

EXECUTIVE SUMMARY

This monthly report covers the ambient air quality data for June 2017 as monitored at KwaZamokuhle monitoring site.

There were three (3) exceedance of the national ambient air quality limit for SO₂ hourly of 134 ppb and nine (9) exceedances of the national ambient air quality limit for SO₂ 10-minutes of 191 ppb. There were twenty three (23) exceedances of the national ambient air quality for PM₁₀ daily limit of 75µg/m³, twenty four (24) exceedances of the national ambient air quality for PM_{2.5} daily limit of 40µg/m³ and there were no exceedances of the other national ambient air quality limits recorded during the monitoring period under review.

Both SO₂ and NO₂ ambient concentrations at KwaZamokuhle monitoring site are influenced by the combination of low-level sources and tall stack emitters. Ambient fine particulate matter concentrations indicate the influence of low-level source emissions at KwaZamokuhle, probably domestic burning.

The dominant winds during the day were from west-north-west, north-west, east-north-east and south-west. The dominant winds during the night were from south-south-east, south and east.

The overall percentage data recovered from the monitoring site during the reporting period was 92% and station availability was 98.9%. The NO_x and solar radiation parameters did not meet SANAS requirement of 90% data recovery per parameter due to being affected by high temperature at site, which then resulted to invalid data and the other monitored parameters met the SANAS requirement.

DISCLAIMER

It is certified that the data presented is, to the best of our knowledge, a true copy of the specified record and for the times and places indicated thereon, as held on file at Research, Testing and Development Department (RT&D). The user assumes the entire risk related to the use of this data. In no event will S&I be liable to the user or to any third party for any direct, indirect, incidental, consequential, special or exemplary damages or profit resulting from any use or misuse of this data.

1. INTRODUCTION

The KwaZamokuhle monitoring station is equipped to continuously monitor ambient concentrations of sulphur dioxide (SO₂), nitrogen oxides (NO, NO₂ and NO_x), ozone (O₃), fine particulate matter (FPM) of particulate size <10µm in diameter (PM₁₀) and fine particulate matter (FPM) of particulate size <2.5µm in diameter (PM_{2.5}). In addition, meteorological parameters of wind speed (WSP), wind direction (WDR), solar radiation (RAD), relative humidity (HUM), rainfall (RFL), pressure (PRS) and ambient temperature (TMP) are also recorded.

The monitoring site was established as part of a greater air quality offset pilot study. The objective of the pilot study is to test the effectiveness of the most promising household emission offset interventions identified during Eskom's pre-feasibility study. This includes identifying the possible

improvement in ambient air quality resulting from emission reductions at a household level. Data measured at KwaZamokuhle will represent baseline and post intervention implementation ambient air quality.

2. SITE LOCATION

The KwaZamokuhle monitoring site is located in Hendrina about 22.5 km south-south-west of Arnot Power Station, 27.3 km east-south-east of Komati Power Station and 18.3 km south-east of Hendrina Power Station. (Co-ordinates: -26.138252, 29.738953)

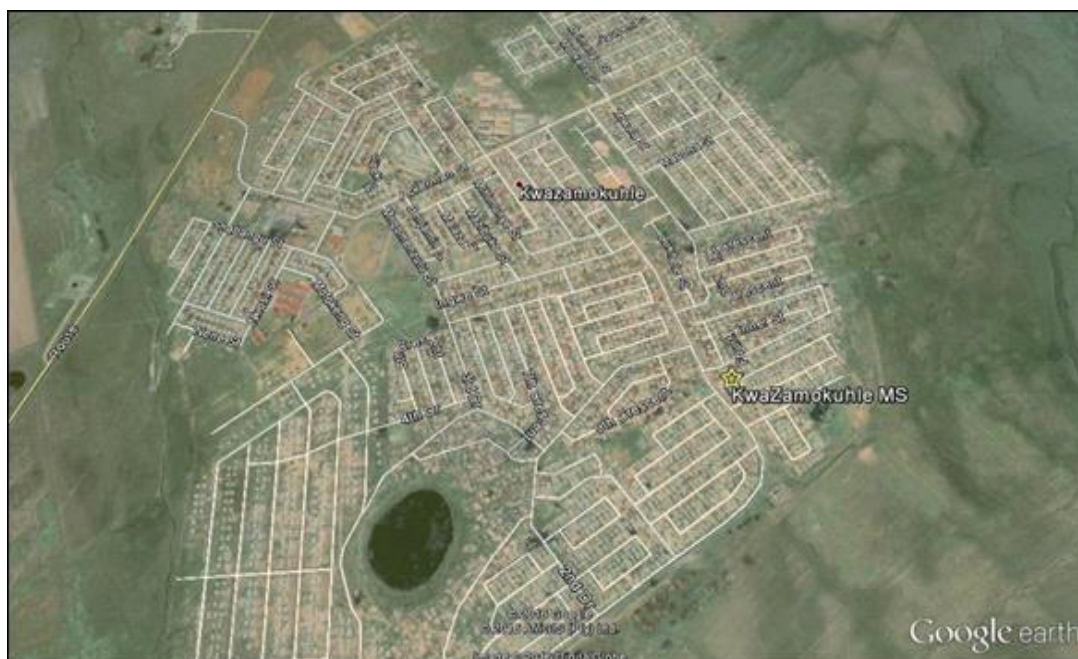


Figure 1: KwaZamokuhle air quality monitoring station in relation to Komati, Hendrina and Arnot power stations and KwaZamokuhle Township

3. DATA RECOVERY

Data was analysed for completeness against a required SANAS guideline of 90% per parameter monitored and is represented in Table 1 for the KwaZamokuhle monitoring site. All parameters met the SANAS guideline

Table1. Percentage data recovered per parameter for June 2017

NO	NO ₂	NO _x	O ₃	PRS	RAD	RFL	SO ₂	TMP	WDR	WSP	WVL	PM _{2.5}	PM ₁₀	HUM	Data Recovery	Station Avail
76.7	76.7	76.7	71.2	100	74.4	99.9	98.3	100	100	100	100	98.1	93.7	100	92	98.9

The overall percentage data recovered from the monitoring site during the reporting period was 92% and station availability was 98.9%. The NO_x and solar radiation parameters did not meet SANAS requirement of 90% data recovery per parameter due to being affected by high temperature at site, which then resulted to invalid data, and the other monitored parameters met the SANAS requirement.

4. SUMMARY OF RESULTS FOR REPORTED PERIOD

The National Department of Environmental Affairs (DEA) has set the South African Ambient Air Quality Standards for the criteria pollutants as illustrated in Table 2.

Table 2: South African National Ambient Air Quality Standards

Pollutant	Averaging Period	Concentration	Allowed Frequency of Exceedances
NO ₂	1 hour	106 ppb	88
	1 year	21 ppb	0
SO ₂	10 minute average	191 ppb	526
	1 hour	134 ppb	88
	24 hours	48 ppb	4
	1 year	19 ppb	0
O ₃	8 hours (running ave)	61 ppb	11
PM ₁₀	24 hours	75 µg/m ³	4
	1 year	40 µg/m ³	0
PM _{2.5}	24 hours	40 µg/m ³	0
		⁽¹⁾ 25 µg/m ³	0
	1 year	20 µg/m ³	0
		⁽¹⁾ 15 µg/m ³	0

⁽¹⁾Compliance required by 1 January 2030

Table 3 is a summary report presenting highest mean concentrations and the number of exceedances of the respective National Ambient Air Quality Standards as monitored at KwaZamokuhle during the monitoring period.

