AIR QUALITY IN HELSBY

2022 Annual Report

Report for: Peel NRE Limited

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EXECUTIVE SUMMARY

This report provides details and results of the air quality monitoring programme which took place in Helsby, Cheshire from 1st January 2022 – 31st December 2022.

The work was carried out by Ricardo Energy and Environment on behalf of Peel NRE Limited. The monitoring programme includes measurements of particulates (PM_{10} and $PM_{2.5}$), heavy metals, and Toxic Organic Micro Pollutants (dioxins, furans, dioxin like polychlorinated biphenyls, and polycyclic aromatic hydrocarbons), to assess their concentrations against the relevant air quality objectives.

Hourly PM_{10} and $PM_{2.5}$ monitoring was carried out using a Fine Dust Analysis System (FIDAS). The data capture rate for PM in 2022 was 90.3%. The annual means measured for PM_{10} and $PM_{2.5}$ were 12.2 μgm^{-3} and 7.4 μgm^{-3}, respectively. The annual mean AQS objectives are >40 μgm^{-3} for PM_{10} and >25 μgm^{-3} for $PM_{2.5}$, therefore, the annual means are below the limit values. The 24-hour mean PM_{10} limit is 50 μgm^{-3} which may not be exceeded more than 35 times per year to meet the objective. There were no exceedances of this limit in 2022, therefore the objective was met.

Monthly collated filter samples of PM_{10} were analysed for a number of heavy metals. Due to an issue with the delivery of the samples collected, data is only available from August to December 2022. The mean values for this period were compared to the UK AQS Objective for lead and Ambient Air Directive target values or Environment Assessment Levels for other compounds where applicable.

Dioxins, furans, dioxin like polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs) were extracted from samples collected and collated every three months from a High-Volume sampler. Benzo(a)pyrene (B[a]P) is used as a marker for PAHs in ambient air. The annual mean concentration of B[a]P in 2022 was 0.092 ngm^{-3}, which is well below the annual mean European target value of 1 ngm^{-3} and the UK objective of 0.25 ngm^{-3}.

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1. INTRODUCTION

This report produced on behalf of Peel NRE Limited, relates to the period 1st January 2022 to 31st December 2022 during which time air quality monitoring of dioxins, furans, particulates, PAHs and heavy metals were undertaken in Helsby, Cheshire.

The monitoring, commissioned on behalf of Peel NRE, followed on from an original contract with the Bioenergy Infrastructure Group (B.I.G) acting on behalf of Ince Bio Power Ltd. The original contract, which was completed in July 2020, was to monitor pollutants prior to and post construction and commissioning of a new biomass renewable energy power plant in Cheshire (Plot 9, Ince Resource Recovery Park). Further information on the air quality monitoring which took place during this initial survey can be found in a report located on the Protos website[1].

Monitoring continued without a break following the initial survey and will be ongoing to provide members of the local and wider community with air quality data on an annual basis. It will also provide monitoring required by businesses operating at Protos to ensure compliance with planning conditions.

During the period 1st January 2022 to 31st December 2022, activity on site at Protos included:

- Operational biomass energy plant on plot 9a.
- Operational timber recycling facility on plot 3.
- Construction of the Energy Recovery Facility (ERF) on plot 8
- Construction of two electricity substations.
- Phase 2 infrastructure works.
- Development of three additional ecology areas.

For more information on any of these activities, please visit www.protos.co.uk/community or email community@protos.co.uk

2. MONITORING SITE AND METHODS

2.1 MONITORING STATION

The monitoring station was set up in 2016 on land owned by Helsby Parish Council adjacent to an office building accessed from Mountain View, Helsby. The site was previously used by Ince Bio Power Ltd and will continue to be used for the purposes of ongoing monitoring for current and future facilities located at Protos.

Protos is an energy and resource site of 54ha, currently under development by Peel NRE. During 2022 two plots within Protos were fully occupied at the site and two further sites under construction. Figure 1 shows the location of the monitoring station (blue marker) with respect to the Protos development (as shown by the red line), the operational Ince Bio Power Plant and Ince Park Renewables Ltd (orange markers) and sites under construction (red markers).

This plan will be updated each year to show facilities at Protos which have been under construction, under commissioning, or operational during the reporting year.

[1] https://www.protos.co.uk/media-centre/community-downloads/#air-quality-documents.

Figure 1 Location of Helsby monitoring station (blue marker) and the Protos development. Operational facilities within the Protos development are shown as orange markers and facilities under construction are shown as red markers.

2.2 POLLUTANTS MONITORED

The monitoring station set up in Helsby is shown in Figure 2. The following sections provide an overview of the pollutants that Ricardo Energy & Environment were contracted to measure at the site in Helsby throughout 2020, firstly by B.I.G., then since July 3rd 2020, by Peel NRE. In addition, hourly meteorological data from Liverpool John Lennon Airport (located 9 km NW of the monitoring station) were sourced from the NOAA Integrated Surface Databased [1] and accessed using the worldmet R package [2].

Figure 2 Monitoring station located on land adjacent to RSK offices accessed from Mountain View in Helsby.

2.2.1 Particulate Matter

Airborne particulate matter varies widely in its physical and chemical composition, source and particle size. The terms PM_{10} and $PM_{2.5}$ are used to describe particles with an effective size with a median aerodynamic diameter of 10 and 2.5 µm respectively. These are of greatest concern with regard to human health, as they are small enough to penetrate deep into the lungs. They can cause inflammation and a worsening of the condition of people with heart and lung diseases. In addition, they may carry surface absorbed carcinogenic compounds into the lungs. Particles with a median aerodynamic diameter greater than 10 µm are less likely to travel as far into the respiratory system. These larger particles are also removed more readily from the air by sedimentation.

The main source of airborne particulate matter in the UK is combustion (industrial, commercial and residential fuel use). Other large sources include production processes, agriculture and road transport. PM and its precursors can also be transported long distances, and transboundary pollution from the continent can result in increased PM in the UK.

PM_{10} and $PM_{2.5}$ were measured using an MCERTS approved Fine Dust Analysis System (FIDAS). The FIDAS analyser utilises a light emitting diode (LED) to determine particle numbers and particle size distribution through light scattering of individual particles.

The output is recorded and stored every 10 seconds and averaged to 15 minute average values by an on-site data logger. This logger is connected to a modem to download the data to Ricardo Energy & Environment. The data are then converted to concentration units and averaged to hourly mean concentrations. Data were processed according to the rigorous quality assurance and quality control procedures used by Ricardo Energy & Environment, and ratified every six months, to produce the final dataset reported here.

2.2.2 Heavy Metals

Heavy metals are toxic metallic elements that can result in adverse health effects. Anthropogenic sources of heavy metals include emissions from industrial processes and fuel combustion.

A Partisol 2025 sampler was used to collect particulates in the PM_{10} fraction on a weekly schedule. The weekly filters were collated into monthly samples and sent to an analytical laboratory to be analysed for heavy metals including: Arsenic, Cadmium, Cobalt, Chromium, Mercury, Manganese, Nickel, Lead, Antimony, Thallium, Vanadium, Zinc, via UKAS accredited procedures, and Chromium VI (not accredited). Due to an issue with some of the samples being lost in transit while shipped to the laboratory, only data from August and December 2022 have been analysed and presented here.

2.2.3 Toxic Organic Micro Pollutants (TOMPs)

Toxic Organic Micro Pollutants include a range of persistent organic pollutants (POPs), such as polychlorinated-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs). Exposure to POPs can have an adverse impact on human health and the environment. The main source of POPs in recent years in the UK are unintentional by-products from the incomplete combustion of fuels.

A High Volume sampler was used to collect samples for analysis of dioxins, furans, dioxin like PCBs and PAHs. Samples were collected every 2 weeks and collated into 3 monthly samples (Table 1). Sample blanks were also obtained and analysed and found to be within acceptable limits. The method used for the analytical measurement complies with US EPA 1613B for the PCBs, dioxins and furans, and EPA-TO-13A for PAHs.

Table 1 Start and end dates of 3-monthly periods for TOMPs sampling in 2022.

Period	Start Date	End Date
Period 1	30/12/2021	06/04/2022
Period 2	06/04/2022	29/06/2022
Period 3	29/06/2022	05/10/2022
Period 4	05/10/2022	27/12/2022

2.3 AIR QUALITY LIMIT VALUES

Table 2 shows the current UK objectives (included in the Air Quality Standards Regulations [3] and subsequent Amendments for the purpose of Local Air Quality Management), for the pollutants monitored at Helsby for this report. These regulations are based on those in the European Commission Directive on Ambient Air Quality and Cleaner Air for Europe [4], [5] (referred to as the Air Quality Directive) when the UK was a member of the European Union. Since Brexit, the UK is no longer tied to the EU limits, however, current objectives in the UK have been adopted from those stated in the Air Quality Directive, as shown in Table 2.

Where target analytes do not have a UK objective limit value, Ambient Air Directive (AAD) target values or Environmental Assessment Levels (EALS) used for Environmental Permit Risk assessments [6] were adopted for the purpose of this study, as shown in Table 3.

Table 2 UK and European air quality objectives for pollutants measured at Helsby.

Pollutant	UK Objective	European Objective	Measured as
PM_{10}	50 μgm^{-3} not to be exceeded more than 35 times a year	50 μgm^{-3} not to be exceeded more than 35 times a year	24 hour mean
PM_{10}	40 μgm^{-3}	40 μgm^{-3}	annual mean
$PM_{2.5}$	20 μgm^{-3}	20 μgm^{-3}	annual mean
Polycyclic Aromatic Hydrocarbons (PAH)	0.25 ngm^{-3} B[a]P	1 ngm^{-3} B[a]P	annual mean
Lead	0.25 μgm^{-3}	0.5 μgm^{-3}	annual mean

Table 3 UK and European air quality objectives for pollutants measured at Helsby.

