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CAPTAINS FLAT AIR QUALITY MONITORING REPORT

JUNE 2021 TO JUNE 2025

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Description	**Data collected from 22 June 2021 to 30 June 2025 for the air quality monitoring program at Captains Flat, NSW**

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CONTENTS

GLOSSARY

Acronym / Symbol	Description
As	Arsenic
AS/NZS	Australian/New Zealand Standard
Ba	Barium
BoM	Bureau of Meteorology
Cd	Cadmium
Co	Cobalt
Cr	Chromium
Cu	Copper
DPIE	Department of Planning, Industry and Environment (NSW)
Fe	Iron
Hg	Mercury
HVAS	High-volume air sampler
IPC-MS	Inductively coupled plasma spectrometric method
Pb	Lead
LOR	Limit of Reporting
Mn	Manganese
Mo	Molybdenum
NATA	National Association of Testing Authorities
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure
NERDDC	National Health and Medical Research Council
Ni	Nickel
$PM_{2.5}$	Particulate matter with an aerodynamic diameter of less than 2.5 microns
PM_{10}	Particulate matter with an aerodynamic diameter of less than 10 microns
Regional NSW	NSW Department of Regional NSW
RFS	Rural Fire Service
SAQP	Sampling and Analysis Quality Plan
SCS	Soil Conservation Services
Se	Selenium
Ti	Titanium
TSP	Total suspended particulates, particulate matter with an aerodynamic diameter of less than 50 to 100 microns (measured at less than 50 microns for this report)
Zn	Zinc
$\mu g/m^3$ or $\mu g\ m^{-3}$	Micrograms per cubic metre

1. EXECUTIVE SUMMARY

An air quality monitoring program was commissioned in Captains Flat, NSW to inform air quality risks associated with heavy metals in airborne particulate matter from the legacy Lake George Mine. Sampling at five locations commenced on 22 June 2021 and is on-going. This report summarises all data from 22 June 2021 to 25 June 2025. Sampling is configured to measure a single 24-hour average sample every six days at five sensitive receptors around the town.

The objective of this program is to provide scientifically and technically robust monitoring of airborne particulate matter and heavy metals in the township of Captains Flat. The data will be used to evaluate the effectiveness of dust management during remediation of the legacy Lake George Mine and to allow for pre-works, during and post-works monitoring results to be compared.

After the first year of monitoring (sample dates from 22 June 2021 to 17 June 2022), the annual average concentrations of total suspended particulate (TSP) and lead were 17.4 µg/m³ and 0.004 µg/m³, respectively. During the second year of monitoring (sample dates from the 23 June 2022 to 18 June 2023), the annual averages increased slightly to 19.6 µg/m³ for TSP and remained at 0.004 µg/m³ for lead. For the third year (sample dates from the 24 June 2023 to 18 June 2024) the concentrations were 18.3 µg/m³ for TSP and 0.006 µg/m³ for lead. The most recent, fourth year, (sample dates from the 24 June 2024 to 19 June 2025) recorded annual average concentrations of 20.09 µg/m³ for TSP and 0.008 µg/m³ for lead. All recorded values remained below the annual average criteria of 90 µg/m³ for TSP and 0.5 µg/m³ for lead. The overall rolling average concentrations for the entire monitoring period currently stand at 18.0 µg/m³ for TSP and 0.005 µg/m³ for lead, remaining well within the NSW EPA annual average limits.

There have been five occasions where the 24-hour TSP concentrations were above the annual TSP criterion. These occurred at:

- AQM1 on 10 August 2022 (97.2 µg/m³)
- AQM2 on 17 February 2022 (117.4 µg/m³) and on 06 February 2023 (91.1 µg/m³)
- AQM4 on 28 August 2022 (109.1 µg/m³) and on 08 March 2024 (126.5 µg/m³)

The 24-hour TSP values do not constitute an exceedance of the criteria but are provided as an indication of discrete events of elevated concentrations. All 24-hour lead concentrations were below the annual average lead air quality criterion.

During the monitoring period, there were multiple instances where the 24-hour concentrations of the heavy metals, barium and nickel exceeded the relevant NSW EPA 1-hour criteria. The EPA has been engaged on these instances. It is worth noting that there has not been a nickel exceedance since March 2022.

2. INTRODUCTION

2.1 Overview

Ramboll Australia Pty Ltd (Ramboll) has been contracted by the Department of Regional NSW to implement and maintain an air quality monitoring program to inform air quality risks associated with the legacy Lake George Mine, in Captains Flat, NSW. The Captains Flat Lead Management Plan was completed by a multi-agency government taskforce. This taskforce included representatives from the Department of Regional NSW, NSW EPA, Transport for NSW, Crown Lands, Department of Education, Department of Health, Department of Primary Industries and Queanbeyan-Palerang Regional Council. The aim of the Lead Management Plan is to reduce community exposure to lead resulting from historic mining in the town (Regional NSW, 2021).

The air quality monitoring program is being managed by the Legacy Mines Program to continue to collect monitoring data whilst the works is being undertaken on the former Lake George mine site. The program involves environmental sampling of multiple media on public properties to assess current risk and provision of guidance regarding lead risk abatement measures. Work commenced early 2021 and is ongoing, with additional data collected, analysed, and reported on a previously every two months and now quarterly basis.

2.1.1 Objective

The objective of this report is to provide scientifically and technically robust monitoring of airborne particulate matter and heavy metals in the township of Captains Flat. The data will be used to evaluate the effectiveness of dust management during remediation of the legacy Lake George Mine and to allow for pre-works, during and post-works monitoring results to be compared.

2.2 Program background

The air quality monitoring program was commissioned on 21 June 2021, with the first sample collected 22 June 2021. From 27 October 2021 routine servicing of the air quality monitoring program was handed over to Soil Conservation Services (SCS), with Ramboll providing calibration and reporting services. Previous reports delivered by Ramboll are listed in Table 2-1

Table 2-1: Previous monitoring reports and data collection periods

Report Name	Monitoring Period	
	Start date	End date
Captains Flat Air Quality Monitoring Report 2021-08	22 June 2021	20 August 2021
Captains Flat Air Quality Monitoring Report 2021-10	22 June 2021	02 October 2021
Captains Flat Air Quality Monitoring Report 2021-12	22 June 2021	07 December 2021
Captains Flat Air Quality Monitoring Report 2022-02	22 June 2021	30 January 2022
Captains Flat Air Quality Monitoring Report 2022-04	22 June 2021	31 March 2022
Captains Flat Air Quality Monitoring Report 2022-06	22 June 2021	30 May 2022
Captains Flat Air Quality Monitoring Report 2022-Q3	22 June 2021	15 September 2022
Captains Flat Air Quality Monitoring Report 2022-Q4	22 June 2021	02 December 2022
Captains Flat Air Quality Monitoring Report 2023-Q1	22 June 2021	01 April 2023
Captains Flat Air Quality Monitoring Report 2023-Q2	22 June 2021	30 July 2023
Captains Flat Air Quality Monitoring Report 2023-Q3	22 June 2021	28 September 2023
Captains Flat Air Quality Monitoring Report 2023-Q4	22 June 2021	31 December 2023
Captains Flat Air Quality Monitoring Report 2024-Q1	22 June 2021	31 March 2024
Captains Flat Air Quality Monitoring Report 2024-Q2	22 June 2021	29 June 2024
Captains Flat Air Quality Monitoring Report 2024-Q3	22 June 2021	16 September 2024
Captains Flat Air Quality Monitoring Report 2024-Q4	22 June 2021	3 December 2024
Captains Flat Air Quality Monitoring Report 2025-Q1	22 June 2021	31 March 2025

2.3 Pollutants of concern

The mine operated from 1892 to 1962 producing lead, zinc, copper, pyrite, silver, and gold (Regional NSW, 2021). All the mine workings were underground with associated processing and transport above ground. Spreading of lead and zinc contamination from the site are the primary issues of concern (Regional NSW, 2021).

Lead (Pb) is emitted to the air from both natural and anthropogenic sources. Measured concentrations in ambient air have greatly reduced nationally following the phase-out of leaded fuels from 2000 to 2002, where typically urban concentrations are now less than 10% of the air quality criteria (NEPC, 2001). **Appendix 2** shows historic annual average lead concentration in Australian capital cities from 1981 to 2000, after which monitoring ceased in urban areas. Ambient lead remains a risk in areas where local point sources exist, such as metal smelting facilities, mining operations and waste incineration. Inhalation and ingestion of lead at elevated levels can lead to a range of health impacts, including cancer, neurotoxicity, and reproductive toxicity.

Zinc (Zn) occurs widely in the environment, but adverse health effects can occur when exposure is high. Elevated exposure can occur through exposure to mining, smelting, and processing or metal ores and metal plating.

Additionally, metals associated with mining and processing ore are of interest to this program. A suite of fifteen metals in air were analysed including:

- arsenic (As);
- barium (Ba);
- cadmium (Cd);
- chromium (Cr);
- cobalt (Co);
- copper (Cu);
- iron (Fe);
- lead (Pb);
- manganese (Mn);
- mercury (Hg);
- molybdenum (Mo);
- nickel (Ni);
- selenium (Se);
- titanium (Ti); and
- zinc (Zn).

3. METHODOLOGY

3.1 Study Area

The legacy Lake George Mine is in the town of Captains Flat, in the Southern Tablelands of rural New South Wales, approximately 50 km south-east of Canberra. Captains Flat has a distinctive valley terrain orientated roughly north to south, which is likely to influence local meteorology (refer to **Figure 3-1**). This is an important characteristic as wind speed and direction directly impact transport and dispersion of air pollutants.

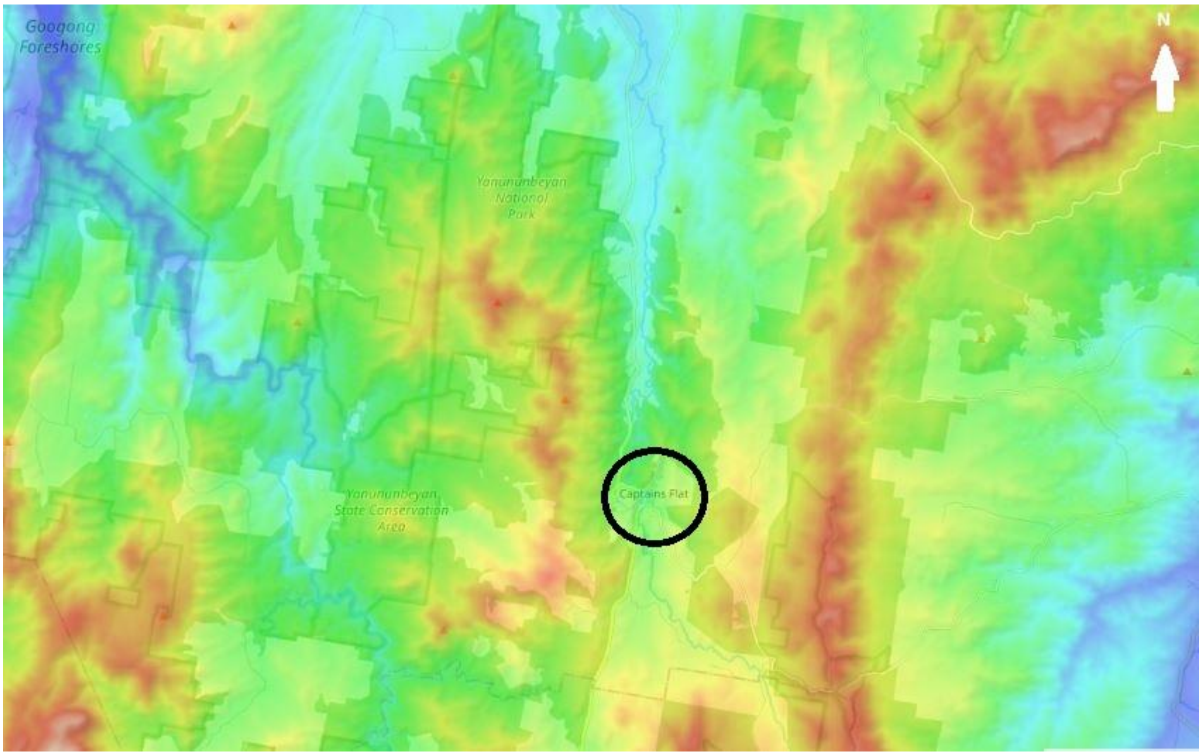

Figure 3-1: Terrain features in and around Captains Flat, NSW

Note. Higher elevations are indicated in red and lower elevations are shown in purple (Yamazaki et al., 2017)

The study area for the air quality monitoring program encompasses areas of former mining activities, including The Old Mine Site, Former Smelter, Northern Tailings Dump, and Former Rail Loadout Facility, which are located around and southeast to the Captains Flat Railway Station. The largest community area is northeast to the station, containing sensitive receptors such as residential properties and Captains Flat Public School. The project boundary and site elements are presented in **Figure 3-2**.

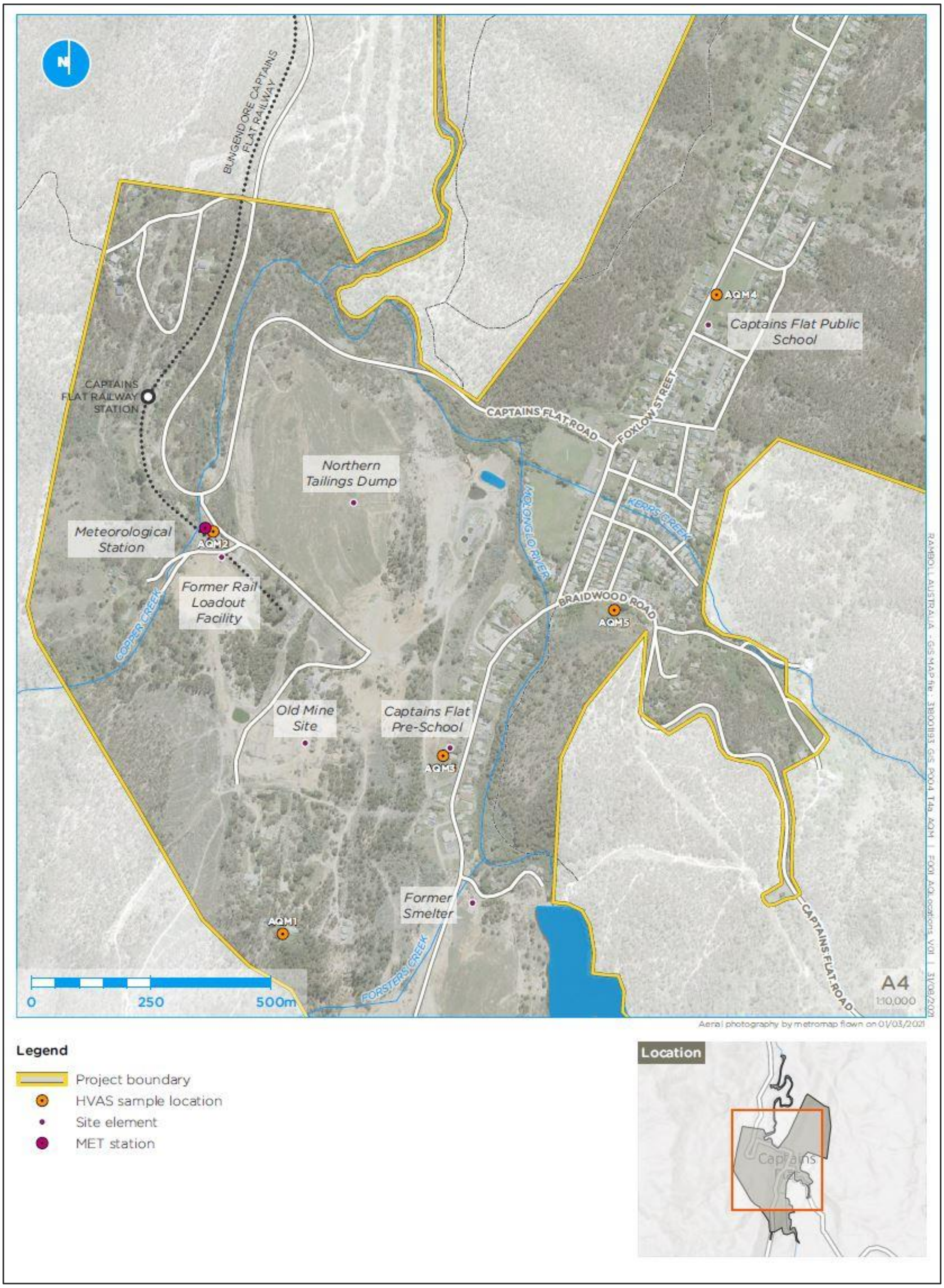

Figure 3-2: Project boundary and locations of interest

3.2 Sampling design

The monitoring program involves environmental sampling of TSP and testing for lead and other heavy metals in particulate form. Five locations of concern were selected within the study area were identified for sampling to be carried out. The five monitoring locations are shown in **Figure 3-2** and summarised in **Table 3-1** with the respective justification for selection. A meteorological station is maintained at one location (AQM2) to inform movement and dispersion of air.

Table 3-1: Air Quality Monitoring Locations

ID	Location description	Address	Justification for selection
AQM1	Residence	Old Mine Road	Representative of potential impacts residential sensitive receptor to the south-west. Located on elevated terrain relative to the other selected locations.
AQM2 & MET	Residence	2 Copper Creek Road	Identified as the nearest sensitive receptor (residents) to the northern tailings dump and the former rail loadout facility.
AQM3	Captains Flat former Preschool	27 Foxlow Street	Identified as a sensitive receptor of interest (residents) and representative of potential impacts to the south-east.
AQM4	New Preschool	Foxlow Street	Representative of potentials impacts to the largest community to the north-east and highly sensitive receptor (preschool).
AQM5	Residence	2 Braidwood Road	Representative of potential impacts to residents down-wind of the mine.

Sensitive receptors include locations where people reside and work, including residential properties, hospitals, schools, and parks. Remnants of materials from past above ground mine processing and transport activities are the source of contaminants (metals, particularly lead and zinc). Wind erosion is expected to be the main exposure pathway, linking pollutant sources to receptors; hence the importance of monitoring wind movements and understanding wind patterns. The five monitoring locations are deemed appropriate to provide results representative of the study area and encompasses the main sensitive receptors in the town.

3.3 Monitoring equipment and siting

High-volume air samplers (HVAS; Hi-Vol 3000) were utilised for sampling TSP. They consist of a TSP sampling head (i.e., inlet) that has a reported cut-point for particles of 50 micrometres (μm) diameter or less. The sampler draws a known volume of air across a pre-weighed filter for 24-hours.

The instruments are calibrated and maintained by Ramboll, as far as practicable, consistent with the recommendations of *AS/NZS 3580.9.3 – Method 9.3 – Determination of suspended particulate matter – Total suspended particulate matter (TSP) – High volume sampler gravimetric method* and the manufacturers recommendations. Sampling is configured for a 24-hour period every 1 day in 6 (midnight to midnight). Prior to Ramboll taking on all the calibration and maintenance duties, SCS serviced the instruments on a 6-day basis, commencing from 27 October 2021 and ending 19 September 2022.

Quality assurance is done using a field blank to capture any influences of the handling and storage process. A blank sample paper is handled in the same way as the actual sample papers and remains on site throughout the sampling exercise. The blank sample is sent for laboratory analysis along with the exposed samples. Established acceptance criterion for TSP field blanks is ±8 mg, above which the handling procedure should be investigated for potential contamination.

A meteorological station was initially supplied by the Rural Fire Service (RFS) and subsequently replaced by a project-owned station commissioned by Ramboll (more information in **Section 3.6**). Photos of the monitoring equipment in-situ are shown in **Appendix 3**.

Siting of all equipment was completed, as far as practicable, in accordance with the recommendations of *AS/NZS 3580.1.1 – Methods for sampling and analysis of ambient air – Part 1.1: Guide to siting air monitoring equipment*. Selection of monitoring locations requires compromises to meet the technical recommendations of *AS 3580.1.1* and practical conditions such as access approval, security, and power availability.

Locating the AQM2 instrument was limited by sewer connections in the residence backyard, which limited trenching for electrical works. The monitoring location is obstructed by the house and shed between the instrument and the nearest potential source of interest, the former rail loadout facility. This, however, was the most appropriate location for the monitor.

Many residences in Captains Flat operate woodfires during the winter which are a significant source of particulate matter. Woodsmoke from the Old Mine Road (AQM1) residence chimney can be seen in **Appendix 3** near the monitoring location. A temporary air quality monitoring campaign completed for the Miners Road and Copper Creek Road Upgrade on behalf of Queanbeyan-Palerang Regional Council during October 2021 confirmed elevated particulate matter concentrations during the night-time period, likely a result of biomass burning in the town.

3.4 Measurement of metals in TSP

TSP are airborne solid particles and water droplets less than approximately 50 to 100 µm in aerodynamic diameter, consisting of a myriad of different constituents from various sources.

The samples are analysed for 15 heavy metals in TSP: As, Ba, Cd, Cr, Co, Cu, Fe, Pb, Mn, Hg, Mo, Ni, Se, Ti, and Zn. The Australian Standard to measure lead in particulates (*AS/NZS 3580.9.15 Determination of suspended particulate matter – Particulate metals high or low volume sampler gravimetric collection – Inductively coupled plasma (ICP) spectrometric method)* requires measurement of the TSP fraction to analyse for lead content. Samples are weighed and analysed by a NATA accredited laboratory consistent with the recommendations of *AS 3580.9.15.*

3.5 Assessment criteria

Relevant NSW ambient air quality criteria for this monitoring program are presented in **Table 3-2**. There are no NSW ambient air quality criteria for the heavy metals, Cobalt, Molybdenum, Selenium, Titanium and Zinc.

Table 3-2: Air Quality Assessment Criteria

Pollutant	Averaging period	Criteria ($\mu g/m^3$)[1]	Source
Arsenic and arsenic compounds	1-hour	0.09	NSW EPA (2022)
Barium (soluble compound)	1-hour	9	NSW EPA (2022)
Cadmium and cadmium compounds	1-hour	0.018	NSW EPA (2022)
Chromium (III) compounds	1-hour	9	NSW EPA (2022)
Copper dusts and mists	1-hour	18	NSW EPA (2022)

Pollutant	Averaging period	Criteria (µg/m³)[1]	Source
Iron oxide fumes	1-hour	90	NSW EPA (2022)
Lead	Annual	0.5	NSW EPA (2022)
Manganese and compounds	1-hour	18	NSW EPA (2022)
Mercury (organic)	1-hour	0.18	NSW EPA (2022)
Nickel and nickel compounds	1-hour	0.18	NSW EPA (2022)
Total suspended particulates (TSP)	Annual	90	NHMRC (1996)

Note:

1. All criteria values referenced to 25°C and 101.3kPa

3.6 Meteorology monitoring and terrain influences

Meteorology is a primary driver of transport and dispersion in the atmosphere. A Bureau of Meteorology (BoM) station is maintained in Tuggeranong, approximately 36 km to the northwest of Captains Flat. These data are unlikely to be representative of Captains Flat given the differences in terrain, as Tuggeranong is a relatively flat urban environment. The nearest BoM station to Captains Flat is located in Braidwood, approximately 34.5 km to the northeast of Captains Flat. Braidwood may be more representative of the conditions at Captains Flat than Tuggeranong, but again the terrain differs significantly. Absence of local meteorology data in Captains Flat was identified as a data gap for the program in the Sampling and Analysis Quality Plan (SAQP; Ramboll, 2021).

The RFS loaned a meteorological station to the monitoring program for short-term use; prior to the project specific meteorological station being installed. The RFS meteorological station was decommissioned during the October reporting for use by RFS operations during fire season. Data between 22 June and 26 September 2021 was sourced from the RFS meteorological station, and data from 27 September 2021 onwards is sourced from the project meteorological station. From 7 August to 20 September 2022 the project station was not logging from capacity issues; meteorological data for this period was sourced from the BoM Goulburn Airport AWS station, located approximately 90 km to the north-east of Captains Flat. The capacity issue has now been resolved.

The RFS monitoring station measured wind speed and direction at 10 m height, wind speed, wind direction, temperature and humidity at 3 m height, and rainfall at ground level. During the June to August 2021 monitoring period, the 10 m wind sensors was calibrated south, so these data were corrected during analysis by 180⁰. Some intermittent data loss occurred from the station, caused by an issue with the firmware but data capture remained high (97.9% 10-minute data capture for the monitoring period). On 31 August 2021 the calibration and firmware issues were reported as rectified by RFS.

The project meteorological station (Lufft WSS800-UMB) measures wind speed and direction, temperature, relative humidity, air pressure, precipitation intensity, precipitation quantity and radiation at 10 m height. The sensors are mounted on a sensor arm fixed to a pump-up mast with lightning stake protection, with data capture and telemetry allowing remote access to the data. From 21 November to 5 December 2022 the unit was offline, potentially bumped by the gardening contractor, where the power cable was found to be wrapped around the logger and the cable not firmly in place on the power outlet. The unit was again found to be offline from 4 February 9:00 to 8 February 13:00 2023, likely from the gardening contractor moving the cable.

3.7 Data presentation and analysis

Monitoring results including all data since program inception were analysed as described below.

3.7.1 Meteorological conditions

Three sets of wind roses were generated to understand wind patterns and prevailing winds:

- Monthly wind roses with all available data.
- Monthly wind roses with data separated into day and night periods, determined by sunrise and sunset at location.
- Monthly wind roses with 24-hour averaged wind data for sample days only: these data are used to create the polar plots that must match the 24-hour pollutant data. This can be compared with the above wind roses using all raw data, and illustrates a limitation of the method, which is further discussed in **Section 4.4**.

Rainfall can contribute to suppressing particulate matter therefore a timeseries graph with daily rainfall data is presented for comparison with reported pollutant results.

3.7.2 TSP and metal concentrations measured

Timeseries graphs of TSP and metals concentrations analysed since the beginning of the monitoring program were plotted for ease of visualization and identification of peak concentrations. Blank sample results are also presented and discussed.

3.7.3 Potential factors influencing dispersion

Bivariate polar plots can be useful for source identification with longer datasets; this technique has been applied to the initial concentration data against the average wind conditions during each sampling day. The requirement to average 24-hour wind conditions to compare to the 24-hour sampling period is a limitation of the method, where wind conditions can vary considerably over a diurnal period (presented in the second set of wind roses mentioned in **Section 3.7.1**).

Additionally, the bivariate plots for the key pollutants TSP, lead and zinc are presented spatially on a topographical map in **Appendix 1**. The plots were prepared using the openair data analysis package in R (Carslaw & Ropkins, 2012).

3.7.4 Correlations for potential source identification

The relationship between concentrations of air pollutants over time can provide an indication of whether the pollutants originated from the same source. Therefore, correlation matrices have been prepared to compare the relationship between each heavy metal and TSP.

The plots, developed using lattice multivariate data visualisation (Sarkar, 2007) in openair, display the correlation coefficient as a shape, colour, and numeric value as a representation of a scatter plot. A perfect or near-perfect correlation is shown as a 45-degree sloped line, whereas zero correlation is shown as a circle.

3.8 Technical limitations

Data collection is limited to a 24-hour period every 1 day in 6, that is, data capture is not continuous which is a limitation of the method appropriate for this application. Moreover, as described in **Section 3.7.3**, the 24-hour sampling period is a limitation of the method, as results are given as a 24-hour average without capturing varying conditions within the day.

As described in **Section 3.6**, the project meteorological station was monitoring but not logging for approximately 1.5 month during August and September 2022. In the absence of local data, meteorological data was sourced from a BoM station. Conditions were however notably different to those at Captains Flat (see **Section 4.2**), reinforcing the importance of having local meteorological data to understand site conditions for dispersion and transport of air pollutants.

Another technical limitation of the 24-hour average concentrations is that comparable air quality criteria do not exist. As a result, the 24-hour concentrations must be compared to criteria for varying time periods (1-hour or annual).

4. RESULTS

4.1 Overview

Results from the monitoring period including all data since program inception are presented in the following sections:

- Meteorological conditions (**Section 4.2**).
- TSP and metal concentrations measured (**Section 4.3**).
- Potential factors influencing dispersion (**Section 4.4**).
- Correlations for potential source identification (**Section 4.5**).

4.2 Meteorology conditions

Wind roses from conditions measured at 10 m height at 2 Copper Creek Road, Captains Flat for quarter 2, 2025 are presented in **Figure 4-1**. Historical wind roses from 22 June 2021 to 31 May 2025 are presented in **Appendix 5**. As described in **Section 3.6**, data from 7 August to 20 September 2022 was sourced from the BoM Goulburn Airport AWS. The location is influenced by local terrain and differences are noted in the August and September 2022 wind roses compared with the previous months, suggesting these conditions are less representative of the local conditions.

Analysis of wind conditions from the start of monitoring shows prevailing winds from the south-west and north-west to north. Calmer conditions were generally recorded in summer, whilst winter and spring recorded higher wind speeds. The strongest winds recorded by the site meteorological station are generally 4 to 6 m/s, with occasional 6 to 8 m/s winds measured from the south and southwest. Average monthly wind speeds for the 2025 Q2 monitoring period are generally low 1.9 - 2.5m/s indicating low potential for wind generated dust. Quarter 2, 2025 wind speeds slightly higher on average than previously recorded wind speeds from this quarter and with a larger predominance of southerly winds.