Table 3: Summary report

Pollutant	Highest Hourly Mean	No of Hourly National Limit Exceedances	Highest Daily Mean	No of Daily National Limit Exceedances	No of 8hr Moving Average Limit	Highest 10min Mean	No of 10min National Limit Exceedances
PM _{2.5} (µg/m ³)	450.4		131.3	24		507.4	
PM ₁₀ (µg/m ³)	458.3		166.4	23		537.2	
NO (ppb)	89.2		17			122.5	
NO ₂ (ppb)	61	0	16.5			122.5	
NO _x (ppb)	122.3		32.9			79.9	
O ₃ (ppb)	29.6		21.3		0	154.2	
SO ₂ (ppb)	151	3	38.4	0		270.8	9
TMP (°C)	23.2		12.6			23.7	
WSP (m/s)	9		4.9			9.8	
WVL (m/s)	8.8		4.8			9.6	

There were three (3) exceedance of the national ambient air quality limit for SO₂ hourly of 134 ppb and nine (9) exceedances of the national ambient air quality limit for SO₂ 10-minutes of 191 ppb. There were twenty three (23) exceedances of the national ambient air quality for PM₁₀ daily limit of 75µg/m³, twenty four (24) exceedances of the national ambient air quality for PM_{2.5} daily limit of 40µg/m³ and there were no exceedances of the other national ambient air quality limits recorded during the monitoring period under review.

Table 4: Exceedances above national ambient air quality standards

SO ₂ hourly exceedances								
Pollutant	Limit	Year	Month	Day	Time	Conc	WD	WV
SO ₂	134	2017	June	15	19:00	148.77	WNW	0.732
SO ₂	134	2017	June	25	19:00	151.03	NNW	0.372
SO ₂	134	2017	June	30	19:00	134.65	NW	0.987
SO ₂ 10 minutes exceedances								
Pollutant	Limit	Year	Month	Day	Time	Conc		
SO ₂	191	2017	June	25	06:10	201.5		
SO ₂	191	2017	June	25	06:30	196.9		
SO ₂	191	2017	June	15	07:10	199.3		
SO ₂	191	2017	June	10	10:50	223.7		
SO ₂	191	2017	June	10	10:40	270.8		
PM ₁₀ daily exceedances								
Pollutant	Limit	Year	Month	Day	Conc.			
PM ₁₀	75	2017	June	04	113.3			
PM ₁₀	75	2017	June	06	96			
PM ₁₀	75	2017	June	07	102.6			

PM ₁₀	75	2017	June	08	101.2
PM ₁₀	75	2017	June	10	83.8
PM ₁₀	75	2017	June	11	126
PM ₁₀	75	2017	June	12	94.4
PM ₁₀	75	2017	June	13	86.2
PM ₁₀	75	2017	June	14	114.1
PM ₁₀	75	2017	June	15	166.1
PM ₁₀	75	2017	June	17	85.6
PM ₁₀	75	2017	June	19	102.9
PM ₁₀	75	2017	June	20	89
PM ₁₀	75	2017	June	21	105.5
PM ₁₀	75	2017	June	22	125.5
PM ₁₀	75	2017	June	23	75.6
PM ₁₀	75	2017	June	24	79.6
PM ₁₀	75	2017	June	25	102.3
PM ₁₀	75	2017	June	26	83.3
PM ₁₀	75	2017	June	27	128.2
PM ₁₀	75	2017	June	28	140.9
PM ₁₀	75	2017	June	29	80.8
PM ₁₀	75	2017	June	30	104.7
PM_{2.5} exceedances					
Pollutant	Limit	Year	Month	Day	Conc.
PM _{2.5}	40	2017	June	02	79.7
PM _{2.5}	40	2017	June	03	95.3
PM _{2.5}	40	2017	June	04	79.6
PM _{2.5}	40	2017	June	06	64
PM _{2.5}	40	2017	June	07	45.6
PM _{2.5}	40	2017	June	08	40.6
PM _{2.5}	40	2017	June	09	48.4
PM _{2.5}	40	2017	June	10	46.7
PM _{2.5}	40	2017	June	11	74.6
PM _{2.5}	40	2017	June	12	59.9
PM _{2.5}	40	2017	June	13	50.7
PM _{2.5}	40	2017	June	14	63.4
PM _{2.5}	40	2017	June	15	82.4

PM _{2.5}	40	2017	June	17	42.6
PM _{2.5}	40	2017	June	19	66.1
PM _{2.5}	40	2017	June	20	46.6
PM _{2.5}	40	2017	June	21	60.4
PM _{2.5}	40	2017	June	22	61.7
PM _{2.5}	40	2017	June	24	43.4
PM _{2.5}	40	2017	June	25	80.2
PM _{2.5}	40	2017	June	26	44.1
PM _{2.5}	40	2017	June	27	79.8
PM _{2.5}	40	2017	June	28	70.5
PM _{2.5}	40	2017	June	30	131.3

5. METEOROLOGICAL OBSERVATIONS

The distribution of wind direction and wind speed for daytime and night-time hours for the reporting period are summarised on polar diagrams in Figure 2. The centre of the wind rose depicts the position of the air quality-monitoring site. The positions of the spokes in the polar diagram represent directions from which the wind was blowing. The length of the segment indicates the percentage of the time the wind blew from that direction and the speed in the various categories are denoted by colours and width.

The dominant winds during the day were from west-north-west, north-west, east-north-east and south-west. The dominant winds during the night were from south-south-east, south and east.