Pollutant	Adopted limit (ngm^{-3})	Standard	Measured as
Arsenic (As)	6	AAD Target Value	annual mean
Cadmium (Cd)	5	AAD Target Value	annual mean
Copper (Cu)	10000	Environmental Assessment levels	annual mean
Mercury (Hg)	250	Environmental Assessment levels	annual mean
Manganese (Mn)	150	Environmental Assessment levels	annual mean
Nickel (Ni)	20	AAD Target Value	annual mean
Antimony (Sb)	5000	Environmental Assessment levels	annual mean

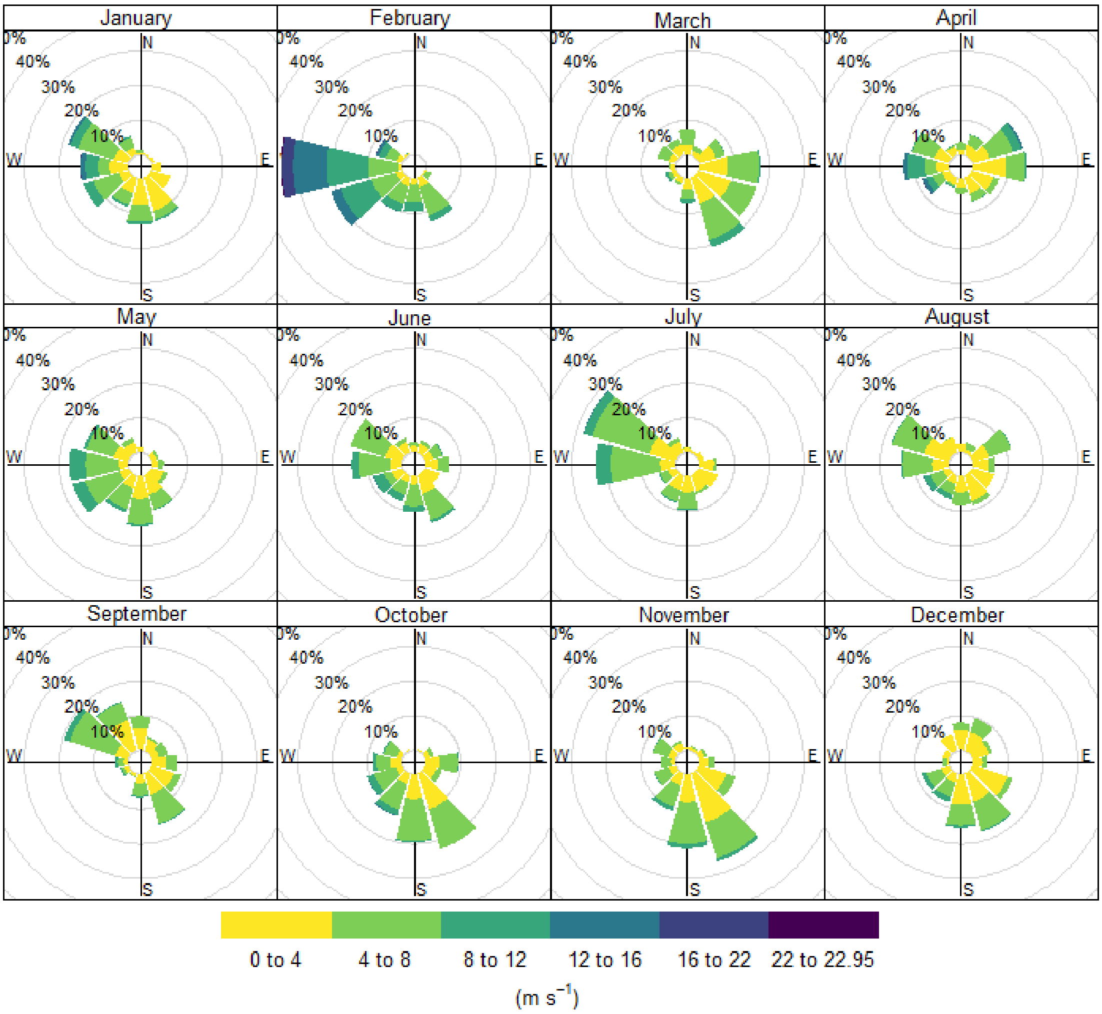
3. RESULTS AND DISCUSSION

The pollutant data measured at Helsby during 2022 have been analysed and where applicable, measurements have also been assessed with respect to current Air Quality Objectives.

3.1 METEOROLOGICAL CONDITIONS

Figure 3 shows the distribution of wind speed and wind direction (wind rose) for each month at Liverpool John Lennon Airport. The "spokes" show the direction the wind is coming from, a longer spoke means a higher frequency of wind from that direction and the colours represent the wind speed (purple= high winds, yellow = calm winds). In February 2022, there were 3 storms (Dudley, Eunice and Franklin) in quick succession arriving at the UK from a westerly direction, bringing high winds and unsettled weather.

Figure 3 Monthly wind roses in 2022 for Liverpool John Lennon Airport. Data source: NOAA Integrated Surface Database (ISD) [1].



3.2 PM DATA ANALYSIS

3.2.1 Summary Statistics

Table 4 shows a summary of the PM data for 2022. The period mean concentrations are below the annual mean air quality objectives for PM_{10} and $PM_{2.5}$. There were no exceedances of the PM_{10} daily mean objective during 2022, therefore the objective was met. The data capture rates in 2022 for both PM fractions is 90.3%.

Table 4 Summary statistics and exceedances for particulate matter measured at Helsby in 2022.

Statistic	PM_{10}	$PM_{2.5}$
Annual Mean (µgm^{-3})	12.2	7.4
Hourly Maximum (µgm^{-3})	115	60.7
Daily Maximum (µgm^{-3})	44	34
Data Capture rate (%)	90.3	90.3
Period mean > annual mean objective	No	No
Exceedances (daily mean > 50 µgm^{-3})	0	0

3.2.2 AQ Index Distribution

The plots below illustrate the distribution of AQ index values for Helsby for PM_{10} and $PM_{2.5}$. The AQIs are based on the daily mean for PM and each plot shows the number of days that concentrations measured are in each index. The index ranges from 1 to 10 and separated into four different bands: 1-3 = Low, 4-6 = Moderate, 7-9 = High, and 10 = Very High. Further information on the AQ Index is available in Table A1 in the appendix and from UK-Air [7]. During 2022, there were no days recorded when the PM_{10} or $PM_{2.5}$ AQI went above the "Low" banding (Index 1-3).

Figure 4 Distribution of AQI for PM_{10}.

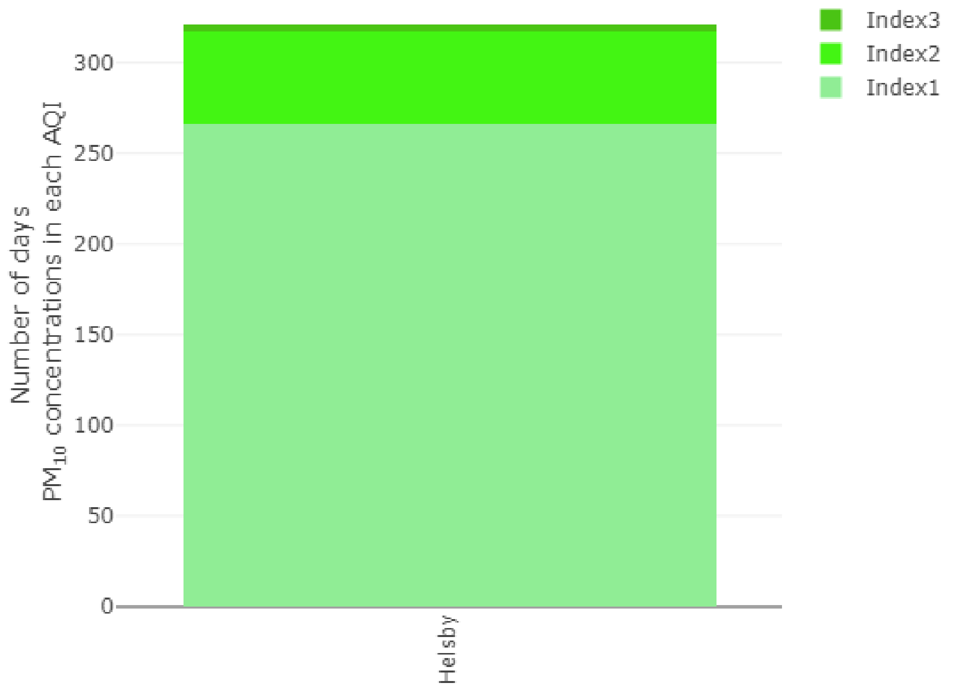
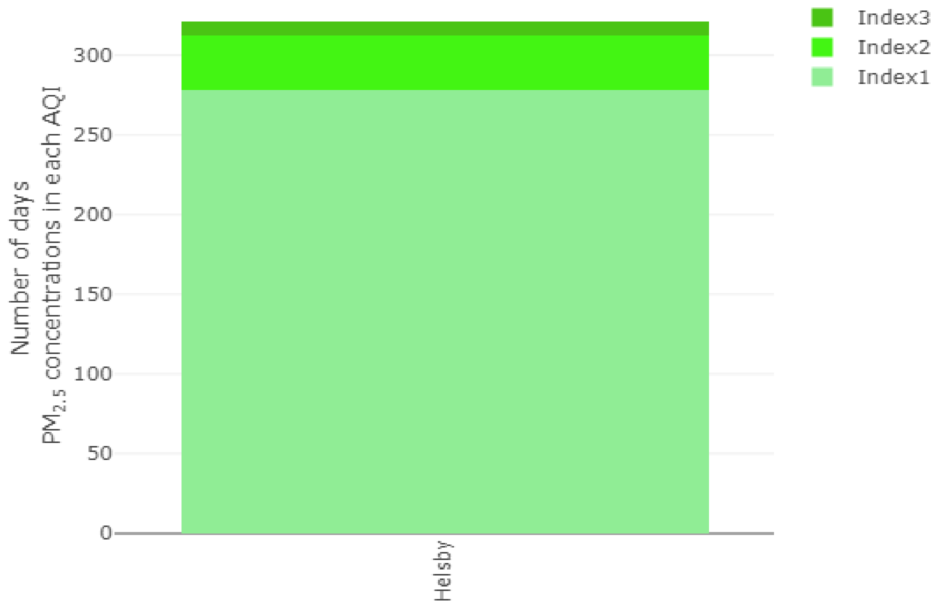