Section 4.4 presents polar plots using averaged wind conditions over 24-hours to match the 24-hour pollutant data. These averaged wind conditions for sample days only, during quarter 2, 2025 are shown in **Figure 4-2**. Historical wind roses from 22 June 2021 to 31 December 2024 for sample days only are presented in **Appendix 5.**

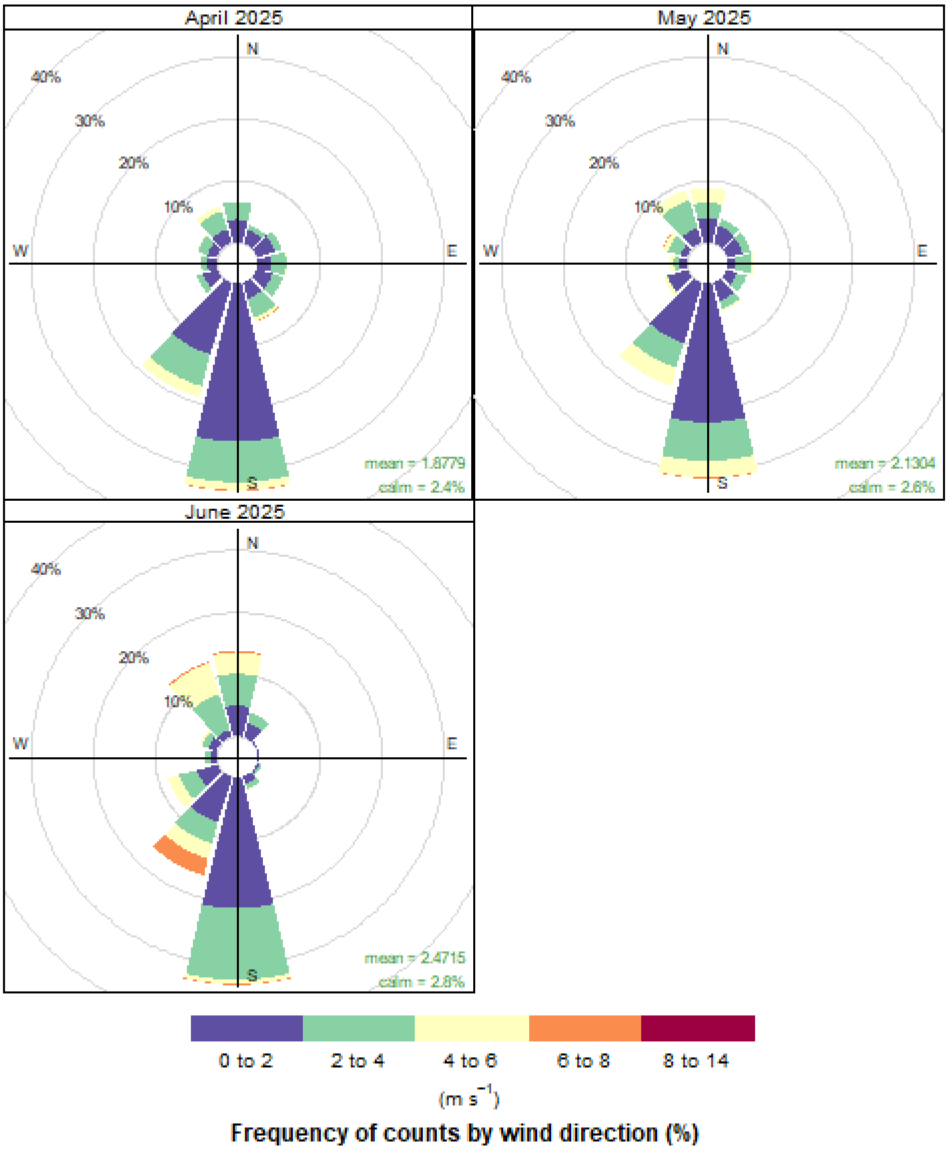

Figure 4-1: Monthly wind roses for all data collected at 2 Copper Creek Road, quarter 2 2025

Notes: produced with openair; Carslaw & Ropkins, 2012.

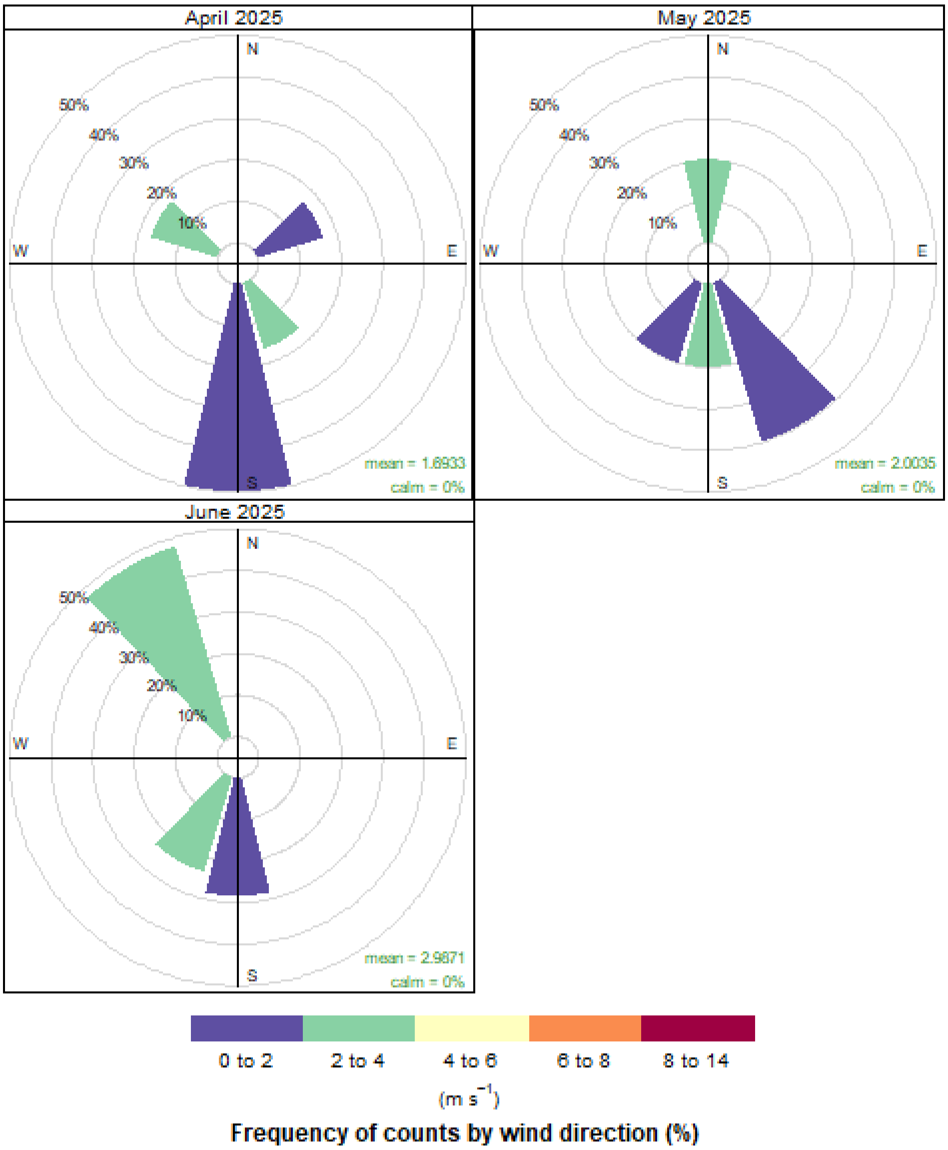

Figure 4-2: 24-hour average wind roses for sample days (24-hour period) only, quarter 2 2025

Notes: produced with openair; Carslaw & Ropkins, 2012.

Daily rainfall data from the RFS, project site, and Goulburn Airport AWS meteorological stations are shown in Figure 4-3. The year 2022 experienced notably high rainfall, with several heavy downpours exceeding 50 mm in a single day during January, April, May, August, and September. In contrast, 2023 was drier, with heavy rainfall (over 50 mm) recorded only in August and November. A particularly intense rain event took place on August 22, 2023, with more than 100 mm of rain recorded, followed by an extended dry period for the remainder of the year. The first half of 2024 remained relatively dry, marked by a single major rainfall event occurring in April. However, the second half the year saw increased rainfall, including a significant event (approximately 120 mm) in September 2024. 2025 has seen moderate rainfall compared to previous years.

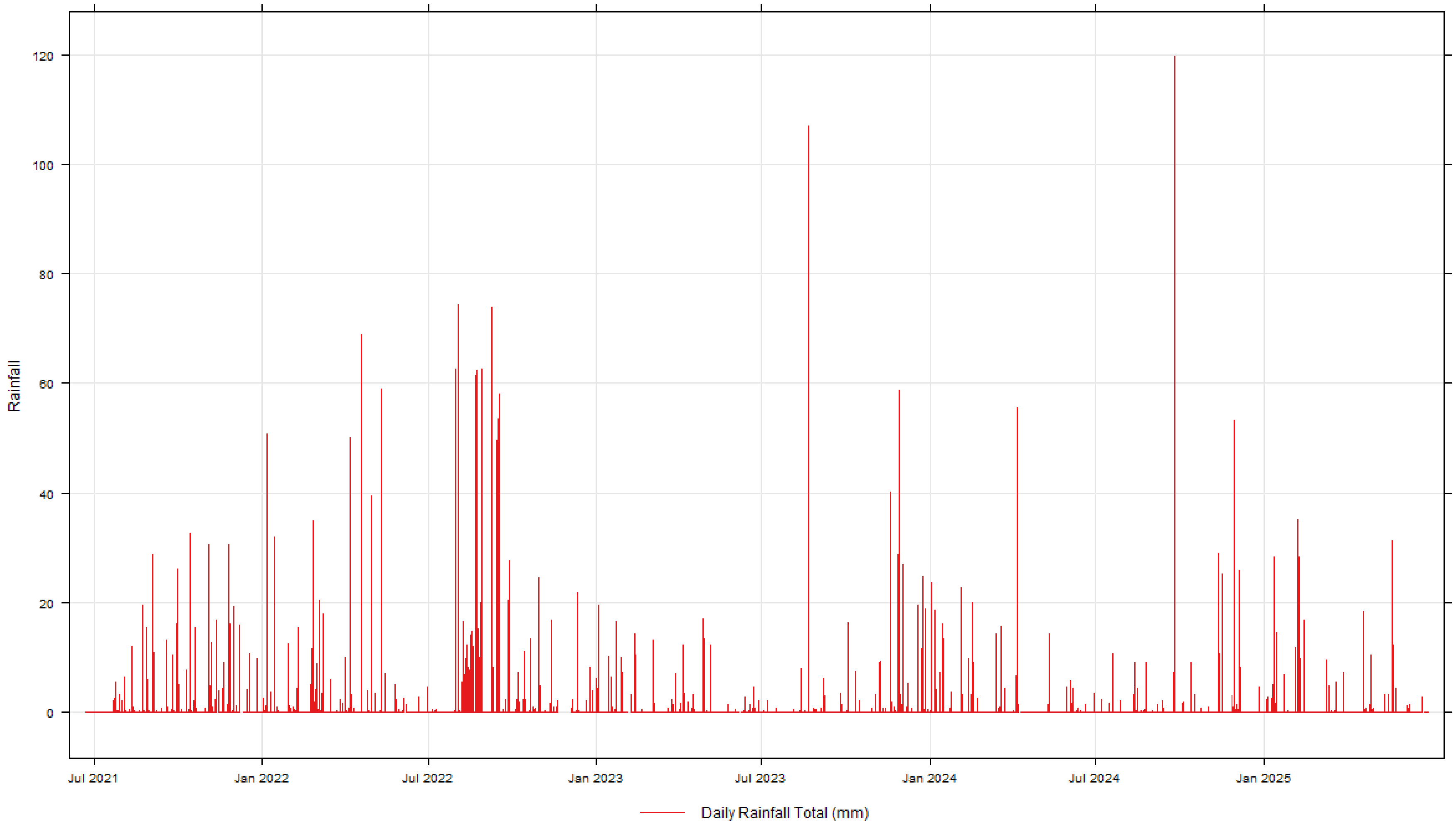

Figure 4-3: Daily rainfall July 2021 – June 2025

Notes: Data from 7 August 13:00 to 20 September was sourced from BoM Goulburn station; No data was recorded from 21 November 17:00 to 05 December 2022, and from 04 February 9:00 to 8 February 13:00 2023 (unit was offline).

4.3 TSP and Heavy Metals

The annual average TSP and lead concentrations for the three complete years (mid June to mid June) of monitoring are presented in Table 4-1. The most recent monitoring year (2024-2025) recorded the highest annual average TSP and lead concentrations sine the monitoring program commenced. These values are however all still well below the annual average criteria of 90 µg/m³ and 0.5 µg/m³ for TSP and lead respectively. The overall rolling average concentrations for the entire monitoring period currently stand at 18.7 µg/m³ for TSP and 0.005 µg/m³ for lead, remaining well within the NSW EPA annual average limits.

Table 4-1: Annual average TSP and Lead for the first three years of monitoring

Monitoring Year	Dates	Annual Average (µg/m³)	
		TSP	Lead
1	22 June 2021 to 17 June 2022	17.4	0.004
2	23 June 2022 to 18 June 2023	19.6	0.004
3	24 June 2023 to 18 June 2024	17.7	0.005
4	24 June 2024 to 19 June 2025	20.09	0.008
Rolling average 22 June 2021 to 19 June 2025		18.7	0.05
Annual Criteria		**90**	**0.5**

Figure 4-4 to **Figure 4-19** show timeseries of TSP and each of the 15 metals analysed with the applicable criteria since the beginning of the monitoring program. There have been six occasions where the 24-hour TSP concentrations were elevated relative to the annual TSP criterion. These instances are listed below and discussed in further detail in **Section 4.3.1**.

- 17 February 2022 at AQM2 (117.4 µg/m³),
- 10 August 2022 at AQM1 (97.2 µg/m³),
- 28 August 2022 at AQM4 (109.1 µg/m³),
- 06 February 2023 at AQM2 (91.1 µg/m³),
- 08 March 2024 at AQM4 (126.5 µg/m³),
- 25 June 2025 at AQM4 (127.0 µg/m³).

All 24-hour lead concentrations were below the annual average lead air quality criterion. Relatively higher concentrations of lead were recorded at the AQM2 and AQM3 monitors in May 2024 and February to March 2025, compared to previous measurements. Similar peaks were also observed in some of the metal concentrations (including As, Ca, Cr, Pb, Mn, Se, Titanium) during this time at these monitors. 24-hour lead concentrations during Q2 2025 remain below the annual average lead air quality criterion and comparatively lower than the previous peaks observed in Q1 2025

Most heavy metals remained below their respective 1-hour criteria; however, concentrations of barium and nickel have been recorded in high concentrations throughout the monitoring period – often recorded well above the 1-hour criteria. The EPA has been engaged on these instances.

Analysis of blank sample results are detailed in **Table 4-2.** Most of the blank samples are within the established acceptance criterion (blank TSP mass difference = ±8 mg between initial and final weighing) with the exception of the August 2022 sample (blank TSP mass difference = 11.3 mg). This result may suggest that the samples were not handled or stored appropriately by the servicing contractor. The program has been modified since this period, with servicing completed by Ramboll from 16 September 2022. The following blank samples recorded some of the lowest differences in masses between the initial and final weighing during the monitoring program, suggesting that the new servicing process has improved sample handling. Due to an analytical service issue, the final filter mass of the TSP samples measured during July 2023 were not recorded and therefore have been marked as NA in the following section. Blank samples from September 2024 to May 2025 were cancelled and have therefore not been reported.

Table 4-2: Blank sample details

Blank sample ID	Date analysed	Initial filter mass (mg)	Final filter mass (mg)	Blank TSP Difference (mg)
AQM5 – HVS723	02/10/2021	2753.3	2755.2	1.9
AQM5 – HVS817	12/10/2021	2741.1	2744.4	3.3
AQM5 – HVS1183	13/12/2021	2684.8	2688.1	3.3
AQM5 – HVS1144	05/02/2022	2829.8	2836.0	6.2
AQM5 – HVS1136	06/04/2022	2821.5	2827	5.5
AQM5 – HVS1436	04/08/2022	2686.5	2697.8	11.3
AQM5 – HVS1586	9/10/2022	2556.8	2558.1	1.3
AQM5 – HVS1698	8/12/2022	2738.7	2741.1	2.4
AQM5 – HVS1826	6/04/2023	2673.5	2673.6	0.1
AQM5 – HVS2015	07/06/2023	2684.4	2683.2	1.2
AQM5 – HVS1976	8/07/2023	2738.2	2736.9	1.3
AQM5 – HVS2045	04/08/2023	2699.5	NA	NA
AQM5 – HVS1966	07/09/2023	2664.9	2667.1	2.2
AQM5 – HVS3072	06/10/2023	2791.8	2792.1	0.3
AQM5 – HVS3109	8/12/2023	2714.7	2719.8	5.1
AQM5 – HVS3249	01/02/2024	2769.9	2774.6	4.7
AQM5 – HVS3411	30/04/2024	2672.7	2678.5	5.8
AQM5 – HVS	5/06/2024	2759	2762.9	3.9
AQM5 – HVS3622	8/08/2024	2738.7	2745.4	6.7
BLANK - HVS	8/05/2025	2744.8	2751.6	6.8

Details of invalidated or missing samples during the monitoring program are outlined in Appendix 4. A summary of invalidated or missing data is as follows:

- On July 4, 2021, a sample from AQM5 was lost due to high winds damaging the instrument.
- Four sets of samples from all sites (November 1 and 7, 2021, April 12, and May 24, 2022) were invalidated due to confusion over sampling procedures during the program's handover to SCS for servicing.
- Sampling in April and May 2022 was not completed by SCS.
- A sample from AQM2 on May 18, 2022, was missing when Ramboll attempted retrieval.
- On May 13, 2023, a sample was excluded due to a damaged filter.
- TSP samples collected in July 2023 were not finalised due to a procedural error at the laboratory.
- On November 9, 2023, both a blank sample from AQM5 and a sample from AQM3 were unmeasured due to being missing.

- The sample from AQM4 on October 4, 2024, was cancelled by the laboratory.

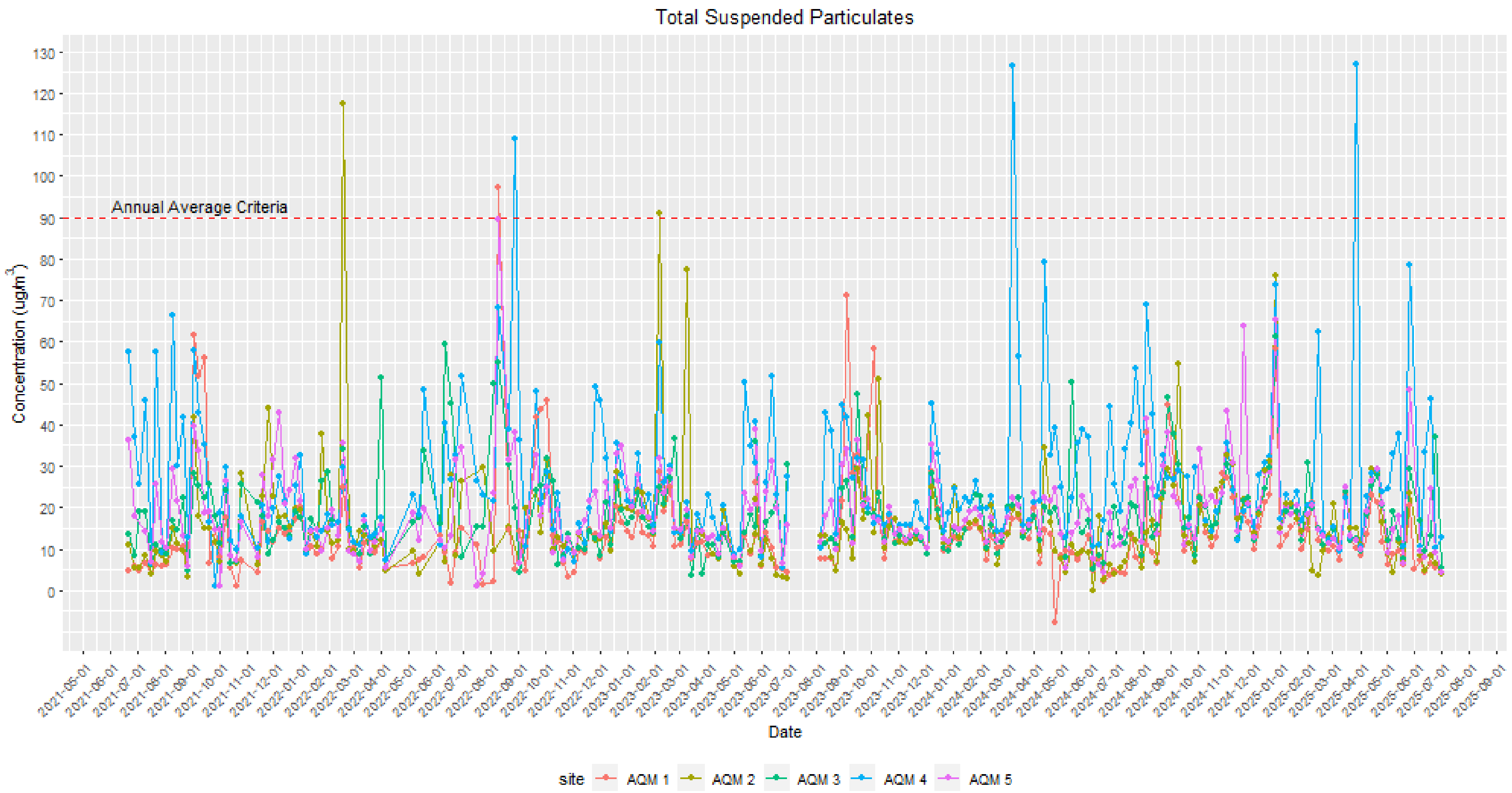

Figure 4-4: 24-hour TSP concentration measured at each sampling location every one day in six, from 22 June 2021

Note. Annual average TSP criteria: 90 µg/m³; LOR 0.0061 µg/m³

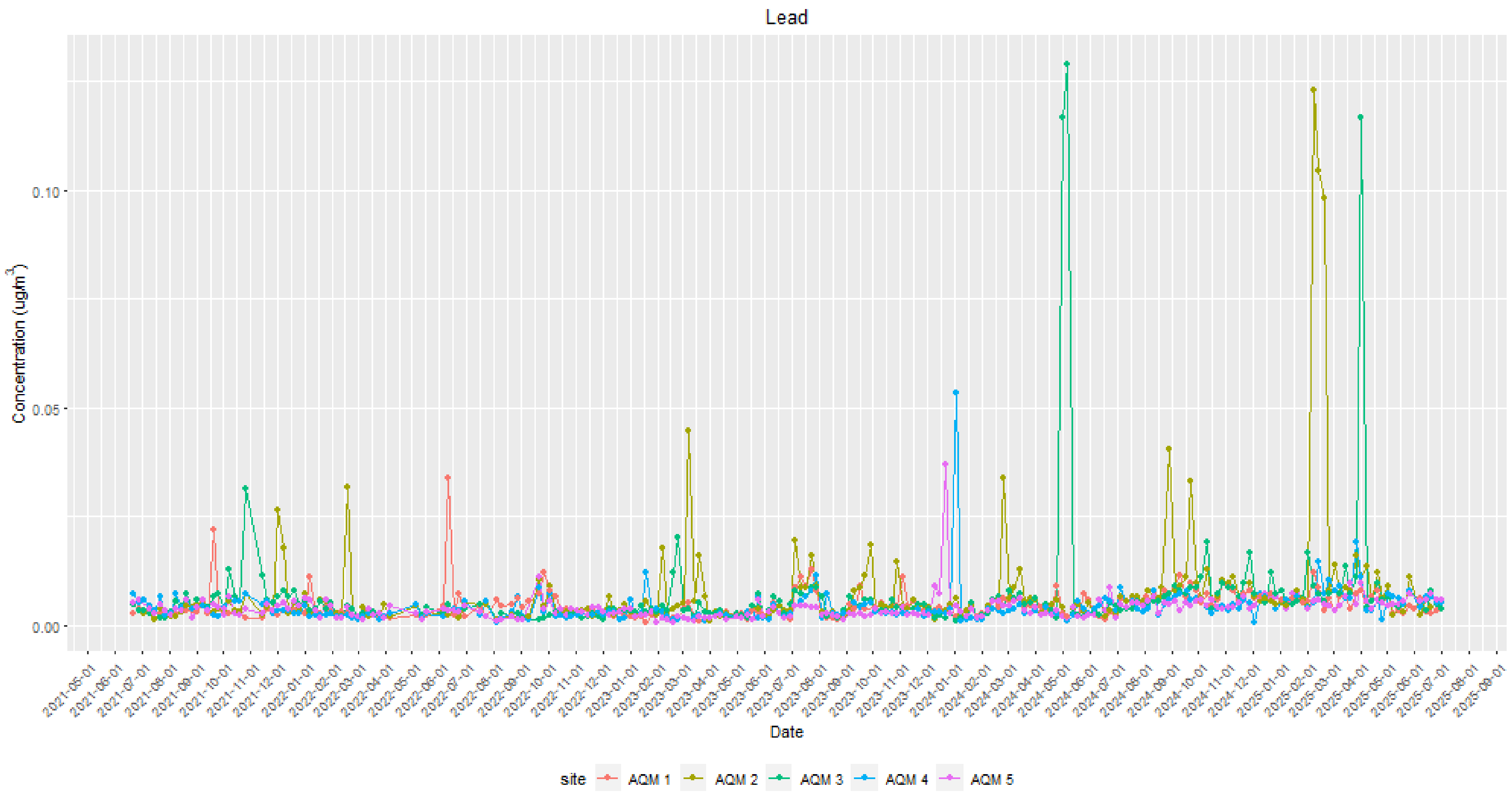

Figure 4-5: 24-hour lead concentration measured at each sampling location every one day in six, from 22 June 2021

Note. Annual average lead criteria not shown: 0.5 µg/m³; LOR 0.0006 µg/m³

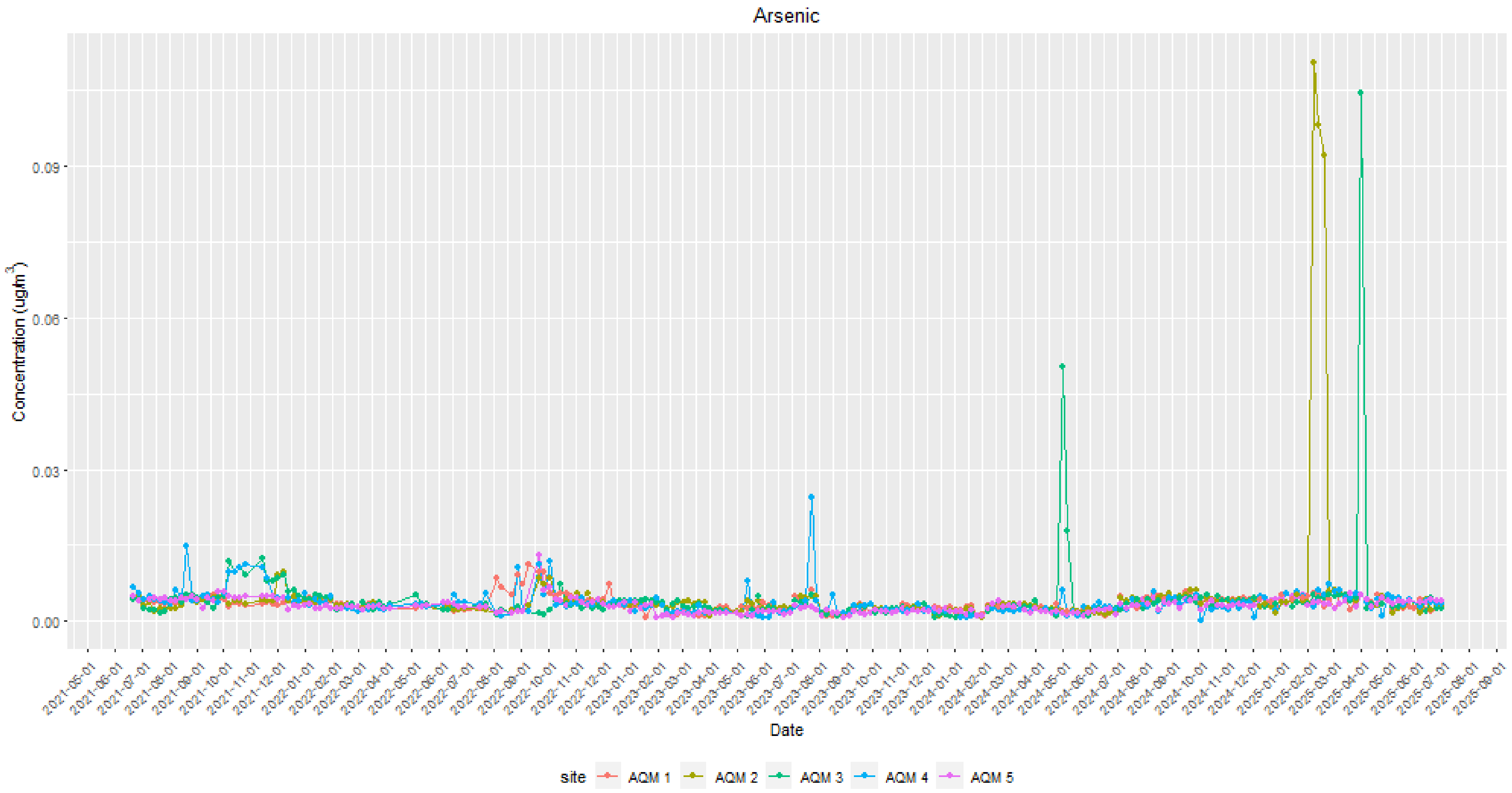

Figure 4-6: 24-hour arsenic concentration measured at each sampling location every one day in six, from 22 June 2021