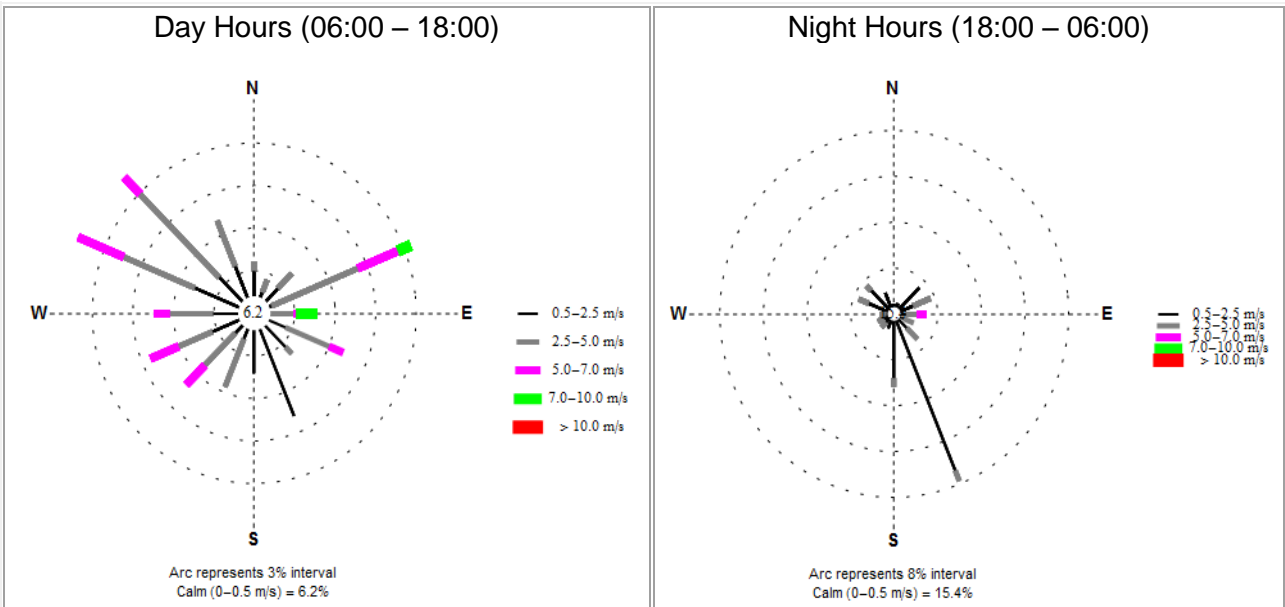


Figure 2: Wind profile at KwaZamokuhle monitoring site

6. DISCUSSION OF POLLUTANTS

Emissions of primary pollutants such as PM₁₀, SO₂, and NO_x from low level sources such as domestic combustion and motor vehicles are expected to impact at ground level more significantly during the evening and early morning hours as a result of temperature inversion. Emissions of such pollutants from tall stacks (power stations and other industries), are expected to have a more significant impact at ground level during the day between 09:00 and 16:00, due to atmospheric turbulence influences.

6.1. SULPHUR DIOXIDE (SO₂).

6.1.1. Source Identification by SO₂ Hourly Diurnal Variations.

Figure 3 shows SO₂ concentrations increasing from 04:00 in the morning. The concentrations continue to rise throughout the afternoon with a peak at 12:00 and indicative of influence from tall stack emitters on the SO₂ ambient concentrations in the area. The concentrations rise again from 16:00 and peak at 20:00 in the evening, indicative of influence from low-level sources, probably domestic coal burning and motor vehicle emissions.

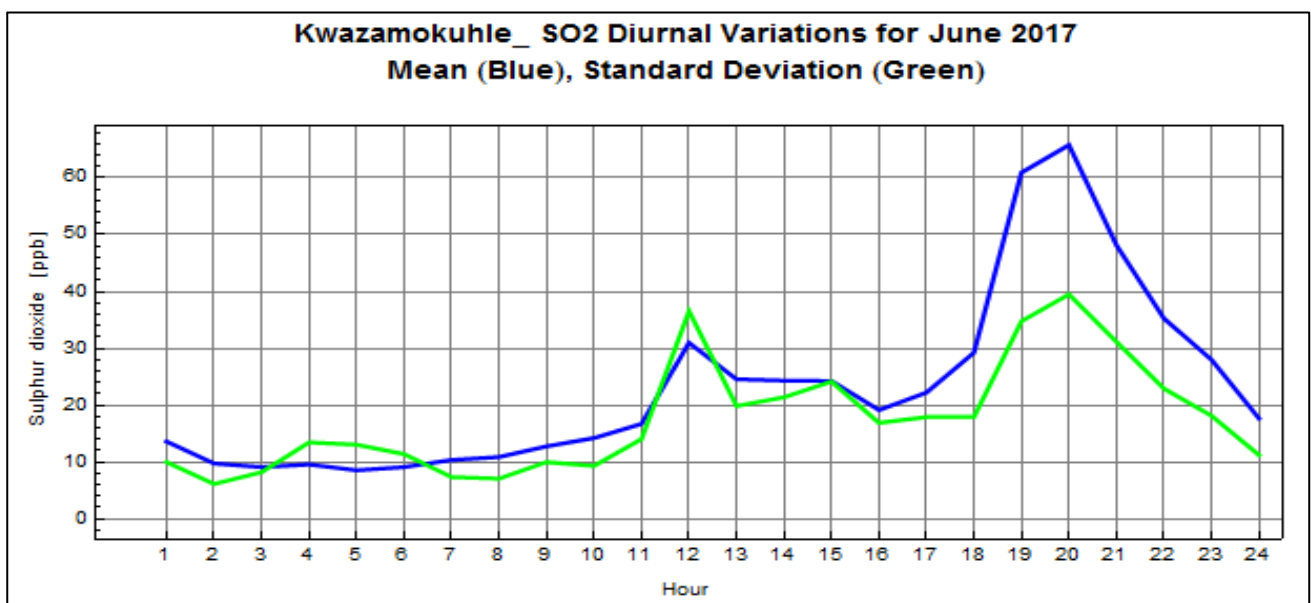


Figure 3: Diurnal variation of SO₂ hourly at KwaZamokuhle for June 2017

6.1.2 Sulphur Dioxide Hourly Event Roses

There were three (3) exceedance of the national ambient air quality limit for SO₂ hourly of 134 ppb and nine (9) exceedances of the national ambient air quality limit for SO₂ 10-minutes of 191 ppb. Figure 4 shows the SO₂ 98th percentile event roses indicating the sectors where highest hourly concentrations were coming from during the day and hourly limit exceedance roses during night times.

During the daytime SO₂ highest hourly concentrations above 100.1 ppb were recorded in the west-north-west, north-west and north-north-west sector; Komati Power Station is located 27.6 km west to west-north-west of the monitoring site. The hourly limit exceedances of 134 ppb during the night-time were recorded in the west-north-west, north-west and north-north-west sectors.

KwaZamokuhle Township is located from south to north and Hendrina power station is located in the north-west sectors of the monitoring site and this could have shown impact on the SO₂ ambient concentrations around the monitoring site.

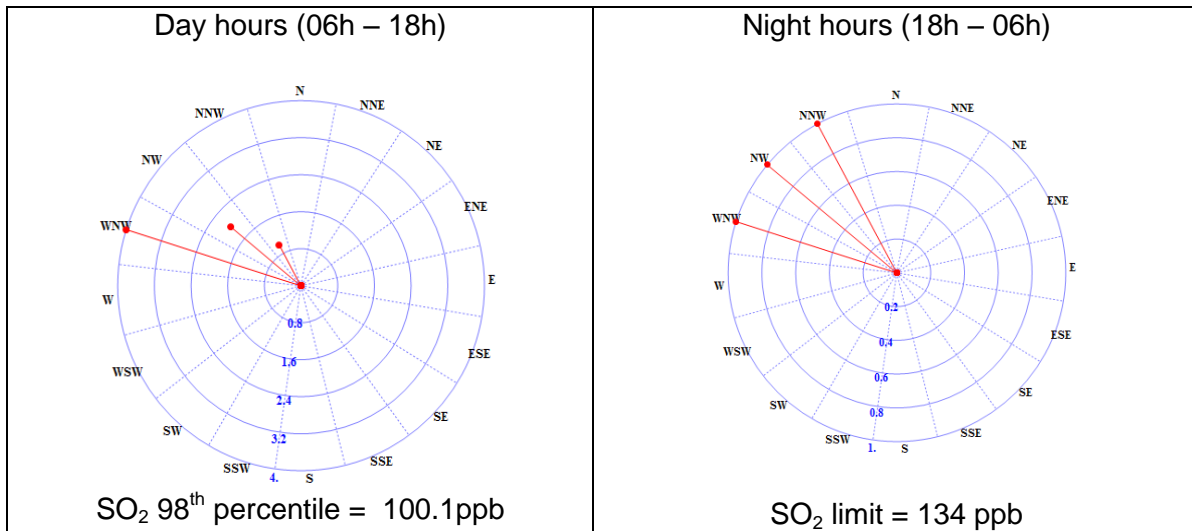


Figure 4: SO₂ highest hourly concentrations for event roses during day and night

Table 5: SO₂ day-time hourly limit for exceedance table

Dir.	N	NNE	NE	ENE	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
Exe	0	0	0	0	0	0	0	0	0	0	0	0	4	2	1
%	0	0	0	0	0	0	0	0	0	0	0	0	57.14	28.57	14.29