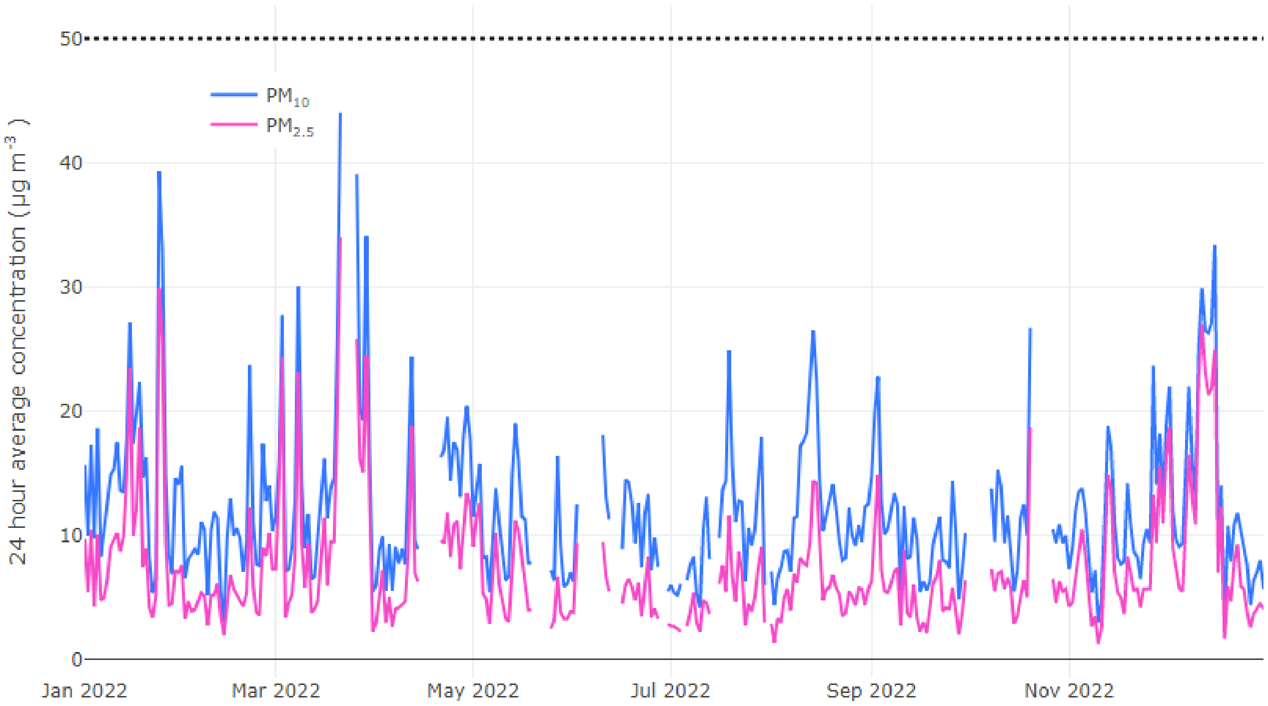
Figure 5 Distribution of AQI for $PM_{2.5}$.



3.2.3 Time Series

Figure 6 shows the 24 hour averaged time series of PM_{10} and $PM_{2.5}$ measured at Helsby during 2022.

Figure 6 24 hour average PM_{10} and $PM_{2.5}$ concentrations measured at Helsby during 2022. The dashed line represents the PM_{10} 24 hour objective.



3.2.4 Time Variations

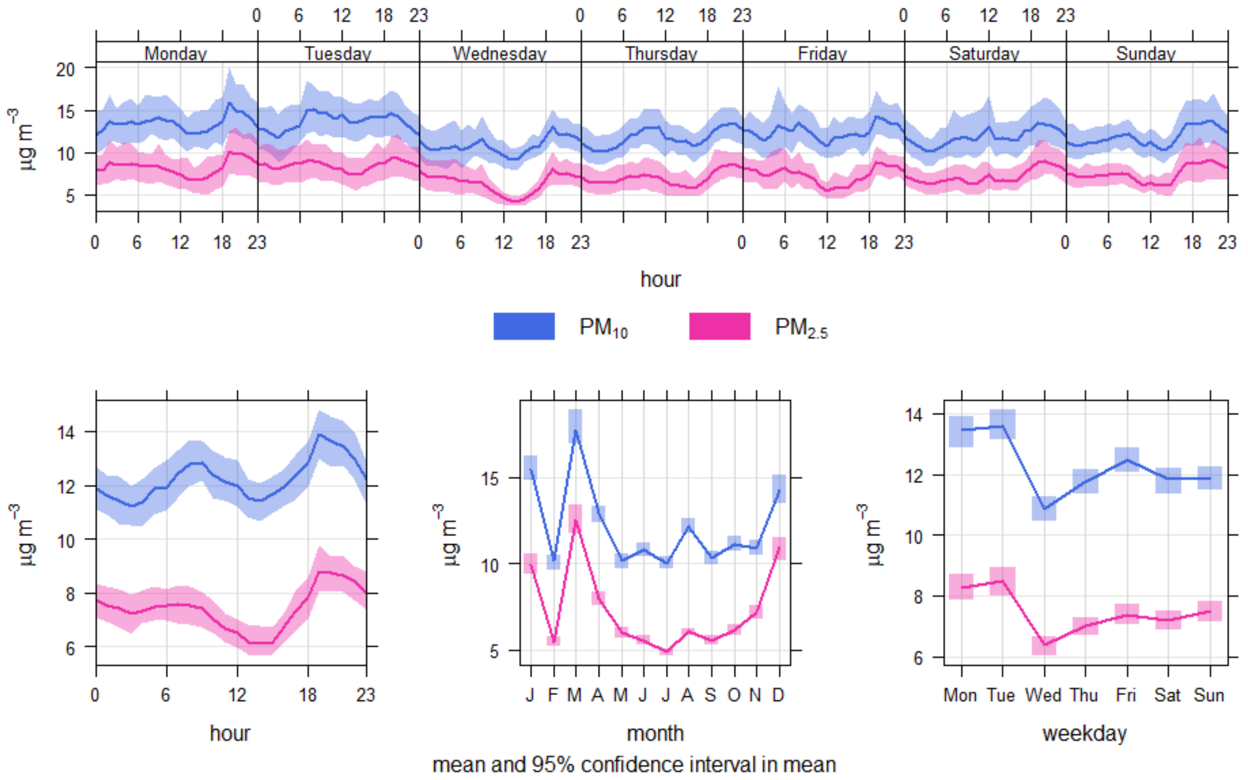
As PM_{10} and $PM_{2.5}$ are continuously measured on an hourly time period, the variability over short and long time periods can be assessed. Figure 7 shows the daily, weekly, and monthly variability in concentrations for 2022.

Seasonal: Variations in the PM concentrations across seasons can be seen in the "month" plot in Figure 7. PM concentrations were elevated during the winter in 2022, likely due to an increase in emissions from residential heating during these colder months. This, coupled with low dispersion under cold/stable conditions can result in elevated levels of PM. Long range transport of pollutants can also result in an increase in PM in the UK. The highest PM levels were observed in March 2022. Further information on the elevated levels during March is provided in section 3.2.5

Weekly: The weekly cycles for PM_{10} and $PM_{2.5}$ are very similar with the lowest concentrations observed on a Wednesday. This cycle is different to that observed in 2021, when the highest concentrations were typically observed mid-week. The difference may, in part, be related to changes in traffic patterns, however, this cannot be concluded without additional information on traffic volumes in the area.

Diurnal: The diurnal cycle, as seen in the "hour" plot in Figure 7 shows a minimum in PM_{10} and $PM_{2.5}$ around noon, and peaks in the morning and evening, which may indicate that emissions of PM in the area is dominated by traffic. Concentrations remain high during the night-time, this might be due to a reduced surface boundary layer height during the night-time, rather than higher emissions of PM at night compared to midday. The surface boundary layer is the turbulent lower layer of the atmosphere that is influenced by the Earth's surface, where vertical mixing of pollutants can occur. When the sun sets a lower stable nocturnal boundary layer forms which can trap pollutants near the ground, resulting in elevated concentrations compared to the daytime.

Figure 7 Temporal variations in PM_{10} and $PM_{2.5}$ concentrations measured at Helsby during 2022.



3.2.5 Calendar Plots

The plots in Figure 8 and 9 show daily variation in concentrations by pollutant for each month in 2022. The colours shown for each day relate to the concentration. The highest daily mean PM_{10} and $PM_{2.5}$ concentrations were observed from 21st March, with average daily concentrations of 44 μgm^{-3} and 34 μgm^{-3}, respectively. The wind direction on 21st March was from an south easterly direction. Southern and easterly winds can often bring polluted air from the continent and dust from the Sahara Desert to the UK, which may result in elevated levels of pollutants observed in the UK. “Moderate” and "High" pollution was observed across most of the UK between 21st and 26th March 2022.

Figure 8 Calendar plot for PM_{10} measured at Helsby during 2022.

