

EXECUTIVE SUMMARY

This monthly report covers the ambient air quality data for September 2016 as monitored at KwaZamokuhle monitoring site.

There were twenty-one exceedances of the national ambient air quality for PM₁₀ daily limit of 75µg/m³ and fifteen of the PM_{2.5} daily limit of 40µg/m³ recorded. There was one exceedance of the national ambient air quality limits for SO₂ 10 minutes. The national ambient air quality for SO₂ hourly was exceeded once. The Ozone 8-hourly average was exceeded thirteen times. There were no exceedances of the national ambient air quality limits for SO₂ daily, and NO₂ hourly 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.

There is non-compliance with SO₂ daily, PM₁₀ daily and PM_{2.5} daily and Ozone 8-hourly standards at KwaZamokuhle. This is a clear indication of a need for air quality improvement interventions that are focused on reducing particulate matter levels in the area.

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

The overall percentage data recovered from the monitoring station during the reporting period was 98.1 % and station availability was 98.4%. The majority of the parameters monitored at site meet the SANAS requirement of 90% data recovery per parameter with the exception of the O₃ analyser that was unstable and was removed for repairs.

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

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 September 2016

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 Availability
98.1	98.1	98.1	79.9	100	100	100	98.1	100	100	100	100	98.4	98.4	100	98.1	98.4

The overall percentage data recovered from the monitoring station during the reporting period was 98.1 % and station availability was 98.4%. The majority of the parameters monitored at site and therefore meet the SANAS requirement of 90% data recovery per parameter, with the exception of the O₃ analyser that was unstable and was removed for repairs.

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 September 2016 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)	312.6		70	15		398.2	
PM ₁₀ (µg/m ³)	430.4		165	21		536.2	
NO (ppb)	59		12.2			119.4	
NO ₂ (ppb)	81.9	0	15.7			52.3	
NOx (ppb)	81.9		26.3			146.9	
OZN (ppb)	73.7		49.1		13	123.8	
SO ₂ (ppb)	140.5	1	31.3	0		228.8	1
TMP (°C)	30.8		21			31.1	
WSP (m/s)	9.6		6.3			10.6	
WVL (m/s)	9.4		6.1			10.4	

There were twenty-one exceedances of the national ambient air quality for PM₁₀ daily limit of 75µg/m³ and fifteen of the PM_{2.5} daily limit of 40µg/m³ recorded. There was one exceedance of the national ambient air quality limits for SO₂ 10 minutes. The national ambient air quality for SO₂ hourly was exceeded once. The Ozone 8-hourly average was exceeded thirteen times. There were no exceedances of the national ambient air quality limits for SO₂ daily, and NO₂ hourly recorded during the monitoring period under review.

Table 4: Exceedances for the National Ambient Air Quality Standards.

SO ₂ hourly averages exceedances							
Limit	Day	Month	Year	Time	Conc	Wind Dir	Wind v
134	27	September	2016	10:00	140.53	NW	3.555

SO ₂ 10-minutes averages exceedances					
Limit	Day	Month	Year	Time	Conc
191	27	September	2016	21:10	228.8

PM ₁₀ daily exceedances				
Limit	Day	Month	Year	Conc
75	01	September	2016	78.7
75	02	September	2016	85.1
75	03	September	2016	93.7
75	04	September	2016	81.2
75	05	September	2016	124.3
75	06	September	2016	119.4
75	07	September	2016	138.2
75	08	September	2016	111.6
75	09	September	2016	149.3
75	10	September	2016	96.5
75	12	September	2016	97
75	13	September	2016	145.5
75	15	September	2016	104.3
75	16	September	2016	165
75	17	September	2016	131.5
75	20	September	2016	102.6
75	21	September	2016	115.3
75	22	September	2016	125.4
75	23	September	2016	78.6

75	27	September	2016	96.6
75	30	September	2016	78.5

PM10 daily exceedances				
Limit	Day	Month	Year	Conc
40	05	September	2016	50.6
40	06	September	2016	51.7
40	07	September	2016	70
40	08	September	2016	43.5
40	09	September	2016	68.1
40	12	September	2016	51.3
40	13	September	2016	56.1
40	15	September	2016	47.7
40	16	September	2016	59.6
40	17	September	2016	51.4
40	20	September	2016	60
40	21	September	2016	56.2
40	22	September	2016	56.2
40	24	September	2016	46.1
40	27	September	2016	44.2