Table 6: SO₂ night-time hourly limit for exceedance table

Dir.	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
Eve	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
%	0	0	0	0	0	0	0	0	0	0	0	0	0	33.33	33.33	33.33

6.2. Nitrogen Dioxide (NO₂)

6.2.1. Source identification by NO₂ diurnal variations

The diurnal variation indicates NO₂ concentrations reaching minor peaks between 07:00 and 10:00 in the afternoon and a maximum peak at 19:00 in the evening as indicated by Figure 5. The peaks observed in the afternoon are influenced by tall stack emissions and the concentration peak observed in the evening could be associated with influence from low-level sources like domestic burning and vehicles

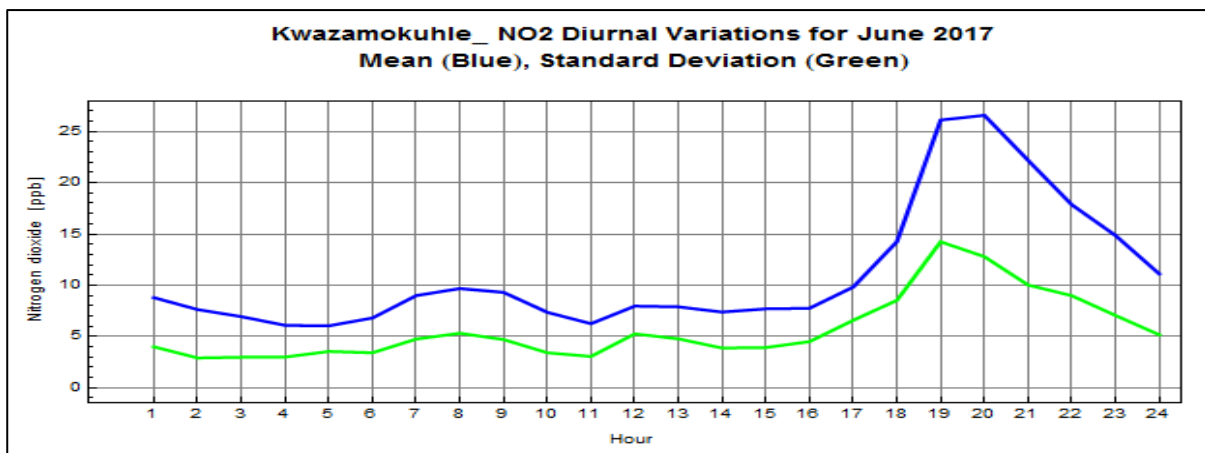


Figure 5: Diurnal variation of NO₂ hourly at KwaZamokuhle for June 2017

6.2.2 Nitrogen dioxide hourly event roses (98th percentile)

There were no exceedances of the NO₂ hourly limit of 106 ppb. Figure 6 shows the 98th percentile event roses indicating the sectors where highest hourly concentrations were coming from during the day and night. During the daytime the highest hourly mean concentrations above 36.38 ppb were recorded in south-south-west, south-west, west-north-west and north-west sectors. The hourly mean concentrations above 35.62 ppb during the night-time were recorded in the east, west-north-west, north-west and north-north-west sectors.

KwaZamokuhle Township is located from south to north and Hendrina power station is located in the north-west sectors of the monitoring site and this could have shown impact on the NO₂ ambient concentrations around the monitoring site.

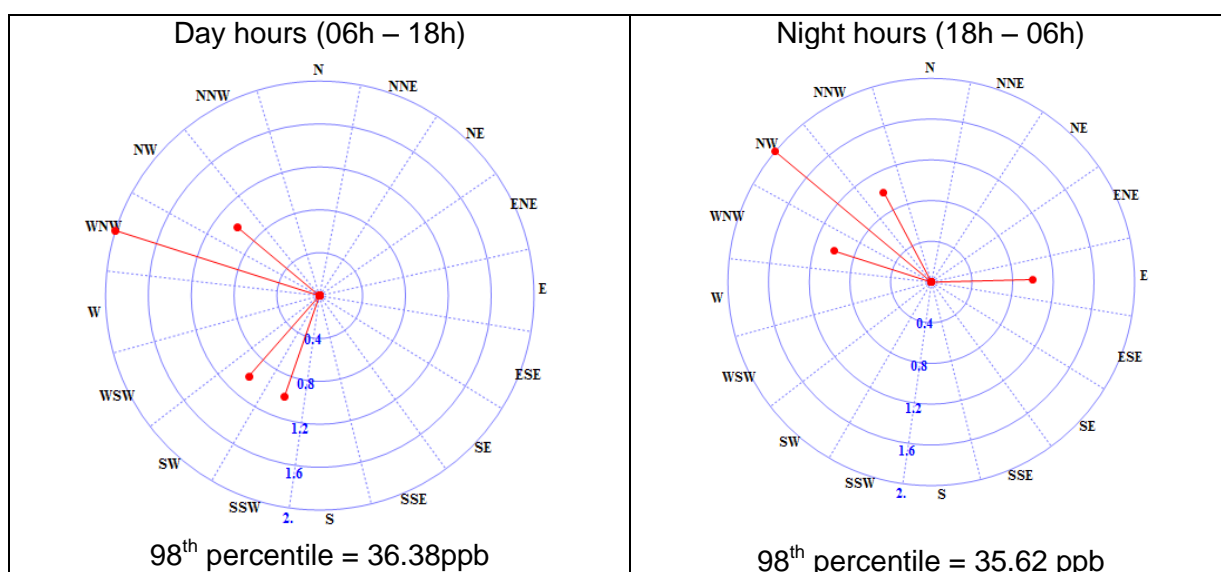


Figure 6: NO₂ hourly mean 98th percentile event roses during day and night times

Table 7: NO₂ day time hourly mean 98th percentile event table

Dir.	N	NNE	NE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
Eve	0	0	0	0	0	0	0	0	1	1	0	0	2	1	0
%	0	0	0	0	0	0	0	0	20	20	0	0	40	20	0

Table 8: NO₂ night-time hourly mean 98th percentile event table

Dir.	N	NNE	NE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
Eve	0	0	0	1	0	0	0	0	0	0	0	0	1	2	1
%	0	0	0	20	0	0	0	0	0	0	0	0	20	40	20

6.3. Fine Particulate Matter (PM₁₀ and PM_{2.5}).

6.3.1. Source identification by PM₁₀ and PM_{2.5} diurnal variations.

The PM_{2.5} and PM₁₀ diurnal variations (Figures 7 and 8) display a similar pattern showing impact of low-level source emissions on the particulate matter ambient concentrations. Two distinct peaks are evident at 10:00 in the morning and 20:00 in the evening and concentrations remained low throughout the day. These peaks are typical of emissions from low-level sources, probably domestic fuel combustion in KwaZamokuhle.