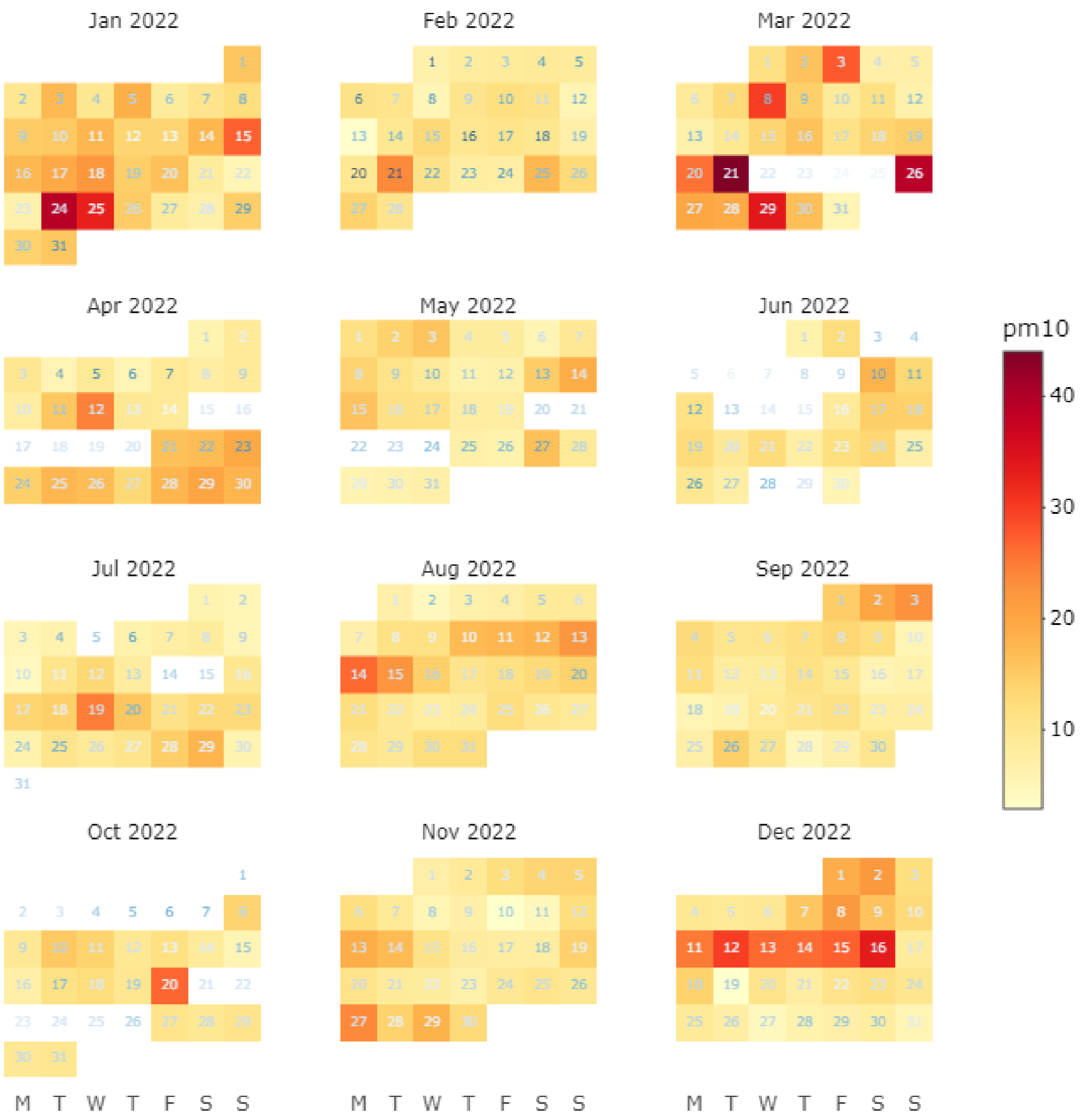
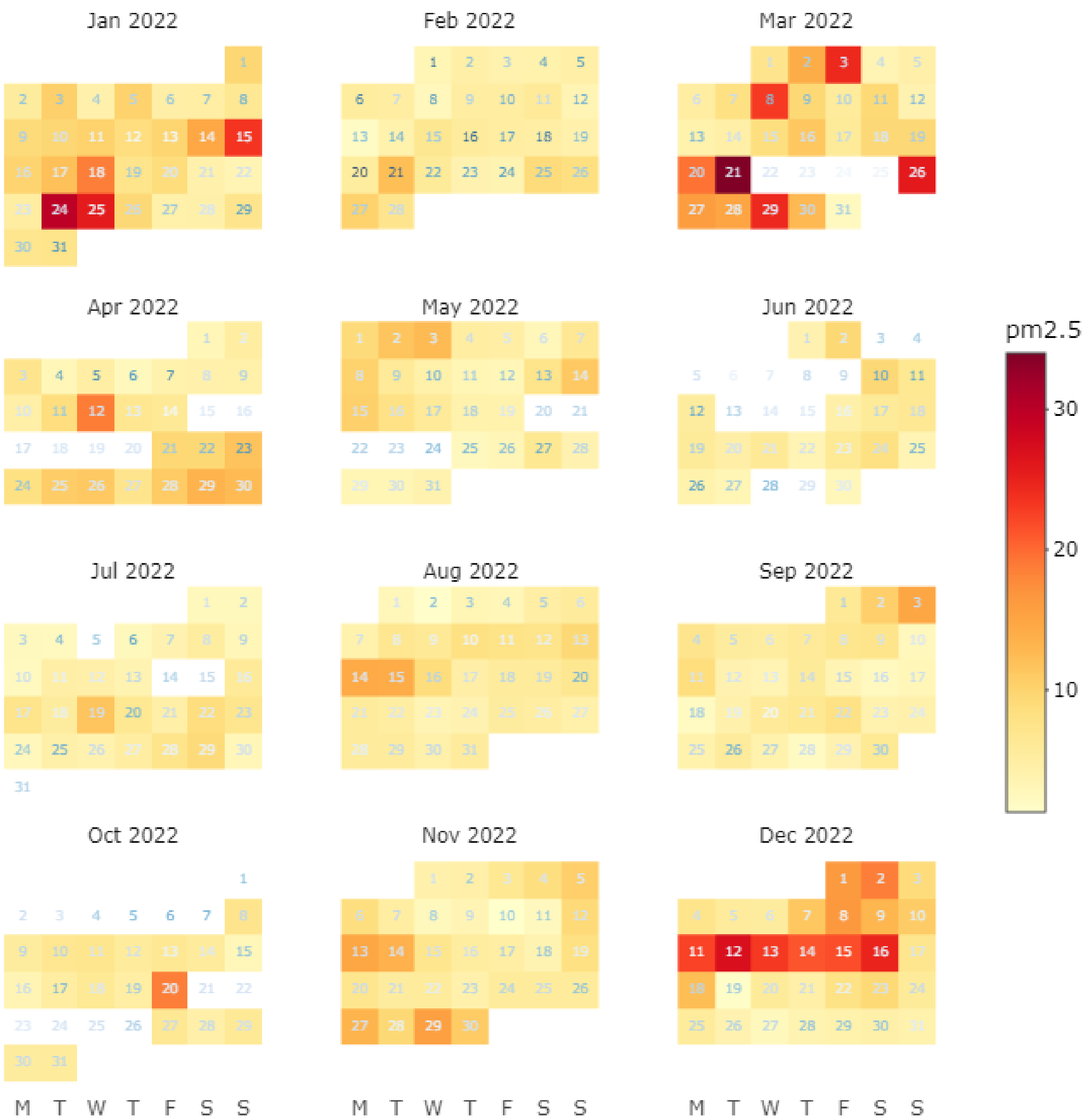


Figure 9 Calendar plot for $PM_{2.5}$ measured at Helsby during 2022.



3.2.6 Polar Plots

To investigate possible sources of PM in 2022, meteorological data measured at Liverpool John Lennon Airport was used to assess the hourly mean PM_{10} and $PM_{2.5}$ concentrations with wind speed and wind direction.

Figure 10 and Figure 11 show bivariate polar plots or “pollution roses” of PM_{10} and $PM_{2.5}$, respectively. The plots indicate how the PM concentration varies with wind direction and wind speed, with blue colours representing lower PM levels, and red colours higher PM levels.

PM_{10}: In 2022, the highest concentrations of PM_{10} were observed when the wind was from the west/northwest and northeast, under high (>10 ms^{-1}) wind speeds. There is also evidence of higher concentrations when the wind was from the east under calmer wind speeds (< 5 ms^{-1}) and southeast under moderate wind speeds (5-10 ms^{-1}).

$PM_{2.5}$: $PM_{2.5}$ shows a similar pattern with wind direction to PM_{10}, however, the highest concentrations are observed under calmer wind speeds.

Figure 10 Bivariate polar plot of PM_{10} for 2022.

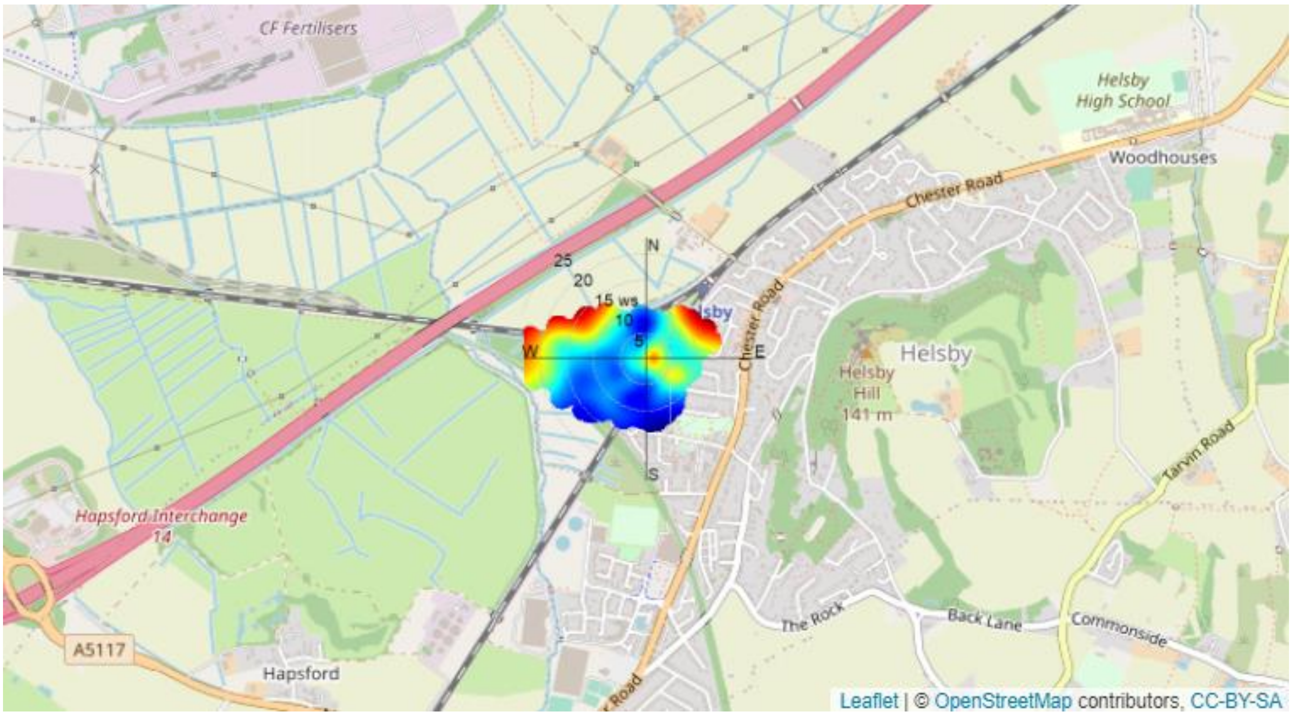
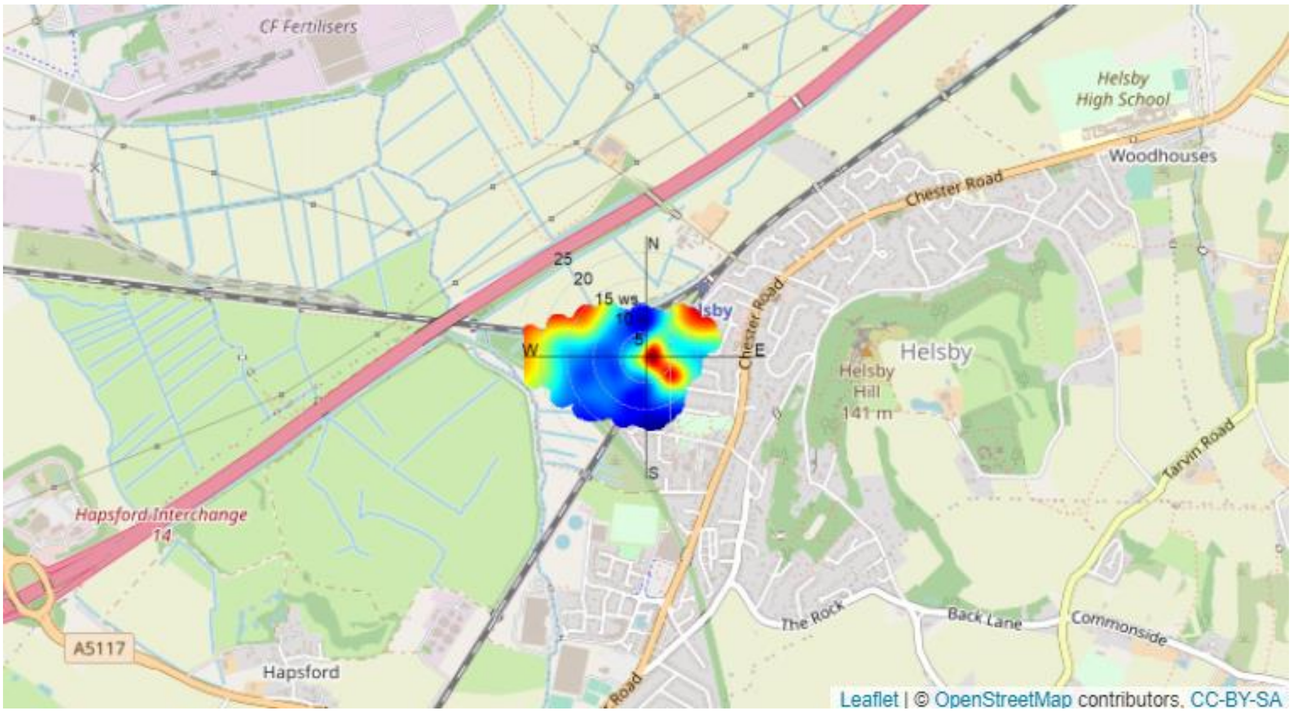


