, Journal of Environmental Health Science Engineering, vol.3, no.3, pp. 161-168, 2006.
[6] M.E.Yassen, Analysis of climatic conditions and air quality observations in Kuala Lumpur and Petaling Jaya, Malaysia, during 1983-1997 [M.S.thesis], University Kebangsaan Malaysia, 2000.

quantity of rainfall in 2020 - 2021 results in increased potential for dust in the previous monitoring periods.

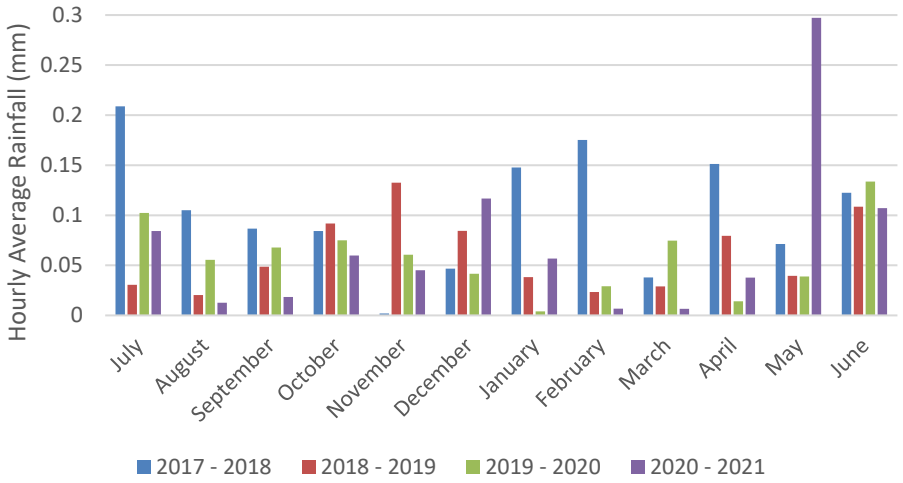


Figure 6: Average Monthly Rainfall at Christchurch Aero Station 4843

- **Relative humidity:**

Relative humidity percentages fluctuated between 21% and 100% in the July 2020 to June 2021 period. Average monthly humidity ranged from 65% to 87% with significant decreases in average humidity noted in September and December (below 65%), indicating these were drier months. June 2021 notably had highest average humidity of 87%. In general, the relative humidity was higher than the previous period over summer and higher on average during the year, suggesting the 2020 – 2021 monitoring period's RH was not a factor driving the higher dust deposition. The average annual relative humidity's in 2015 to 2021 ranged between 69% and 75% with the average in 2021 being 72% (Figure 7). In summary, relative humidity in 2020 -2021 was average when compared previous years.

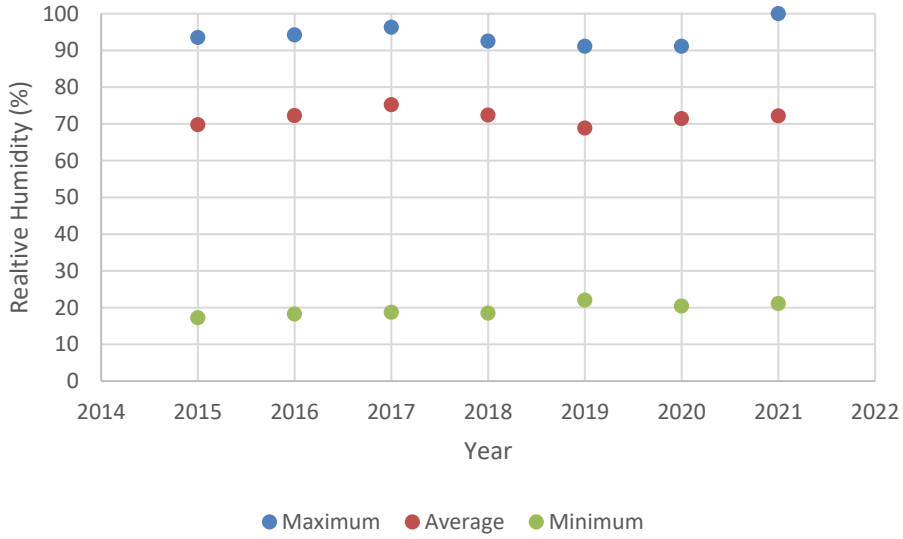


Figure 7: Relative Humidity at New Brighton Pier 2015 – 2021

- **Site activities and dust management**

LE informed PDP site activities and dust management were not typical of regular operation throughout the year. This is due to a number of circumstances requiring adaptive management of the site as LE prepares to have all material removed from the outside area by January 2021. LE note the following about site operations during the 2020-2021 period:

- LE are currently managing their transition to remove the product from the outside area on site to offsite locations which inherently resulted in increased sources of dust suspended in air. This increased activity is likely to continue until the end of January 2022.
- LE have continued the new night shift operations to reduce odour effects on surrounding residents, which subsequently may result in changes to dust generation with differing air suspension conditions for dust at night.
- There is a facility which manages shingle, soil and other materials on stockpiles for bulk sales west of the site on the other side of State Highway 74. This has generated visible plumes of suspended material during windy days However, this type of activity is more likely to result in TAD than TODD and therefore is unlikely to be measured as TODD in dust gauges.

The 2019 – 2020 period noted LE's analysis of monthly input from the CCC kerbside collections increasing volumes of green waste and trending generally upward. This meant that larger volumes are being processed at the facility and this has also been a consideration for whether a new location and larger facility is required.

While this 2020-2021 monitoring round report may reflect changes in dust fall that have occurred as a result of increased processing at the plant, it is noted that the above noted changes and disruptions to typical management are what are most likely drove the high dust deposition rates observed in this year's monitoring results.

The high measurements of onsite impact sites 2 and 3 demonstrate the increased suspension of material inside the boundary due to these changes in management onsite. The high measurements offsite at impact site 5 and in one circumstance at site 7, show how the disruption of typical management and shifting of windrow locations, increased screening and a higher number of truck movements can have a negative influence on dust deposition.

Impact site 6 at Dogwatch had no exceedances during this year's monitoring period, which is potentially attributed to the effective boundary controls at this location. In comparison impact site 5 had exceedances in 11 out of 12 months of the monitoring period. Notably the processes undertaken (window turning/truck movements and screening) immediately next to the Affordable Storage boundary at impact site 5 are more likely to generate suspended dust in the immediate area than other locations.

Overall, the meteorological and site operational conditions in 2020-2021 have varied significantly from previous years due to LE's target to change the way the operations are undertaken in the future. The investigation indicated that the higher dust levels monitored in 2020 to 2021 compared to the previous year may be attributed to less rainfall, operation disruptions, and changes in practices onsite throughout the year.

The exceedance at the pump station impact site 7 in February may be due to a high frequency of winds from the NEE direction with 5% of winds from this direction being greater than 7.5 m/s. This would result in the impact site being directly downwind during these periods, where windrows were placed closer to the boundary than typically undertaken. Notably February also had lower rainfall than previous monitoring years creating dry operating conditions onsite.

It should be noted that sites 2 and 3 are inside the boundary of the LE site and that therefore only measured exceedances at impact sites 5 and 7 are offsite exceedances. The consistent exceedances were mostly localised at impact site 5 which is immediately next to the site boundary near an area with a high number of truck movements and material shifting. There is one other exceedance at impact site 7 which may suggest some less localised effects of dust have occurred due to the operational changes and need to remove compost offsite.

4.3 Remedial Actions

It is noted that, while all exceedances of the dust deposition consent limit are reported to CCC, only months with exceedances at off-site monitors (or a combination of both) are reported to CRC.

The developments of LE's dust mitigation procedures are summarised below.

2016: Watering systems including sprinklers, portable low-pressure mister towers and a portable mist unit have been operated onsite to assist with dust suppression since 2016. A sweeper attachment for a small loader has also been used since 2016 and sweeps the site's yards while the main sweeper truck is being used elsewhere. LE uses the sweeper truck for dual purposes, and it is often used to water the windrows while sweeping. The watering systems were improved in 2016 including revision of timing and duration of the sprinkler and water truck operated near the Dogwatch boundary.

2017: As a part of remedial actions for dust complaints in January 2017, loader movements were shifted away from the site boundary and a new windrow turning machine was used onsite from October 2017. This machine decreases the amount of time taken to turn windrows from approximately 3 hours to 15 minutes. The use of the windrow turning machine allows LE to select times of the day with low wind speeds and therefore low dust risk to turn the windrows. The use of this machine therefore reduces risk of dust generation from this process being blown offsite.

2018: A new biofilter and canopy was installed on the screening shed in May 2018.

2019: One portable water mister was upgraded to increase output. In addition, a water curtain was installed on the screen shed to mitigate dust and water vapour escaping through this area.

2020: LE focused on water application with sprinklers and misters. A third truck was acquired to assist with keeping the pavement wet during site operations. Additional dust suppression cannons were bought onto site to mitigate the increase windrow turning since March.

2021: LE continued to focus on water application however LE's main focus during this monitoring period was to explore options for future site improvements, which has involved in LE aiming to remove all outdoor stockpiles offsite by January 2022. While this change has temporarily increased dust deposition due to increased truck movements it can be expected that after January 2022, there are unlikely to be any further exceedances as a result of LE activities after January due to the removal of outdoor windrows and stockpiles.

5.0 Complaints

There were no dust complaints received for adverse dust impacts by LE during the July 2020 to June 2021 period. This is consistent with the previous monitoring year where there were also no complaints, which is unexpected given the much higher dust deposition recorded in this period.

It is noted that complaints have decreased in comparison to previous years, this may reflect public anticipation and satisfaction that dust and odour from the LE site will be improved through removal of material offsite. However, in general it can be concluded that the number of dust complaints is consistent and low each year.