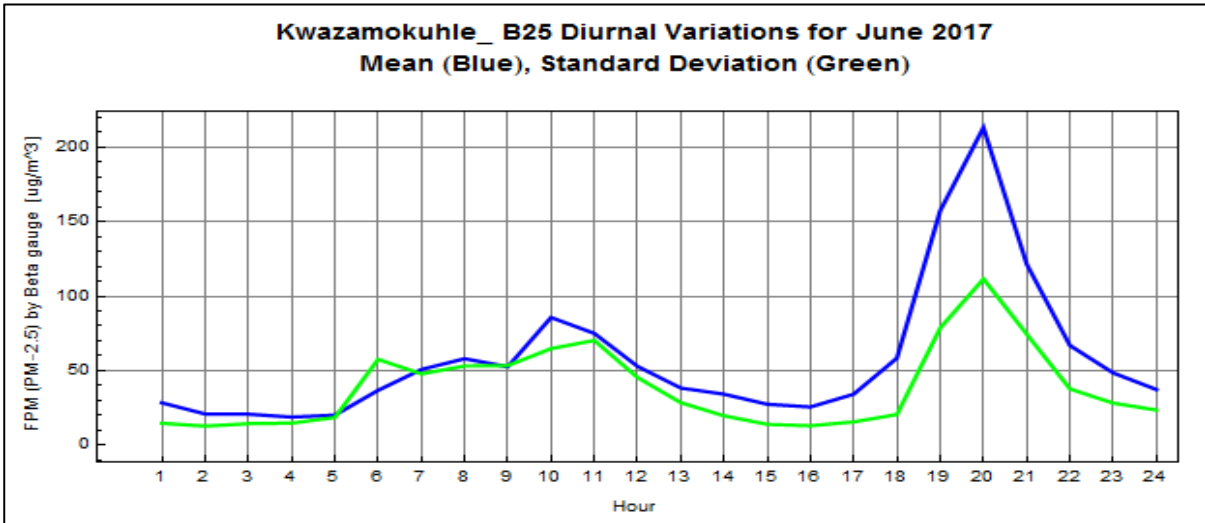


Figure 7: Diurnal variation of PM_{2.5} concentrations at KwaZamokuhle for June 2017

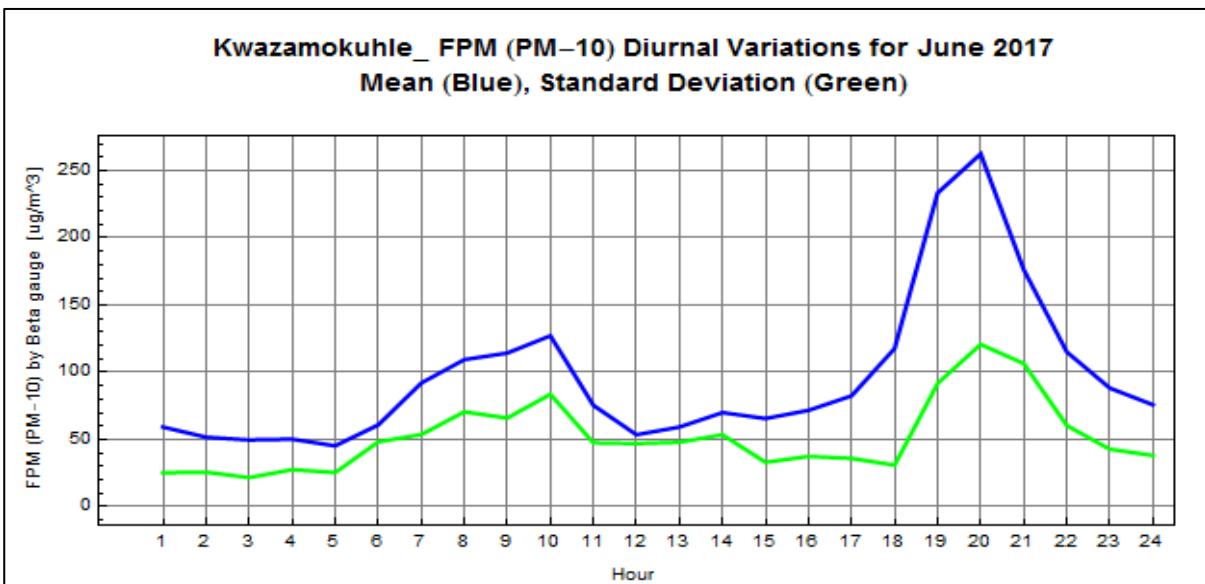


Figure 8: Diurnal variation of PM₁₀ concentrations at KwaZamokuhle for June 2017

6.3.2 Particulate fine matter hourly 98th percentile event roses.

Since there are no national hourly PM standards, the hourly mean 98th percentile daytime and night-time event roses are presented to identify the wind sectors from which the highest hourly concentrations were derived from during the monitoring period.

Figure 9 shows the PM_{2.5} hourly mean 98th percentile event roses during day and night times. During the daytime the PM_{2.5} hourly mean concentrations above 240.98µg/m³ were recorded in the south-south-west, west-south-west, west-north-west and north-north-west sectors. The hourly mean sector concentrations above 307.03µg/m³ during the night-time were recorded in south-south-east, south, west-north-west, north-west and north-north-west sectors.

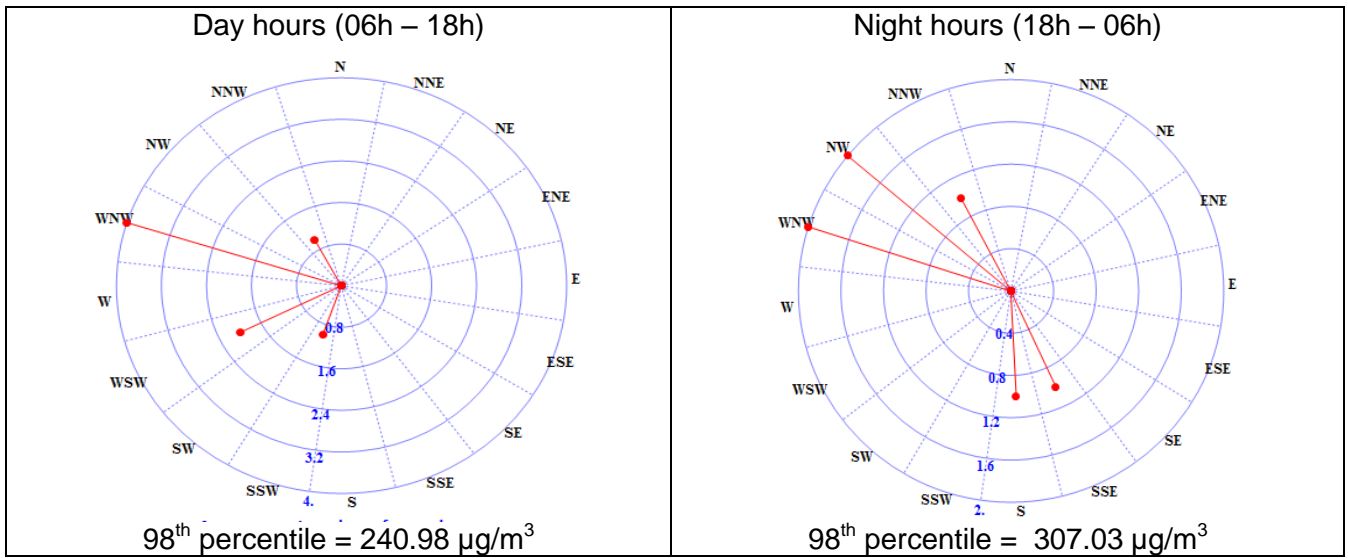


Figure 9: PM_{2.5} hourly mean 98th percentile event roses during day and night times

