9.2. Annual Air Quality Report 2024

Prepared for: Science and Resilience Committee

Report No. GOV2542

Activity: Governance Report

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PURPOSE

[1] This report presents the results of the State of the Environment (SOE) monitoring for air quality for the calendar year 2024.

EXECUTIVE SUMMARY

[2] This report provides an analysis on the 2024 air quality data only. State and Trends reports, which contain long and short-term trend analysis, are produced every five years, the most recent one was published in June 2024.

[3] Monitoring of PM_{10} (particulate matter with a diameter less than 10 micrometres) was undertaken in the Alexandra, Arrowtown, Central Dunedin and Mosgiel airsheds in 2024. Alexandra, Arrowtown and Mosgiel recorded exceedances of the National Environmental Standard for Air Quality (NESAQ) during the winter months. The NESAQ limit for PM_{10} is 50 µg/m³ for a 24-hour average. There were a total of 28 exceedances of the NESAQ in 2024, which is eleven more than 2023. Alexandra and Arrowtown recorded 11 and 16 exceedances, respectively, and Mosgiel recorded one.

[4] $PM_{2.5}$ (particulate matter with a diameter less than 2.5 micrometres) was monitored in Arrowtown, Central Dunedin, Clyde, Cromwell, Milton, Mosgiel and Wānaka in 2024. A new site in Frankton was also set up in late 2024. The sites with the highest annual averages were Clyde and Mosgiel, both with 13 µg/m³. The site with the highest 24-hour average was Milton, with 97 µg/³ on 23 June 2024.

[5] Monitoring of black carbon (BC) was undertaken at Arrowtown. BC is a component of particulate matter, however there are no standards or guidelines for it. The data shows strong seasonal and daily patterns, similar to that of PM_{10}. The highest 24-hour average was 7 µg/m³, occurring on 4/07/2024.

RECOMMENDATION

That the Committee:

1) ***Notes*** *this report.*

BACKGROUND

[6] Otago has several towns where air quality is considered degraded during winter, namely Alexandra, Arrowtown, Clyde, Cromwell and Milton. The main pollutant of concern in Otago is particulate matter (PM) which is a product of combustion. In Otago, the main source of PM is home heating emissions in winter (Wilton, 2019). Long-term exposure to PM_{10} and $PM_{2.5}$ contributes to the risks of developing and exacerbating existing

cardiovascular and respiratory conditions, which makes them a serious threat to human health. Furthermore, recent research provides evidence that air pollution is dangerous at lower concentrations than previously thought, and supports the lowering of existing limits (WHO, 2021).

[7] ORC operates an SOE monitoring network for air quality monitoring and is required to report[1] exceedances of the NESAQ (50 µg/m³, 24-hour average for PM_{10}). The SOE network is currently being upgraded to include monitoring for $PM_{2.5}$ as well as expanded to add new sites including a new mobile site. The upgrade process includes a period of co-location and subsequent equivalence testing of the new instruments compared to the existing ones. Further comparison data is still required to be able to correct for the new instruments and accurately report some of their data, but once completed, any data corrections can be backdated. During 2024, PM_{10} was monitored at four sites and $PM_{2.5}$ at seven sites.

AIR QUALITY ASSESSMENT FRAMEWORK

[8] Under the Resource Management Act (RMA), councils are required to monitor air quality according to the NESAQ. PM_{10} and $PM_{2.5}$ can be compared to 24-hour and annual limits for the NESAQ 2004, the proposed NESAQ 2020 and the World Health Organization guidelines 2021 (Table 1). The proposed NESAQ shows that $PM_{2.5}$ limits are being considered in Aotearoa New Zealand, but it is uncertain what they will be since they are no longer in line with current health research like the WHO guidelines. The update of the NESAQ is currently indefinitely delayed.

Table 1: **Standards and guidelines for PM_{10} and $PM_{2.5}$**

Pollutant	Averaging Time	NESAQ 2004		Proposed NESAQ 2020		WHO 2021	
		Value (µg/m³)	Allowable exceedances	Value (µg/m³)	Allowable exceedances	Value (µg/m³)	Allowable exceedances
PM_{10}	24-hour	50	1 per annum	50	1 per annum	45	3-4[b]
	Annual	20[a]	NA	NA	NA	15	NA
$PM_{2.5}$	24-hour			25	3 per annum	15	3-4[b]
	Annual			10	NA	5	NA

[a] Ambient Air Quality Guideline (AAQG) limit, applies here because there is no equivalent NESAQ limit

[b] 99th percentile, there can be 3-4 exceedances per year

[9] The air quality results can also be categorised according to the Ministry for the Environment (MfE) Environmental Performance Indicators (EPI)[2]. The EPI categories indicate an appropriate action according to the concentrations (Table 2).

