Appendix E: Ambient monitoring data review

REPORT

Tonkin+Taylor

Air Quality Assessment Appendix E - Ambient Monitoring Data Review

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Tonkin & Taylor Ltd
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1 Introduction

New Zealand Steel Limited (NZ Steel) is the New Zealand-based subsidiary of Australasian company Bluescope Steel, producing steel slab, billets and a variety of processed steel products at the Steel Mill at Mission Bush Road, Glenbrook (the 'Site'). NZ Steel is seeking replacement consents for the continuation of the discharges authorised by both the Main Air Permit (DIS80296529) and the Commercial Iron Plating Air Permit (DIS60363772).

This report, which forms Appendix E to the Air Quality Assessment (AQA), summarise the extensive air quality monitoring that has been undertaken in the vicinity of the Operational Area. Air quality monitoring has been undertaken for a variety of different contaminants. The results from continuous instrumental monitoring methods are reported over different averaging periods to correspond with the averaging periods of the assessment criteria for that contaminant (for example air quality guidelines for PM_{10} are expressed as 24-hour and annual averages). This report presents statistical summary information and, where appropriate, compares the measured concentrations with relevant assessment criteria. This information is used to inform the evaluation of the effects of emissions to air from the Site, which is set out in the AQA.

2 Historical ambient air quality monitoring

Ambient air quality monitoring has been carried out in various forms around the Site since 1966, before the Steel Mill was commissioned. Early air quality monitoring was carried out by the Department of Health (DoH) (the regulatory body at the time) and comprised a mixture of monitoring for deposited particulate and Total Suspended Particulate (TSP), both as 7-day averages. The DoH operated 20 different monitoring sites around the Site at various times. From 1988 to 1999, NZ Steel operated a number of additional deposition gauges to measure deposited particulate as a 30-day average, to better align with the deposited particulate assessment criterion in use at the time. The dust deposition monitoring was disestablished after a review of the usefulness of the data (which was found not to correlate with dust complaints). Consequently, the historical deposited particulate monitoring is not discussed in this report.

In January 1995, NZ Steel installed two high volume samplers to measure PM_{10} (particulate less than 10 micron in aerodynamic diameter) at the Training Centre (Site 3) and NZS Northern Boundary (Site 4B) monitoring sites (see Table 2.1). This followed the publication in 1994 of the first ambient air quality guidelines for New Zealand, which included a 24-hour average guideline value for PM_{10}. A further PM_{10} monitor was installed in April 1998.

In 1998, NZ Steel commenced monitoring using six medium volume sampling units (Partisols) to measure TSP as a 24-hour average. The pre-existing 7-day samplers were retained for a short period of time before being disestablished.

The Partisol and high volume sampler methods for TSP and PM_{10}, respectively, are both gravimetric sampling methods whereby airborne dust is captured on a filter and the weight of particulate is determined. The monitoring results are calculated as a 24-hour average concentration. Sampling was carried out over a 24-hour period on a 1-day-in-6 basis (i.e., monitoring was undertaken every sixth day). Table 2.1 summarises the locations and time periods of monitoring undertaken using these methods. Monitoring is still undertaken at some of these locations (using different techniques). However, when the Main Air Permit was granted, it required monitoring to be undertaken using different (continuous) methods, as discussed in the following section.

Table 2.1: Historical TSP and PM_{10} monitoring sites and parameters

Site ID	Location	TSP (24-hour average)		PM_{10} (24-hour average)	
		Start Date	End Date (if relevant	Start Date	End Date
3	NZS Training Centre	January 1998	2009	January 1995	December 2006
4	NZS Northern Boundary	January 1998	ongoing	January 1995	1998/99 (partial)
5	Carters Farm	1998	December 2008	-	-
17	Glenbrook School	January 1998	June 2007	April 1998	July 2007
18	Boundary Rd	1998	2009	-	-
19	Sandspit Reserve	1998	2008	-	-

3 Current ambient air quality monitoring

3.1 Air quality monitoring required by the current resource consent

The Main Air Permit requires monitoring for TSP (at two locations) and PM_{10} (at three locations) at locations to be agreed with the Auckland Regional Council (now the Auckland Council) (Conditions 27 to 32). The consent requires the monitoring to be carried out using equipment taking "continuous measurements". Consequently, the Partisols and high-volume samplers described in the previous sub-section were phased out and Beta Attenuation Monitors (BAMs) were installed. BAMs provide a continuous near-real time measure of particulate concentrations and can be fitted with size selective inlets to measure TSP, PM_{10} or $PM_{2.5}$.

In agreement with the Auckland Council, BAMs were installed at the following locations between 2007 and 2008.

Monitoring for TSP:

- NZS Training Centre (Site 3),
- Boundary Rd (Site 18).

Monitoring for PM_{10}:

- Glenbrook School (Site 18),
- Sandspit Reserve (Site 19),
- 64 Glenbrook Beach Rd (Site 20).

The monitoring locations are shown on Appendix A Figure 1 in Appendix A.

In addition to particulate concentrations, meteorological data is also collected at all the sites listed above. A summary of the wind speed/direction mast heights and other relevant data is included in Appendix B.

As there can be systematic differences between results obtained using different monitoring methods, the historical and current TSP and PM_{10} monitoring datasets have not been combined. Therefore, for the purposes of this report, the historical air quality monitoring data (described in the previous section) has not been included in the evaluation.

3.2 Air quality monitoring to inform the consent application

In addition to the TSP and PM_{10} monitoring required by the Main Air Permit described above, NZ Steel has undertaken additional monitoring specifically to obtain information to support the resource consent applications.

Monitoring for the following contaminants has been undertaken in accordance with the monitoring methods stipulated in the National Environmental Standards for Air Quality (NESAQ):

1 Monitoring for particulate less than 2.5 micron ($PM_{2.5}$) (using a BAM):
   a 64 Glenbrook Beach Rd (Site 20.)
2 Monitoring for sulphur dioxide (SO_2) (using a molecular UV-fluorescence analyser):
   a NZS Training Centre (Site 3) and then moved to Glenbrook School (Site 18),
   b 64 Glenbrook Beach Rd (Site 20).
3 Monitoring for total oxides of nitrogen (NO_x) and nitric oxide (NO) (using a chemiluminescence analyser):
   a 64 Glenbrook Beach Rd (Site 20).

Additional monitoring was undertaken for specific contaminants not managed under the NESAQ, as follows:

- Deposited metals at 64 Glenbrook Beach Rd (Site 20), NZS Northern Boundary (Site 4B[1]) and Boundary Rd (Site 19) using deposition gauges.
- Dioxins and furans (PCDD/F) and poly-aromatic hydrocarbons (PAHs) using a high volume sampler and solid filter media (PUF/XAD) at 64 Glenbrook Beach Rd (Site 20).
- Suspended metals and black carbon at NZS Northern Boundary (Site 4B) based on analysis of 1-day-in-6 TSP filters collected using a partisol.

For completeness, it is noted that three rounds of testing for metals in roof-collected drinking water from dwellings in the area were collected and analysed to support the findings of the deposition gauge monitoring. As this monitoring is not ambient air quality monitoring, the results are not summarised in this report. The analysis can instead be found as Appendix I of the AQA.

3.3 Summary of available ambient air quality monitoring data

A summary of the ambient air quality monitoring locations, contaminants monitored and the locations in this report where the data is summarised, is shown in Table 3.1. The locations of the monitoring stations are shown on Figure 1 in Appendix A.

[1] Site 4B is close to the original NZS Northern Boundary monitoring site (Site 4)

Table 3.1: Available ambient monitoring data

Site name	Site ID number	Classification of monitoring site	Approximate distance and direction from nearest Operational Area boundary	Contaminant	Monitoring period	Section of this Report
Training Centre	3	On-site	~0.1 km northeast	TSP	Sept 2008 - Current	6
				SO_2	March 2017 – June 2018	7
NZS Northern Boundary	4B	Boundary (within the Site)	~1.1 km north northwest	Deposited metals	Sept 2017 – Dec 2019	9
				Suspended metals	May 2018 – Current	9.3
				Black carbon	May 2018 – May 2019	11
Glenbrook School	17	Off-site (sensitive receptor)	~1.3 km east	PM_{10}	Feb 2007 – Current	6
				SO_2	June 2018 – June 2020	7
Boundary Road	18	Background (west of Site)	~1.4 km west	TSP	Sept 2008 – Current	6
				Deposited metals	Sept 2017 – Dec 2019	9
Sandspit Reserve	19	Background (closest urban centre)	~2.3 km south	PM_{10}	June 2007 – Current	6
64 Glenbrook Beach Road	20	Boundary (within the Site)	~0.6 km northeast	PM_{10}	Dec 2008 – Current	6
				$PM_{2.5}$	March 2018 – Feb 2021	6
				SO_2	March 2017 – June 2020	7
				NO_X	Nov 2018 – Feb 2021	8
				Deposited metals	Sept 2017 – Dec 2019	9
				PCDD/F and PAHs	Nov 2019 – Feb 2020[b]	9.3

Notes:

an Operational Area boundary shown in Appendix A Figure 1

b Data is not available for all months in this period.

4 Techniques used to evaluate and summarise monitoring data

Various techniques have been used to evaluate and summarise the monitoring data selected as appropriate to the nature of the data available. For example, some techniques can only be used for continuous monitoring data, i.e. for particulate matter (Section 6), sulphur dioxide (Section 7) and oxides of nitrogen (Section 8).

Summary statistics

Average and 75th percentile values over all the monitoring data have been tabulated. Where relevant, the summary statistics include a comparison of maximum measured concentrations with the relevant assessment criterion adopted in the AQA.

The selection of assessment criteria is described in Section 7.1 of the AQA. Sources include the ambient air quality standards set in the NESAQ, the New Zealand Ambient Air Quality Guidelines (AAQG) and the Auckland Ambient Air Quality Targets (AAAQT) as set in the Auckland Unitary Plan (AUP).

Environmental Performance Indicator categories

Environmental Performance Indicator (EPI) categories are a technique for reporting monitoring data within concentration bands using air quality categories, as shown in Table 4.1 below.

Table 4.1: Environmental performance indicator categories

Category	Value relative to guideline	Comment
Excellent	Less than 10% of the guideline	Of little concern
Good	Between 10% and 33% of the guideline	Peak measurements in this range are unlikely to affect air quality
Acceptable	Between 33% and 66% of the guideline	A broad category where no particular action is generally necessary
Alert	Between 66% and 100% of the guideline	A warning level, which can lead to the guideline being exceeded if trends are not curbed
Action	More than 100% of the guideline	The NES provides for one allowable exceedance per year

Bivariate polar plots of pollutant concentrations, wind speed and wind direction

Bivariate polar plots illustrate how the average concentration of a contaminant varies with wind speed and direction. The monitoring site is situated at the centre of the polar plot, the radius shows the wind speed, and the colour gradient indicates the mean concentration of the contaminant over all measurements under those wind speed and direction conditions. Polar plots assist in identifying likely sources (upwind directions) of contaminants in the vicinity of the monitoring site. The relationship between wind speed and average concentration can provide clues as to source type or distance from the monitor.

Time-varying trends

Analysis of time-varying trends, such as plots of hourly, daily and monthly averages has been used to investigate the particulate monitoring data at 64 Glenbrook Beach Rd (Site 20) (see Section 6.4) to help differentiate the influence of different sources on measured concentrations.

5 Use of wind speed and direction data

Wind speed and direction data have been used in the polar plots and time-varying trend plots to help identify likely sources of contaminants and in understanding background concentrations of contaminants (i.e. levels of contaminants in the absence of contributions from the Steel Mill).

The wind speed and direction conditions at each monitoring site are summarised in Appendix B using annual wind roses.

The patterns of predominant wind directions are similar at all sites except for Sandspit Reserve (Site 19). This site has very low wind speeds and an (unusual) predominance of south easterly winds that are almost absent from the other wind roses. The wind rose patterns suggest that this site is sheltered from the predominant southwesterlies. The Sandpit Reserve (Site 19) PM_{10} monitoring site does not show any influence of emissions from the Steel Mill and therefore this finding is not material to any of the analysis in this report.

64 Glenbrook Beach Rd (Site 20) is a key monitoring site relied on to evaluate the impacts of emissions from the Site. In 2018, wind direction data was not recorded for 18% of the year at this site. Wind direction measurements for 2018 and 2019 this location were also found to be uncharacteristic compared to previous years, showing a higher proportion of westerlies compared to the usually dominant southwesterlies. Similar meteorological variations were not observed in these years at the other monitoring stations, such as the Training Centre (Site 3) or Boundary Rd (Site 18), which generally showed consistent patterns year to year. A possible explanation is that the wind direction monitor at 64 Glenbrook Beach Rd (Site 20) was incorrectly calibrated over this period. Given the uncertainty over the wind data recorded in 2018 and 2019, corresponding wind data collected at the Training Centre (Site 3) has been used in the analysis of pollutant concentrations at 64 Glenbrook Beach Rd (Site 20) in these years.

6 Particulate matter

6.1 TSP

6.1.1 Summary statistics

24-hour average TSP monitoring data at the NZS Training Centre (Site 3) and Boundary Road (Site 18) are summarised in Table 6.1.

Table 6.1: Ambient TSP concentration monitoring summary statistics

Parameter	Boundary Road (Site 18)	NZS Training Centre (Site 3)
Start of data	01 November 2008	01 November 2008
End of data*	31 July 2021	31 July 2021
24-hour		
Average (µg/m^3)	12.5	26.7
75th percentile (µg/m^3)	16.5	32.0

* End of data refers only to evaluation for this report.

6.1.2 Comparison with investigation trigger level

The Main Air Permit (Condition 31) includes a TSP Investigation Trigger Level of 80 µg/m^3. Although not stated in the Permit, this level is expressed as a 24-hour average concentration. Current good practice guidance is more focussed on acute (short term) effects of dust and the recommended trigger level is 250 µg/m^3 as a 1-hour average for moderately sensitive receiving environments[2]. An assessment of the measured TSP concentrations against this recommended acute trigger level is set out in Section 8.5.1 of the AQA.

The Training Centre (Site 3) monitoring site is much closer to the Steel Mill's activities than off-site sensitive receptors (such as dwellings). Therefore, the TSP levels measured at the Training Centre are not considered to be representative of levels that would occur at dwellings. However. monitoring at this location is useful to inform on-site dust management. The Boundary Rd monitoring site is indicative of background dust levels (i.e. not related to the Steel Mill).

Figure 6.1 below shows the number of days in each year where 24-hour average concentrations exceeded the Investigation Trigger Level set in the Main Air Permit.

[2] Ministry for the Environment. (2016). Good Practice Guide for Assessing and Managing Dust. Wellington. Table 4, p30

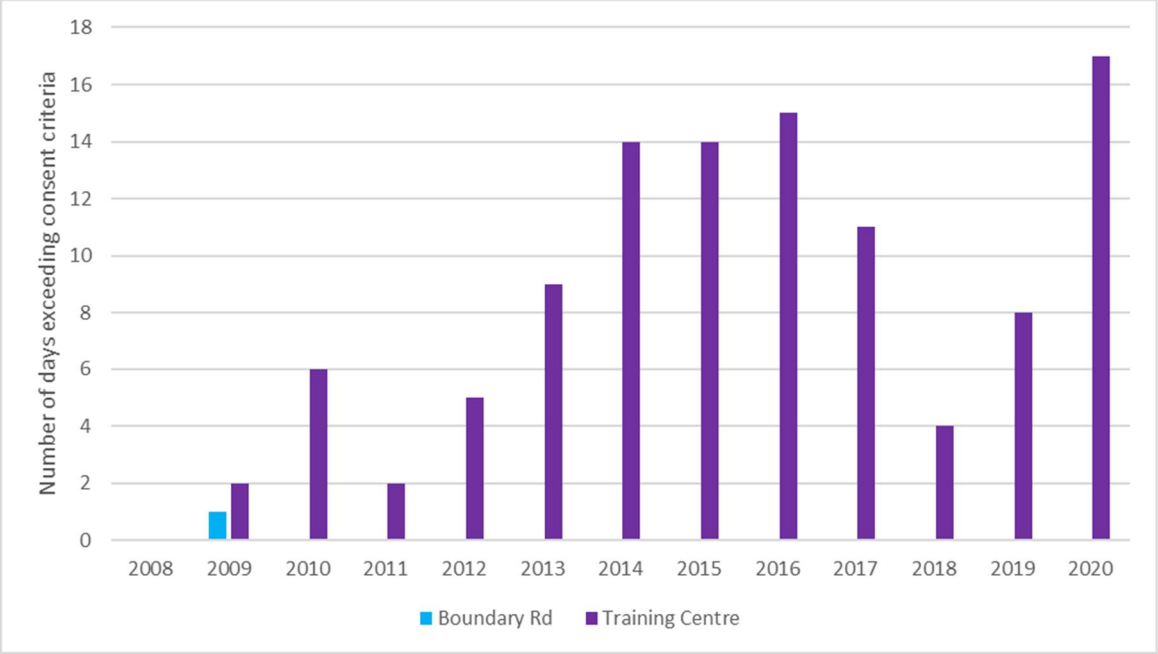

Figure 6.1: Count of days above the 80 µg/m^3 Investigation Trigger level as a 24-hour average for TSP at monitored sites (2008 – 2020)

6.1.3 Polar plots

Polar plots of TSP measurements at the Training Centre (Site 3) and Boundary Road (Site 18) are shown below in Figure 6.2. Polar plots graphically depict the pollutant concentration (in this case the mean hourly TSP concentration) under different combinations of wind speed and wind direction. Where the plot is grey, this indicates there was a very low incidence of this combination of wind speed and direction conditions and therefore an average concentration has not been calculated.

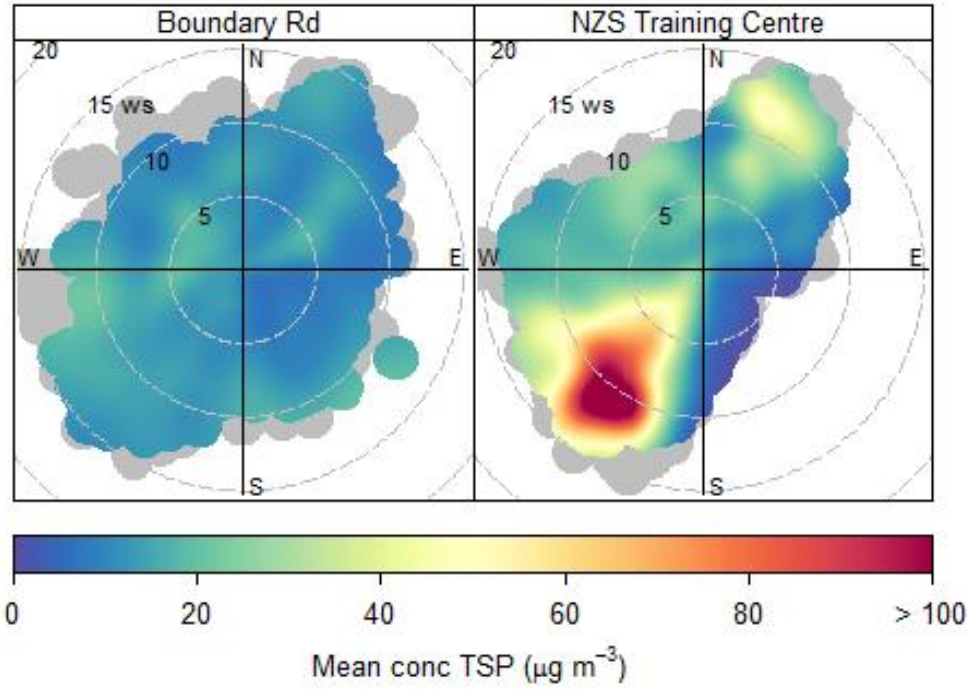

Figure 6.2: Bivariate polar plots of average hourly TSP concentration, wind speed and wind direction at Boundary Road (Site 18) (L) and the Training Centre (Site 3) (R), 2009 - 2020

The polar plot for the Training Centre (Site 3) shows that the mean hourly TSP concentrations are highest during high wind speed (>10 m/s) from the south southwest (the direction of the Operational Area at the Steel Mill). Average TSP concentrations are higher under high wind speeds compared to low wind speeds, which is consistent with increased wind pick up of dust from open areas and stockpiles. Overall, this data is likely to reflect the influence of fugitive dust from raw materials, waste and co-product handling. Further discussion of TSP influences at the Training Centre (Site 3) monitoring location, such as seasonal and weekday variations, are set out in Section 6.4.

The Training Centre (Site 3) polar plot also indicates a secondary (lesser) source during high winds from the northeast. This is likely to be fugitive dust emissions from NZ Steel landfill-related activities which are not part of the scope of the consent replacement application but are noted as they form part of the environment against which effects of the current application are assessed.

The polar plot for Boundary Rd (Site 18) does not suggest any material influence of sources in the upwind direction of the Site (which is to the east of the Boundary Rd monitor).

6.2 PM_{10}

6.2.1 Summary statistics

As outlined in Section 3.1, three monitoring sites are maintained for PM_{10} in the areas surrounding the Steel Mill: 64 Glenbrook Beach Rd (Site 20), Glenbrook School (Site 17) and Sandspit Reserve (Site 19).

It is important to note that the monitors measure the cumulative PM_{10} levels from all sources, which will include natural sources (such as marine aerosols, soil particles and pollen), dust generated by agricultural activities, and emissions from the Steel Mill activities. While the background levels of PM_{10} have been estimated in Appendix D2, the ambient air quality standards in the NESAQ apply to

cumulative exposure and therefore cumulative measured concentrations are considered in Table 6.2 (i.e., background concentrations have not been deducted).

Table 6.2: Ambient PM_{10} concentration summary statistics

Parameter	64 Glenbrook Beach Road (Site 20)	Glenbrook School (Site 17)	Sandpit Reserve (Site 19)
Start of data	12 February 2008	15 February 2007	15 June 2007
End of data*	31 July 2021	31 July 2021	31 July 2021
24-hour average			
Average over all data (µg/m^3)	16.6	13.0	13.6
75th percentile over all data (µg/m^3)	21.5	17.4	18.0
Annual average			
Maximum annual mean (µg/m^3) (based on calendar year)	19.5 (2019)	16.1 (2019)	15.6 (2019)
No. > AAQG (20 µg/m^3)	0	0	0

* End of data refers only to evaluation for this report. Ambient monitoring is a requirement of air permit, so continues beyond this end date.

6.2.2 Comparison with assessment criteria

The applicable human health assessment criteria for PM_{10} are:

- 50 µg/m^3 as a 24-hour average set by the NESAQ; and
- 20 µg/m^3 annual average value set in the AAQG and as an AAAQT. There have been no measured exceedances of the AAQG value at any of the monitoring sites.

Figure 6.3 shows the number of days in each year where 24-hour average PM_{10} concentrations were greater than the NESAQ value at each of the monitoring sites. Further discussion of the implications of these monitoring results with respect to possible effects on people's health are set out in Section 7.2 of the AQA.

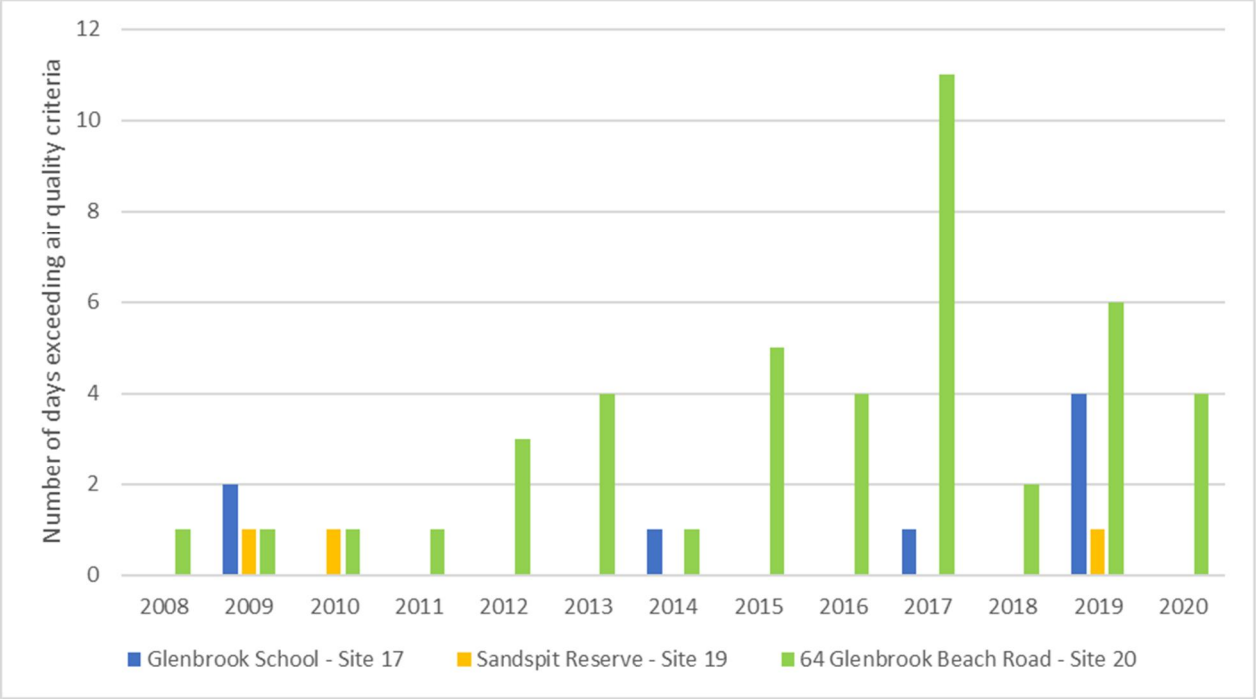

Figure 6.3: Count of days exceeding NESAQ for PM_{10} at monitored sites

The 64 Glenbrook Beach Rd (Site 20) monitoring site is the closest monitoring location beyond the boundary of the Site, at a location that is considered representative of the most affected off-site sensitive receptors. Measured 24-hour average concentrations of PM_{10} at 64 Glenbrook Beach Rd have been greater than the ambient air quality standard set in the NESAQ on a number of occasions over the last 12 years of monitoring, as shown in Figure 6.3. Annual average concentrations are consistently below the AAQG value.

Further information on some of the measurements is provided below:

- In 2009, PM_{10} concentrations above 50 µg/m^3 (24-hour average) were recorded at all monitoring sites on the same day. High PM_{10} values were recorded across much of New Zealand at this time, caused by long range transport of particulate matter from Australian dust storms.
- There were four days in 2019 where PM_{10} concentrations at Glenbrook School (Site 17) were greater than 50 µg/m^3 (24-hour average). These four occasions have been investigated in more detail and were found to be unlikely to be related to activities at the Steel Mill for the following reasons:
  - On one of the days the 24-hour PM_{10} level was above the NESAQ value at all three PM_{10} monitoring sites during low speed north-westerly wind conditions. This is considered likely to be attributable to long range transport of particulate from Australian bushfires as elevated concentrations were seen across most of the air quality monitoring sites in the Auckland region;
  - Windspeeds on two of the days were low and from the north-northwest (i.e. not from the direction of the Steel Mill), suggesting PM_{10} was likely to be due to agricultural activities rather than the Site; and
  - On the remaining day, concentrations were very high over a 3-hour window when windspeeds were very low and from the northeast, suggesting emissions from a nearby activity such as open burning rather than the Site.

6.2.3 Environmental performance indicator categories

Air quality measurements at the three PM_{10} monitoring sites are depicted graphically in terms of EPI categories in Figure 6.4 (64 Glenbrook Beach Rd (Site 20)), Figure 6.5 (Glenbrook School (Site 17)) and Figure 6.6 (Sandspit Reserve (Site 19)).

The monitoring data collected at 64 Glenbrook Beach Rd (Site 20) demonstrates 'Acceptable' or better 24-hour average PM_{10} concentrations compared to the NESAQ for 90 to 96% of days (depending on the year).

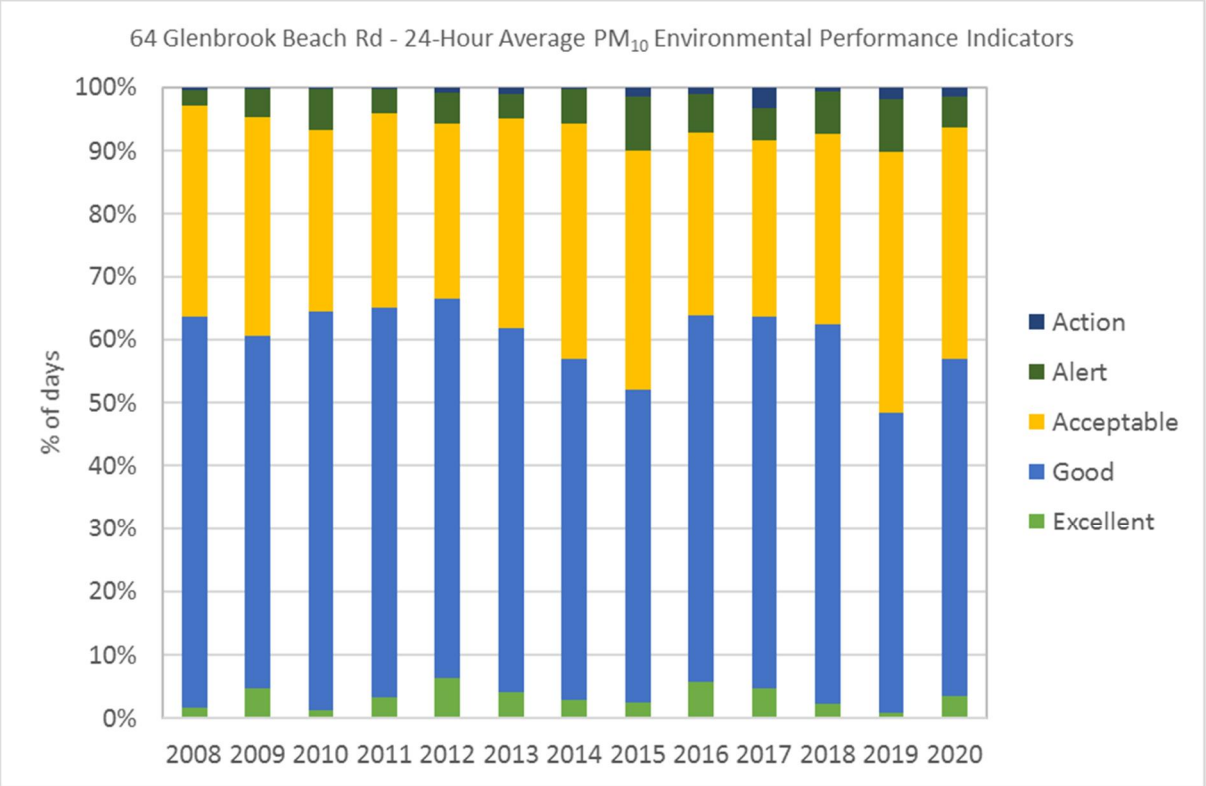

Figure 6.4: PM_{10} air quality at 64 Glenbrook Beach Rd (Site 20) by EPI category – comparison against 24-hour average NESAQ

The Glenbrook School (Site 17) PM_{10} monitoring data is 'Acceptable' or better for 99% of the data for all years except 2019. All sites showed worse PM_{10} air quality in 2019, which is discussed further below.

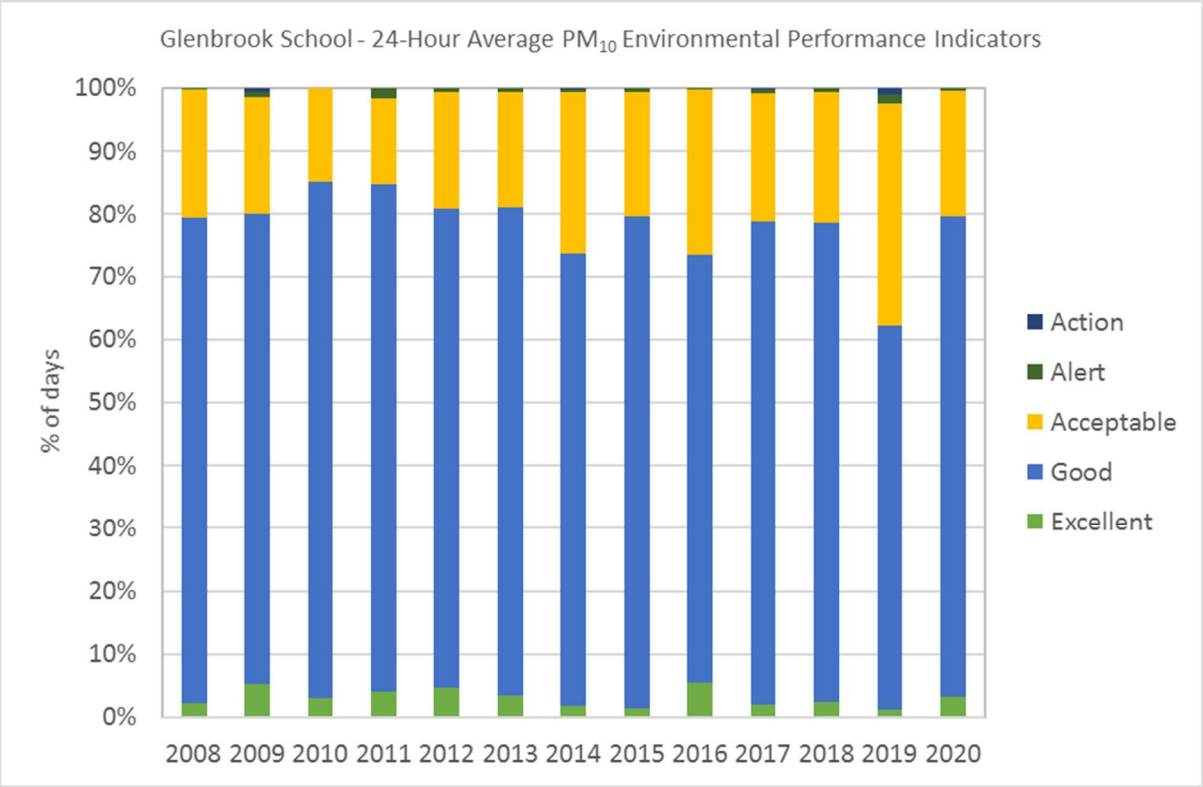

Figure 6.5: PM_{10} air quality at Glenbrook School (Site 17) by EPI category – comparison against 24-hour average NESAQ

At Sandspit Reserve (Site 19), 99% of data can be categorised as 'Acceptable' or better. Air quality at this site does not appear to be affected by the Steel Mill but will be influenced by local urban sources such as domestic heating.

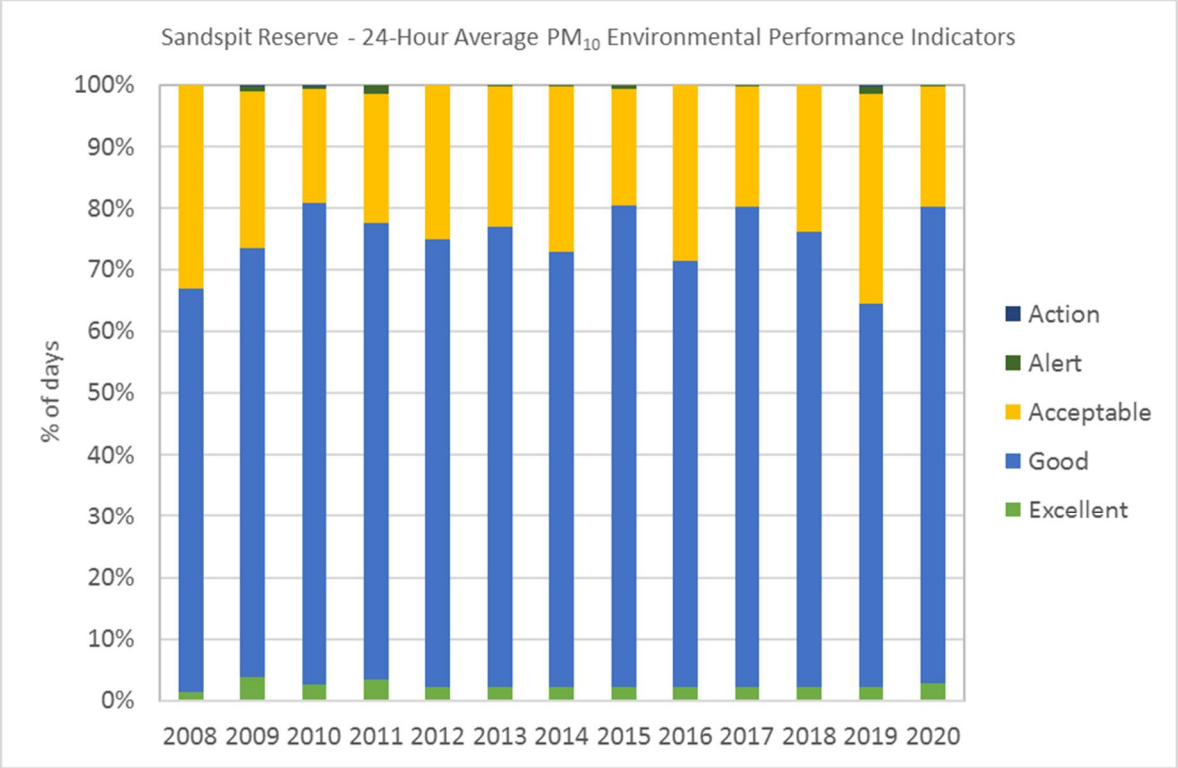

Figure 6.6: PM_{10} air quality at Sandspit Reserve (Site 19) by EPI category – comparison against 24-hour average NESAQ

PM_{10} air quality in 2019 at all sites was relatively poor (a decrease in the proportion of Good and Excellent rated days) when compared with other years. Annual average PM_{10} concentrations at other monitoring sites in the Auckland region (apart from Takapuna) showed a similar pattern (see Figure 6.7). The poorer air quality in 2019 compared to the previous 3 years is likely to be attributable to long range transport of particulate from the Australian bushfires.