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

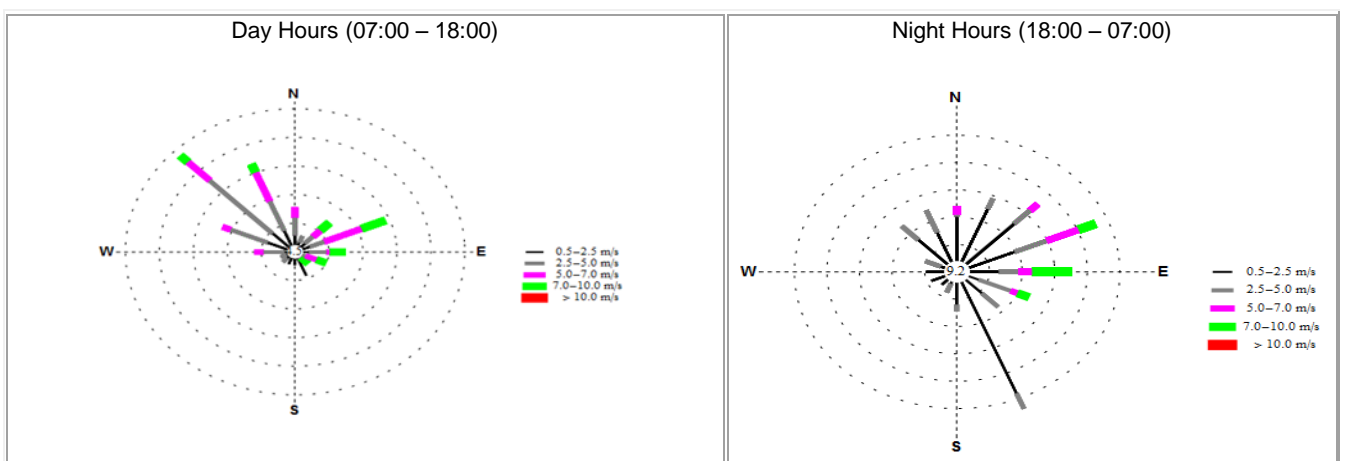


Figure 2: Wind profile at KwaZamokuhle monitoring site

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 illustrates SO₂ concentrations increasing from the morning. The concentrations continue to rise throughout the afternoon until maximum peak is reached at 20h00. The morning and evening peaks are from low-level sources, probably domestic coal burning, and the higher concentrations in the afternoon are indicative of tall stack sources.

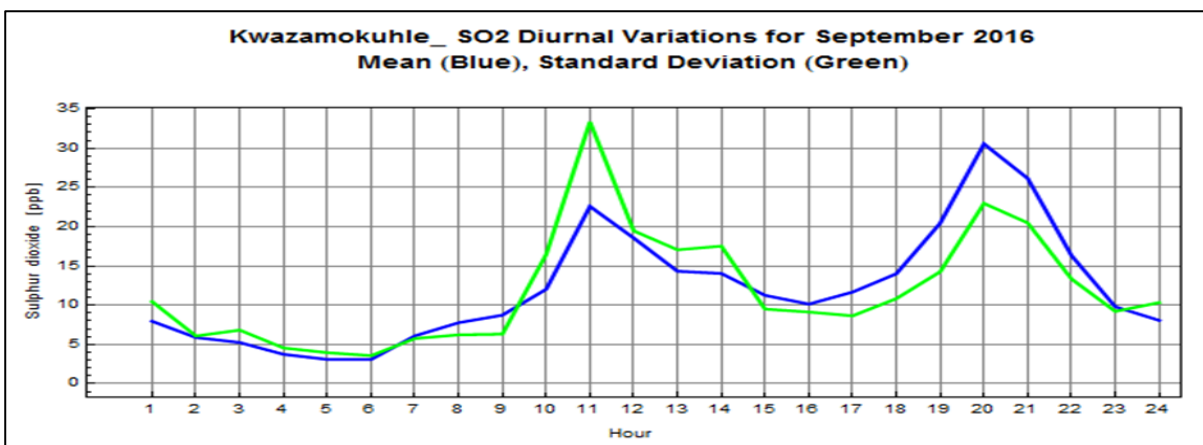


Figure 3: Diurnal variation of SO₂ hourly at KwaZamokuhle for September 2016

6.1.2 Sulphur Dioxide Hourly Event Roses

During daytime, there was one exceedance of concentrations for SO₂ 10-minutes limit. The national ambient air quality for SO₂ hourly was exceeded once. Figure 5 show the exceedance roses to indicate the sectors where the exceedances of hourly limit concentrations were coming from during the day and the highest mean concentrations during night.