6.0 Summary of the Monitoring Programme 2020-2021

PDP have reviewed the TAD and TODD data supplied by LE and their calculation of resultant monthly organic dust deposition rates. The monitoring period was from July 2020 to June 2021 inclusive.

An examination of wind data showed that higher TODD levels occur in months with a higher frequency of moderate to strong easterly winds, such as has occurred historically over summer months for the site. The resulting monthly TODD rates indicated exceedances of the consent limit of 4 g/m²/30-days. LE has reported all exceedances to CCC. There were also off-site exceedances which were reported to CRC during the monitoring year.

Investigations of probable causes of exceedances at the monitor sites 2 and 3 (located within LE's boundary) conclude that dust levels above 4 g/m²/30 days recorded in the year 2020-2021 have been likely influenced by the changes and disruptions in typical operation in preparation to remove all material from the outdoor area onsite. In general, it is considered that the exceedances at these onsite impact sites are due to proximity to the dust discharge activities undertaken by LE.

There were significant exceedances at impact site 5 beyond the boundary in the Affordable Storage above 4 g/m²/30 days recorded in August to June 2020. This is attributed the high level of LE activities moving material in the area immediately next to the Affordable Storage boundary.

There was one exceedance at impact site 7 at the pump station in February 2021. This attributed to high wind frequency and speed in conjunction with placement of windrows closer to the boundary than typical operation and low seasonal rainfall.

No complaints were received relating to dust impacts in July 2020 to June 2021 period. LE has continued to undertake its various dust control measures in order to provide effective dust control. In this monitoring season LE has not added additional controls and instead focused on changes to site practices to allow for

investigation into both adding more buildings onsite and then adapting to removal of material offsite instead of allowing for maturation of product in windrows. Receiving no complaints compared to previous monitoring years is likely a reflection of public perception that changes are being implemented.

7.0 Compliance with Consent Conditions 2020-2021

With regard to compliance with the consent conditions, the following conclusions are made:

> *"33. (a) Dust deposition monitoring shall occur in at least two dust gauges sited near to the boundary with Affordable Storage Limited or successor and the boundary with Dogwatch Sanctuary Trust or successor and at least one further control dust gauge. The location of the dust deposition gauges shall be determined by a suitably qualified person and shall be provided in writing to the Canterbury Regional Council. The method of monitoring shall be ISO DIS-4222.2 or a similar method to the satisfaction of the Canterbury Regional Council. Samples shall be collected monthly and the monitoring results shall be included and summarised in the Annual Environmental Report required under Condition 36."*

The dust monitoring programme undertaken by LE in 2020-2021 is compliant with the requirements of consent condition 33(a).

> *"33. (b) Dust control measures shall be implemented to maintain the rate of dust deposition at the consent holder's boundary, measured in accordance with Condition 33(a), at less than 4g/m²/30 days above the background concentration measured at the control site. Any exceedance of this trigger level shall be reported to the Canterbury Regional Council, including the likely reasons for exceedance and any remedial action undertaken."*

The dust deposition limit was exceeded on 11 of the 12 months with available measurements in the 2020-2021 reporting period. However, 19 of the 31 2020-2021 exceedances (61%) were recorded at on-site monitoring locations. The dust deposition limit was exceeded at off-site from August 2020 to June 2021. LE has reported exceedances to CCC, CRC and to the Community Liaison Group. Subsequent remedial action has been taken, however, notably the main priority of the site has been changing practices and removing material offsite to meet the January target of no outdoor windows by January 2022 which has caused disruption to the regular dust mitigation systems in place. Updates on any exceedances are provided to the CRC via the Community Liaison Group meeting reports.

As addressed in Section 4.2, the exceedances offsite are considered a reflection of abnormal operations and disruptions in standard practices. The most frequent exceedances are localised to a small area at impact site 5 close to a busy area of the site where material is being loaded for removal offsite.

There is one exceedance further away from the site at the pump station which is likely due to winds and low rainfall in conjunction with disruption in regular practices.

LE has a continual improvement process in place which aims to reduce the impacts of dust to ensure full compliance with condition 33(b). LE proposes to prepare and submit an early report next year summarising the results up to March 2022 to track and demonstrate dust reduction following removal of material onsite. This will be submitted in conjunction with the regular annual monitoring report.

> *"36. The consent holder shall, no later than the 30th of June of each year, provide an Annual Environmental Report to the Canterbury Regional Council setting out all monitoring and reporting results required by conditions of consent and their interpretation by an appropriately qualified person, including dust deposition monitoring and complaints recording undertaken in relation to this consent over the previous period. Where the result of any test or monitoring undertaken in relation to this consent exceeds the relevant limit/trigger level or does not comply with the relevant condition, then the steps that were taken to rectify the non-compliance shall be specified."*

This report meets the requirements of complying with consent condition 36. However there has been a delay in submission of this years monitoring report while LE undertook a thorough investigation of likely causes of exceedances.

8.0 Future Dust Deposition Monitoring at the Site

LE's operations in 2020-2021 had a higher level of non-compliance with the requirements of 33(b) than experienced in 2019-2020 and in previous years. The increase in non-compliance can be attributed to lower annual rainfall, changes in practice resulting in increased vehicle movements and increased screening and throughput at LE. However, LE notes this is a part of remedial actions to eliminate the long-term effects of the operations beyond the property boundary by removing material entirely from the outside area.

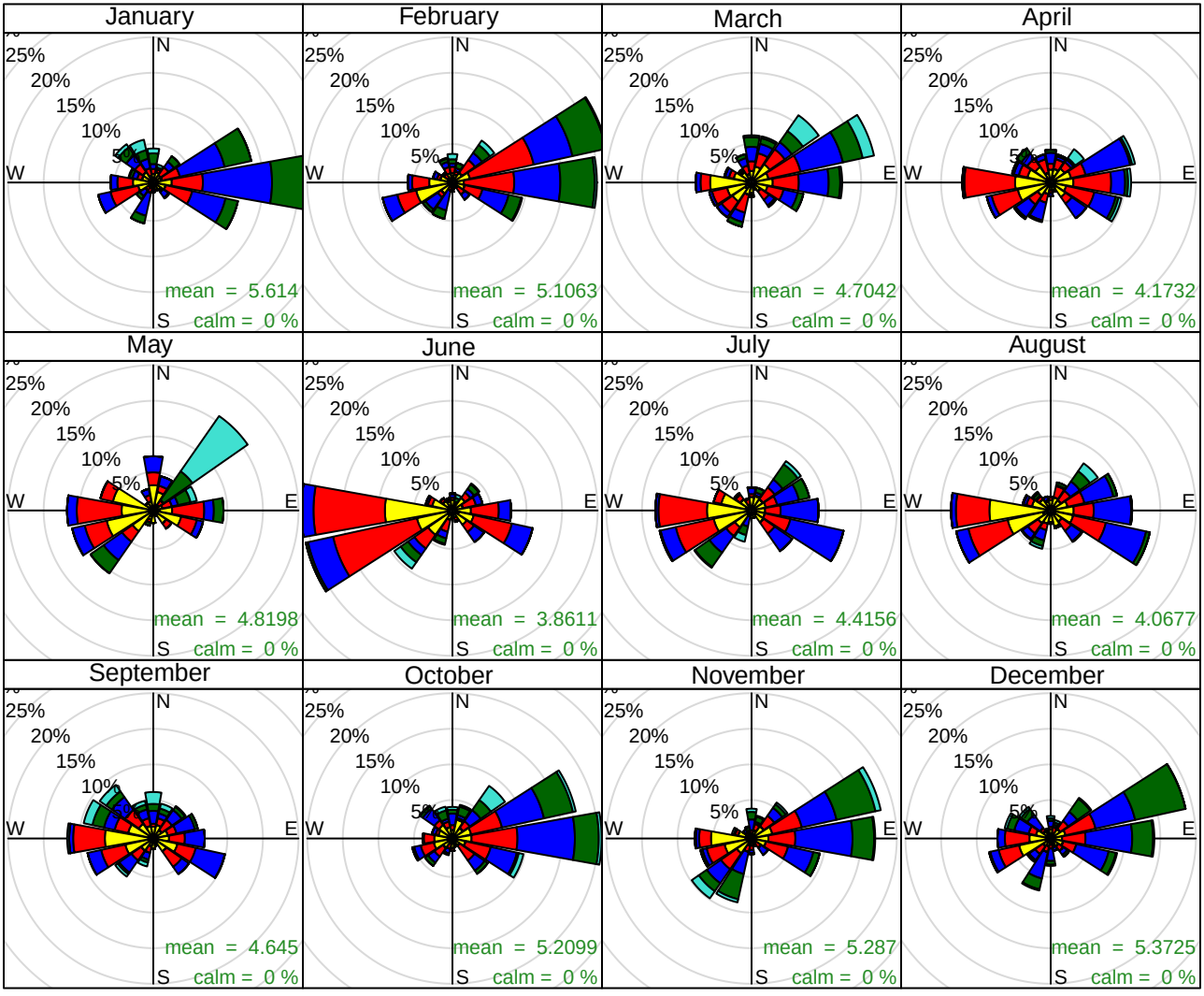
To quantify the change in dust deposition and to demonstrate the improvement which is anticipated to result from the removal of outdoor windrows from the site the dust deposition monitoring programme will be continued for the 2021-22 monitoring year.

It is expected that next year's monitoring report will show significantly less dust deposition as a result of the removal of outdoor windrows from the site. Should the 2021-22 monitoring report demonstrate a significant reduction in offsite dust deposition, LE will review the value of the dust monitoring programme and if required will apply to CRC to amend the relevant conditions of consent.