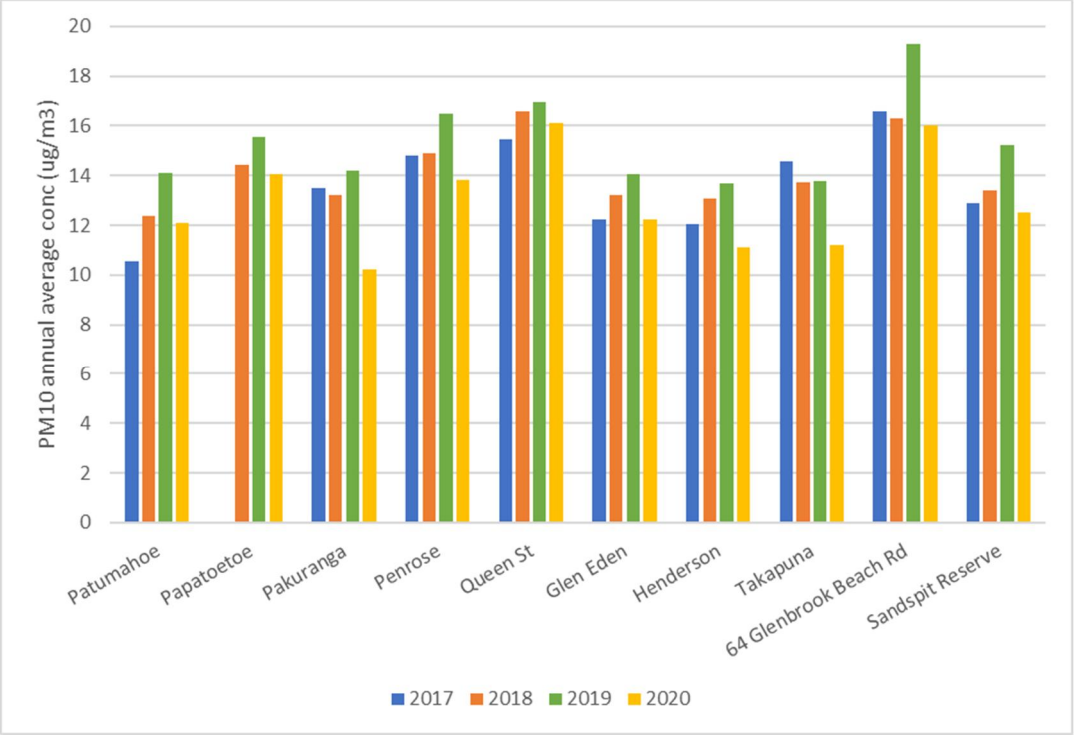

Figure 6.7: Annual average PM_{10} concentrations at Auckland Council Monitoring Stations, with 64 Glenbrook Beach Rd (Site 20) and Sandspit Reserve (Site 19) data represented to the right.

6.2.4 Polar plots

Polar plots for mean hourly PM_{10} concentrations at the three monitoring sites are shown in Figure 6.8. Changes at each site over time and annual variations can be seen in the yearly polar plots shown in Appendix C of this report. The key features and interpretation of the polar plots are as follows:

- 64 Glenbrook Beach Rd (Site 20) clearly shows the influence of emissions from the Steel Mill at the monitoring site. Individual yearly polar plots shown in Appendix C Figure 1 to this report illustrate how average PM_{10} concentrations, when winds are from the direction of the Steel Mill, have increased over time. There has not been any increase in particulate stack emissions over this time and therefore this increase is likely to be due to increasing emissions of fugitive dust from raw material, waste and co-product storage and handling at the northern end of the Steel Mill, as discussed in Section 6.4.
- The slightly higher PM_{10} concentrations experienced at both Glenbrook School (Site 17) and Sandspit Reserve (Site 19) under westerly winds is suggestive of the influence of marine aerosols. This pattern likely also underlies the monitoring data at 64 Glenbrook Beach Rd (Site 20).
- Sandspit Reserve (Site 19) does not show any influence of PM_{10} from the direction of the Steel Mill (to the north). As discussed in Section 5, the wind patterns recorded at Sandspit Reserve shows a very low incidence of stronger speed southwesterly winds. This monitoring site appears to be sheltered from the typically dominant wind direction in the wider area.

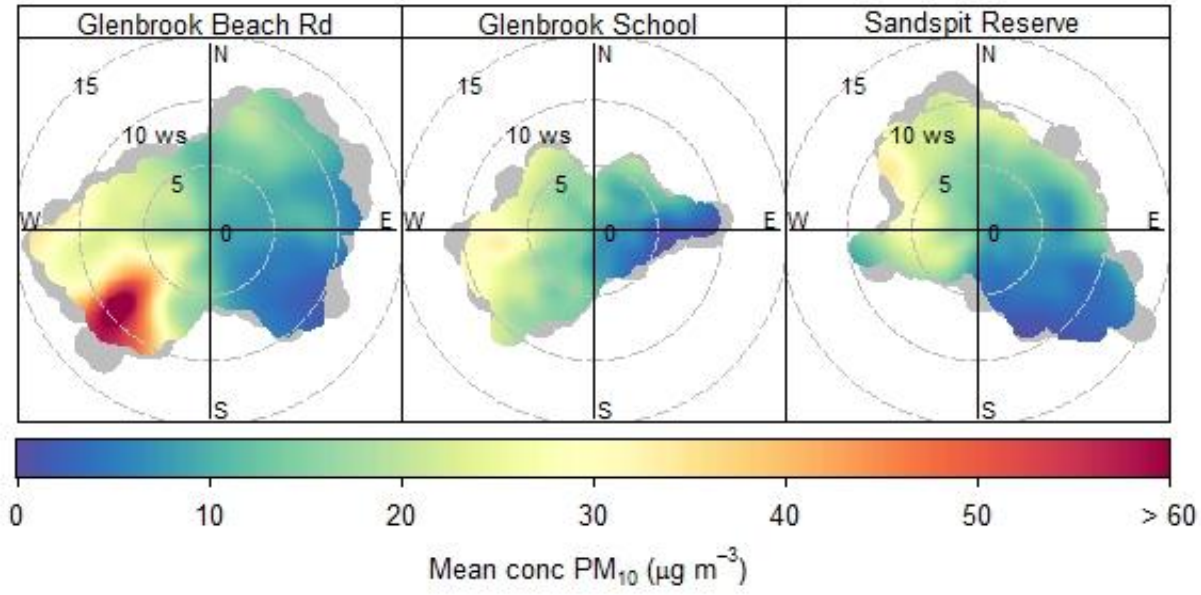

Figure 6.8: Bivariate polar plots of average hourly PM_{10} concentration, wind speed and wind direction, n at 64 Glenbrook Beach Rd (Site 20) (L), Glenbrook School (Site 17) (C), Sandspit Reserve (Site 19) (R), 2008 - 2020

6.3 $PM_{2.5}$

6.3.1 Summary statistics and comparison with assessment criteria

As with PM_{10}, the measured $PM_{2.5}$ concentrations include the contribution from all sources, both anthropogenic and natural. While the background levels of $PM_{2.5}$ have been estimated in Appendix D of this report, ambient air quality guidelines apply to cumulative exposure and therefore cumulative measured concentrations are considered in Table 6.3 (i.e. background concentrations have not been deducted).

Summary statistics for $PM_{2.5}$ measured at 64 Glenbrook Beach Rd (Site 20) are presented in Table 6.3. The monitoring results are all below the proposed NESAQ values of 25 µg/m^3 (24-hour average) or 10 µg/m^3 (annual average).

Table 6.3: Ambient $PM_{2.5}$ concentration summary statistics

Parameter	64 Glenbrook Beach Road (Site 20)
Start of data	16 March 2018
End of data	28 February 2021
24-hour average	
Average (µg/m^3)	6.2
Maximum (µg/m^3)	22.3
75th percentile (µg/m^3)	9.4
No. > proposed NESAQ (25 µg/m^3)	0
Annual average	
Annual mean (based on calendar year) (µg/m^3)	6.5 (2019) 6.0 (2020)
No. > proposed NESAQ (10 µg/m^3)	0

6.3.2 Environmental performance indicator categories

Measured air quality at 64 Glenbrook Beach Rd (Site 20) is depicted graphically in terms of the EPI categories in Figure 6.9. Data collected at this station shows that 99% of all days are Acceptable or better, and there were no measurements above the proposed NESAQ value.

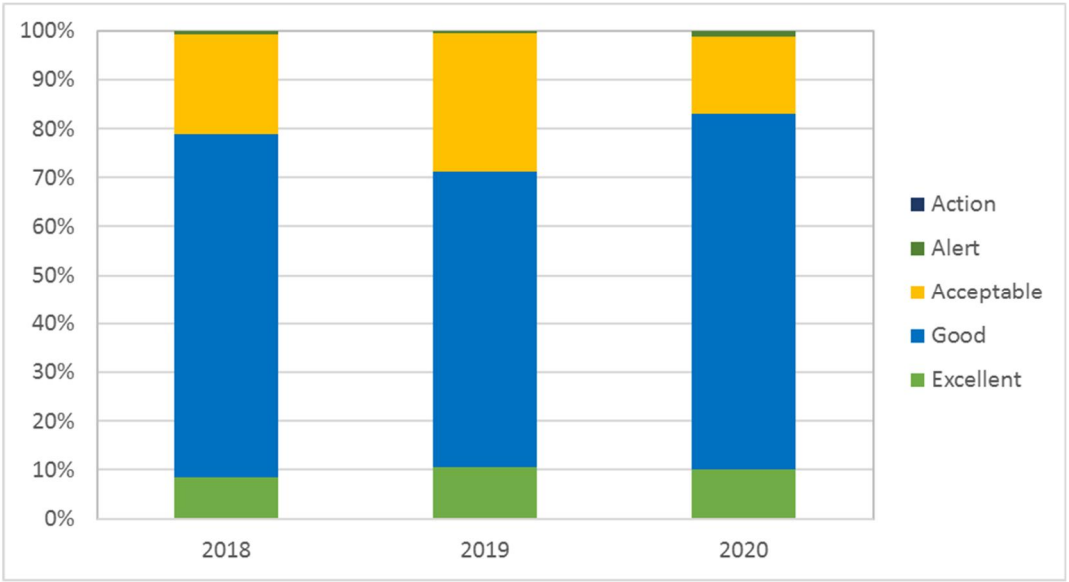

Figure 6.9: $PM_{2.5}$ air quality by EPI category – comparison of measurements at 64 Glenbrook Beach Rd (Site 20) against proposed 24-hour average NESAQ limit as set out in the 2020 proposed amendments.

6.3.3 Polar plot

The polar plot for $PM_{2.5}$ (Figure 6.10) illustrates that there is a significant source to the southwest of the 64 Glenbrook Beach Rd (Site 20) monitor, which corresponds with the location of the Steel Mill. The darker spot (wind speed and direction conditions under which higher average concentrations occur) is less diffuse than the pattern shown for PM_{10}, which suggests a more localised source compared to PM_{10}. This would be consistent with the main source(s) of $PM_{2.5}$ being stack sources rather than fugitive sources in the northern yard, which cover a larger area. The highest average

concentrations also occur under a narrower range of wind speed conditions compared to the PM_{10} data, which is again indicative of a more discrete source (or sources).

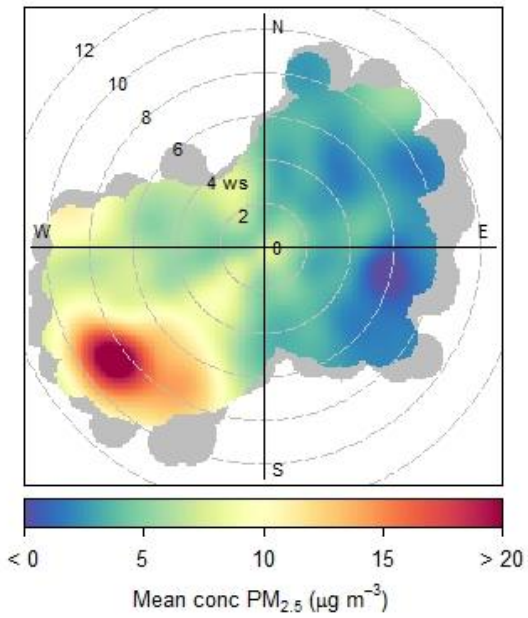

Figure 6.10: Bivariate polar plot of average hourly $PM_{2.5}$ concentration, wind speed and wind direction at 64 Glenbrook Beach Road (Site 20)

6.4 Evaluation of data patterns to infer significant sources of particulate matter

6.4.1 Introduction

There are a variety of different sources of particulate matter emissions at the Steel Mill, including:

- Discrete stack sources with varying emission rates and physical parameters;
- Fugitive emission sources associated with manufacturing processes and with raw material, waste and co-product storage and handling; and
- Heavy vehicle movements on site roads.

Fugitive dust from materials storage and handling and truck movements are likely to mainly comprise coarser particles that will be measured as TSP and, to a lesser extent PM_{10}. Although there may be a very small component of fugitive dust that will be in the $PM_{2.5}$ size fraction, $PM_{2.5}$ will mostly be associated with process emissions (stack or fugitive emissions). The largest discrete emission sources of $PM_{2.5}$ at the Steel Mill are the MHF and Kiln Stacks.

Understanding the relative contribution of the different potential sources (or source types) of particulate matter to off-site concentrations is important in identifying priorities for emission reduction. This is particularly important for PM_{10} because concentrations at 64 Glenbrook Beach Rd (Site 20) are above the NESAQ value at times.

6.4.2 Time- and wind speed-dependent patterns

Time-varying plots of TSP concentrations at the NZS Training Centre (Site 3) and PM_{10} and $PM_{2.5}$ concentrations at 64 Glenbrook Beach Rd (Site 20) have been compared to identify patterns in these

metrics. Figure 6.11, Figure 6.12 and Figure 6.13 present plots showing how the mean concentrations of these pollutants vary by:

- Hour-of-the-day and week (upper plot);
- Day-of-the-week (bottom right-hand plot); and
- Month-by-month (bottom middle plot).

These figures also include a plot of hourly normalised concentration and wind speed (bottom left-hand plot in each figure).

Bivariate polar plots of PM_{10} concentrations at 64 Glenbrook Beach Rd (Site 20) for weekdays versus weekends (Figure 6.14) and seasonally (Figure 6.15) have also been presented.

The key features and interpretation of these graphs are as follows:

- TSP and PM_{10} concentrations show a distinct diurnal pattern with increased concentrations during the day compared to at night (Figure 6.11 and Figure 6.12, respectively). Peak concentrations occur in the early afternoon, which also coincides with the period of highest average wind speeds. Although a diurnal pattern is still apparent on the weekends, it is less marked. As wind patterns will be the same on weekends compared to weekdays, the difference in average concentrations is most likely due to differences in emission sources.
- Bivariate polar plots of PM_{10} concentrations at 64 Glenbrook Beach Rd (Site 20) for weekends compared to weekdays (Figure 6.14) also supports the finding that average concentrations are lower on weekends. Overall, this suggests there are some high dust-generating activities at the Steel Mill that occur only on weekdays. Activities at the Steel Mill that are likely to contribute to weekday (but not weekend) PM_{10} levels are discussed in Section 8.3.3 of the AQA.
- There is a strong correlation between higher windspeeds and higher TSP and PM_{10} concentrations. TSP and PM_{10} concentrations are highest during the summer months and lowest in the winter. These features point towards dust generated from outdoor materials handling and vehicle movements as important sources of TSP and PM_{10} (emissions from these sources will be greatest during dry windy conditions).
- The patterns in $PM_{2.5}$ monitoring data have significant differences to the patterns in TSP and PM_{10}. Average $PM_{2.5}$ concentrations show only a weak seasonal trend and are the same on all days of the week. The relationship between concentration and wind speed is inverted for $PM_{2.5}$ compared to TSP and PM_{10}, with higher wind speeds (which tend to occur through the middle of the day) being associated with lower concentrations. This suggests that the main source(s) of $PM_{2.5}$ are continuous stack emission sources, which will be better dispersed under high wind speed conditions resulting in lower ground level concentrations.
- Coal stockpiling and handling is expected to be one of the more significant fugitive dust sources at the Site. A recent study[3] for the Lyttelton Port Company (LPC) on particulate discharges from its coal stockyard at the north-eastern extent of the port in Te Awaparahi Bay included source apportionment analysis of particulate samples collected downwind of the Stockyard. Sampling and analysis of ambient particulate was carried out between 24 December 2020 to 03 May 2021 using ion beam analysis (IBA) techniques to determine the elemental composition of the samples. This study found that 90% of the PM_{10} attributable to coal was present in the coarser fraction ($PM_{2.5} – PM_{10}$) with only approximately 10% sub-$PM_{2.5}$. This further supports a conclusion that fugitive sources, particularly coal, have a minor contribution to $PM_{2.5}$ levels off site.

[3] Tonkin & Taylor Ltd. Coal Stockyard, Air Quality Assessment, August 2021

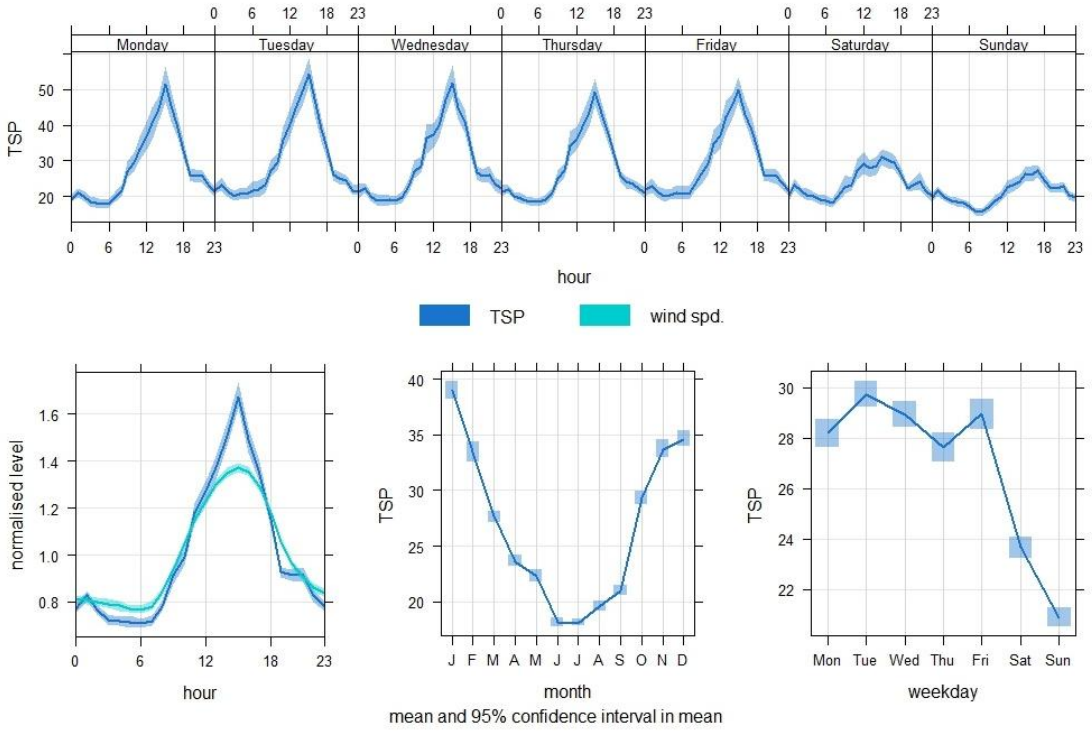

Figure 6.11: Time and wind-speed dependent plots for one hour averaged TSP concentrations at the NZS Training Centre (Site 3), 2008-2020

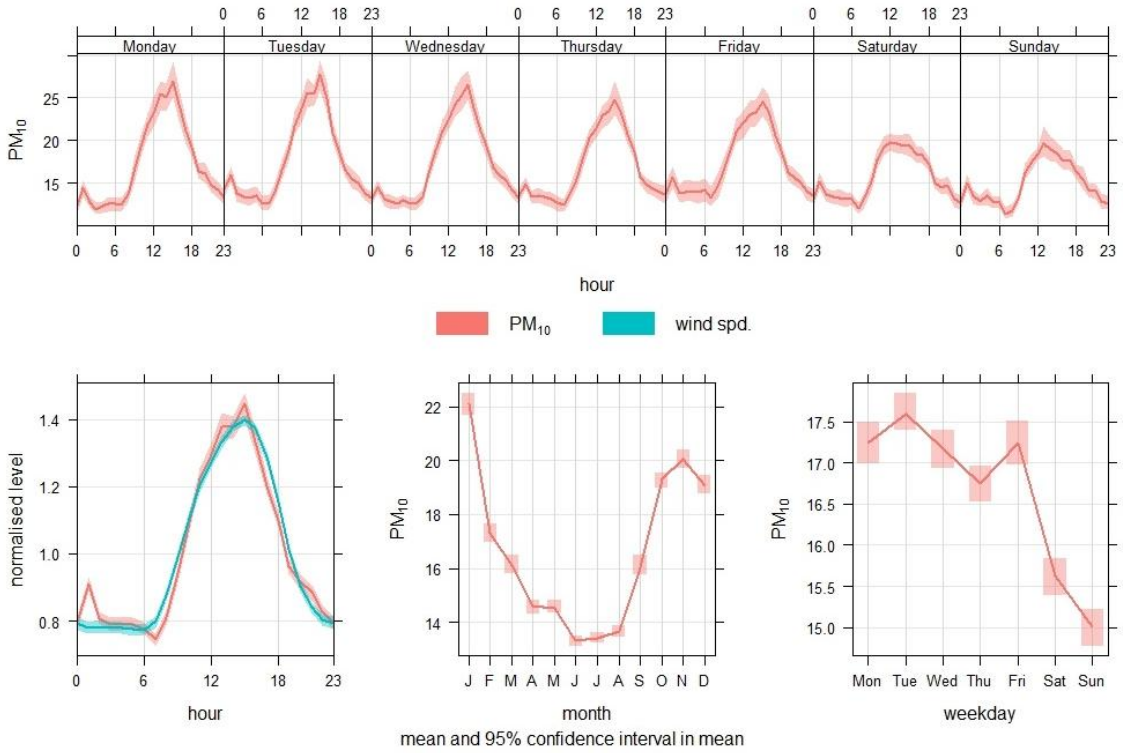

Figure 6.12: Time and wind-speed dependent plots for one hour averaged PM_{10} concentrations at 64 Glenbrook Beach Rd (Site20), 2008-2020

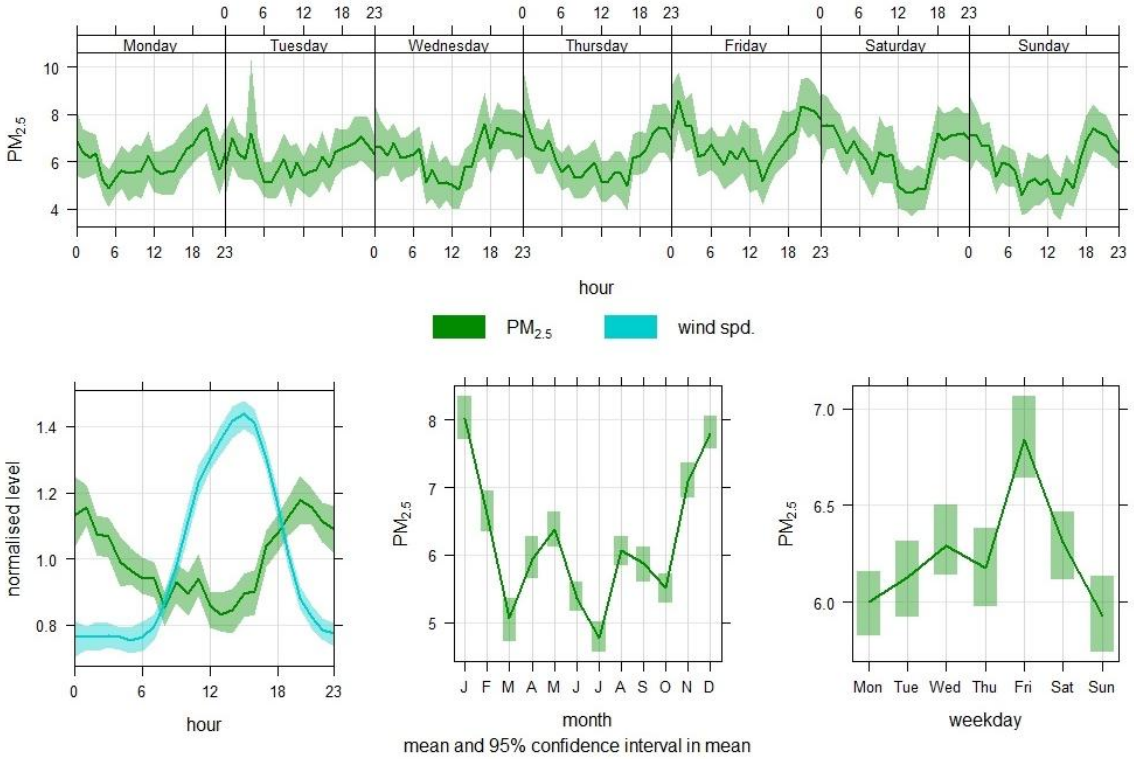

Figure 6.13: Time and wind-speed dependent plots for one hour averaged $PM_{2.5}$ concentrations at 64 Glenbrook Beach Rd (Site 20), 2018-2020

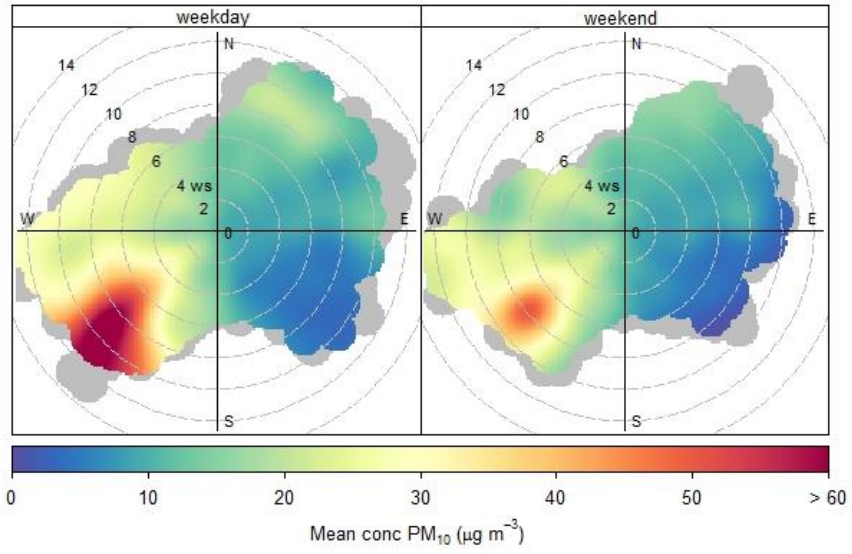

Figure 6.14: Bivariate polar plots for mean PM_{10} concentrations, weekday dataset (left) and weekend dataset (right) at 64 Glenbrook Beach Rd (Site 20), 2008-2020

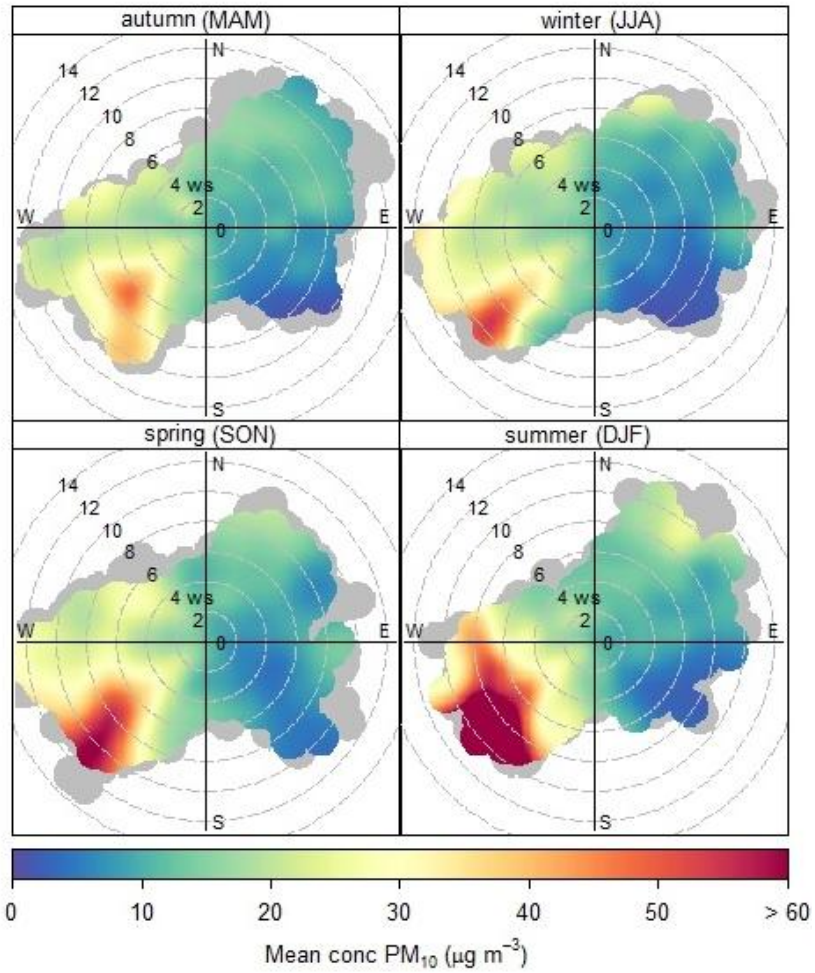

Figure 6.15: Bivariate polar plots for mean PM_{10} concentrations, data split by season as indicated, at 64 Glenbrook Beach Rd (Site 20), 2008-2020

6.4.3 Relationship between PM_{10}, $PM_{2.5}$ and SO_2 concentrations at 64 Glenbrook Beach Rd (Site 20)

The relationship between concentrations of PM_{10}, $PM_{2.5}$ and SO_2 at 64 Glenbrook Beach Rd (Site 20) have been investigated to assist in understanding relative source contributions. Various time-dependent plots for these contaminants are compared in Figure 6.16 and bivariate polar plots of $PM_{2.5}$ and SO_2 are shown in Figure 6.17.

The MHF stacks and, to a lesser extent the Kiln stacks, in the Iron Plant are the main source of SO_2 emissions at the site. The MHFs and Kiln stacks are also the most significant stack emission sources of $PM_{2.5}$ at the Steel Mill. The strong similarity in time-varying patterns of $PM_{2.5}$ and SO_2, and the clear differences compared to the patterns of PM_{10} support the hypothesis that PM_{10} measurements at 64 Glenbrook Beach Rd are dominated by fugitive emission sources while $PM_{2.5}$ is dominated by emissions from the MHF and Kiln stacks.

The polar plots show that the highest average concentrations of $PM_{2.5}$ and SO_2 occur under very similar wind speed and direction conditions, further supporting the conclusion that the Kilns and MHFs are the main source contributors to measured levels of both contaminants.

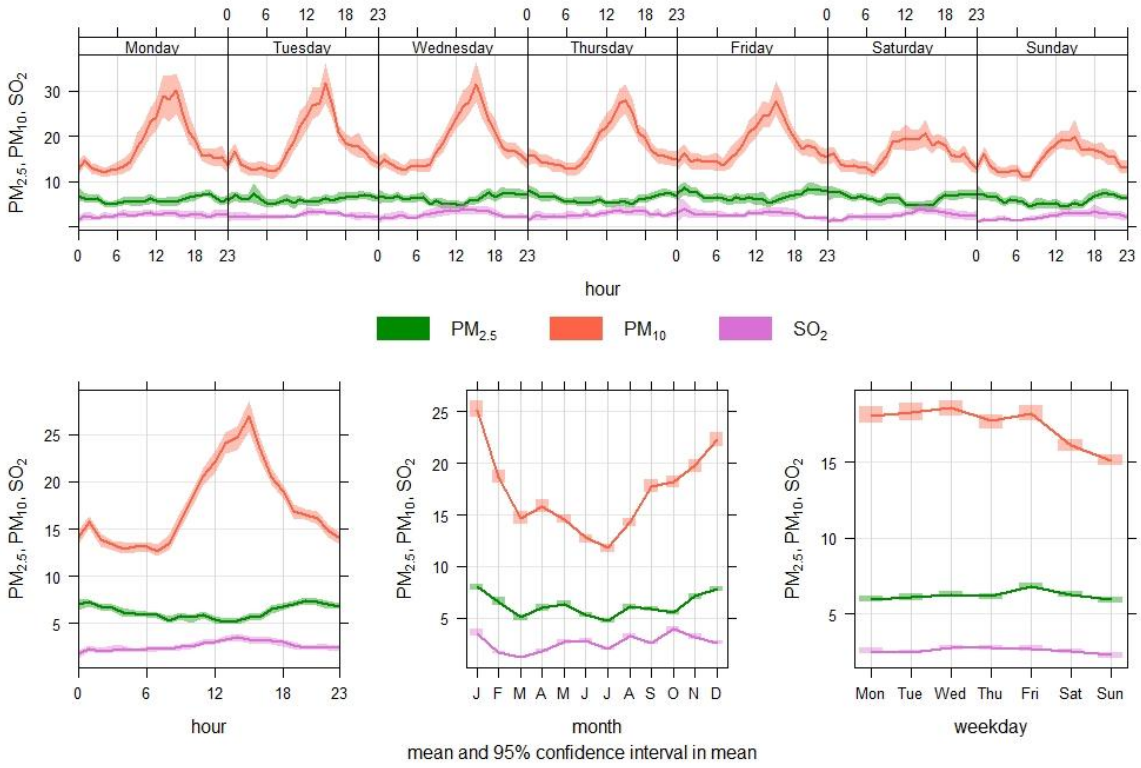

Figure 6.16: Time-dependent plots of hourly PM_{10}, $PM_{2.5}$ and SO_2 at 64 Glenbrook Beach Rd (Site 20) (PM_{10} and SO_2 datasets 2017-2020, $PM_{2.5}$ dataset 2018-2020)

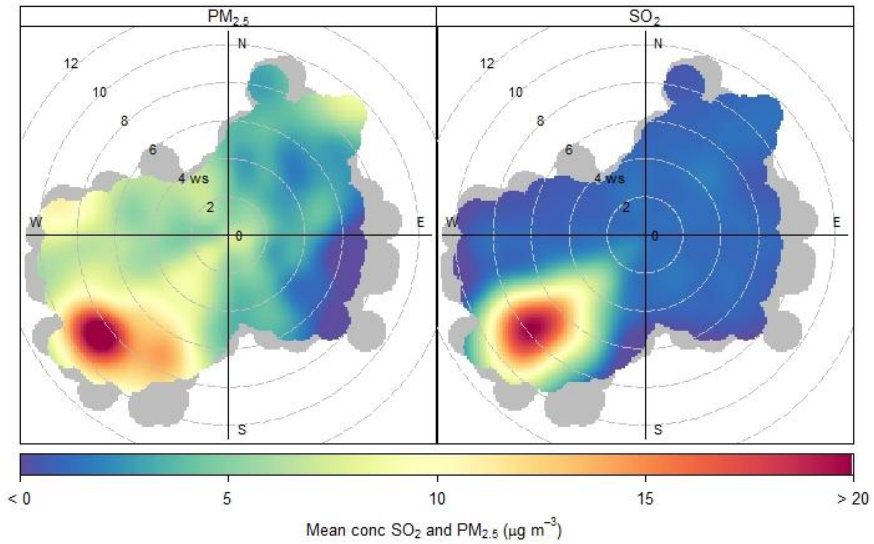

Figure 6.17: Bivariate polar plots for $PM_{2.5}$ (left) and SO_2 (right) at 64 Glenbrook Beach Rd (Site 20) (March 2018-June 2020)

7 Sulphur dioxide

7.1 Summary statistics and comparison with assessment criteria

The SO_2 monitoring results are summarised in Table 7.1.

Table 7.1: Ambient SO_2 concentration monitoring summary statistics

Parameter	64 Glenbrook Beach Road (Site 20)	Glenbrook School (Site 17)
Start of data	24 March 2017	01 June 2018
End of data*	30 June 2020	30 June 2020
1-hour average		
Average (µg/m^3)	2.6	0.9
Maximum (µg/m^3)	101.2	24.0
75th percentile (µg/m^3)	1.9	0.9
No. > NZ AAQG (350 µg/m^3)	0	0
24-hour average		
Average (µg/m^3)	2.6	0.9
Maximum (µg/m^3)	31.7	8.6
75th percentile (µg/m^3)	2.4	1.0
No. > NZ AAQG (120 µg/m^3)	0	0
No. > WHO guideline (20 µg/m^3)	Total: 10 2017 (8 months): 4 2018: 3 2019: 1 2020 (6 months): 2	Total: 0 2018: 0 2019: 0 2020 (6 months): 0
Annual average		
Annual mean (based on 2019 calendar year) (µg/m^3)	3.0	0.9

* End of data refers only to evaluation for this report.