[1] Currently ORC reports exceedances by way of public notice in the Otago Daily Times every month exceedances occur.

[2] From the Ambient Air Quality Guidelines (AAQG, 2002).

Table 2: **Ministry for the Environment Environmental Performance Indicators for air quality**

Category	Monitoring result compared to guideline	Description
Action	Exceeds the guideline	Unacceptable and action is required to reduce emissions
Alert	66-100%	Warning level which could lead to exceedances if trends are not curbed
Acceptable	33-66%	Maximum values might be a concern in sensitive locations, urgent action is not warranted
Good	10-33%	Peak measurements not likely to affect air quality
Excellent	0-10%	Not recommended for PM_{10} monitoring, PM_{10} in this range is classified as good instead

SOE MONITORING RESULTS: PM_{10}

[10] PM_{10} was monitored continuously at four sites across the region in 2024: Alexandra, Arrowtown, Central Dunedin and Mosgiel. A summary of the key PM_{10} indicators for 2024 are given in Table 3 and a list of the NESAQ exceedances are shown in Appendix 1. The highest annual mean occurred at the Alexandra site with 16 µg/m³, which is an exceedance of the WHO guideline (15 µg/m³). All the other annual averages are just below the WHO guideline. The highest daily concentration was also recorded at Alexandra, with a concentration of 88 µg/m³ recorded on 27/07/2024. The most frequent number of exceedances occurred at the Arrowtown site, with daily concentrations exceeding the limit 16 times. Data capture was at least 95% at all four sites, although it should be noted that the Alexandra site was missing data during winter-time between 21-26/06/2024 and 31/07/2024 – 05/08/2024 due to instrument errors.

Table 3: **Key PM_{10} indicators for 2024**

Site	Annual mean (µg/m³)	Winter mean (µg/m³)	Maximum daily concentration (µg/m³)	2nd highest daily concentration (µg/m³)	Number of NESAQ exceedances	Data capture (%)
Alexandra	16	28	88	62	11	95
Arrowtown	14	28	80	72	16	98
Central Dunedin	14	14	35	32	0	96
Mosgiel	13	17	66	44	1	95

[11] Figures 1 and 2 show the seasonal patterns of the 24-hour average data and the distribution of data, respectively, in relation to the NESAQ limit and WHO guideline. Alexandra and Arrowtown have extreme seasonal variation (Figure 1), with high PM_{10} concentrations coming very close to and exceeding the limits. This can be seen in Figure 2, particularly in Arrowtown, where the distribution is skewed to the right because the

majority of the 24-hour averages consist of very low concentrations reflecting excellent air quality during summer and shoulder seasons. This data also shows that the concentrations can frequently be high (>40 µg/m³) without becoming an exceedance. Mosgiel data also shows a slight seasonal pattern, but the Central Dunedin site has no annual variation (Figure 1), and the distribution of concentrations are distributed fairly evenly around the mean (Figure 2).

[12] This data is reflective of PM sources in each airshed; Central Dunedin does not show a seasonal variation as home heating emissions are not an important source, compared to vehicle emissions and industrial activity. Mosgiel has a mixture of sources, while Alexandra and Arrowtown PM sources are primarily from winter home heating.