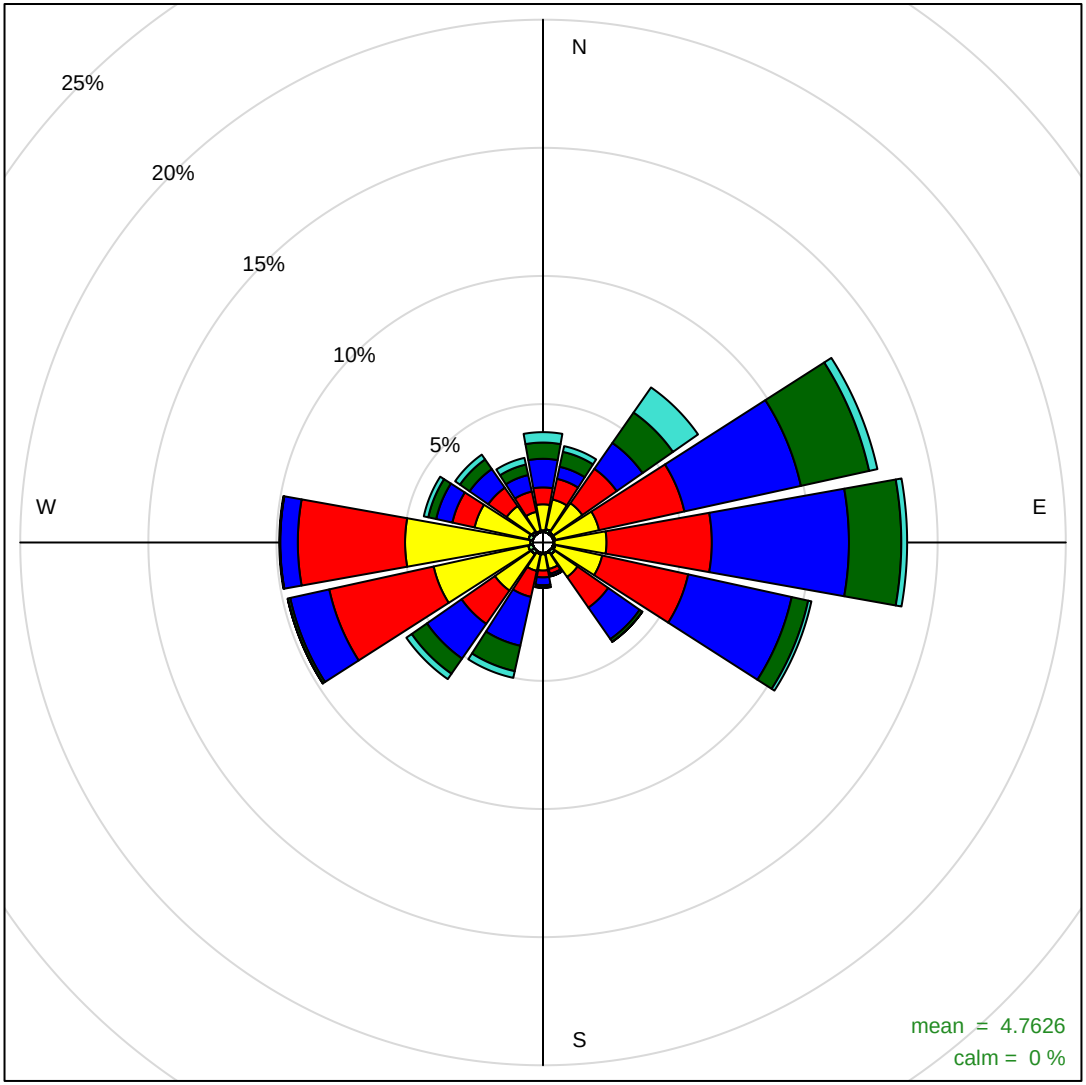
Appendix A

Monthly Wind Roses (New Brighton Pier AWS MetService Meteorological Station)

New Brighton Windroses − July 2020 to June 2021



New Brighton Windrose

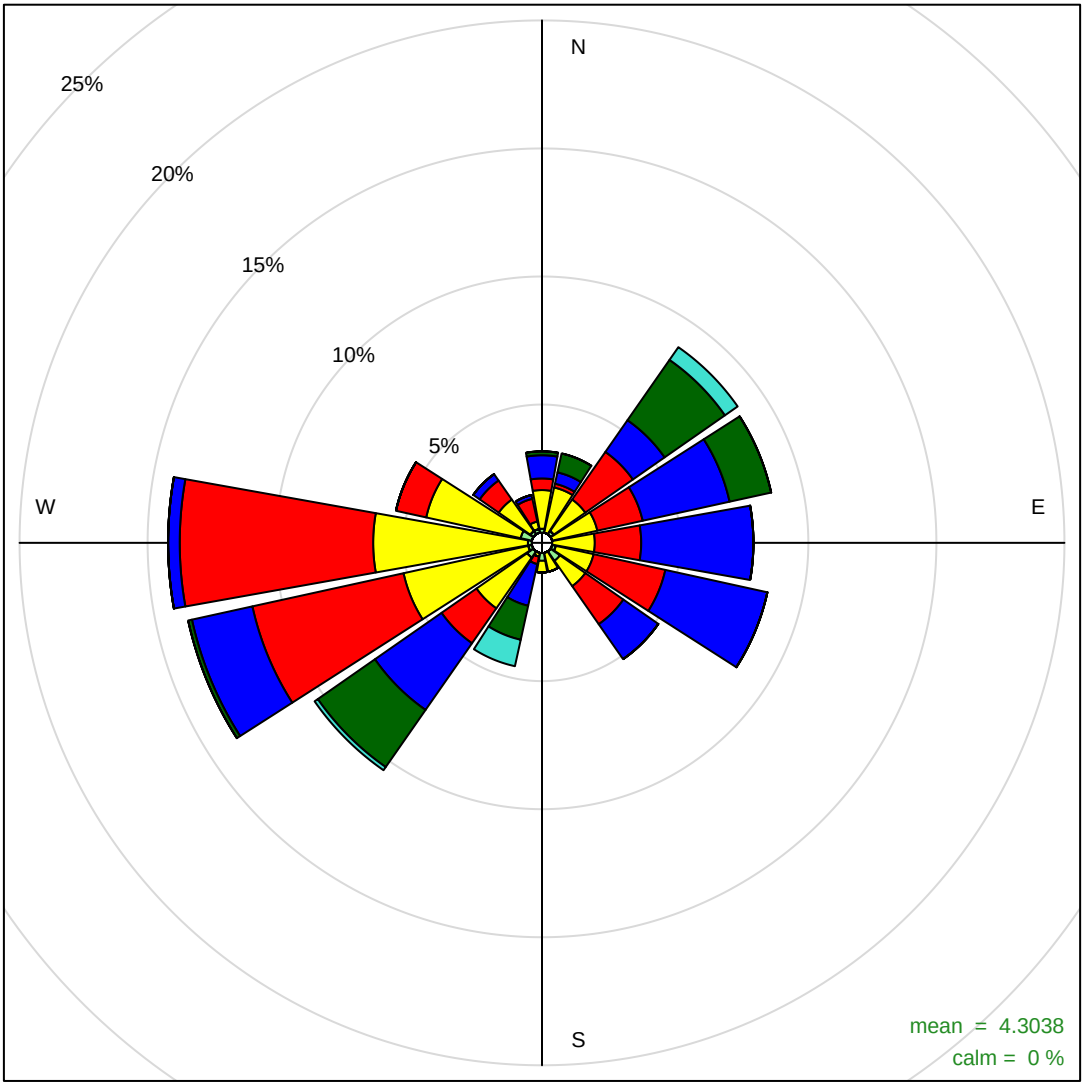


Frequency of counts by wind direction (%)

Appendix B

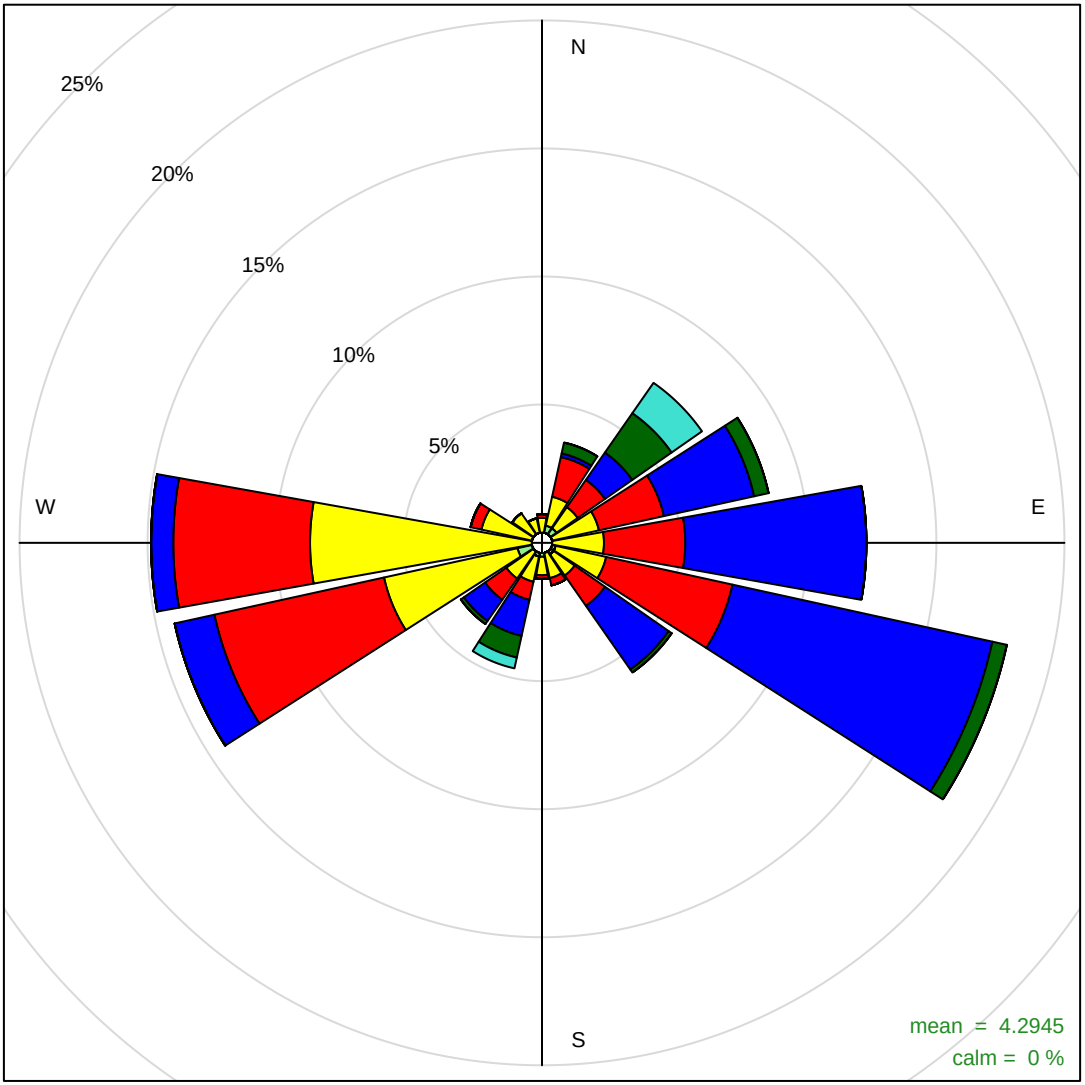
Exceedance Period Wind Roses (New Brighton Pier AWS MetService Meteorological Station