During daytime, there was one exceedance for SO₂ hourly limit that was recorded from north-west sector (Table 5), in the direction of Hendrina Power Station. During the nighttime, the highest hourly mean concentrations above 51.39 ppb (Table 6) were recorded in the north, north-north-east, west, west-north-west and north-west sectors. The Kwazamokuhle township is on the surroundings of north to south sector of the monitoring site and this could have impacted on the monitoring site. Local SO₂ emissions from domestic coal burning probably make the greatest contribution to SO₂ levels in KwaZamokuhle.

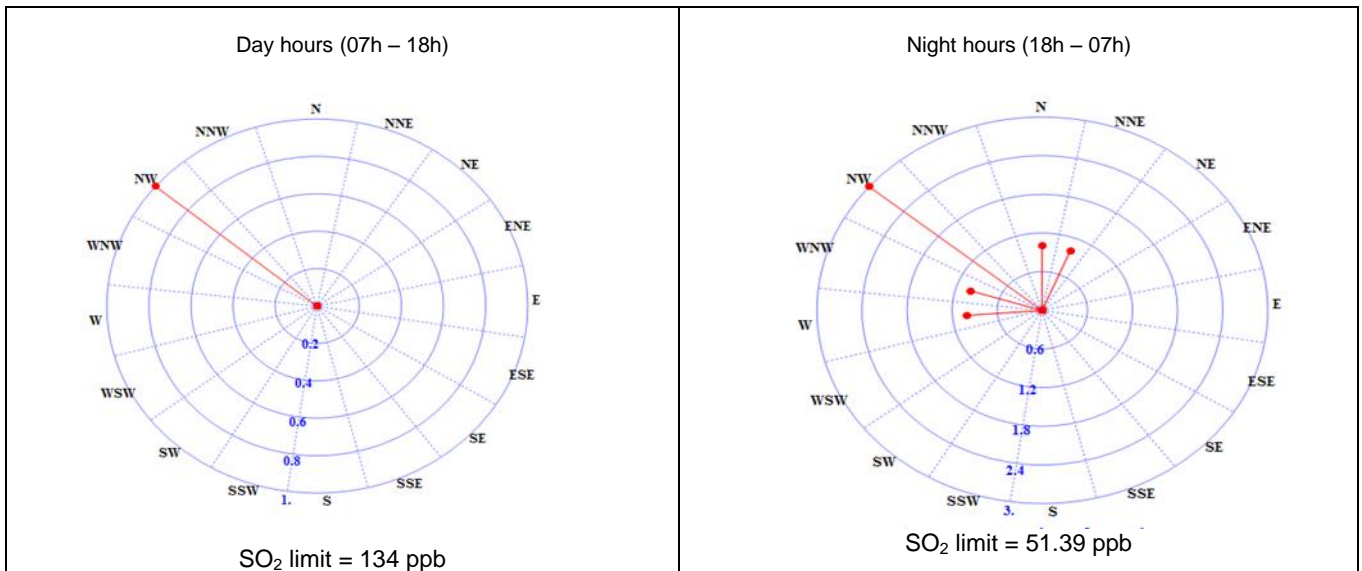


Figure 4: SO₂ hourly limit for exceedance roses and hourly mean 98th percentile event roses for September 2016

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

Dir.	N	NNE	NE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
Exc	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
%	0	0	0	0	0	0	0	0	0	0	0	0	0	100	0

Table 6: SO₂ night-time hourly mean 98th percentile for event table

Dir.	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
Eve	1	1	0	0	0	0	0	0	0	0	0	0	1	1	3	0
%	14.29	14.29	0	0	0	0	0	0	0	0	0	0	14.29	14.29	42.86	0

6.2. Nitrogen Dioxide (NO₂)

6.2.1. Source identification by NO₂ diurnal variations

The NO₂ diurnal variation shows NO₂ concentrations reaching peaks at 08:00 and 12:00 in the morning and afternoon, and another peak at 20:00 in the evening as indicated by Figure 6 below. The concentration peaks observed in the morning and evenings are associated with influence from low-level sources like domestic burning and vehicles.