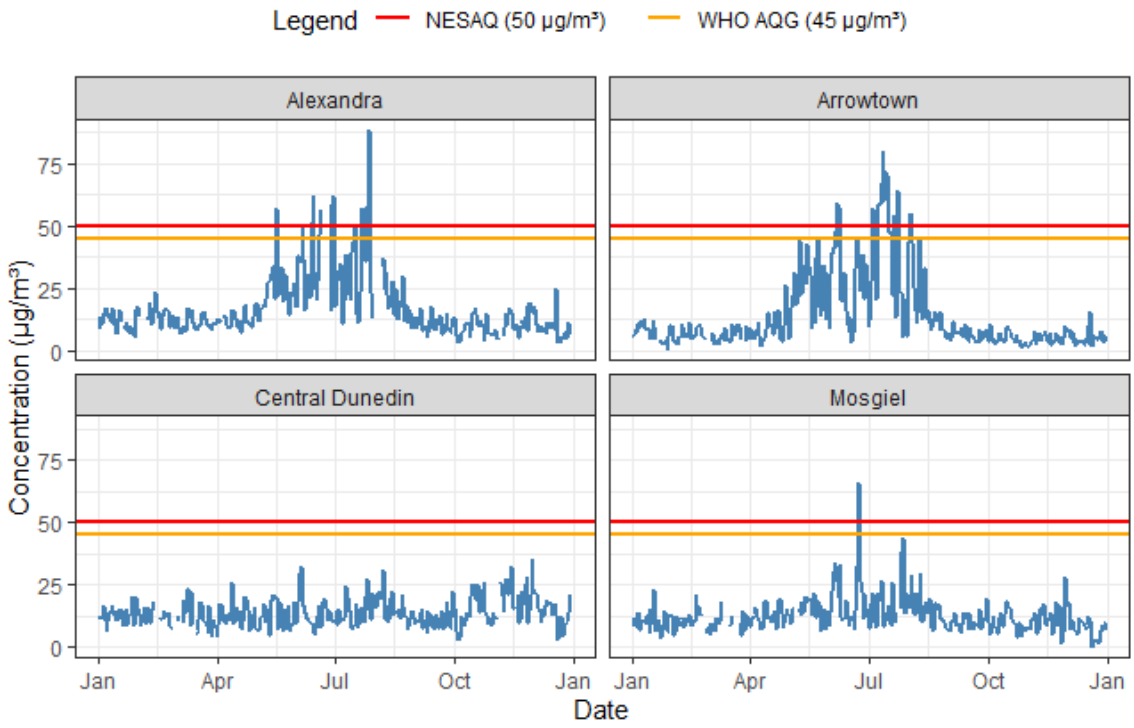

Figure 1: PM_{10} concentrations for 2024 (24-hour average).