New Brighton July 23/06/2020 − 28/07/2020



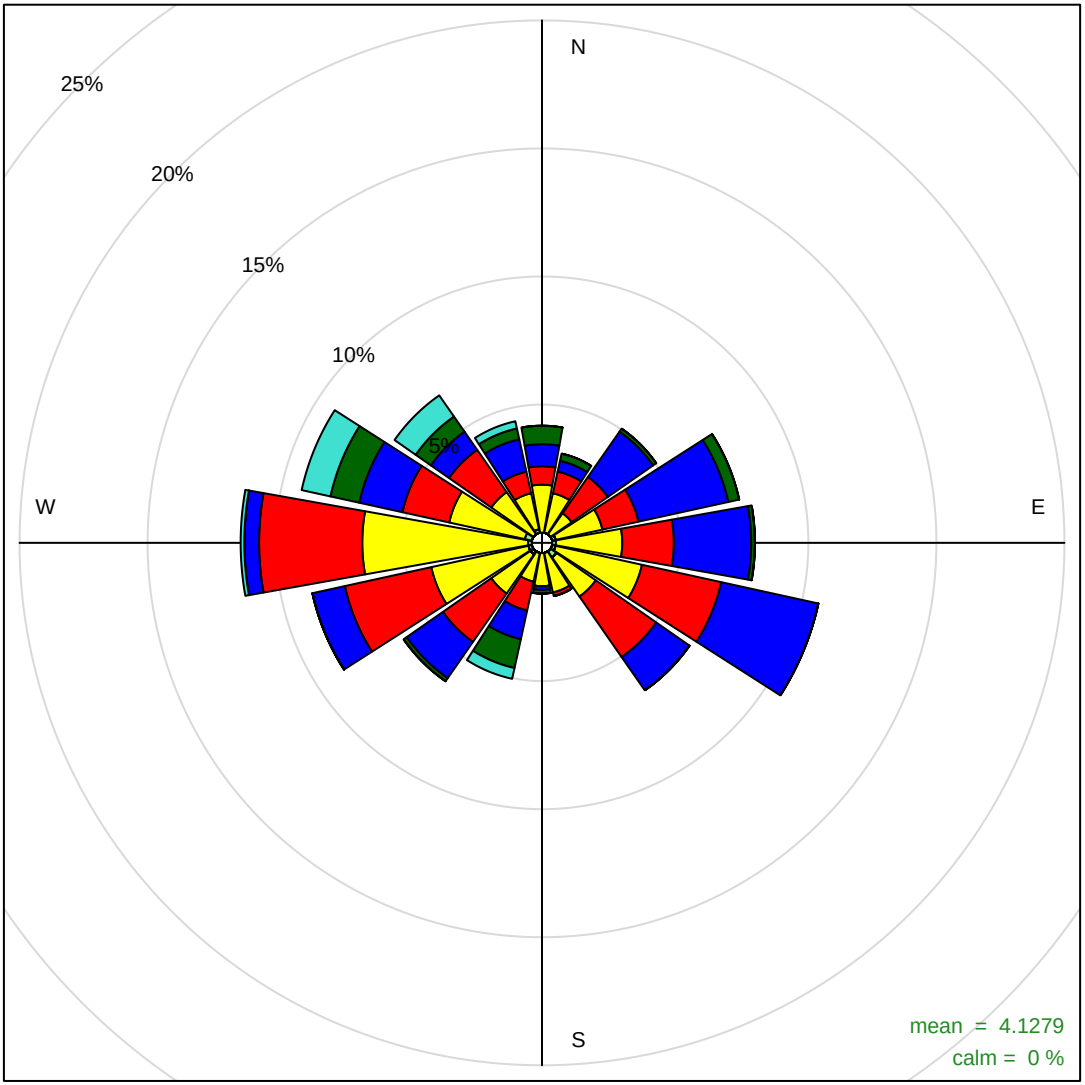
Frequency of counts by wind direction (%)

New Brighton August 28/07/2020 − 25/08/2020



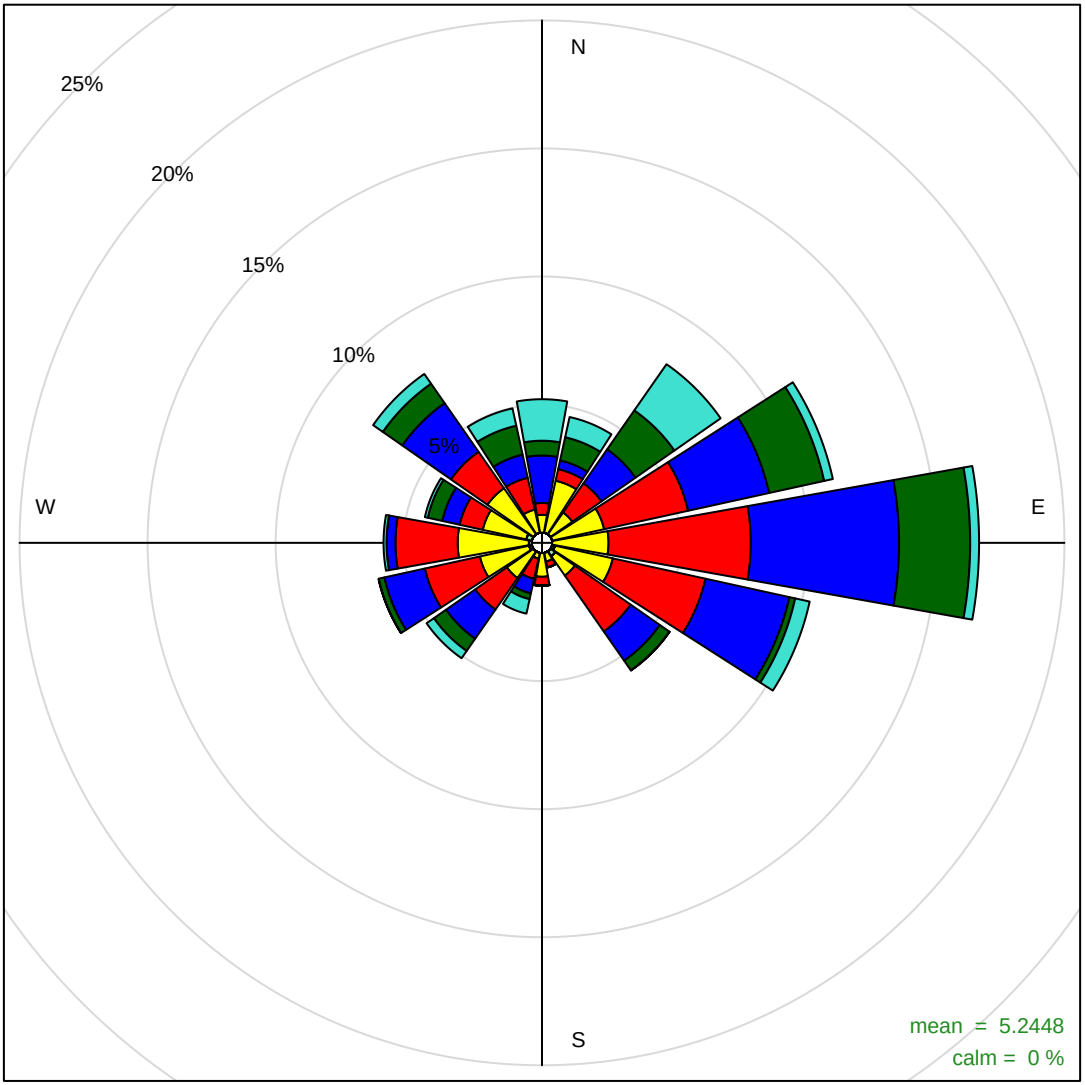
Frequency of counts by wind direction (%)