Note. 1-hour average arsenic criteria not shown: 0.09 µg/m³; LOR 0.0006 µg/m³

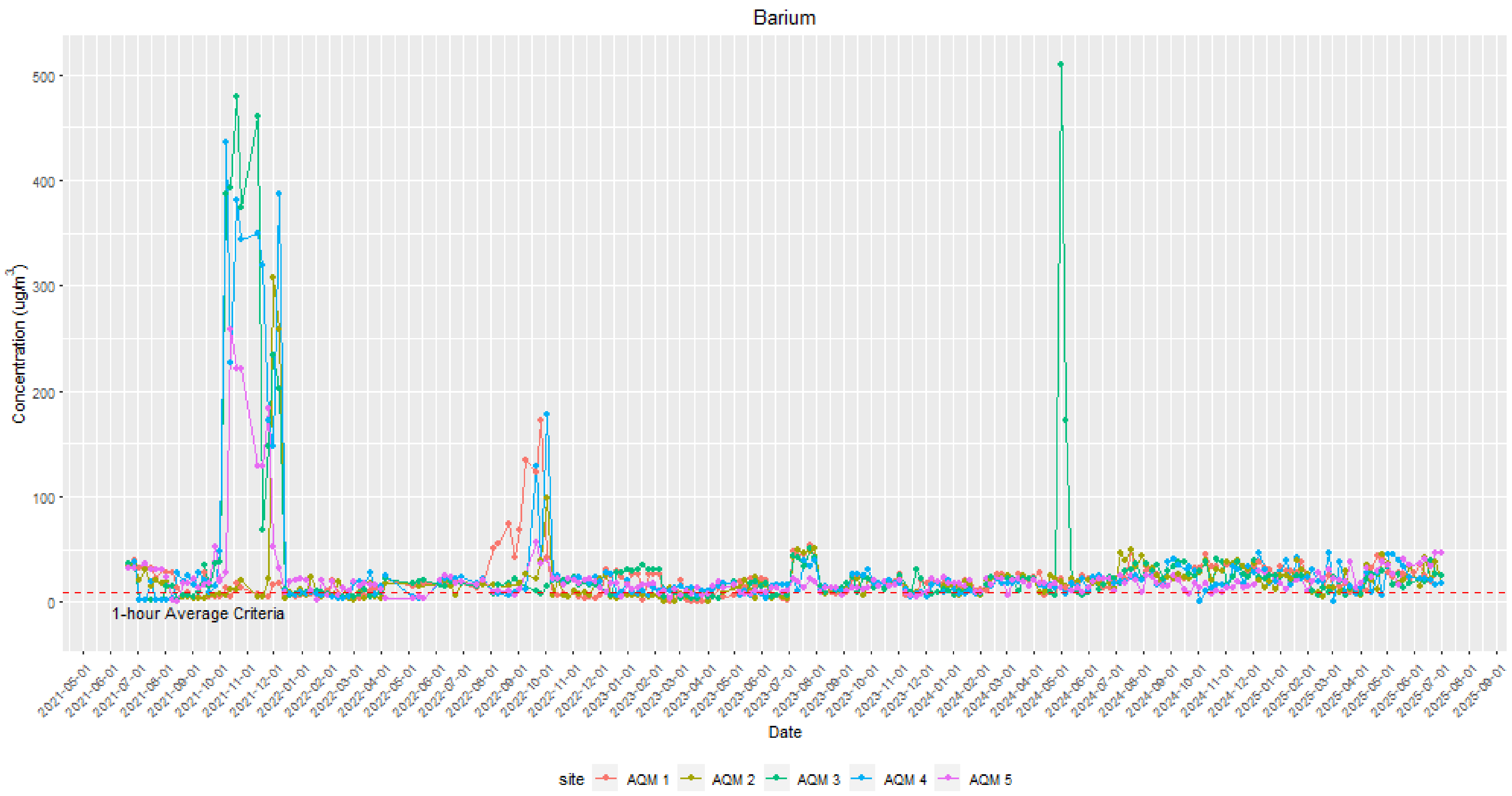

Figure 4-7: 24-hour barium concentration measured at each sampling location every one day in six, from 22 June 2021

Note. 1-hour average barium criteria: 9 µg/m³; LOR 0.0006 µg/m³

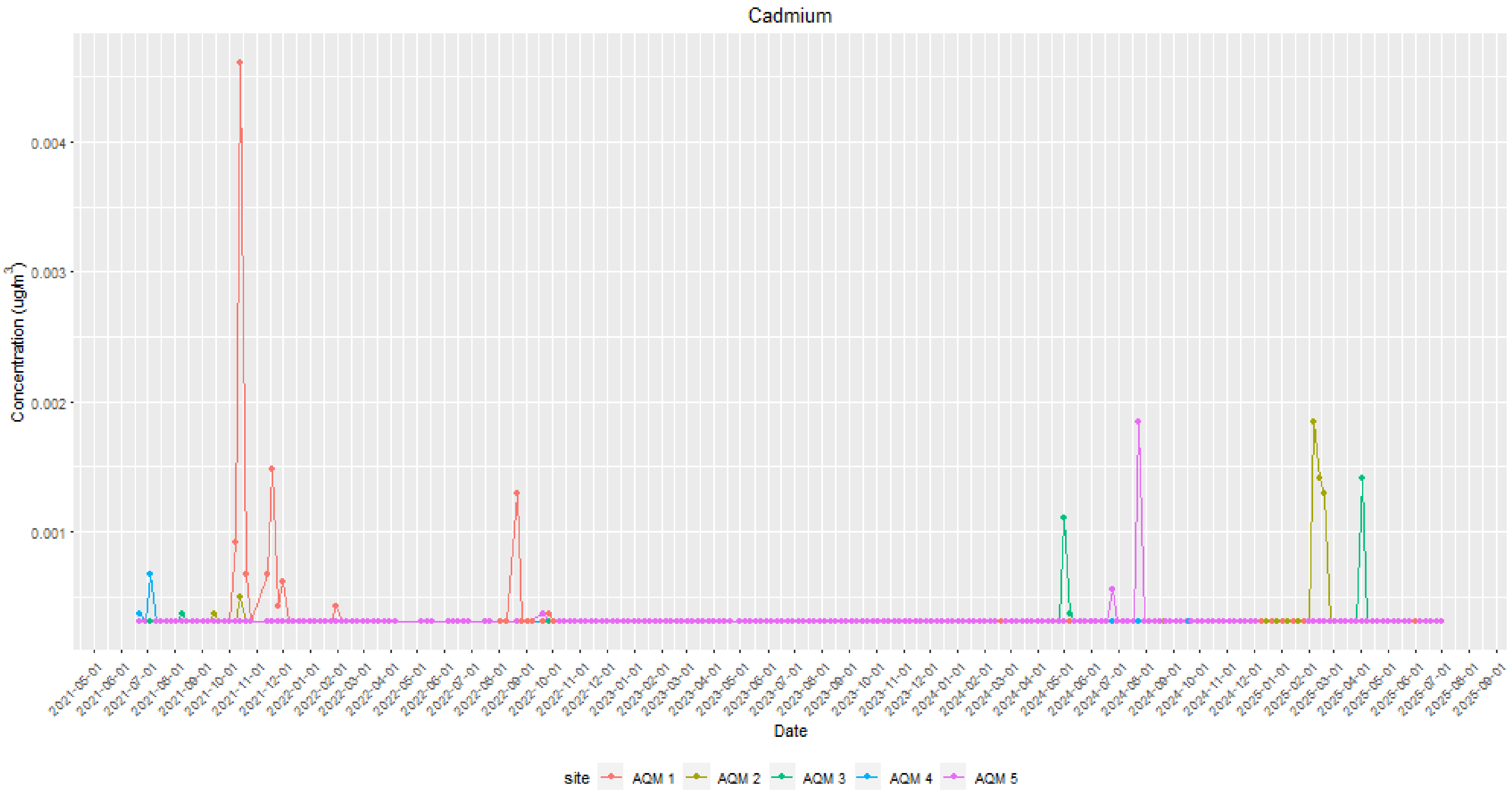

Figure 4-8: 24-hour cadmium concentration measured at each sampling location every one day in six, from 22 June 2021

Note. 1-hour average cadmium criteria not shown: 0.018 µg/m³; LOR 0.0003 µg/m³

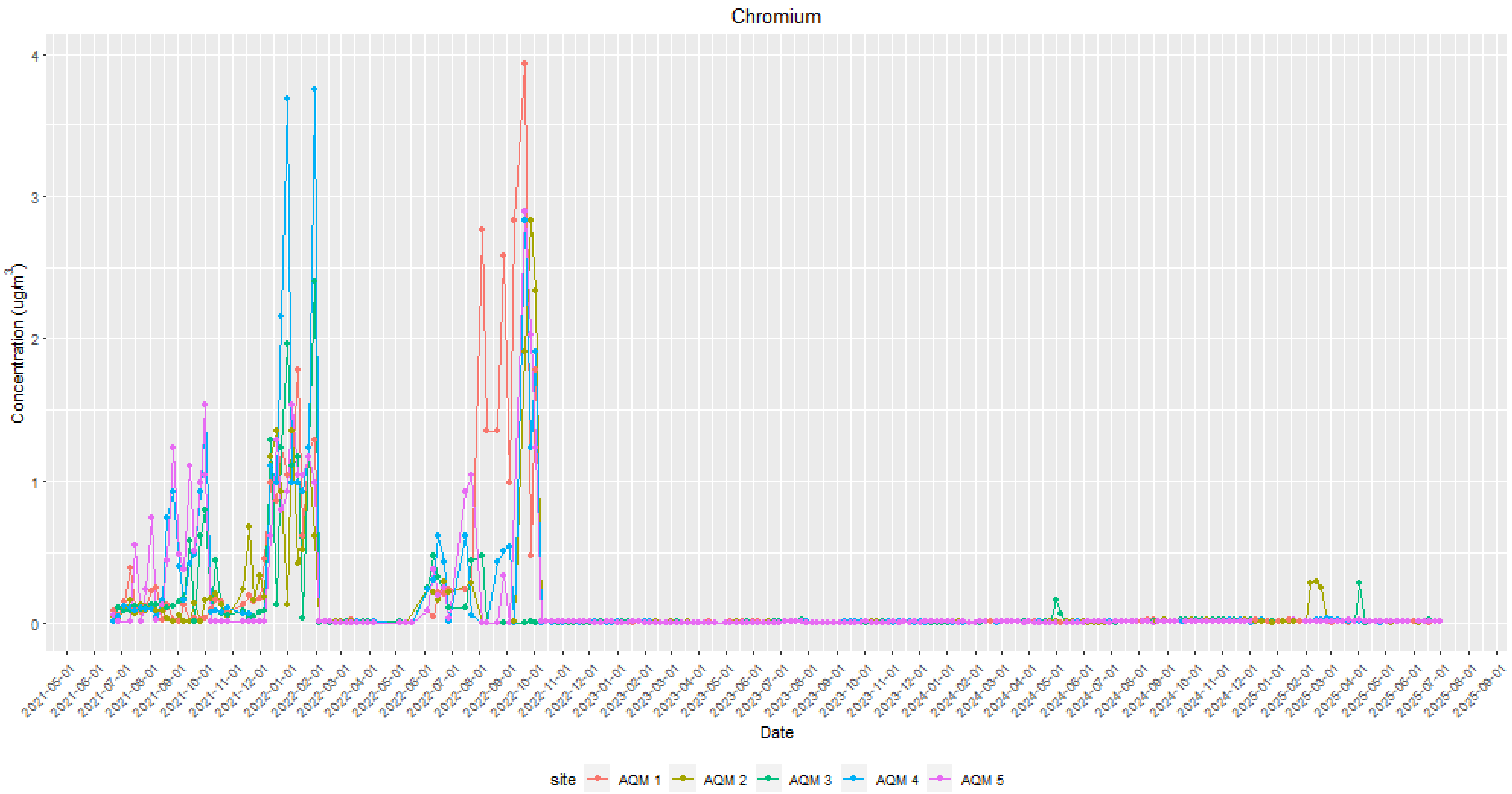

Figure 4-9: 24-hour chromium concentration measured at each sampling location every one day in six, from 22 June 2021

Note. 1-hour average chromium criteria not shown: 9 µg/m³; LOR 0.0006 µg/m³

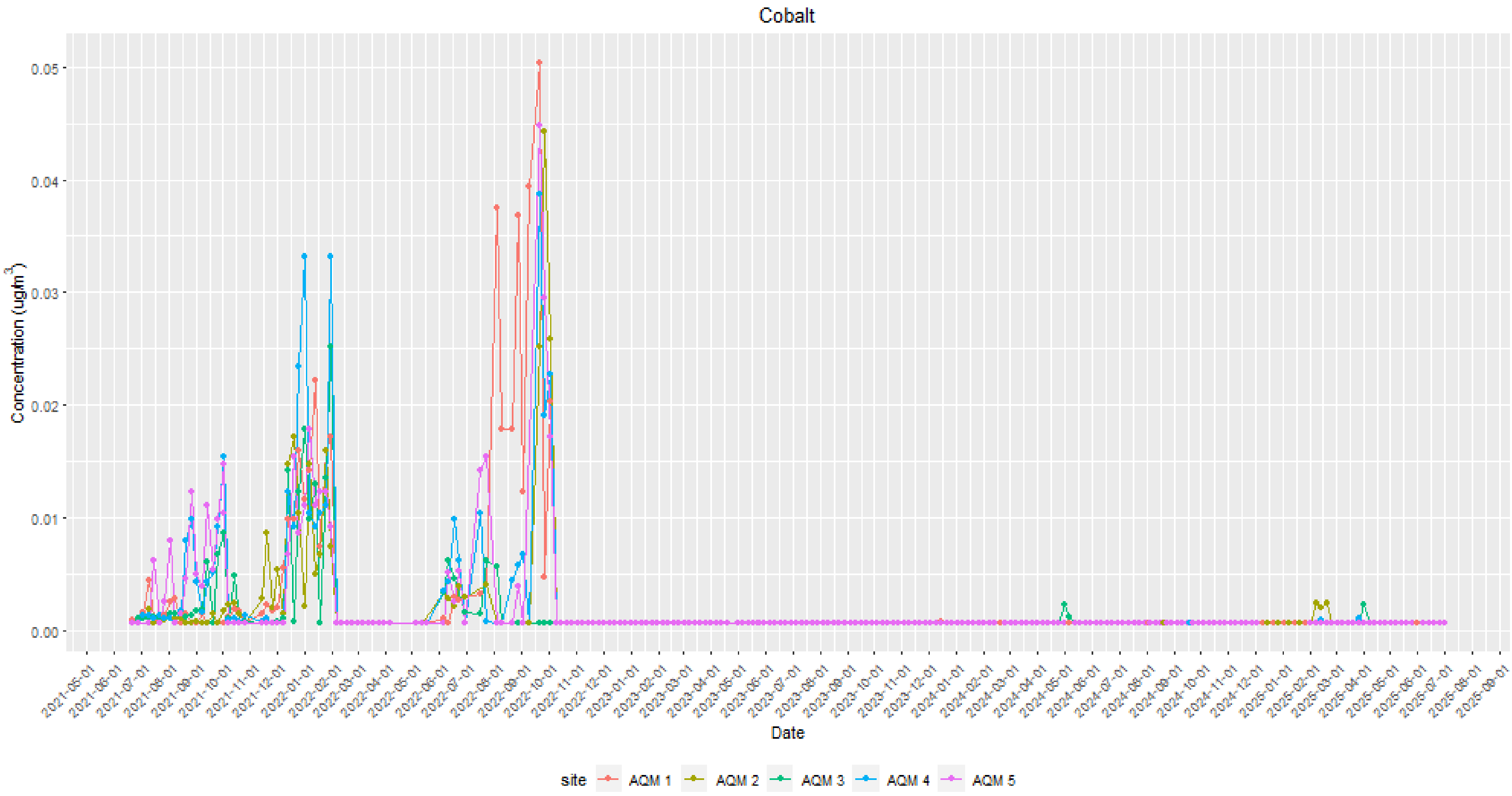

Figure 4-10: 24-hour cobalt concentration measured at each sampling location every one day in six, from 22 June 2021

Note. LOR 0.0006 µg/m³

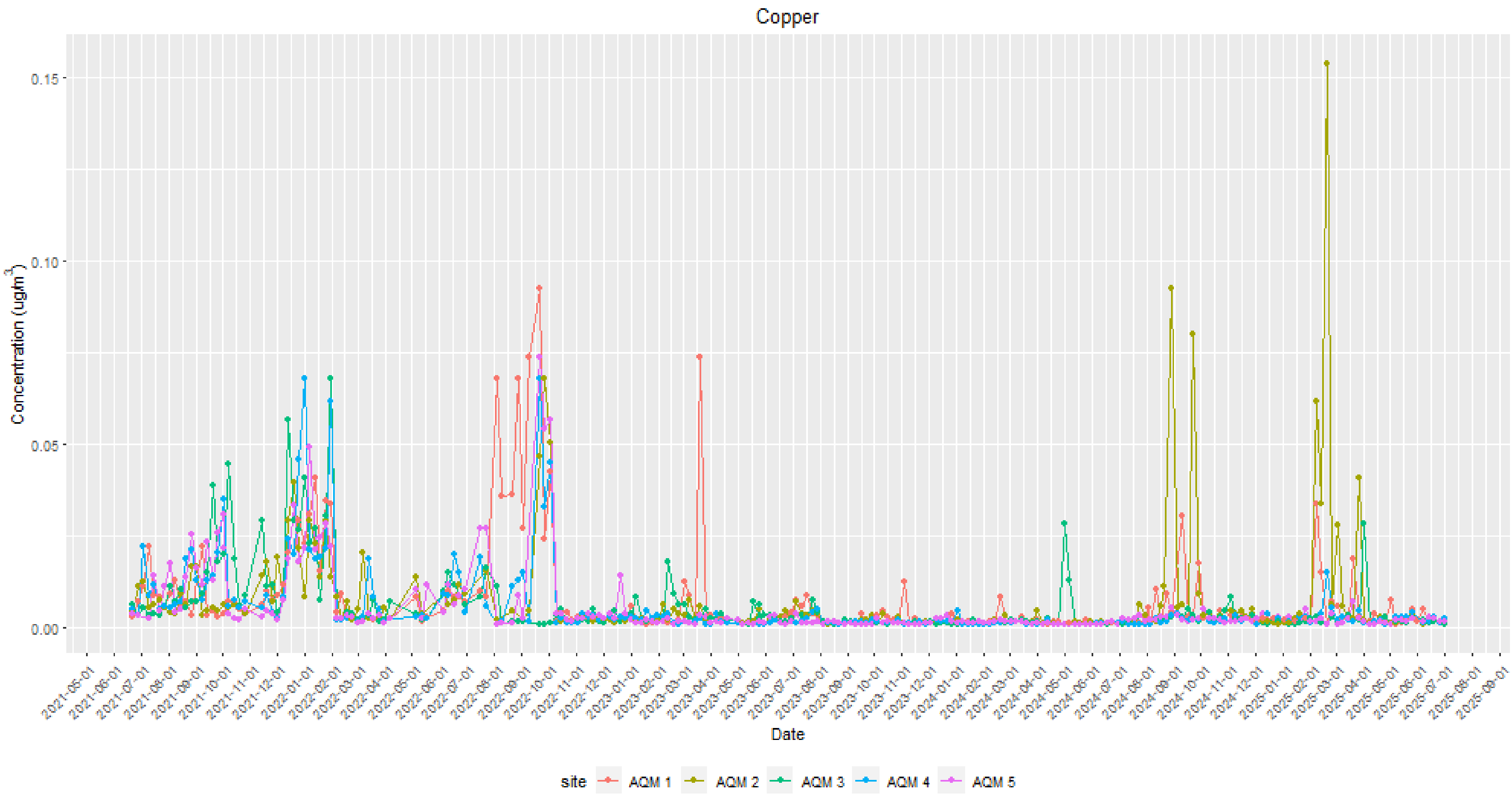

Figure 4-11: 24-hour copper concentration measured at each sampling location every one day in six, from 22 June 2021

Note. 1-hour average copper criteria not shown: 18 µg/m³; LOR 0.0006 µg/m³

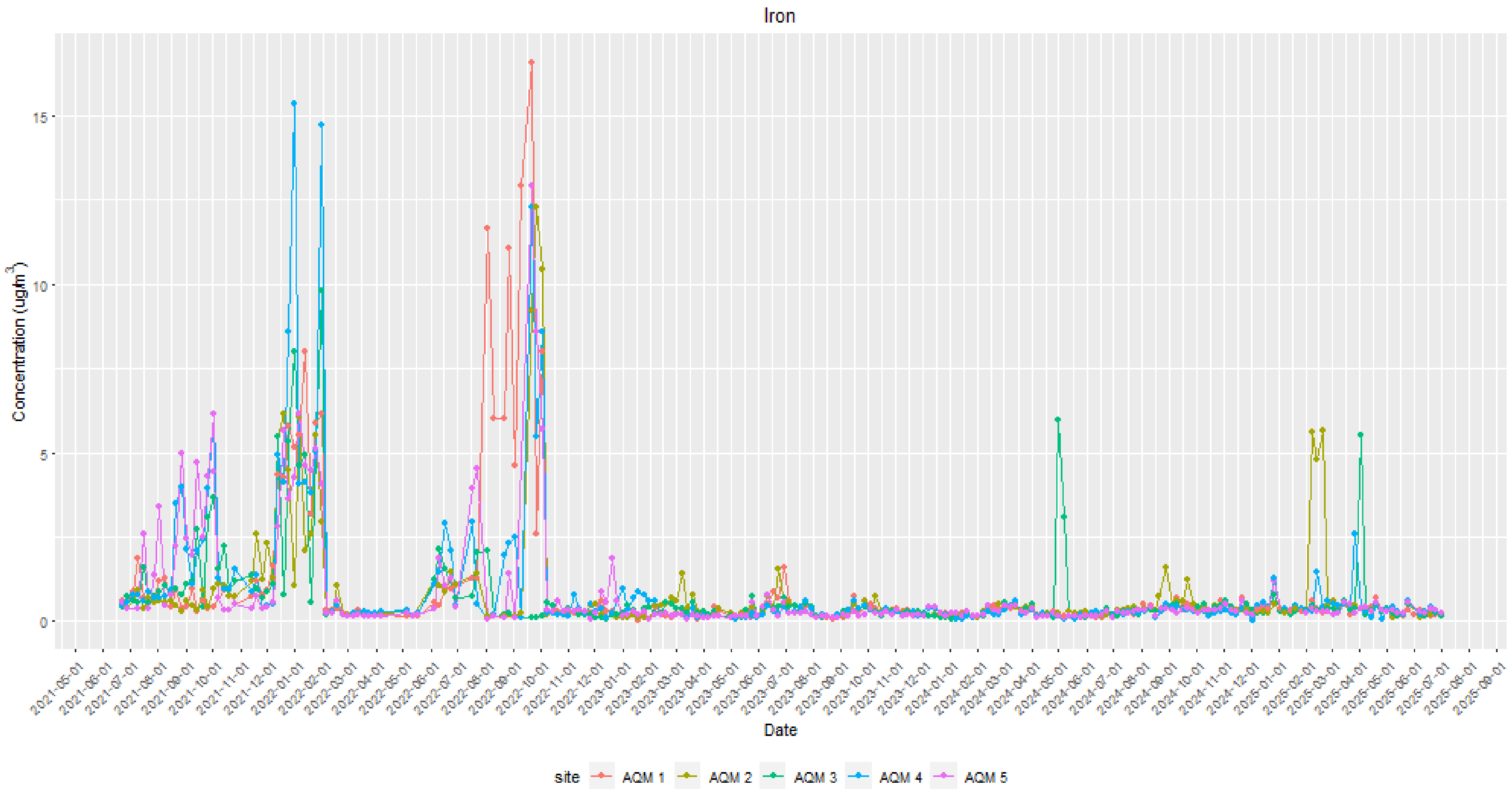

Figure 4-12: 24-hour iron concentration measured at each sampling location every one day in six, from 22 June 2021

Note. 1-hour average iron criteria not shown: 90 µg/m³; LOR 0.0061 µg/m³

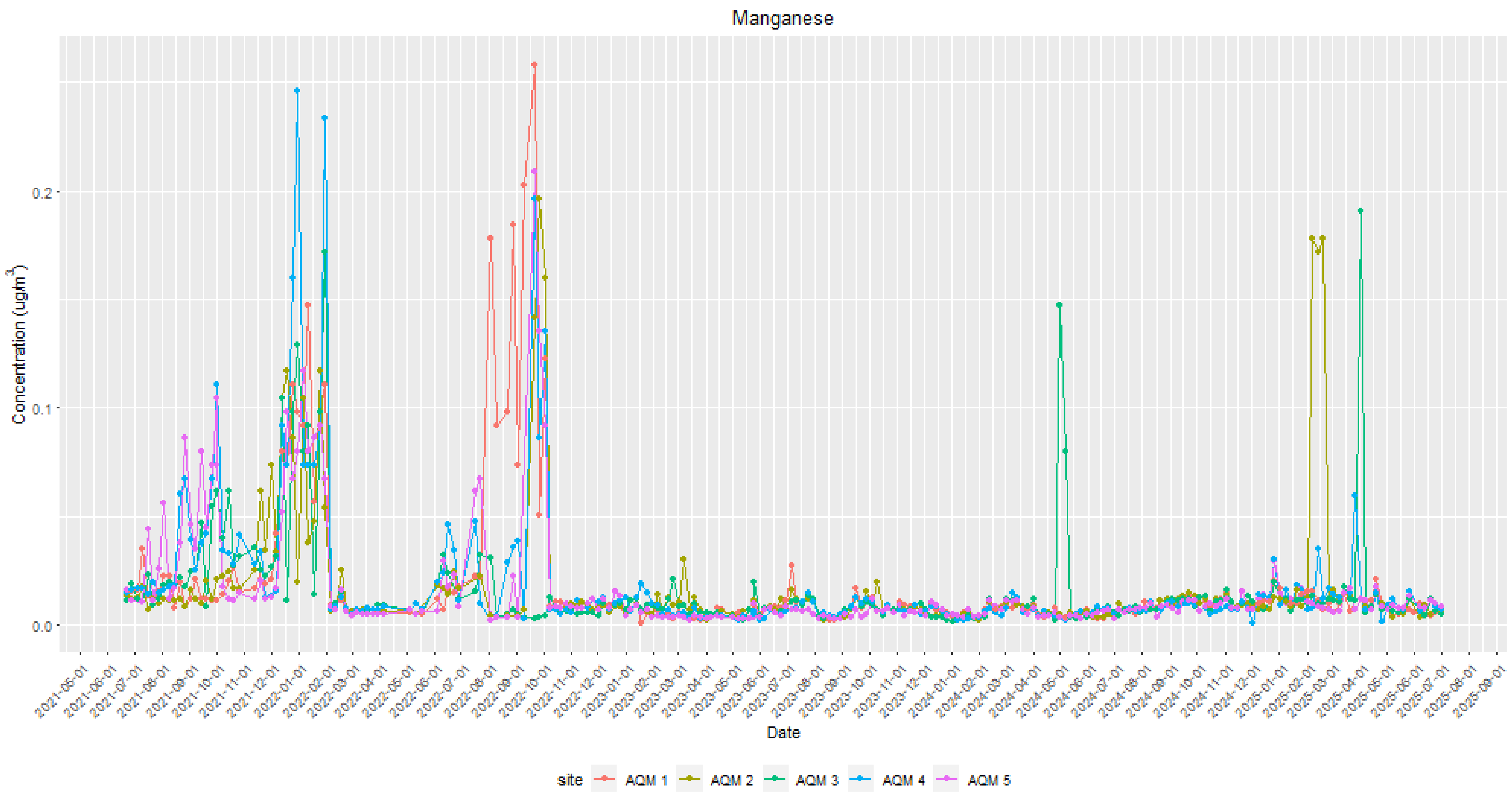

Figure 4-13: 24-hour manganese concentration measured at each sampling location every one day in six, from 22 June 2021

Note. 1-hour average manganese criteria not shown: 18 µg/m³; LOR 0.0006 µg/m³

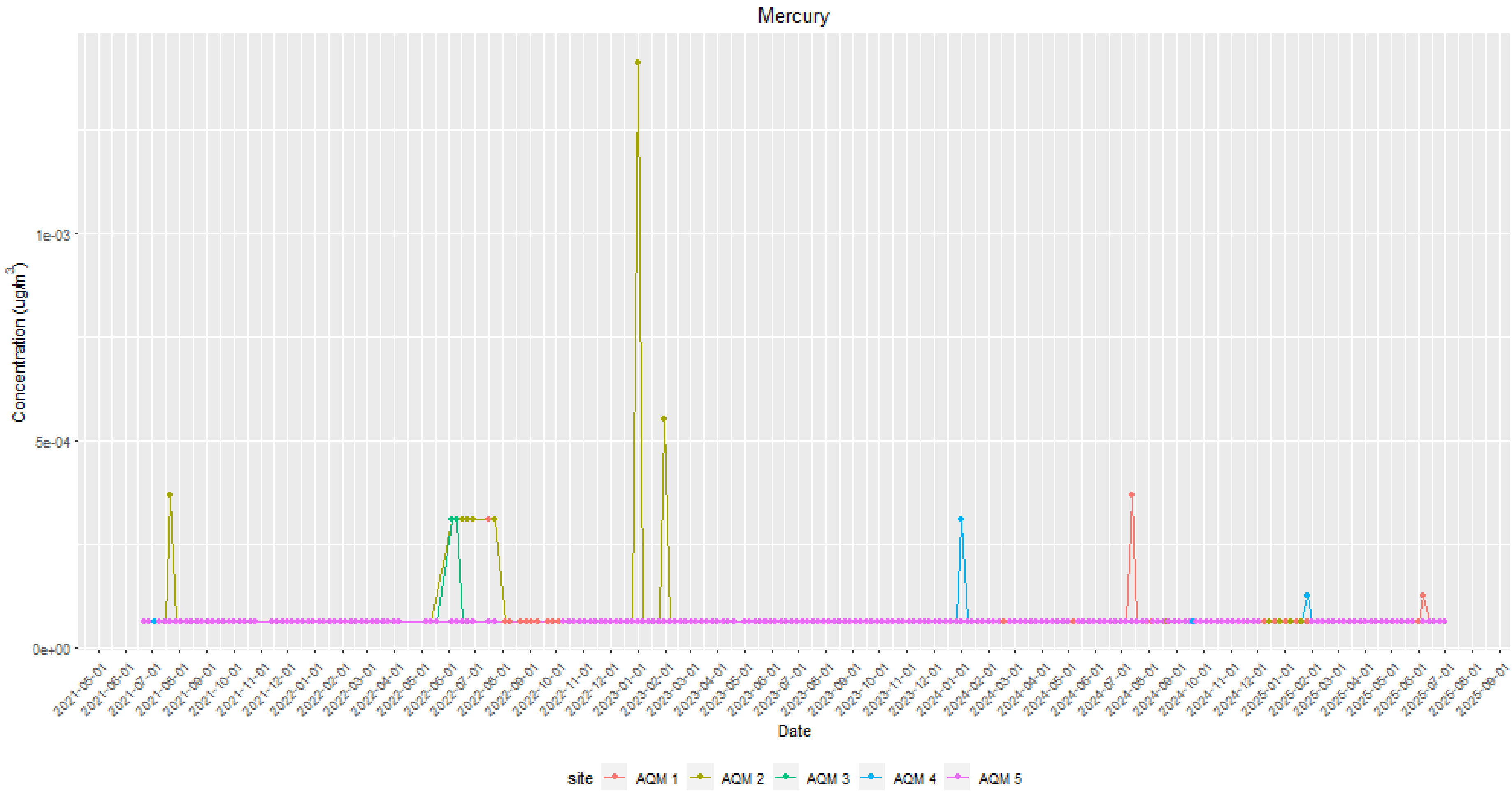

Figure 4-14: 24-hour mercury concentration measured at each sampling location every one day in six, from 22 June 2021

Note. 1-hour average mercury criteria not shown: 0.18 µg/m³; LOR 0.0001 µg/m³[1]

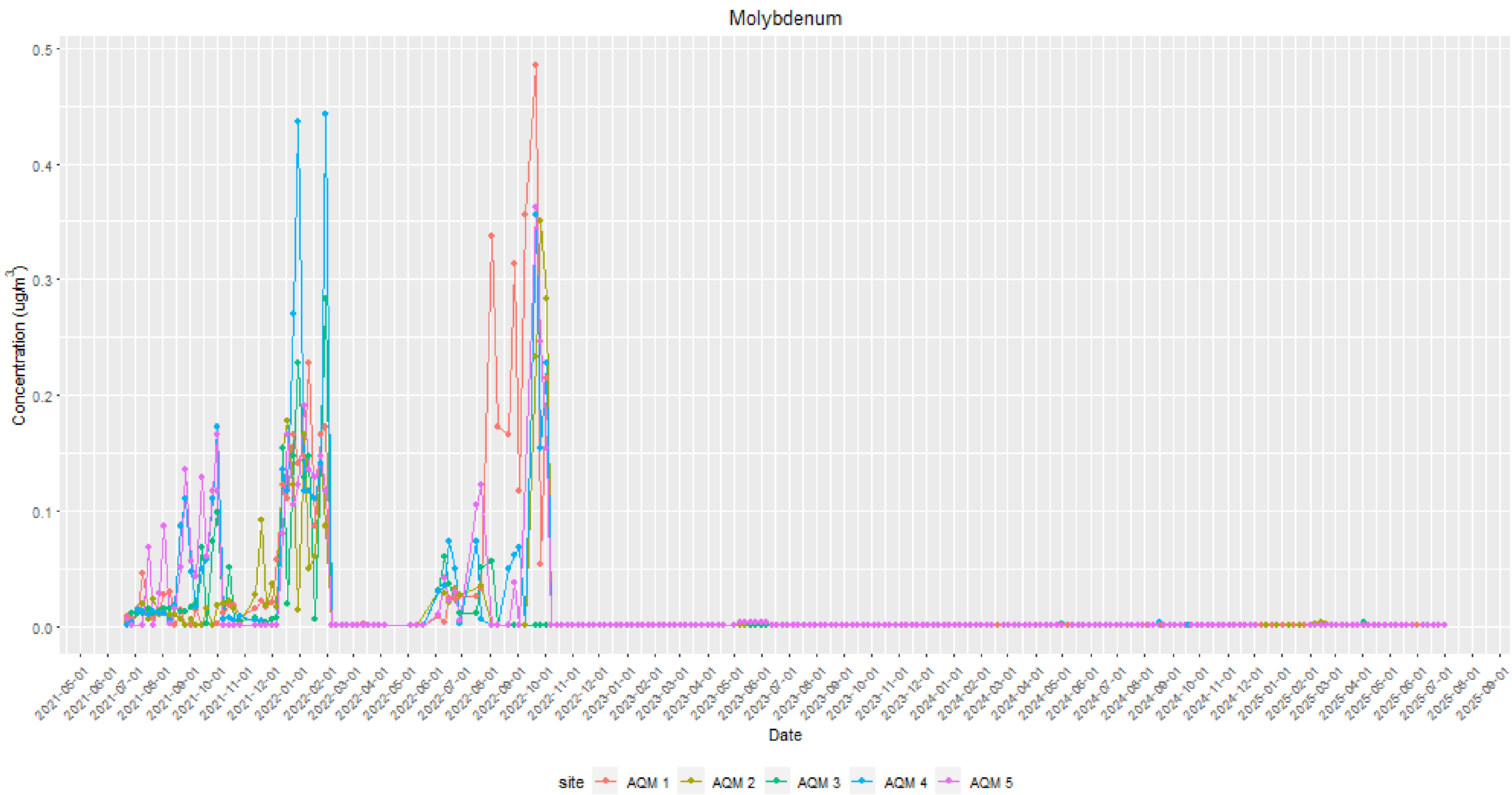

Figure 4-15: 24-hour molybdenum concentration measured at each sampling location every one day in six, from 22 June 2021

Note. LOR 0.0006 µg/m³

[1] LOR 0.0003 µg/m³ (5 times dilution needed to be placed) in the AQM1 samples from the 05, 11, 17, 23 and 29 June, and 17 and 23 July 2022, the AQM2 samples from the 05, 11, 17, 23 and 29 June, and 23 July 2022, and the AQM3 samples from the 05 and 11 June 2022.