Table 9: PM_{2.5} daytime hourly mean 98th percentile event table

Dir	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
Eve	0	0	0	0	0	0	0	0	0	1	0	4	0	0	0	1
%	0	0	0	0	0	0	0	0	0	12.5	0	25	0	0	0	12.5

Table 10: PM_{2.5} night time hourly mean 98th percentile event table

Dir	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
Eve	0	0	0	0	0	0	0	1	1	0	0	0	0	2	2	1
%	0	0	0	0	0	0	0	14.29	14.29	0	0	0	0	28.57	28.57	14.29

Figure 10 shows the PM₁₀ hourly mean 98th percentile event roses during day and night times. PM₁₀ hourly mean sector concentrations above 335.42µg/m³ were recorded in the north-north-east, north-east, south-south-east, west-south-west, and west and north-north-west sectors. During the night, the hourly mean concentrations above 413.63µg/m³ were recorded in north, south-south-east, south, south-south-west and west-north-west sectors. Domestic burning in KwaZamokuhle is probably the largest source of PM₁₀.

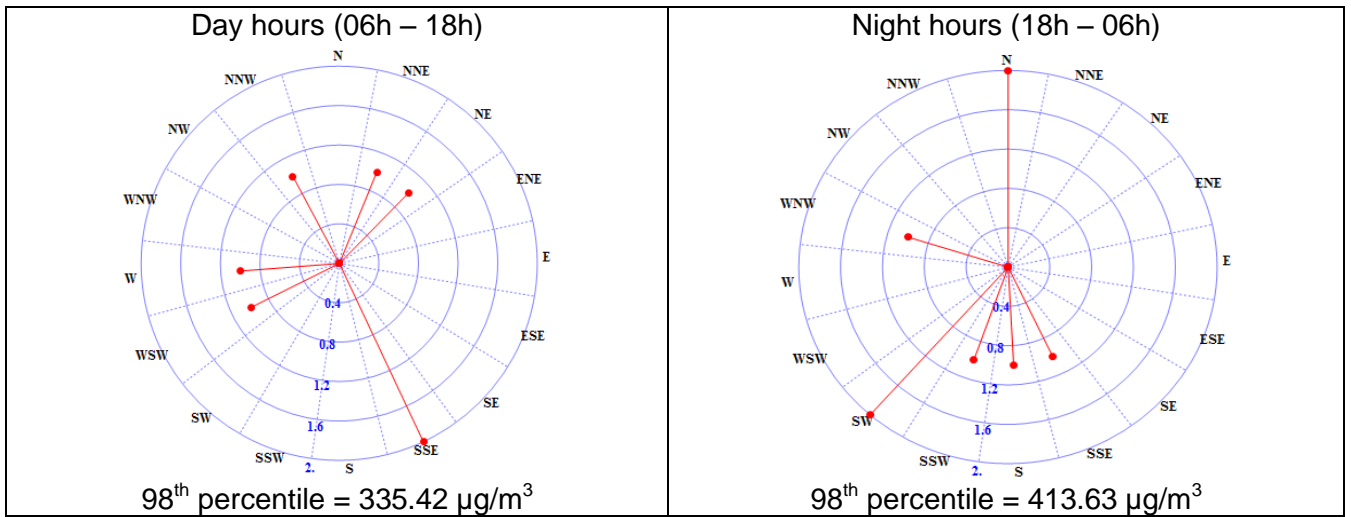


Figure 10: PM₁₀ hourly mean 98th percentile event roses during day and night times

Table 11: PM₁₀ daytime hourly mean 98th percentile event table

Dir	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
Eve	0	0	0	0	0	0	0	0	1	0	0	0	0	1	2	1
%	0	0	0	0	0	0	0	0	16.67	0	0	0	0	16.67	33.33	16.67

Table 12: PM₁₀ night time hourly mean 98th percentile event table

Dir	N	NNE	NE	E	ENE	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
Eve	0	0	1	0	0	0	0	0	1	0	0	0	0	1	2	1
%	0	0	16.67	0	0	0	0	0	16.67	0	0	0	0	16.67	33.33	16.67

6.4. OZONE (O₃)

6.4.1. Source identification by O₃ diurnal variations

The O₃ hourly mean diurnal variations show low concentrations in the morning with an increase from 08:00 in the morning due to the break of the inversion layer when the sun goes up. The concentrations increase throughout the day as a result of photochemical reaction, peaking at 15:00 before decaying rapidly due to the lack of sunlight during the night-time period shown in Figure 11. The ozone 8-hourly average limit was exceeded twenty eight times.

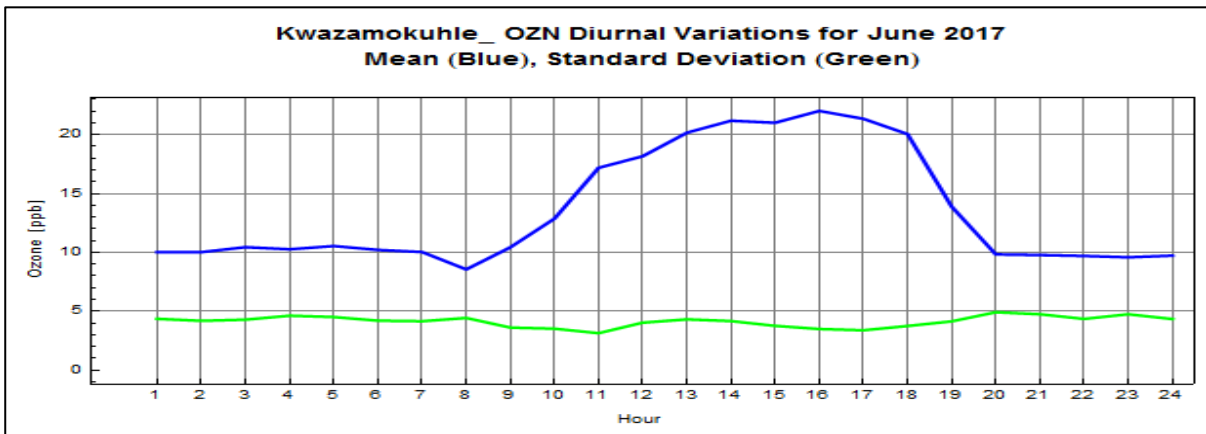


Figure 11: Diurnal variation of Ozone concentrations at KwaZamokuhle for June 2017

7. MONTHLY MEANS FOR THE CURRENT CALENDAR YEAR

7.1. TRENDS OVER THE REPORTING PERIOD

Time series graphs for each pollutant with respect to the national ambient limits are represented from the beginning of each month for the reporting period or since inception of the monitors. The resultant period may vary for each analyser, depending on when it was installed.