New Brighton September 25/08/2020 − 22/09/2020



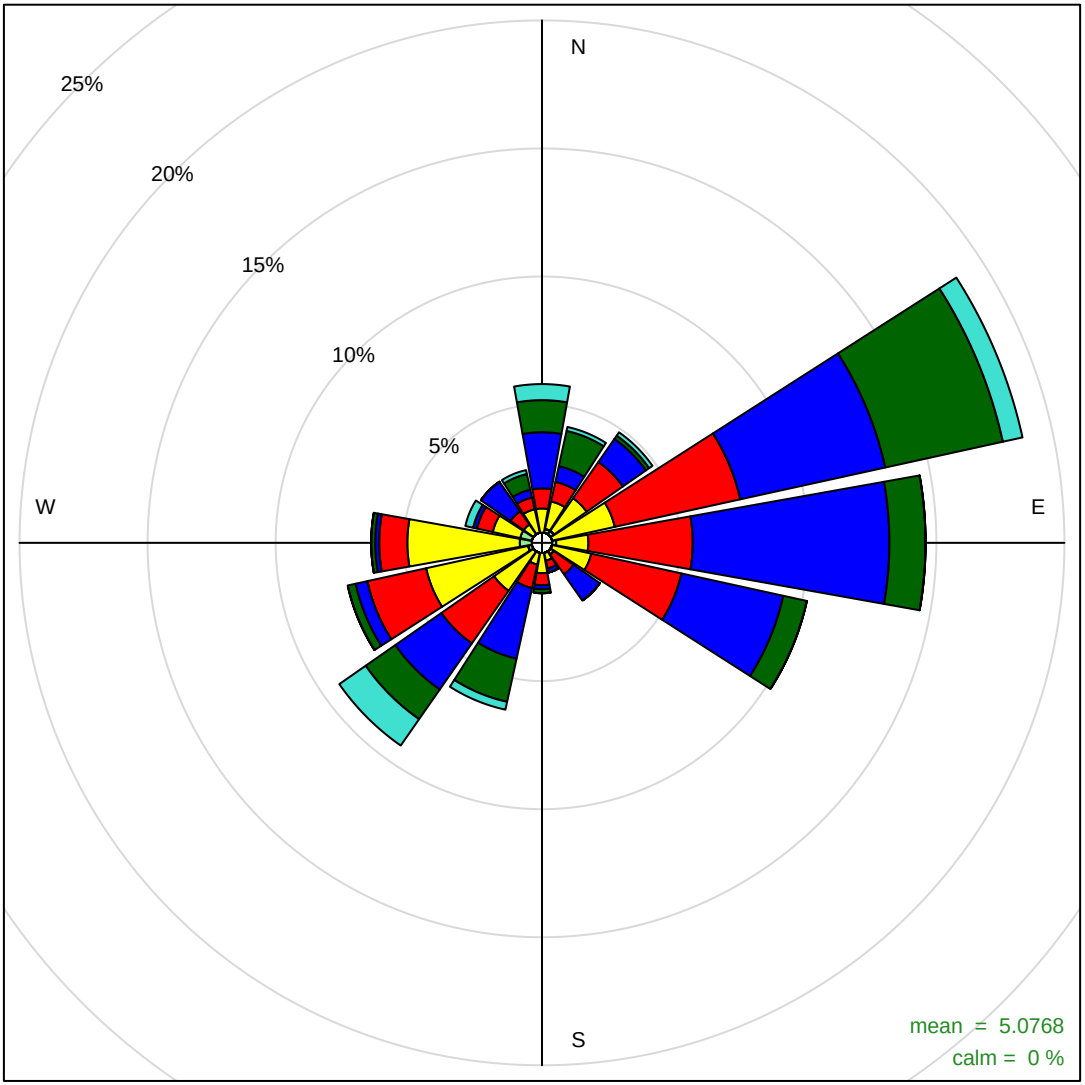
Frequency of counts by wind direction (%)

New Brighton October 22/09/2020 − 27/10/2020



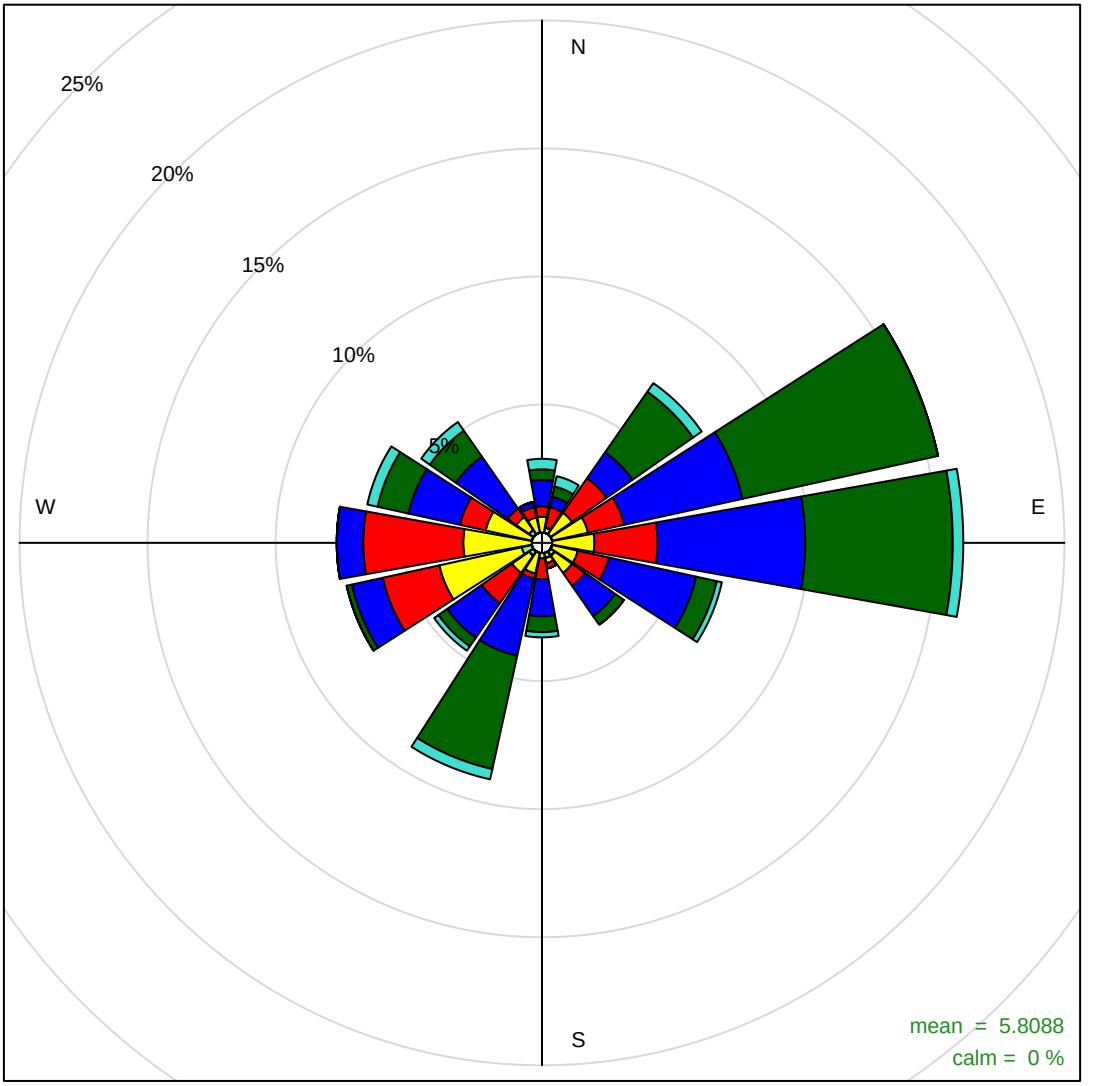
Frequency of counts by wind direction (%)

New Brighton November 27/10/2020 − 24/11/2020



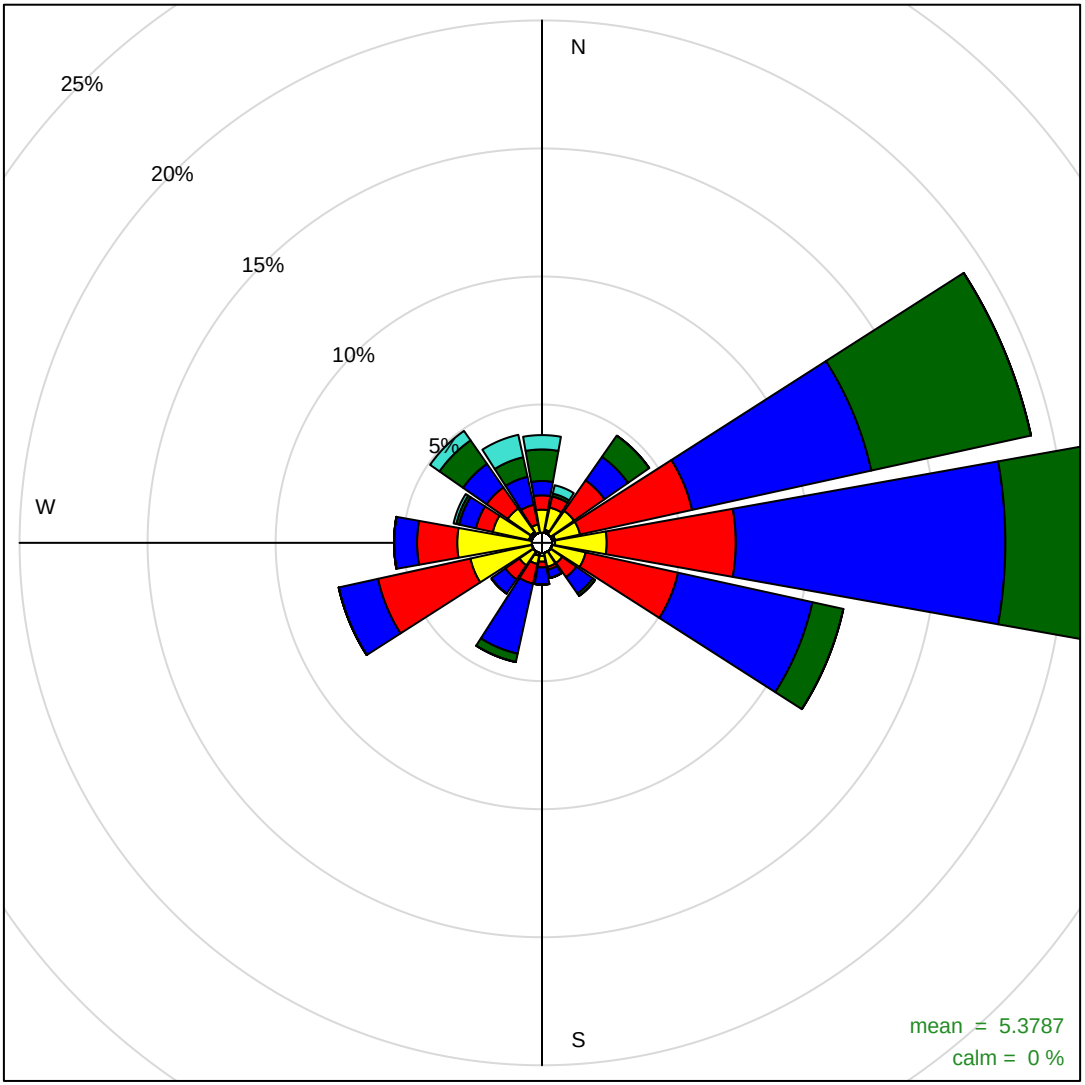
Frequency of counts by wind direction (%)