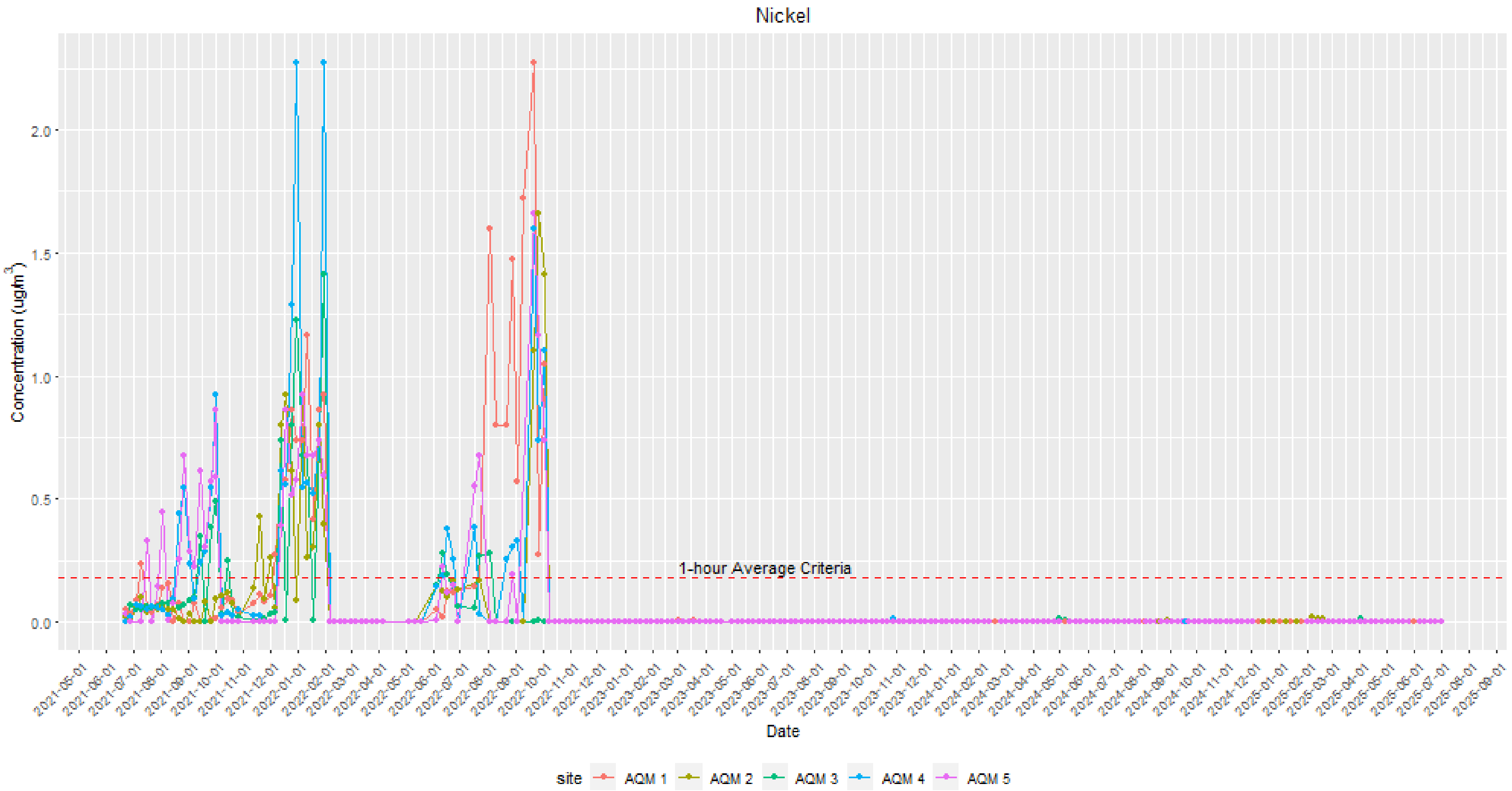

Figure 4-16: 24-hour nickel concentration measured at each sampling location every one day in six, from 22 June 2021

Note. 1-hour average nickel criteria: 0.18 µg/m³; LOR 0.0006 µg/m³

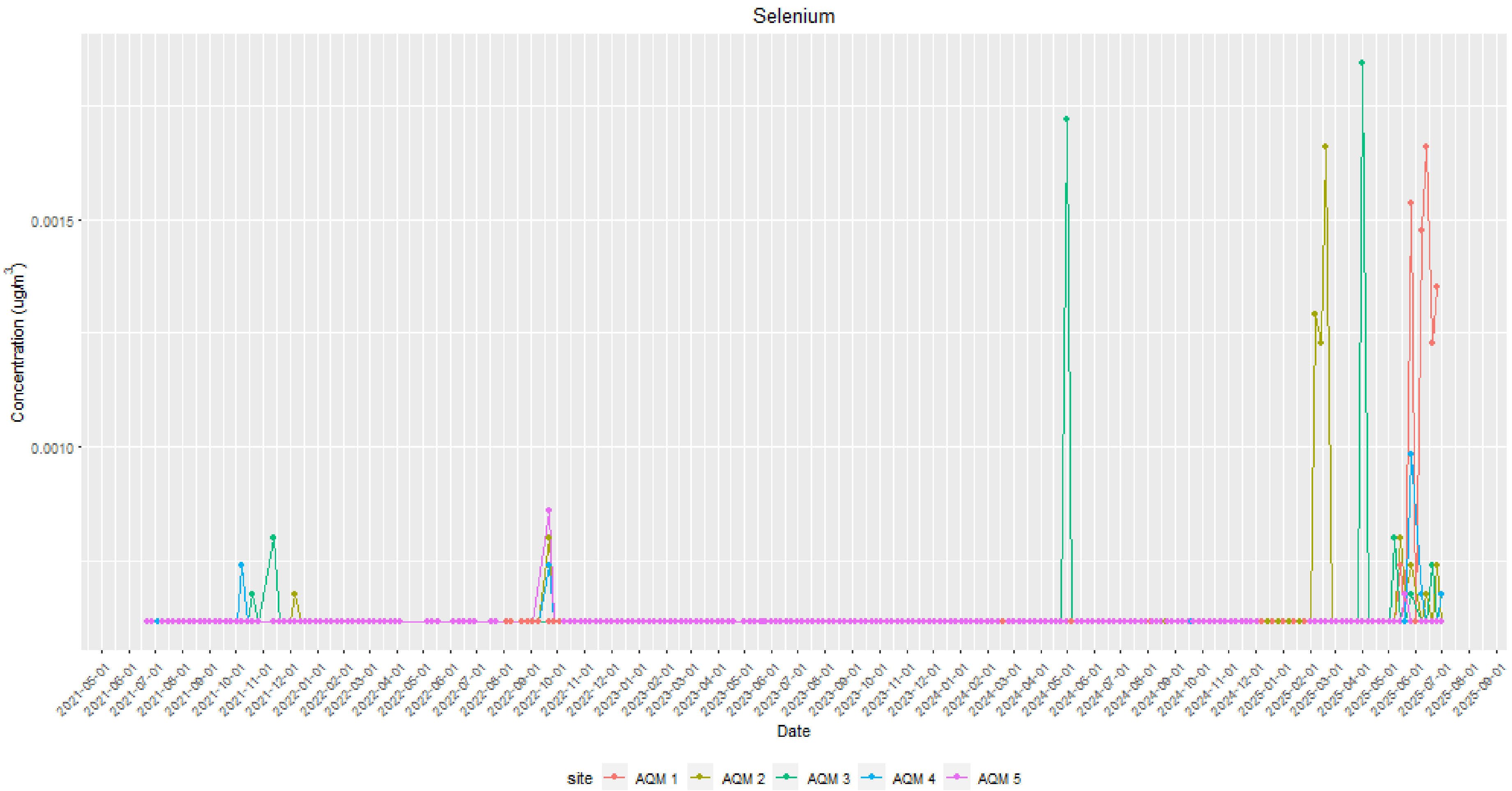

Figure 4-17: 24-hour selenium concentration measured at each sampling location every one day in six, from 22 June 2021

Note. LOR 0.0006 µg/m³

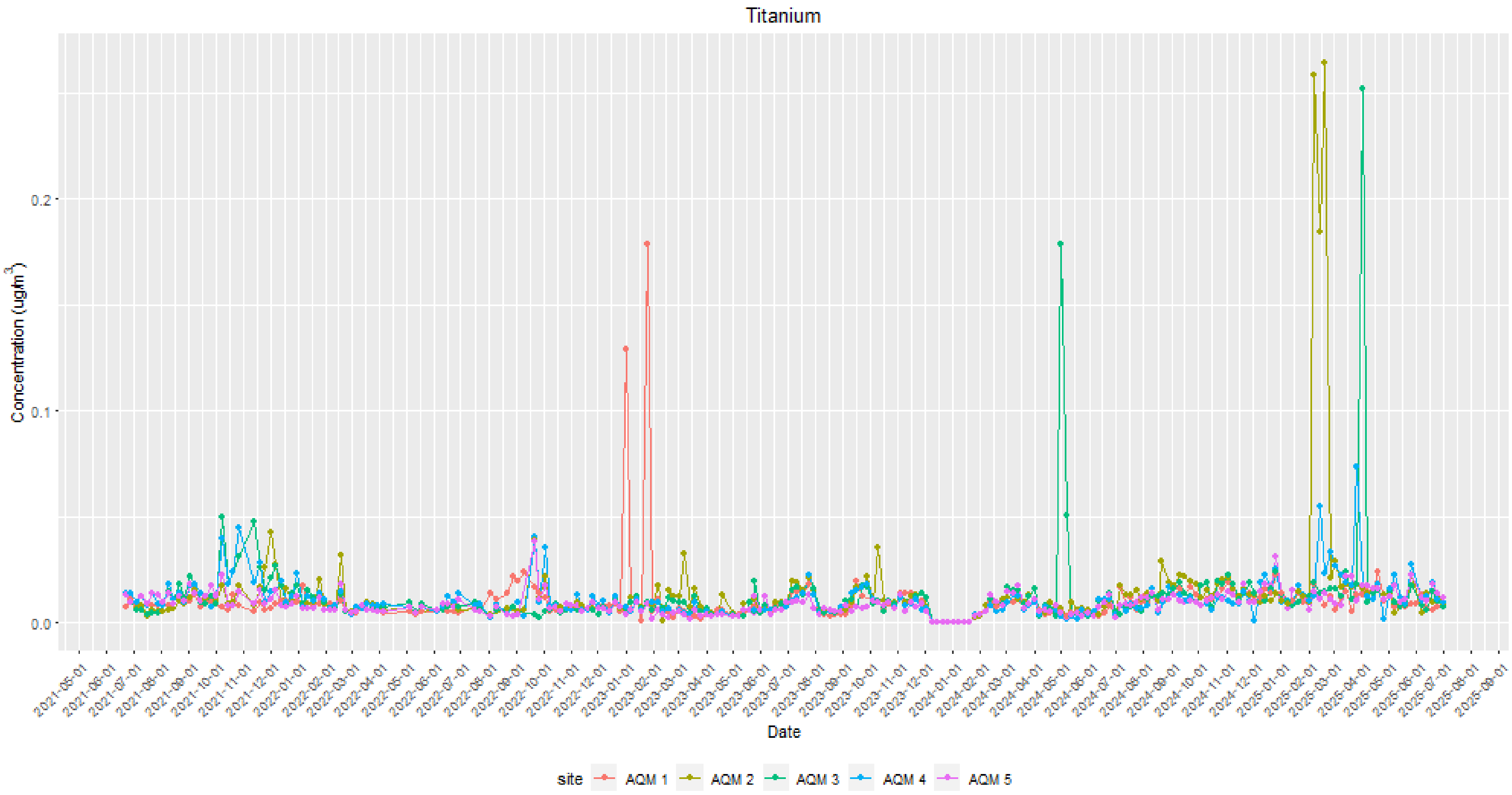

Figure 4-18: 24-hour titanium concentration measured at each sampling location every one day in six, from 22 June 2021

Note. LOR 0.0006 µg/m³

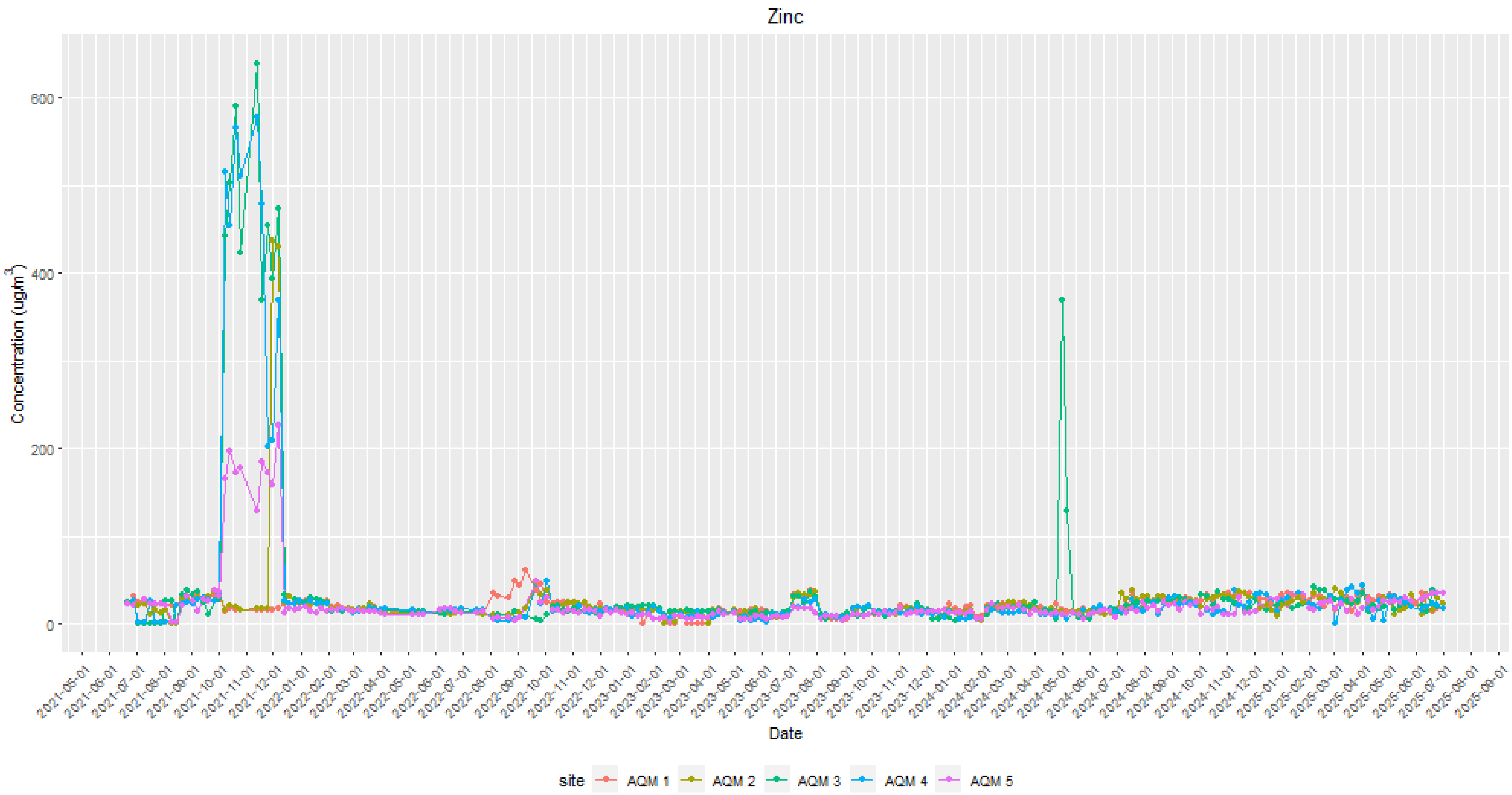

Figure 4-19: 24-hour zinc concentration measured at each sampling location every one day in six, from 22 June 2021

Note. LOR 0.0006 µg/m³

4.3.1 Exceedance Investigation – TSP

Days where the concentrations exceeded the annual criteria have been further investigated and are summarised in **Table 4-3**. It is worth highlighting that this criterion applies for annual period averages, so the comparison to a daily average is a conservative approach to identify concentrations worth further investigation.

Table 4-3: Investigation days

Location and sample ID	Date	24-hour average TSP (µg/m³)	Reason	On the day and antecedent rainfall
AQM 2 – HVS1059	17/02/2022	117.4	Above annual average criteria	0 mm, 6th day without rain
AQM 1 – HVS1352	10/08/2022	97.2	Above annual average criteria	Not analysed due to lack of local meteorology
AQM 4 – HVS1315	28/08/2022	109.1	Above annual average criteria	Not analysed due to lack of local meteorology
AQM 2- HVS1707	06/02/2023	91.1	Above annual average criteria	Not analysed due to meteorological station being offline
AQM 4 – HVS3363	08/03/2024	126.5	Above annual average criteria	0 mm, no rain since 22 February 2024
AQM 4 – HVS4034	27/03/2025	127.0	Above annual average criteria	0 mm, 6th day without rain

The 24-hour average TSP concentrations that were above the annual criterion from the 10 and 28 of August 2022 recorded at monitoring stations AQM1 and AQM4 respectively, were not further investigated due to the absence of local meteorological. Furthermore, these samples are from August 2022 when sufficient QA was not achieved (see Section 4.3), suggesting potential contamination during the handling procedure. Similarly, the 24-hour average TSP concentration of 91.1 µg/m³ (i.e., slightly above the annual criterion) recorded by AQM2 on 6 February 2023 was not further investigated as the meteorological station was offline on that day following adjustment of the cable by the gardening contractor.

The remaining investigations days; 17 February 2022, 8 March 2024 and 25 June 2025 were investigated in the following paragraphs.

On 17 February 2022, a 24-hour concentration for TSP, above the annual criteria, was recorded at location AQM2. Rainfall results indicate that the weather was dry, with no recorded rainfall on the day or 5 days prior. Wind roses of the day (**Figure 4-20**) show night winds coming from south-west, and stronger day winds coming from north and northwest. Considering the northern tailings dump sits to the east of AQM2 and was not directly upwind of the monitoring station it is unlikely that the elevated concentrations originated from Captains Flat.

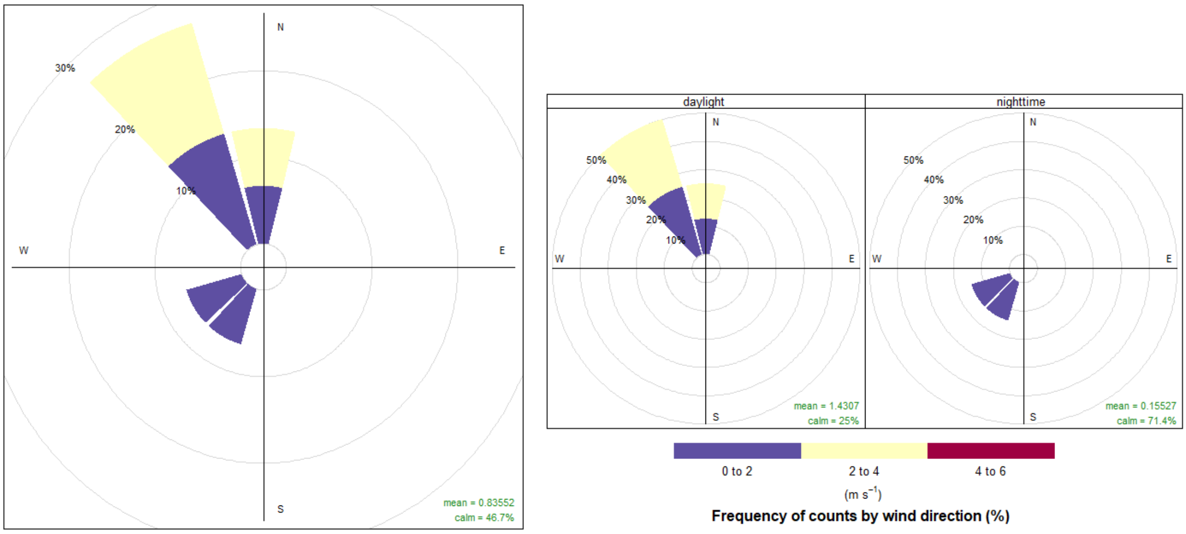

Figure 4-20: Wind roses on 17 February 2022 at 2 Copper Creek Road, Captains Flat, NSW

Note. produced with openair; Carslaw & Ropkins, 2012

The 24-hour TSP concentration recorded on 8 March 2025 at AQM4 was above the annual TSP criteria after 14 days without rainfall. Analysis of the wind roses from 08 March 2024 (**Figure 5-23**) shows strong day winds coming from the north. AQM4 is located north-east of all four locations hosting former mining activities, indicating that the source of the high concentration of TSP on 08 March 2024 were unlikely associated with former mining activities at Captains Flat.

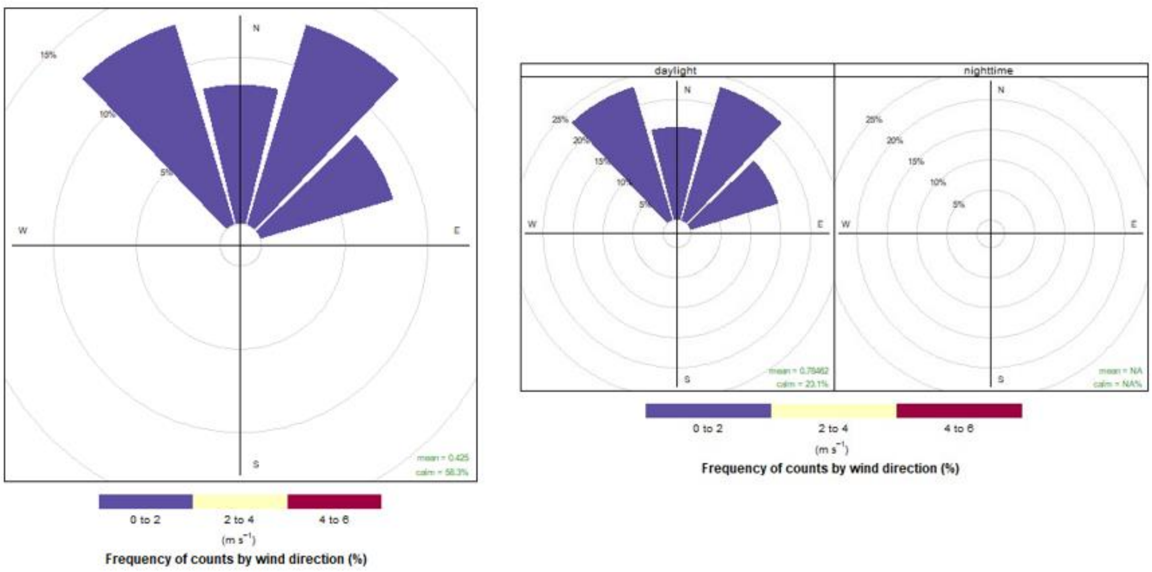

Figure 4-21: Wind roses on 08 March 2024 at 2 Copper Creek Road, Captains Flat, NSW.

Note. produced with openair; Carslaw & Ropkins, 2012

On 27 March 2025, a 24-hour average concentration of TSP above the annual criteria, was recorded at AQM4. Rainfall measurements indicate that the weather was dry, with no recorded rainfall on the day or 5 days prior to the elevated reading. Wind roses of the day from 27 March 2025 (Figure 4-22) show night winds coming from southwest, and stronger day winds coming from the east. With the nighttime winds being downwind of the legacy mine, it is possible the elevated concentrations were contributed to by the site; however the wind speeds were very low during this time (0-2 m/s) which is not typical of conditions for significant wind erosion. Therefore, considering the predominant daylight wind direction and elevated wind speeds, it is unlikely the elevated concentrations originated from Captains Flat.

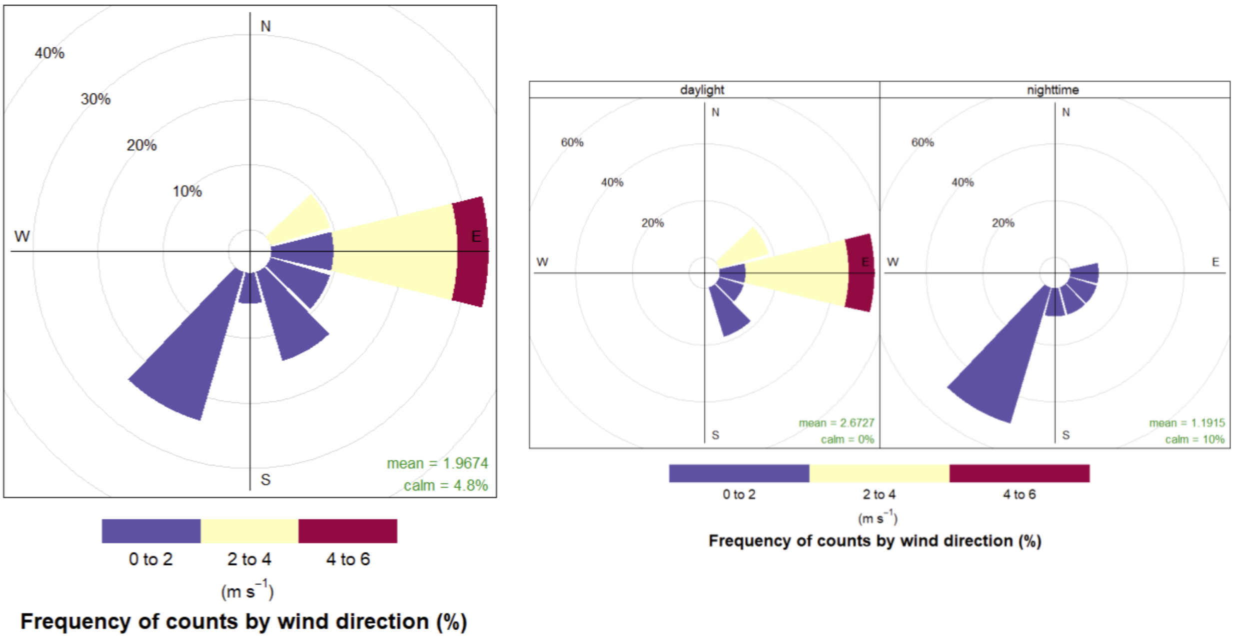

Figure 4-22: Wind roses on 27 March 2025 at 2 Copper Creek Road, Captains Flat, NSW

Note. produced with openair; Carslaw & Ropkins, 2012

4.3.2 Exceedances Investigation – Barium and Nickel

The heavy metals barium and nickel have been recorded in concentrations which exceed the 1-hour NSW EPA criteria on multiple occasions throughout the study period. There were in total, 887 instances where the barium 24-hour concentrations were above the 1-hour NSW EPA criteria and 101 instances where nickel was recorded in concentrations above the NSW EPA criteria. It is important to note that there has not been a nickel exceedance recorded since 10 March 2022. However, both barium and nickel concentrations have been reported to the EPA.