7.2 Comparison with assessment criteria

7.2.1 Assessment criteria for protection of human health

There were no exceedances of the NESAQ value of 350 µg/m^3 (1-hour average) or AAQG value of 120 µg/m^3 (24-hour average) for SO_2 at any of the monitored sites.

The monitoring results have also been compared against the WHO 24-hour average guideline value of 20 µg/m^3 (24-hour average) as a secondary assessment criterion (noting this guideline value is lower than the current AAQG but does not have any regulatory status in New Zealand). As shown in Table 7.2, measured concentrations have occasionally exceeded the WHO guideline at the 64 Glenbrook Beach Rd (Site 20) monitoring site. The maximum measured 24-hour average concentration at Glenbrook School (Site 17) is less than half (43%) of the WHO guideline.

Table 7.2: Exceedances of the WHO 24-hour average guideline for SO_2 at 64 Glenbrook Beach Rd (Site 20)

Date of exceedance	24-hr average concentration (µg/m^3)
4/05/2017	31.7
19/05/2017	26.4
14/06/2017	25.4
15/10/2017	22.3
25/08/2018	31.4
5/11/2018	21.2
26/12/2018	29.6
25/10/2019	28.5
4/01/2020	22.5
6/01/2020	23.6

NZ Steel undertook a review in 2018 of the MHF operating conditions and meteorological conditions for the days listed in Table 7.2 (up to 5/11/2018) and for days when the 24-hour average SO_2 concentration recorded at the Training Centre (Site 3) exceeded 20 µg/m^3. This review found that higher SO_2 concentrations are strongly correlated with wind speed and direction from the Steel Mill (which is not unexpected). While some of the peaks coincided with adjustments to the Primary Concentrate feed rate or combustion air addition, there was no clear relationship (on some occasions the feed rate had increased, on others it decreased, and for three of the thirteen days reviewed, there were no apparent process condition changes). Of the thirteen days reviewed in December 2018, only one peak coincided with a flap lift at one of the MHFs, indicating that unplanned emissions are not key contributors to elevated off site SO_2.

Overall, it is unlikely that process adjustments or flap lifts explain the elevated SO_2 concentrations, and it is more likely that they are related to meteorological conditions that influence the dispersion of emissions from the MHF stacks.

7.2.2 Assessment criteria for protection of ecosystems

As described in Section 6.2 of the AQA report, there are three critical levels of SO_2 specified in the AAQG for the protection of different terrestrial ecological systems, as follows:

- 30 µg/m^3 for agricultural crops as an annual and winter average;
- 20 µg/m^3 for forest and natural vegetation as an annual and winter average; and
- 10 µg/m^3 for lichen as an annual average only.

Table 7.3 presents the annual and winter average concentrations at the two monitoring sites, for comparison with these assessment criteria. There is little difference between the annual average value and the winter average (calculated for the months of June, July and August) at each site.

SO_2 levels at the two monitoring sites comply with the most stringent ecological criterion of 10 µg/m^3 for protection of lichen and will therefore comply with the criteria for other ecological environments.

Table 7.3: Annual average concentrations of SO_2

Year	Monitoring site			
	64 Glenbrook Beach Rd (Site 20) (µg/m^3)		Glenbrook School (Site 17) (µg/m^3)	
	Annual average	Winter average	Annual average	Winter average
2018	2.7	2.6	N/A*	N/A*
2019	3.0	3.6	0.9	1.0

* Monitoring at Glenbrook School for SO_2 commenced in June 2018

7.3 Environmental performance indicator categories

Air quality at the two monitoring sites is depicted graphically in terms of the EPI categories in Figure 7.1, Figure 7.2 and Figure 7.3 for the different assessment criteria applicable to SO_2.

Figure 7.1 shows that 100% of data can be categorised as Excellent or Good at 64 Glenbrook Beach Rd (Site 20), and 100% Excellent at Glenbrook School (Site 17) when compared with the 1-hour average NESAQ value of 350 µg/m^3.

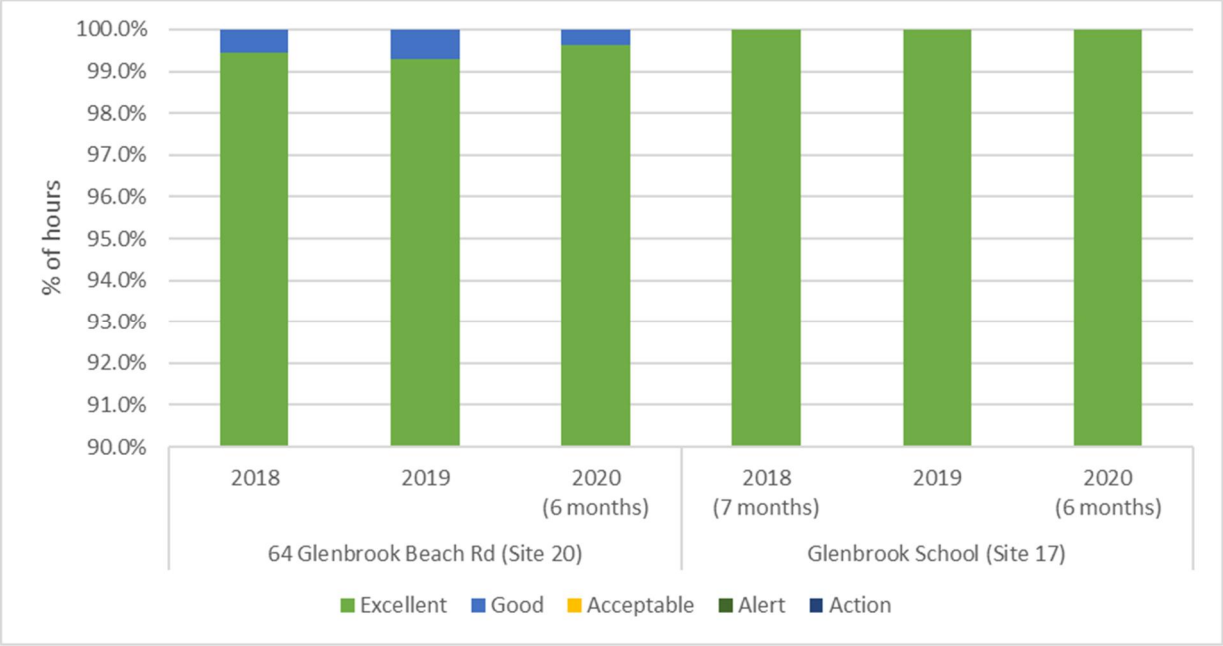

Figure 7.1: SO_2 air quality by EPI category – comparison against 1-hour average NESAQ value

Figure 7.2 shows that 100% of data can be categorised as Excellent or Good at 64 Glenbrook Beach Rd (Site 20), and 100% Excellent at Glenbrook School (Site 17) when compared with the 24-hour average NZ AAQG and AAAQT value of 120 µg/m^3.

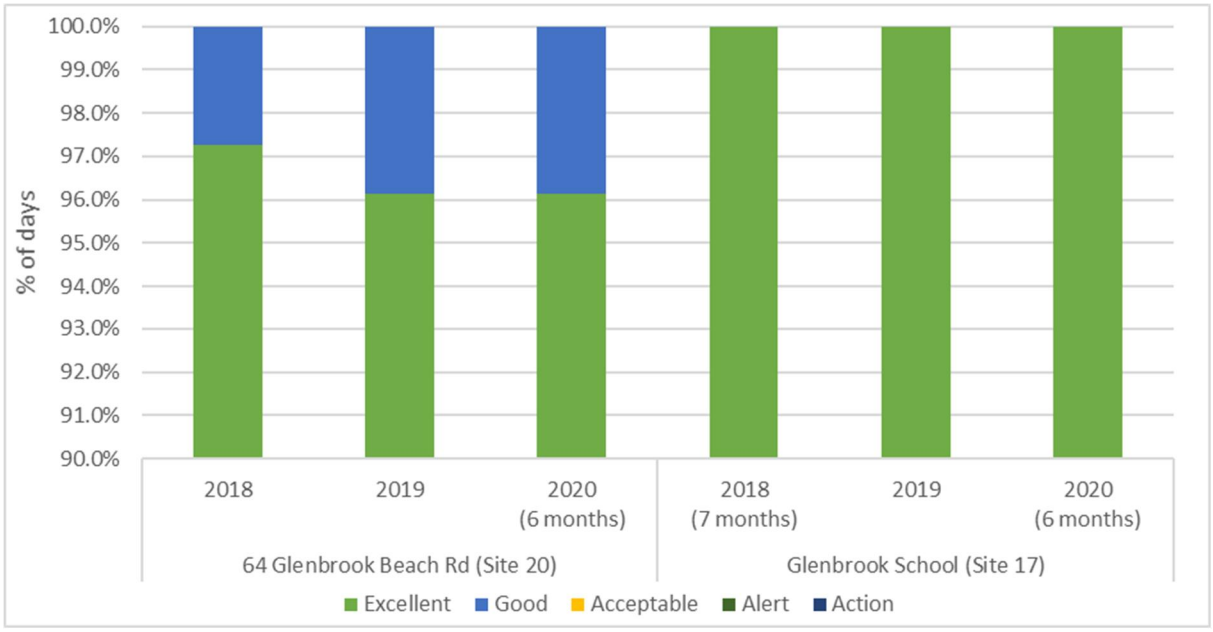

Figure 7.2: SO_2 air quality by EPI category – comparison against 24-hour average NZ AAQG and AAAQT value

Figure 7.3 below shows that between 96-98% of the data can be categorised as acceptable or better at 64 Glenbrook Beach Rd (Site 20).

100% of the data collected at Glenbrook School (Site 17) is categorised as Acceptable or better.

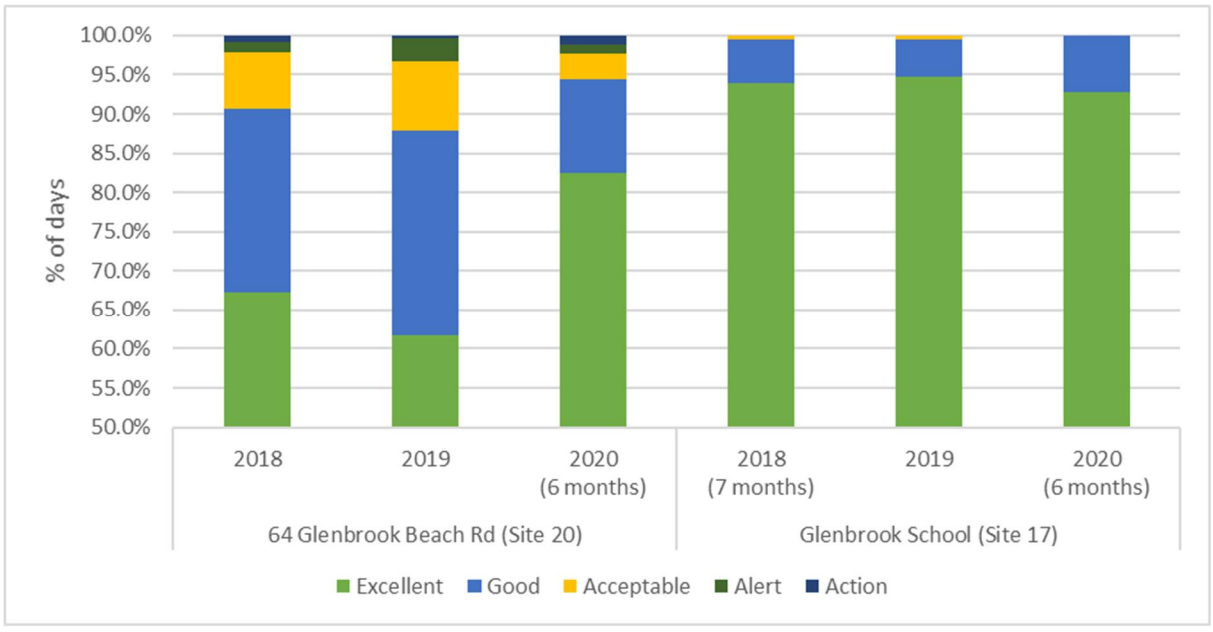

Figure 7.3: SO_2 air quality by EPI category – comparison against 24-hour average WHO guideline

7.4 Polar plots

Polar plots for mean hourly SO_2 concentrations at the two monitoring sites are shown in Figure 7.4. These plots confirm that the Steel Mill is the only appreciable source of SO_2 in the area, as shown by the higher mean concentrations during winds from the southwest of the 64 Glenbrook Beach Rd (Site 20) monitor, and low mean levels for all other wind conditions. A very small influence of SO_2

emissions from the Steel Mill can be seen in the measurements at the Glenbrook School (Site 17) monitor.

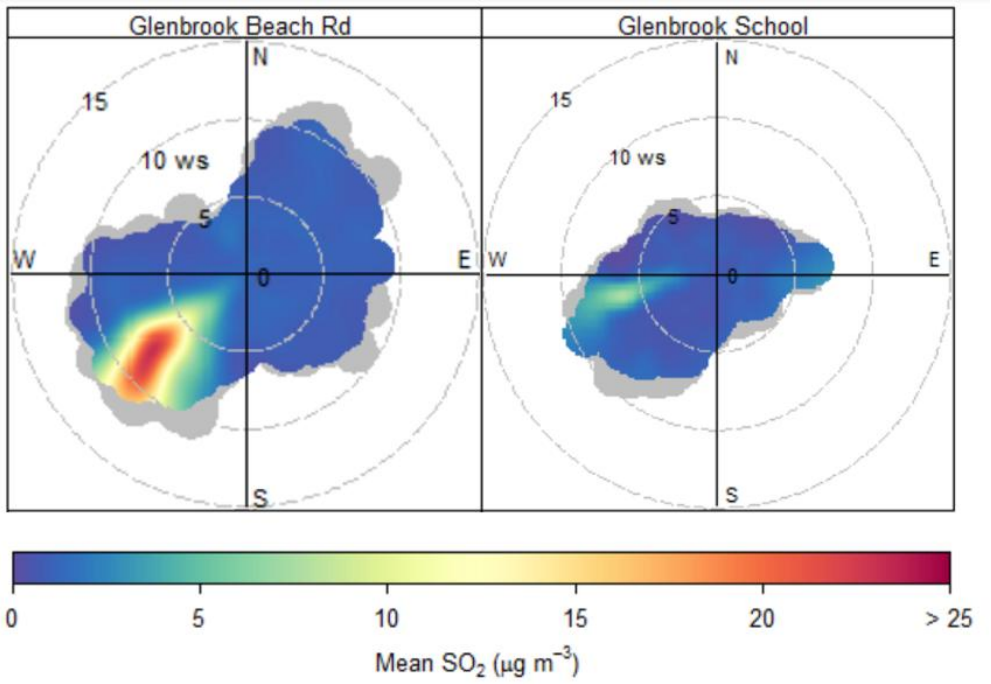

Figure 7.4: Bivariate polar plot of average hourly SO_2 concentration, wind speed and wind direction at 64 Glenbrook Beach Road (Site 20) (left), and Glenbrook School (Site 17) (right)

8 Oxides of nitrogen

8.1 Summary statistics and comparison with assessment criteria

Monitoring for NO and NO_X is carried out using a chemiluminescence gas analyser. NO_2, which is the contaminant of interest with respect to potential effects, is calculated as the balance of NO_X that is not NO. A discussion of atmospheric chemistry reactions involving NO_X and ozone is included as Appendix E.

The available NO_2 data is summarised in Table 8.1.

Table 8.1: Ambient NO_2 concentration monitoring summary statistics

Parameter	64 Glenbrook Beach Rd (Site 20)
Start of data	20 November 2018
End of data	28 February 2021
1 hour average	
Average (µg/m^3)	5.6
Maximum (µg/m^3)	57.0
75th percentile (µg/m^3)	6.9
No. > NESAQ (200 µg/m^3)	0
24-hour average	
Average (µg/m^3)	5.6
Maximum (µg/m^3)	27.9
75th percentile (µg/m^3)	6.9
No. > NZ AAQG and AAAQT (100 µg/m^3)	0
Annual average	
Annual mean (based on calendar year)* (µg/m^3)	6.2 (2019) 5.4 (2020)
No. > AAAQT (40 µg/m^3)	0

* The annual mean values are different to the mean of the 1-hour and 24-hour average values because they are based on a 12-month sub-set of the overall data.

8.1.1 Assessment criteria for protection of human health

There have been no measurements above the NESAQ value of 200 µg/m^3 (1-hour average), the NZ AAQG and AAAQT values of 100 µg/m^3 (24-hour average) or AAAQT value of 40 µg/m^3 (annual average).

8.1.2 Assessment criteria for protection of ecosystems

The AAQG ecological criteria sets a critical level for NO2 of 30 µg/m^3 as an annual average. The annual average concentrations of NO2 at the 64 Glenbrook Beach Rd (Site 20) monitoring site are shown in Table 8.1 above. The annual average concentrations measured in 2019 and 2020 were well below the critical level.

8.2 Environmental performance indicator categories

Measured air quality at the 64 Glenbrook Beach Rd (Site 20) monitoring site is depicted graphically in terms of the EPI categories for human health criteria in Figure 8.1 and Figure 8.2 below. 100% of the data can be categorised as Good or Excellent.

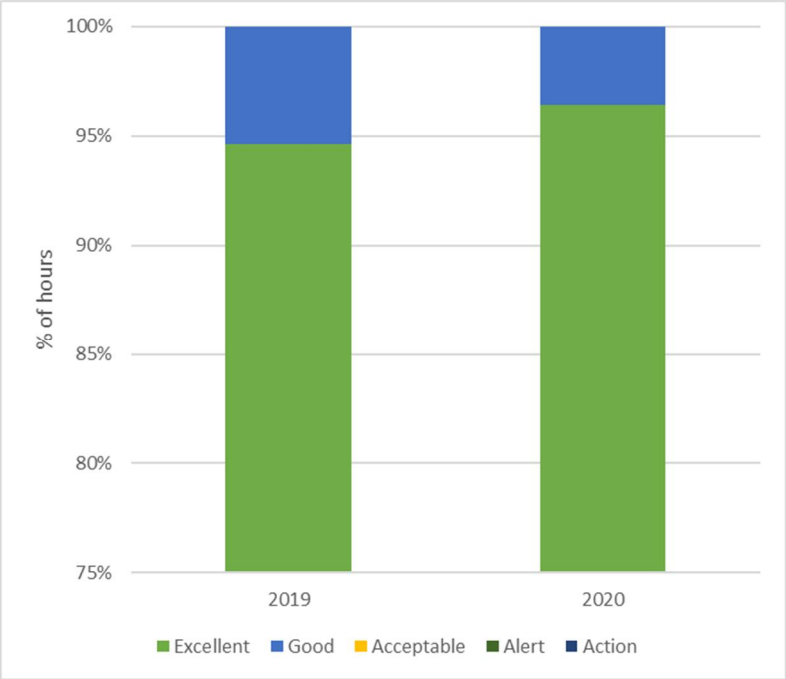

Figure 8.1: NO_2 air quality by EPI category – comparison against 1-hour average NESAQ, 64 Glenbrook Beach Rd (Site 20)

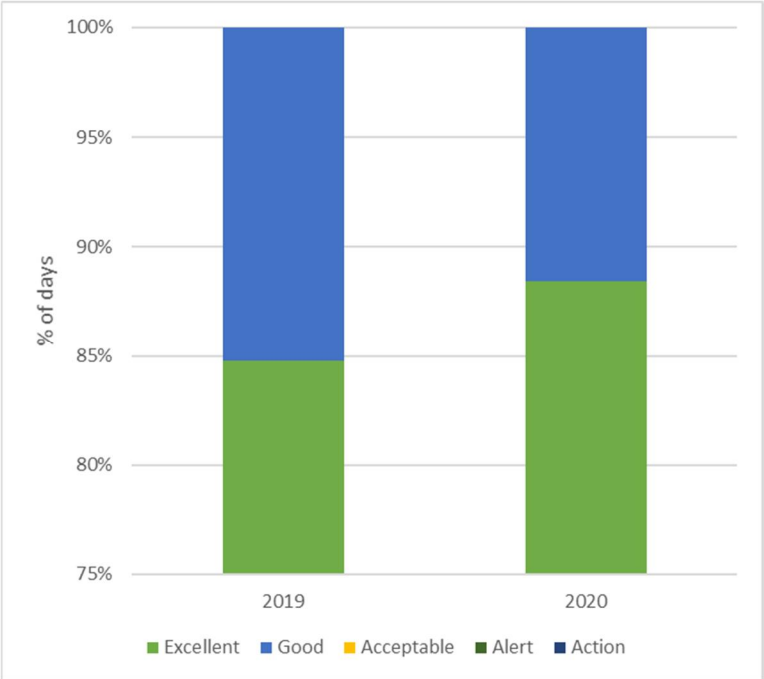

Figure 8.2: NO_2 air quality by EPI category – comparison against 24-hour average AAQG/AAAQT, 64 Glenbrook Beach Rd (Site 20)

8.3 Polar plot analysis

A polar plot of the mean hourly NO_2 concentration at 64 Glenbrook Beach Rd (Site 20) is shown in Figure 7.4. The plot confirms that the Steel Mill is the only appreciable source of NO_2 in the area. The plot is broadly similar to the plot for SO_2, which suggests that they have similar main source contributions.

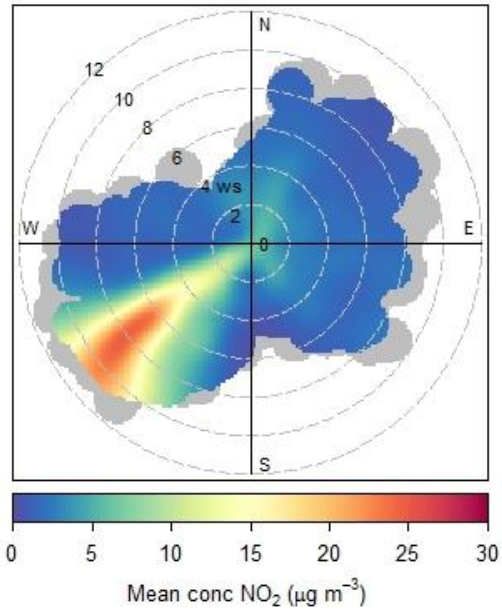

Figure 8.3: Polar plot for the 1-hour averaged NO_2 measurements at 64 Glenbrook Beach Rd (Site 20), November 2018 - February 2021

8.4 Estimated nitrogen deposition rates

A critical nitrogen load of 5 kg/ha/year to protect against soil acidification was suggested in the supporting documentation to the AAQG (Stevenson et al, 2000)[4]. This guideline was developed for use in the European Union and is not formally adopted in the AAQG as it was not considered appropriate due to NZ's very low background nitrogen supply. However, Stevenson *et al* notes that in the NZ context, a total atmospheric load below 5 kg/ha/year is likely to be protective of any local ecosystem.

As with sulphate deposition set out in Section 0, the annual average nitrogen deposition rate has been estimated using UK guidance set out in AQTAG06[5], which specifies the following calculation methodology to estimate the deposition rates from ambient concentrations:

- Conversion from ambient concentration to dry deposition flux using the equation:
  - Dry deposition flux (µg/m^2/s) = ambient concentration (µg/m^3) × deposition velocity (m/s),
  - The recommended dry deposition velocity values for forests are 0.003 m/s for NO_2 and 0.0015 m/s for grasslands.

[4] Stevenson et al. *Effects of Air Contaminants on Ecosystems and Recommended Critical Levels and Critical Loads*. Ministry for the Environment. October 2000.
[5] Habitats Directive 2014. Technical Guidance on Detailed Modelling Approach for an Appropriate Assessment for Emissions to Air – AQTAG06.

- To convert the dry deposition flux from units of µg/m^2/s to units of kg/ha/year, the dry deposition flux is multiplied by the following conversion factors:
  - NO_2 to convert to N: multiply by 96.

The following deposition rates for comparison with the critical load are determined using the 2019 annual average ambient concentration of NO_X (10.9 µg/m^3) at the 64 Glenbrook Beach Rd (Site 20) monitoring site:

- Annual nitrogen deposition rate of 3.1 kg N/ha/year for forests,
- Annual nitrogen deposition rate of 1.6 kg N/ha/year for grasslands.

The nitrogen deposition rates calculated for the 64 Glenbrook Beach Rd (Site 20) monitoring location comply with the critical load considered protective of NZ ecosystems.

9 Metals

9.1 Introduction

There are a variety of metals that may be present in the discharges to air from the Steel Mill. These metals will tend to be present in the solid phase as fine particulate matter. Metals may be present in coarser dust particles that will tend to deposit to the ground or in finer particles that may remain suspended in the air or can be washed out by rainfall.

Monitoring for deposited metals was undertaken at three locations in the vicinity of the Site to identify the extent to which discharges to air from the Site may contribute to deposition rates of metals. Deposition gauge samples collected between September 2017 to December 2019 were analysed by an accredited laboratory. The findings were assessed using a conservative screening approach considering the potential for effects if the measured deposition rates were to occur onto roofs used for collection of drinking water.

Suspended metals were measured by analysis of TSP filters collected at the NZS Northern Boundary (Site 4B) monitoring site as described further in Section 9.3. The filters were collected between 17 June 2018 to 18 June 2019 and the results of analysis compared with the available criteria for chronic exposure to metals.

9.2 Deposited metals

9.2.1 Deposition monitoring method

Deposition gauges were operated at three sites as summarised in Table 9.1 and shown in Appendix A.

The 64 Glenbrook Beach Rd (Site 20) and NZS Northern boundary (Site 4B) sites are representative of deposition rates at off-site locations downwind of the predominant wind direction at varying distances from the Site. The Boundary Rd (Site 18) monitoring site lies across the Waiuku Estuary and is a background site, where air quality is expected to be largely unaffected by NZ Steel's activities.

Table 9.1: Deposition monitor locations

Location	Reference	Approximate distance from Operational Area (m)
Boundary Road (Site 18)	Site 18	1,350 (W)
64 Glenbrook Beach Road (Site 20)	Site 20	620 (NE)
NZS Northern boundary (Site 4B)	Site 4B	1,110 (NE)

The deposition monitoring was undertaken using horizontal deposit gauges in general accordance with the International Standards Organisation method *ISO/DIS 4222-2 Air quality – measurement of atmospheric dustfall – horizontal deposit gauge method*. The equipment consists of a 200 mm straight sided bucket partially filled with water. This collector is exposed for a 30-day period (± 2 days).

The deposition gauge samples were collected for testing at an IANZ accredited laboratory monthly for a suite of metals, both dissolved and insoluble. Results are reported in terms of the concentration of each metal in the sample along with the volume of the sample, such that the mass of deposited metal is calculable. From these test results the 30-day deposition rate is calculated per the ISO/DIS 4222-2 method:

$$D_{30\ days} = (\frac{m}{A_G}) \cdot \frac{30}{t}$$

Where:

$D_{30\ days}$	the 30-day deposition rate for each metal, in milligrams per square meter per 30 days
m	the total (soluble and insoluble) mass of the metal in milligrams collected in the sample
A_G	the cross sectional area in square metres of the gauge aperture (0.031416 m^2)
t	the period, in days, over which the sample was collected

The annual deposition rate has been calculated by multiplying the average 30-day deposition rate by (365/30).

9.2.2 Investigation of Steel Mill influence on deposition rates of metals

Natural sources, such as windblown soil and sand, will contribute to metals deposition rates regardless of any impacts from the Steel Mill emissions. Therefore, to characterise the impacts (if any) of emissions from the Steel Mill, the metals deposition rates at 64 Glenbrook Beach Rd (Site 20) and the NZS Northern Boundary (Site 4B) have been compared with deposition rates at the Boundary Road (Site 18) background monitoring site.

The annual deposition rate of each metal is shown in Table 9.3 along with the result as a percentage of the measurement at the Boundary Road site (Site 18). For ease of reference, the data is sorted from highest to lowest percentage difference at 64 Glenbrook Beach Rd (Site 20). For monitoring site locations refer to Appendix A Figure 1 in Appendix A.

Some of the values in Table 9.3 are negative numbers. This means that the metals deposition rate at the background site is higher than at the monitoring site being considered. This indicates that:

- there is no measurable influence of the Steel Mill's emissions at this location; and
- there is a degree of natural variability in the metals deposition rates, which needs to be considered when interpreting the data.

In this context, the results are colour coded per the key provided in Table 9.2. It is important to note that the deposition rates are all small, i.e., well below 1 gram per square metre over an entire year.

Table 9.2: Steel Mill influence colour key

Degree of influence	% above background reading	Colour
Material influence of NZ Steel activities on deposition rate.	>100%	
Some influence of NZ Steel activities on deposition rate.	25% - 100%	
No influence of NZ Steel activities on deposition rate detected.	≤25%	

Table 9.3: Influence of NZ Steel discharges on metals deposition rates

Metal	Average deposition rate (mg/m^2/year)			Difference between Site 20 and Site 18	Difference between Site 4B and Site 18
	NZS Northern boundary Site 4B	64 Glenbrook Beach Road Site 20	Boundary Road Site 18		
Vanadium	8.9	26.5	3.1	759%	190%
Manganese	19.5	40.1	7.5	434%	160%
Titanium	7.9	17.0	4.5	276%	75%
Cadmium	0.20	0.53	0.19	177%	3%
Cobalt	0.08	0.14	0.05	172%	53%
Iron	107	190	76	150%	41%
Chromium	0.67	0.9	0.46	101%	43%
Boron	18.2	22.2	13.1	70%	39%
Nickel	0.15	0.2	0.17	39%	-15%
Magnesium[1]	607	786	592	33%	3%
Arsenic	0.42	0.45	0.37	21%	15%
Beryllium	0.03	0.03	0.03	4%	18%
Mercury	0.03	0.03	0.03	4%	10%
Copper	1.27	1.20	1.29	-6%	-2%
Zinc	69.7	27.5	29.9	-8%	133%
Aluminium	55.7	47.7	63.0	-24%	-12%
Lead	0.25	0.18	0.28	-35%	-10%

1. The presence of magnesium in all deposition gauges is likely to be indicative of deposition of marine aerosols as seawater contains approximately 1300 ppm magnesium

A clear demonstration of influence of the Steel Mill can be seen in the first ten metals listed in Table 9.3, where both:

a the right-hand cells in Table 9.3 are coloured red or yellow; and

b the deposition rate is higher at 64 Glenbrook Beach Road (Site 20), which is closer to the Site, than at the NZS Northern Boundary (Site 4B)

In the case of zinc, while there is an apparent influence of NZ Steel activities at the NZS Northern Boundary (Site 4B) (red coloured cell), deposition rates at 64 Glenbrook Beach Rd (Site 20) are similar to the background site (Site 18) and lower than at the Northern Boundary (Site 4B). A possible explanation for this is that the NZ Steel landfill, which is closer to the NZS Northern Boundary (Site 4B) than the Steel Mill and is relatively infrequently upwind of 64 Glenbrook Beach Rd (Site 20), may be a source of zinc.

There are no assessment criteria for direct comparison with deposition rates of metals, as the risk to heath depends on subsequent exposure pathways. In order to provide some context for these deposition rates, a screening assessment has been undertaken of the potential for health effects based on a scenario of metals depositing onto roofs used to collect drinking water.

9.2.3 Screening assessment of deposited metals

9.2.3.1 Assessment method

The average annual deposition rate of each metal and the annual rainfall measured at the Site[6] (tenth percentile for a conservative result) has been used to estimate the concentration of deposited metals in a roof-collected drinking water tank (if rainfall were to be collected for this purpose at the monitoring location). The calculation was performed in three steps:

$$M_d = D_{30\ days} \cdot \frac{365}{30} \cdot A_R$$

M_d the annual deposited mass in milligrams of a metal to a roof of surface area A_R

$D_{30\ days}$ the average 30-day deposition rate for each metal, in milligrams per square meter per 30 days

A_R the area of a roof in square meters

$$V = R_A \cdot A_R$$

V the annual volume of rainwater collected from a roof of area A_R

R_A the annual rainfall (tenth percentile)

$$C = \frac{M_d}{V} = \frac{D_{30\ days} \cdot \frac{365}{30} \cdot A_R}{R_A \cdot A_R}$$

C the concentration of the metal in roof collected rainwater, in milligrams per litre

In the calculation, A_R is arbitrary due to being cancelled out in the final calculation step.

The calculated concentrations in drinking water are then compared to drinking water standards. This concentration represents the cumulative contribution of metals by deposition from all sources, including both natural and anthropogenic sources.

9.2.3.2 Assessment criteria for drinking water

Minimum standards for the quality of drinking water in New Zealand to protect public health are set out in the Drinking Water Standards for New Zealand 2005 (revised 2018) (DWSNZ). Maximum Allowable Values (MAVs) are specified for concentrations of metal contaminants (in milligrams per litre) that are considered to *constitute no significant risk to the health of a person who consumes 2 litres of that water a day over their lifetime (usually taken as 70 years)*.

MAVs have not been specified in the DWSNZ for all metals monitored at locations around the Steel Mill. In these cases, the drinking water standards published by the WHO[7] and California Office of Environmental Health Hazard Assessment (OEHHA) have been referred to. Some of the monitored metals have no known health effects and may be dietary essentials or conventional components of drinking water. In these cases, no MAV or provisional MAV can be listed.

The MAVs and source of the value for all deposited metals monitored by NZ Steel are shown in Table 9.4. Where a MAV has not been provided by DWSNZ, the background to the derived value is provided in Appendix F.

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[6] The representative annual rainfall value (1142 mm) is the 10th percentile value of annual rainfall measured at the site between 2010 and 2018. For this assessment, a lower rainfall value will give a higher estimated metal concentration in drinking water.

[7] WHO. (2017). Guidelines for drinking-water quality, 4th edition, incorporating the 1st addendum

Table 9.4: Maximum allowable value in drinking water

Metal deposit	Guideline basis	MAV (µg/L)	Source
Aluminium	Health based guideline	1000	Refer Appendix F
Arsenic	Health based guideline	10	DWSNZ
Beryllium	Health based guideline	4	DWSNZ (previous edition)
Boron	Health based guideline	1400	DWSNZ
Cadmium	Health based guideline	4	DWSNZ
Chromium	Health based guideline	50	DWSNZ (provisional)
Cobalt	Health based guideline	70	Refer Appendix F
Copper	Health based guideline	2000	DWSNZ
Iron	Health based guideline	2000	Refer Appendix F
Lead	Health based guideline	10	DWSNZ
Magnesium	No health-based guideline	-	No provisional guideline
Manganese	Health based guideline	400	DWSNZ
Mercury	Health based guideline	7	DWSNZ
Nickel	Health based guideline	80	DWSNZ
Titanium	No health based guideline	-	No provisional guideline
Vanadium	Health based guideline	15	OEHHA Notification Level, also see Appendix F
Zinc	Health based guideline	7000	Refer Appendix F

9.2.3.3 Screening assessment results

The calculated metal concentrations in drinking water are compared with the corresponding MAVs in Table 9.6. The results are sorted from highest to lowest based on the measurements at 64 Glenbrook Beach Rd (Site 20) and the metals where there may be some influence from the Steel Mill's activities are underlined. The assessment criteria are set for cumulative exposure, so it is appropriate to consider the total deposition rates and not just the contribution from the Steel Mill.

Where a non-detect result was reported in the monitoring results (i.e. the concentration was below the detection limit), a value of half the detection limit was used in the deposition rate calculations as per convention.

The results are colour coded per the key provided in Table 9.5. The assessment criteria are based on MAV's, which typically allocate 10% of the Tolerable Daily Intake to drinking water. This means that a concentration of 50% of the MAV would typically represents 10% of the Tolerable Daily Intake. A threshold of >50% of the MAV is a conservative basis for identifying contaminants that warrant further investigation.

Overall, this data suggests that vanadium is the only metal where deposition rates are sufficiently high to warrant further consideration. The exposure pathway for vanadium has been reviewed in detail in the AQA Section 7.4

Table 9.5: Screening assessment colour key

% of MAV	Colour
≥ 50 %	
≥ 25 %	
≥ 0	
No MAV	

Table 9.6: Screening assessment results (comparison of estimated drinking water concentrations with MAVs)

Metal	MAV	Site 4B NZS Northern boundary		Site 20 64 Glenbrook Beach Rd		Site 18 Boundary Road	
		Conc.	% of MAV	Conc.	% of MAV	Conc.	% of MAV
Unit	µg /L	µg/L	%	µg/L	%	µg/L	%
Vanadium	15	7.83	52.2%	23.17	154.5%	2.33	15.6%
Cadmium	4	0.17	4.3%	0.46	11.6%	0.14	3.6%
Manganese	400	17.11	4.3%	35.09	8.8%	5.69	1.4%
Iron	2000	93.52	4.7%	165.95	8.3%	57.56	2.9%
Aluminium	1000	48.75	4.9%	41.75	4.2%	47.79	4.8%
Arsenic	10	0.37	3.7%	0.39	3.9%	0.28	2.8%
Chromium	50	0.58	1.2%	0.82	1.6 %	0.35	0.7%
Lead	10	0.22	2.2%	0.16	1.6%	0.21	2.1%
Boron	1400	15.89	1.1%	19.43	1.4%	9.90	0.7%
Beryllium	4	0.03	0.7%	0.02	0.6 %	0.02	0.7%
Mercury	7	0.03	0.4%	0.02	0.3%	0.02	0.3%
Zinc	7000	61.04	0.87%	24.08	0.3%	22.69	0.3%
Nickel	80	0.13	0.2%	0.21	0.3%	0.13	0.2%
Copper	2000	1.11	0.1%	1.06	0.1%	0.98	0.0%
Cobalt	70	0.07	0.0%	0.12	0.0%	0.04	0.0%
Magnesium	-	531.83		688.61		449.01	
Titanium	-	6.91		14.86		3.42	

- MAV unable to be established for this metal

9.3 Airborne (suspended) metals

9.3.1 Monitoring method

Airborne levels of metals have been measured by analysing 12 months of TSP filters collected at the NZS Northern Boundary (Site 4B) monitoring site.