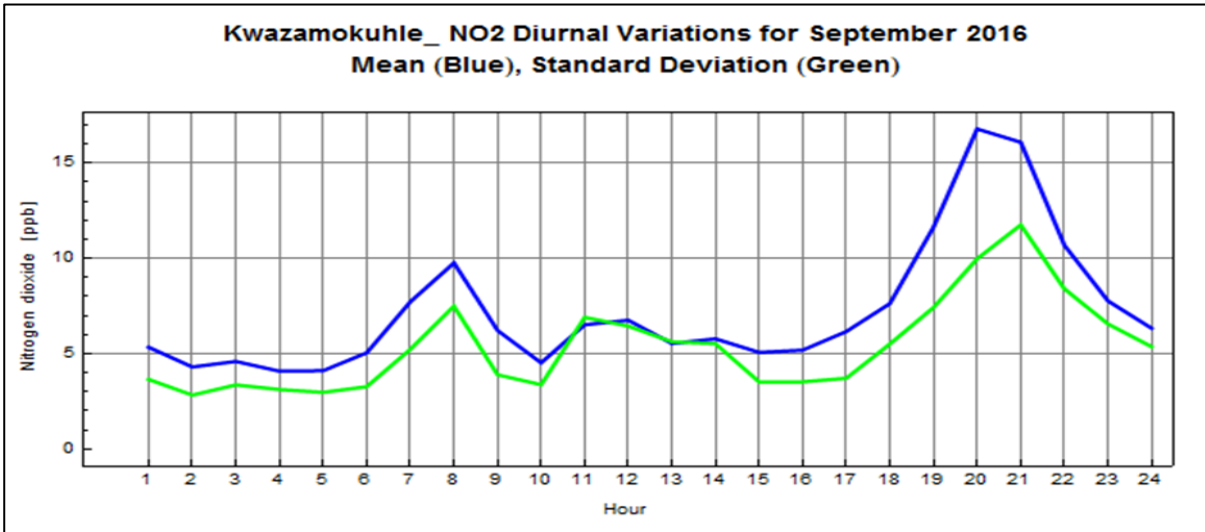


Figure 5: Diurnal variation of NO₂ hourly at KwaZamokuhle for September 2016

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 23.59 ppb (Table 7) were recorded in the east-south-east, west-north-west and north-west sectors. The hourly mean concentrations above 29.94 ppb (Table 8) during the night-time were recorded in the west-south-west, west, west-north-west and north-west sectors. There is Coalfields located east-south-east of the monitoring site which might have an influence on the monitoring site.