4.4 Potential Factors Influencing Dispersion

Bivariate polar plots (concentrations as a function of wind speed and direction) are presented for TSP and heavy metals analysed in **Figure 4-4** to **Figure 4-9**. Additionally, the bivariate plots for key pollutants TSP, lead and zinc are presented spatially on a topographical map in **Appendix 1**.

Higher concentrations of TSP are generally observed at AQM4 from all directions compared to other monitors. Analysis of pollutants (i.e., Pb, As, Ca, Se and Ti) at AQM2 suggests that a higher frequency of elevated concentrations occur from westerly winds, where there are no sites of former mining activities. AQM3 is largely affected by south-easterly winds for some pollutants (i.e., Pb, As, Ba, Ca, Cu, Fe, Mn, Se, Ti), additionally, outside the arc of influence of Captains Flat.

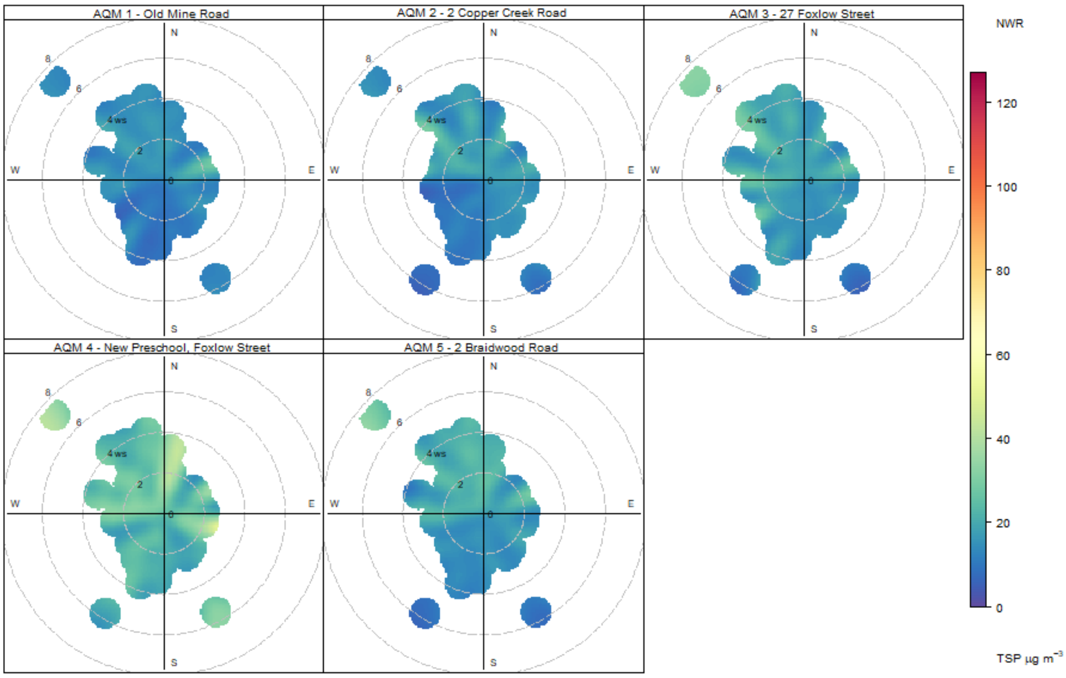

Figure 4-24: Polar plots for 24-hour TSP, wind speed and direction (22/06/2021-25/06/2025)

Note. Prepared with openair; Carslaw & Ropkins, 2012

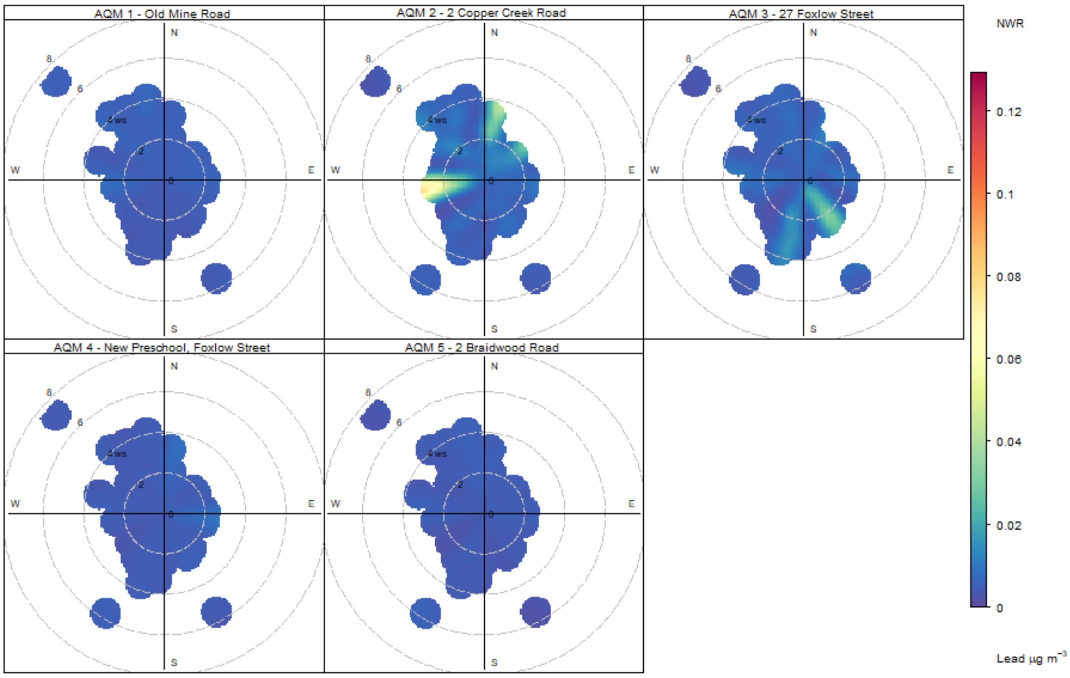

Figure 4-25: Polar plots of 24-hour lead, wind speed and direction (22/06/2021-25/06/2025)

Note. Prepared with openair; Carslaw & Ropkins, 2012

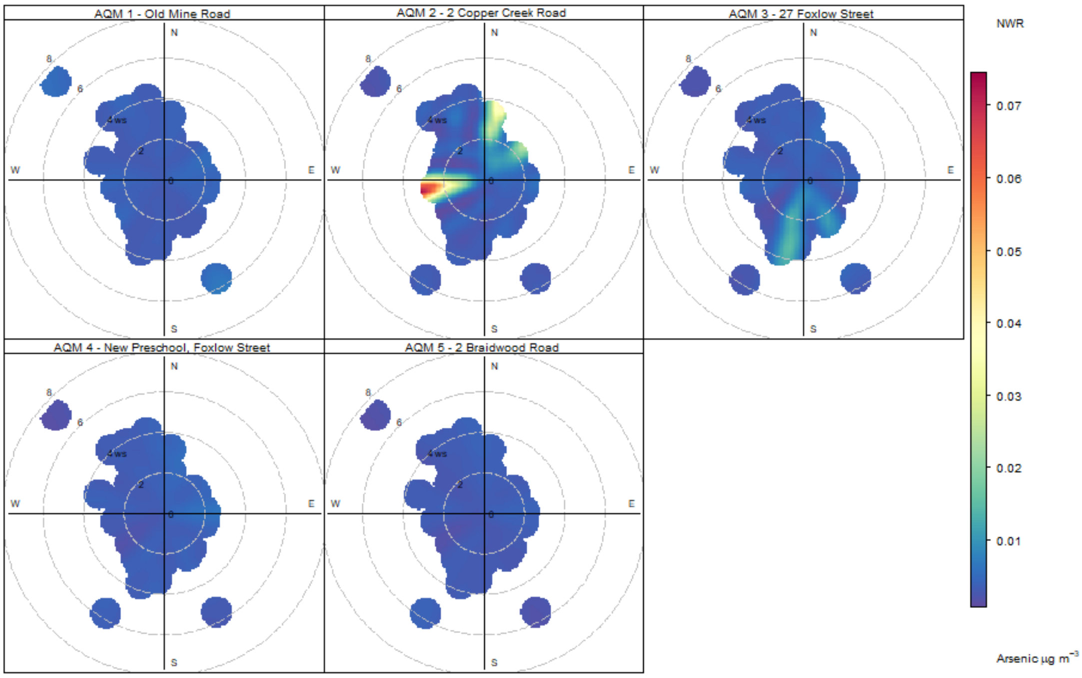

Figure 4-26: Polar plots of 24-hour arsenic, wind speed and direction (22/06/2021-25/06/2025)

Note. Prepared with openair; Carslaw & Ropkins, 2012

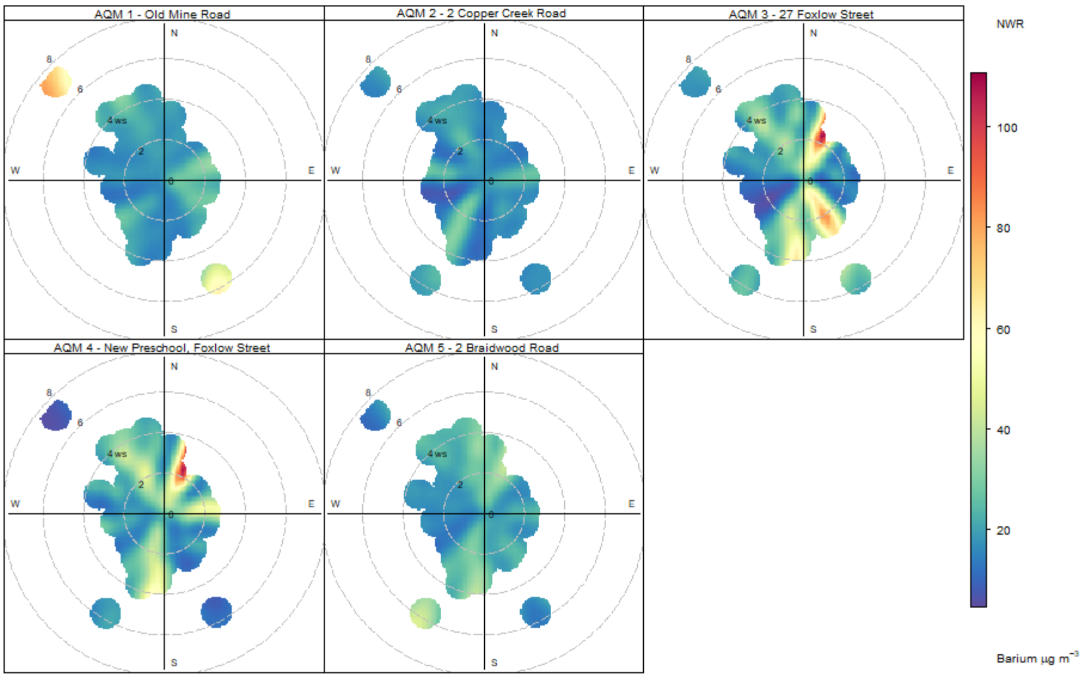

Figure 4-27: Polar plots of 24-hour barium, wind speed and direction (22/06/2021-25/06/2025)

Note. Prepared with openair; Carslaw & Ropkins, 2012

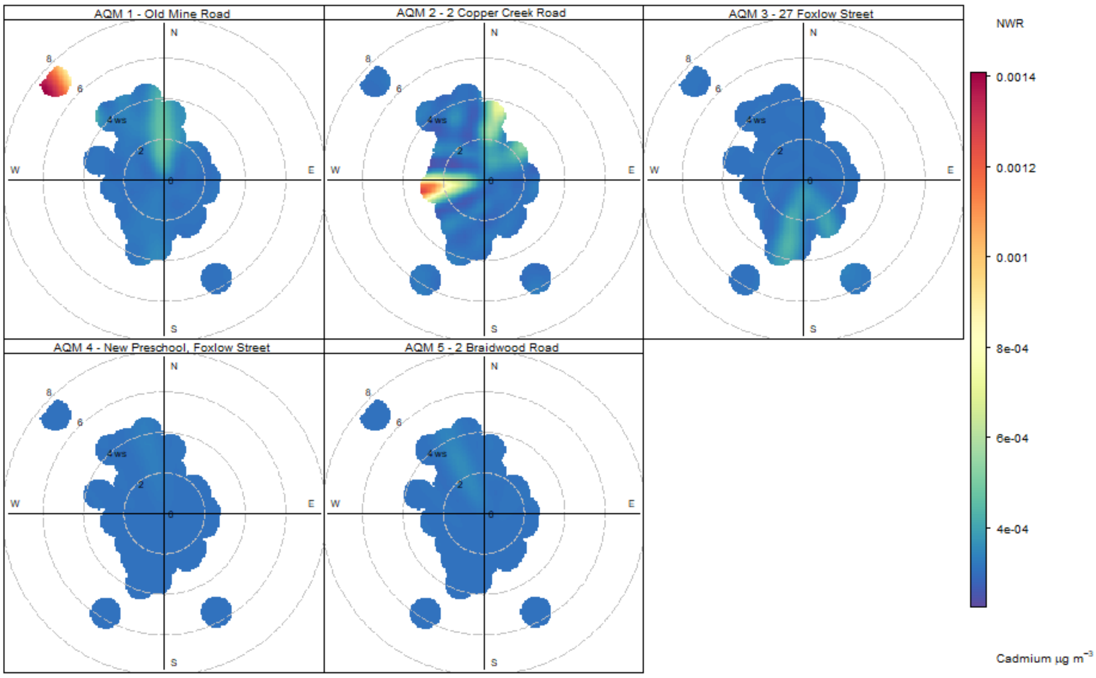

Figure 4-28: Polar plots of 24-hour cadmium, wind speed and direction (22/06/2021-25/06/2025)

Note. Prepared with openair; Carslaw & Ropkins, 2012

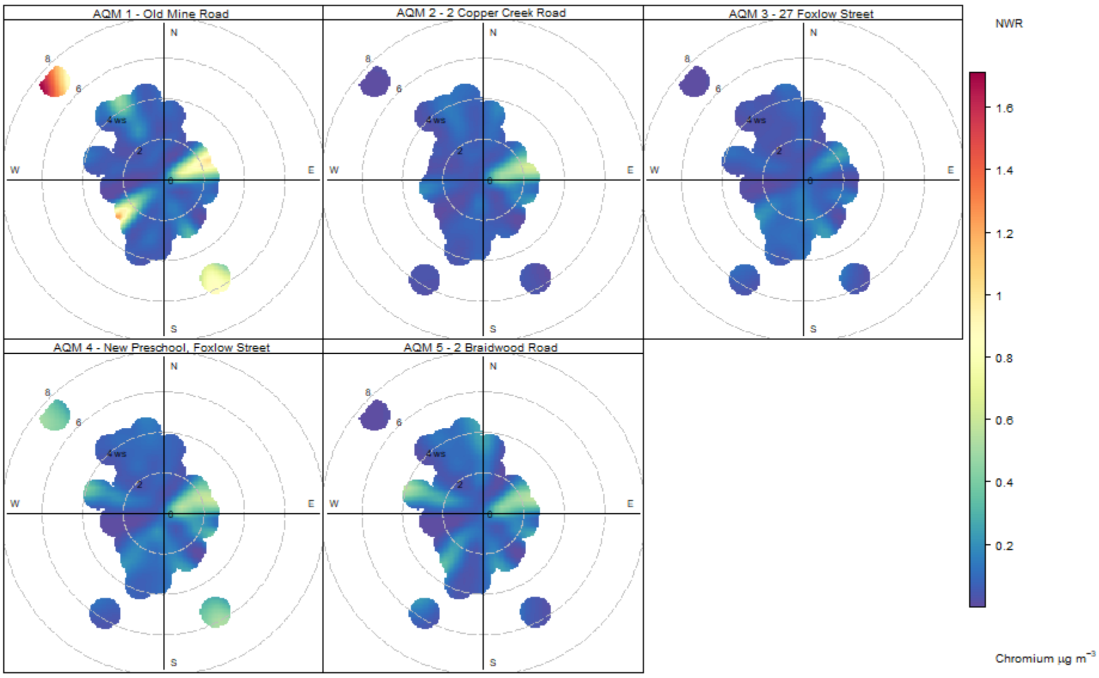

Figure 4-29: Polar plots of 24-hour chromium concentration, wind speed and direction (22/06/2021-25/06/2025)

Note. Prepared with openair; Carslaw & Ropkins, 2012

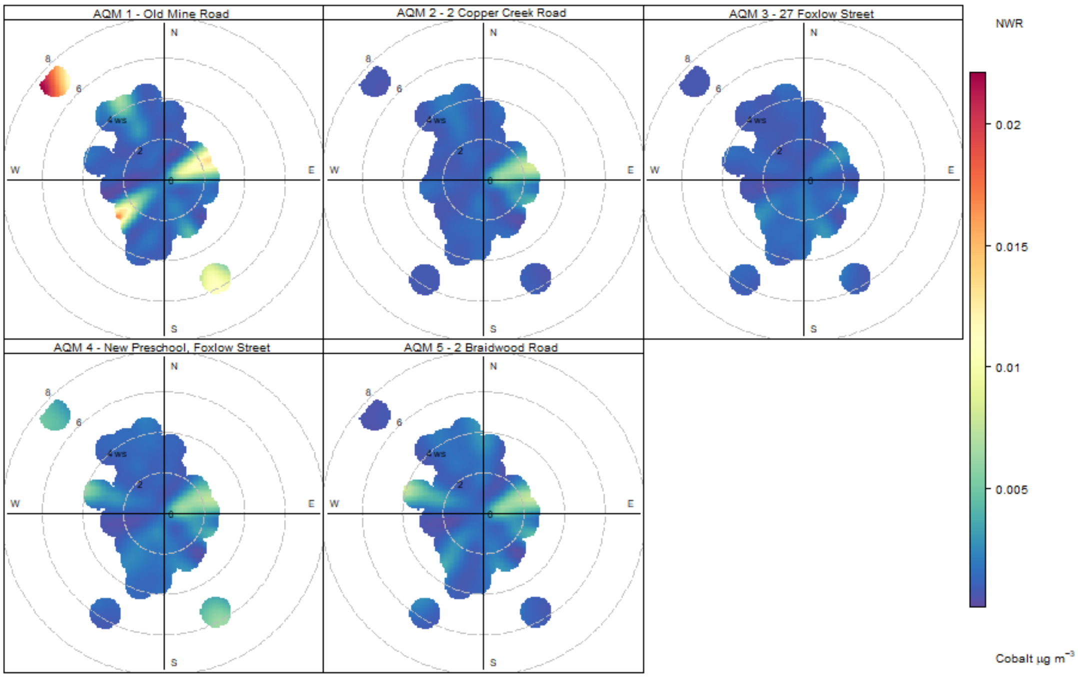

Figure 4-30: Polar plots of 24-hour cobalt, wind speed and direction (22/06/2021-25/06/2025)

Note. Prepared with openair; Carslaw & Ropkins, 2012

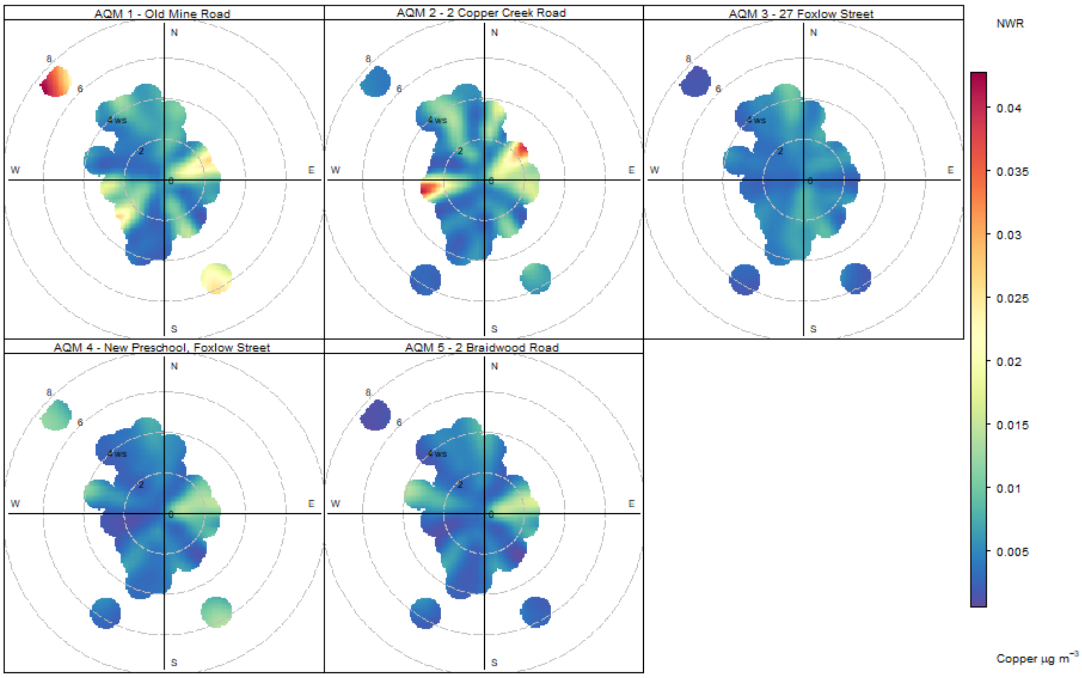

Figure 4-31: Polar plots of 24-hour copper, wind speed and direction (22/06/2021-25/06/2025)

Note. Prepared with openair; Carslaw & Ropkins, 2012

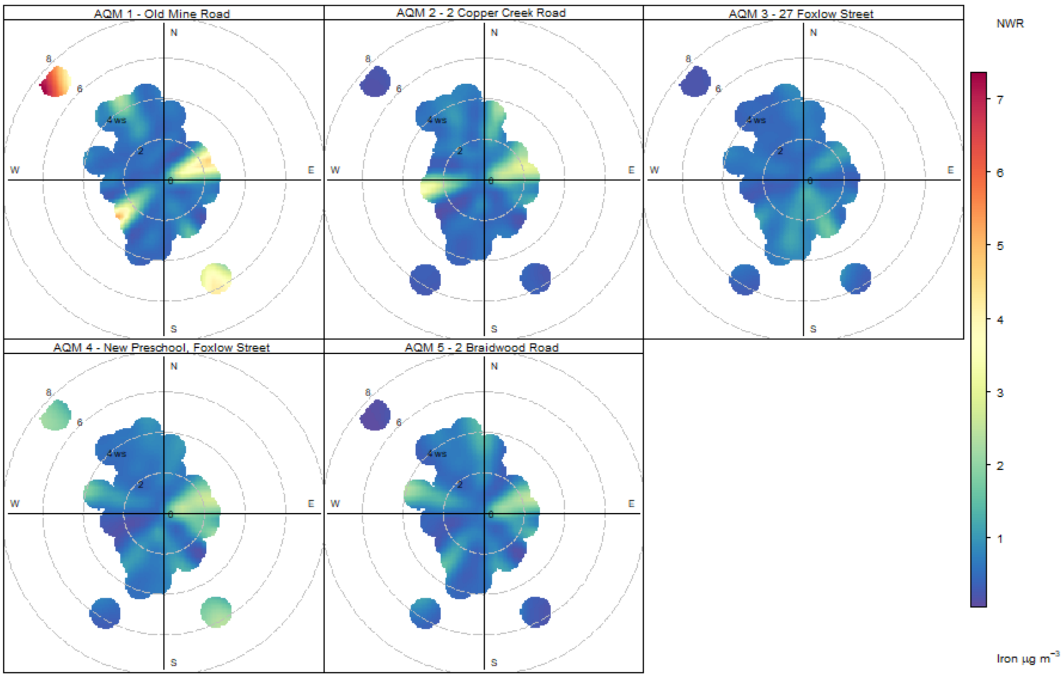

Figure 4-32: Polar plots of 24-hour iron, wind speed and direction (22/06/2021-25/06/2025)

Note. Prepared with openair; Carslaw & Ropkins, 2012

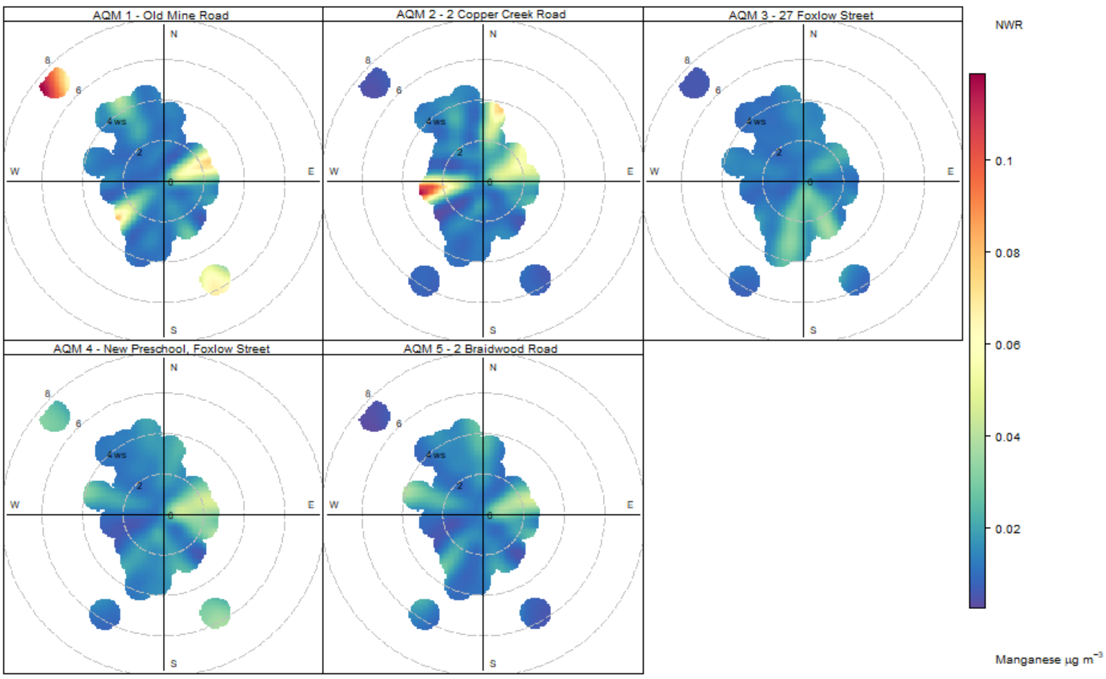

Figure 4-33: Polar plots of 24-hour manganese, wind speed and direction (22/06/2021-25/06/2025)

Note. Prepared with openair; Carslaw & Ropkins, 2012

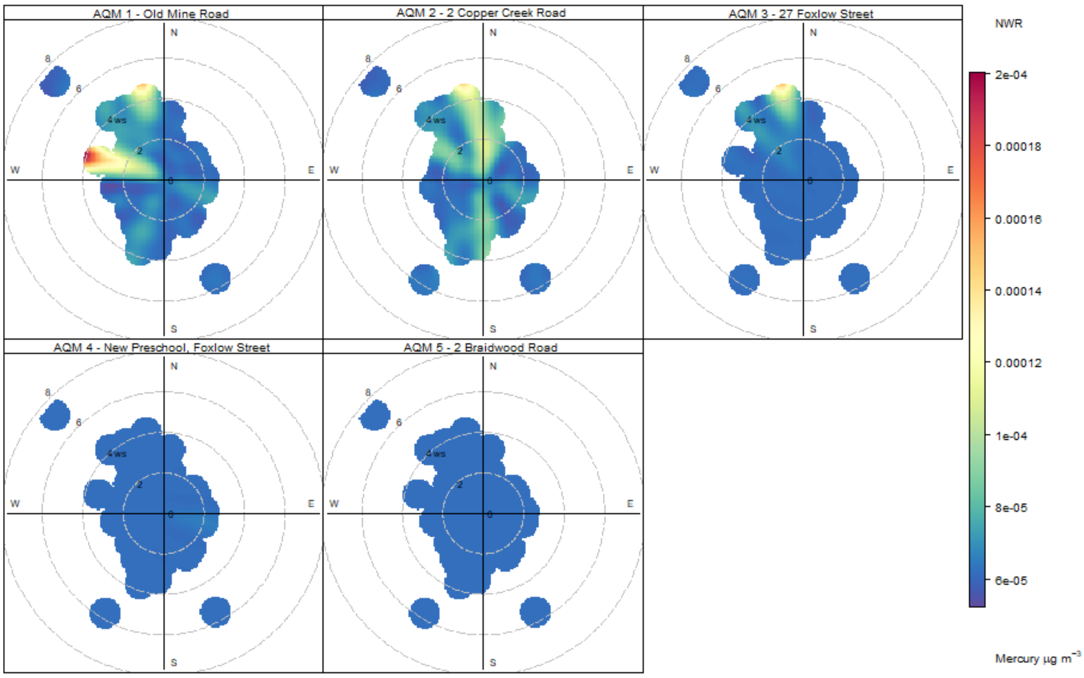

Figure 4-34: Polar plots of 24-hour mercury, wind speed and direction (22/06/2021-25/06/2025)