Although it is not a consent requirement, NZ Steel have continued to operate a Partisol sampler at the NZS Northern Boundary (Site 4B) monitoring site on a 1 in 6-day basis to measure TSP. Filters

collected between 17 June 2018 and 18 June 2019 were analysed for metals using a method in which the filter is digested in hot acid and the resulting solution tested with a spectrometer.[8]

The Partisol uses relatively large filters, with dimensions of 20.3 x 25.4 cm. The filters were cut into quarters, with one quarter being tested for a suite of metals and one quarter for black carbon (see Section 11). There were 58 filters collected out of a possible 61 over the 12-month period. Two of the 58 collected filters did not have a corresponding air volume measurement recorded. These filters were analysed and had a metal concentration profile consistent with other samples, however they could not be used to calculate a concentration in air due to the lack of a volumetric measurement. Two blank filters were also tested to control for the analytical method and any metals present in the filter media.

9.3.2 Results

Table 9.7 below shows the average mass of each metal detected on the field filter samples and the average mass on the two blank filters. The difference between the two is then reported as the blank-adjusted average mass. This step removes the influence of the metal content of the borosilicate glass filters. The blank-adjusted measurement shows that, similar to the deposited metals results, magnesium, iron and aluminium constitute the majority of the detected metal particulate, with a smaller contribution from zinc and trace levels of other metals.

Table 9.7: Mass of metal per quarter-filter sample

Metal	Blank filter average	Field filter average	Field filter blank-adjusted average
	µg/sample		
Aluminium	225	346	121
Arsenic	0.25	0.58	0.3
Beryllium	0.03	0.03	0.0
Cadmium	0.02	0.03	0.01
Chromium	1.6	1.2	-0.3
Cobalt	0.05	0.11	0.06
Copper	1.1	3.1	2.1
Iron	37.5	193	155
Lead	0.1	0.8	0.6
Magnesium	350	621	271
Manganese	2.0	7.6	5.6
Nickel	1.7	0.8	-0.9
Vanadium	1.5	3.8	2.3
Zinc	7.4	30	22
Titanium	1.5	7.8	6.3

9.3.3 Comparison with assessment criteria

The 24-hour average concentration of each metal in air has been calculated by multiplying the mass on the ¼ filter by four and dividing by the volume of air sampled. The monitoring method allows

[8] Modified aqua regia digestion of client filter or thimble, analysis by ICP-MS. In-house based on NIOSH method 7303, issue 1 (modified).

concentrations to be expressed for averaging periods of 24-hours or greater (e.g. 3-monthly or annual averages) so they can be directly compared to the relevant assessment criteria. The average of the 24-hour average concentrations over the monitoring period (17 June 2018 to 18 June 2019) has been adopted as the annual average concentration. Where the assessment criterion is for an averaging period less than a full year, the maximum concentration corresponding to that period has been adopted.

The assessment criteria for inhalation of metals, which are taken from the AAQG and international guidelines, are set out in Appendix B Section B4.1 of the AQA. These assessment criteria are for metals in respirable particulate (PM_{10}). This assessment approach is therefore conservative (i.e. it will over-state potential exposure to respirable metals) as a portion of TSP will be too coarse to be respirable.

The calculated ambient air concentrations are compared with the relevant assessment criteria in Table 9.8. The table does not include metals for which there is no relevant long term assessment criterion.

The results for chromium and nickel are affected by the relatively high concentrations of these metals in the blank (presumably from the filter media) compared to the concentrations in the field samples. The blank-adjusted concentrations of both these metals are effectively zero.

For all other metals considered, both the uncorrected and blank-adjusted concentrations are well below the relevant assessment criteria.

Table 9.8: Evaluation of metals in total suspended particulate against assessment criteria

Metal	Assessment Criterion (µg/m³)	Averaging period	Uncorrected concentration		Blank-adjusted concentration	
			Concentration (µg/m³)	% of guideline	Concentration (µg/m³)	% of guideline
Arsenic	0.0055	Annual average	0.001	17%	0.001	9.8%
Cadmium	0.3	Annual average	0.000048	0.02%	0.000011	0.004%
Chromium	0.11 (Cr III)	Annual average	0.002	1.8%	See Note 1	-
	0.0011 (Cr VI)	Annual average		182%		-
Lead	0.2	3-month rolling average	0.0015	0.8%	0.0013	0.6%
Manganese	0.15	Annual average	0.013	8.4%	0.009	6.2%
Nickel	0.0025	Annual average	0.001	53%	See Note 1	-
Vanadium	1	24-hour average	0.027	2.7%	0.025	2.5%
Zinc	2	Annual average	0.049	2.4%	0.036	1.8%

Note 1: The filter media contains chromium and nickel. Once the analytical results are adjusted for the metal in the filter media, the measured concentration of chromium and nickel in suspended particulate is effectively zero.

10 Dioxins/furans and polyaromatic hydrocarbons

10.1 Monitoring method

Ambient monitoring for dioxins/furans (PCDD/F) and polyaromatic hydrocarbons (PAHs) has been undertaken at the 64 Glenbrook Beach Rd (Site 20) monitoring location. A high-volume sampler was used to draw air through a quartz fibre filter and solid polyurethane foam and polymeric (PUF/XAD/PUF) adsorbent. The method incorporated spikes and field and method blanks. The filters are collected from the field and replaced on a one-month cycle. The first month of sampling was carried out in November 2019.

Two monitors were co-located at 64 Glenbrook Beach Rd (Site 20). It was originally intended to undertake wind-directional sampling to differentiate between the impact of the Steel Mill and the impact of dioxins from other sources in the general area. However, due to operational issues the wind directional settings were not functional, resulting in collection of duplicate samples. As a result, the two samples collected in each sampling round have been treated as duplicates. The available valid monitoring records are shown in Table 10.1 below.

Table 10.1: Valid PCDD/F and PAH monitoring records

Sample date	Volume of air sampled (m^3)	Run time (days)
Nov-19	6955.8	24.9
Nov-19	6336	23.7
Dec-19	6741.3	31.9
Dec-19	7992.8	31.9
Jan-20	8333.8	29.9
Jan-20	7418.1	29.9
Feb-20	7692	28.9
Feb-20	6868	28.9
Oct-20	2884.6	12.0
Jan-21	8328.5	38.0
Feb-21	6208	26.1

Samples tested in the early part of the programme were analysed by AsureQuality in Wellington. AsureQuality stopped offering PCDD/F testing partway in mid-2020 and the samples from October 2020 onwards have been tested at the Eurofins Laboratory in Australia. There are some differences in the analytical suites and detection limits between the two laboratories.

10.2 Comparison with assessment criteria

10.2.1 Introduction

The assessment criteria for PCDD/F and PAHs are expressed as an annual average. The available data does not allow the calculation of an annual average concentration. However, the average over all the results has been compared to the assessment criterion to provide some context for the results.

10.2.2 Dioxins and furans

In assessing the effects of exposure to a mixture of PCDD/F, each congener is assigned a Toxic Equivalence Factor (TEFs), which indicates its toxicity relative to 2,3,7,8-TCDD. The concentration of each congener is multiplied by its TEF and these are then added together to give the total dioxin concentration expressed as the Toxic Equivalent[9] (TEQ). This report uses the WHO (205) TEF regime for calculation of the TEQ, as is consistent with New Zealand guidance.[10]

The lower, middle and upper bound TEQs for dioxins for each valid sample (monthly average concentration) are shown in Figure 10.1. Although the October 2020 sample has been included, the shorter sampling period resulted in a smaller sample mass (i.e. greater analytical error) compared to the other samples that were collected over 24 to 32 days.

The California OEHHA annual guideline of 0.00004 µg/m³ has been adopted as the assessment criterion. This value is equivalent to 40,000 femtograms per cubic metre (fg/m^3).

The average of the middle-bound dioxin WHO-TEQ concentrations over the sampling period was equivalent to 0.023% of the assessment criterion (Table 10.2).

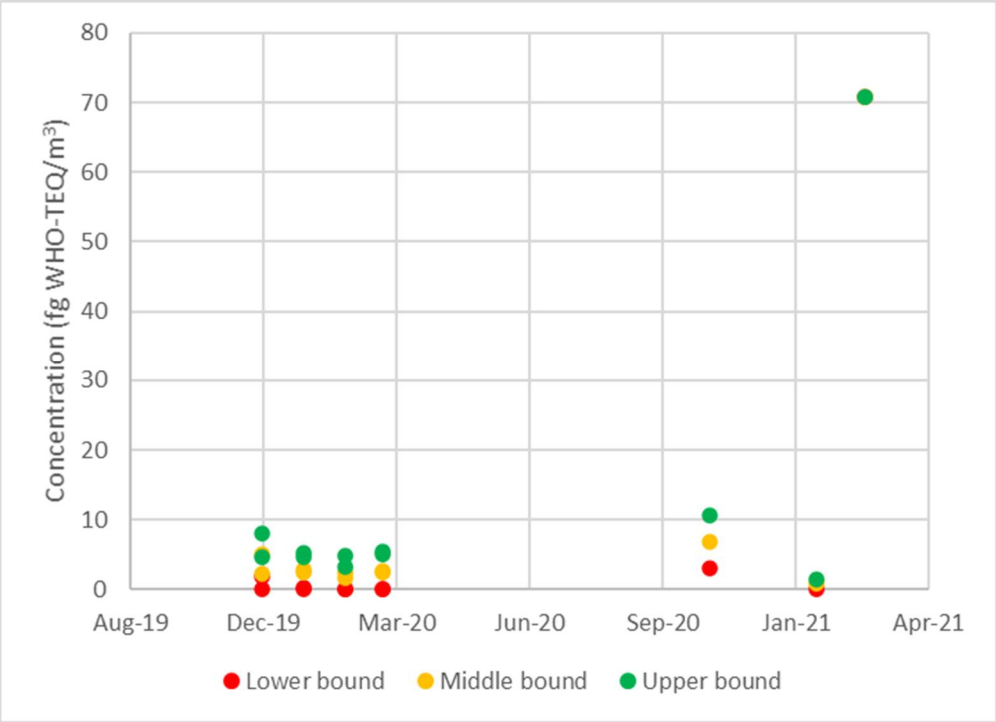

Figure 10.1: Dioxin WHO-TEQ monthly concentrations at 64 Glenbrook Beach Rd (note: assessment criterion is 40,000 fg WHO-TEQ/m^3 (annual average))

Table 10.2: Dioxin comparison with assessment criterion

Parameter	Assessment criterion	Average concentration over sampling period (middle bound)	
	(fg WHO-TEQ/m^3, annual average)	(fg WHO-TEQ/m^3)	% of criteria
Dioxins (WHO-TEQ)	40,000	9.1	0.023%

[9] The TEQ is the amount of 2,3,7,8-TCDD it would take to equal the combined toxic effect of all the dioxins in the mixture.
[10] Ministry for the Environment. (2011). Methodology for deriving standards for contaminants in soil to protect human health. Wellington. p90

10.2.3 PAHs

Similar to dioxins and furans, PAHs are a group of chemical compounds with varying toxicity. Benzo[a]pyrene (BaP) is considered the most toxic PAH and individual PAH species are assigned a Potency Equivalence Factor relative to BaP to develop an overall BaP equivalence concentration (BAP_{eq}). [11]

The lower, middle and upper bound BAP_{eq} for each valid sample (monthly average concentration) are shown in Figure 10.2.

The concentration of BaP_{eq} can be compared to the AAQG value of 0.0003 µg/m³ (annual average). This value is equivalent to 300 picograms per cubic metre (pg/m^3). The average of the middle bound BaP_{eq} concentrations over the sampling period was equivalent to 3.7% of the assessment criterion (Table 10.3).

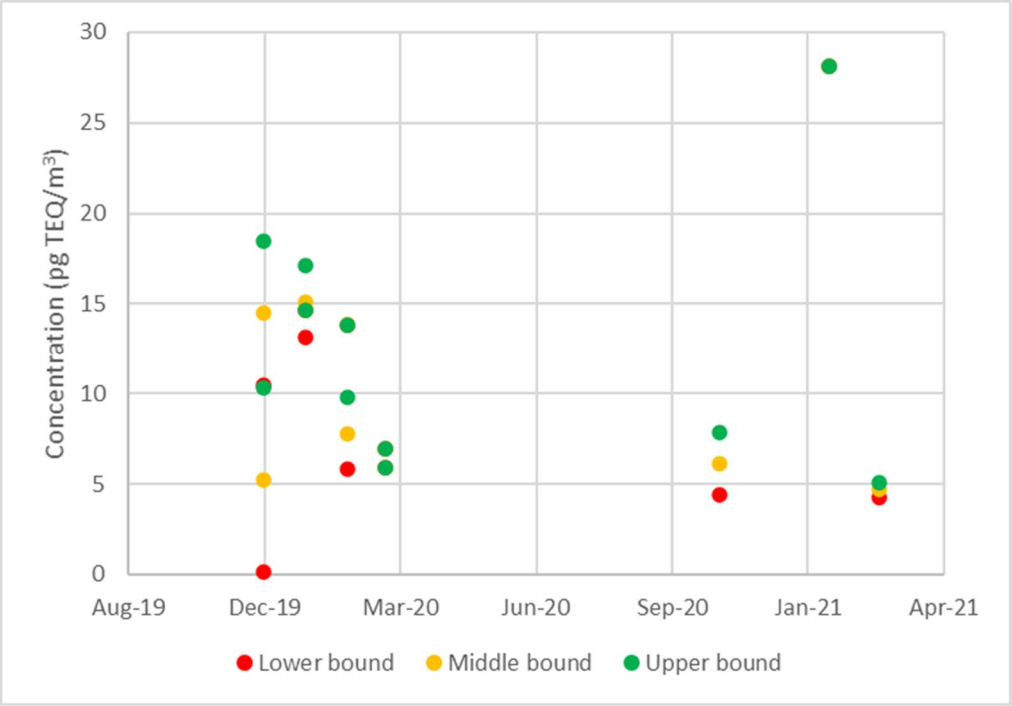

Figure 10.2: Benzo[a]pyrene equivalent monthly average concentrations at 64 Glenbrook Beach Rd (note: assessment criterion is 300 pg TEQ/m^3 (annual average))

Table 10.3: BaP_{eq} comparison with assessment criteria

Parameter	Assessment criterion	Average concentration over sampling period (middle bound)	
	(pg/m^3, annual average)	(pg/m^3)	% of criteria
Benzo[a]pyrene equivalent	300	11.2	3.7%

[11] MFE (2011) p 84

11 Black carbon

11.1.1 Monitoring method

Black carbon is a term used to describe ultrafine carbon-rich particles that occur in the air, as a result of natural and anthropogenic combustion sources. Black carbon is measured by light absorption. It is a component of $PM_{2.5}$. Black carbon can be more useful as an indicator of particulate from combustion sources compared to unspeciated $PM_{2.5}$.

The same filters tested for airborne (suspended) metals were analysed for black carbon. The methodology is therefore very similar to that discussed in Section 9.3.1. One quarter of each Partisol filter collected at NZS Northern Boundary (Site 4B) monitoring site over the period 17 June 2018 to 18 June 2019 was tested for black carbon using the light reflection/transmission method at GNS laboratories. The corresponding volume of air recorded for each filter was used to calculate the 24-hour average concentration of black carbon for each sample.

11.1.2 Results and discussion

There are not enough clinical or toxicological studies to evaluate the differences between the health effects of exposure to black carbon or to $PM_{2.5}$ and therefore there are no assessment criteria relevant to black carbon[12]. For context, the results have been compared to measurements at locations in urban Auckland.

The individual 24-hour average black carbon concentrations are plotted on Figure 11.1. There is no seasonal pattern evident, although some of the highest concentrations were recorded in the winter (July and August 2018). The average black carbon concentration over the monitoring period was 0.51 $\mu g/m^3$.

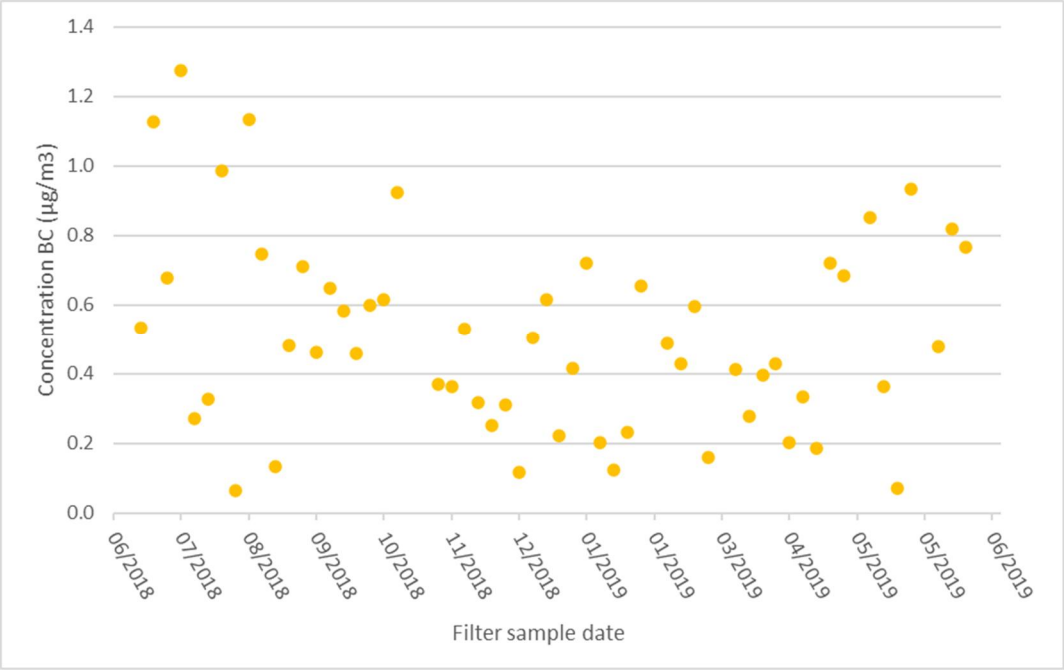

Figure 11.1: Black carbon concentration (24-hour average) at the NZS Northern Boundary (Site 4B)

[12] Janssen, NAH, Gerlofs-Nijland ME, Lanki T, Salonen RO, Cassee F, Hoek G, Fischer P, Brunekreef B, Krzyzanowski M. (2012). Health effects of black carbon. WHO Geneva

Black carbon levels in Auckland were reported in a Source Apportionment Study at five locations (Takapuna, Henderson, Penrose, Khyber Pass Road and Queen Street).[13] The concentrations of black carbon in these urban locations in Auckland are typically within the range 1 to 6 µg/m^3 (annual average) as shown in Figure 11.2. The black carbon concentration measured at the NZS Northern Boundary (Site 4B) of 0.51 µg/m^3 (annual average) is lower than the concentrations recorded in urban areas of Auckland.

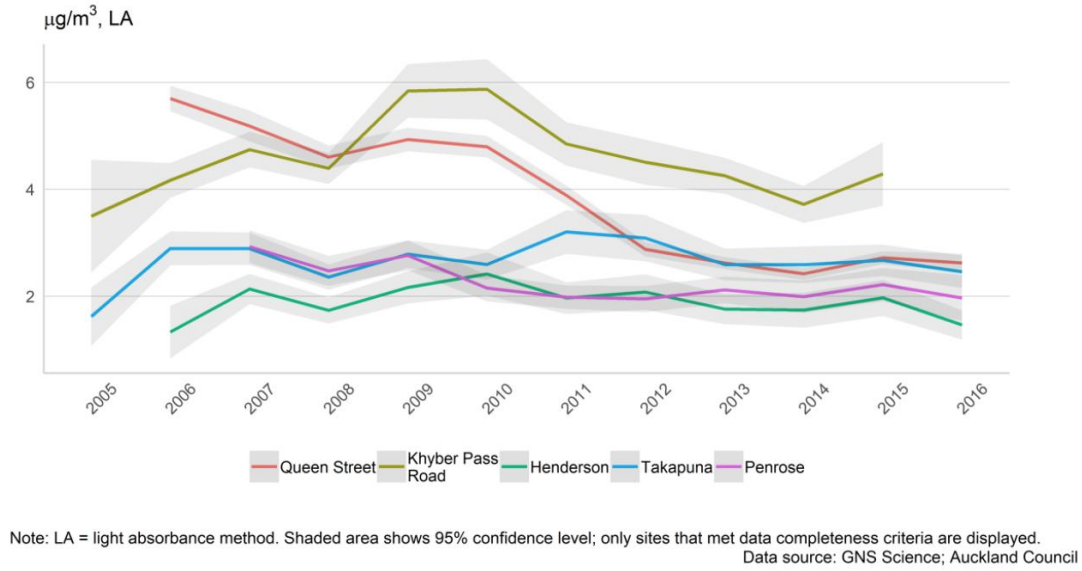

Figure 11.2: Annual average black carbon concentrations at monitored Auckland sites, 2005-2016 (reproduced from https://www.stats.govt.nz/indicators/black-carbon-concentrations)

[13] Davy, P. K., Ancelet, T., Trompetter, W. J and Markwitz, A (2017). Source apportionment and trend analysis of air particulate matter in the Auckland region. Prepared by the Institute of Geological and Nuclear Sciences Ltd, GNS Science for Auckland Council. Auckland Council technical report, TR2017/001

12 Applicability

This report has been prepared for the exclusive use of our client New Zealand Steel Limited, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

We understand and agree that our client will submit this report as part of an application for resource consent and that Auckland Council as the consenting authority will use this report for the purpose of assessing that application.

Tonkin & Taylor Ltd

Report prepared by:	Authorised for Tonkin & Taylor Ltd by:
	
.....	.....
Rose Turnwald	Jenny Simpson
Environmental Engineer	Project Director

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Appendix A: Monitoring locations

Appendix A Figure 1: Ambient air monitoring site locations

Appendix B: Meteorological data

A summary of the wind monitoring mast heights at each monitoring site is provided in Appendix B Table 1 below.

Appendix B Table 1: Comparison of mast height at each monitoring site

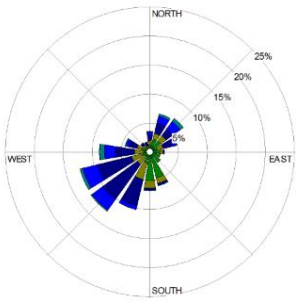
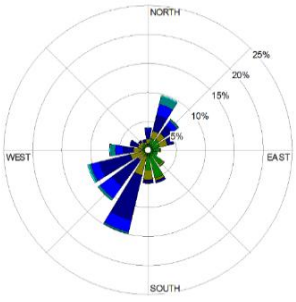
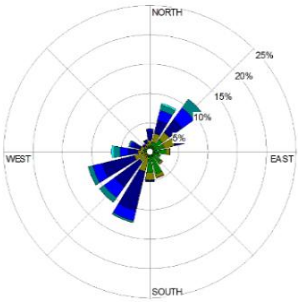
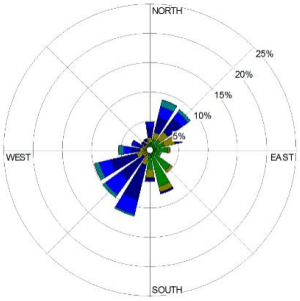
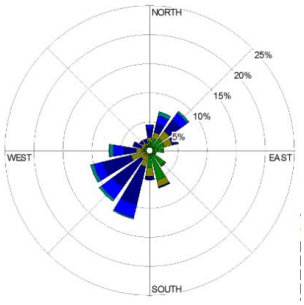
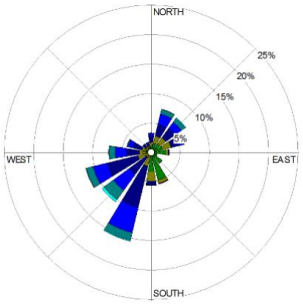
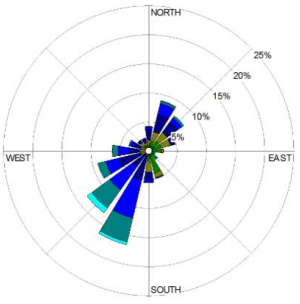
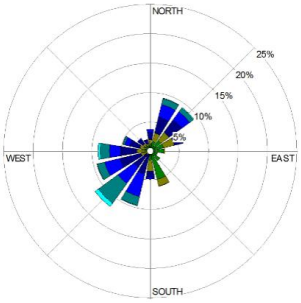
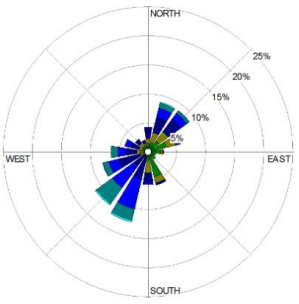
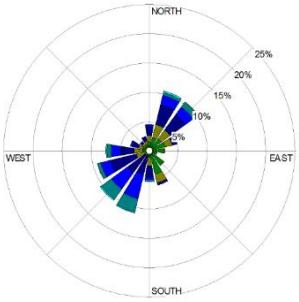
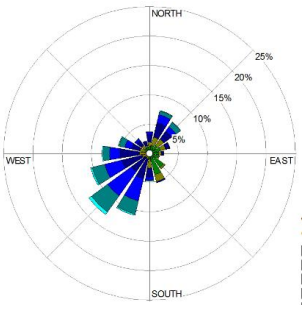
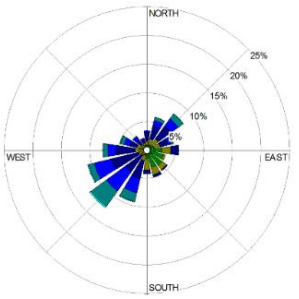
Site	Mast height
Training Centre Site 3	Pre-June 2019: 4 m Post June 2019: 10 m
Glenbrook School Site 17	6 m
Boundary Road Site 18	6 m
Sandspit Reserve Site 19	6 m
64 Glenbrook Beach Rd Site 20	6 m

The annual wind roses for each ambient air monitoring site from 2009 to 2020 are included below as Appendix B Figure 2 to Appendix B Figure 6. Each wind rose represents the annual distribution of windspeeds from the direction of the individual wind rose arms (or "petals").

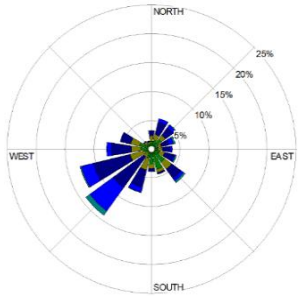
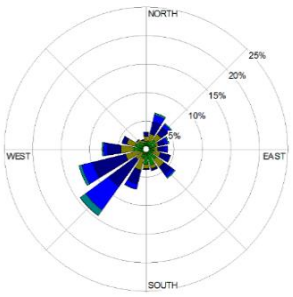
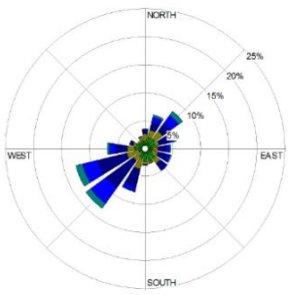
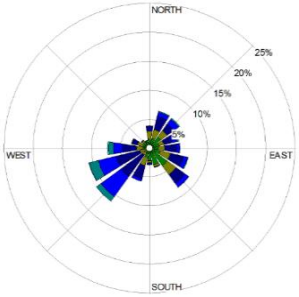
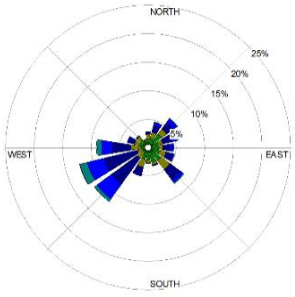
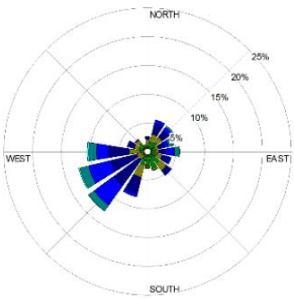
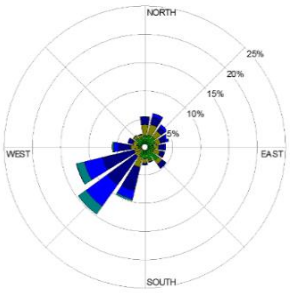
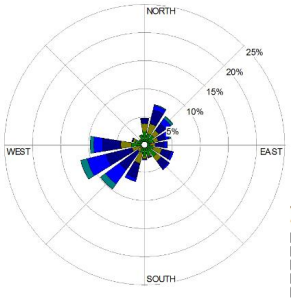
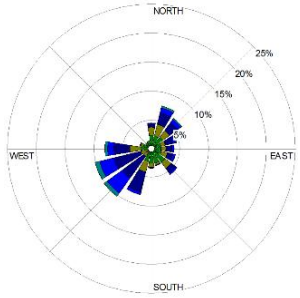
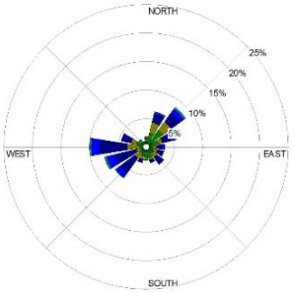
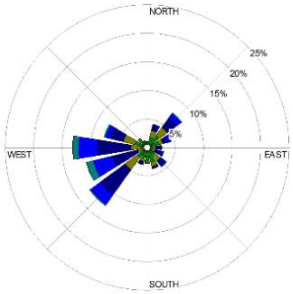
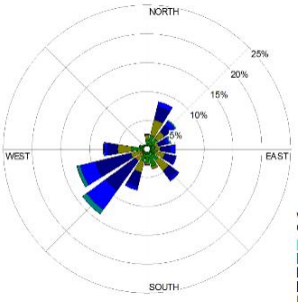
Each site shows a consistent year-on -year pattern apart from 64 Glenbrook Beach Rd (Site 20), which shows unusual wind rose patterns for 2018 and 2019, with very low incidence of south-south-westerly winds and a predominance of westerlies. This variation was not observed at the nearby Training Centre (Site 3) site, which is approximately 570 m southwest of the 64 Glenbrook Beach Rd (Site 20) monitoring site with no intervening significant terrain changes that would alter the wind pattern at this proximity. All other years the wind distribution at the Training Centre (Site 3) has exhibited a similar pattern to 64 Glenbrook Beach Rd (Site 20).

Notably in 2018 at the 64 Glenbrook Beach Rd (Site 20), almost 18% of wind direction data was not recorded. In order to form meaningful polar plot analyses for contaminants monitored at 64 Glenbrook Beach Rd (Site 20) during 2018 and 2019, the wind direction data recorded at the NZS Training Centre (Site 3) was substituted into the dataset for polar plot analyses and determination of background contaminant levels in Appendix C. Wind speed data collected at 64 Glenbrook Beach Rd (Site 20) has not been substituted.

Appendix B Figure 1: Wind speed key for win roses

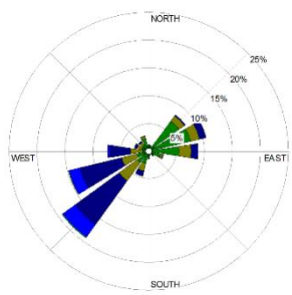
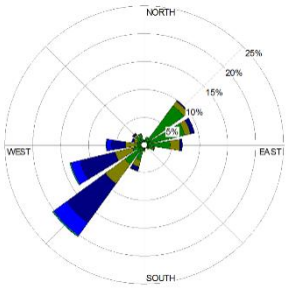
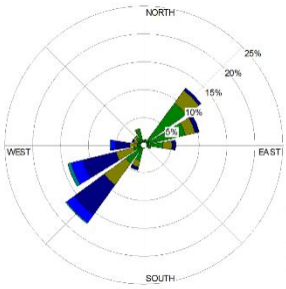
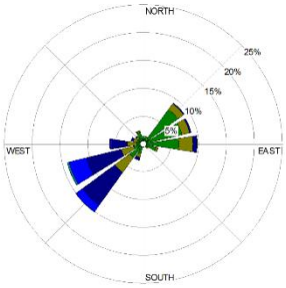
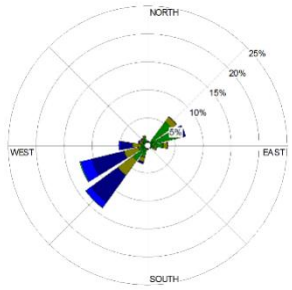
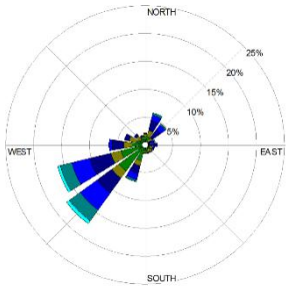
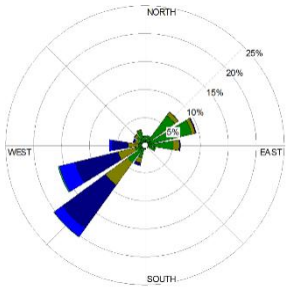
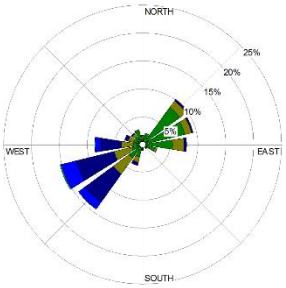
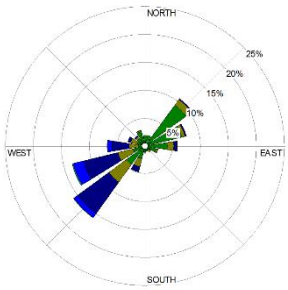
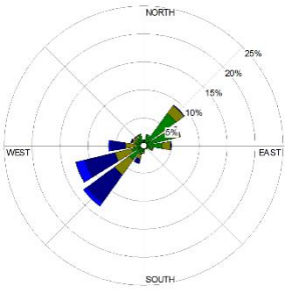
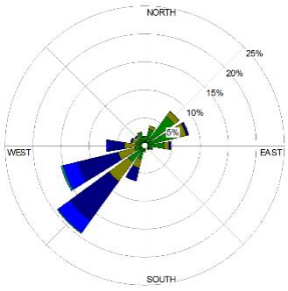
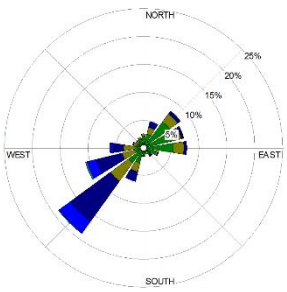
			
2009 Calms: 3.48%	2010 Calms: 3.30%	2011 Calms: 3.47%	2012 Calms: 3.84%
			
2013 Calms: 4.73%	2014 Calms: 4.55%	2015 Calms: 3.98%	2016 Calms: 4.66%
			
2017 Calms: 4.41%	2018 Calms: 4.27%	2019 Calms: 2.55%	2020 Calms: 2.54%

Appendix B Figure 2: Annual wind roses for the Training Centre (Site 3) monitoring site

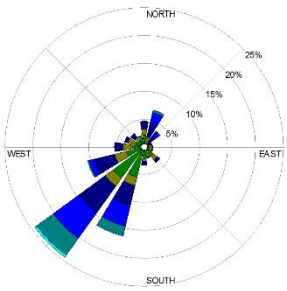
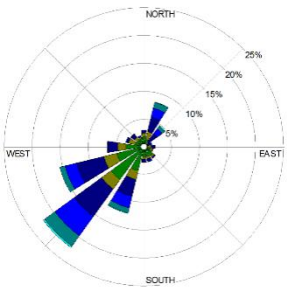
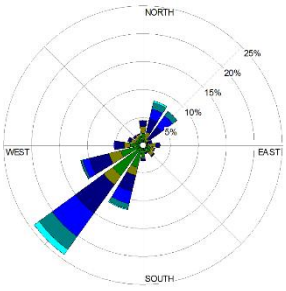
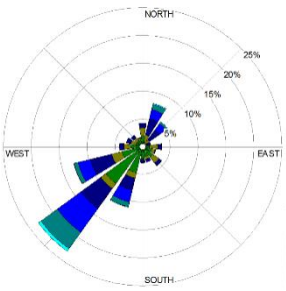
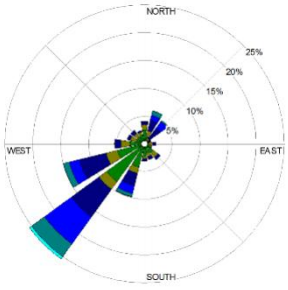
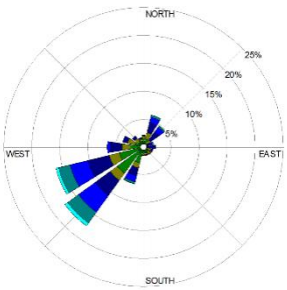
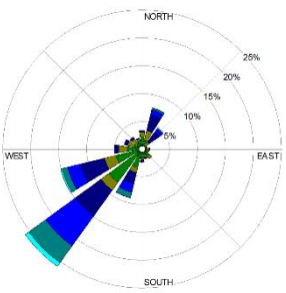
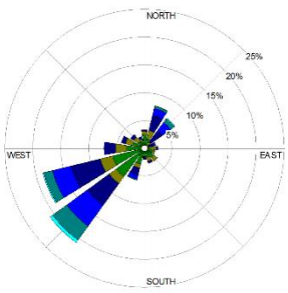
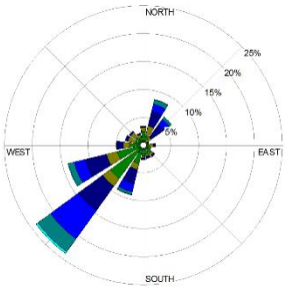
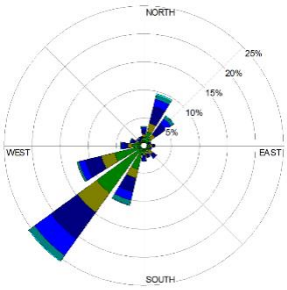
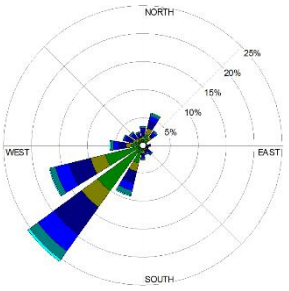
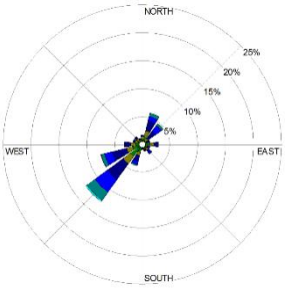
			