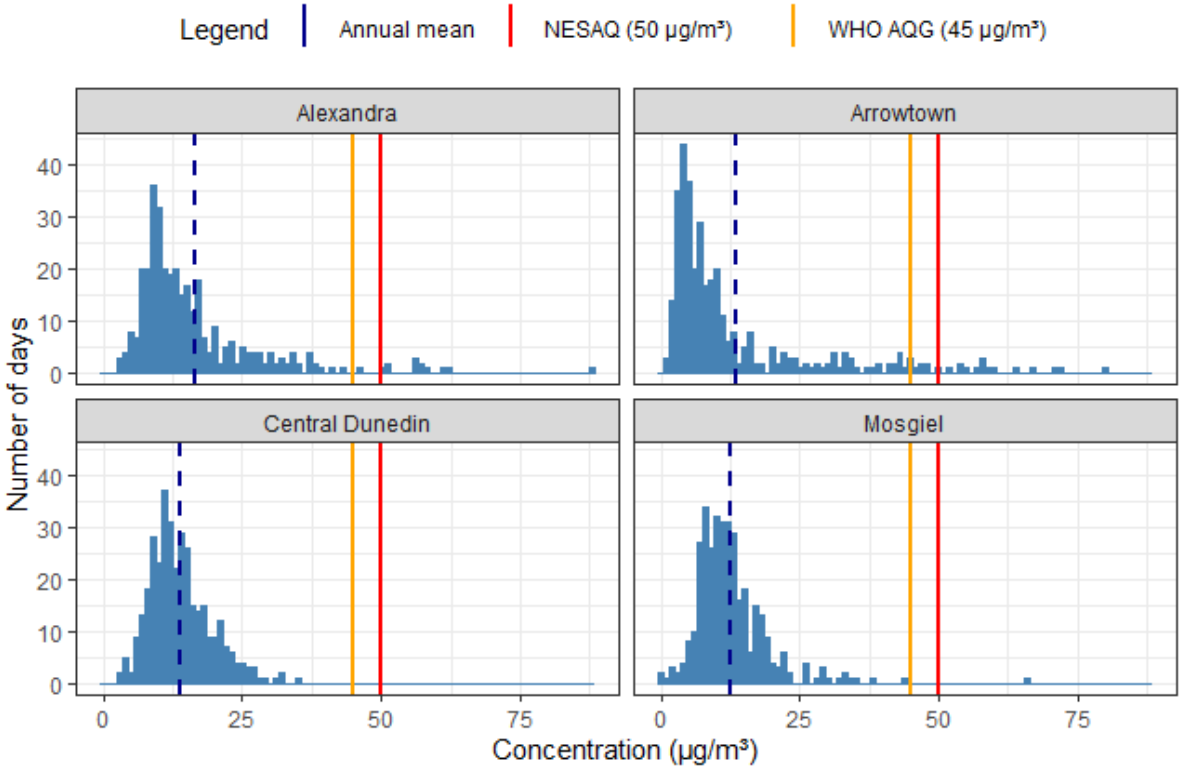

Figure 2: Distribution of daily PM_{10} concentrations for 2024 (24- hour average), in comparison to the NESAQ and WHO standards. Annual averages are 16 µg/m³ (Alexandra), 14 µg/m³ (Arrowtown and Central Dunedin) and 13 µg/m³ (Mosgiel). Histogram bin width is 1.

[13] When the PM_{10} data is sorted into the MfE indicator categories (Figure 3), all sites have over 70% of days in the "good" category. Alexandra and Arrowtown have approximately 10% of their data divided into the "alert" and "action" categories. Central Dunedin only had one day that can be categorised as "alert". The Mosgiel data showed that less than 5% of days were in either the "alert" or "action" categories.

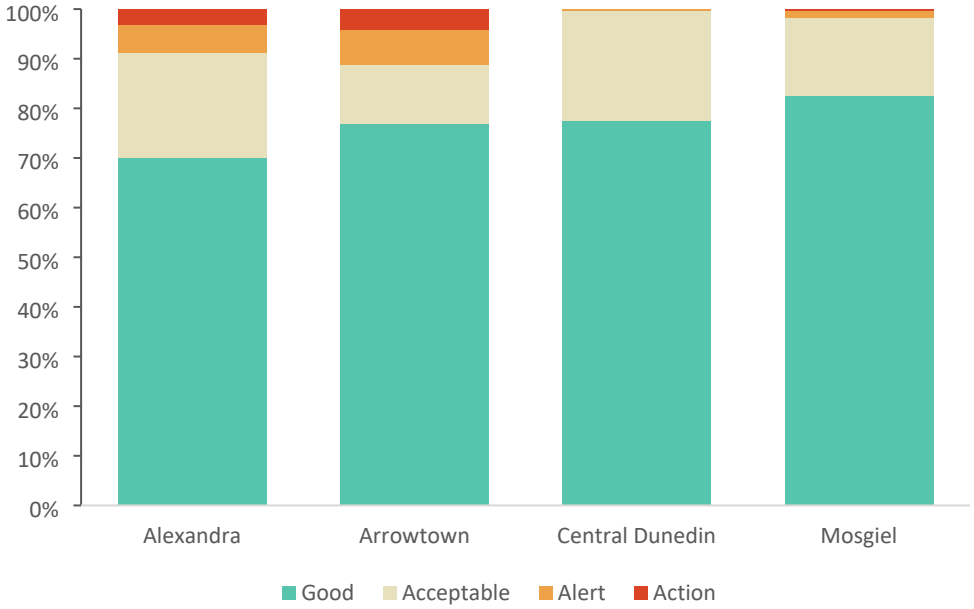

Figure 3: PM_{10} concentrations as air quality indicator categories for 2024 (24- hour average)

SOE MONITORING RESULTS: $PM_{2.5}$

[14] $PM_{2.5}$ was monitored continuously at seven sites across the region in 2024: Arrowtown, Central Dunedin, Clyde, Cromwell, Milton, Mosgiel and Wanaka. An eighth site was also set up in Frankton, Queenstown, towards the end of the year. The results from this site will be reported from the next annual report onwards. The instruments at Arrowtown, Central Dunedin and Mosgiel are considered equivalent to reference methods[3]. As such they will be able to be compared to standards and guidelines. However, a twelve-month period of co-location needs to be undertaken in order to establish a correction factor. As this has not been undertaken yet, none of the $PM_{2.5}$ data has been compared to limits or guidelines.