Note. Prepared with openair; Carslaw & Ropkins, 2012

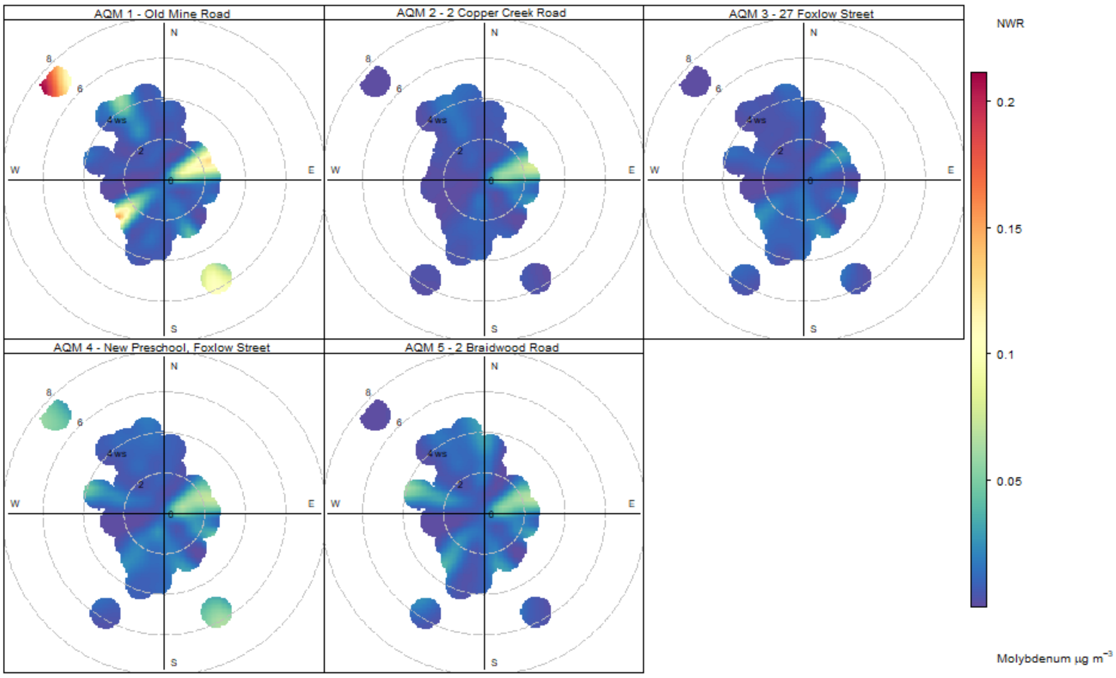

Figure 4-35: Polar plots of 24-hour molybdenum, wind speed and direction (22/06/2021-25/06/2025)

Note. Prepared with openair; Carslaw & Ropkins, 2012

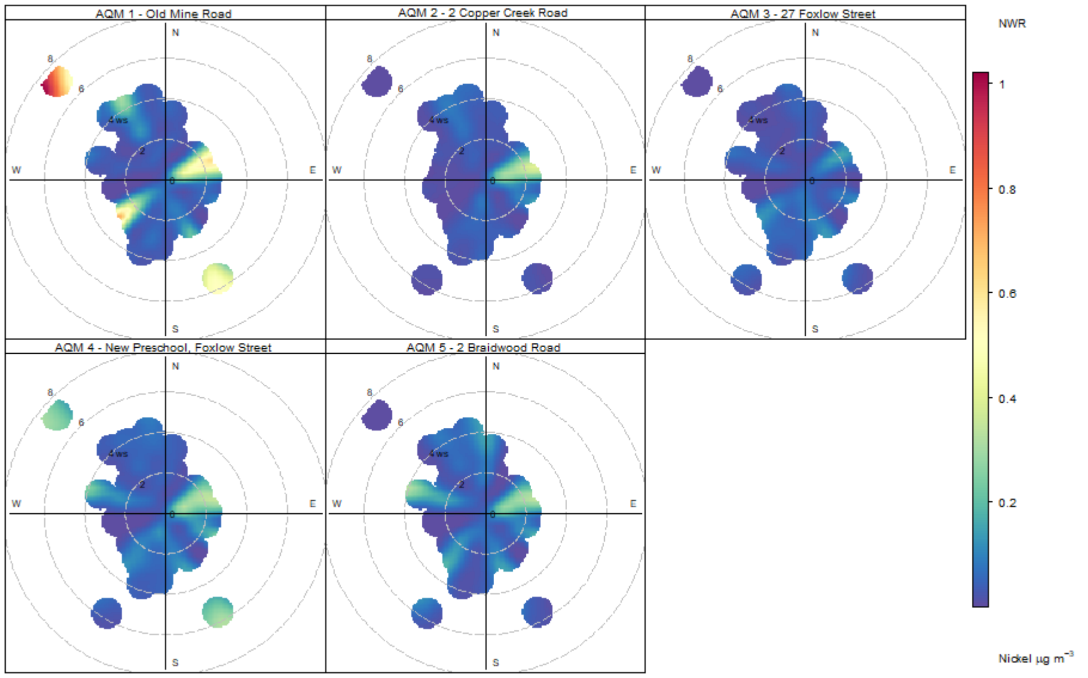

Figure 4-36: Polar plots of 24-hour nickel, wind speed and direction (22/06/2021-25/06/2025)

Note. Prepared with openair; Carslaw & Ropkins, 2012

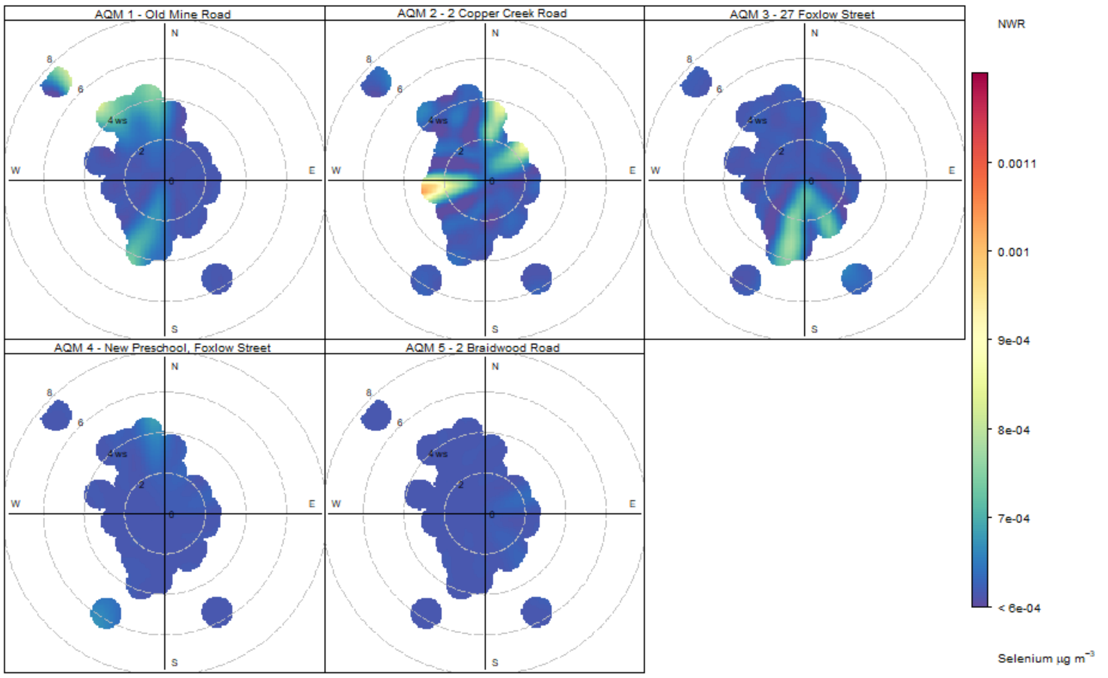

Figure 4-37: Polar plots of 24-hour selenium, wind speed and direction (22/06/2021-25/06/2025)

Note. Prepared with openair; Carslaw & Ropkins, 2012

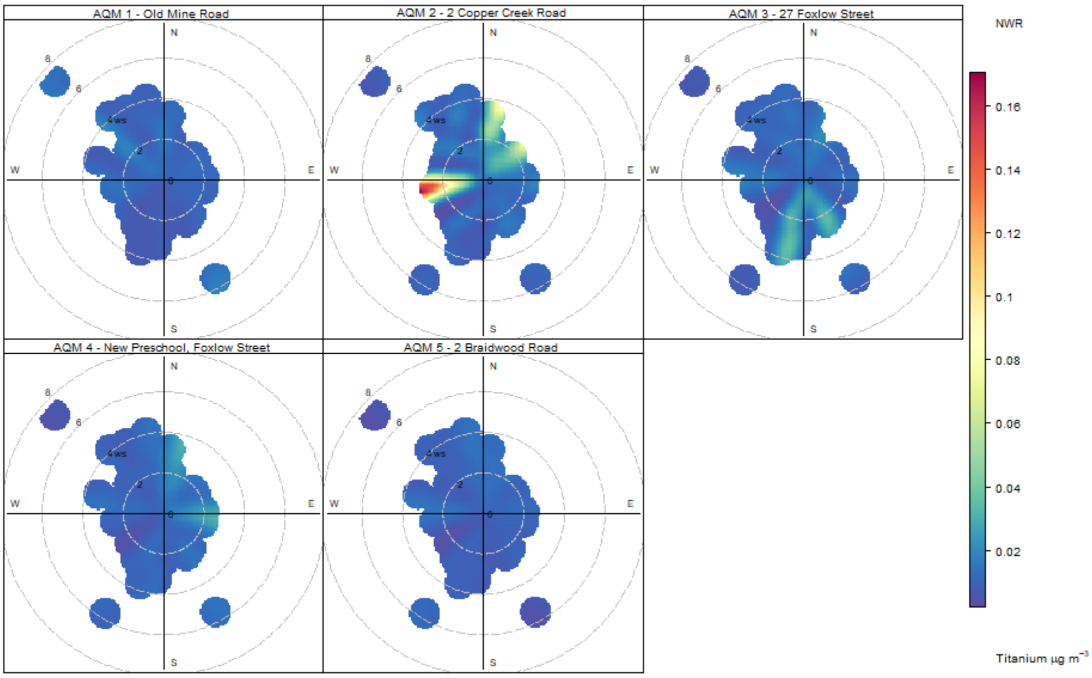

Figure 4-38: Polar plots of 24-hour titanium, wind speed and direction (22/06/2021-25/06/2025)

Note. Prepared with openair; Carslaw & Ropkins, 2012

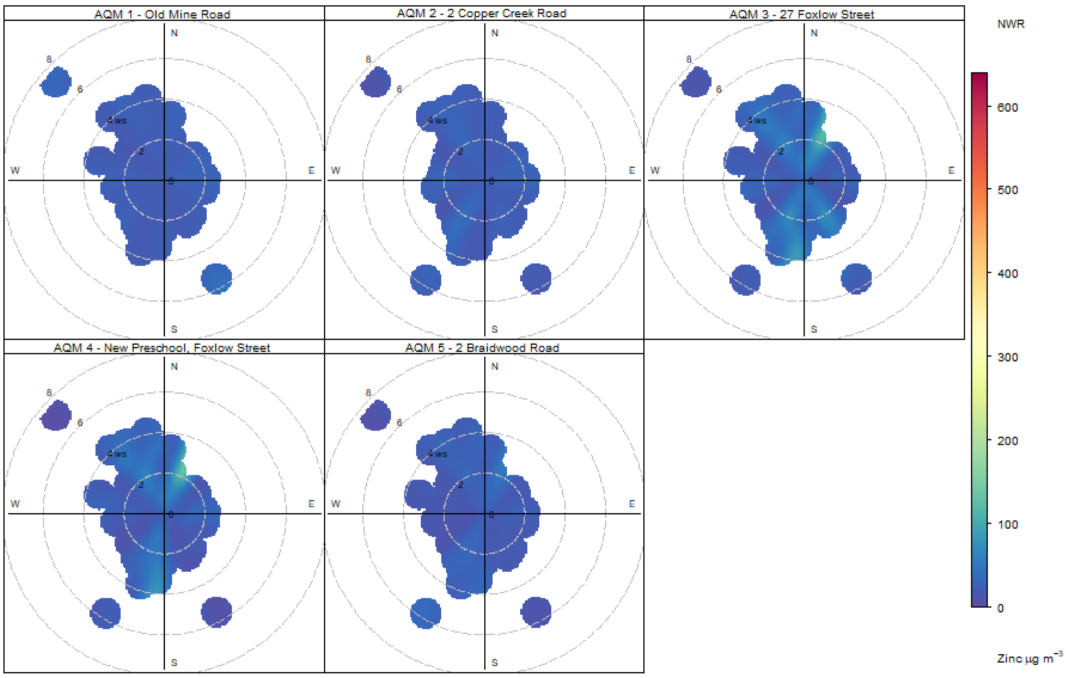

Figure 4-39: Polar plots of 24-hour zinc, wind speed and direction (22/06/2021-25/06/2025)

Note. Prepared with openair; Carslaw & Ropkins, 2012

4.5 Correlations for potential source identification

Correlation matrices are presented for each sampling location from **Figure 4-40** to **Figure 4-44** to compare the relationship between each heavy metal and TSP. The data is clustered by relationship, so each plot is ordered differently depending on the determined correlation, there are also limitations on how the data is presented when pollutants are below LOR.

The data shows strong correlations between several pollutants, particularly copper, manganese, cobalt, molybdenum, nickel, chromium, and iron which may reflect their consistent co-occurrence in the local soil composition. Lead is not highly correlated with TSP or any other metal, suggesting it may originate from a distinct source or have different emission or dispersion characteristics. An exception is observed at AQM3, where lead shows higher correlation with some metals, notably arsenic and titanium, though the reason for this association at that location remains unclear.

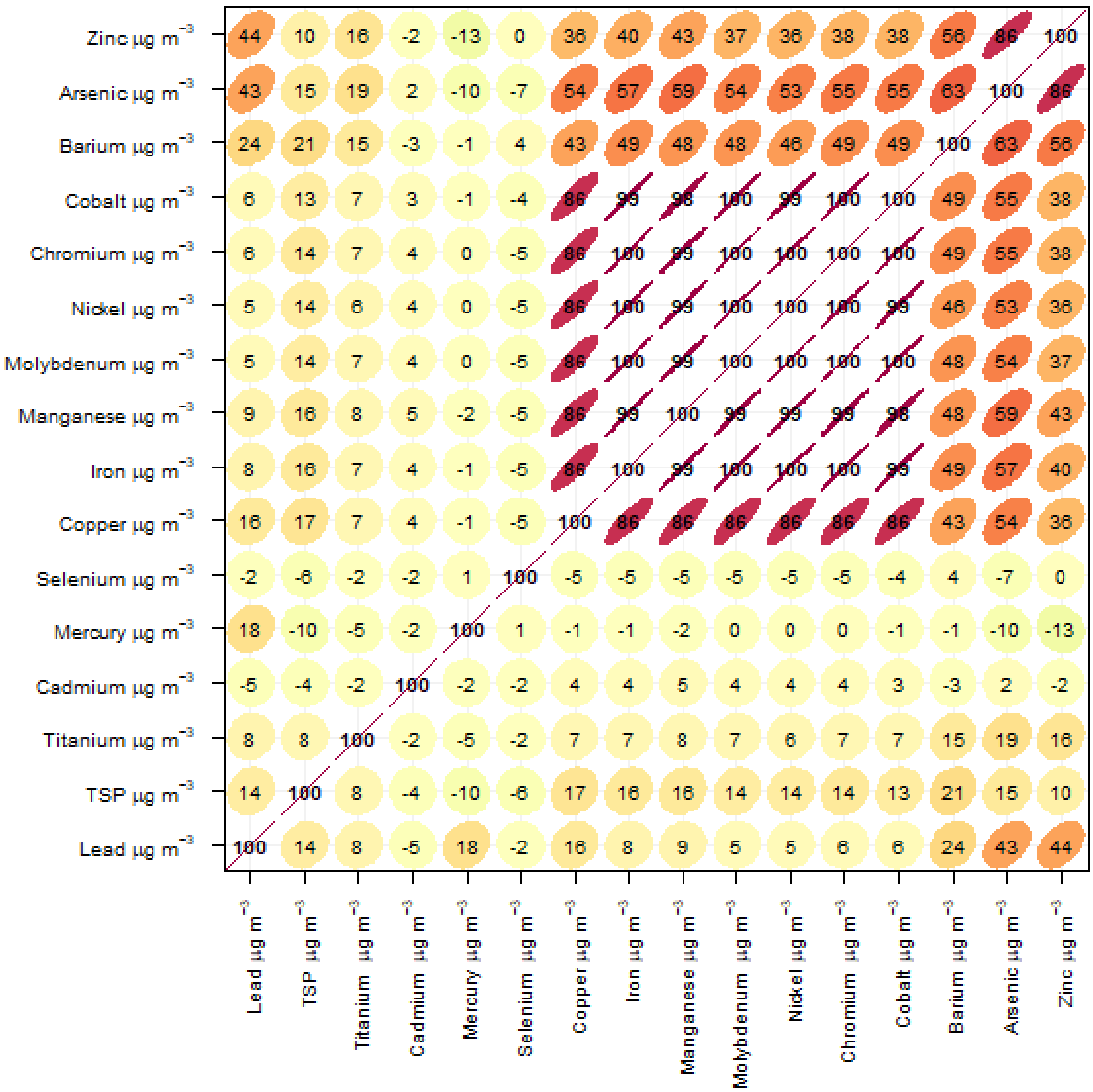

Figure 4-40: Heavy metal and TSP correlations in all samples collected since 22 June 2021 at AQM1

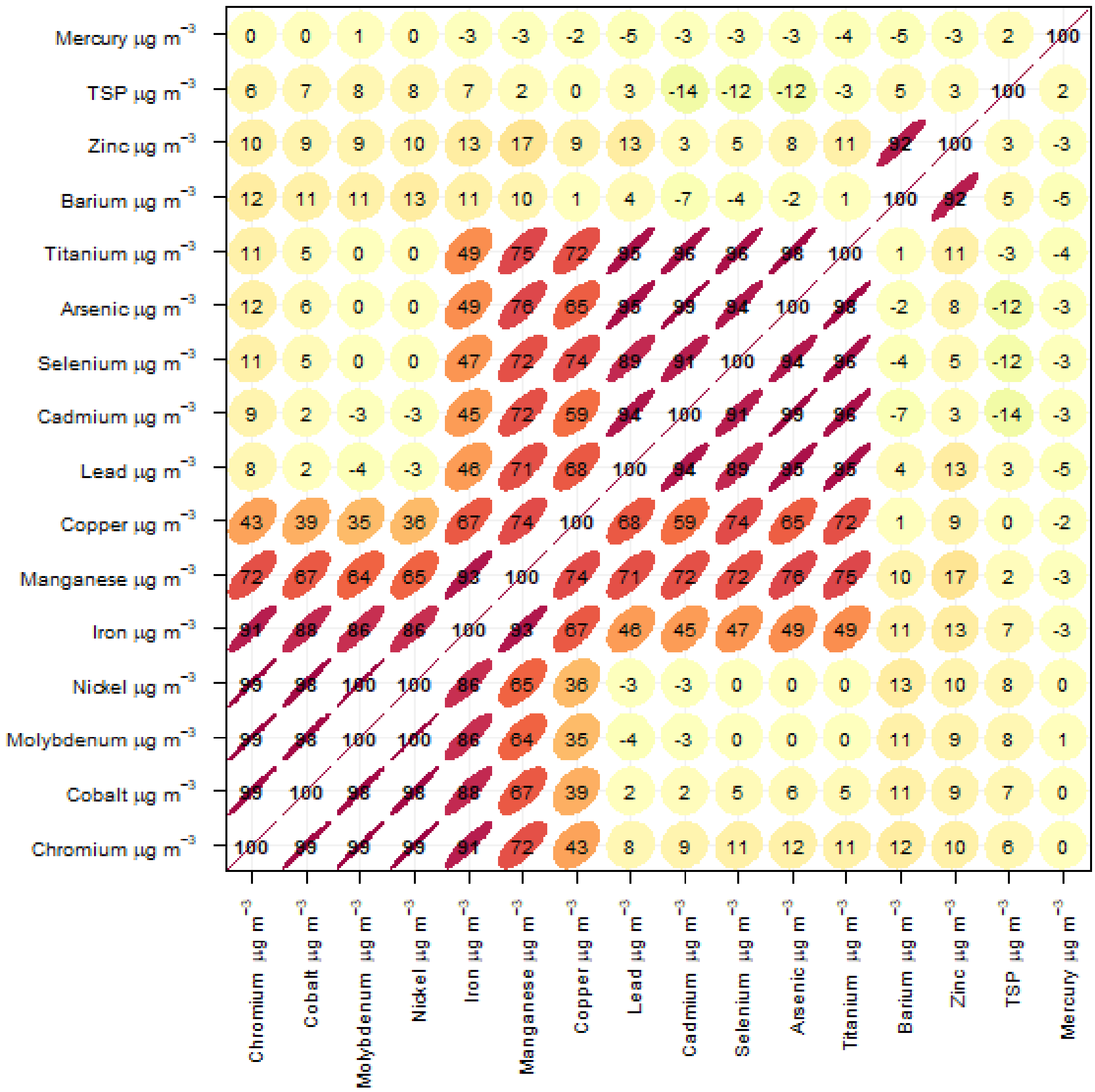

Figure 4-41: Heavy metal and TSP correlations in all samples collected since 22 June 2021 at AQM2

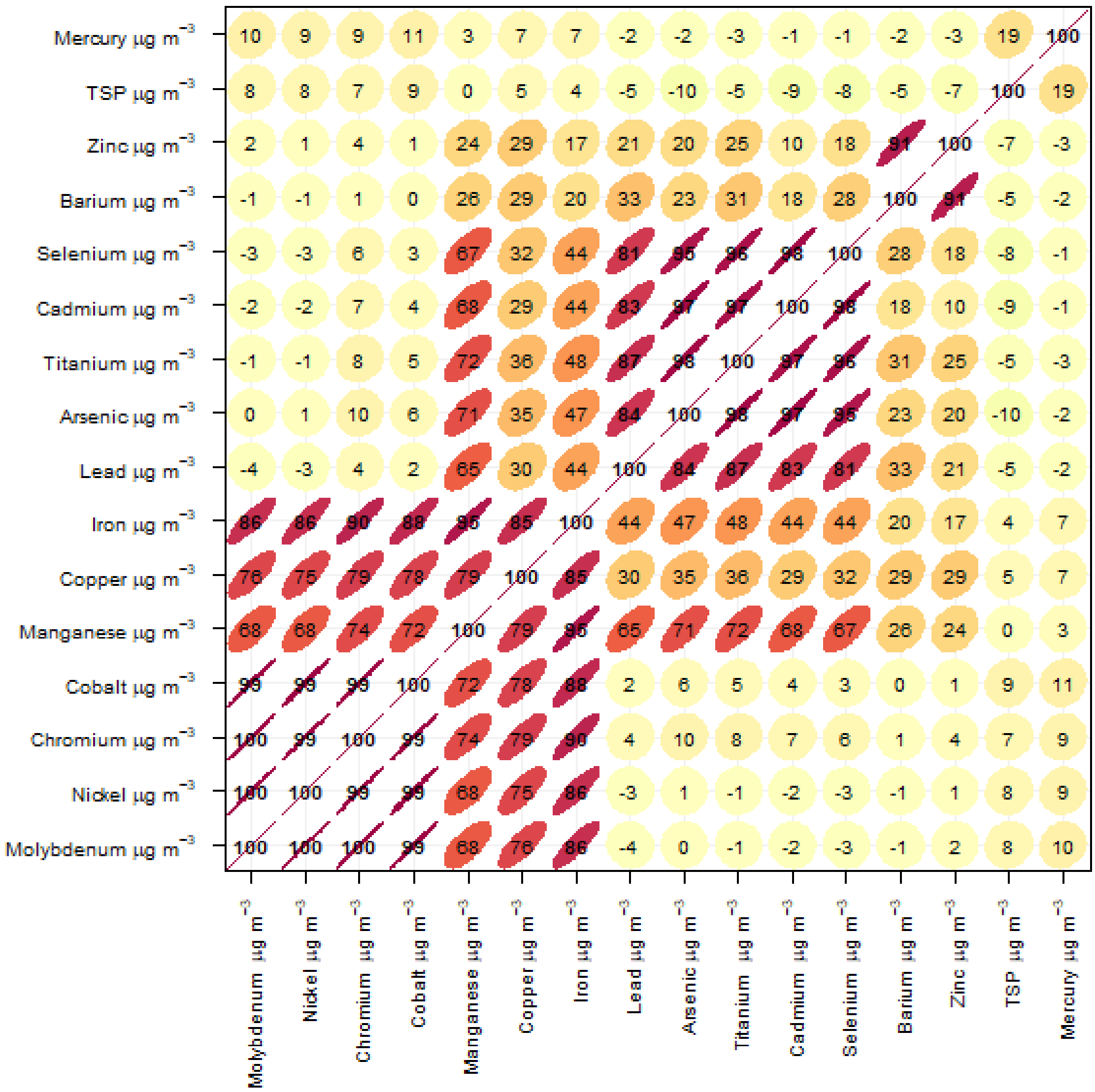

Figure 4-42: Heavy metal and TSP correlations in all samples collected since 22 June 2021 at AQM3

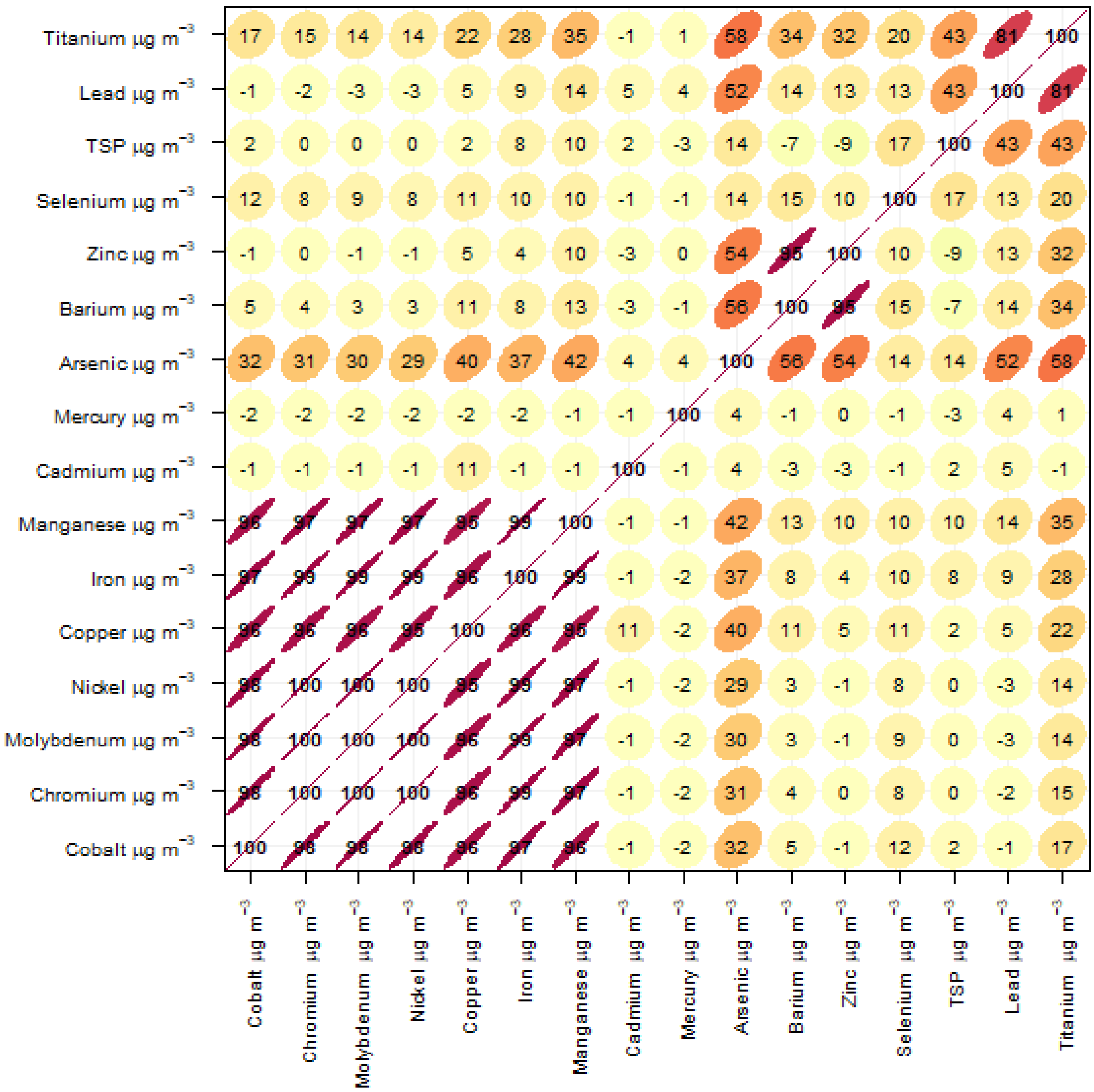

Figure 4-43: Heavy metal and TSP correlations in all samples collected since 22 June 2021 at AQM4

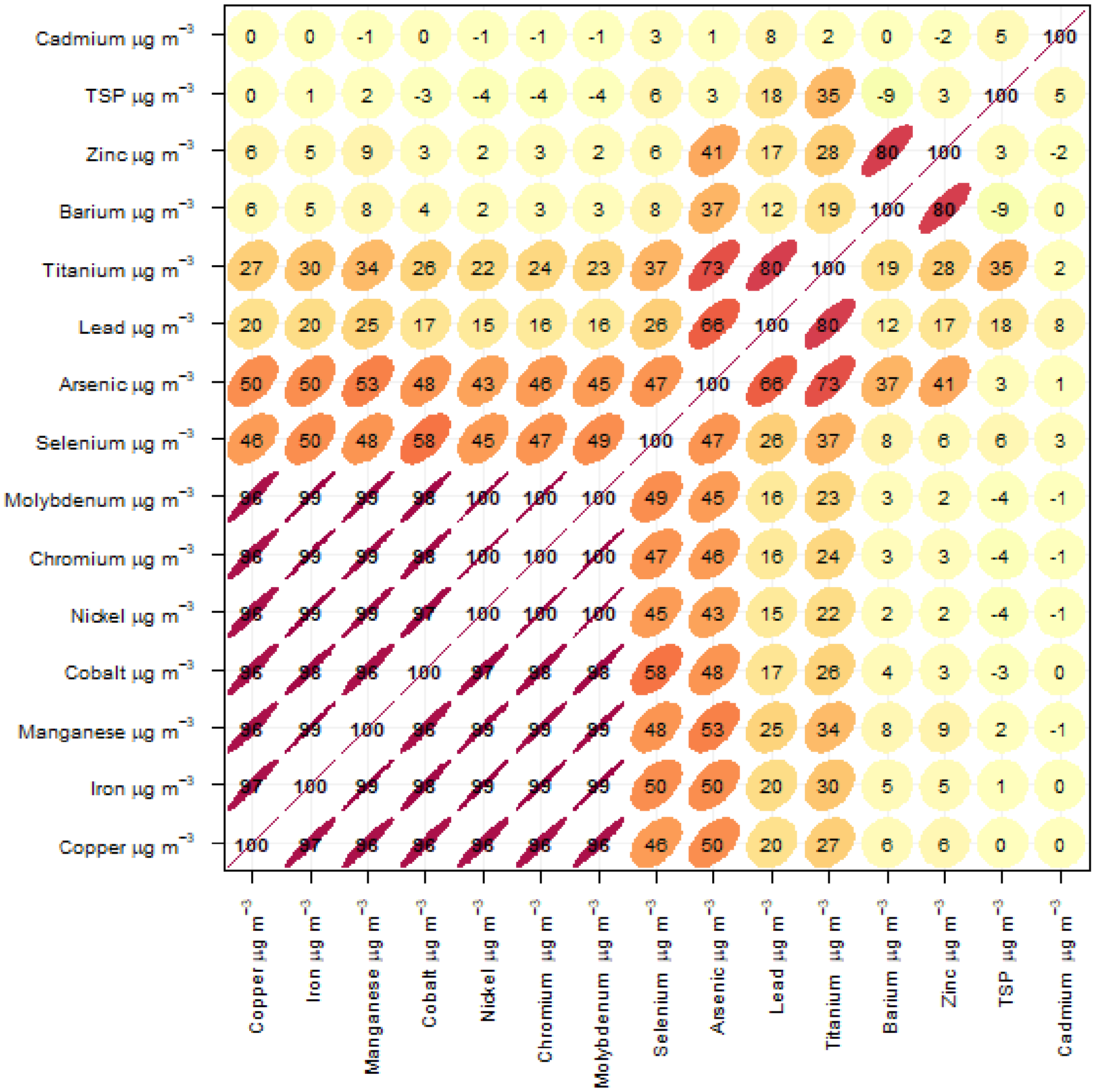

Figure 4-44: Heavy metal and TSP correlations in all samples collected since 22 June 2021 at AQM5

5. DISCUSSION

An air quality monitoring program was commissioned in Captains Flat, NSW to inform air quality risks associated with heavy metals in airborne particulate matter from the legacy Lake George Mine. Sampling at five locations commenced on 22 June 2021 and is ongoing. This report summarises all data from 22 June 2021 to 25 June 2025. Sampling is configured to measure a 24-hour average sample every one day in six at five sensitive receptors around the town.