New Brighton December 24/11/2020 − 14/12/2020



Frequency of counts by wind direction (%)

New Brighton January 14/12/2020 − 26/01/2021

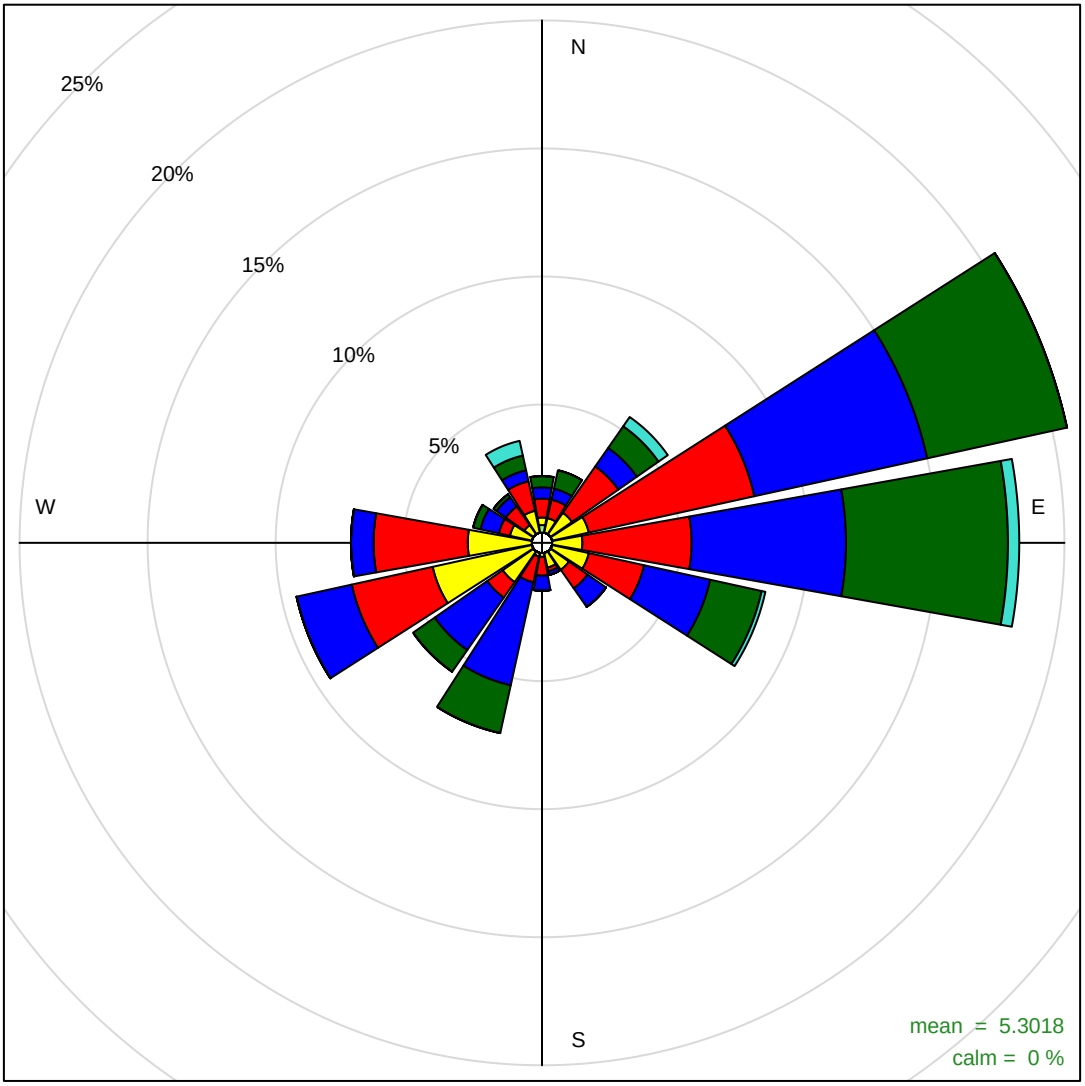


0.5 to 1 | 1 to 3 | 3 to 5 | 5 to 7.5 | 7.5 to 10 | 10 to 15

(m s^{-1})

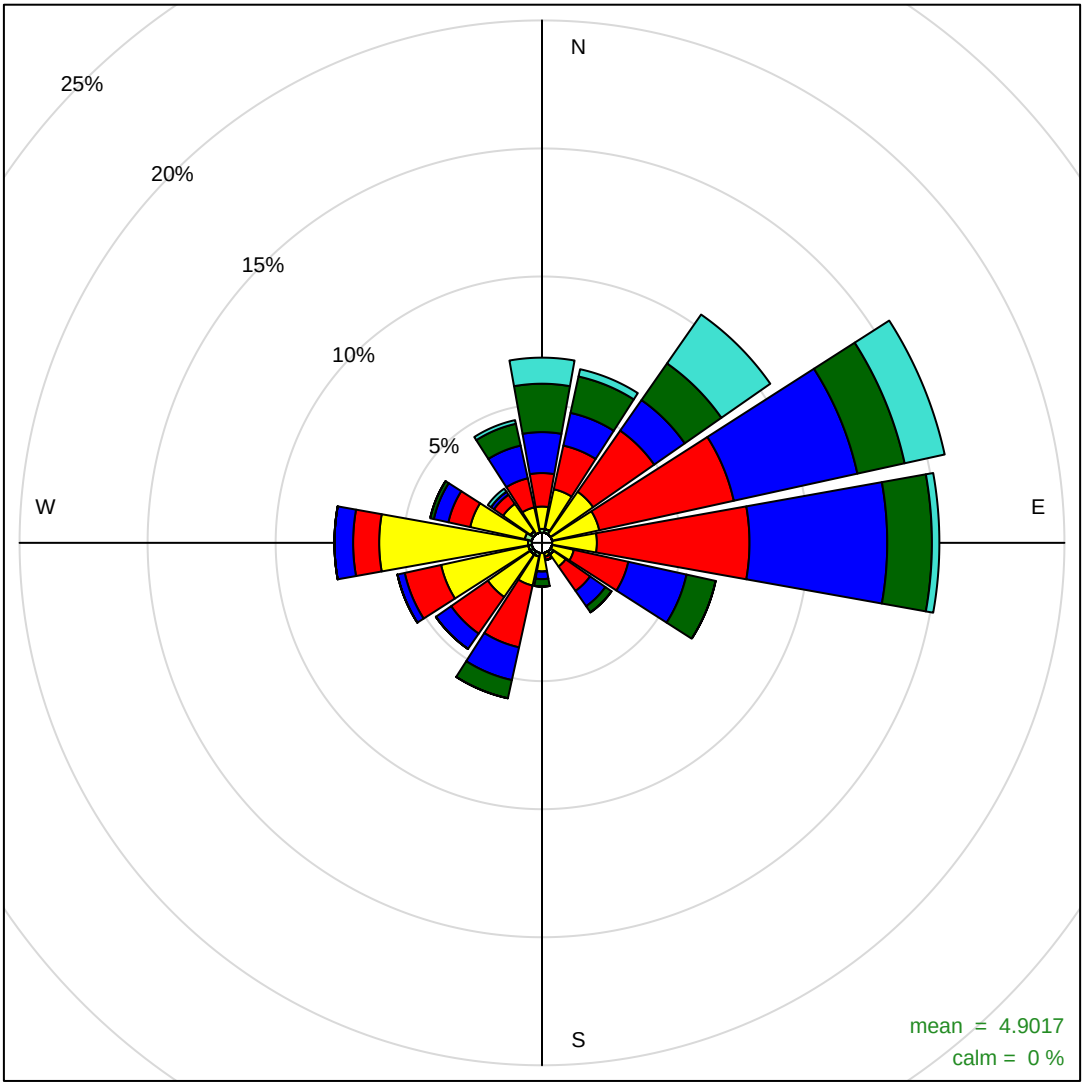
Frequency of counts by wind direction (%)