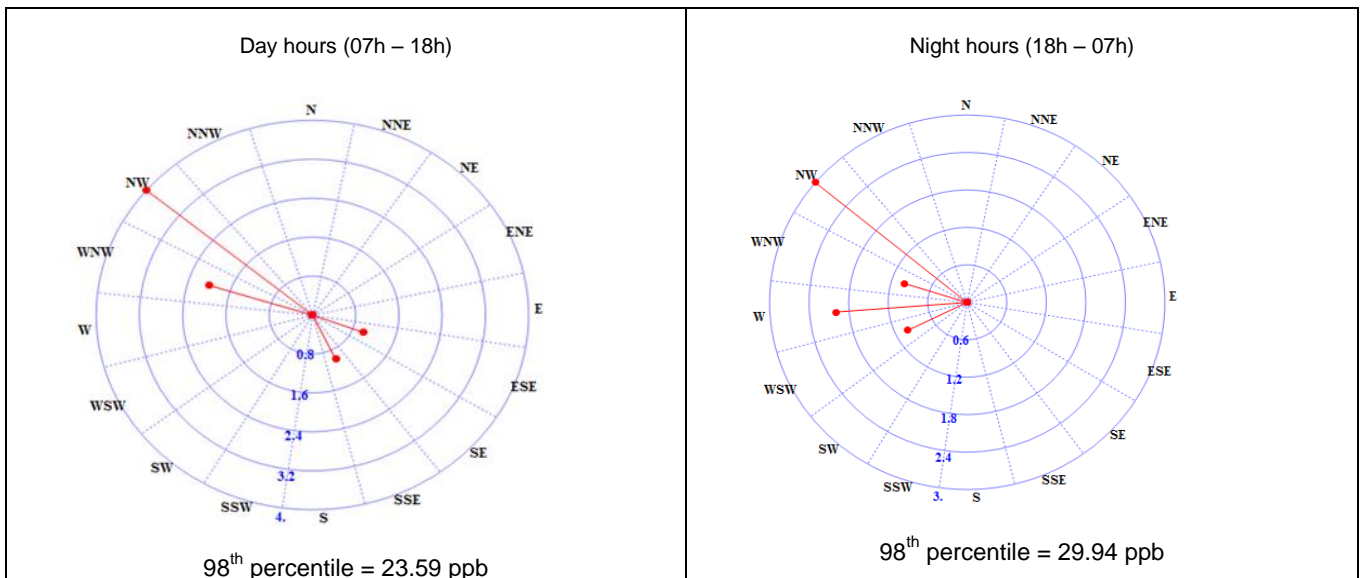


Figure 6: NO₂ hourly mean 98th percentile event roses during day and night times

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	1	0	0	0	0	0	0	0	2	4	0
%	0	0	0	0	12.5	0	12.5	0	0	0	0	0	25	50	0

Table 8: NO₂ 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	0	0	0	0	1	2	1	3	0
%	0	0	0	0	0	0	0	0	0	0	0	14.29	28.57	14.29	42.86	0

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 8 and 9) display a similar pattern indicative of low-level emission sources. The concentrations increase from 02:00 and peak at 08:00 in the morning. Thereafter they decrease until 12:00 and remain low throughout the afternoon. The concentrations increase again from 17:00, reaching a maximum peak at 20:00 and decrease throughout the evening. These peaks observed in the morning and evenings are typical of emissions from low-level sources, probably domestic combustion at KwaZamokhule.

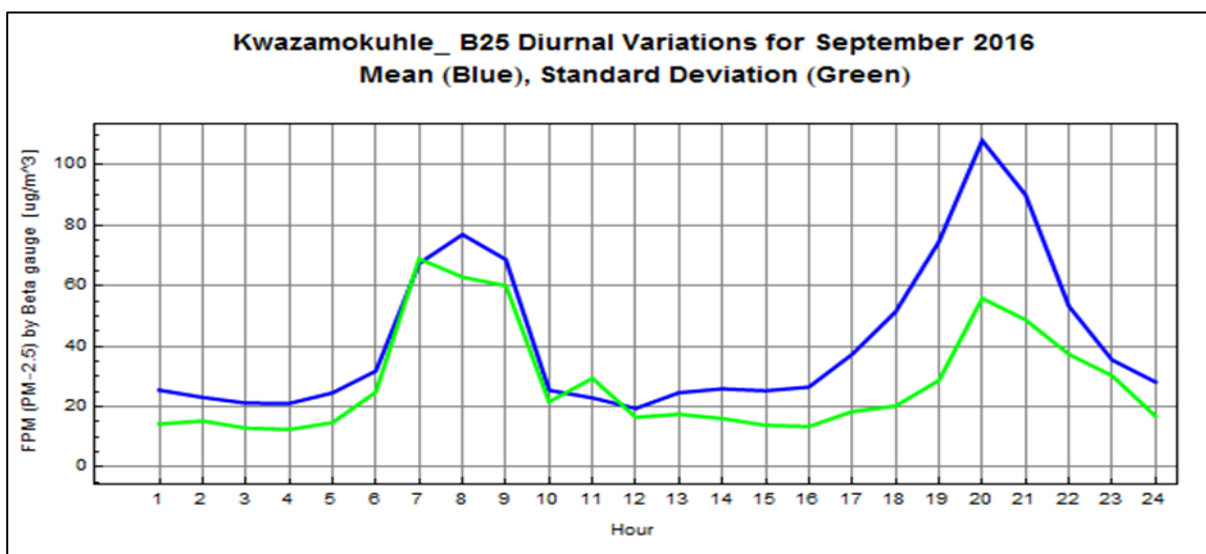


Figure 7: Diurnal variation of PM_{2.5} concentrations at KwaZamokuhle for September 2016