Figure 11 Bivariate polar plot of $PM_{2.5}$ for 2022.



3.2.7 Annual Variation

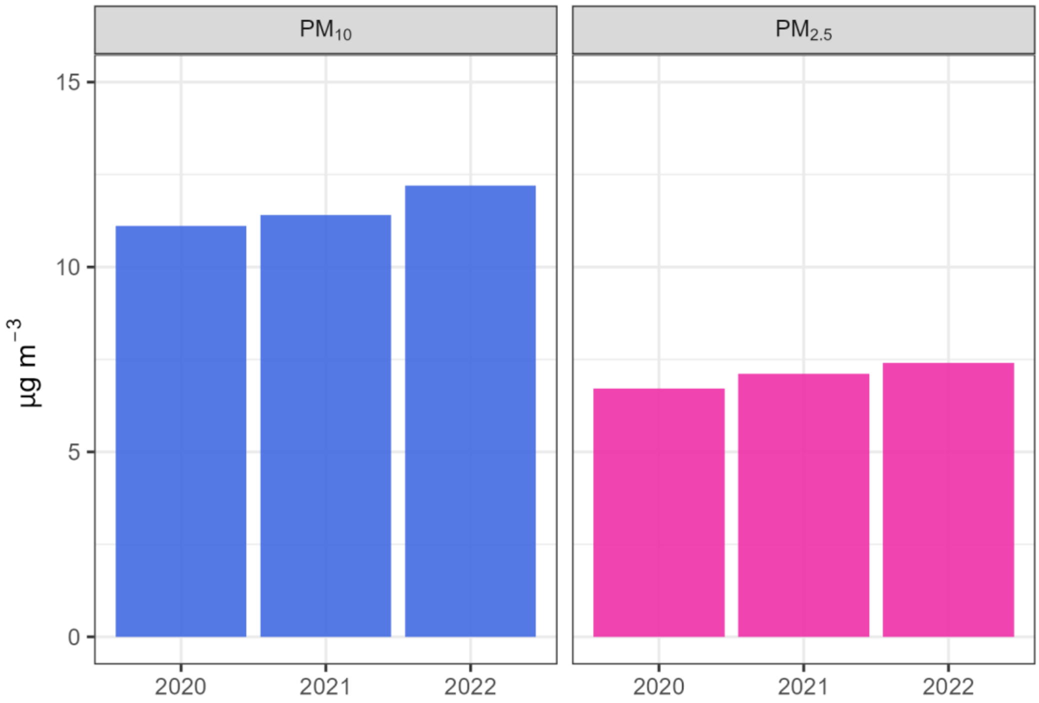
A small increase is observed each year. The measured concentrations, however, are well below the annual mean air quality objectives for PM_{10} and $PM_{2.5}$ in all three years.

PM can be transported long distances in the atmosphere, therefore, variations in concentrations year-on-year can be caused by changes in meteorological conditions, in addition to variations in local emissions.

Figure 12 shows the annual mean PM_{10} and $PM_{2.5}$ concentrations measured at Helsby from 2020 to 2022. A small increase is observed each year. The measured concentrations, however, are well below the annual mean air quality objectives for PM_{10} and $PM_{2.5}$ in all three years.

PM can be transported long distances in the atmosphere, therefore, variations in concentrations year-on-year can be caused by changes in meteorological conditions, in addition to variations in local emissions.

Figure 12 PM_{10} and $PM_{2.5}$ annual mean concentrations from 2020 to 2022.



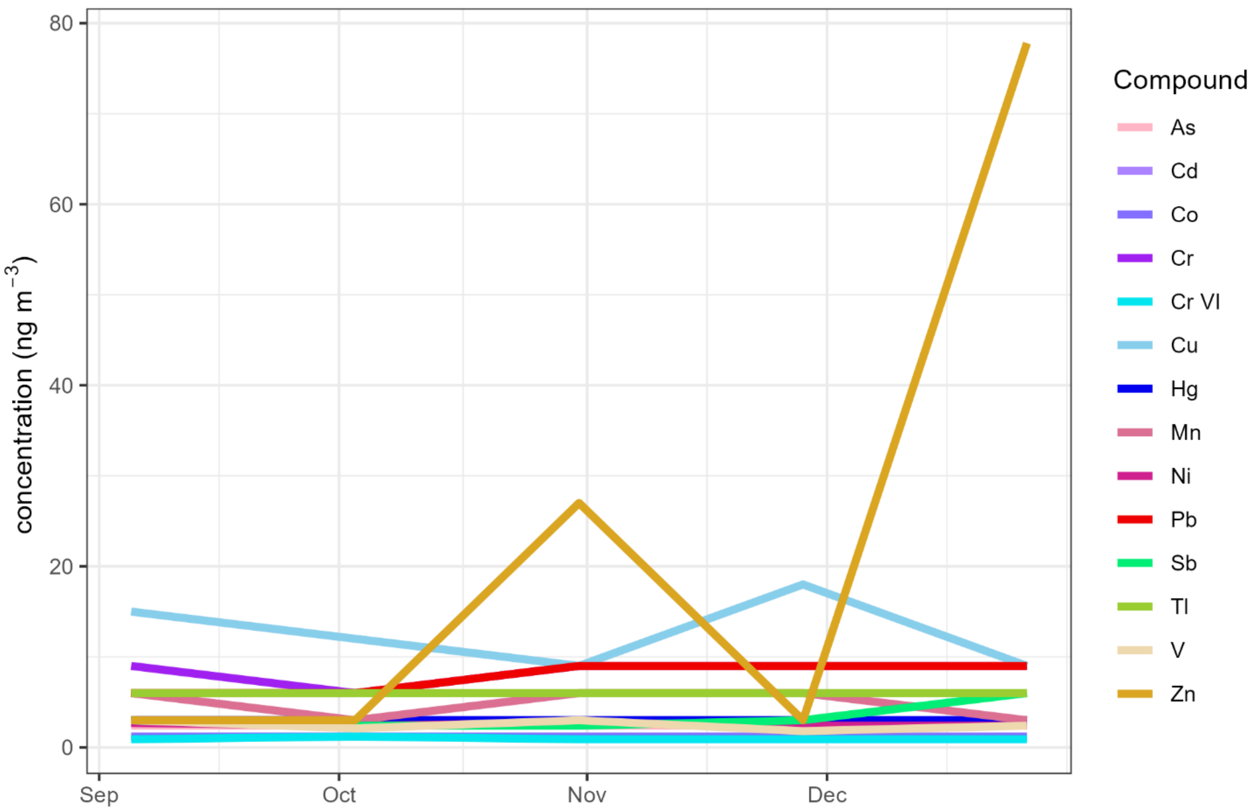
3.3 HEAVY METALS ANALYSIS

As discussed in section 2.2.2, some samples of the heavy metals measured at Helsby were lost in transit to the analysis laboratory. As a result, data is only available for the final 5 months of 2022.

Figure 13 shows a time series of the metal concentrations for each month, during 2022. Data from the analysis of the monthly samples are provided in Table C1 in Appendix 3.

In 2021, it was observed that zinc concentrations drop rapidly between May and June 2021 and remain below detectable limits for the rest of the year. As only 5 months of data are available for 2022, it is difficult to ascertain whether there is a continuous trend in zinc concentrations, however, it is observed that the zinc concentrations in 2022 are highly variable, with levels above the detection limit observed in October and December, and levels below the detection limit during the remaining months. Similarly to 2021, there is no obvious correlation between the change in zinc concentrations and the wind conditions. With continuous monitoring additional evaluation will be undertaken on the zinc data in 2023.

Figure 13 Heavy metal concentrations measured at Helsby during 2022. Points shown at mid-point of 4-week period.



To assess the concentrations of heavy metals measured in Helsby, a comparison of annual means against UK AQS Objective, Ambient Air Directive target values or Environment Assessment Levels (outlined in Table 3) is usually undertaken. Due to the reduced data available for the heavy metals in 2022, an assessment of these limits cannot be undertaken. However, it is useful still to compare the period averages with the limit values for information.

Period averages for heavy metal concentrations measured during 2022 are shown in Table 5. The period averages with and without measurements below detectable limits are provided. For some heavy metals concentrations were below the LOD for each sampling period during the year. In these cases period averages calculated without measurements below detectable limits are blank.