[15] A summary of the key $PM_{2.5}$ monitoring indicators for 2024 are given in Table 4. The highest annual mean occurred in Clyde and Milton, each with concentrations of 13 µg/m³; the lowest annual means occurred in Wānaka and Central Dunedin with concentrations of 5 µg/m³ and 6 µg/m³, respectively. The highest winter mean for 2024, 31 µg/m³, was recorded at the Clyde site. The highest daily concentration occurred in Milton followed by Clyde with 97 µg/m³ and 93 µg/m³, respectively. The data in Figure 3 shows very high winter concentrations in Arrowtown, Clyde, Cromwell and Milton, and to a lesser extent but still seasonal patterns in Mosgiel and Wānaka. Central Dunedin does not show seasonal variation for $PM_{2.5}$. These patterns match those of PM_{10}. Data capture for these sites was between 100% for most sites; the Arrowtown site had a data gap between 27/02/2024 11:50 and 04/03/2024 04:10 and the Mosgiel site had a data gap between 14/09/2023 04:30 and 26/02/2024 08:50. Both of these cases were due to instrument failure.

Table 4: Key $PM_{2.5}$ indicators for 2024

Site	Annual mean (µg/m³)	Winter mean (µg/m³)	Maximum daily concentration (µg/m³)	2nd highest daily concentration (µg/m³)	Data capture (%)
Arrowtown	11	25	77	69	91
Central Dunedin	6	7	16	15	100
Clyde	13	31	93	89	100
Cromwell	10	26	73	72	100
Milton	13	25	97	75	100
Mosgiel	8	13	76	46	84
Wānaka	5	10	28	23	100