Throughout the study period a total of six 24-hour average concentrations were recorded above the annual TSP criterion of 90µg/m^3. No exceedances were recorded in quarter 2, 2025. Three of these elevated concentrations were able to be further investigated with the support of meteorological data. It was concluded that elevated 24-hour concentrations recorded on the 17 February 2022 at AQM2 and the 8 March 2024 at AQM4 were likely attributed to dry conditions and strong winds from the north. On these days the monitoring stations AQM2 and AQM4 were not located downwind of the four identified locations of former mining activities, suggest that it is unlikely legacy mine locations at Captains Flat contributed to the elevated TSP concentrations. On 25 June 2025 the 24-hour concentration of TSP recorded at AQM4, was above the annual criteria. The predominant daylight wind direction and nighttime wind patterns indicated that the elevated concentrations unlikely originated from Captains Flat.

Concentrations of most of the heavy metals, including lead, remained below their respective 1-hour criteria throughout the monitoring period. Exceedances of the NSW EPA 1-hour criteria of barium and nickel were, however, observed on multiple days throughout the study period. Ramboll has made recommendations to Regional NSW, and they have subsequently engaged the EPA on this matter.

Analysis of pollutants (Pb, As, Ca, Se and Ti) at AQM2 suggests that a higher frequency of elevated concentrations occur from westerly winds, where there are no sites of former mining activities. Additionally, AQM3 is largely affected by south-easterly winds for some pollutants (i.e., Pb, As, Ba, Ca, Cu, Fe, Mn, Se, Ti), outside the arc of influence of Captains Flat. These findings indicate that sources other than the former mining area at Captains Flat are generally contributing more to the elevated pollutant concentrations observed at both monitoring sites.

Further examination of heavy metal concentrations during the monitoring period found that AQM3 and AQM4 reported similar results for some pollutants (i.e., As, Ba, Cr, Co, Cu, Fe, Mn, Ni, Mo, Se, Ti, Zn). This suggests that these locations may be affected by the same pollution source. Specifically of the pollutants examined a very strong correlation was found to exist between Cr, Co, Cu, Fe, Mn, Mo, and Ni, supporting the conclusion that these pollutants could be originating from the same source(s).

6. LIMITATIONS

This document is issued in confidence to Regional NSW for the purposes of assessing air quality risks to inform the lead management plan for Captains Flat, NSW *including the mine site rehabilitation and public space lead abatement works that are refenced in the Lead Management Plan*. It should not be used for any other purpose.

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7. REFERENCES

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APPENDIX 1
SPATIAL BIVARIATE PLOTS

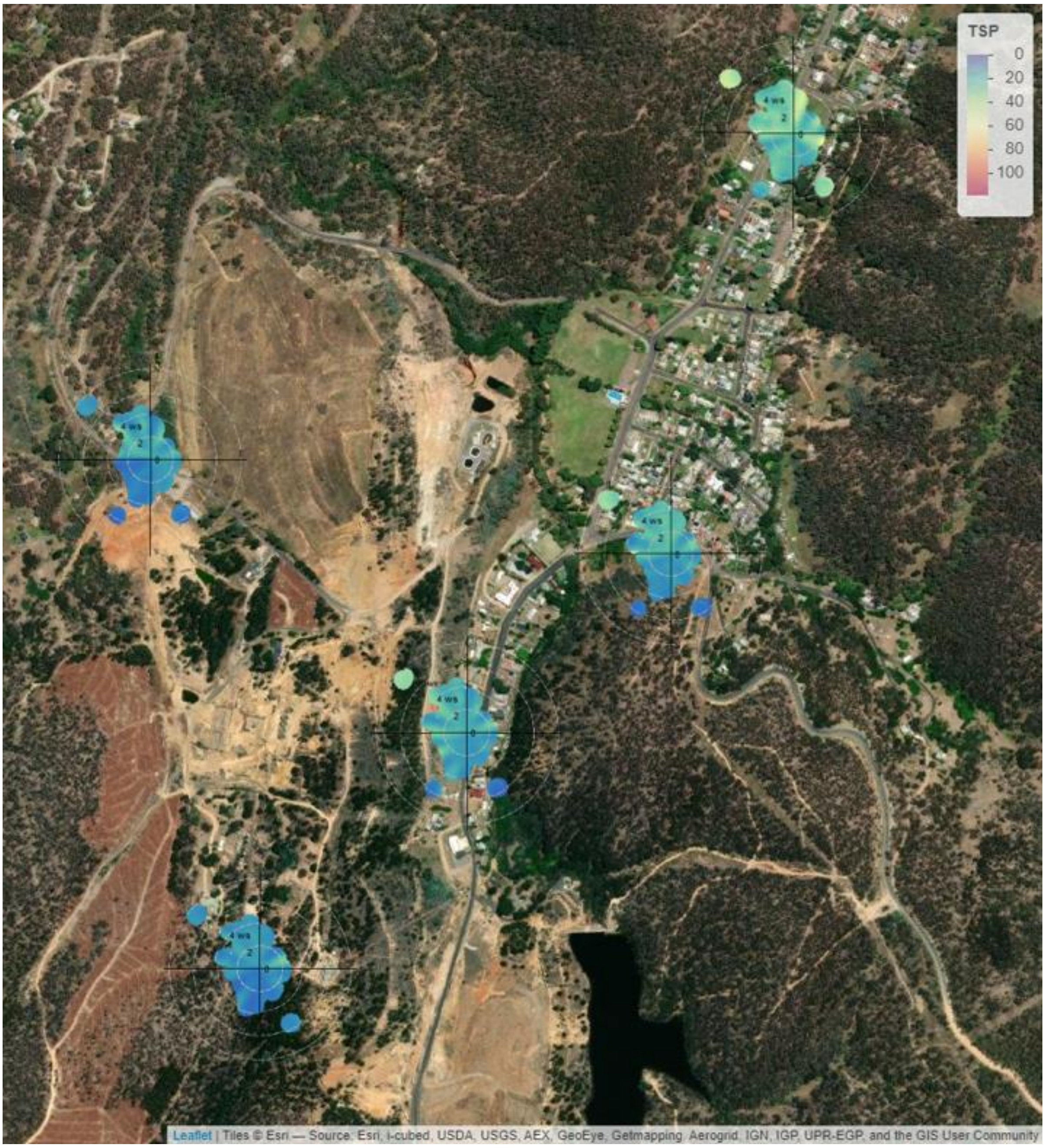


Figure 7-1: Polar map plots showing 24-hour TSP concentration (µg/m^3) and 24-hour average wind speed and direction at each monitoring location, from 22 June 2021

Note. Prepared with openair; Carslaw & Ropkins, 2012

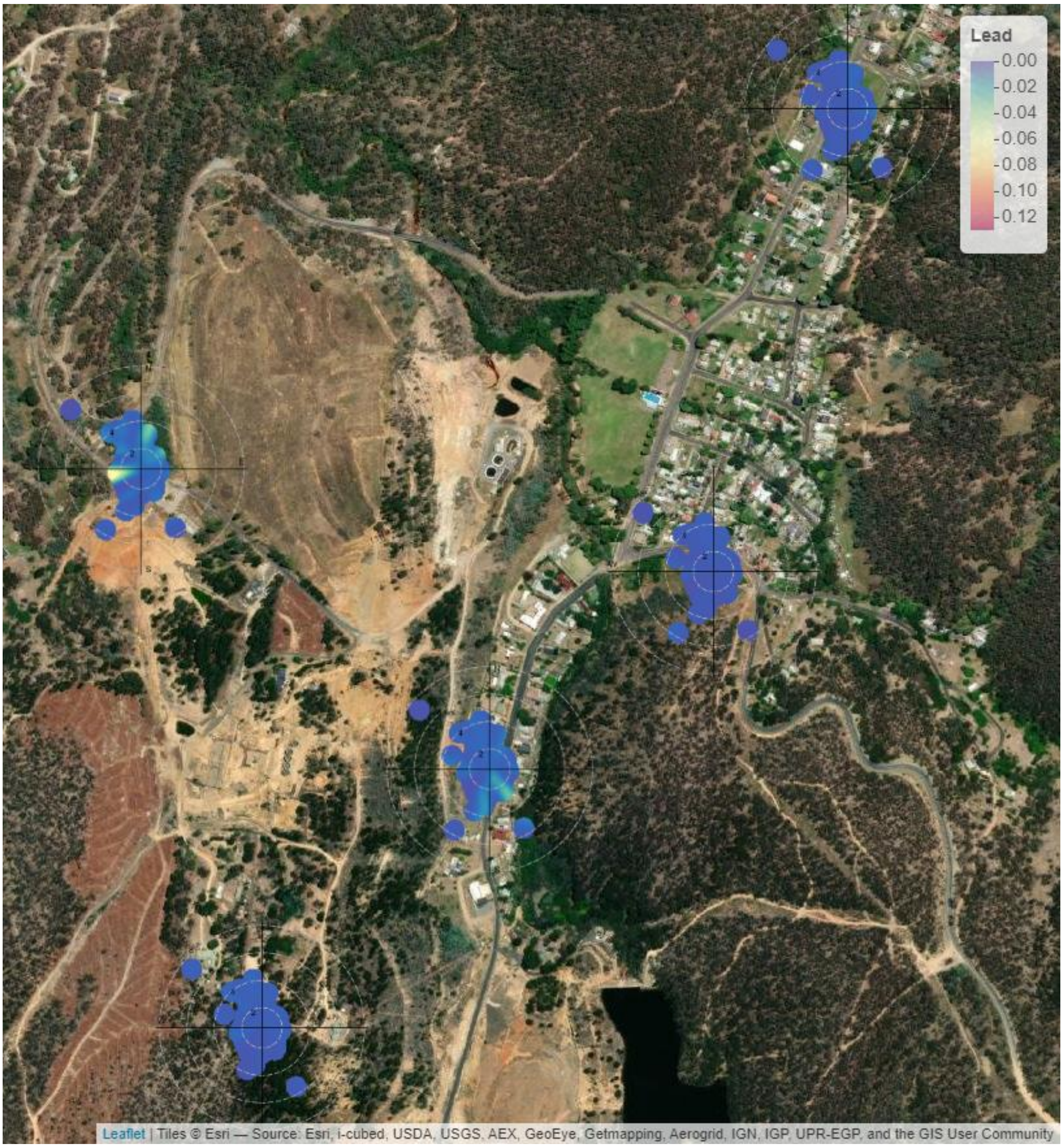


Figure 7-2: Polar map plots showing 24-hour lead concentration (µg/m³) and 24-hour average wind speed and direction at each monitoring location, from 22 June 2021

Note. Prepared with openair; Carslaw & Ropkins, 2012

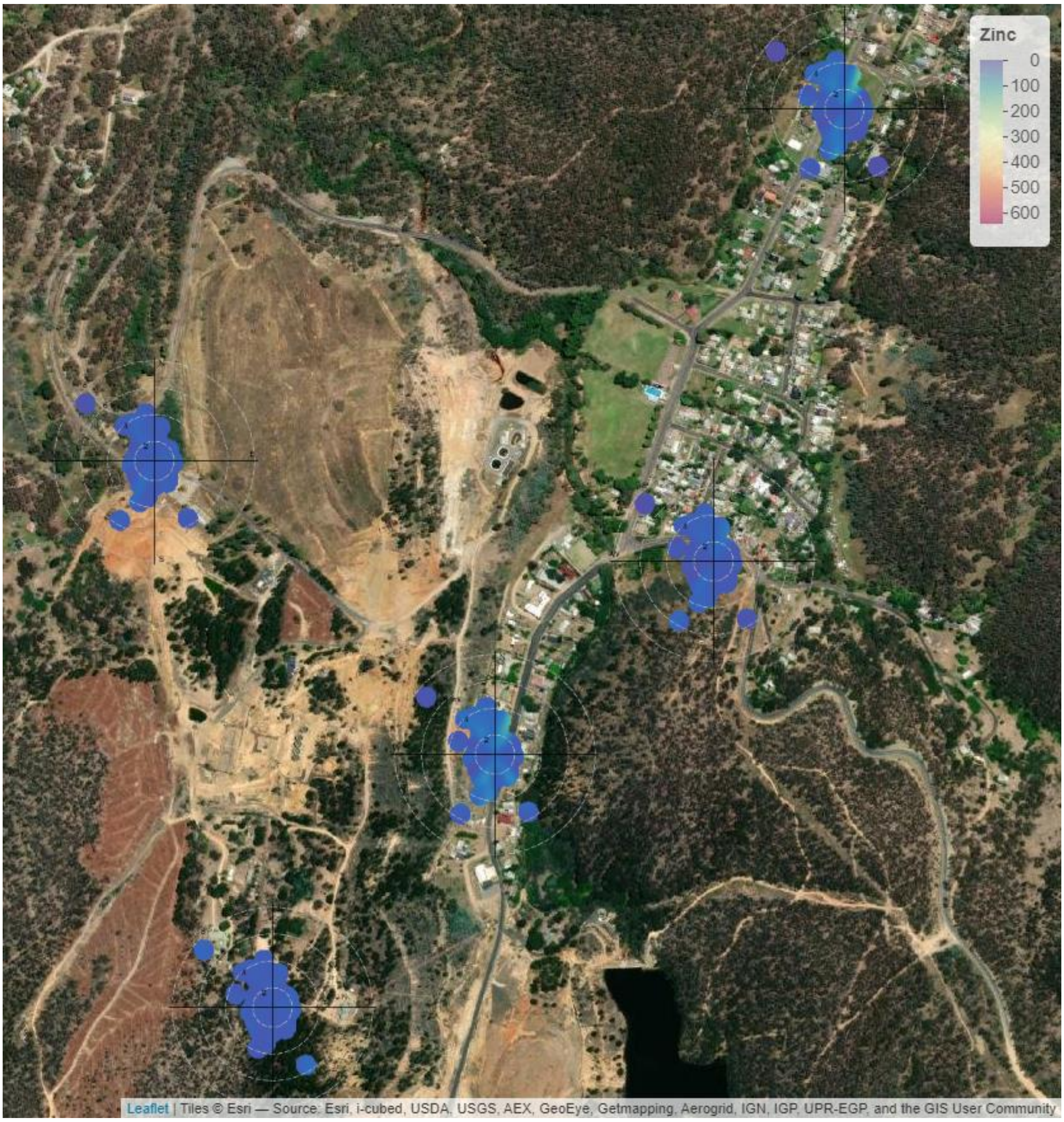


Figure 7-3: Polar map plots showing 24-hour zinc concentration (µg/m³) and 24-hour average wind speed and direction at each monitoring location, from 22 June 2021

Note. Prepared with openair; Carslaw & Ropkins, 2012

APPENDIX 2
HISTORICAL LEAD CONCENTRATIONS AROUND AUSTRALIA (NEPC, 2001)

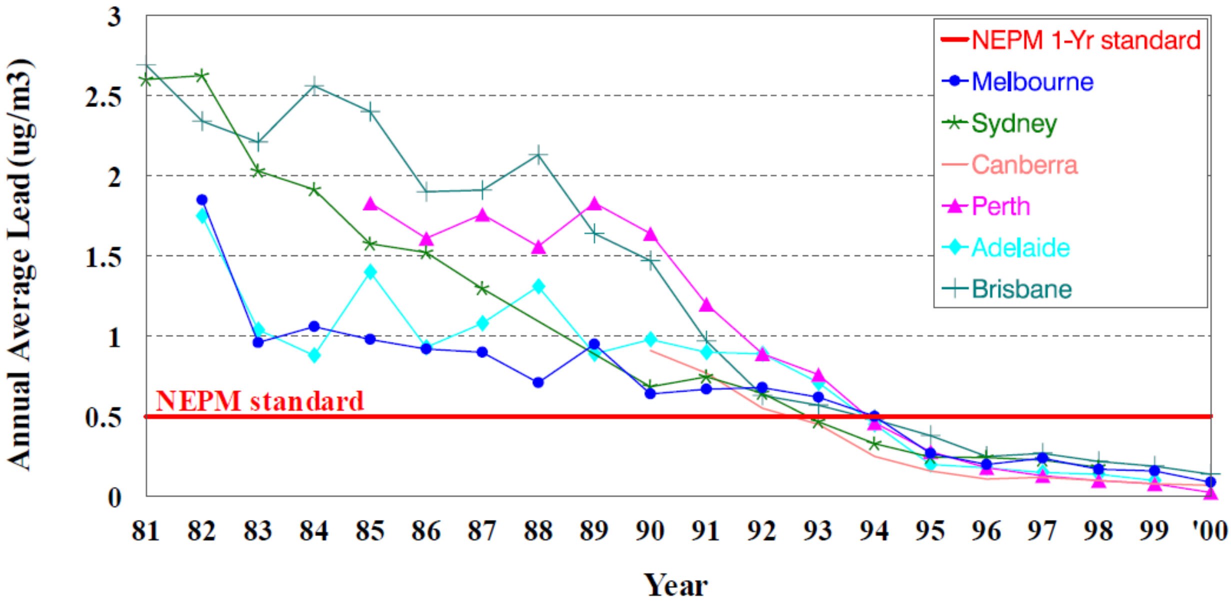


Figure A: Annual lead concentrations in Australian Capital Cities, 1981-2000 (NEPC, 2001)

APPENDIX 3
IMAGES OF AIR QUALITY MONITORING INSTRUMENTS IN-SITU

AQM1 – Old Mine Road

AQM2 – 2 Cooper Creek Road

MET – 2 Copper Creek Road (project station foreground, RFS station background)

AQM3 – Former Pre-School

AQM4 – New Preschool

AQM5 – 2 Braidwood Road

Figure B: High-volume air samplers and meteorological station in-situ in Captains Flat, NSW

APPENDIX 4
MISSING SAMPLES

Table A: Invalidated or missing samples [1]

Date sampled	Site	Sample ID	Comments
04/07/2021	AQM5	No sample	Lost during high winds
01/11/2021	AQM1	AQM 1 – HVS847	Invalidated – not serviced on correct day by SCS
01/11/2021	AQM2	AQM 2 – HVS848	Invalidated – not serviced on correct day by SCS
01/11/2021	AQM3	AQM 3 – HVS846	Invalidated – not serviced on correct day by SCS
01/11/2021	AQM4	AQM 4 – HVS844	Invalidated – not serviced on correct day by SCS
01/11/2021	AQM5	AQM 5 – HVS845	Invalidated – not serviced on correct day by SCS
07/11/2021	AQM1	AQM 1 – HVS854	Invalidated – not serviced on correct day by SCS
07/11/2021	AQM2	AQM 2 – HVS855	Invalidated – not serviced on correct day by SCS
07/11/2021	AQM3	AQM 3 – HVS849	Invalidated – not serviced on correct day by SCS
07/11/2021	AQM4	AQM 4 – HVS853	Invalidated – not serviced on correct day by SCS
07/11/2021	AQM5	AQM 5 – HVS856	Invalidated – not serviced on correct day by SCS
12/04/2022	AQM1	AQM 1 – HVS1073	No sample – Not replaced by SCS
12/04/2022	AQM2	AQM 2 – HVS1060	No sample – Not replaced by SCS
12/04/2022	AQM3	AQM 3 – HVS985	No sample – Not replaced by SCS
12/04/2022	AQM4	AQM 4 – HVS1170	No sample – Not replaced by SCS
12/04/2022	AQM5	AQM 5 – HVS1163	No sample – Not replaced by SCS
18/04/2022	AQM1	No sample	No sample – Not replaced by SCS
18/04/2022	AQM2	No sample	No sample – Not replaced by SCS
18/04/2022	AQM3	No sample	No sample – Not replaced by SCS
18/04/2022	AQM4	No sample	No sample – Not replaced by SCS
18/04/2022	AQM5	No sample	No sample – Not replaced by SCS
30/04/2022	AQM1	No sample	No sample – Not replaced by SCS
30/04/2022	AQM2	No sample	No sample – Not replaced by SCS
30/04/2022	AQM3	No sample	No sample – Not replaced by SCS
30/04/2022	AQM4	No sample	No sample – Not replaced by SCS
30/04/2022	AQM5	No sample	No sample – Not replaced by SCS
18/05/2022	AQM2	No sample	Missing upon retrieval
24/05/2022	AQM1	AQM 1 – HVS1155	No sample – Not replaced by SCS
24/05/2022	AQM2	AQM 2 – HVS1122	No sample – Not replaced by SCS
24/05/2022	AQM3	AQM 3 – HVS1133	No sample – Not replaced by SCS
24/05/2022	AQM4	AQM 4 – HVS1139	No sample – Not replaced by SCS
24/05/2022	AQM5	AQM 5 – HVS1246	No sample – Not replaced by SCS
30/05/2022	AQM1	No sample	No sample – Not replaced by SCS
30/05/2022	AQM2	No sample	No sample – Not replaced by SCS
30/05/2022	AQM3	No sample	No sample – Not replaced by SCS

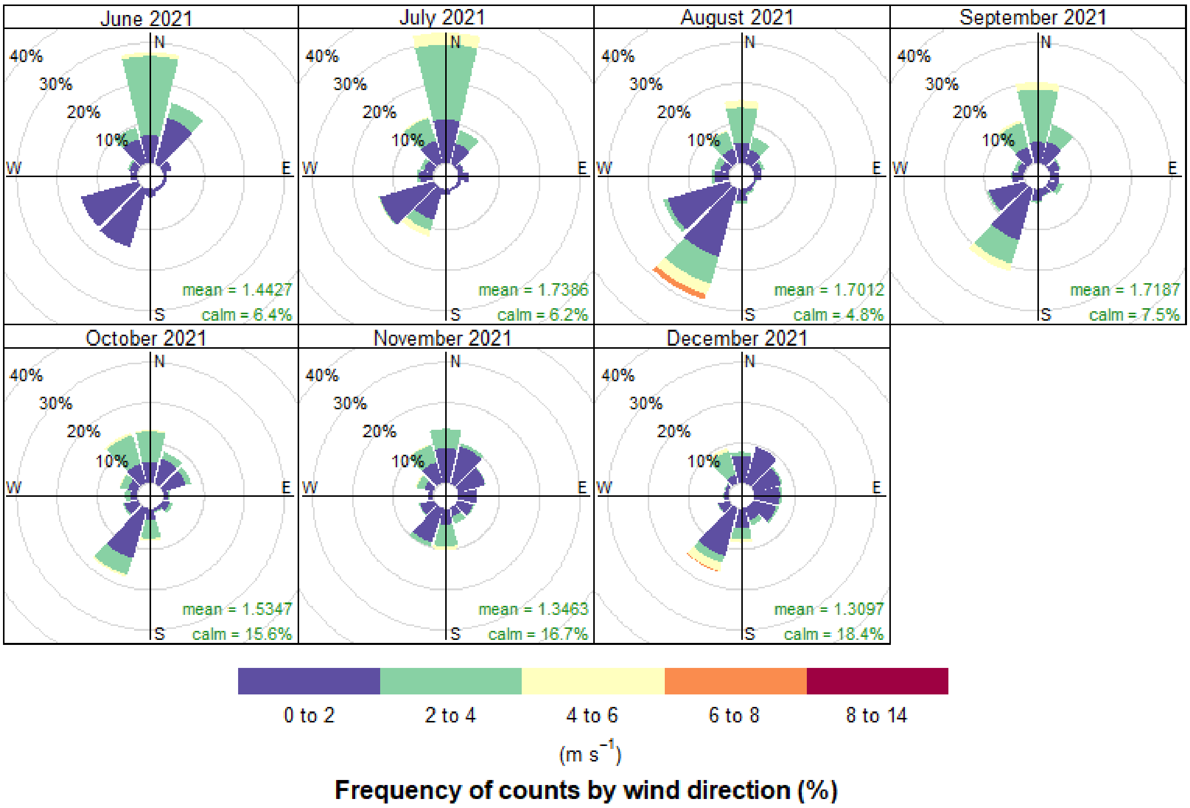
Date sampled	Site	Sample ID	Comments
30/05/2022	AQM4	No sample	No sample – Not replaced by SCS
30/05/2022	AQM5	No sample	No sample – Not replaced by SCS
23/06/2022	AQM3	AQM 3 – HVS1255	Filter damaged
05/07/2022	AQM1	AQM 1 – HVS1240	Invalidated
05/07/2022	AQM2	AQM 2 – HVS1243	Invalidated
05/07/2022	AQM3	AQM 3 – HVS1253	Invalidated
05/07/2022	AQM4	AQM 4 – HVS1270	Invalidated
05/07/2022	AQM5	AQM 5 – HVS1263	Invalidated
11/07/2022	AQM1	No sample	
11/07/2022	AQM2	No sample	
11/07/2022	AQM3	No sample	
11/07/2022	AQM4	No sample	
11/07/2022	AQM5	No sample	
17/07/2022	AQM2	AQM 2 – HVS1234	Filter damaged
29/07/2022	AQM1	No sample	
29/07/2022	AQM2	No sample	
29/07/2022	AQM3	No sample	
29/07/2022	AQM4	No sample	
29/07/2022	AQM5	No sample	
10/08/2022	AQM2	AQM 2 – HVS1259	Filter damaged
16/08/2022	AQM1	No sample	Missing
16/08/2022	AQM2	No sample	Missing
16/08/2022	AQM3	No sample	Missing
16/08/2022	AQM4	HVS 1141	Missing
16/08/2022	AQM5	No sample	Missing
28/08/2022	AQM2	AQM 2 – HVS1358	Filter damaged
09/09/2022	AQM3	AQM 3 – HVS1250	Filter damaged
09/09/2022	AQM5	AQM 5 – HVS1259	Filter damaged
15/09/2022	AQM1	AQM 1 – HVS_UNKNOWN	Missing
15/09/2022	AQM2	AQM 2 – HVS_UNKNOWN	Missing
15/09/2022	AQM3	AQM 3 – HVS_UNKNOWN	Missing
15/09/2022	AQM4	AQM 4 – HVS_UNKNOWN	Missing
15/09/2022	AQM5	AQM 5 – HVS_UNKNOWN	Missing
13/05/2023	AQM2	AQM 2 – HVS17494	Filter damaged
30/07/2023	AQM1	AQM 1 – HVS2031	Filter papers not post-weighed
24/07/2023	AQM1	AQM 1 – HVS1965	Filter papers not post-weighed
18/07/2023	AQM1	AQM 1 – HVS2046	Filter papers not post-weighed
12/07/2023	AQM1	AQM 1 – HVS2021	Filter papers not post-weighed
6/07/2023	AQM1	AQM 1 – HVS2006	Filter papers not post-weighed

Date sampled	Site	Sample ID	Comments
30/07/2023	AQM2	AQM 2 – HVS2030	Filter papers not post-weighed
24/07/2023	AQM2	AQM 2 – HVS1967	Filter papers not post-weighed
18/07/2023	AQM2	AQM 2 – HVS2047	Filter papers not post-weighed
12/07/2023	AQM2	AQM 2 – HVS2038	Filter papers not post-weighed
6/07/2023	AQM2	AQM 2 – HVS2007	Filter papers not post-weighed
30/07/2023	AQM3	AQM 3 – HVS2029	Filter papers not post-weighed
24/07/2023	AQM3	AQM 3 – HVS1963	Filter papers not post-weighed
18/07/2023	AQM3	AQM 3 – HVS2048	Filter papers not post-weighed
12/07/2023	AQM3	AQM 3 – HVS2037	Filter papers not post-weighed
6/07/2023	AQM3	AQM 3 – HVS1997	Filter papers not post-weighed
30/07/2023	AQM4	AQM 4 – HVS2028	Filter papers not post-weighed
24/07/2023	AQM4	AQM 4 – HVS2023	Filter papers not post-weighed
18/07/2023	AQM4	AQM 4 – HVS2049	Filter papers not post-weighed
12/07/2023	AQM4	AQM 4 – HVS2036	Filter papers not post-weighed
6/07/2023	AQM4	AQM 4 – HVS2005	Filter papers not post-weighed
30/07/2023	AQM5	AQM 5 – HVS2027	Filter papers not post-weighed
24/07/2023	AQM5	AQM 5 – HVS1961	Filter papers not post-weighed
18/07/2023	AQM5	AQM 5 – HVS2050	Filter papers not post-weighed
12/07/2023	AQM5	AQM 5 – HVS2035	Filter papers not post-weighed
6/07/2023	AQM5	AQM 5 – HVS1998	Filter papers not post-weighed
9/11/2023	AQM5	No sample	Missing
9/11/2023	AQM3	AQM 3 – HVS3154	Missing
4/10/2024	AQM4	AQM 4 – HVS3711	Cancelled

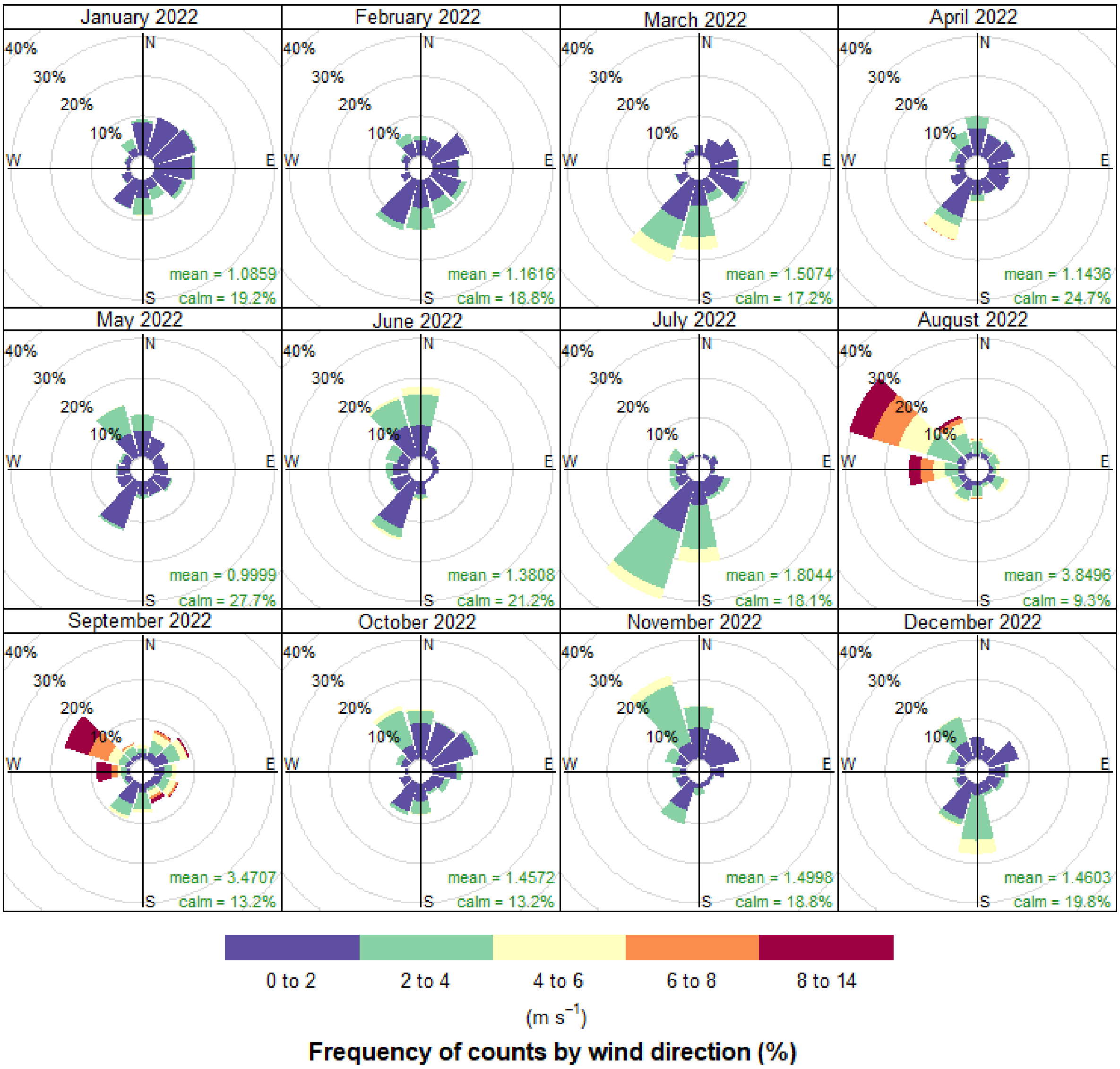
Note: Ramboll took over the servicing of the program from 16 September 2022.