Figures 12 - 16 show seasonal trends where high concentrations were recorded from May to August 2016 (winter season) and low concentrations are also recorded from January 2016 – April 2016 and October 2016 - June 2017 (summer season) and concentrations are becoming high since winter season has approached for the parameters monitored at the site. Gaps in the data are as a result of the analysers being out of service due to faults experienced, tripping of circuit breakers and incoming power interruptions. There is no distinct trend observed on the O₃ 8hourly moving average monthly concentrations during the 2016 monitoring period, however there has been an increase on the O₃ concentrations levels from July 2016 – January 2017, in February – June 2017 concentrations were low (Figure 17).

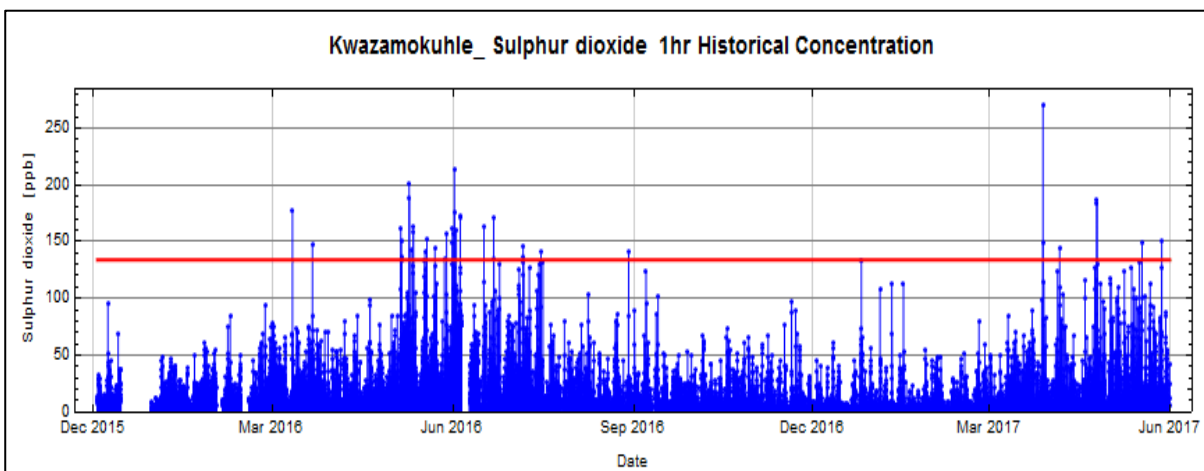


Figure 12: SO₂ 1hr mean concentration

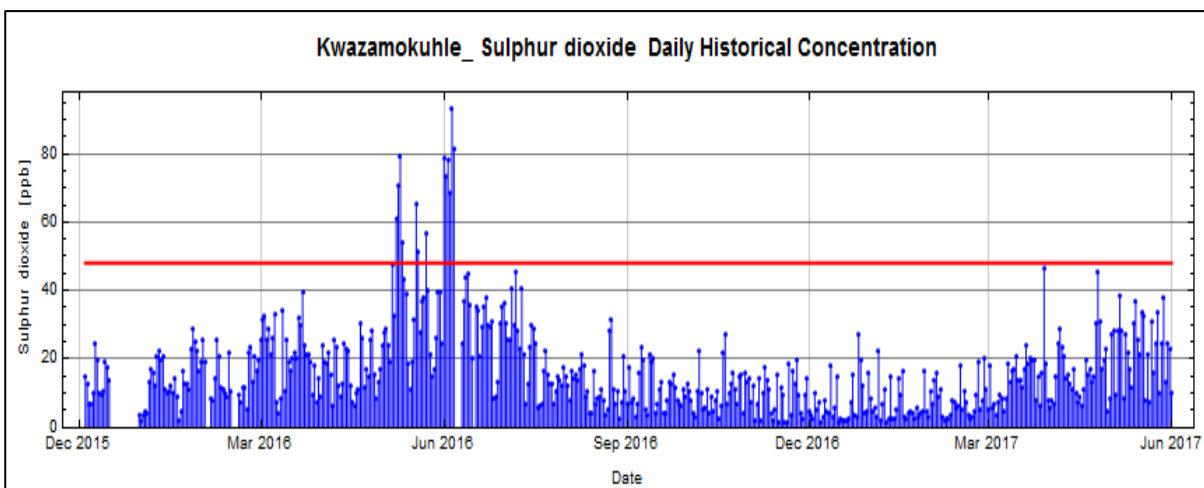


Figure 13: SO₂ daily monthly concentrations

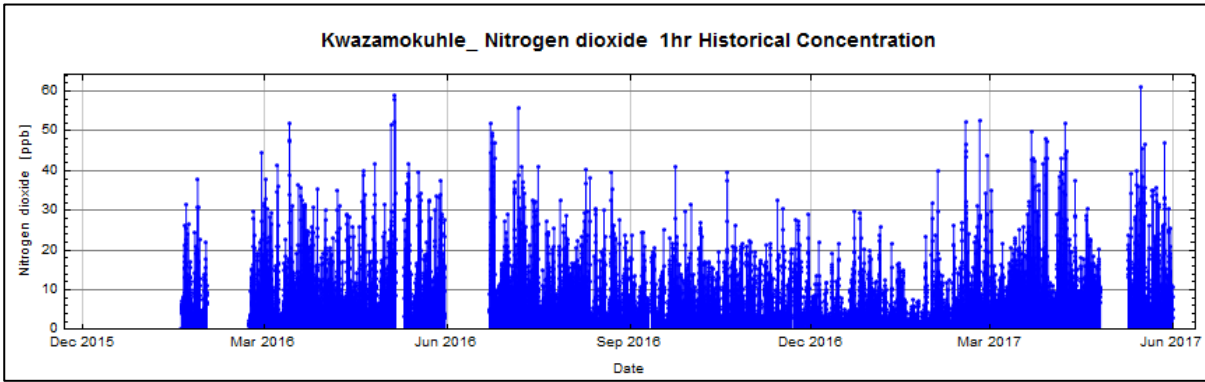


Figure 14: NO₂ 1hr monthly concentration

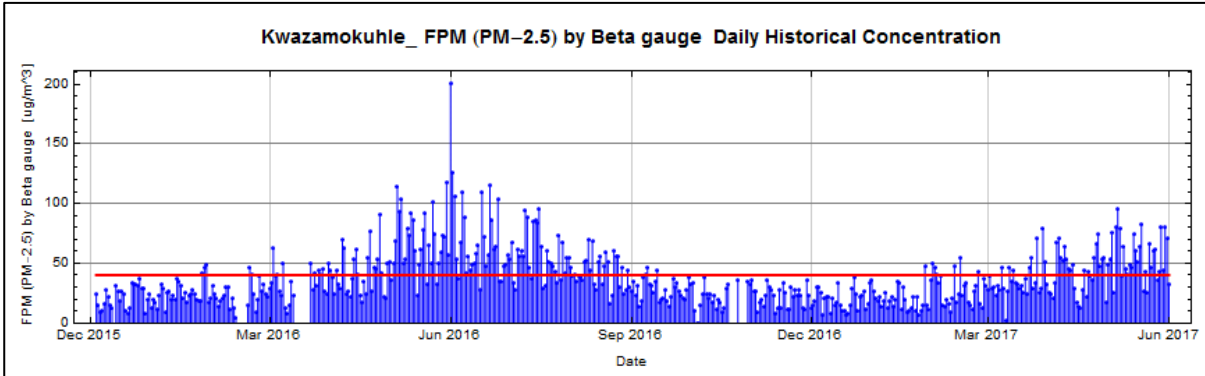


Figure 15: PM_{2.5} daily monthly concentration

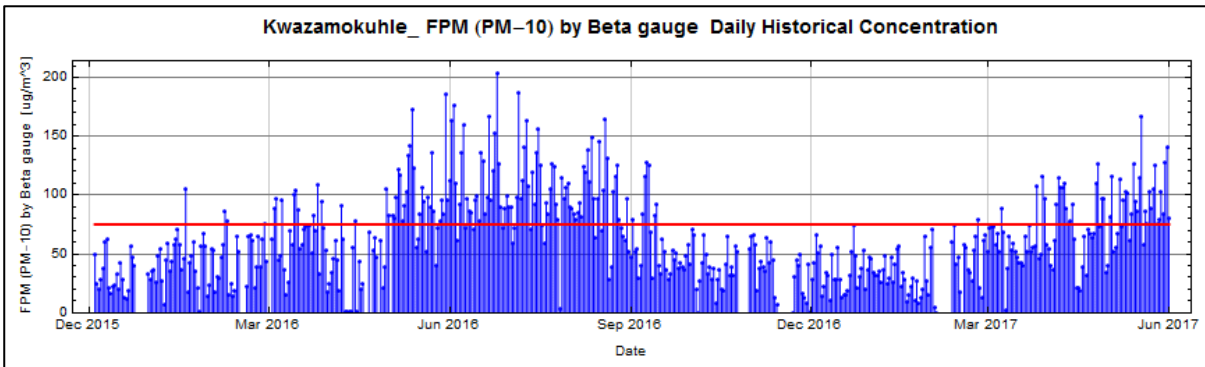


Figure 16: PM₁₀ daily monthly concentrations

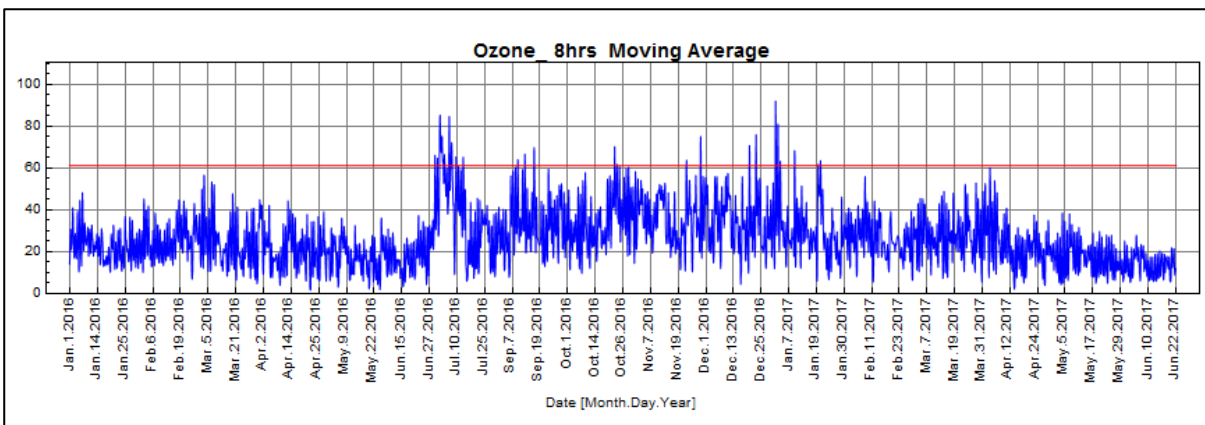


Figure 17: O₃ 8hrs moving average

Table 13: Monthly means for the calendar year 2017

Parameter measured	Jan	Feb	Mar	Apr	May	June
PM _{2.5} (µg/m ³)	21	19.3	28.3	35.1	45.2	57.7
PM ₁₀ (µg/m ³)	33	30.7	50	59.2	73.7	94.7
NO ₂ (ppb)	5.3	3.9	7.9	9.4	10.9	11.1
O ₃ (ppb)	22	25.8	27.1	22.4	16.4	13.5
SO ₂ (ppb)	11	6.6	8.2	14.1	17.8	23.1

Table 14: Number of exceedances of the National Ambient Air Quality Limits

Period	SO ₂ hourly	SO ₂ 10-minutes	SO ₂ daily	NO ₂ hourly	PM ₁₀ daily	PM _{2.5} daily	O ₃ 8-Hourly
Jan	0	0	0	0	0	0	28
Feb	0	1	0	0	0	1	0
Mar	0	0	0	0	1	6	0
Apr	2	7	0	0	4	8	0
May	3	9	0	0	15	20	0
	3	5	0	0	23	24	0
Total	8	22	0	0	43	59	28
Allowed no of exceedances	88	526	4	88	4	4	11

There is non-compliance with the ambient PM₁₀ daily, PM_{2.5} daily and O₃ 8-hourly moving averages and all other monitored parameters are within their respective allowed number of exceedances per year at KwaZamokuhle.

8. CONCLUSION