2009 Calms: 6.12%	2010 Calms:6.24%	2011 Calms: 7.65%	2012 Calms: 6.90%
			
2013 Calms:7.48%	2014 Calms:6.62%	2015 Calms:7.65%	2016 Calms:8.54%
			
2017 Calms:9.38%	2018 Calms:9.38%	2019 Calms:10.6%	2020 Calms:9.29%

Appendix B Figure 3: Annual wind roses for the 64 Glenbrook Beach Rd (Site 20) monitoring site

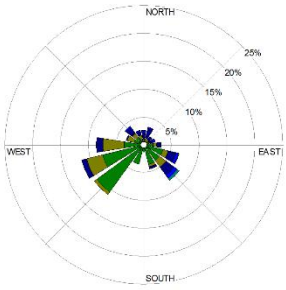
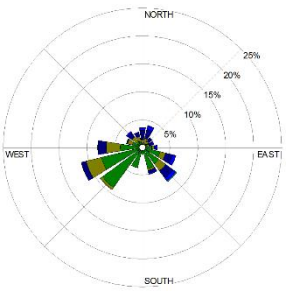
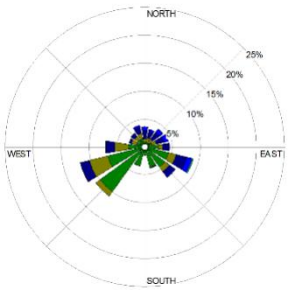
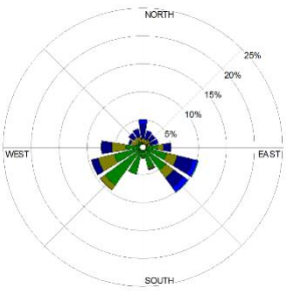
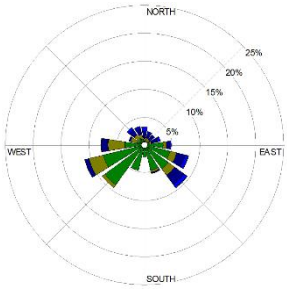
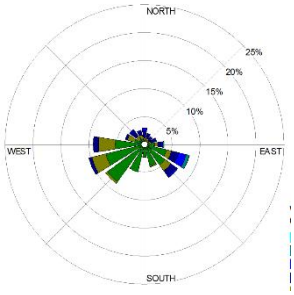
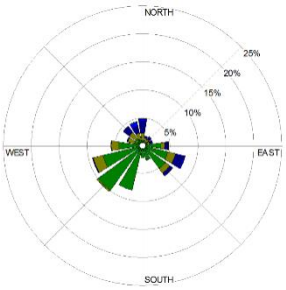
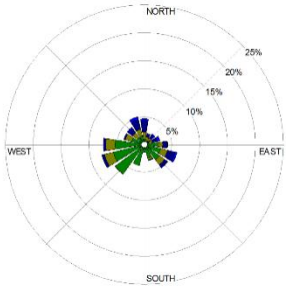
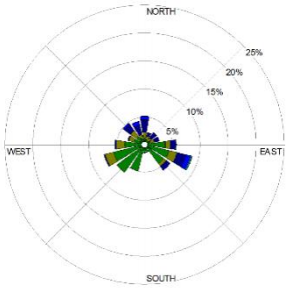
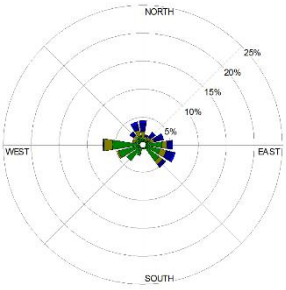
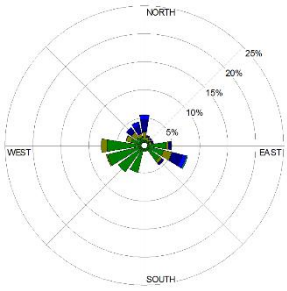
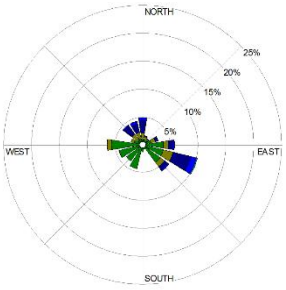
In 2018, 17.7% of the wind direction data was unavailable. The wind roses for 2018 and 2019 appear skewed to show a predominance of westerlies, which is not reflected in the monitoring at the nearby Training Centre (Site 3) or Boundary Road (Site 18).

			
2009 Calms: 9.69%	2010 Calms: 11.04%	2011 Calms:13.31 %	2012 Calms: 13.48%
			
2013 Calms: 10.18%	2014 Calms: 3.95%	2015 Calms: 13.13%	2016 Calms: 12.00%
			
2017 Calms: 14.58%	2018 Calms: 16.44%	2019 Calms: 12.73%	2020 Calms: 11.96%

Appendix B Figure 4: Annual wind roses for the Glenbrook School (Site 17) monitoring site

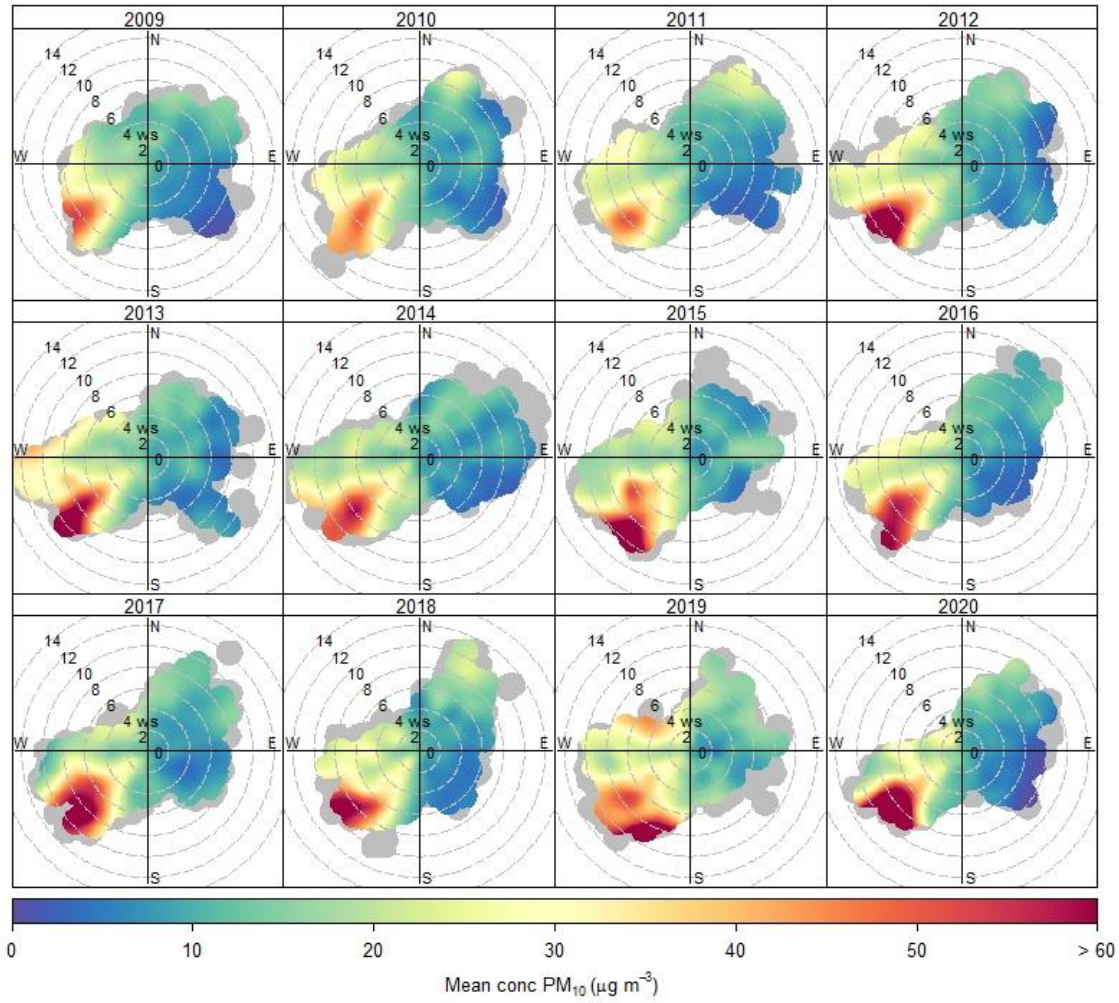
			
2009 Calms: 3.62%	2010 Calms:4.03 %	2011 Calms: 4.37%	2012 Calms: 4.01%
			
2013 Calms: 4.60%	2014 Calms:3.95 %	2015 Calms:4.51 %	2016 Calms 4.74: %
			
2017 Calms: 6.84%	2018 Calms: 7.36%	2019 Calms: 7.11%	2020 Calms: 9.19%

Appendix B Figure 5: Annual wind roses for the Boundary Rd (Site 18) monitoring site

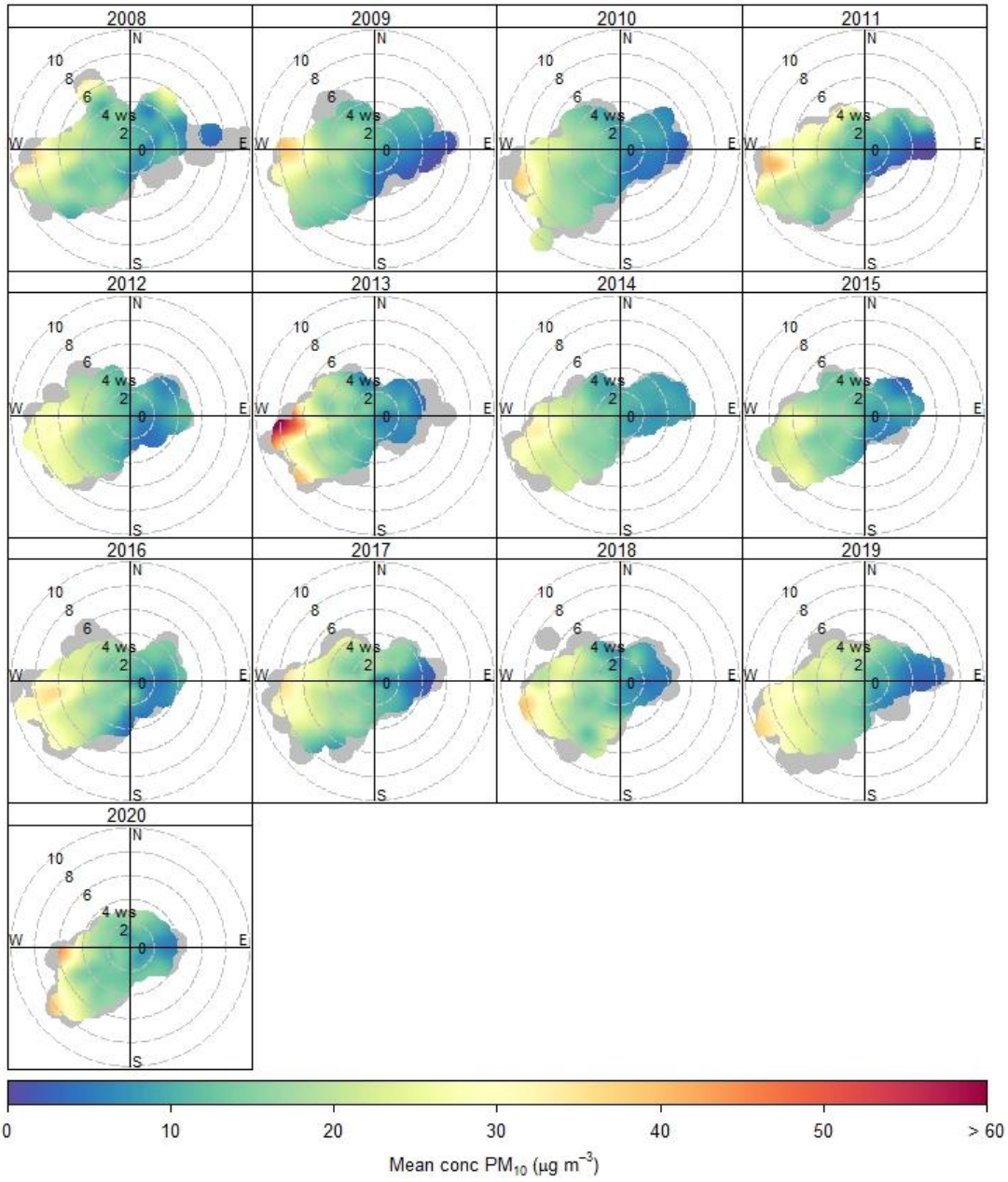
			
2009 Calms: 19.54	2010 Calms: 21.74%	2011 Calms: 15.12%	2012 Calms: 13.27%
			
2013 Calms: 15.10%	2014 Calms: 13.25%	2015 Calms: 18.85%	2016 Calms: 20.04%
			
2017 Calms: 24.30%	2018 Calms: 22.15%	2019 Calms: 30.50%	2020 Calms: 32.73%

Appendix B Figure 6: Annual wind roses for the Sandspit Reserve (Site 19) monitoring site

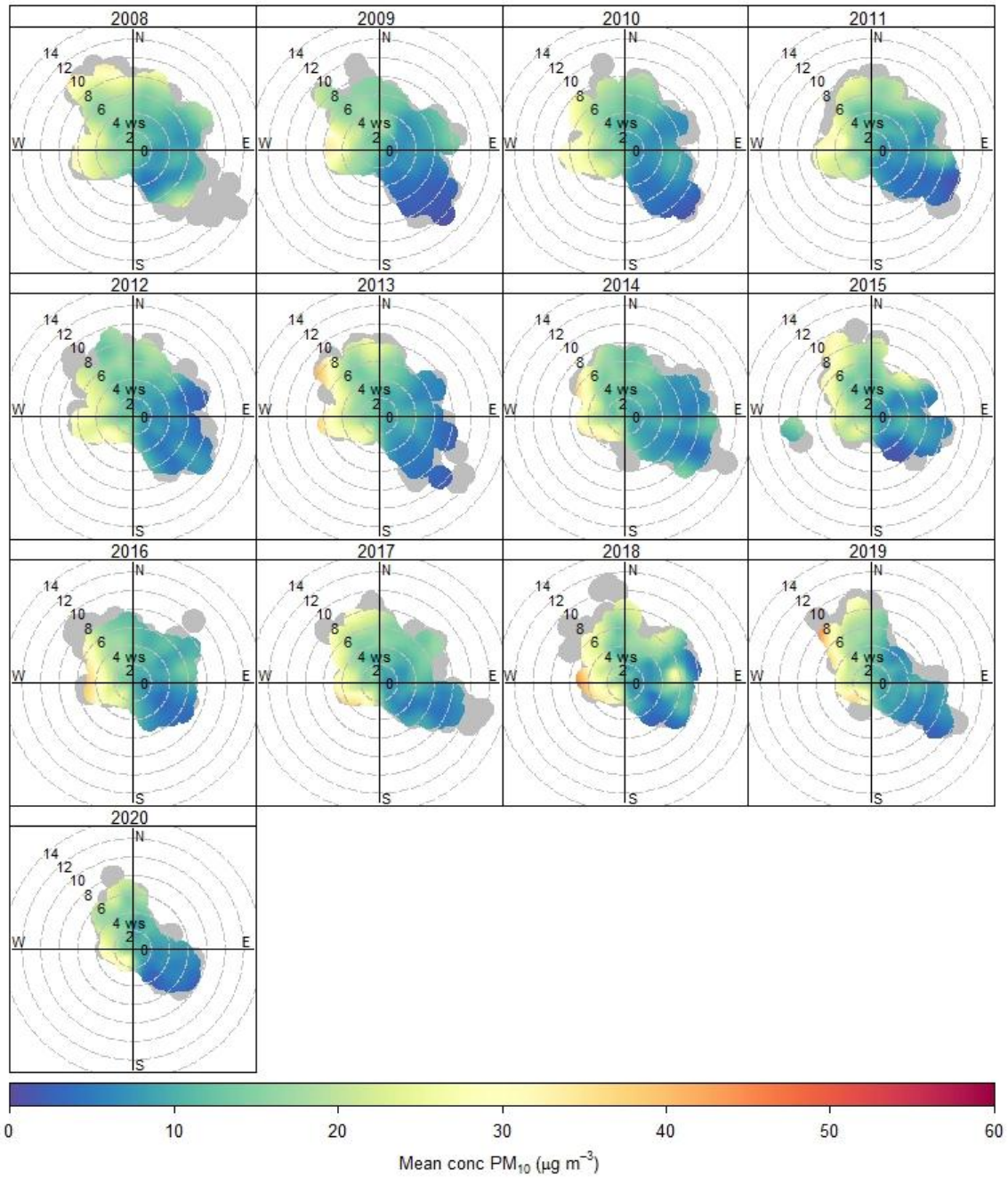
Appendix C: Individual yearly PM_{10} polar plots



Appendix C Figure 1: Yearly bivariate polar plots at 64 Glenbrook Beach Rd (Site 20) monitoring site



Appendix C Figure 2: Yearly bivariate polar plots at Glenbrook School (Site 17) monitoring site



Appendix C Figure 3: Yearly bivariate polar plots at Sandspit Reserve (Site 19) monitoring site

Appendix D: Derivation of background concentrations

D1 Estimating background air quality from monitoring data

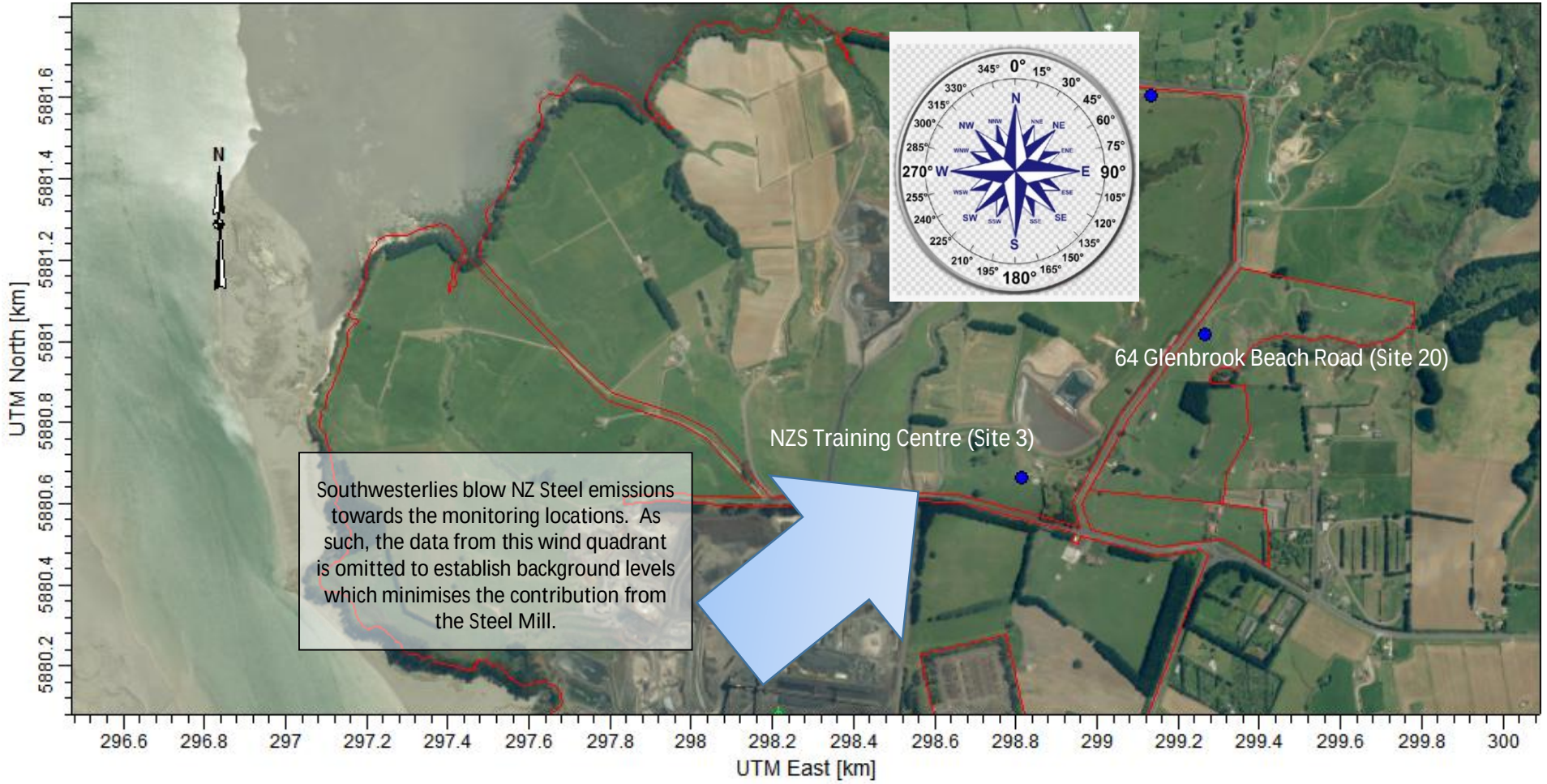
Background air quality is the term used to describe air quality in the absence of emissions from the Steel Mill. Background air quality has been estimated from air quality monitoring data from the two nearest monitoring stations (NZS Training Centre (Site 3) and 64 Glenbrook Beach Rd (Site 20)). The arc of wind directions where these sites will be influence by emissions from the Steel Mill have been determined. Data during these hours has been excluded from the dataset, and the remaining data is assumed to be representative of background air quality. This is illustrated in Appendix D Figure 1.

Background concentrations of particulate will be strongly influenced by marine aerosols, which will be most significant during winds from the southwest through to northwest directions (on-shore winds). The approach used is likely to under-estimate the contribution of marine aerosols to background air quality. This is because southwesterlies, which have been excluded from the dataset, are the predominant winds and therefore the prevalence of off-shore winds (will be over-represented in the air quality monitoring data).

Appendix D Table 1 summarises the 1-hour average background contaminant concentrations. The 75th percentile value of the 1-hour average concentrations have been adopted as representative 1-hour and 24-hour average concentrations. The overall average has been adopted as the representative annual average concentration.

Appendix D Table 1: Estimated 1-hour background concentrations

Site	64 Glenbrook Beach Road (Site 20)					Training Centre (Site 3)
Contaminant	SO_2	NO_2	NO_x	PM_{10}	$PM_{2.5}$	TSP
Directional adjustment based on wind angle	Excluded SW data (180°-270°) from consideration of background concentrations					
Count (hours)	15848	9963		65346	13370	61071
Average concentration (µg/m^3)	1.1	4.0	5.6	11.3	5.0	15.9
75th percentile concentration (µg/m^3)	1.3	5.1	6.8	15.2	7.7	18.2
Start date	4/04/2017	20/11/2018		20/02/2008	16/03/2018	1/11/2008
End date	30/06/2020	31/12/2020		31/01/2021	31/01/2021	31/01/2021



Appendix D Figure 1: Wind filtering of background monitoring data (NZ Steel landholding boundary in red)

Appendix D Table 2: Summary of estimated/adopted background concentrations

Contaminant	Concentration	Averaging period	Source
Ambient concentrations			
TSP	18.2 µg/m³	24-hour	Directionally adjusted data from Training Centre (Site 3)
PM_{10}	15.2 µg/m³ 11.3 µg/m³	24-hour Annual	Directionally adjusted data from 64 Glenbrook Beach Rd (Site 20)
$PM_{2.5}$	7.7 µg/m³ 5.0 µg/m³	24-hour Annual	
SO_2	1.3 µg/m³ 1.1 µg/m³	1-hour/ 24-hour Annual	
NO_2	5.1 µg/m³ 4.0 µg/m³	1-hour/24-hour Annual	
CO	5 mg/m³ 2 mg/m³	1-hour 8-hour	Default value for areas outside the urban extent of Auckland City
Other contaminants	zero	Various	Background assumed to be negligible as there are no other identified point sources

Appendix E: Atmospheric chemistry of nitrogen oxides

E1 Introduction

This appendix describes the reactions in the atmosphere that influence the chemical form of NO_x species (predominantly NO and NO_2) present in ambient air. In particular, it explains the effect of seasonal changes, principally changes in daylight hours and ambient ozone levels, on NO_2 concentrations at 64 Glenbrook Beach Rd (Site 20) monitoring site.

E2 Summary of NO_x chemistry

E2.1 NO_x generation from combustion sources

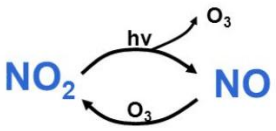
NO_X is generated during combustion through two main mechanisms:

- Fuel NO_X: Fuel NO_x is formed by the reaction of nitrogen bound in the fuel with oxygen in the combustion air; and
- Thermal NO_X: Thermal NO_x is created by the reaction between the nitrogen and oxygen in the combustion air. The generation of thermal NO_X increases significantly at combustion temperatures above 1,300°C.

NZ Steel operates a number of large furnaces and processes that involve combustion of waste gases at high temperatures in the Iron Plant. The NO_x emissions from these processes comprise mainly NO with a varying fraction of the NO_x present as NO_2 in the stack emissions (measurements can range between 0.3 to 30%). A portion of the emitted NO is converted to NO_2 through atmospheric reactions. Consequently the ratio of NO_2:NO_x at the monitoring site will differ from (and generally be higher than) the ratio in the stack emissions.

E2.2 Reactions of NO_x components in the atmosphere

In the troposphere, NO and NO_2 are in a photochemical equilibrium with ozone in what is known as a 'photostationary state' illustrated in Appendix E Figure 1 below, where 'hv' represents a light energy (photons).



Appendix E Figure 1: Diagram showing the steady state conversion of NO to NO_2 with photons of light and ozone in the atmosphere

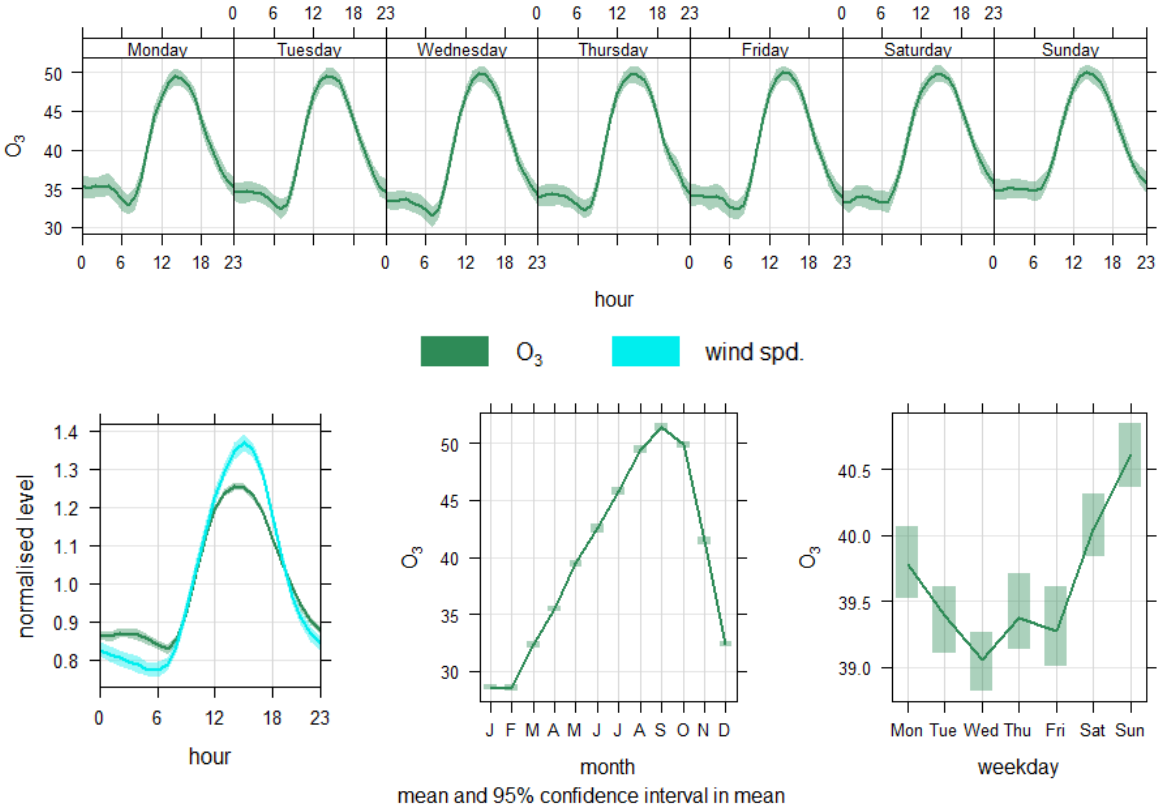
During daylight hours, the fraction of NO_X that is NO is increased and the NO_2 fraction will correspondingly decrease.

The additional presence of volatile organic compounds (VOCs) in the troposphere will generate free radicals in a reaction with sunlight. These free radicals react with NO to produce more NO_2, which will then convert back to NO in the sunlight and produce ozone. This cycle can continue until the VOCs are reduced to non-reactive short chain carbon compounds. These processes involving VOCs

are more common in urban settings with relatively high VOC emissions, for example from motor vehicle emission contributions. While VOCs may be present at residual levels from the Paint Line incinerator stacks or residually from coal waste gas at the MHF and Kiln afterburners, they are not expected to play a significant role in atmospheric chemistry reactions near the Steel Mill. The main influence on atmospheric chemistry reactions is expected to be the background ozone concentration and diurnal and seasonal pattern that influence sunlight hours.

E3 Background ozone concentrations

Ozone concentrations are measured at the Auckland Council monitoring site at Patumahoe. Measured ozone levels are shown on the time dependent plot in Appendix E Figure 2 below, which illustrates the increased ambient ozone levels during the winter months compared to summer months. Average ozone concentrations are in the range from approximately 30 µg/m^3 in summertime up to approximately 50 µg/m^3 in wintertime, but also vary diurnally, with higher concentrations during the day compared to at night.



Appendix E Figure 2: Time and wind-speed dependent plots for one hour averaged PM_{10} concentrations (µg/m^3) at Auckland Council's Patumahoe monitoring site), January 2010 – July 2021

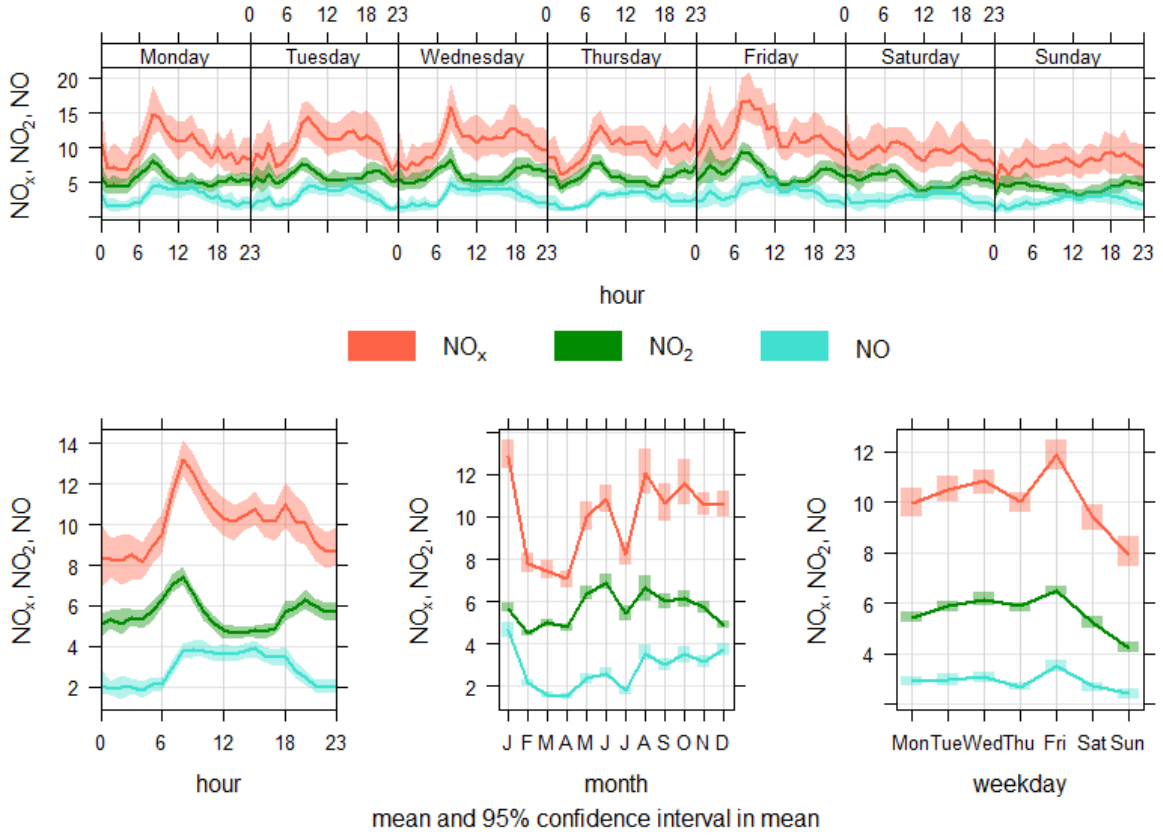
E4 NO_x monitoring data trends

A time dependent plot for nitrogen oxide species is shown in Appendix E Figure 3 below. This shows that generally NO_2 levels peak in the early morning and then reduce during the day, likely through a combination of increased wind dispersion and increased conversion to NO by sunlight.

The NO_x concentrations in these plots are expressed as NO_2-equivalent. When comparing the concentrations in the plots, it is important to note that the sum of the NO and NO_2 concentrations will not equal the NO_x concentration because of the difference in molecular weights (adjusting for the difference in molecular weight (46/30), 1 µg/m^3 NO can be expressed 1.5 µg/m^3 NO_2-equivalent). However, the plots are useful for showing relative trends.

The key features of these plots are that:

- NO_x concentrations are not influenced by atmospheric chemistry and therefore the month-by-month differences are most likely due to meteorology (as average emission rates from the Mill are reasonably consistent). However, the differences in NO_x concentrations between weekdays and weekends may reflect differences in emission patterns, such as from heavy traffic.
- NO concentrations are relatively higher during the day and NO_2 concentrations are relatively lower, reflecting the expected conversion of NO_2 to NO in the presence of sunlight (see Appendix E Figure 3).



Appendix E Figure 3: Time and wind-speed dependent plots for one hour averaged concentrations of nitrogen oxide species (µg/m^3) at 64 Glenbrook Beach Rd (Site 20) monitoring site, November 2018 – February 2021

The relationship between NO and NO_2 concentrations in winter (July 2019 and July 2020) and summer (January 2020 and January 2021) are shown in Appendix E Figure 5. As expected, the

equilibrium between NO and NO_2 is pushed towards NO in the summer and towards NO_2 in the winter.

The relationship between hourly concentrations of NO_2 and total NO_x is shown in Appendix E Figure 4. The minimum ratio of NO_2/NO_x is around 20%, which is likely to reflect periods of minimal conversion of NO to NO_2 by ozone. This will be similar to the ratio in the stack emissions.

At ambient NO_x concentrations less than about 40 µg/m^3, there are times when all of the NO_x is present as NO_2 i.e. the atmospheric chemistry reactions are NO_x-limited at these times rather than ozone limited.