APPENDIX 5
HISTORICAL WIND ROSES

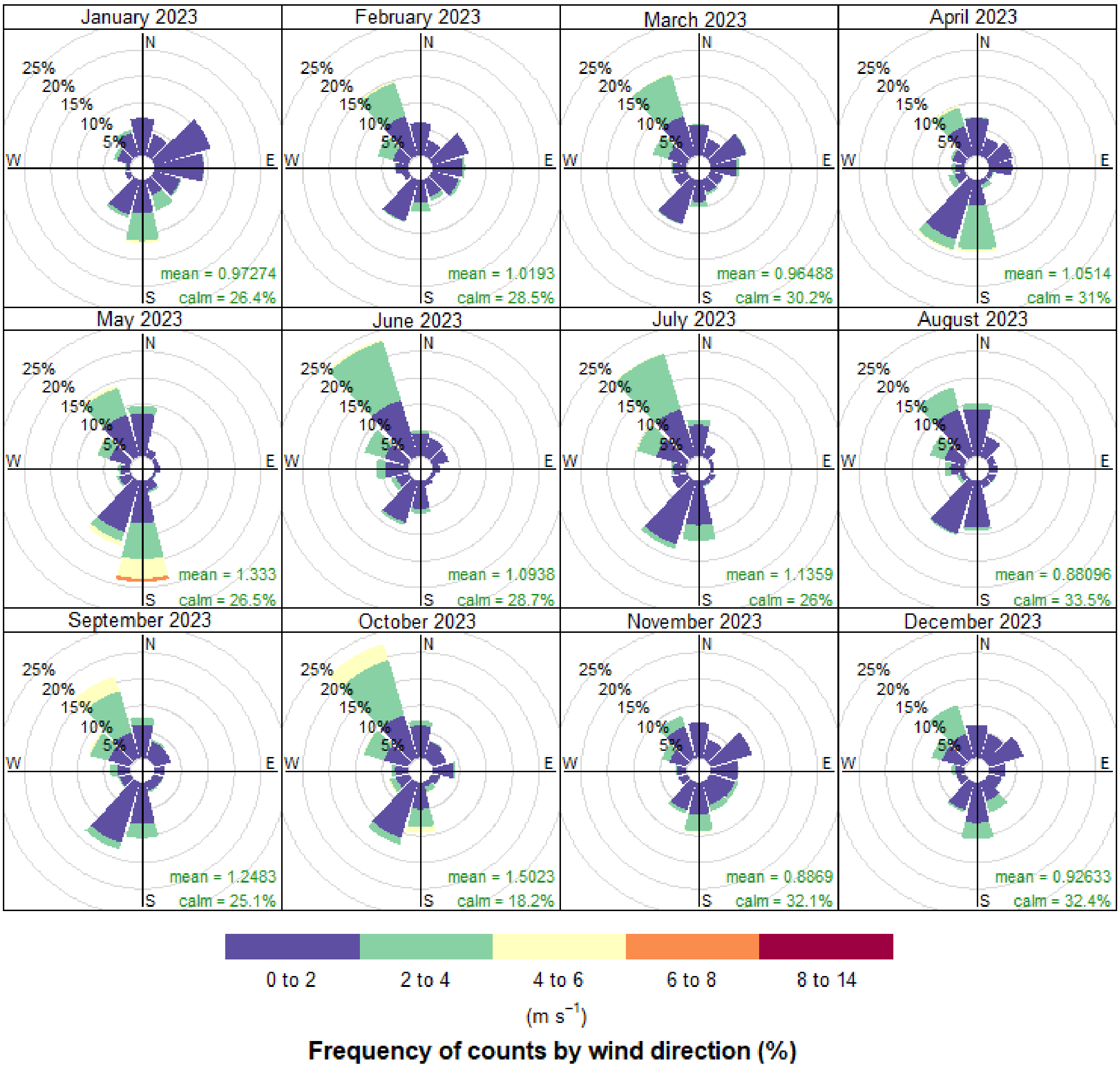
2021 – Monthly



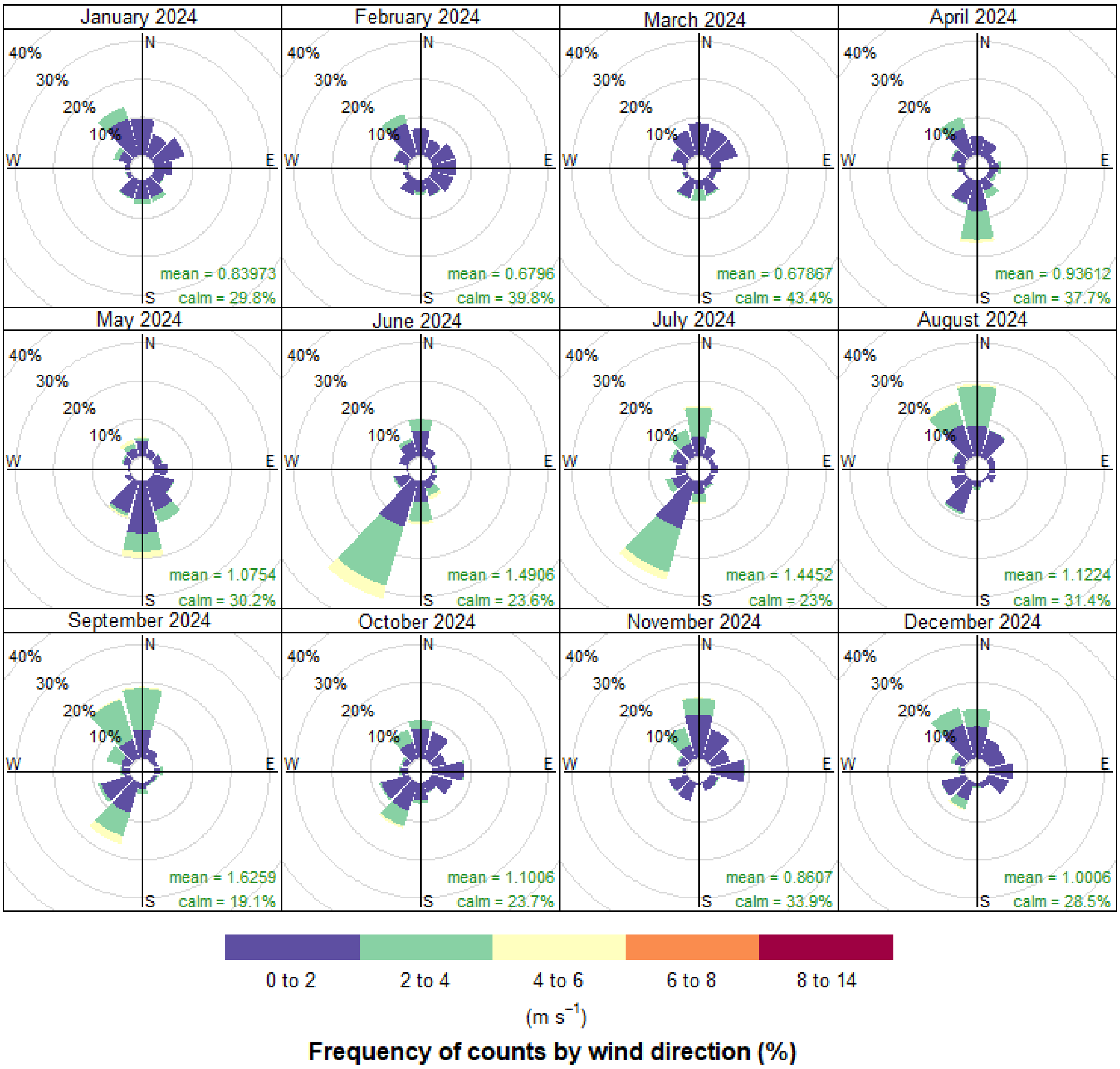
2022 – Monthly



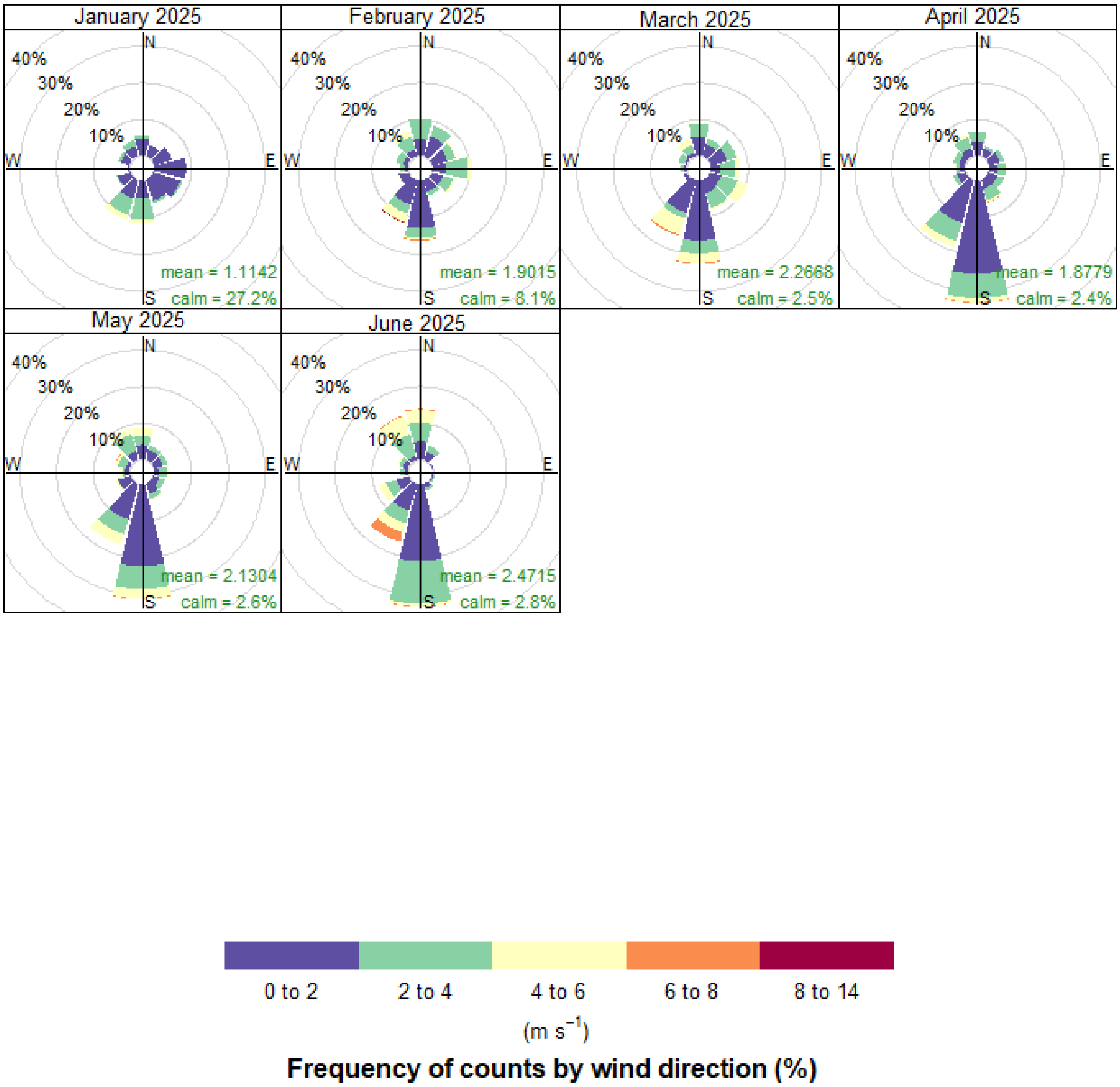
2023 – Monthly



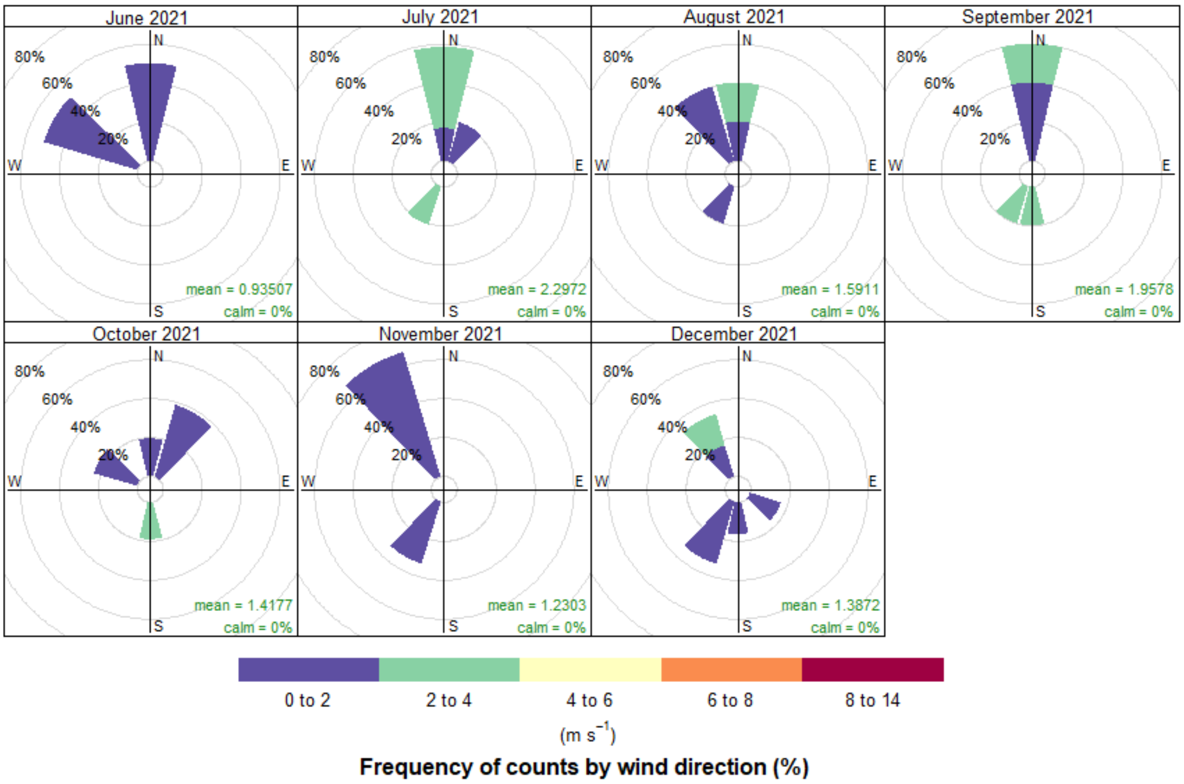
2024 – Monthly



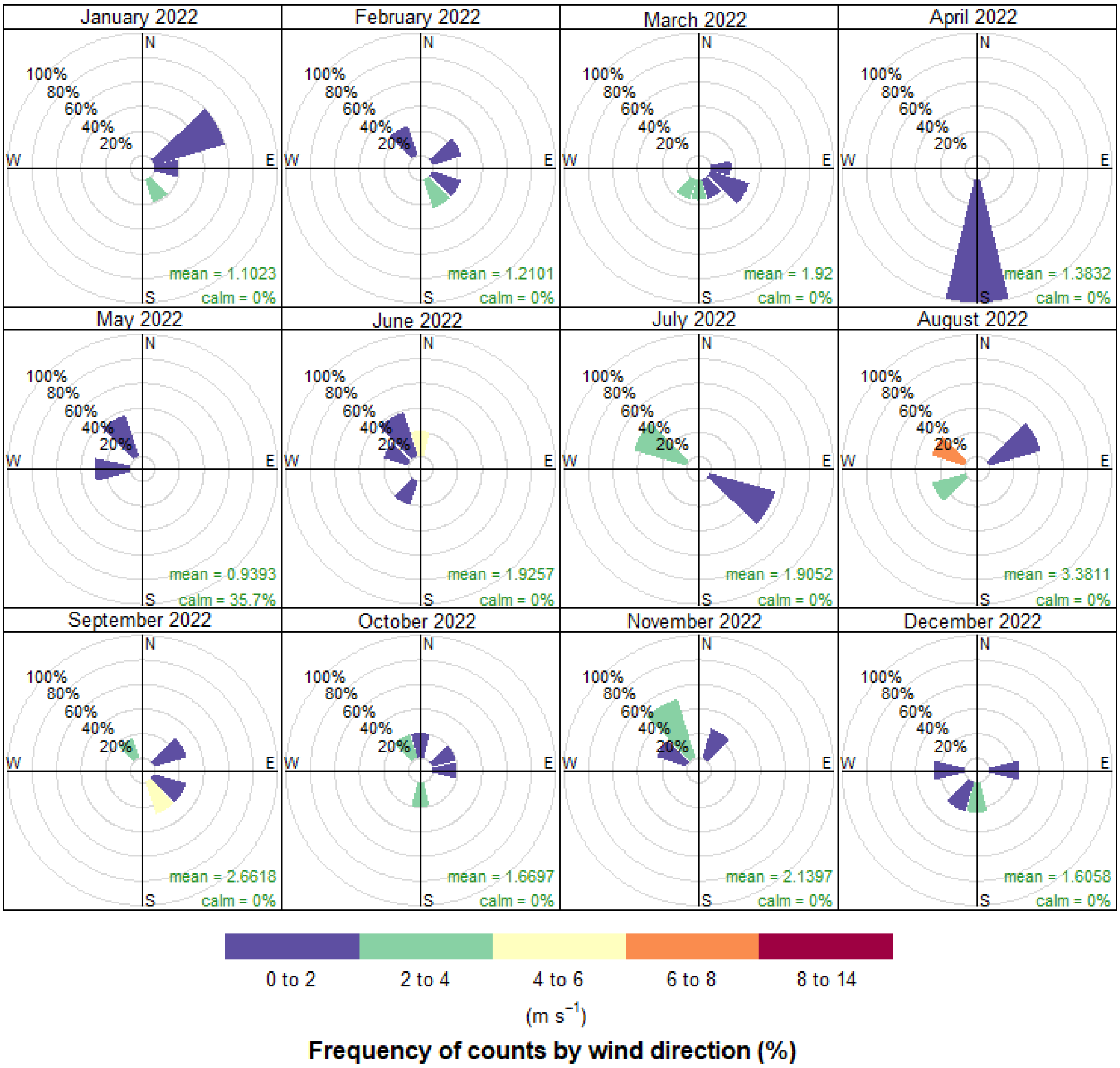
2025 – Monthly



2021 – Sample Days Only



2022 – Sample Days Only



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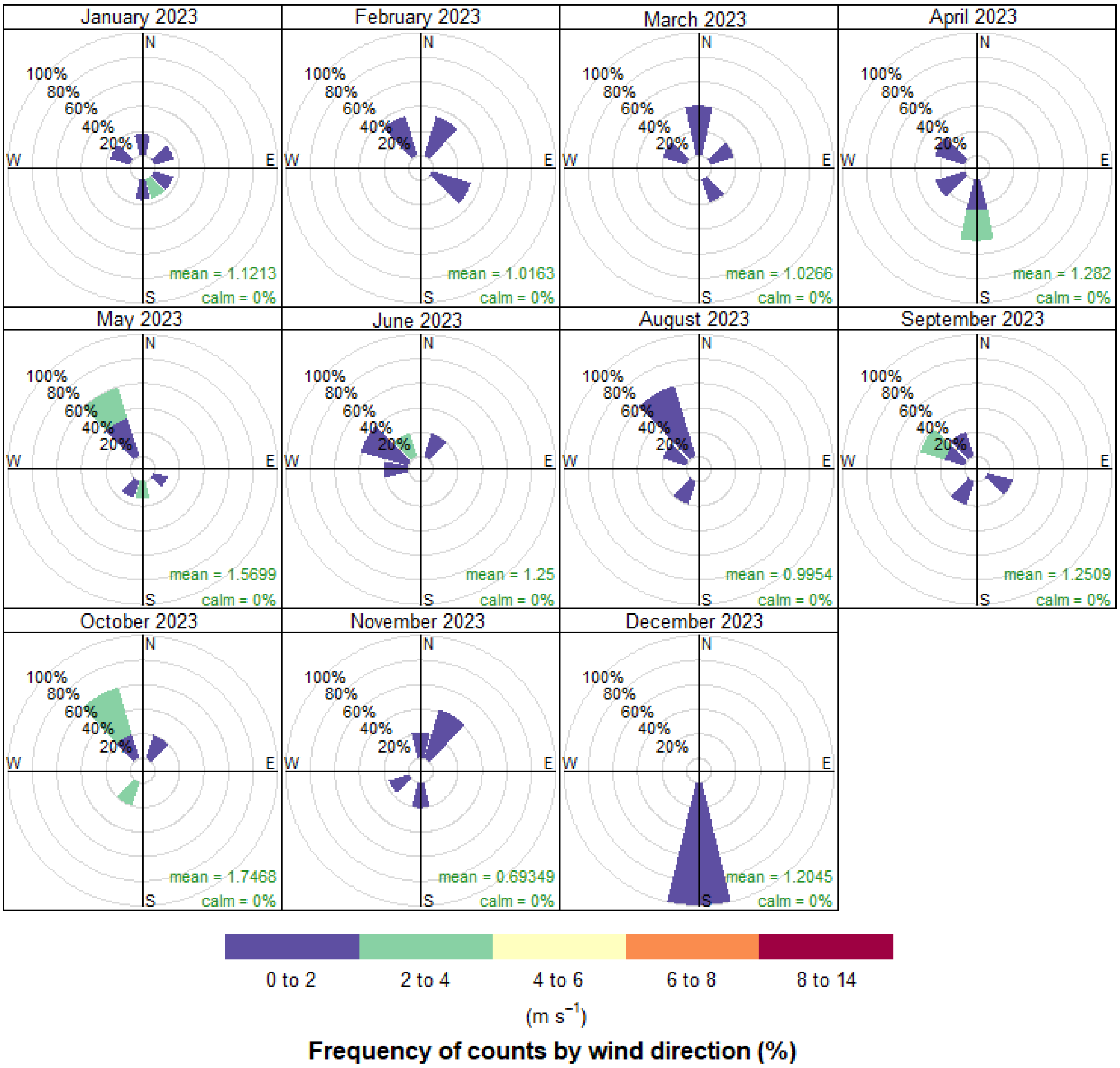
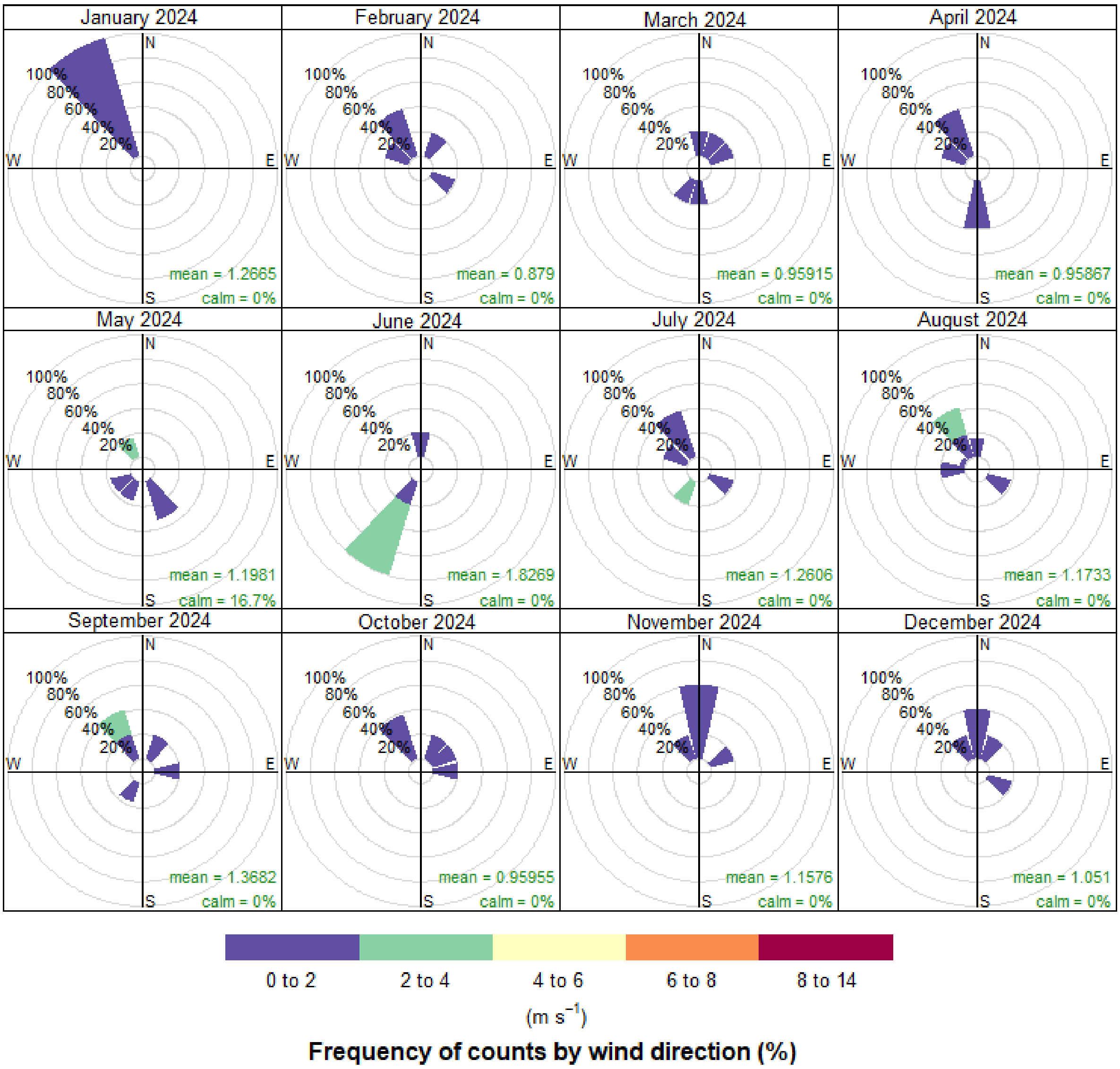


2024 – Sample Days Only



2024 – Sample Days Only