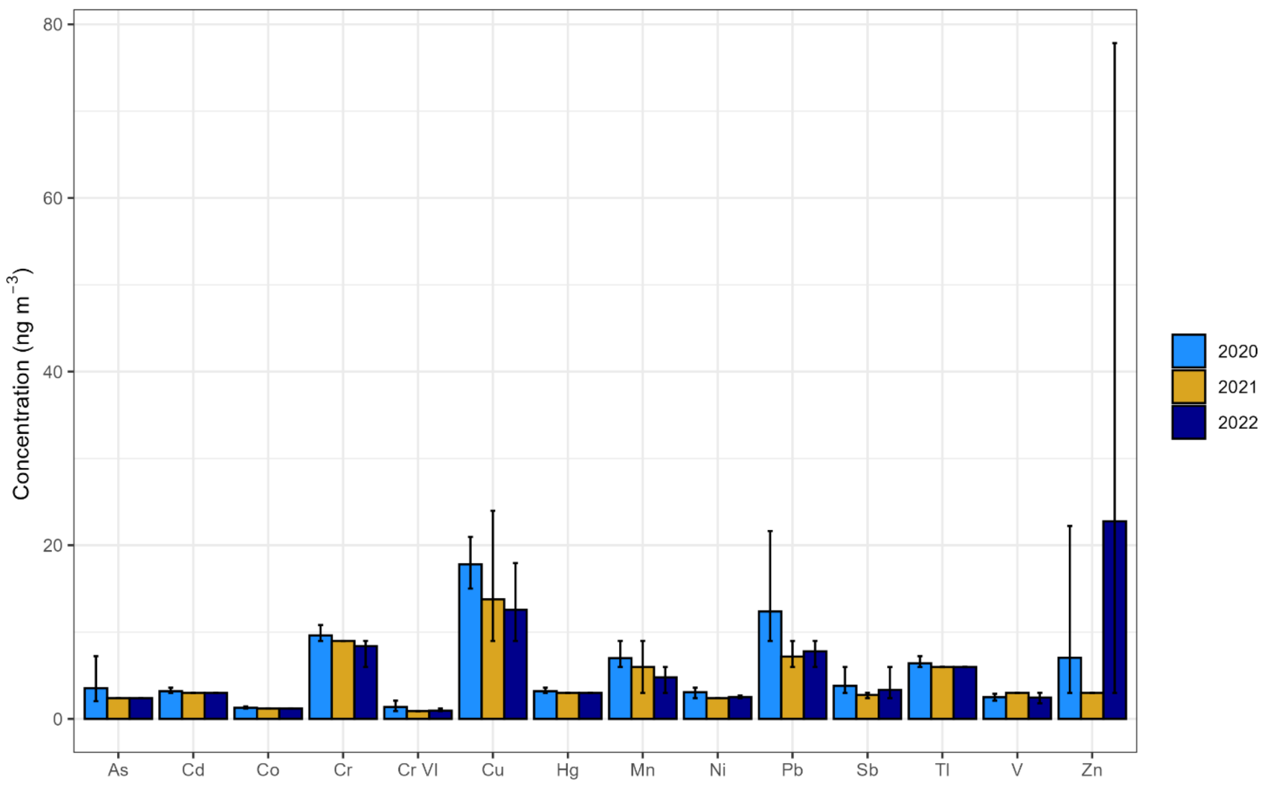
Table 5 Summary statistics for heavy metals during 2022.

Adopted limits ($ng.m^{-3}$)	As 6	Cd 5	Co -	Cr -	Cu 10000	Hg 250	Mn 150	Ni 20	Pb 250	Sb 5000	Tl -	V -	Zn -	Cr VI -
Annual Average	2.4	3.0	1.2	8.4	13	3.0	4.8	2.5	7.8	3.4	6.0	2.5	23	0.96
% of limit	40%	60%			0.1%	1.2%	3.2%	13%	3.1%	0.1%				
Annual Average (without < LOD)				8.4	12.6		4.8	2.6	7.8	3.6		2.5	52.4	
% of limit (without < LOD)					0.1%		3.2%	13%	3.1%	0.1%				

To assess how concentrations of heavy metals have varied over time, the mean concentrations for each heavy metal species sampled during the months August to December, for 2020, 2021 and 2022 were calculated (see Figure 14).

The results show, for many species, there is very little change in the average concentration over the past three years. This is expected as the concentrations are often close to, or below, the LOD. For those compounds where the measured concentrations are typically above the LOD (e.g. Cu, Mn, Pb), a decrease in average concentrations is observed from 2020 to 2022.

Figure 14 Average of heavy metal concentrations measured at Helsby from August to December for 2020, 2021 and 2022. Error bars represent the maximum and minimum values recorded.



3.4 PAH ANALYSIS

Table 6 shows the period mean of the measured PAHs in PM_{10} calculated from the 3-monthly samples in 2022. All compounds sampled were above the LOD. Benzo(a)pyrene (B[a]P) is used as a marker for assessment of PAHs against UK and European objectives. The annual mean concentration of B[a]P in 2022 was 0.092 ngm^{-3}, which is well below the European target value of 1 ngm^{-3} and below the stricter UK objective of 0.25 ngm^{-3}. To assess the use of B[a]P as a marker for PAHs, additional PAHs are required to be measured as per the Fourth Daughter Directive (DD4). These additional compounds should include at a minimum: benz[a]anthracene, benzo[b]fluoranthene, benzo[j]fluoranthene, benzo[k]fluoranthene, indeno[1,2,3-cd]pyrene and dibenz[a,h]anthracene. All these compounds were measured at Helsby, along with other PAHs. Please note, however, that the naphthalene concentrations reported are highly uncertain due to potential breakthrough on the sampling media at the flow rates used.

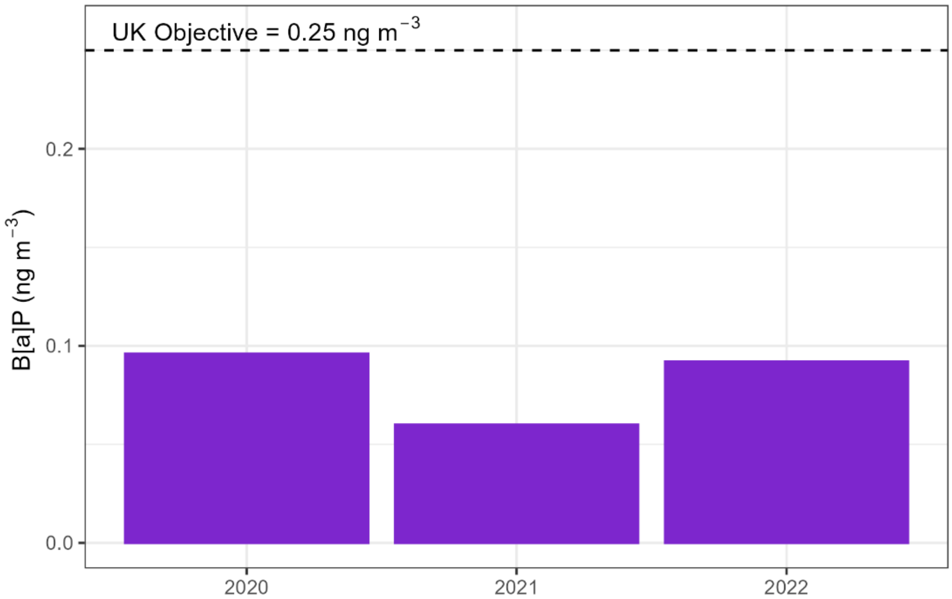
Table 6: Summary statistics for PAHs during 2022. Benzo(a)pyrene is used for assessment of PAHs against air quality objectives.

Compound	Annual Mean (ngm^{-3})
Naphthalene	0.14
Acenaphthylene	0.021

Compound	Annual Mean (ngm^{-3})
Acenaphthene	0.068
Fluorene	0.31
Phenanthrene	1.9
Anthracene	0.091
Fluoranthene	0.67
Pyrene	0.55
Benzo(a)anthracene	0.09
Chrysene	0.16
Benzo(b)fluoranthene	0.16
Benzo(k)fluoranthene	0.059
Benzo(a)pyrene	0.092
Indeno(1,2,3-cd)pyrene	0.12
Dibenzo(ah)anthracene	0.016
Benzo(ghi)perylene	0.13
Benzo(j)fluoranthene	0.075
Dibenzo(ac)anthracene	0.013

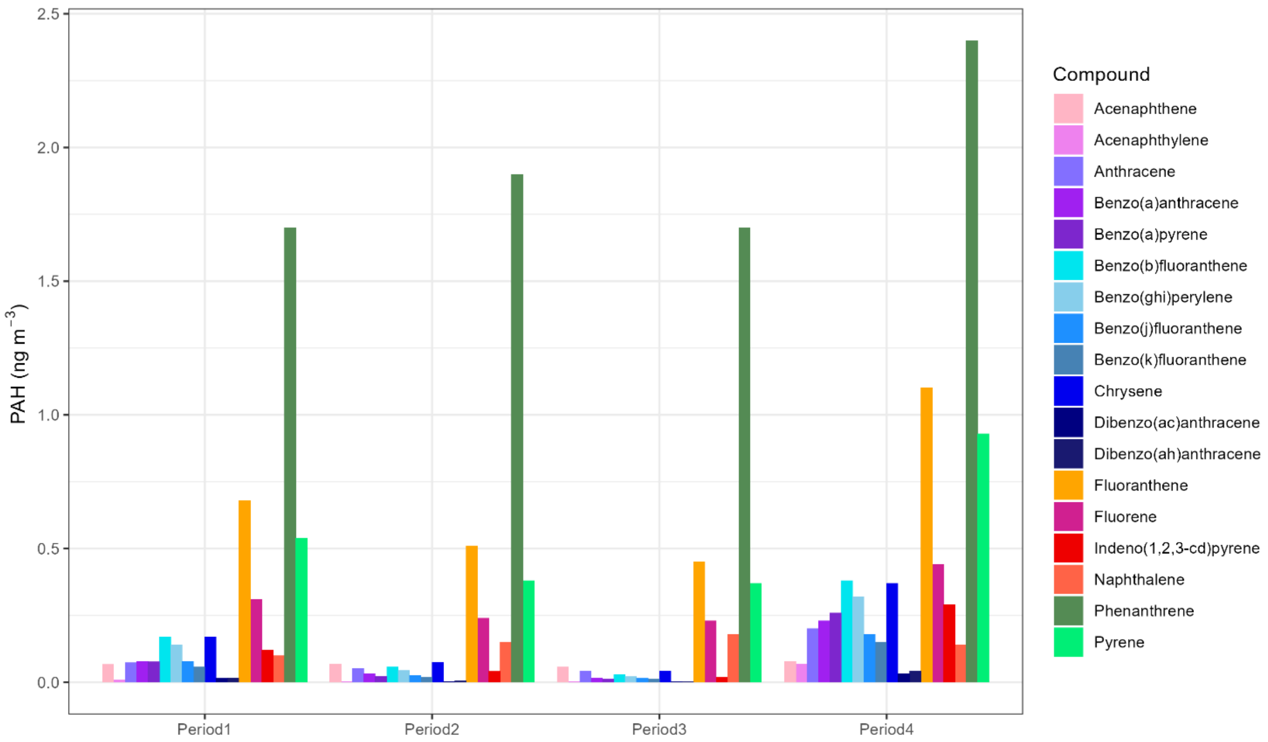
Figure 15 shows a comparison of annual mean B[a]P concentration from 2020 to 2022. The analysis shows that B[a]P decreased on average in 2021 when compared to 2020 and then increased again in 2022. The measured concentrations were well below the UK objective of 0.25 ngm^{-3} in all three years. The annual mean B[a]P concentrations will continue to be reported in future years, to assess the long-term changes in this PAH.