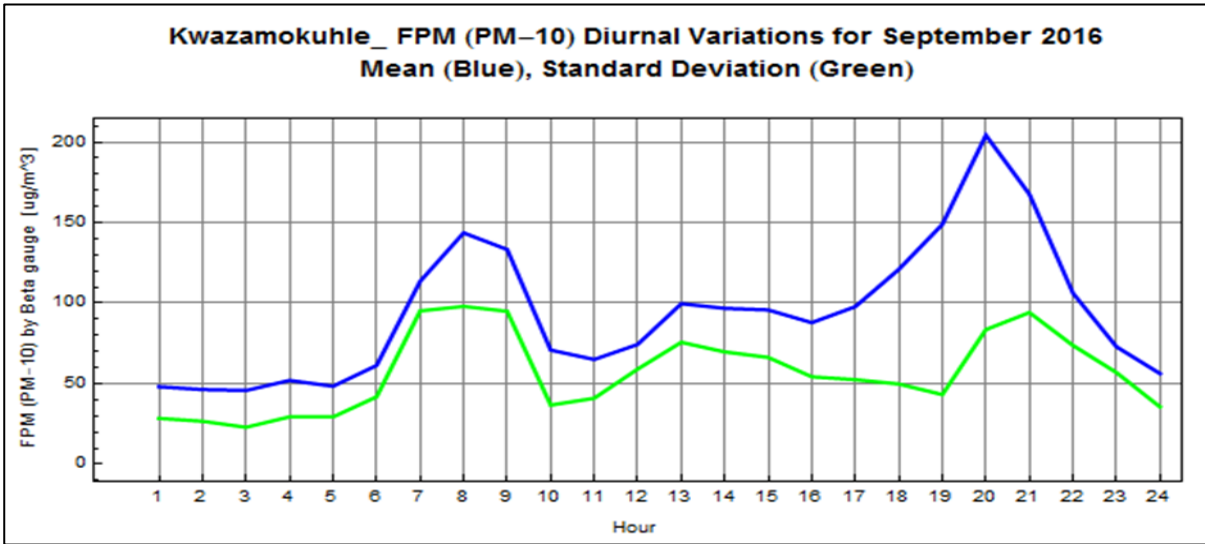


Figure 8: Diurnal variation of PM₁₀ concentrations at KwaZamokuhle for September 2016

6.3.2 Particulate fine matter hourly 98th percentile event roses. As 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 sector concentrations above 270.22µg/m³ (Table 9) were recorded in the north, south, south-south-west, west-north-west and north-west sectors. The hourly mean sector concentrations above 350.28µg/m³ (Table 10) during the night-time were recorded in east-south-east, south-south-west, south-west and north-west sectors.

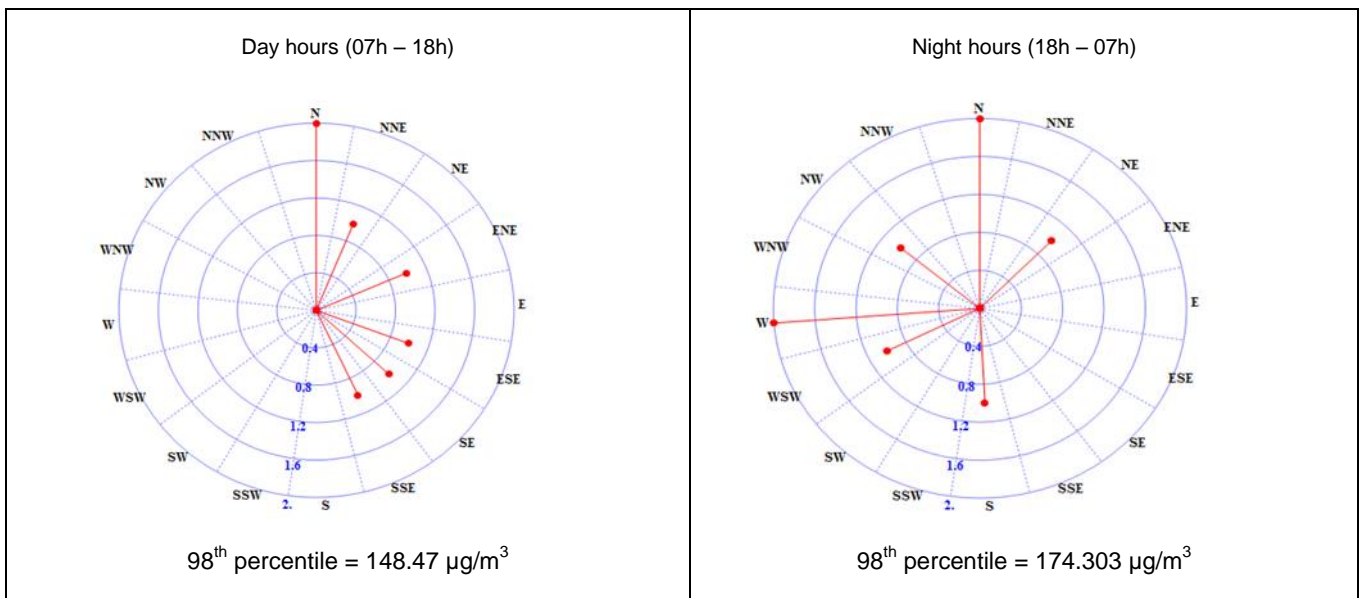


Figure 9: PM_{2.5} hourly mean 98th percentile event roses during day and night times