[3] Monitoring methods required by NESAQ

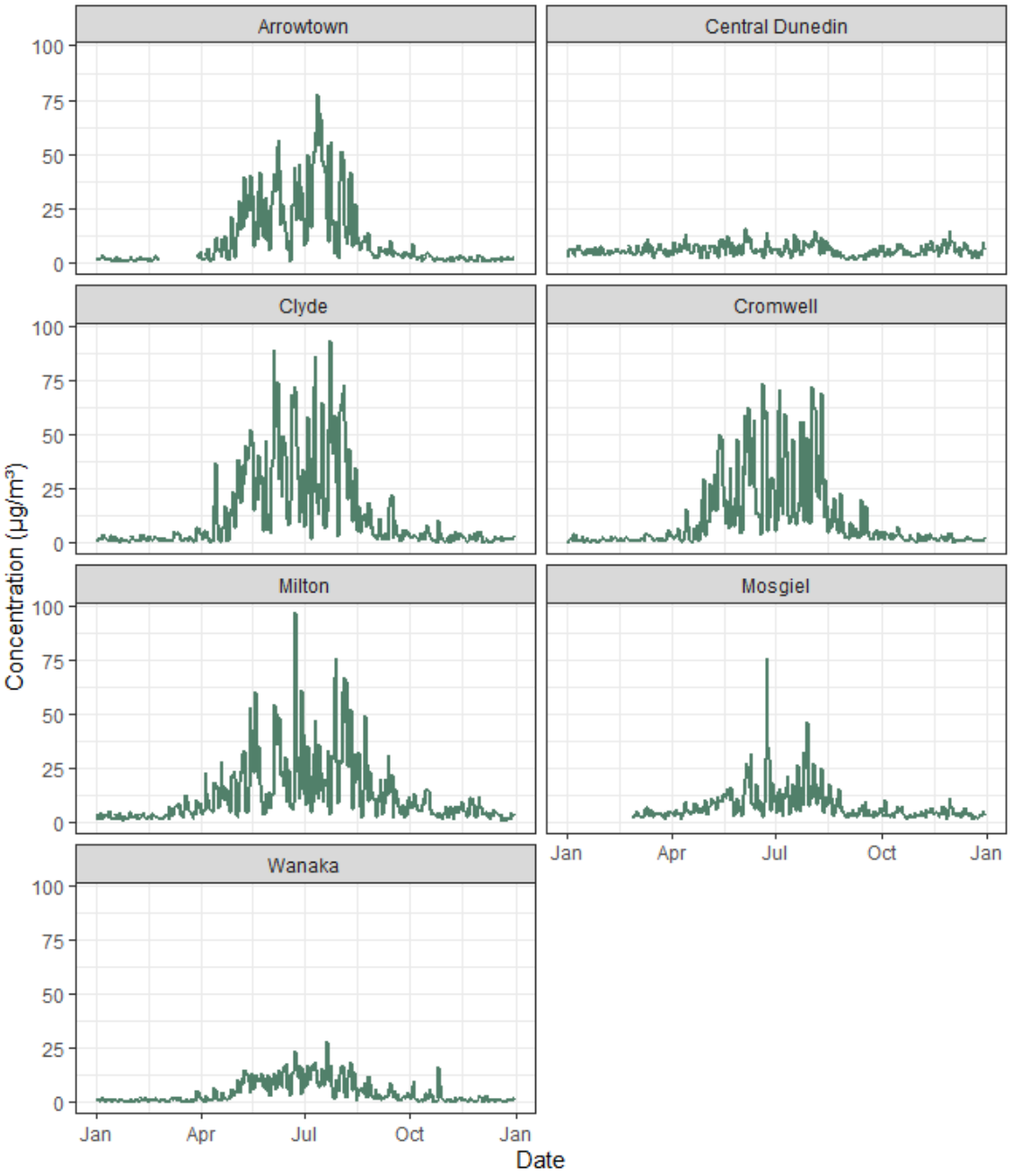

Figure 4: $PM_{2.5}$ concentrations for 2024 (24-hour average)

OTHER RESULTS: BLACK CARBON

[16] Black carbon (BC) is both a climate change pollutant and human health pollutant as a component of particulate matter. BC was monitored in Arrowtown during 2024, and the data shows very similar seasonal and daily patterns (Figure 5) to PM_{10}. BC is highest between the hours of 8:00 and 11:00 in the morning and then again between 19:00 and midnight (Figure 6). Because BC is only produced by combustion emissions, compared to PM_{10} which has other sources in Arrowtown such as dust and pollen, it is comparatively very low during non-winter seasons, as seen in the monthly graph in Figure 6.

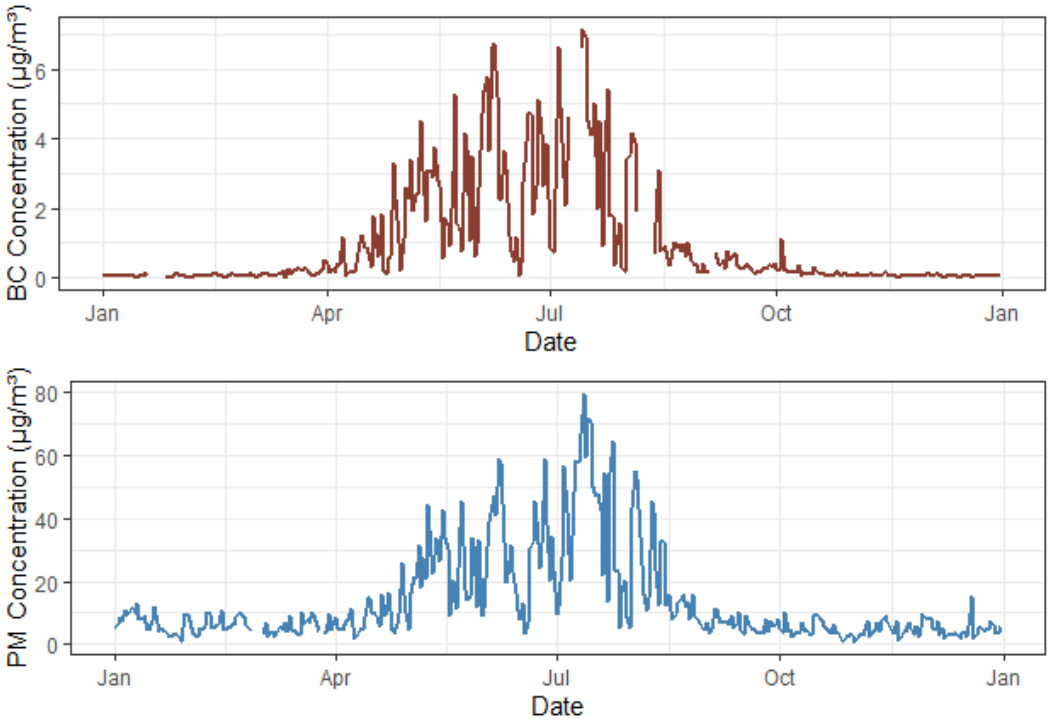

Figure 5: Black carbon and PM_{10}, Arrowtown 2024 (24-hour average)