New Brighton February 26/01/2021 − 23/02/2021



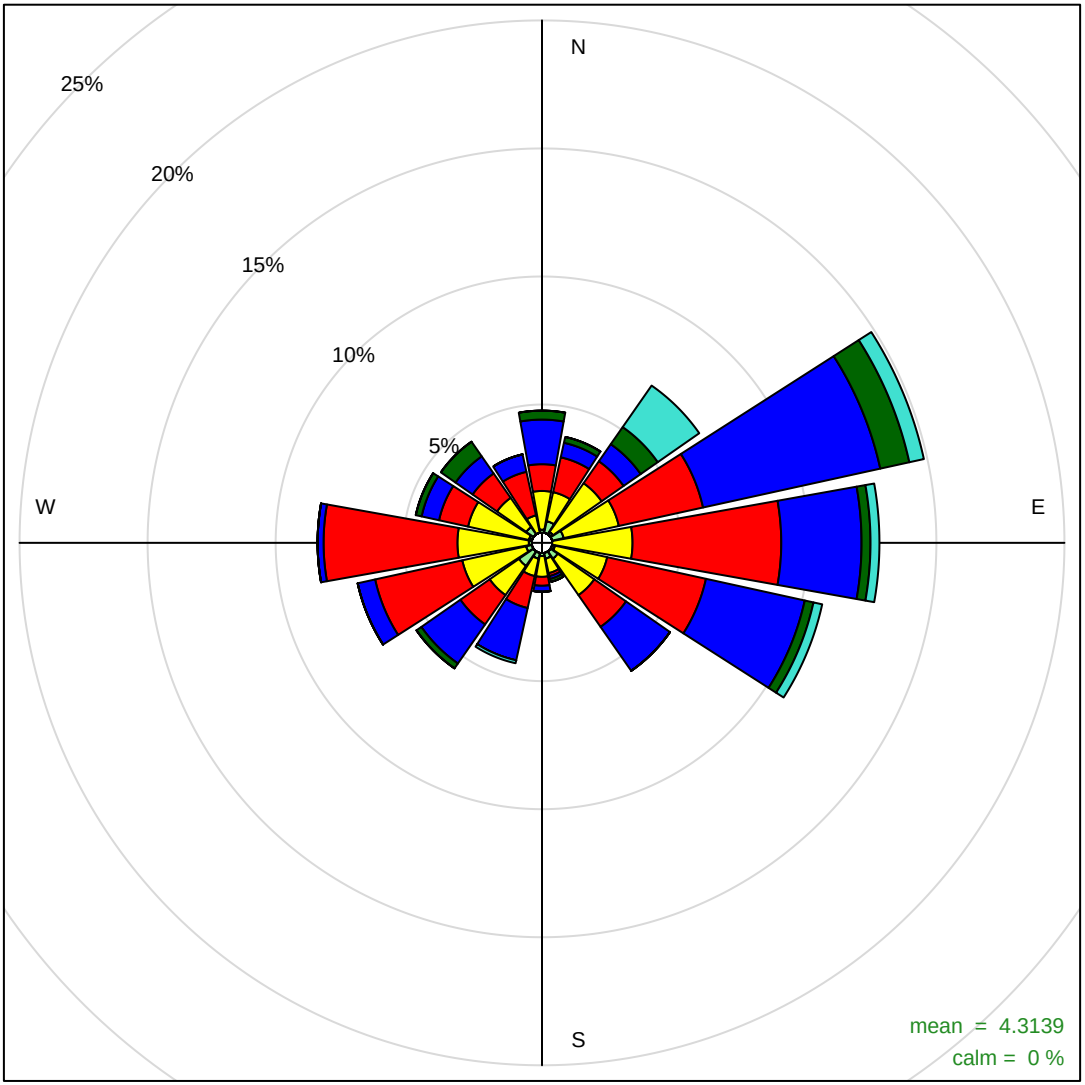
Frequency of counts by wind direction (%)

New Brighton March 23/02/2021 − 23/03/2021



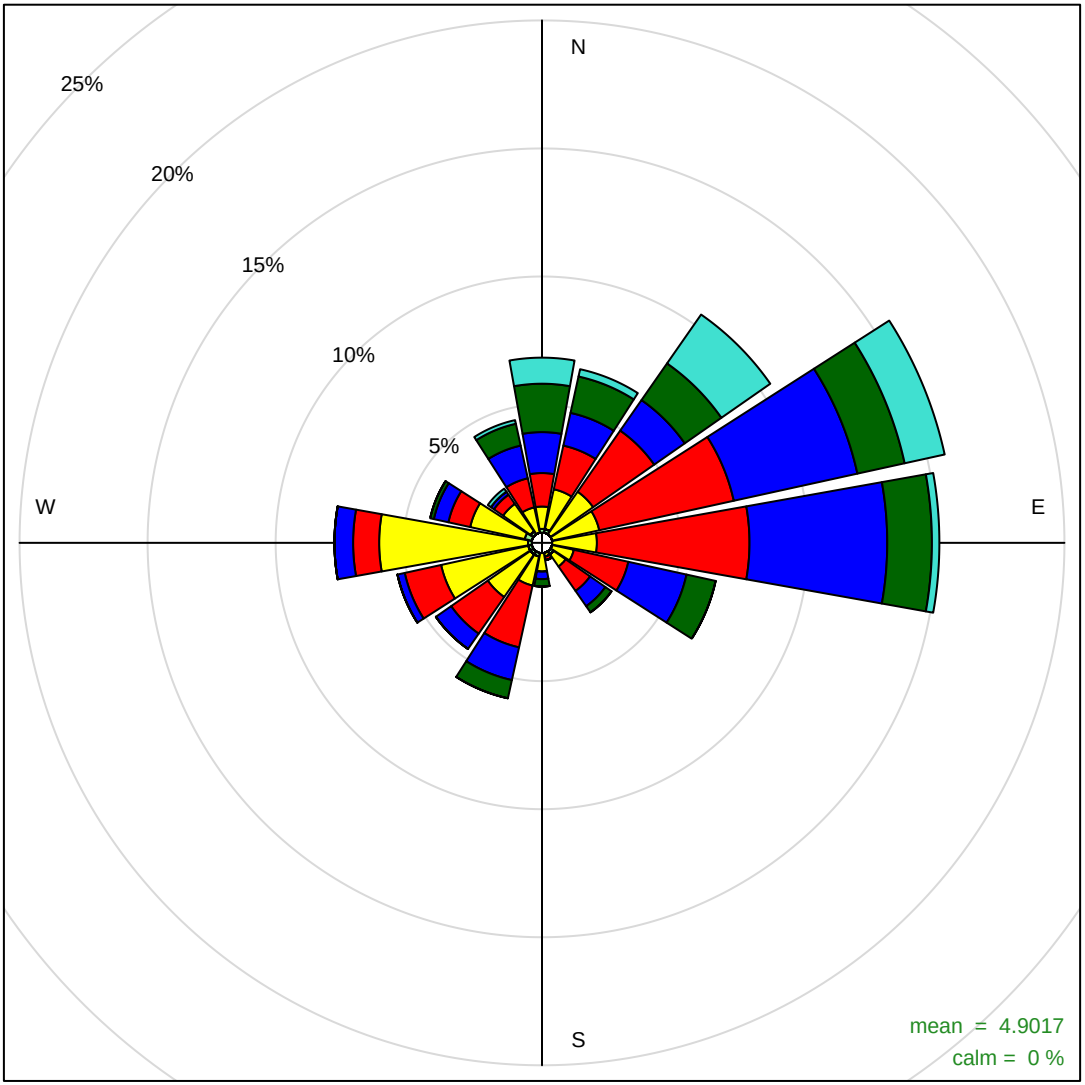
Frequency of counts by wind direction (%)

New Brighton April 23/03/2021 − 27/04/2021



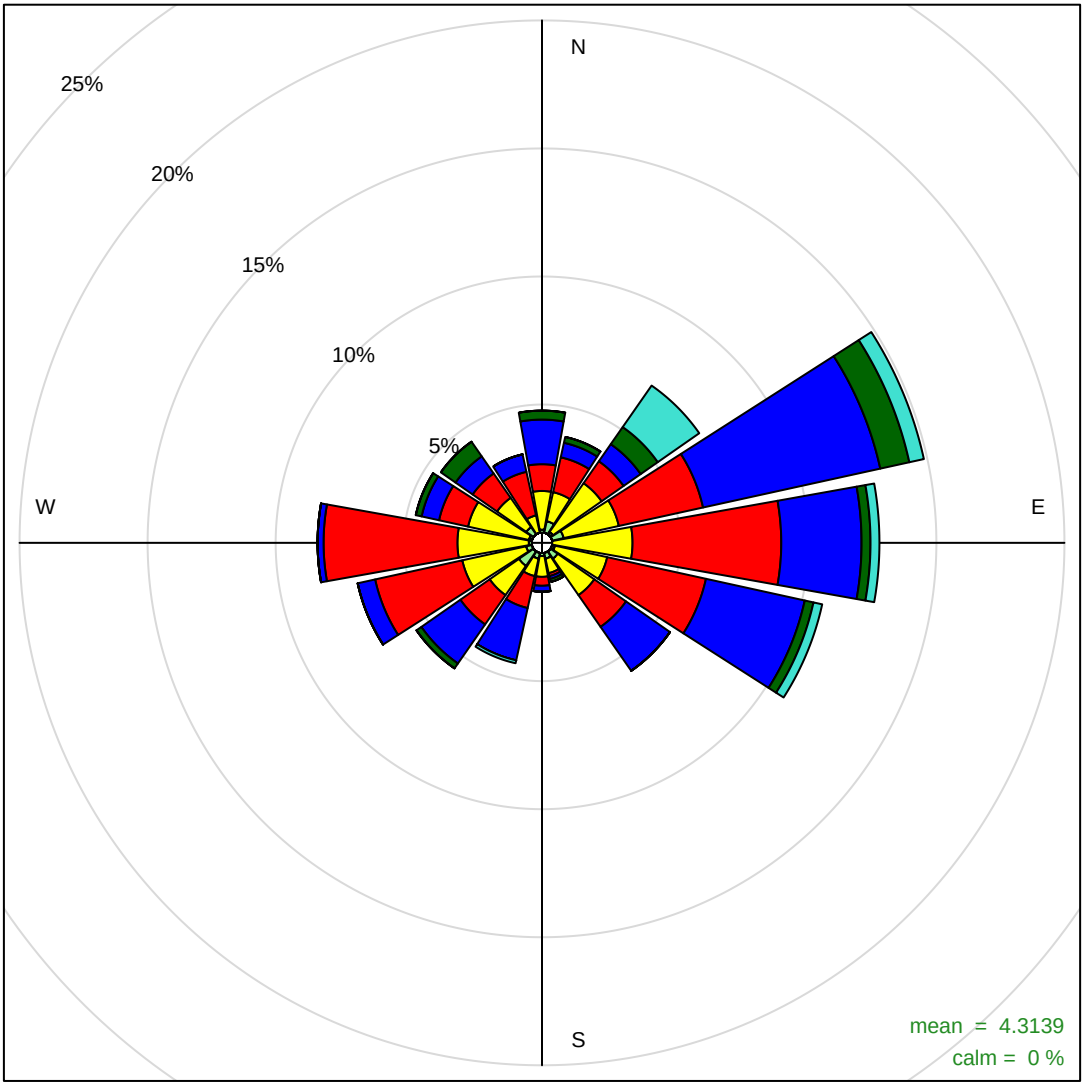
Frequency of counts by wind direction (%)