In the hour when the highest NO_2 concentration was measured (57 µg/m^3), the NO_x concentration (expressed as NO_2) was 72 µg/m^3. This hour also had the highest measured NO_2/NO_x ratio of approximately 80%. Assuming the percentage of NO_2 in the stack emissions was about 20%, this suggests that about 46 µg/m^3 NO_2 was present as a result of atmospheric conversion of NO. Appendix E Table 1 shows the stoichiometric calculation for the production of 46 µg NO_2 from NO using the following chemical reaction:

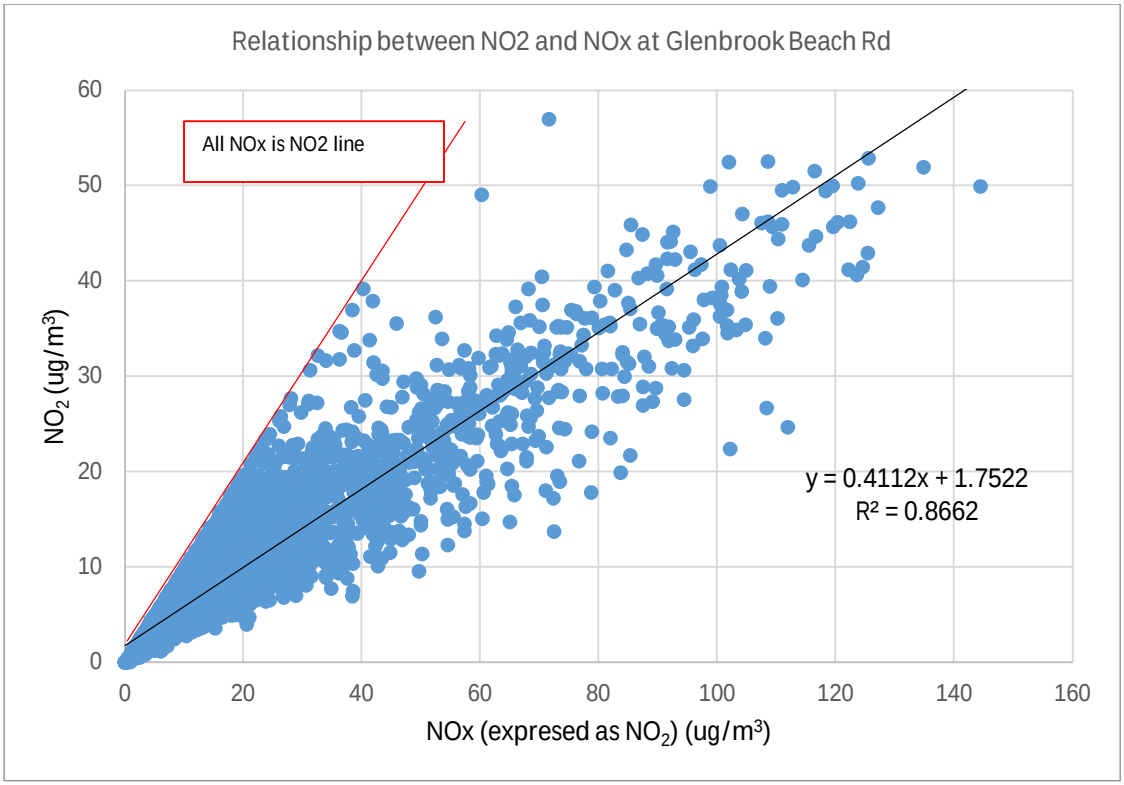
$$[NO] + [O_3] \rightarrow [NO_2] + [O_2]$$

The reaction to generate 46 µg NO_2 uses 50 µg ozone and 19.5 µg NO. A concentration of 50 µg/m^3 ozone is consistent with the highest measured ozone concentrations at Patumahoe. Based on this analysis, NO emissions from the stack have the potential to contribute up to about 46 µg/m^3 additional NO_2 to the primary NO_2 emitted from the stack. However, this can only occur at times when the atmospheric reactions are not NO_x-limited, i.e. weather conditions are unfavourable for the dispersion of the stack emissions.

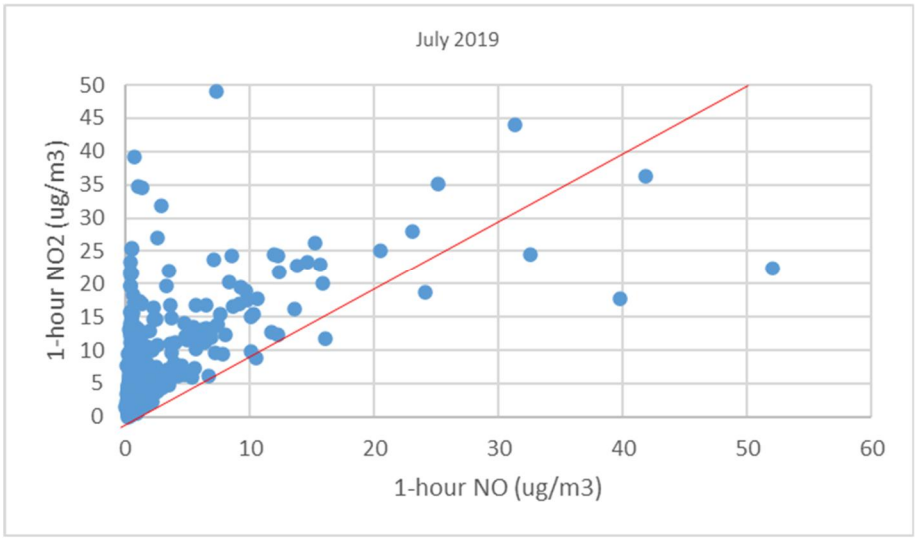
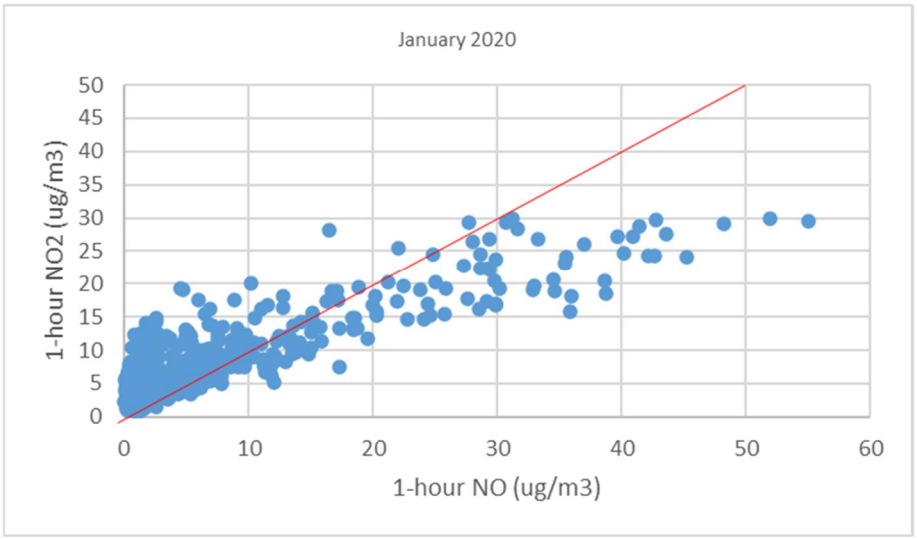
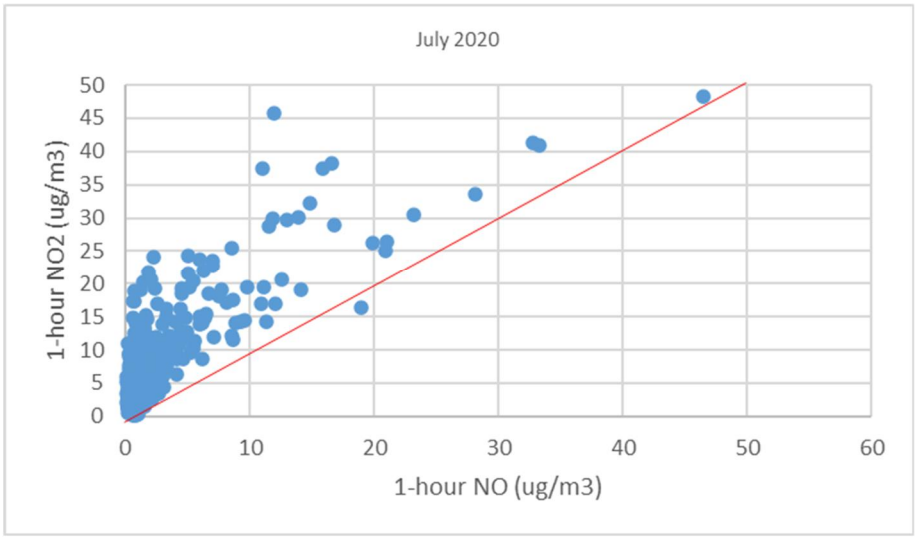
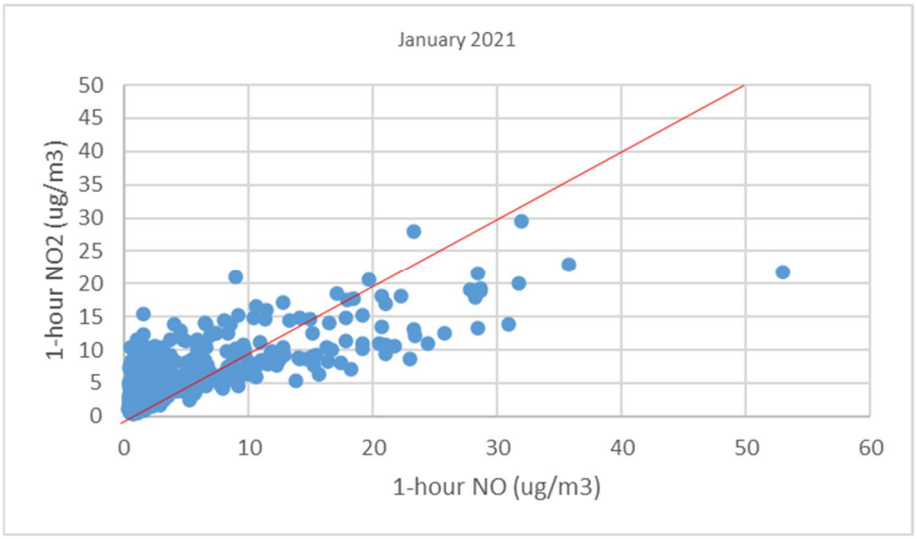
Appendix E Table 1: Stoichiometric calculations for conversion of NO to NO_2

	Molecules			
	NO	O_3	NO_2	O_2
MW (g/mol)	30	48	46	32
Mass (µg)	19.5	50	46	22
Moles (µ-mol)	0.65	1.04	1	0.69

The linear regression correlation between NO_2 and NO_X concentrations shows that, on average, about 40% of the NO_x in the ambient air measurements is present as NO_2. This demonstrates that, on average, there is only a modest impact of atmospheric conversion of NO to NO_2 (i.e. a large proportion of the emitted NO is not converted to NO_2).



Appendix E Figure 4: Plots of 1-hour averaged NO_2 concentrations against NO_x (expressed as NO_2) November 2018 – February 2021.

Winter	Summer
	
	

Appendix E Figure 5: Plots of 1-hour averaged NO_2 concentrations against NO concentrations for the months indicated. Red line in each shows the 1:1 ratio.

Appendix F: Derived MAVs for drinking water

In calculating the following derived MAVs, a body weight of 70 kg and a daily water intake of 2 L/day were used in alignment with the DWSNZ. In each calculation, only a fraction of the limit is allocated to drinking water sources. All allocation fractions used were those recommended in WHO (2017) "Guidelines for drinking-water quality, 4th edition, incorporating the 1st addendum". The sources of the derived MAVs as stated in WHO (2017) are provided below.

Aluminium:

The WHO guidelines' datasheet for aluminium cites a Provisional Tolerable Weekly Intake (PTWI) for aluminium from all sources of 1 mg/kg body weight, developed by the Joint FAO/WHO Expert Committee on Food Additives (JECFA). The MAV of 1000 µg/L was then calculated using an allocation of 20% of the PTWI to drinking-water. WHO guidelines note that there remain uncertainties as to the extent of aluminium absorption from drinking-water.

Cobalt:

The Agency for Toxic Substances and Disease Registry (ATSDR), a federal public health agency of the U.S. Department of Health provides a minimum risk level for cobalt ingestion of 0.01mg/kg body weight/day. An allocation of 20% of this value to drinking water sources was used to derive an MAV for the screening assessment.

Iron:

The WHO guidelines' datasheet for iron cites a Provisional Tolerable Maximum Daily Intake (PTMDI) developed by JECFA in 1983 of 0.8 mg/kg body weight. Allocation of 10% to drinking water produced an MAV for the screening assessment of 2000 µg/L.

Vanadium:

The DWSNZ refer to the Notification Level set in the California OEHHA. OEHHA have derived the notification level of 15 µg/L using the lowest observed adverse effect level of 2.1 mg/kg-day identified in a reproductive and developmental study in rats, multiplied by an uncertainty factor of 1000 and a 20% allocation to drinking water.

Zinc:

The WHO guidelines' datasheet for zinc cites the PMTDI of 1 mg/kg body weight developed by JECFA in 1982. An allocation of 20% to drinking water was used to find an MAV of 7000 µg/L.

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Appendix F: Public Health Assessment

Environmental Medicine Limited
www.envirodoctors.com
PO Box 28 424 Remuera
Auckland 1541 New Zealand
Phone: (649) 920 9779
Email: doctor@envirodoctors.com

16 April 2021

Attention: Jenny Simpson
Tonkin & Taylor Ltd
JSimpson@tonkintaylor.co.nz

Dear Jenny

Re: NZ Steel Air Quality Assessment public health review comments

This letter primarily provides advice from a public health perspective on two aspects of the air quality assessment for the Glenbrook Mill, namely:

- Exposure to SO_2, related to occasional exceedances of the WHO 24-hour guideline; and
- Exposure to PM_{10}, related to exceedances of the 24-hour National Environmental Standard value.

Also, as requested, I have considered:

- The $PM_{2.5}$ monitoring information
- Background monitoring information
- Effects of metals deposition on roof collected drinking water

I refer to the following information:

- Your emailed summaries of exposure to SO_2 and PM_{10}, dated 4 February.
- Your emailed summaries of exposure to $PM_{2.5}$, dated 10 February.
- Your emailed estimates for annual average marine aerosols.
- NZ Steel Air Quality Assessment PRELIMINARY DRAFT (v2) received 19 March.
- The World Health Organisation (WHO) Technical reports:
    - WHO (2000). Guidelines for air quality. Geneva: WHO.
    - WHO (2006). Air Quality Guidelines global update 2005. Geneva: WHO.
    - WHO (2013). Review of evidence on health aspects of air pollution – REVIHAAP Project. Technical Report. WHO Regional Office for Europe, Copenhagen.

Monitoring sites and information:

The Glenbrook Beach Rd air quality monitoring site is the closest ambient air quality monitoring station to the Glenbrook Steel Mill for relevant air pollutants. It is beyond the operational area of the Mill but within the wider New Zealand Steel Ltd (NZS) landholding. The location is considered representative of the worst-affected off-site residences in proximity of the NZS site. I concur with the selection of a location in proximity to the site and to represent worst-affected residences. Glenbrook school also provides a useful location.

Other air quality monitoring sites include:

Sandspit Rd (in Waiuku) - PM_{10}; and
Glenbrook School (east of the site) - PM_{10} and SO_2.

Exposure to sulphur dioxide and exceedances of WHO 24 hour guideline:

Sulphur dioxide (SO_2) is a respiratory irritant and elevated exposures are well-established as a source of respiratory symptoms (eye, nose, throat, airways) including provocation of bronchospasm (asthma reactions) in susceptible individuals. Associated systemic difficulties can include aggravation of cardiac problems or headache. The NES one hour averaging period provides a standard to protect from irritant effects from short-term exposure.

The WHO reviews of health effects from SO_2 exposure (2006, 2013) have included the public health effects of variation of daily and annual exposures in the urban environment, associated with mixed combustion activities including transport. The associations of adverse health outcomes with daily SO_2 has been found where there are frequent, repeated and ongoing daily elevations often due to multiple and diffuse sources. The direct causal association with SO_2 is uncertain for some of the observed outcomes. For mortality outcomes, controlling particulate exposure has been observed to be essential. A guideline for 24-hour exposures to sulphur dioxide has been proposed by WHO but not adopted as a national guideline in New Zealand.

The sulphur dioxide monitoring commenced 24 March 2017 and was discontinued on 30 June 2020 with three full years of data.

The Glenbrook Beach Road monitoring data shows that there were no exceedances of the NESAQ or NZ AAQG values over the monitoring period. However, there were occasional exceedances (10 over the monitoring period) of the 24-hour average WHO guideline value (20 $\mu g/m^3$). The dates of the ten measurements above 20 $\mu g/m^3$ were available to me and I note they arose sporadically across the 3 years and only 2 days were in the same week (4 and 6 Jan 2020, 22.5 and 23.6 $\mu g/m^3$). Measurements above 10 $\mu g/m^3$ were uncommon and a majority of days were below 2 $\mu g/m^3$. The overall pattern and distribution of the data supports a conclusion that exposure to 24 hour average values is consistent with minimal health effects.

Exposure to particulate and exceedances of the NES value:

People with pre-existing lung disease, young children and the elderly are most likely in New Zealand to suffer adverse health effects from inhalation of particulate matter. The NES 24-hour average PM_{10} (50 $\mu g/m^3$) and annual average guideline value (20 $\mu g/m^3$) provide for protection from adverse health effects. The WHO (2006) note that the 24-hour average values recommended as PM guidelines "refer to the 99th percentile of the distribution of daily values ie the fourth next highest value of the year." [1] The NES allows for one 24-hour exceedance per 12 month period.

The New Zealand 2012 HAPINZ Study[2] presents an exposure response methodology that incorporates the following adverse outcomes as associated causally with particulate exposure:

- Mortality all ages – annual PM_{10};
- Morbidity and particulate:
    - Cardiac hospital admissions all ages daily mean PM_{10}

[1] WHO (2006) Page 278 with reference to table 6
[2] Updated Health and Air Pollution in New Zealand Study. Volume 2: Technical reports. (March 2012)

- Respiratory hospital admissions all ages daily mean PM_{10}
- Respiratory hospital admissions ages 1 – 4 years and 5 – 14 years daily mean PM_{10}
- Morbidity and restricted activity days all ages – annual mean $PM_{2.5}$

$PM_{2.5}$ will feature in future guidance documents about protection from particulate effects on health. The properties of fine and ultrafine particles include penetration into the smaller airways and absorption into the circulatory system. The historic associations of adverse outcomes with PM_{10} exposure are partly attributable to the smaller fractions included in the composite PM_{10} measure. A proposed NESAQ/AAAQT for $PM_{2.5}$ 24 hour and annual averages (25 µg/m^3 and 10 µg/m^3 respectively) has been included in the Air Quality Assessment[3].

Monitoring at Glenbrook Beach Rd for PM_{10} and $PM_{2.5}$ particulate is undertaken using a Beta-Attenuation Monitor (BAM), which provide a continuous near-real time measure of particulate concentrations. PM_{10} monitoring has been undertaken for many years and $PM_{2.5}$ monitoring commenced in March 2018.[4]

Daily PM_{10} exposure

The 24-hour average PM_{10} concentrations measured at Glenbrook Beach Rd are generally within the NESAQ standard of 50 µg/m^3, however there have been occasional exceedances of the 24-hour NESAQ value over the last 12 years of monitoring, as shown in Figure 7.1.[5] Data plots show that in 3 years the highest 24-hour measurement was approximately 90 µg/m^3 (2013) and 80 µg/m^3 (2017, 2019).

Assessing the occasional days with 24-hour average data above 50 µg/m^3, a distributional table shows that in no year was the fourth next highest value (WHO, 2006) above 60 µg/m^3. In 2013, 2015, 2017 and 2019 the fourth next highest value was between 55 and 60 µg/m^3 and in 2016 and 2020 it was between 50 and 55 µg/m^3 and in the remaining 7 years the value was below the WHO guideline. While these infrequent sporadic days above 50 are an exceedance of the NES value, I assess the health effects as minor.

Annual average PM_{10} exposure

Figure 7.2 shows that annual averages for PM_{10} are below 20 µg/m^3 at all monitoring sites in each year 2007 to 2020. HAPINZ (2012) used annual average PM_{10} to assess mortality risk (all ages).

Tonkin and Taylor have estimated background concentrations of PM_{10} and $PM_{2.5}$ from the hours when the wind is <u>not</u> blowing from the Mill. From this, they have estimated annual average background concentrations of:

- PM_{10}: 11.3 ug/m^3 (compared to annual average concentrations typically in excess of 16 ug/m^3 at Glenbrook Beach Rd)
- $PM_{2.5}$: 5.1 ug/m^3 (compared to the annual average concentration of 6.5 ug/m^3 in 2019 at Glenbrook Beach Rd)

[3] T+T Air Quality Assessment Draft (March 2021)
[4] T+T Air Quality Assessment Draft (March 2021)
[5] T+T Air Quality Assessment Draft (March 2021)

Annual average and daily $PM_{2.5}$ exposure

For $PM_{2.5}$, the maximum 24-hour average concentration that has been measured to date is 22.3 µg/m^3 and the maximal annual average concentration was in 2019 at 6.5 µg/m^3, both of which are below the current WHO guidelines. Therefore, my assessment of the health effects from $PM_{2.5}$ is that they are less than minor.

Effects of metals deposition on roof collected drinking water:

I support the use of the MAVs for drinking water as an appropriate guidance for safety of roof collected water. I note that the evaluation of six household drinking water sources (table 7.8) shows potential presence from vanadium deposition but the results are all below the MAV. A calculation sets out Tolerable Daily Intake and exposure assumptions used in this assessment and I support the method used to derive a MAV for vanadium (7.4.5)

The observation that house 5 appears to show cadmium from roofing materials is consistent with my experience.

I agree with the assessment of mercury as a volatile element (7.4.4) and the conservative assumption that all mercury in the coal and limestone raw materials is volatilised and released. I agree with the conclusion that the predicted annual average concentration at the worst-case sensitive receptor is not a risk to health.

Conclusions:

For sulphur dioxide the health effects from one hour average exposures are less than minor.

For sulphur dioxide daily exposure (24-hour averages), the overall pattern and distribution of the data supports a conclusion that effects are less than minor.

The monitoring data for PM_{10} show exceedance of the NES value. I assess the health effects on these infrequent sporadic days as minor. I assess the overall effects as less than minor.

The health effects from $PM_{2.5}$ are less than minor.

The effects of metals deposition on drinking water from roof collection are less than minor.

Yours sincerely

Francesca Kelly

Dr Francesca Kelly
MB ChB, Dip Com Health, FAFPHM (RACP), FRACMA
Public Health Physician
Director, Environmental Medicine Ltd

Appendix G: Draft Air Quality Management Plan

Glenbrook Industrial Site
Air Quality Management Plan

DRAFT v1 April 2021

This draft Air Quality Management Plan (AQMP) has been prepared based on the existing Main Air Permit (Permit 14317), for reference in the Resource Consent Application for a replacement Air Permit for the Glenbrook Steel Mill. As such, it does not reference any *Proposed Consent Conditions* included in Appendix L to the Resource Consent Application.

Following issue of the new Air Permit, the AQMP will be revised to reflect the consent conditions and submitted to Council.

Contents

1 Introduction

This Air Quality Management Plan (AQMP) addresses the health, safety and environmental requirements to manage dust, particulates and other air-borne contaminants from fugitive and point-sources, associated with the operations of the New Zealand Steel (NZ STEEL) Steel Mill industrial site at Glenbrook (Site).

NZ STEEL holds Resource Consent 14317 (Main Air Permit) granted by Auckland Regional Council on 29 November 2006 (Change of Conditions 2 and 21 were granted on 4 November 2014). The Main Air Permit covers all discharges to air from the Site, excluding those related to the landfills. NZ STEEL also holds Resource Consent DIS60363772 granted by the Auckland Council on 8 October 2020 and which covers discharges to air from commercial iron plating activities (Commercial Iron Plating Air Permit). Both the Main Air Permit and the Commercial Iron Plating Air Permit are sought to be renewed.

This AQMP should be read in conjunction with the Glenbrook Environmental Management Plan (EMP), the existing Main Air Permit (issued by Auckland Council) and any dust management requirements set out in NZ STEEL health, safety and environmental procedures. Key NZ Steel procedures associated with the AQMP are listed in Section 14.

Section 4 outlines the key responsibilities of the NZS operational, maintenance and support teams. Sections 5, 6 and 7 provides an overview of the receiving environment for the Glenbrook Site and the generation and nature of emissions.

Sections 8 and 9 outlines the key controls for fugitive dust and point source emissions. Where standard operating procedures (Procedures) provide further detail on these controls, they are referenced. NZ Steel Procedures have a specified owner within the business and they are regularly reviewed and updated to ensure currency and effectiveness.

Section 10 is an overview of the monitoring program requirements to verify that the Main Air Permit conditions are being met and Section 11 outlines auditing requirements, response to incidents and complaints. Finally, Section 12 provides an overview of reporting on compliance to Auckland Council.

2 Purpose and Scope

The purpose of this AQMP is to outline key requirements for all personnel engaged in activities on the Site, to ensure compliance with existing resource consents associated with discharges to air from the Site, in order to minimise harm to people and the natural environment.

In addition to the Main Air Permit relating to the Site, a separate consent was issued for Landfill East (reference ARC34752). As the landfill activities may impact the ambient monitoring results associated with the Main Air Permit, the key controls in this AQMP also apply to East Landfill. (The Landfill Management Plan also contains an AQMP relating to its specific consent conditions and therefore has priority for the Landfill.)

The AQMP identifies aspects specific to the Site, including:

- Key personnel accountable for implementing the AQMP and their responsibilities;
- Location characteristics affecting air emissions beyond the Site boundary;
- Sources of dust and other air-borne contaminants;
- Key mitigation and prevention mechanisms and controls;
- Key maintenance and operational requirements;
- Air quality monitoring program (ambient and stack);
- Methods for managing incidents and complaints;
- Compliance reporting and air quality records relating to the compliance; and
- Requirements for assessing the impact of changes to facilities, processes and activities.

3 Definitions

Common terms used in this AQMP and their abbreviations are defined in the table below. In addition, Section 6 provides a fuller explanation of the nature of air emissions, by type and source.

Term	Definition	Abbreviation
Air-borne contaminants	General term used in the AQMP in reference to emissions to air, with potential to cause harm or nuisance, beyond the Site boundary.	
Ambient air monitoring	Measurement of concentrations of contaminants of interest present in the air, as captured by specific monitoring equipment. May measure fine fraction (PM_{10} or less), TSP or other air-borne contaminants	
Ancillary activities	Supporting activities, including movement of molten iron and steel slabs between manufacturing plants; stockpiling and processing of raw materials, co-products and waste; tipping of slag, iron and RPCC; and all supporting vehicle movements.	
Best Practicable Option (BPO)	Defined in section 2(1) of the RMA, as: "in relation to a discharge of a practicable contaminant or an emission of noise, means the best method for option preventing or minimising the adverse effects on the environment having regard, among other things, to — (a) the nature of the discharge or emission and the sensitivity of the receiving environment to adverse effects; and (b) the financial implications, and the effects on the environment, of that option when compared with other options; and (c) the current state of technical knowledge and the likelihood that the option can be successfully applied."	

Contaminant	Defined in section 2(1) of the RMA, as: "including any substance (including gases, odorous compounds, liquids, solids, and micro— organisms) or energy (excluding noise) or heat, that either by itself or in combination with the same, similar, or other substances, energy, or heat— (a) when discharged into water, changes or is likely to change the physical, chemical, or biological condition of water; or (b) when discharged onto or into land or into air, changes or is likely to change the physical, chemical or biological condition of the land or air onto or into which it is discharged."	
Deposited particulate	Dust generally greater that 50 µm in diameter	
Dust Emission Ranking	Dust Emission Ranking system is a guide to assess the risk of an activity generated dust that will affect on site personnel and could travel beyond the Site boundary, creating nuisance or elevated monitored PM10 and TSP.	DER
Fugitive emission/dust	Diffuse emissions to air, also referred to as non-point source discharges.	
Investigation Trigger Limit	The Main Air Permit specifies a 24-hour average concentration of TSP or PM_{10} referred to by NZ Steel as the Investigation Trigger Level. If ambient concentrations measured at a continuous monitoring station established under the Main Air Permit exceed this level, NZ Steel will investigate the cause of the exceedance. If the cause is determined to be attributable to NZ Steel's activities, action shall be taken to reduce the discharge from the activity.	
Iron Plant	Where NZ Steel manufactures molten iron from the raw materials such as Primary Concentrate, coal and lime. This plant includes the MHF, Kilns, Melters and Cogeneration facilities.	
Main Air Permit	The "main" air discharge permit, which was granted on 29 November 2006 and authorises discharges to air from the production of iron and steel and associated activities (Auckland Council reference DIS80296529 [NRSI-14317])	
Managing Risk and Safety	System for recording and reporting safety, environmental and related information.	MARS
Metal Coating Line	The line cleans, anneals, coats and surface treat the steel in a continuous operation.	MCL
Multi Hearth Furnace	The first process in the Iron Plant, which raises the temperature of the raw materials (primary concentrate and coal) to 900°C and removes volatile compounds from the coal.	MHF
Operational Area	Area within the wider NZ STEEL landholdings that is used for Steel Mill operations. This area does not include areas that are farmed, or the area currently used as a landfill for waste materials generated at the Site.	
Oxygen Steel Making Furnace (KOBM)	Vessel, specifically the Klockner Oxygen Blown Maxhutte Furnace (KOBM)within which molten iron and scrap steel is turned into liquid steel.	KOBM

Paint Line	The Paint Line produces COLORSTEEL® prepainted steel products. These products are used extensively in building applications: roofs, fascias, gutters and cladding. Only New Zealand Steel manufactures COLORSTEEL®	
Particulate Matter / Total suspended particulate	Mixture of solid particles and liquid droplets found in the air, ranging in diameter from 10 to 50 µm (microns). Reference to fine particulates which can be inhaled are 10 microns or less (PM_{10}) and 2.5 micron or less ($PM_{2.5}$).	TSP PM_{10} $PM_{2.5}$
Pickle Line	A series of pickling tanks containing hydrochloric acid solutions and wash water that removes the fine layer of iron oxide scale that is generated during hot rolling and produces a strip surface suitable for cold rolling. This process is part of the Rolling Mills.	
Plate Line	Where heavy plates (up to 50mm thick) produced by Roughing and Finishing Mills are air cooled, levelled, inspected and cut to final length. This process is part of the Rolling Mills.	
Plating/Iron Plating	Process whereby molten iron is poured into pits to solidify.	
Point source emissions	Emissions from stacks and chimneys, so not diffuse like fugitive or non-point source emissions.	
Primary concentrate	Iron sand (from the Waikato) that has been through a separation processes (magnetic/gravity) to increase the iron content/reduce any mineral impurities.	PC
Primary Plants/Operations	Consists of the Iron Plant, Steel Plant and associated raw material handling. The MHF and Kilns Cogeneration facilities are also closely associated with these facilities.	
Reduced Primary Concentrate and Char	The Kilns convert pre-heated primary concentrate and char mixture from the MHFs to metallic iron by chemical reduction to produce RPCC. RPCC is then discharged from the Kilns to closed transfer vessels for delivery to the Melters. Note RPCC consists of: · prime RPCC, which is RPCC that meets the specification for further processing at the Melters; · off-specification RPCC, which is RPCC that does not contain sufficient iron content for further processing; and accretion RPCC, which is a boulder-like build up that must be removed from the Kilns.	RPCC
Rolling Mills	Hot Strip Mill - Slabs produced during the Steel Production process are transported to the Hot Strip Mill where they are re-heated and hot rolled to produce coil and plate. Cold Mill- Steel is processed cold	
Slag	A co-product of the iron and steel making process that is similar in character to volcanic rock. Slag is a mixture of non-metallic and metallic materials that float on top of the molten iron or steel (removing impurities such as silicon, titanium and sulphur). Melter Slag is a co-product of the iron making process, that is similar in character to volcanic rock.	

	KOBM Slag is a co-product of the steel making process, formed in the KOBM. It has cementitious properties and is used to partly replace limestone on Site. Vanadium Slag is a co-product of the steel making process, formed after oxygen is blown into a ladle of molten iron at the VRU. Steelmaking Slag means both KOBM Slag and Vanadium Slag.	
Stack testing	Measurement of emissions to air exiting a stack, chimney or vent.	
Steel Mill	The integrated steel making facility in Glenbrook and ancillary activities on the Site.	
Steel Plant	Where NZ Steel manufactures steel slabs and billets made from iron produced at the Iron Plant.	
Steelserv Limited	Company that operates large mobile equipment on Site and provides a range of services, including stockpiling and handling of coal, movement of iron lades to the steel plant, slag ladles and bins to the tipping banks, waste and co-products to processing areas. Steelserv also operates the Site landfill and the screening and crushing facilities for production of a range of slag products for direct sale. recovers the metal co-product (known as 'slag') from the iron and steel making processes, stockpiles and further processes the slag for direct sale.	Steelserv
Utilities	The NZ Steel team supporting provision of key utilities to the Site, including gas, water, electricity, water treatment, internal roads.	

4 Responsibilities

An overview of key personnel with responsibility for ensuring compliance with the Main Air Permit and the AQMP, are set out in this section. In addition, specific responsibilities will be included in NZ STEEL procedures relating to environmental control of emissions to air as referenced in this AQMP.

4.1 Operation and Maintenance Superintendents

The responsibilities for NZ Steel and Steelserv Operations and Maintenance Superintendents include:

- Ensuring employees and contractors are familiar with requirements of AQMP and plant-specific operating procedures relating to mitigation of air emissions;
- Ensuring employees and embedded contractors receive training on the content of the AQMP to ensure compliance with this AQMP and associated procedures;
- Any proposed operational changes with potential to affect air quality monitoring, compliance with the Main Air Permit or governance requirements being reviewed by the NZPI Environment Team;
- Making plant available for stack testing to meet the Main Air Permit schedule, including safety controls for access to platforms and testing location;
- Schedule and lead audits of key air quality controls, outlined in the AQMP and associated procedures, to ensure compliance and to identify opportunities to reduce risk to the environment and people;
- Report (via MARS) and lead incident investigations related to breach of Main Air Permit conditions or near-misses;
- Support complaint investigations, as requested by the NZPI Environment Team; and
- When there are proposed operational changes with potential to affect relevant Main Air Permit monitoring, compliance and governance requirements liaise with NZPI Environment Team to ensure appropriate environmental assessment.
- Set out the Management of change process for any amendments to the AQMP, including assessment of whether changes are material (Condition XXX) and whether changes ensure the effects are the same or similar in character, intensity and scale to the effects described by the application documents (Condition 11).

4.2 Engineering Project Managers, Alinta and Contractors

The responsibilities of Engineering Project Managers and Managers of Steelserv, Alinta and site-based contracting businesses, include: -

- Direct reports and contractors' familiarisation with AQMP, plant-specific operating procedures;
- JSEA's set out environmental controls to minimise dust emissions and other air-borne contaminants;
- Employees and embedded contractors receive training to ensure compliance with this AQMP and associated procedures;
- Any proposed operational changes with potential to affect air quality monitoring, compliance with the Main Air Permit, or governance requirements are reviewed by the NZPI Environment Team;

- Making plant available for stack testing to meet Main Air Permit schedule, including safety controls for access to platforms and testing location;
- Schedule and lead audits of key air quality controls, outlined in the AQMP and associated procedures, to ensure compliance and to identify opportunities to reduce risk to the environment and people;
- Lead incident investigations related to breach of Main Air Permit conditions or near-misses;
- Support complaint investigation, as requested by the NZPI Environment Team.

4.3 Environment Team

Responsibilities for the Environment Team include:

- Support maintenance of and improvement to the NZ Steel Environmental Management System, which is part of the Integrated Management System;
- Ensuring ambient air monitoring is undertaken as specified by the Main Air Permit;
- Circulate any revised and approved versions of this AQMP and provide guidance, as required;
- Support Superintendent, plant personnel and contactors to implement this AQMP;
- Review compliance monitoring results and initiate incident investigations;
- Prepare compliance reports for Council and NZ Steel;
- Lead Council compliance reviews;
- Support regular audits to ensure this AQMP is followed and identify opportunities to reduce risk to the environment and people;
- Support compliance and ambient alert incident investigations; and
- Respond to and lead investigation of complaints.

4.4 Laboratory Manager

Responsibilities for the NZ Steel Laboratory Manager include:

- Coordinate point source testing to meet the timeframes and requirements of the Main Air Permit, including liaison with Operational and/or Maintenance Superintendents and the Stack Testing contractor to schedule stack testing when manufacturing facilities are operating under “normal conditions”;
- Ensure Stack Testing contractor provides early advice of a breach of stack emission limit, reporting to relevant Superintendent to enable timely incident investigations;
- Ensure integrity of data and testing provided by the NZ Steel Laboratory and contractors supplying testing services to NZ Steel;
- Manage incumbent contractor responsible for maintaining ambient air monitoring stations (currently Watercare) to ensure Main Air Permit conditions are met;
- Support processes for additional stack and ambient air monitoring, which may be required for investigation purposes; and
- Timely notification to relevant Superintendents and Environment Team of all results.

5 Description of Site and Operational Area

Approximately 190 hectares of the Site is used for the operational aspects of the Steel Mill (defined above as the 'Operational Area'). This is denoted by the white dashed line in Figure 5.1, which also generally characterises the activities undertaken within the Operational Area.