Figure 15: Annual mean B[a]P concentrations from 2020 to 2022. The dashed line represents the UK objective limit for B[a]P (0.25 ngm^{-3}).



Concentrations of PAHs for each of the four periods in 2022 are shown in Figure 16. The data for each period are provided in Table C2 in Appendix A3.

Figure 16: PAH concentrations measured at Helsby during 2022.



3.5 DIOXINS, FURANS AND PCB ANALYSIS

The TOMPs data (Dioxins, Furans and PCBs) for Helsby have been converted to Toxic Equivalency using the World Health Organization Toxic Equivalency Factors (see Appendix A2). The annual mean concentrations for each set of compounds measured at Helsby are provided in the tables below.

Table 7: Summary statistics for Dioxins at Helsby during 2022.

Compound	Annual Mean (fgm^{-3} TEF)
2378 Tetra CDD	0.82
12378 Penta CDD	4.8
123478 Hexa CDD	0.44
123678 Hexa CDD	1.3
123789 Hexa CDD	0.74
1234678 Hepta CDD	0.71
OCDD Octa CDD	0.013

Table 8: Summary statistics for Furans at Helsby during 2022.

Compound	Annual Mean (fgm^{-3} TEF)
2378 Tetra CDF	0.62

Compound	Annual Mean (fgm^{-3} TEF)
12378 Penta CDF	0.41
23478 Penta CDF	8.10
123478 Hexa CDF	1.3
123678 Hexa CDF	1.6
234678 Hexa CDF	2
123789 Hexa CDF	0.52
1234678 Hepta CDF	0.43
1234789 Hepta CDF	0.042
OCDF Octa CDF	0.002

Table 9: Summary statistics for PCBs at Helsby during 2022.

Compound	Annual Mean (fgm^{-3} TEF)
PCB-81	0.0021
PCB-77	0.0055
PCB-123	0.00031
PCB-118	0.015
PCB-114	0.00048
PCB-105	0.0044
PCB-126	1
PCB-167	0.0004
PCB-156	0.0008
PCB-157	0.00025
PCB-169	0.011
PCB-189	0.00016

Bar plots showing the concentrations of Dioxins, Furans and PCBs measured at Helsby for each of the four periods in 2022 are shown in Figure 17 to Figure 19, below. The data for each period and compound are provided in Table C3 in Appendix A3.

Figure 17: Dioxin concentrations measured at Helsby during 2022.

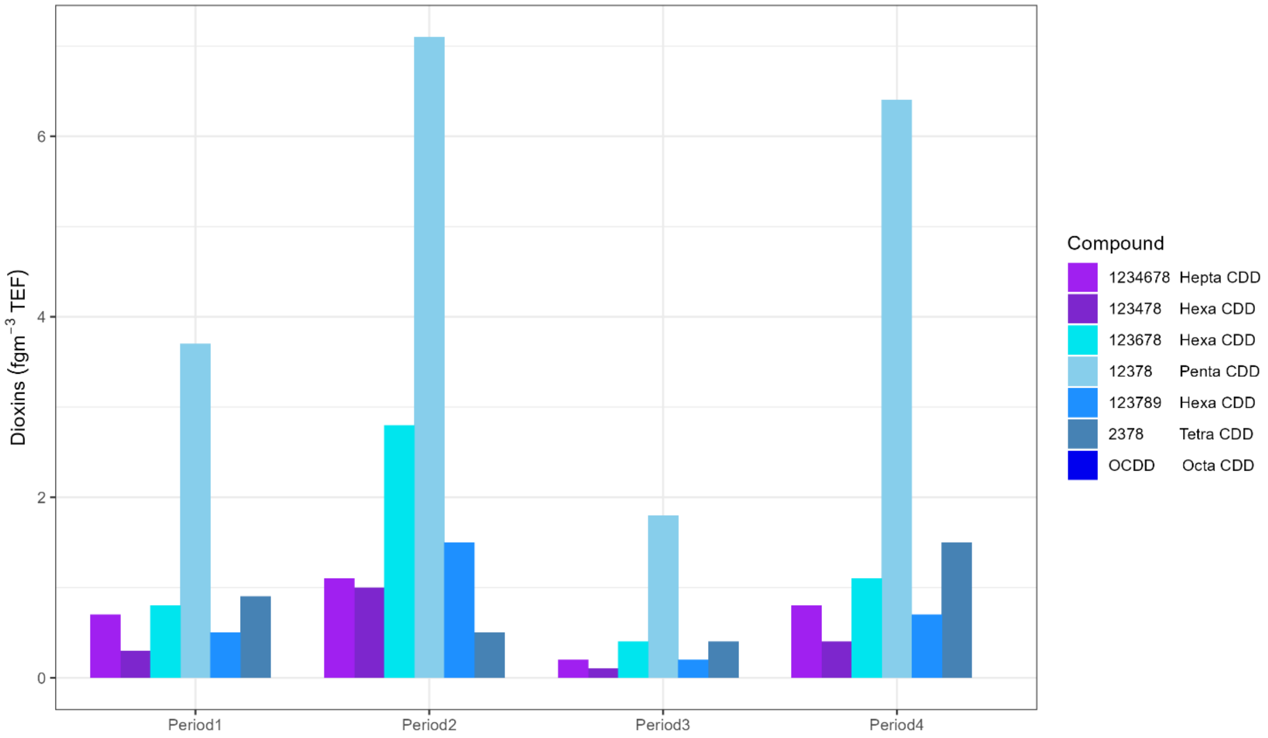


Figure 18: Furan concentrations measured at Helsby during 2022.

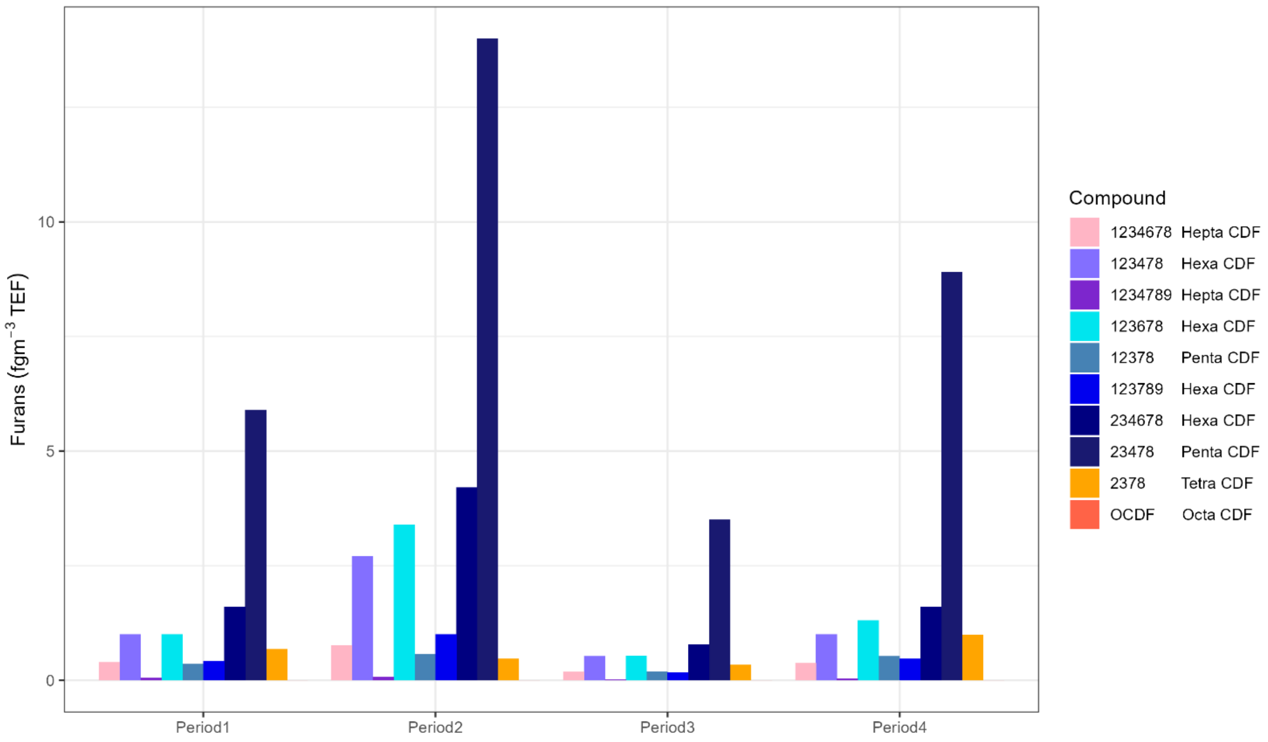
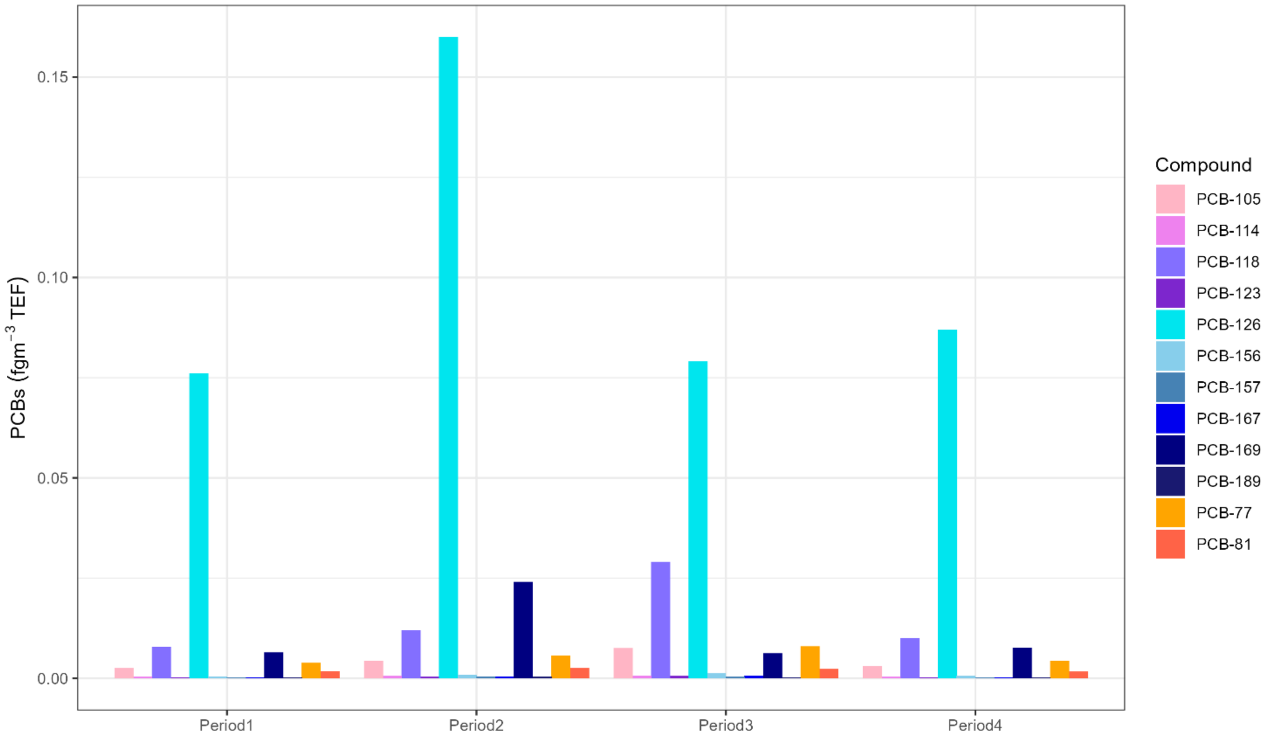