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

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

Table 10: PM_{2.5} 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	2	0	1	0	0	0	0	0	1	0	0	1	2	0	1	0
%	25	0	12.5	0	0	0	0	0	12.5	0	0	12.5	25	0	12.5	0

Figure 10 shows the PM₁₀ hourly mean 98th percentile event roses during day and night times. PM₁₀ hourly mean sector concentrations above 324.72 µg/m³ (Table 11) were recorded in north, east-north-east, east-south-east, south-east and north-west sectors during the daytime. During the night, the hourly mean concentrations above 309.77µg/m³ (Table 12) were recorded in the north, south, west, west-north-west, north-west and north-north-west sectors. Domestic burning in KwaZamokuhle is probably the largest source of PM₁₀.

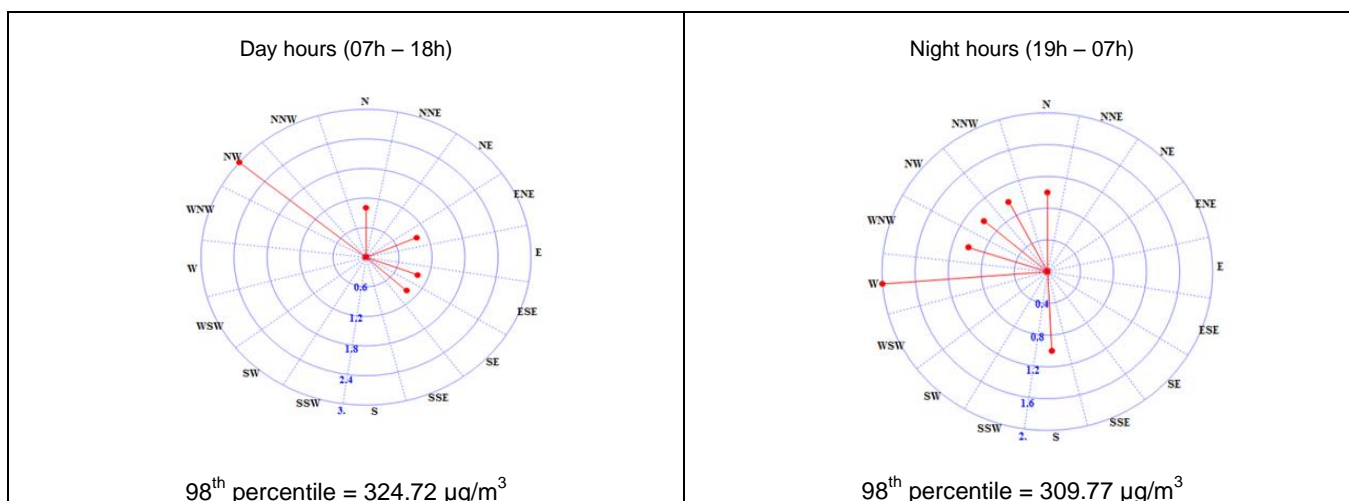


Figure 10: PM₁₀ hourly mean 98th percentile event roses during day and night times

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

Dir	N	NNE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
Eve	1	0	1	0	1	1	0	0	0	0	0	0	0	3	0
%	14.29	0	0	0	14.29	14.29	0	0	0	0	0	0	0	42.86	0

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	1	0	0	0	0	0	0	0	1	0	0	0	2	1	1	1
%	14.29	0	0	0	0	0	0	0	14.29	0	0	0	28.57	14.29	14.29	14.29

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 07:00 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 16:00 before decaying rapidly due to the lack of sunlight during the night-time period shown in Figure 11.