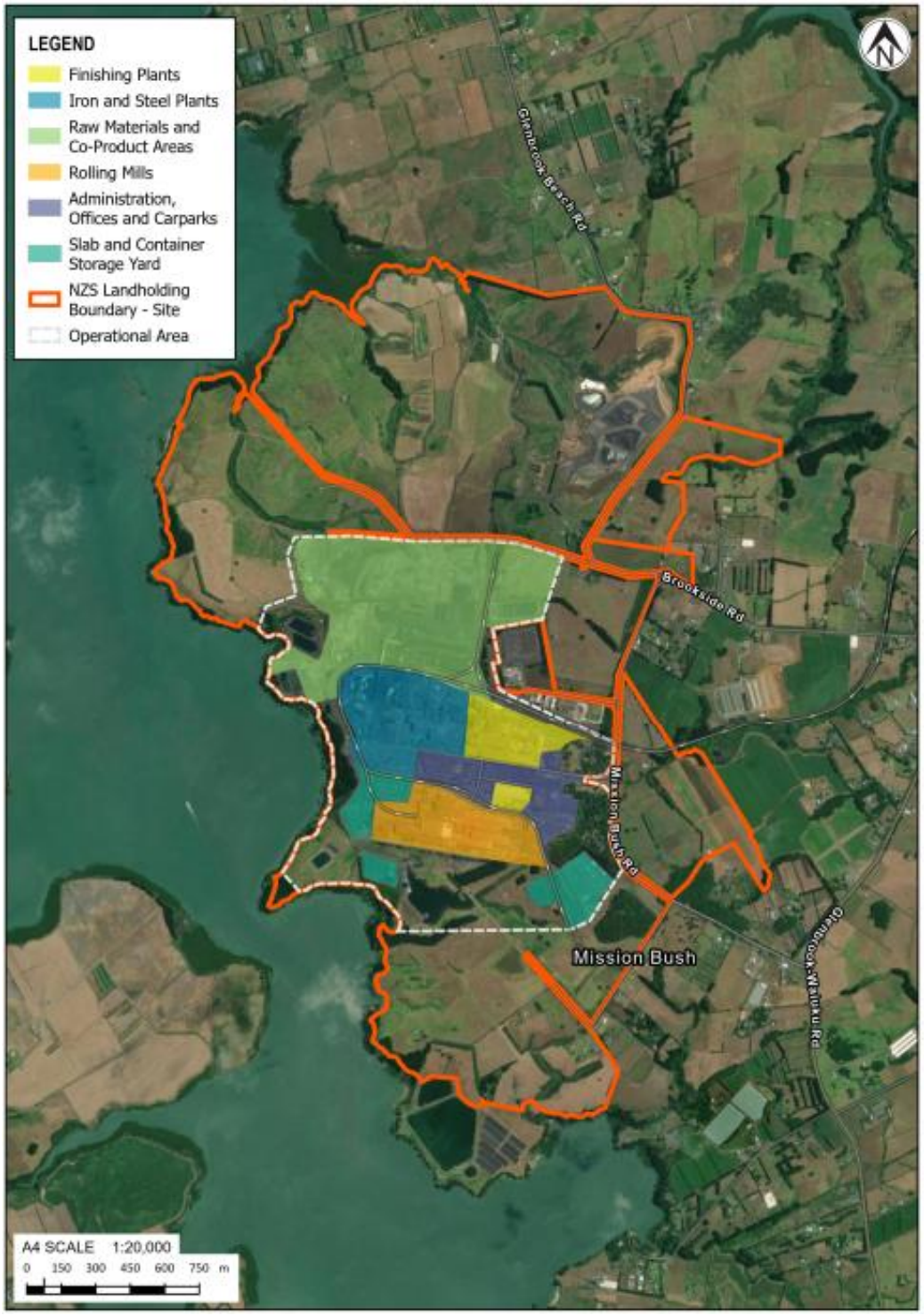


Figure 5.1: NZ Steel Site, Operational Area and key activities

The northern portion of the Operational Area is where the majority of the raw materials in the iron and steel making process are stockpiled, including coal and Primary Concentrate (PC). The central part of the Operational Area comprises the Iron and Steel Plants. To the east and south of the Iron and Steel Plants are the Finishing Plants, Rolling Mills, storage yards and administration offices.

The Operational Area comprises a number of buildings, structures and stockpiles of varying sizes, the highest of which are the stacks at approximately 60 metres. The nature of emissions as a result of Steel Mill manufacturing processes and ancillary activities that occur within the Operational Area are described in Sections 6, 7 and 8.

The Site is heavily modified by the Steel Mill's activity including its associated plant, infrastructure and ancillary structures and activities. The Steel Mill contrasts to the generally rural surrounds and creates a distinctive and prominent landmark. It is noted that the Steel Mill is located within the Auckland Rural Airshed.

There are two road access points to the Site, via Mission Bush Road and Glenbrook Beach Road/Glenbrook Road. The Steel Mill is also served by the Mission Bush Branch railway line, which was formerly a branch line to Waiuku.

The Operational Area, plus some additional land to the north and south (which is currently used for rural purposes) is zoned Business – Heavy Industry in the AUP. The AUP's Business – Heavy Industry Zone provides for large-scale industrial activities, such as the Steel Mill, that may produce objectionable odour, dust and noise emissions[1]. Heavy traffic movements are anticipated as the zone is noted to typically be located close to key freight routes. Storage or production of hazardous materials are also anticipated through higher quantity thresholds identified for the zone[2]. Consequently, a lower level of air quality amenity is anticipated by the AUP in these zones.

The AUP contains specific recognition of the Steel Mill through the 'Glenbrook Steel Mill Precinct':

> *"The purpose of the Glenbrook Steel Mill Precinct is to support and enable the continued operation of the existing steel mill and associated facilities. The Glenbrook Steel Mill is located on Mission Bush Road, Glenbrook and is a significant industrial resource within the Auckland region. This precinct seeks to provide for the mill's growth and operation in a way that continues to support the local, regional and national economy.[3]"*

Outside the industrial zoned Operational Area, NZ Steel owns land to the north, east and south which is zoned, and generally used, for rural purposes. This forms a greenbelt around the Steel Mill and acts as a buffer between the Steel Mill and the surrounding farmland and communities.

Pockets of vegetation are located on the Site, two of which in the south-eastern corner are identified as Significant Ecological Area -Terrestrial (SEA-T) area within the AUP. Boundary vegetation is also used for screening of the Steel Mill from the local surrounds.

[1] H16.1 Zone Description
[2] Table E31.4.3 of the AUP. Note the Steel Mill is not designated as a Major Hazardous Facility by Worksafe.
[3] Precinct description - Section I415.1 of the AUP

5.1 Potential Sensitive Receptors

Within the rural environment beyond the Site, there are activities that have a relatively higher sensitivity to air quality impacts compared to rural land uses (these are known as 'sensitive receptors'[4]). The nearest identified sensitive receptors are: [5]

- Dispersed rural residential dwellings: the closest residential dwelling is located approximately 350 m east/south-east of the Operational Area; the closest dwellings in Waipipi (on the western side of the Waiuku Estuary) are over 1.4 km away.
- Glenbrook School: located approximately 1.3 km to the east of the Operational Area.
- The Wymer Road Rest Home: located approximately 3.6 km east of the Operational Area.
- The township of Waiuku located approximately 2.3 km to the south of the Site and the smaller settlement of Glenbrook Beach located approximately 3.4 km north of the Site.

Figure 5.2 identifies the nearest sensitive receptors surrounding the Site.

[4] As discussed at Section 3.7 of the GPG Industry. Sensitive receptors are locations where people may be present at all times of the day, both indoors and outdoors and may include people of high sensitivity (such as children or elderly). Sensitive land uses include, but are not limited to, hospitals, schools, childcare facilities, rest homes, marae, residential dwellings and recreation spaces. .

[5] Note that these are measured from the Operational Area boundary (shown in white dash in Figure 5.2)

Figure 5.2: NZ Steel Site, Operational Area and key activities

5.2 Meteorological Conditions

Meteorological conditions influence the generation and dispersion of air discharges. The most influential meteorological parameters are wind speed (particularly high wind speeds), wind direction, rainfall and temperature.

Meteorological conditions and ambient air quality are currently monitored by five monitoring stations in the proximity of the Site. Details of locations of the stations are provided in Attachment 1. Figure 5.3 shows typical wind roses for the Glenbrook Beach Road (Site 20) monitoring site and the Training Centre (Site 3) monitoring site. These two stations are the closest to the Site and show similar patterns.

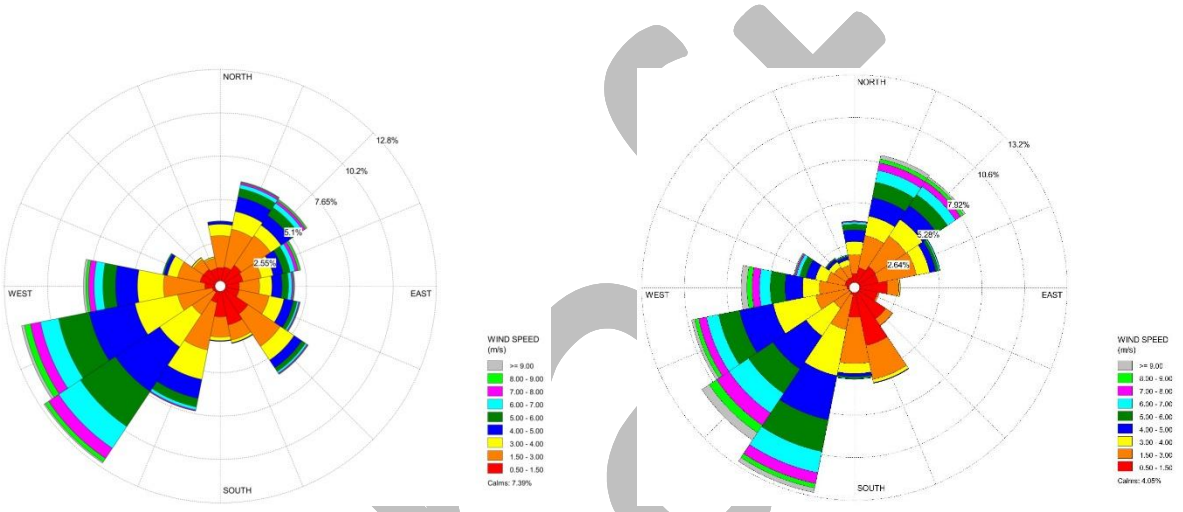


Figure 5.3 Glenbrook Beach Road (left) and Training Centre (right) – 01 January 2009 – 31 December 2017 (Source T&T Monitoring Review)

Overall, the Site is dominated by south-westerly winds. At most of the weather stations the highest frequency of strong winds (wind speeds greater than 5 m/s) were also recorded from this quadrant, with local variations. Secondary winds are observed from the north east and, for one monitoring location, south east.

6 Generation of Site Air Emissions

Table 6-1 summarises the nature of air emissions generated within the Operational Area. The particulate generated from material handling processes is likely to be made up predominantly of larger size fractions (greater than 10 µm). The major source of the finer particulates PM_{10} and $PM_{2.5}$ in the atmosphere is from combustion processes.

Table 6-1 Generation of Air Emissions at the Glenbrook Site

PC Stockpiles	PC particles are relatively large (0.1-2mm) and remain intact unless exposed to heavy mechanical operations such as cutting or drilling. PC stockpiles are expected to contain a low fraction of fine particles.

Coal Stockpiles	High fraction of fine dust can be generated, potential heavy metal content in the coal dust. Spontaneous combustion
Slag Yard and Metal Cutting Yard	Slag storage generally do not generate a high fraction of fine fugitive dust. Processes such as crushing, screening and cutting may create fine dust particles with high heavy metal content.
Ferrous scrap	Stored materials such as scrap metal
Waste and Co –product handling	Fines are typically released when material is dry, particularly during handling by large mobile equipment and processing in crushing and screening plants.
Melter Aggregates	Melter aggregates generally do not have a high risk of dust generation. Processes such as crushing and sorting can create fine dust particles with high heavy metal content.
Unsealed roads and yards	Fine dust can be created by heavy traffic pulverising unsealed surfaces and materials deposited on unsealed surfaces.
Tipping of hot materials	Hot materials from the kilns, melters, steel plant and cogeneration facilities, tipped in the open will generate particulates.
Manufacturing combustion	A source of the finer particulates PM_{10} and $PM_{2.5}$ in the atmosphere is from combustion processes and are emitted from air pollution control equipment such wet scrubbers and baghouses. These processes are also the key point sources for CO, SO_2, NO_X, HCl and CL_2.
Manufacturing loss of containment	Material hoppers, conveyors and skips are likely to release courser dust[6] [7], generally referred to as fugitive dust or fugitive emission.

7 Nature of Air Emissions

Emissions to air from the Site are a mixture of solid, liquid or solid and liquid particles suspended in the air. The liquid or gaseous component of air emissions may also contain levels of chemicals that can be harmful to people, property or the natural environment.

[6] *Assessment of Environmental Effects of Discharges to Air. BHP NZ Steel Glenbrook*. Woodward Clyde Ltd. September 1995.
[7] *Fugitive Dust Assessment*. Tonkin & Taylor Ltd. July 2015.

Suspended particles vary in size, composition and origin. It is convenient to classify particles by their aerodynamic properties because:

(a) these properties govern the transport and removal of particles from the air;

(b) they also govern their deposition within the respiratory system, and

(c) they are associated with the chemical composition and sources of particles.

7.1 Deposited Dust

The larger size fraction of dust material is generally greater that 50 µm in diameter. Due to the relatively large size, deposited particulate usually falls out of the air within a short distance (approximately 100 to 200m of the source). It has the potential to create a nuisance effect due to soiling of surfaces and by causing irritation to eyes and nose. Beyond such irritation, such large particles are not posing a major risk to human health as they are too large to penetrate into respiratory system.

7.2 Suspended Particulate

The finer material is defined as suspended particulate and known as total suspended particulate (TSP). It is generally less than 50 µm and can travel large distances downwind. The portions of TSP that pose the greatest potential health effect are particulates less than 10 µm in diameter (PM_{10}), especially particulates less than 2.5 µm ($PM_{2.5}$). PM_{10} is able to penetrate the upper respiratory tract and consequently has the impact on human health. $PM_{2.5}$ can penetrate even further into the lung and is suspected of being the fraction of PM_{10} responsible for potentially serious health effects.

7.3 Combustion gases

7.3.1 Sulphur dioxide

Sulphur dioxide (SO_2) is a product of coal combustion processes, and is primarily emitted from the MHF stacks, with the Kiln stacks as a secondary source. SO_2 is of interest with respect to potential human health effects because it is a potent respiratory irritant when inhaled. The source of sulphur in the process is the raw material coal, which when processed at high temperatures in the Iron Plant will produce SO_2. This is minimised by ensuring purchasing agreements specify low sulphur blend coals, such that the average sulphur content of the coal received in the Multi-Hearth Furnaces is below 0.5%.

7.3.2 Oxides of nitrogen

The main sources of nitrogen oxide (NO_X) emissions at the Site are associated with the use of coal in the Iron Plant, primarily from the MHF stacks, with the Kiln stacks and the associated cogeneration plant as a secondary but still significant source. Other sources of NO_X at the Site include various natural gas combustion processes, such as the slab reheat furnace, the ladle preheaters and periodic supplementation of waste gas combustion with natural gas at the cogeneration plants.

The NOx discharge is largely composed of nitric oxide (NO) and to a lesser degree the more toxic nitrogen dioxide (NO_2). For external combustion appliances, such as the sites furnaces, NO_2 typically comprises 10 % of total NOx at the discharge point. NO_2 is of interest with respect to potential human and ecological health impacts.

7.3.3 Carbon monoxide

High exposures to carbon monoxide (CO) can cause acute poisoning, with coma and eventually collapse occurring. However, ambient exposures to CO are typically several orders of magnitude lower than those associated with acute poisoning.

NZ Steel is the only significant source of CO in the area. CO is generated in the waste gas of the MHFs, Kilns, Melters and the KOBM, and will also constitute a fraction of the emissions from smaller natural gas combustion processes at the Site. CO gas is highly flammable, so the waste gases from the iron and steelmaking processes are directed to either afterburners for energy capture or flared at the stack exit, which converts the CO to carbon dioxide.

7.4 Hydrogen chloride and chlorine

Hydrogen chloride gas (HCl) is an acidic gas and acts as an irritant in the respiratory tract. Chlorine gas (Cl_2) gas is moderately water soluble, and it can form hypochlorous acid and hydrochloric acid as it dissolves into airway surface liquid when contacting mucosal surfaces and airways, causing similar irritation in the respiratory tract.

The key point sources of HCl and Cl_2 at the Site are the acid regeneration plant (ARP), the pickle line scrubber, and the metal coating line cleaning section. HCl is used on site to clean metal oxides from the products prior to surface finishing. The HCl may be converted to Cl_2 as a by-product at the ARP where the spent acid is roasted to oxidise the dissolved iron and regenerate the acid. HCl and Cl_2 emissions are minimised by absorption in gas cleaning systems prior to the discharge points for these processes.

8 Fugitive Dust Sources and Control

The consent condition requirements relating to the minimising and control of fugitive emissions are detailed in Conditions 10 to 16 of the current Main Air Permit. This section outlines the key requirements for ensuring compliance with those. Sections on the emission monitoring requirements and incident response should be read in conjunction with Section 8.

Later Sections explain the NZ Steel ambient air monitoring program and response to Investigation Trigger Alerts. This continuous monitoring and automated notification to Steelserv (as a key support service for managing dust control) and the NZPI Environment Team provides an opportunity to investigate potential causes of elevated ambient dust and respond appropriately.

Section 4 sets out key responsibilities for control of fugitive dust and associated procedures will contain task or activity specific responsibilities.

8.1 Influencing Factors

The five major factors which influence fugitive dust generated from the Site are:

- Wind speed across the surface;
- Percentage of fine particles in the material on the surface;
- Moisture content of the material;
- Area of exposed surface; and
- Disturbances such as traffic, excavation, loading and unloading of materials.

Dust emissions from exposed surfaces, typically stockpiles, generally increase with increasing wind speed and will therefore be influenced by height (for example, stockpiles). However, dust picked up by wind is only significant at wind speeds above 5 m/s. The smaller the particle size of the material on an exposed surface, the more easily the particles are able to be picked up and entrained in the wind. Moisture (water and chemicals) binds particles together reducing the potential for them from being disturbed by winds or vehicle movements. Similarly, vegetated or covered surfaces are less prone to wind erosion than bare surfaces.

Vehicles travelling over unsealed surfaces tend to pulverise any surface particles. Particles are lifted and dropped from rolling wheels and the surface. Particles are entrained in the turbulent wake of moving vehicles. The larger the area of the exposed unsealed surfaces, the more potential there will be for dust emission.

Conditions	Compliance Requirement
10	Dust generation from roads maintained to lowest possible levels
11	Fugitive emissions of particulate matter from pollution control equipment and from the handling and transfer of dusty materials shall me maintained at a minimum practicable level.
12	That emissions arising from the dumping of RPCC and from the plating of molten iron shall be kept to a practicable minimum.
13	That the flaring of melter gas shall be kept to a practicable minimum
15	Material may not be disposed of through open burning

In addition, Condition 49 sets out a requirement for NZ Steel to maintain an environmental management system, to provide for among other things the following: -

49	f)	Setting objectives and targets to minimise waste and process interruptions and shall include the following: i. Methods to ensure that fugitive dust emissions are maintained at a minimum practicable level as required by conditions 10,11,19 and 20 ii. Targets and methods for limiting dumping of RPCC (condition 12) iii. Targets and method for limiting plating iv. Targets and methods for lowering the number of pressure release flap lifts (MHF) v. Targets and methods for minimising of the flaring of melter gas as a percentage of total melter gas produced. vi. Targets and methods for minimising the frequency of flare failures in the melters and on the KOBM primary waste gas ventilation; vii. Targets and methods for minimising the frequency of Pan Conveyer scrubber maintenance downtimes

8.2 Key Sources of fugitive dusts

The major sources of fugitive emissions at the Site are from various sources:

- Vehicle movements on both sealed and unsealed roads;
- Vehicle tyres, drawer bars collect dust;
- Handling the coal and waste (loader to truck);
- Stockpiles, wind exposure
- Slag (dry waste) processing and tipping operations;
- Plating operations, reduced primary concentrate and char (RPCC) dumping;
- Transfer of raw materials/ tipping
- Losses from dust capture systems at the primary operations, processing plants and associated facilities.[8][9]

A site map of the stockpiles and main material handling areas is provided in Attachment 1.

8.3 Controls for fugitive dusts

8.3.1 Dust Emission Ranking Guide

The following table is a good practice guide for dust control and mitigation and needs to be read in conjunction with the visual references included in Attachment 2.

Note "area" in the context of this Table is the area of the activity e.g. Vanadium Slag yard, J Banks and boundaries of a yard or road.

[8] *Assessment of Environmental Effects of Discharges to Air. BHP NZ Steel Glenbrook*. Woodward Clyde Ltd. September 1995.
[9] *Fugitive Dust Assessment*. Tonkin & Taylor Ltd. July 2015.

Dust Emission Rankings (DER) are determined by reference to both the appropriate activity column descriptions (middle column, the impact descriptions (2nd column) (both in Table 8.1) and the picture tables in (Attachment 2).

The Supervisor responsible for activities should review conditions prior to start of task and outline to operators what must be done in event dust occurs. Materials are dry and so may generate dust.

Fugitive Dust: stockpiles, process and roads

NEW ZEALAND STEEL

DER TABLE

DER	Impact	Roads/vehicle movement	Material tipping	Stockpiles & Other Work	Action
0	No visible emission	n/a	n/a	No dust raised	Nil
1	Localised emission. No dust fall outside area. Dust visible locally only.	Dust raises to half vehicle height	Dust raises to half height of loader or tipping tray of truck	Dust is raised. Dust is visible inside the area.	Consider starting dust control measures
2	Localised impact that warrants control measures. Visible outside area.	Dust to top of vehicle	Dust raises to top of loader or tipping tray of truck	Dust noticeable *from* outside the area. Dust fall within the area.	Initiate existing control measures Generate a near miss report.
3	Dust remains in the air. Dust falls outside area. Vision obscured. Dust creates a possible hazard.	Dust above top of vehicle	Dust above top of loader or tipping tray of truck	Dust is noticeable outside the area. Dust falls outside stockpile area.	**As above plus generate incident report.** (report includes actions taken & wind speed)
4	Dust extends within the Works boundary	Dust to twice the height or length of the vehicle.	Dust to twice the height of loader or tipping tray of truck	Dust widespread within the Works	As above plus stop activity until measures in place to control dust.
5	Dust extends outside the Works boundary	Dust to more than twice the height or length of the vehicle.	Dust to more than twice the height of loader or tipping tray of truck	Dust extends outside works boundary	Stop activity unless essential for personnel safety.

Table 8.1 - Dust Emission Ranking Table

8.3.2 Minimising Dust Load and Carryover

Where unsealed yards and roads lead onto sealed roads, the exit must be stabilised (typically, 1.5 times the distance of the entry/exit width) to minimise dust carryover (for example, stablished aggregate, concrete or tar seal). Stabilised areas are to be included in sweeping schedule. Areas adjacent to roads (ie verges), particularly around the Iron Plant will also, be cleared of any debris build up to avoid material spilling back onto roads.

Regular inspection by Steelserv and Primary Operations Team must be undertaken to determine whether there is, or could be, drag-out from unsealed areas, verges or other working areas.

The purpose of the inspection is to determine the cause of elevated dust levels and agree on immediate action, including any adjustment to the ongoing housekeeping program for the area.

Appropriate action must be followed for timely clean-up or rectification. These issues may also contribute to Site water quality issues.

Inspections must be documented in MARS (audit), with photos, to provide record of remedial work or preventative activity.

8.4 Sealed Roads

General environmental control procedures are covered by the NZ STEEL road and yard operational control procedures (EV-5000.020). In addition, the following activities support compliance with the Main Air Permit.

8.4.1 Internal Road 56

A wheel wash is installed 500 metres from the North Gate (Weighbridge Road Exit) for trucks leaving unsealed yards and road to travel onto the sealed internal road and Brookside Road. This portion of sealed road has the highest volume of movements for vehicles exiting the Site.

8.4.2 Sweeper

Sweeper operation is scheduled for all sealed roads, based on the volume of traffic and the potential for material to deposit on the road. Where high loads of dust are evident on sealed roads Steelserv is to deploy a water-cart prior to sweeping (to maximise dust pickup).

The sweeper is to be maintained and operated to avoid fugitive dust during its operation, such as use of water sprays and emptying.

Where an ambient alert is received or an incident reported related to dust on sealed road, an inspection must be undertaken to determine the likely cause of elevated dust levels on a sealed. road

8.4.3 Maintenance of Sealed Roads

Re-surfacing and maintenance of roads is scheduled by Utilities, to minimise pot holes and road deterioration. (Pot holing is likely to generate dust and the hole enlarges over time).

8.5 Unsealed Roads

General environmental control procedures are covered by NZ STEEL road and yard operational control procedures (EV-5000.020). In addition, the following activities support compliance with the Main Air Permit.

Where high loads of dust are evident on sealed or unsealed roads Steelserv is required to initiate an inspection.

8.5.1 Dust Suppression Chemical Application

The detailed dust suppression programme undertaken by Steelserv, is set out in the “New Zealand Steel Dust Management Specification” document, which was last reviewed in February 2018.

Any outage of the chemical additions system is to be rectified as quickly as possible and reported in MARS as an incident.

8.5.2 Road Watering

Regular watering of the unsealed roads to reduce fugitive dust is undertaken by water trucks operated by Steelserv. Chemical dust suppressants are used to bind materials and may reduce the frequency of water cart passes. Procedures are to be established for water truck operations by Steelserv including regular key routes and timing. In addition, contingency measures are to be set out to increase frequency in dry and/or windy conditions.

Priority roads for watering are:

- Landfill Main Excess Road;
- Roads next to RPCC tipping banks;
- Kress tip bays and Road 54;
- Weighbridge Road;
- South Coal Yard Road; and
- North Side Ponds area.

8.5.3 Limiting Vehicle Speed

The speed limit on most site sealed and unsealed roads is 30 km/hour. The following roads and equipment have additional speed limitations: -

- Landfill (Main Access Road and Landfill) - 20km/hour for all vehicles;
- Steelserv heavy vehicles – 25k/hour maximum;

Coal delivery truck and trailers - 10 km/hour maximum. Further reductions of vehicle speed may be required in dry and windy conditions in all areas, as directed by Steelserv and the Environment Team.

8.5.4 Re-surfacing of Unsealed Roads

Steelserv has developed a maintenance plan to provide regular maintenance and grading based on road traffic. Regular review of the plan is required. Grading protocols must include no accumulation of material (windrows) on the unsealed roads, as this material can be re-entrained or enter Site water systems.

8.5.5 Other Measures

In addition to the above controls, fugitive dust can be minimised through: -

- Minimising haul distances and unnecessary movements, where practicable
- Requiring vehicles entering and leaving the site that are carrying dusty materials to cover their load.

8.6 Stockpiles and Material Handling

Stockpile handling and controls for raw material stockpiles are specified in procedure (EV-5000.030). In addition, the following activities support compliance with the Main Air Permit.

Where high loads of dust are evident on sealed or unsealed roads Steelserv is to initiate an inspection, and it may be relevant to include a person from the relevant operational team or the Environment Team. The inspection is to address the following, as a minimum:

- Materials stored in defined stockpile areas;
- Use "Management of Change" (MOC) process to identify any additional controls, based on proximity to waterways and wind exposure;
- Prevent overflow of materials onto roads by implementing concrete barriers or other similar means.
- Review stockpile locations to place denser materials against prevailing wind directions to shield materials with finer particles;
- Consider stockpile height and shape to reduce wind effects;
- Implement additional compaction of long-term stockpiles, especially in the wind pre-dominant direction to reduce dust emissions; and
- Ensure inspection of coal stockpiles to identify spontaneous combustion and respond to minimise emissions from spontaneous combustion.

8.7 Material Conveyancing and Handling

Control measures to minimise fugitive dust from processes is specific to a manufacturing plant, process or activity. General principles of material conveyancing and handling (including screening and crushing) are outlined in NZ STEEL Environmental Controls EV-5000.010.

In addition, the following activities support compliance with the Main Air Permit: -

- Use enclosed or covered conveyors for materials where dust may be generated;
- Use water sprays or sprinklers where dusty materials are exposed;
- Minimise drop height to less than 1.5 m unless otherwise justified;
- Clean up spills around conveyor transfer points at regular intervals;
- Minimise handling during windy conditions;
- Regularly maintain material handling equipment for optimal operation; and
- Cease dust generating activities when dust travelling in excess of 5 metres from activity.

8.8 Hot material tipping (RPCC and iron)

The Main Air Permit issued in 2006 set out requirements to minimise RPCC product tipping and iron plating as a result of process disruption. Product tipping may generate dust and fume, with potential to contribute to the dust load beyond the Site boundary.

In 2020 NZ Steel was granted a second Air Permit providing for Commercial Iron Plating, to enable the sale of plated iron. Auckland Council issued this and it provides for a maximum daily volume of Commercial Iron Plating produced does not exceed 500 tonnes per day and to a maximum of 210 tonnes an hour. This is in addition to the Main Air Permit condition which continues to provide for tipping molten iron as a result of process disruption.

Operating and maintenance practices and procedures include methods to minimise tipping of hot materials from the iron and steel plant. (This excludes tipping ironmaking and steelmaking slags which are an integral part of the primary production process.) An overview of these practices is outlined below.

The key controls for minimising RPCC product dumping are: -

- Kiln start-up following plant shut down (planned or unplanned);
- Metallisation limits for Melter receipt of kiln material (RPCC); and
- Raw materials feed control, including reduced feed rates during planned maintenance activities.

9 Stack emissions

The Consent requirements relating to operating and maintaining air pollution control equipment emissions are set out in Conditions 11, 13, 14 and 16 to 21. This section and Section 10, outline the key requirements for ensuring compliance for stack emissions (point sources). Sections on the emission monitoring requirements and incident response, should be read in conjunction with Section 9.

Conditions	Compliance Requirement
11	Fugitive emissions of particulate matter form pollution control equipment and from the handling and transfer of dusty materials shall be maintained at a minimum practicable level.
13	That the flaring of melter gas shall be kept to a practicable minimum
14	KOBM waste gas flare outages and Melter flare outages shall kept to a practicable minimum to ensure discharges of unburnt carbon monoxide are minimised.
16	The sulphur content of coal used in the MHF shall not exceed 0.5% by weight.
17	With the exception of the Pan Conveyer scrubbers, no part of process shall commence operation without the associated air pollution and control equipment being fully operational and functioning correctly.
18	The Pan Conveyer scrubbers shall be fully operational and functioning correctly as much a practicable the pan conveyor systems are operating. Any scrubber down-time that occurs during the process operation shall be for maintenance purposes only.
19	All air pollution control equipment and associated ducting shall be maintained in good condition and as far as practicable be free from leaks.
20	All ducting shall draw sufficient negative pressure to ensure that fugitives emissions are kept to a practicable minimum.
21	The paint line afterburners shall be operated so that all solvent- based paint application and curing are held at a minimum temperature of 750 0c for the prime line after burner and 650 0c for the finish line after burner in excess oxygen for a minimum period of 0.5 seconds.

In addition, Condition 49 sets out a requirement for NZS to maintain an Environmental Management System, to provide for among other things the following: -

49	a) Methods to ensure that pollution control systems are functioning correctly and consistently in accordance with conditions 17,18,19,20 and 21. b) Actions taken in response to any alarms or alarm conditions

	c) Daily visual inspections of all stacks and vents discharging to air including the KOBM baghouse. d) 12 monthly dye testing of the iron and steelmaking bag house e) Monitoring of gas leaks around the Kilns Co- generation plant by-pass damper to ensure that carbon monoxide emissions are kept to a practicable minimum. f) Setting objectives and targets to minimise waste and process interruptions and shall include the following: i. Methods to ensure that fugitive dust emissions are maintained at a minimum practicable level as required by conditions 10,11,19 and 20 ii. Targets and methods for limiting dumping of RPCC (condition 12) iii. Targets and method for limiting plating iv. Targets and methods for lowering the number of pressure release flap lifts (MHF) v. Targets and methods for minimising of the flaring of melter gas as a percentage of total melter gas produced. vi. Targets and methods for minimising the frequency of flare failures in the melters and on the KOBM primary waste gas ventilation. vii. Targets and methods for minimising the frequency of Pan Conveyer scrubber maintenance downtimes.

9.1 Equipment and Maintenance

A description of the installed air pollution control equipment for the Site manufacturing facilities is set out in the series of procedures, listed in procedure EV-5000.020. (These NZS procedures are a controlled document and as such, require regular review to ensure they remain current and reflect current practices.)

The procedure for each operating plant categorises and describes appropriate controls for fume/ waste gas generation, capture and treatment. A key focus is on the hierarchy of controls, in the following order of priority:

1. Minimisation
2. Engineering
3. Administrative

The plant procedure also provides an overview of the descriptions and key operating parameters crucial for the safe and effective use of the air pollution controls to ensure compliance with the Main Air Permit and include:

- Operating parameters;
- Maintenance schedules;
- Key reference documents for design and maintenance of equipment; and

- Control of fugitive emissions, such as leakage from building vents, baghouse bins, failure of fume capture equipment.

9.2 Combustion gases and other emissions

In addition to particulates, there are a range of stacks where the Main Air Permit specifies limits, or controls, for the following air pollutants: -

- HCl from the Acid Regeneration Plant (ARP);
- SO_x and NO_X in the Iron and Steel Plant and Hot Rolling Mill;
- VOCs from the Paint Line

Although no limits are set in the Main Air Permit for SO_x (sulphur dioxide) and NOx (nitrogen oxide) there is an implied limit based on the documentation submitted with the 1999 consent application. SO_x emissions are a function of sulphur content of coal used in the NZ STEEL manufacturing process and as such a limit is provided in the Main Air Permit for sulphur content of coal.

The temperature of the Paint line Prime and Finish Oven incinerators are set at a minimum of 750 °C and 650 °C, respectively, to ensure sufficient treatment of the off-gases. However, the Finish Oven incinerator is typically operated at higher temperatures owing to the high solvent load in the waste gas reporting to the incinerator.

9.3 Intermittent process emissions

9.3.1 Iron Plant emergency flap lifts

The Kiln and MHF and their respective afterburners both have explosion flaps which lift or open for the purpose of pressure relief. A “flap lift” occurs when the gas pressure in the system reaches or exceeds a safe level for the equipment, opening the emergency vent and releasing hot un-scrubbed waste gas directly to atmosphere.

When a flap lift occurs, the process is interlocked to cut the feed of material into the MHF or Kiln. The incidence of these events may be unavoidable (such as equipment failure or power outage) and at other times an investigation may determine a circumstance that would have been preventable. NZ STEEL keep records of pressure relief flap lifts in order to monitor performance and identify issues for resolution.

NZ Steel aims to minimise flap lifts and this is achieved by the following methods: -

- Ensuring equipment associated with interlock tripping is maintained to a high standard on a regular basis;
- Ensuring the pressure control equipment is functioning properly and tested according to the plant procedure

9.3.2 Melter gas flaring

Melter gas is a high energy waste gas generated by the production of molten iron in the Melters. As such it is used for steam and electricity generation in the MHF and Kilns Cogeneration plant. Melter gas, however, for reasons of process safety is flared off as a function of the Melter furnace pressure control system.

Since the Main Air Permit was first issued NZ STEEL has had an [internal objective to minimise Melter gas flaring and set a target to flare no more than 15% of total Melter gas produced. This is routinely monitored and reported to Auckland Council by NZ Steel.

10 Air Emission Monitoring

The Consent requirements relating to emission monitoring are set out in Conditions 22 to 26, relating to process monitoring and stack testing. Sections 8 and 9 relating to control of emissions and Section 11 outlining incident response, should be read in conjunction with Section 10.

Conditions	Compliance Requirement
	Process Monitoring
22	(a) Flaring of melter gas as a percentage of total melter gas produced
	(c) Pan Conveyor scrubber maintenance downtimes
	(d)Times and dates that explosion flap lifts occur at kilns and multi hearth furnaces
	(e) Temperature of wastes gases exiting afterburner(s)
	(f) KOBM baghouse checked for leaks and damaged bags

The stack emission testing schedule, as specified by Condition 23, is set out in Attachment 3.

	Stack Emission Testing
24	All emission tests carried out in accordance with condition 23 shall: (a) Be conducted during process conditions that are representative of normal process emissions. (b) Comprise of not less than 3 separated samples taken on the same day (c) Be carried out by IANZ accredited sampling methods
25	Shall maintain permanent and safe access to all sampling points to enable compliance with condition 23.
26	Dye testing of the Iron and Steel making baghouses when the associated plant is not operating and where vent emissions are visible or a stack limit is exceeded.

10.1 Process Monitoring

Process monitoring, as set out by Condition 22, and ensuring the information is available for reporting to Council, is the responsibility of the Superintendent. The Environment Team will collate the following information to report to Auckland Council (as set out in Conditions 35 to 40):

- Percentage of the flaring of Melter gas to the total Melter gas produced;
- Mass of RPCC dumped;
- Amount of plating occurring as a result of process disruption and commercial plate iron sale;
- Pan conveyer scrubber maintenance downtimes;

- Times and dates of explosion flap lifts at the Kilns and MHF;
- Continuous monitoring of the temperature of waste gases leaving the afterburners; and
- Daily inspections of the KOBM baghouse for damage and visible emissions.