There were three (3) exceedance of the national ambient air quality limit for SO₂ hourly of 134 ppb and nine (9) exceedances of the national ambient air quality limit for SO₂ 10-minutes of 191 ppb. There were twenty three (23) exceedances of the national ambient air quality for PM₁₀ daily limit of 75µg/m³, twenty four (24) exceedances of the national ambient air quality for PM_{2.5} daily limit of 40µg/m³ and there were no exceedances of the other national ambient air quality limits recorded during the monitoring period under review.

Both SO₂ and NO₂ ambient concentrations at KwaZamokuhle monitoring site are influenced by the combination of low-level sources and tall stack emitters. Ambient fine particulate matter concentrations indicate the influence of low-level source emissions at KwaZamokuhle, probably domestic burning.

The dominant winds during the day were from west-north-west, north-west, east-north-east and south-west. The dominant winds during the night were from south-south-east, south and east.

The overall percentage data recovered from the monitoring site during the reporting period was 92% and station availability was 98.9%. The NO_x and solar radiation parameters did not meet SANAS requirement of 90% data recovery per parameter due to being affected by high temperature at site, which then resulted to invalid data and other monitored parameters met the SANAS requirement.

ESE	East-south-east
FPM	Fine particulate matter
HUM	Humidity
m/s	Meters per second
MWP	Megawatt Park
N	North
NE	North-east
NNE	North-north-east
NNW	North-north-west
NO ₁	Nitric oxide
NO ₂	Nitrogen dioxide
NO _x	Oxides of nitrogen
NW	North-west
Ozn/O ₃	Ozone
PM-10	Particulate matter < 10 microns in diameter
PM-2.5	Particulate matter < 2.5 microns in diameter
ppb	Parts per billion
ppm	Parts per million
PRS	Pressure
RAD	Solar Radiation
RFL	Rain Fall
RT&D	Research, Testing and Development
S	South
SANAS	South African National Accreditation System
SE	South-east
SGT	Sigma theta
SO ₂	Sulphur Dioxide
SSE	South-south-east
SSW	South-south-west
SW	South-west
TMP	Ambient temperature
W	West
WDR	Wind direction from true North
WNW	West-north-west
WSP	Wind speed
WSW	West-south-west
WVL	Wind velocity