Figure 19: PCB concentrations measured at Helsby during 2022. Note, for PCB-126 actual concentrations are x10.



4. CONCLUSIONS

This report provides the results from the analysis of the pollutant data measured at the site in Helsby in 2022.

The results show that both PM_{10} and $PM_{2.5}$ annual means in 2022, were well below the annual mean AQS objective of 40 µgm^{-3} for PM_{10} and 20 µgm^{-3} for $PM_{2.5}$. There were no exceedances of the 24-hour PM_{10} limit of 50 µmg^{-3}.

Variations in hourly PM_{10} and $PM_{2.5}$ concentrations with wind speed and direction were assessed to investigate sources of particulates. Higher concentrations of PM_{10} were associated with high winds from the west/northwest. For $PM_{2.5}$, the highest concentrations were observed under low wind speeds.

Filter samples of PM_{10} were collected every month and heavy metal concentrations extracted. Due to a loss of samples during shipment to the analysis laboratory, only data from the final 5 months of 2022 could be analysed. The mean concentrations during these periods were below the associated target values.

Samples were collected and collated every 3 months for analysis of dioxins, furans, PCBs, and PAHs. The annual mean concentration of Benzo(a)pyrene (B[a]P), which is used as a marker compound for PAHs, was 0.092 ngm^{-3} in 2022, which is below the European (1 ngm^{-3}) and UK (0.25 ngm^{-3}) objectives.

5. REFERENCES

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APPENDICES

Appendix 1 Air Pollution Bandings

Table A1 *Description of air pollution bandings*

Banding	Index	Accompanying health messages for at-risk individuals
Low	1,2,3	Enjoy your usual outdoor activities.
Moderate	4,5,6	Adults and children with lung problems, and adults with heart problems, who experience symptoms, should consider reducing strenuous physical activity, particularly outdoors.
High	7,8,9	Adults and children with lung problems, and adults with heart problems, should reduce strenuous physical exertion, particularly outdoors, and particularly if they experience symptoms. People with asthma may find they need to use their reliever inhaler more often. Older people should also reduce physical exertion.
Very High	10	Adults and children with lung problems, adults with heart problems, and older people, should avoid strenuous physical activity. People with asthma may find they need to use their reliever inhaler more often.

Appendix 2 Toxic Equivalency Factors

The International Toxic Equivalent (ITEQ) values for individual congeners are calculated for each sample using the WHO schemes. The factors are provided in Table B2. Where an isomer has a result less than the LOD a value equivalent to the LOD is used to determine the ITEQ. Therefore, these values represent a worst case assessment. Additional total ITEQ values are also calculated, assuming that where a result is less than the limit of detection then the ITEQ contribution is zero.

Table A2 Toxic equivalency factors for TOMPs

Compound	WHO TEF	Compound	WHO TEF
DIOXINS		**PCBs**	
2378 Tetra CDD	1	PCB-81	0.0003
12378 Penta CDD	1	PCB-77	0.0001
123478 Hexa CDD	0.1	PCB-123	0.00003
123678 Hexa CDD	0.1	PCB-118	0.00003
123789 Hexa CDD	0.1	PCB-114	0.00003
1234678 Hepta CDD	0.01	PCB-105	0.00003
OCDD Octa CDD	0.0001	PCB-126	0.1
FURANS		PCB-167	0.00003
2378 Tetra CDF	0.1	PCB-156	0.00003
12378 Penta CDF	0.05	PCB-157	0.00003
23478 Penta CDF	0.5	PCB-169	0.003
123478 Hexa CDF	0.1	PCB-189	0.00003
123678 Hexa CDF	0.1		
234678 Hexa CDF	0.1		
123789 Hexa CDF	0.1		
1234678 Hepta CDF	0.01		
1234789 Hepta CDF	0.01		
OCDF Octa CDF	0.0001		

Appendix 3 Datasets

Table C1 provides the analysis of heavy, metals for each period during 2022.

Table C1 Analysis of heavy metals for each period. Values with the prefix “<” denote data where the values were below the limit of detection.

start	end	Report ID	As	Cd	Co	Cr	Cu	Hg	Mn	Ni	Pb	Sb	Tl	V	Zn	Cr VI
22/08/2022	19/09/2022	ASC/SOP/117	<2.40	<3.00	<1.20	8.99	14.98	<3.00	5.99	2.70	5.99	3.00	<5.99	3.00	<3.00	<0.90
19/09/2022	17/10/2022	ASC/56949.001	<2.40	<3.00	<1.20	5.99	11.98	<3.00	3.00	2.40	5.99	<2.40	<5.99	2.10	<3.00	<1.20
17/10/2022	14/11/2022	ASC/57149.001	<2.40	<3.00	<1.20	8.99	8.99	<3.00	5.99	2.70	8.99	2.40	<5.99	3.00	26.96	<0.90
14/11/2022	12/12/2022	ASC/57342.001	<2.40	<2.99	<1.20	8.98	17.96	<2.99	5.99	<2.40	8.98	2.99	<5.99	1.80	<2.99	<0.90
12/12/2022	09/01/2023	ASC/57521.001	<2.40	<2.99	<1.20	8.98	8.98	<2.99	2.99	<2.40	8.98	5.99	<5.99	2.40	77.84	<0.90

Table C2 Analysis of PAHs for each period.

Compound	Period 1	Period 2	Period 3	Period 4
Naphthalene	0.104	0.151	0.176	0.138
Acenaphthylene	0.008	0.003	0.003	0.068
Acenaphthene	0.067	0.068	0.058	0.079
Fluorene	0.310	0.243	0.232	0.440
Phenanthrene	1.657	1.866	1.667	2.447
Anthracene	0.074	0.052	0.043	0.195
Fluoranthene	0.679	0.510	0.452	1.057
Pyrene	0.542	0.375	0.365	0.930
Benzo(a)anthracene	0.079	0.032	0.017	0.233
Chrysene	0.166	0.075	0.042	0.369
Benzo(b)fluoranthene	0.168	0.058	0.030	0.376
Benzo(k)fluoranthene	0.058	0.020	0.011	0.146
Benzo(a)pyrene	0.076	0.023	0.012	0.256
Indeno(1,2,3-cd)pyrene	0.117	0.041	0.020	0.286
Dibenzo(ah)anthracene	0.016	0.004	0.002	0.042
Benzo(ghi)perylene	0.139	0.044	0.021	0.321
Benzo(j)fluoranthene	0.078	0.027	0.014	0.183
Dibenzo(ac)anthracene	0.014	0.004	0.002	0.033

Table C3 Analysis of Dioxins, Furans and PCBs, for each period.

Compound	Period 1	Period 2	Period 3	Period 4
DIOXINS				
2378 Tetra CDD	0.9	0.53	0.35	1.5
12378 Penta CDD	3.7	7.1	1.8	6.4
123478 Hexa CDD	0.28	0.97	0.12	0.37
123678 Hexa CDD	0.85	2.8	0.35	1.1
123789 Hexa CDD	0.54	1.5	0.2	0.72
1234678 Hepta CDD	0.69	1.1	0.21	0.82
OCDD Octa CDD	0.015	0.0098	0.0047	0.021
FURANS				
2378 Tetra CDF	0.68	0.47	0.33	0.99
12378 Penta CDF	0.35	0.57	0.19	0.52
23478 Penta CDF	5.9	14	3.5	8.9
123478 Hexa CDF	1	2.7	0.52	1
123678 Hexa CDF	1	3.4	0.53	1.3

Compound	Period 1	Period 2	Period 3	Period 4
234678 Hexa CDF	1.6	4.2	0.78	1.6
123789 Hexa CDF	0.42	1	0.17	0.47
1234678 Hepta CDF	0.39	0.76	0.18	0.37
1234789 Hepta CDF	0.047	0.064	0.015	0.04
OCDF Octa CDF	0.0019	0.0017	0.00083	0.0017
PCBs				
PCB-81	0.0018	0.0025	0.0023	0.0016
PCB-77	0.0038	0.0057	0.0079	0.0044
PCB-123	0.0002	0.00031	0.0005	0.00021
PCB-118	0.0078	0.012	0.029	0.01
PCB-114	0.00032	0.00055	0.0007	0.00036
PCB-105	0.0025	0.0044	0.0075	0.003
PCB-126	0.76	1.6	0.79	0.87
PCB-167	0.0002	0.00048	0.00065	0.00026
PCB-156	0.00049	0.0009	0.0012	0.0006
PCB-157	0.00014	0.00039	0.0003	0.00017
PCB-169	0.0064	0.024	0.0062	0.0076
PCB-189	0.00009	0.00035	0.00011	0.00009

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