10.2 Stack (Point Source) Testing

Condition 6 of the Main Air Permit set out the stack emission limits for point source air pollutants and monitoring conditions. Attachment 3 outlines the current monitoring program, which is managed by the NZS Laboratory Manager. Air Resource Management are engaged to undertake the testing program, to approved testing standards.

Operational Superintendents are to ensure that their plant and air pollution control equipment are operating under "normal" conditions when stack testing is undertaken. Safe access to testing ports on stacks must be provided for the personnel undertaking testing, to ensure that NZS can provide stack test results, within the specified timeframe, to demonstrate compliance.

10.3 Site Ambient Air Monitoring

Ambient air quality on and in the vicinity of the Site is monitored in accordance with Conditions 27-32 of the Main Air Permit.

Ambient air monitoring is necessary to provide an assessment of the contribution of the Sites air discharges on ambient air quality. This is because ambient air quality monitoring data represents the cumulative concentrations of air contaminants as a result of emissions.

Beta Attenuation Monitors (BAMs) were installed at the locations indicated in Attachment 1, between 2007 and 2008. BAMs provide a continuous near-real time measure of particulate concentrations and are currently fitted with size selective inlets in order to measure TSP and PM_{10}.

Table 10.1 sets out the current parameters monitored at the NZS BAM site and the table references the source of the monitored values.

Table 10.1 Ambient air quality standards and guidelines for particulate matter

Substance	Averaging period	Value (µg/m^3)	Reference
TSP	24-hour	80*	Main Air Permit (condition 31)
PM_{10}	24-hour	50**	National Environmental Standard – Ambient Air Quality
	Annual	20	Auckland Ambient Air Quality Targets

* Trigger level for investigation

** The NESAQ allows for 1 exceedance of the concentration limit in a 12-month period

The five existing ambient air monitoring stations provide an early alert where the daily average is exceeded in the proceeding hour (as tabled above). The Environment Team and Steelserv Shift Managers receive text message alerts when the average for the previous 1-hour is above the daily average. This provides an opportunity to inspect the Site to determine if activities needed to be controlled or stopped, to avoid exceeded the 24-hour average set out in the Main Air Permit.

11 Auditing and Incident Response

Procedure EV-7400.010 sets out the incident investigation and reporting requirements. When a 24-hour average Investigation Trigger is above the level specified in the Main Air Permit a full investigation will be undertaken by NZPI Environmental Team to determine if NZS is the likely source of the elevated daily level.

Reports are sent to Auckland Council, as set out in procedures. Follow up action may be required by Council.

11.1 Audits

Auditing by operational teams are recommended, to assess effectiveness of controls to ensure ongoing compliance with consent conditions. Site audits are to be conducted (minimum 1 audit per year for the areas

The purpose of auditing is to demonstrate:

I. Existence of a local procedure, outlining key controls to support compliance;
II. Evidence that operators are trained and using the procedure;
III. Specified dust control measures are being used;
IV. Incidents are being reported and documented in MARS;
V. Fugitive dust related risks are recorded into the MARS incident / risk management/reporting system and that the risk is reviewed as per NZPI risk management procedural requirements;
VI. Environmental controls are included in local procedures, including identification of responsible personnel;
VII. Fugitive Dust related DER Training for employees is included in the departmental Training matrix;

11.2 Complaints

All air discharge related complaints are stringently / thoroughly reviewed to ensure compliance. On this basis further action may be taken by NZS to resolve any issues identified and to liaise with Council on such matters.

Detailed Complaints Procedures are covered in NZ STEEL Document EV-7400.020 "Environmental Complaint Investigation and Response". A Complaints Register is maintained in the MARS system and made available to the Council.

The NZPI Environmental Team has the responsibility to respond and follow up all complaints regarding air discharges from the Site. The Environmental Manager shall determine whether the Regulatory Authorities are to be immediately advised, due to the severity of the incident. Otherwise the relevant authorities will be advised within the timeframe specified in the Main Air Permit (Conditions 38 and 39) or the regular monthly report whichever is sooner.

11.3 Operational Incidents

All incidents are to be entered and reported through the MARS system, including: -

- Ambient Air quality recordings above Investigation Trigger Level;
- Stack Testing limit consent exceedance; and

- Fugitive emissions with potential to affect ambient air monitoring stations e.g. material handling controls not followed by wetting dusty material to Metal Recovery plant.

12 Compliance Reporting

Requirements for reporting to Auckland Council are set out in Conditions 35 to 44. Regular reporting requirements are contained in Condition 40. Monitoring data is collated by the NZPI Environment Team and a report prepared for Auckland Council as set out in the procedure EV-7040.020. The report to Council will include process monitoring information, stack emission testing results reference to any incidents and complaints relating to the Main Air Permit, the investigation undertaken and the outcomes from the investigation.

13 Document Review

This AQMP will be reviewed on a 5-yearly basis or following a significant air quality incident or persistent complaint. The NZPI Environmental Manager is to lead the review and involve the relevant Operations and Maintenance Superintendents.

14 Associated Documents

Number	Procedure Name	Issue Status – Last Revision Date
EV-5000.020	Road and Yard Operational Procedures	September 2020
EV-5000.030	Stockpile Operational Procedures	May 2016
EV-5000.010	Material Conveyancing and Handling	December 2018
Steelserv	NZ STEEL Dust Management Specification	February 2018
EV-5400.020	Air Quality Environmental Controls	January 2021
IP-0420.020	MHF s Air Quality Environmental Controls	April 2020
IP-0420.030	Kilns Air Quality Environmental Controls	April 2020
	Melter Air Quality Environmental Controls	To be drafted
SP-0303.001	Steel Plant Air Quality Environmental Controls	Drafted – in final review
GP-0425.060	MCP Air Quality Environmental Controls	Drafted – in final review
RA–0002.155	Rolling Mill Air Quality Environmental Controls	Drafted – in final review
CC-0900.200	Paint Line Air Quality Environmental Controls	In draft
EV-7400.020	Environment Complaints Investigation and Response	August 2017

15 References

1. *Good practice guide for assessing and managing dust*. Ministry for the Environment. November 2016
2. *Coal Mine Particulate Matter Control Best Practice*. NSW Government November 2011
3. *BlueScope Steel – EPL 6092. PRP 166 – Particulate Matter Control Best Practice* – Part A: Assessment Report.
4. *Integrated Pollution Prevention and Control Reference Document on Best Available Techniques on Emissions from Storage.* European Commission. July 2006
5. *Guidance on the Assessment of Mineral Dust Impacts for Planning*
6. *Resource Consent, Permit No. 14317.* Auckland Regional Council. 29 November 2006. *"To authorise the discharge of contaminants to air […] Glenbrook Iron and Steel Zone"*. - available on the NZ Steel intranet
7. *Resource Consent, Permit No.* 34752. Auckland Regional Council. To discharge contaminants to air from a landfill […] - available on the NZ Steel intranet

Attachment 1 – Existing Ambient Air Quality Monitoring

NZ Steel Existing Ambient Air Monitoring Stations

Existing requirement in Air Permit 14317

Proposed for new Air Permit

Equipment type	BAM	BAM	BAM	BAM	BAM	BAM		BAM
Installed	2007-2008	Sep-08	2007-2008	2007-2008	2007-2008	2007-2008		16-Mar-18
REVIEW CONTINUTATION	Permit renewal	Permit renewal	Permit renewal	Permit renewal	Permit renewal	Permit renewal		Proposed for new Air Permit
Removed	-	-	-	-	-	-		
Analysis	*PM10*	*TSP*	*Wind Speed*	*Wind Direction*	*Ambient Temperature*	*Relative Humidity*		*PM2.5*
Training Centre – Site 3		Y	Y	Y	Y	Y		
Glenbrook School - Site 17	Y		Y	Y	Y	Y		
Boundary Road – Site 18		Y	Y	Y	Y	Y		
Sandspit – Site 19	Y		Y	Y	Y	Y		
Glenbrook Beach Road – Site 20	Y		Y	Y	Y	Y		Y

Attachment 2 – Dust Emission Ranking System

To be read in conjunction with Section 8 and Table 8.1. Table 8.1 (repeated in Attachment for ease of use)

Fugitive Dust: stockpiles, process and roads

NEW ZEALAND STEEL

DER TABLE

DER	Impact	Roads/vehicle movement	Material tipping	Stockpiles & Other Work	Action
0	No visible emission	n/a	n/a	No dust raised	Nil
1	Localised emission. No dust fall outside area. Dust visible locally only.	Dust raises to half vehicle height	Dust raises to half height of loader or tipping tray of truck	Dust is raised. Dust is visible inside the area.	Consider starting dust control measures
2	Localised impact that warrants control measures. Visible outside area.	Dust to top of vehicle	Dust raises to top of loader or tipping tray of truck	Dust noticeable *from* outside the area. Dust fall within the area.	Initiate existing control measures Generate a near miss report.
3	Dust remains in the air. Dust falls outside area. Vision obscured. Dust creates a possible hazard.	Dust above top of vehicle	Dust above top of loader or tipping tray of truck	Dust is noticeable outside the area. Dust falls outside stockpile area.	**As above plus generate incident report.** (report includes actions taken & wind speed)
4	Dust extends within the Works boundary	Dust to twice the height or length of the vehicle.	Dust to twice the height of loader or tipping tray of truck	Dust widespread within the Works	As above plus stop activity until measures in place to control dust.
5	Dust extends outside the Works boundary	Dust to more than twice the height or length of the vehicle.	Dust to more than twice the height of loader or tipping tray of truck	Dust extends outside works boundary	Stop activity unless essential for personnel safety.

Use of the following audit table is set out in Section 8.3 and can be used in conjunction with the illustrative diagrams also included in this attachment.

Rating	Description	Immediate Actions / Reporting Requirements	Auditing Guidelines
0	No dragout observable on sealed road. Slight colouration of road allowable due to pigmentation from material.	Record Environmental Audit	<u>Sweepers</u> How well does the sweeper collect dust on the road? Is there much dust left from the areas it has passed over? Are there areas that the sweeper hasn't covered properly? Are there dust emissions coming out the top of the sweeper? Audit driver understanding of dust management procedure. <u>Water Carts</u> Effectiveness of dust suppression on sealed roads, particularly in dry conditions. Note: the use of water carts is prohibited on some roads due to stormwater impacts. <u>Truckwashes / Wheel Baths</u> How full is the soakaway pit? What colour is the water? How effectively do the sprays cover the vehicle? Comment on the condition of the area exiting the wheel bath to determine effectiveness of the control. <u>Overall</u> Measurement of dragout on sealed roads How thick is the dragout? How far does the dragout extend from the source of the material? What is the potential for fugitive dust emissions from vehicles using this road? Note weather conditions.
1	Small amount of material deposited on the road contained within a small area. Minimal discolouration of road and minimal risk of dust liberation.	Record Environmental audit	
2	Material deposited on the road extending <10m. Slight discolouration of road and low risk of dust liberation.	Monitor controls. Record Environmental audit	
3	Material deposited on the road extending <40m. Moderate discolouration of road and moderate risk of dust liberation.	Ensure controls are in place and operating adequately. Record Environmental audit	
4	Material or dust deposited on the road extending <100m. Road is highly discoloured and high risk of dust liberation.	Implement additional controls. (Eg. Road Sweeper, Water Cart or manual cleaning) Review maintenance and operation of dust emission controls. Generate near miss report.	
5	Dragout is thick and extends ≥100m. Road is extremely discoloured. Any vehicle travelling through this area has a very high likelihood of liberating dust from the road surface.	Implement additional controls. (Eg. Road Sweeper, Water Cart or manual cleaning) Review maintenance and operation of dust emission controls. Modify or halt operating conditions if necessary. Generate near miss report.	

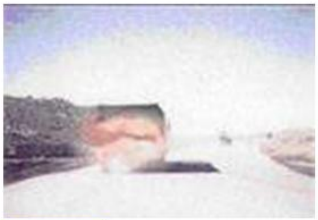
Dust Emission Ranking (DER) – Roads

DER 0

No Action Required
RECORD ENVIRONMENTAL AUDIT

DER 1

Monitor
RECORD ENVIRONMENTAL AUDIT



DER 2

Initiate Controls
NEAR MISS REPORT

DER 3

ENVIRONMENTAL INCIDENT REPORT REQUIRED
Controls in place. Note actions in report

DER 4

STOP ACTIVITY UNTIL CONTROLS EFFECTIVE

DER 5

STOP WORK
Contact Supt and Environment Department within 24 hours

Dust Emission Ranking (DER) – Loader Activities

DER 0

No Action Required
RECORD ENVIRONMENTAL AUDIT

DER 1

Monitor
RECORD ENVIRONMENTAL AUDIT

DER 2

Initiate Controls
NEAR MISS REPORT

DER 3

ENVIRONMENTAL INCIDENT REPORT REQUIRED
Controls In Place. Note Actions In Report

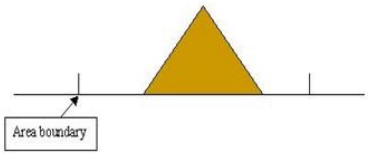
DER 4

STOP ACTIVITY UNTIL CONTROLS EFFECTIVE

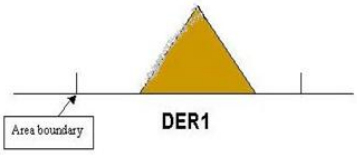
DER 5

STOP WORK
Contact Supt and Environment Department within 24 hours

Dust Emission Ranking (DER) – Stockpiles



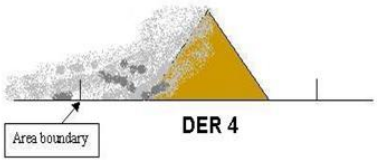
No Action Required



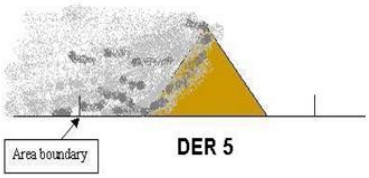
No action required
Some dust visible on stockpile

Initiate dust controls
Dust within work stockpile area
NEAR MISS REPORT

Dust falls outside stockpile area
ENVIRONMENTAL INCIDENT REPORT REQUIRED
Ensure controls in place
Note actions and wind speed in report

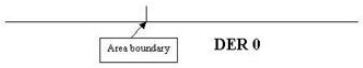


Dust widespread through Works
STOP ACTIVITY UNTIL CONTROLS EFFECTIVE



Dust outside Works boundary
STOP ANY WORK
Contact Supt and Environment Department within 24 hours

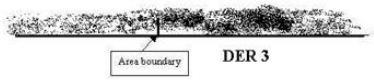
Dust Emission Ranking (DER) – Areas



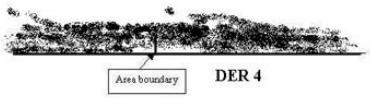
No Action Required

No action required
Some dust visible on area
Record environment audit

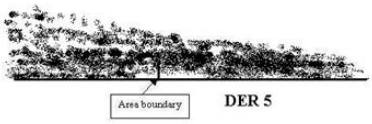
Initiate dust controls
Dust within work area
NEAR MISS REPORT



Dust falls outside stockpile area
ENVIRONMENTAL INCIDENT REPORT REQUIRED
Ensure controls in place
Note actions and wind speed in report
*



Dust widespread through Works
STOP ACTIVITY UNTIL CONTROLS EFFECTIVE



Dust outside Works boundary
STOP ACTIVITY
Contact Supt and Environment Department within 24 hours

Dust Emission Control Ranking (DECR) – Truckwash and Wheel Baths

DECR 0 — No Action Required
RECORD ENVIRONMENTAL AUDIT

DECR 1 — Monitor
RECORD ENVIRONMENTAL AUDIT

DECR 2 — Monitor
RECORD ENVIRONMENTAL AUDIT

DECR 3 — Review control conditions and alter if required
RECORD ENVIRONMENTAL AUDIT

DECR 4 — ENVIRONMENTAL NEAR MISS REPORT REQUIRED
Controls in place. Note actions in report

DECR 5 — STOP ACTIVITY UNTIL CONTROLS EFFECTIVE
Initiate additional controls
Contact Supt and Environment Department within 24 hours

Attachment 3 – Stack Emission Testing Program

Existing Stack Testing Program

Source ID	Source Name	Particulate Matter (TSP)	NOx	CO	HCL/Cl
CSM3	Pickle Line scrubber				Annual
CSM3	Acid Regen Plant				Quarterly
HSM1	Reheat Furnace		Annual		
PM2	Pipe Mill Galv Baghouse	Annual			
SP4	KOBM Baghouse (VRU baghouse)	6 monthly			
PM3	Pipemill Blowout extraction system stack	Quarterly			
IP32	Melter Slagside baghouses	Quarterly			
IP33/34	Melter metalside baghouses	Quarterly			
SP1	KOBM Flarestack	Quarterly	Annual		
IP1-4	MHF Stacks	6 monthly	Annual		
IP 23-26	Kilns wet gas scrubber stacks	6 monthly	Annual	6 monthly	
	Millscale and ironsand drier (PC Drier-SteelServ)	6 monthly			

Appendix H: Fugitive dust source prioritisation methodology

H1 Introduction

The purpose of this methodology is to rank fugitive dust sources with respect to their potential to generate off-site effects.

The methodology for the ranking of sources comprised:

1 Identifying and compiling a list of fugitive dust sources at the site, including sources from roads, stockpiles, and processes;

2 For each dust source, characterise the key factors that describe the likely frequency and magnitude of dust discharges and their potential for effects as this relates to their location and proximity to the boundary and off-site receptors. Dust sources categorised into those from roads, stockpiles, and processes were characterised separately.

3 A qualitative risk assessment process was used to prioritise the sources within each category.

H2 Background

Fugitive dust is defined as dust that is generated or emitted from open air operations (emissions that do not pass through a stack or a vent). Fugitive dust sources at the site fall broadly into three categories:

- Dust emissions from vehicle movements on roadways.
- Wind-blown dust from stockpiles and open areas.
- Dust emissions related to processes or activities (e.g. dust from uncovered conveyors or from cleaning activities).

The qualitative ranking system for roads, stockpiles and processes at NZ Steel was developed in 2014 to identify the priority areas for increased controls.

H3 Methodology of the qualitative ranking system

The qualitative scores for the key factors identified as contributing to the generation of dust from roads, stockpiles and processes are described in **Appendix H Table 1**, **Appendix H Table 2** and **Appendix H Table 3**.

Appendix H Table 1: Ranking score system for roads source category

Roads	Qualitative ranking
Road surface (silt loading)	2 Paved and regularly swept (no silt build up) 3 Paved and not swept (silt built up on road) 4 Unpaved but regularly re-surfaced with granular material 5 Unpaved, occasionally re-surfaced (no programme for monitoring or replacing road surface)

Roads	Qualitative ranking
Vehicle speed (road speed limit)	1 0 – 10 km/hour 2 10 – 20 km/hour 3 20 – 30 km/hour 4 > 30 km/hour
Vehicle type (number of wheels, height and weight)	1 Site cars (general use) 2 Utility vehicles 3 Trucks and heavy vehicles
Number of vehicles	1. Low amount 2. Delivery dependant 3. Moderate amount 4. High amount
Road watering regime (moisture content)	1 Regularly watered (at least once per week)(or unpaved) 2 Occasionally watered 3 Never or ad hoc watering
Road grade	1. Flat 2. Slight grade 3. Steep grade
Location	1 High distance to sensitive receivers (>1 km) 2 Moderate distance to sensitive receivers (<1 km, >500 m) 3 Nearby sensitive receivers (<500 m)
Sheltering	0.5 Sheltered 0.75 Partially sheltered 1 Not sheltered

Appendix H Table 2: Ranking score system for stockpiles source category

Stockpiles	Qualitative ranking
Particle size (fines content)	1 Low fines content 2 Medium fines content 3 High fines content, including very fine material
Particle density	1 Heavy material, e.g. slag 2 Medium density material, e.g. coal dust 3 Light or fluffy material
Moisture content	1. Stockpile regularly watered, or tends to crust on surface 2. Stockpile occasionally watered or light crust 3. Stockpile never or ad hoc watered, no crust
Stockpile height	0.5 <3 m 1 >3 m and <10 m 1.5 >10 m
Frequency of loading/unloading	1 Stockpile loaded/unloaded infrequently, e.g. no more than once per week 2 Stockpile loaded/unloaded infrequently, e.g. no more than two hours per day 3 Stockpile continuously loaded/unloaded

Stockpiles	Qualitative ranking
Location	1 High distance to sensitive receivers (>1 km) 2 Moderate distance to sensitive receivers (<1 km, >500 m) 3 Nearby sensitive receivers (<500 m)
Sheltering	0.5 Sheltered 0.75 Partially sheltered 1 Not sheltered

Appendix H Table 3: Ranking score system for processes or activities source category

Roads	Example qualitative ranking (to be reviewed and confirmed)
Particle size (fines content)	1 Low fines content 2 Medium fines content 3 High fines content, including very fine material
Particle density	1 Heavy material, e.g. slag 2 Medium density material, e.g. coal dust 3 Light or fluffy material
Height of release	1 Ground level to 1m 2 Between 1 m and 10 m or within 2 m of roof of adjacent buildings 3 Greater than 10 m, or higher than roof of adjacent buildings
Frequency of activity	1 Occasional (less than once per month) 2 Intermittent (once or twice a week) 3 Frequency (more than twice per week) 4 Continuous activity
Location	1 High distance to sensitive receivers (>1 km) 2 Moderate distance to sensitive receivers (<1 km, >500 m) 3 Nearby sensitive receivers (<500 m)
Sheltering	0.5 Sheltered 0.75 Partially sheltered 1 Not sheltered

Appendix I: Drinking water sampling

I1 Sampling locations

NZ Steel took samples of roof-collected water at six locations (5 houses and a shed) in the vicinity of the Site (see **Figure Appendix I.1**). A description of each of the sampling locations is presented in **Appendix I Table 1**.

House 3 was selected as a background monitoring site because it is not expected to have any influence of Mill activities due to its distance (over 8.5 km) from the Site.

Three rounds of sampling were carried out on 29 July 2020, 23 September 2020 and 27 October 2020. The concentrations of metals in roof-collected water at these locations are lower than the drinking water MAVs at all sites, except for one measured concentrations of lead at the background site. This elevated lead concentration is most likely to be related to fittings (e.g. plumbing or lead flashings) at the house.

Appendix I Table 1: Description of drinking water sample locations

Site name	Location relative to Operational Area boundary	Roof type	Downpipe type	Tank type	Sample location
House 1	1.5 km E	Colorsteel	PVC	-	Pipe at base of tank
House 2	0.5 km S	Colorsteel	PVC	Plastic	From outside tap pre-filter
House 3	8.6 km E	Colorsteel (with some painted)	PVC	-	Tap at side of house (pre-filter)
House 4	2.4 km NE	Colorsteel and PCC on Garage	PVC	Concrete	From pipes pre-filter
House 5	2.4 km NE	Galvanised Steel (50 years old) and Zincalume	PVC	Polyethylene	From pipes pre-filter
Shed 6	0.2 km E	Old galvanised roof	PVC	-	Directly from top of tank

Notes on roof type:

Colorsteel® and PCC roofing are both pre-painted steel roofing (manufactured in New Zealand).

Galv Steel®, galvanised steel and Zincalume® are metal-coated steel roofing material, which may be painted after installation.

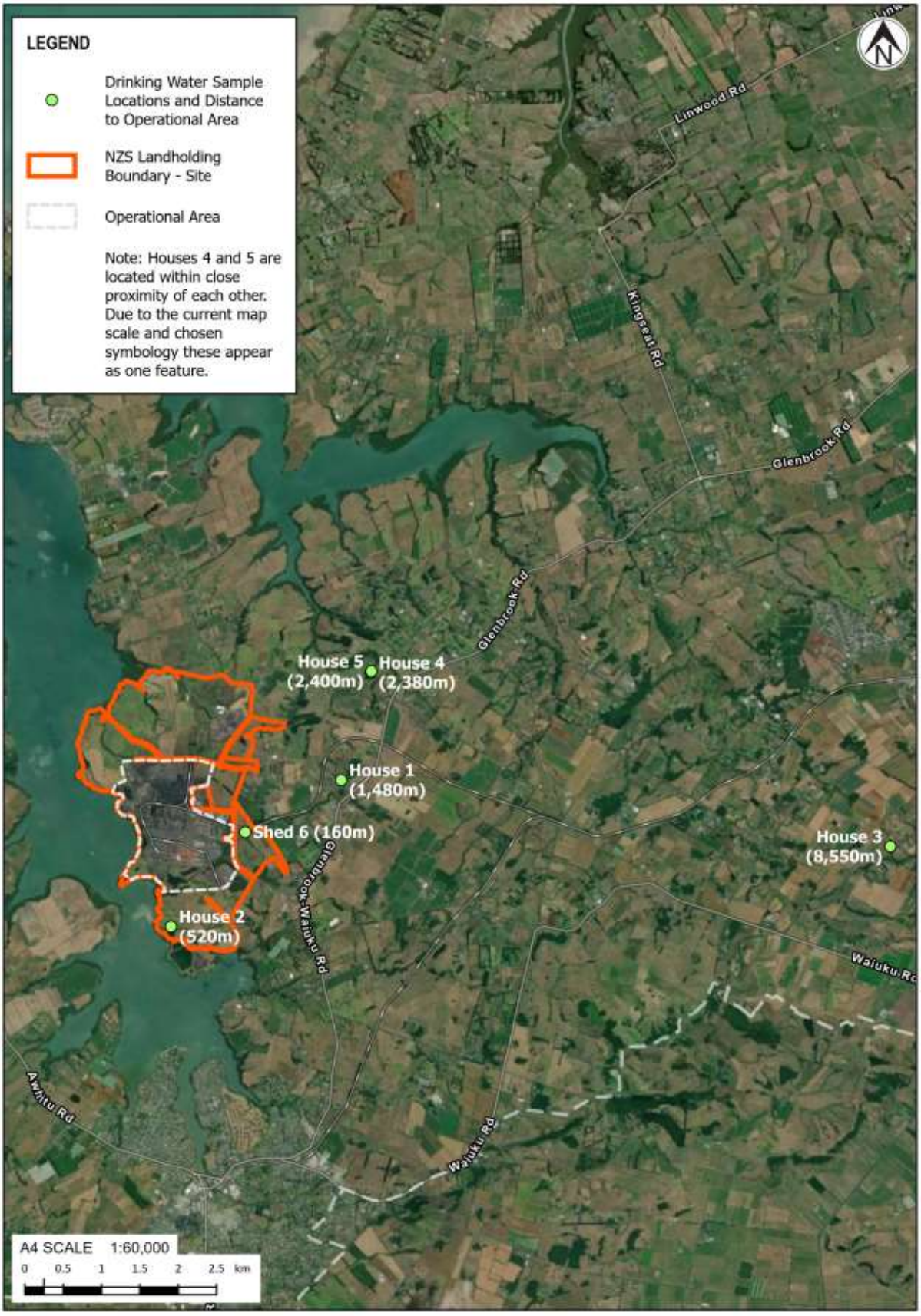


Figure Appendix I.1: Locations of drinking water sample collection (yellow) and boundary of NZ Steel landholding

I2 Evaluation of drinking water results

The results of drinking water analysis have been evaluated by comparing the average concentration over three samples to the MAV (see **Appendix I Table 3**). Where metals were reported below the detection limit, the detection limit value has been used in calculating the average concentration.

Appendix I Table 2: Screening assessment colour key

% of MAV	Colour
≥ 50 %	
≥ 25 %	
≥ 5 %	
≥ 0	
No MAV	

Appendix I Table 3: Screening assessment results (comparison of sampled drinking water concentrations with MAVs)

Date	MAV mg/L	Average concentration in drinking water as a percentage of the MAV					
		House 1	House 2	House 3 (background)	House 4	House 5	Shed 6
		1.5 km E	0.5 km S	8.6 km E	2.4 km NE	2.4 km NE	0.2 km E
Vanadium	0.015	48%	35%	10%	64%	31%	84%
Arsenic[1]	0.01	11%	11%	12%	11%	11%	11%
Beryllium[2]	0.004	3%	3%	3%	3%	3%	3%
Lead	0.01	2%	49%	44%	2%	15%	2%
Aluminium	1	<0.5%	1%	13%	2%	1%	1%
Cadmium	0.004	2%	2%	1%	1%	45%	1%
Manganese	0.4	2%	3%	3%	1%	4%	6%
Mercury[2]	0.007	1%	1%	1%	1%	1%	1%
Boron	1.4	1%	1%	1%	1%	1%	1%
Chromium[2]	0.05	1%	1%	2%	1%	2%	1%
Iron	2.0	1%	4%	4%	2%	1%	1%
Zinc	7	15%	4%	1%	1%	31%	21%
Nickel	0.08	1%	2%	1%	1%	2%	1%
Cobalt[1]	0.07	<0.5%	<0.5%	<0.5%	<0.5%	<0.5%	<0.5%
Copper	2	<0.5%	11%	1%	<0.5%	<0.5%	<0.5%
Titanium	-	-	-	-	-	-	-

- MAV not established for this metal

1. Arsenic and cobalt detected at House 3 (background) only in the third round of sampling, not detected at any other sites or during any other sampling rounds

2 Concentration below detection limit in all samples

Although arsenic is shown as being present at a concentration >5% of the MAV, all samples were below the analytical detection limits, with the exception of arsenic at House 3 (background site) during the third round of sampling. Further, the evaluation of NZ Steel influences (AQA **Appendix E** Section 9.2.2) did not suggest that discharges to air from the Site were likely to contribute to deposition rates of arsenic.

A number of metals are elevated above the background at some sites and not others, which indicates that the presence of the metal is not due to the deposition of ambient metals from the Site but are instead likely to be due to the roof materials or pipework, or another source specific to the dwelling.

The slightly elevated levels of cadmium and zinc at House 5 are attributed to the age of the roofing material. While zinc appears elevated at some locations, it is not consistently higher at locations that would be expected to be impacted by NZ Steel. For instance, House 4 and House 5 are co-located, but House 4 shows similar zinc levels to the background site.

House 2 consistently recorded elevated lead levels relative to other sites (31 - 82% of the MAV). This is likely to be a caused by materials of construction rather than any influence from the Site. House 3 showed lead results below 4% of the MAV for the first two rounds of sampling but was detected at 125% of the MAV for the sample collected in October. Communication with the house occupants has determined that part of the roof is constructed using lead nails, and that low rainfall in October may have exacerbated the effect of leaching from these materials.

Vanadium was detected in all samples. The pattern of reducing concentrations of vanadium with increasing distance from the Site is consistent with the Site being a material contributor to the measured vanadium levels in roof collected water. A discussion of the measured concentrations of vanadium in drinking water compared to the derived MAV is set out in the following sub-section.

Concentrations of other metals, including those identified as having potential contributions from the Site (AQA **Appendix E** Section 9.2.2) were well below the relevant MAVs.

I3 Discussion of vanadium

The pattern of concentrations of vanadium in drinking water samples indicates that there is an influence from NZ Steel activities. This is consistent with the findings of the evaluation of measured deposition rates around the Site compared to at a background site (AQA **Appendix E** Section 9.2).

Vanadium is a naturally occurring metal that is the 22nd most abundant element in the earth's crust. It is a trace component of both the coal and the iron sands used to prepare the Reduced Primary Concentrate. Vanadium is an impurity in steel that is removed during the steelmaking process in the form of a vanadium rich slag, which is processed and sold as a valuable co-product.

There is no MAV set in the DWSNZ or WHO guidelines for vanadium and the MAV used for the screening assessment is derived from the notification level (investigative trigger level) set by the California OEHHA. The OEHHA sets notification levels for chemicals for which there are no formal Californian regulatory standards. OEHHA derived the notification level of 15 µg/L using the lowest observed adverse effect level identified in a reproductive and developmental study in rats multiplied by an uncertainty factor of 1000.[33] It is noted that a number of human and animal studies show no adverse effects at higher doses and longer durations, so the derived value is considered appropriate as an investigative trigger protective of human health. For comparison, the Minnesota Department

[33] Ministry of Health. (2019). Guidelines for Drinking Water Quality Management in New Zealand. Volume 3 Datasheets – Chemical and physical determinands.

of Health have set chronic health risk limit for vanadium of 50 µg/L and the limit for vanadium in Italian drinking water is 140 µg/L.

The vanadium concentration in roof-collected water was highest at Shed 6, which is only 160 m from the Operational Area boundary. The average concentration at this site was 84% of the OEHHA notification level. Given the greater distance to dwellings where people would be exposed, this is considered to represent a worst-case value for impacts on drinking water in the local area.

Appendix J: Point source emission controls

Table 14.4: Point source emission controls - Other

Stack ID	Detail	Description	Control method	Detail
IP5-8	Multi-hearth furnace emergency vents	MHF waste gas	-	The emergency vent may emit un-scrubbed gases from the MHF during abnormal processing conditions for pressure control. These events are referred to as “flap lifts” (See Section 4.9.2).
IP9-12	Multi-hearth furnace afterburner emergency vents	MHF waste gas	Cyclone	The afterburner emergency vent is downstream of the bank of cyclones and top of the afterburner, such that some coarse particulate and highly flammable substances are emitted during abnormal processing conditions for pressure control. As with IP5-8, these events are referred to as “flap lifts” (See Section 4.9.2).
IP13-16	Multi-hearth furnace pan conveyors	Process dust	Wet scrubber	The pan conveyors carry primary concentrate and char leaving the base of the MHFs to the Kilns. This conveyor is covered hence any fugitive particulate from the material is captured and treated by a wet scrubber to remove particulate.
IP19	Consumption line flarestack	Scrubbed melter off gas	Flare	Emission from this flarestack only occur as a means of pressure control in the transmission of waste gas from the Melters to the MHF afterburners or Kiln’s Cogeneration plant.
IP27-30	Kiln emergency vents	Kiln off gas	-	The emergency vent is above the drop out chamber and may emit un-scrubbed gases from the kiln during abnormal processing conditions for pressure control. These events are referred to as “flap lifts” (See Section 4.9.2).
IP31	Melter charging dedusting systems	RPCC Dust	Venturi scrubber	In the process of filling the Melter charging bins with RPCC, dust laden gas is generated. Each of the 24 charging bins is connected to an extraction duct and the collected gases are passed through a single stage venturi scrubber and dewatering cyclone to remove particulate matter before discharge to atmosphere.
IP35	Iron plant additions silo	Dust	Baghouse	Venting from the additions silo is via a bag filter for removal of suspended dust prior to discharge.
IP36	Melter concentrate/additives	Lime and PC dust	Baghouse	Emissions from this source are vented through bag filters for removal of particulate.

Stack ID	Detail	Description	Control method	Detail
IP37	RPCC hopper dedusting system	RPCC Dust	Venturi scrubber	Emissions from the RPCC hopper dedusting system are treated via a venturi scrubber, a wet method designed to clean particulate from the gas stream.
SP5	Slab making plant additives system	Dust	Baghouse	Only in use during raw material addition. Emissions from this source are captured by baghouses over the transfer points or conveyors.
SP6-13	Slab making plant additives system	Slab making plant fume	Baghouse	Only in use during raw material addition. Emissions from this source are captured by baghouses over the transfer points or conveyors.
SP14-16	Lime transfer system	Lime dust	Baghouse	Only in use during lime transfers. Emissions from this source are vented through bag filters for removal of particulate.
HSM2	Hot Strip Mill process fume exhaust	Process waste gas	Scrubber	
CSM2	Acid Regeneration Plant baghouse	Iron oxide	Baghouse	Iron oxide collection at the ARP occurs via bag filters to retain this valuable co-product.
CSM3	Pickle Line scrubber	Pickle line acid fume	Wet scrubber, mist eliminator	Emissions from the Pickle Line are ducted to a scrubber and mist eliminator for removal of acid fume.
CSM4	Annealing furnace stack	Combustion gases	-	
CSM5	Annealing furnace stack	Combustion gases	-	
CSM6	4 high combination mill	Process fume	Mist eliminator	Waste gases from this process are passed through a mist eliminator to remove liquids from the gas stream prior to discharge.
CSM7	6 high reversing mill	Process fume	Mist eliminator	Waste gases from this process are passed through a mist eliminator to remove liquids from the gas stream prior to discharge.
CSM8-9	Strip oiler	Process fume	Mist eliminator	Waste gases from this process are passed through a mist eliminator to remove liquids from the gas stream prior to discharge.
RS1	Bearing washer	Solvent fume	Mist eliminator	Waste gases from this process are passed through a mist eliminator to remove liquids from the gas stream prior to discharge.
RS2	Shot blaster	Dust	Baghouse	Emissions from this source are vented through bag filters for removal of particulate.

Stack ID	Detail	Description	Control method	Detail
MCL1	Cleaning section stack	Cleaning section fume	Wet scrubber	Fume from this process is treated via a wet scrubber for removal of particulate.
MCL2	Annealing furnace emergency vent	Furnace inert gases	-	Contingency vent only.
MCL3	Chromate treatment stack	Chromate fume	Wet scrubber	Fume from this process is treated via a wet scrubber for removal of particulate.
MCL4	Induction oven	Air	-	-
CCL1	Pre-treatment drying oven	Pretreatment oven waste	-	-
CCL2	Strip cleaning ventilation	Steam	-	-
SR1	Primary concentrate drier baghouse	Drier	Baghouse	Emissions from this source are vented through bag filters for removal of particulate.

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