New Brighton March 23/02/2021 − 23/03/2021



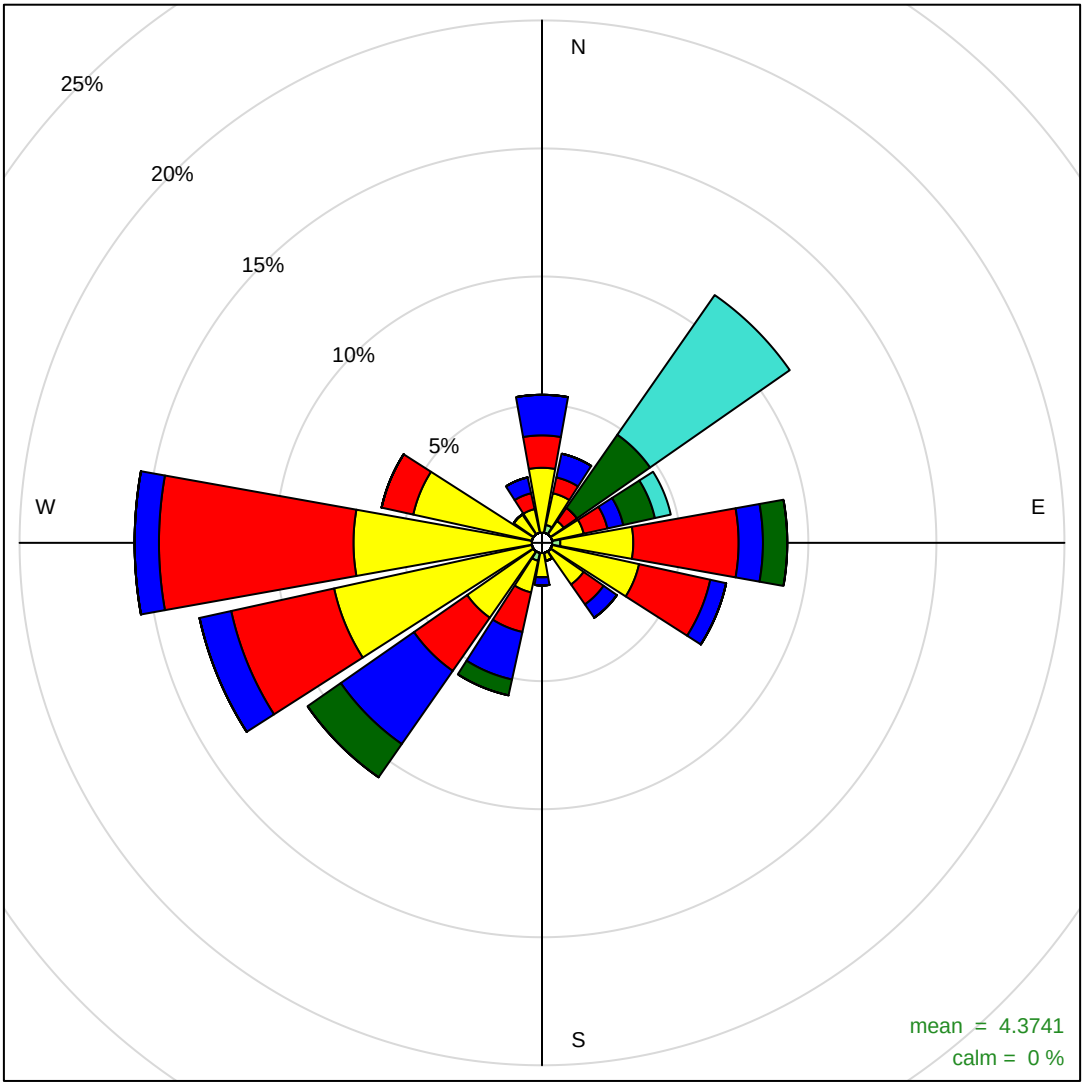
Frequency of counts by wind direction (%)

New Brighton April 27/04/2021 − 27/04/2021



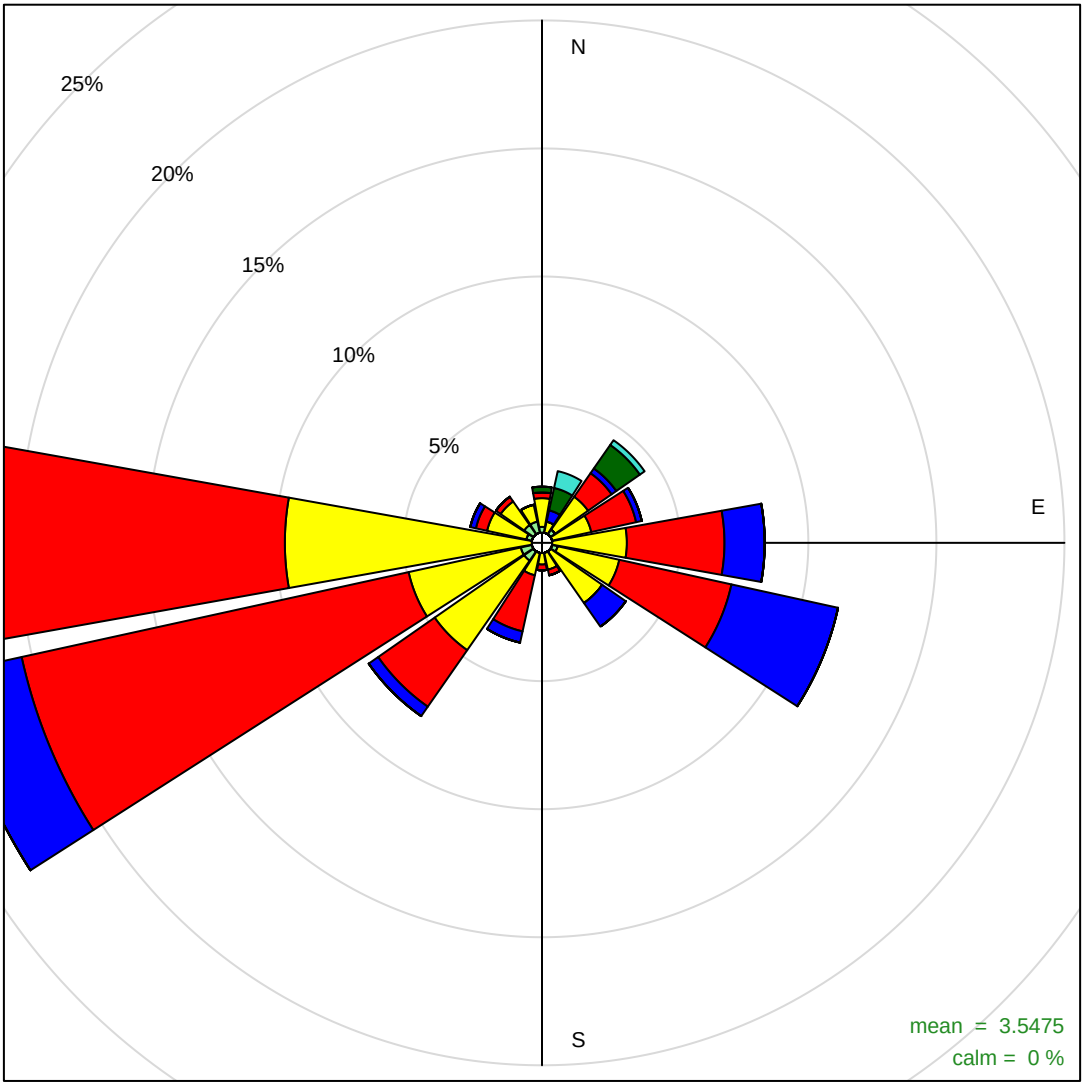
Frequency of counts by wind direction (%)

New Brighton May 27/04/2021 − 25/05/2021



Frequency of counts by wind direction (%)

New Brighton June 25/05/2021 − 22/06/2021



Frequency of counts by wind direction (%)