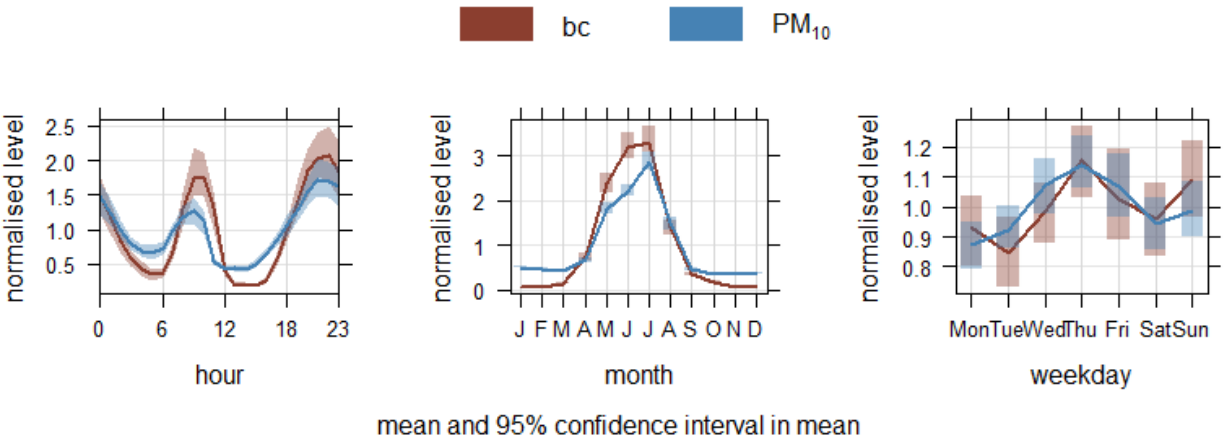

Figure 6: Arrowtown normalised means of black carbon and PM_{10} at Arrowtown for hour of the day (left), month (middle) and day of the week (right). Shading represents 95% confidence interval of the mean. Data have been normalised (divided by their means) for comparison on the same scale.

CONSIDERATIONS

Strategic Framework and Policy Considerations

[17] Monitoring Otago's air quality contributes towards the environmental element of the Strategic Directions of healthy air and managing air sustainably.

[18] The data will be available for the Air Plan and Strategy reviews.

Financial Considerations

[19] The air quality monitoring programme is a planned LTP activity for Science and Environmental Monitoring.

Significance and Engagement

[20] N/A

Legislative and Risk Considerations

[21] Managing air quality is a regional council requirement in accordance with the NESAQ.

Climate Change Considerations

[22] Monitoring black carbon contributes to ORC's understanding of this pollutant as a climate driver.

Communications Considerations

[23] Air quality communications will continue during 2025 with the Burn Dry Breathe Easy campaign.

[24] Due to a data recording error the data entering ORC's database was subject to the same offset twice for the Arrowtown site. Consequently, the number of exceedances recorded in Arrowtown was incorrect prior to data validation. This incorrect number (25 exceedances) was reported in an ORC media release and will be corrected (16 exceedances) in the media release for this report.

NEXT STEPS

[25] Monitoring network upgrades will continue in 2025.

[26] The next SOE State and Trends five-yearly report is due in 2029.

REFERENCES

Wilton, E., 2019. Wanaka, Cromwell and Clyde Air Emission Inventory – 2019. Environet Ltd. https://www.orc.govt.nz/media/12354/emissions-inventory_-clyde-cromwell-and-wanaka-2019.pdf

World Health Organization, 2021. WHO global air quality guidelines: particulate matter (PM2.5 and PM10), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide. https://iris.who.int/handle/10665/345329

APPENDIX 1: PM_{10} Exceedance table for 2024

Site	Alexandra	Arrowtown	Central Dunedin	Mosgiel
Date	**Concentration (µg/m³) 24-hour average**			
17/05/2024	56			
6/06/2024	51			
7/06/2024		59		
8/06/2024		58		
13/06/2024	51			
14/06/2024	61			
20/06/2024	56			
23/06/2024				66
26/06/2024		59		
28/06/2024	58			
30/06/2024	62			
4/07/2024		57		
9/07/2024		58		
10/07/2024		58		
11/07/2024		67		
12/07/2024		80		
13/07/2024		60		
14/07/2024		72		
15/07/2024		71		
21/07/2024		54		
22/07/2024	57			
23/07/2024	56	54		
24/07/2024		64		
26/07/2024	57			
27/07/2024	88			
2/08/2024		55		
3/08/2024		53		
Total number of exceedances	**11**	**16**	**0**	**1**

ATTACHMENTS
Nil