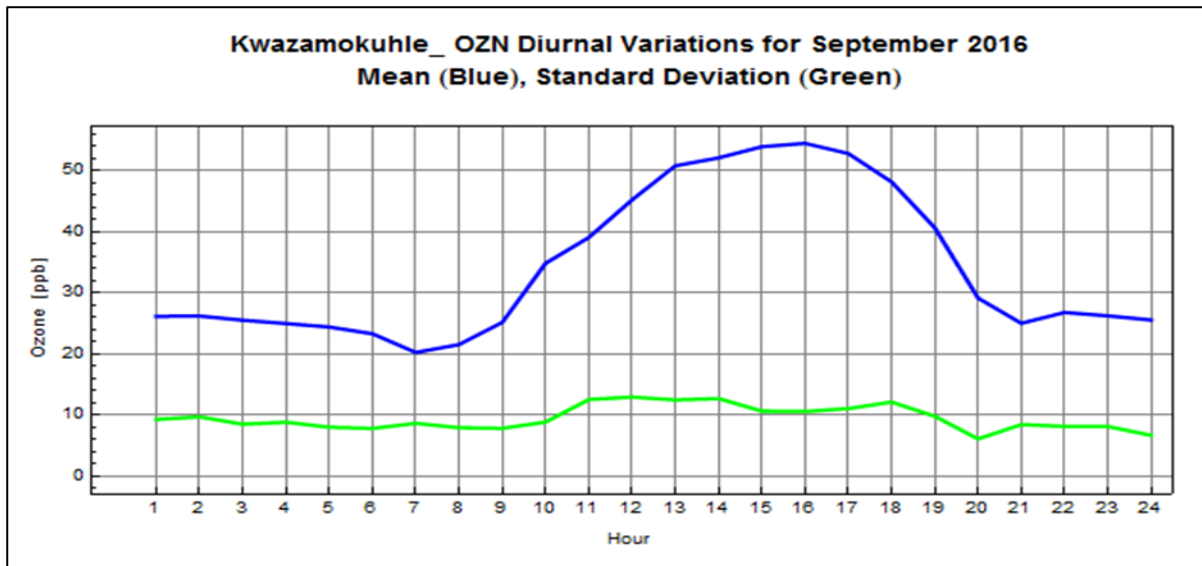


Figure 11: Diurnal variation of Ozone concentrations at KwaZamokuhle for September 2016

7. MONTHLY MEANS FOR THE CURRENT CALENDAR YEAR

7.1. TRENDS OVER THE REPORTING PERIOD (Jan 2015 –September 2016)

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 2015 (winter season) and low concentrations are also recorded from January – April 2016 (summer season) and May 2016 the winter season has started and we observe high concentrations 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 2015 and 2016 monitoring period (Figure 17).

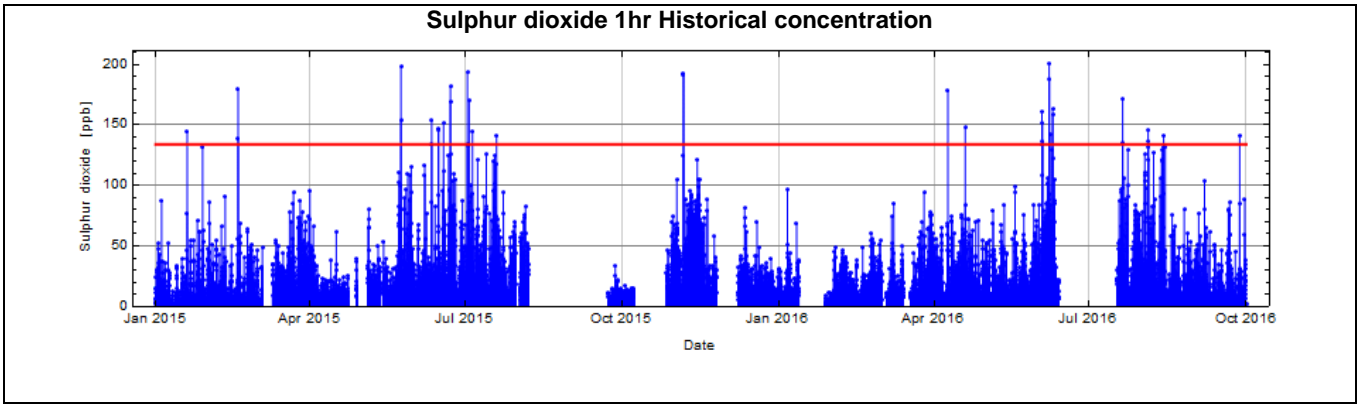


Figure 12: SO₂ 1hr mean concentration

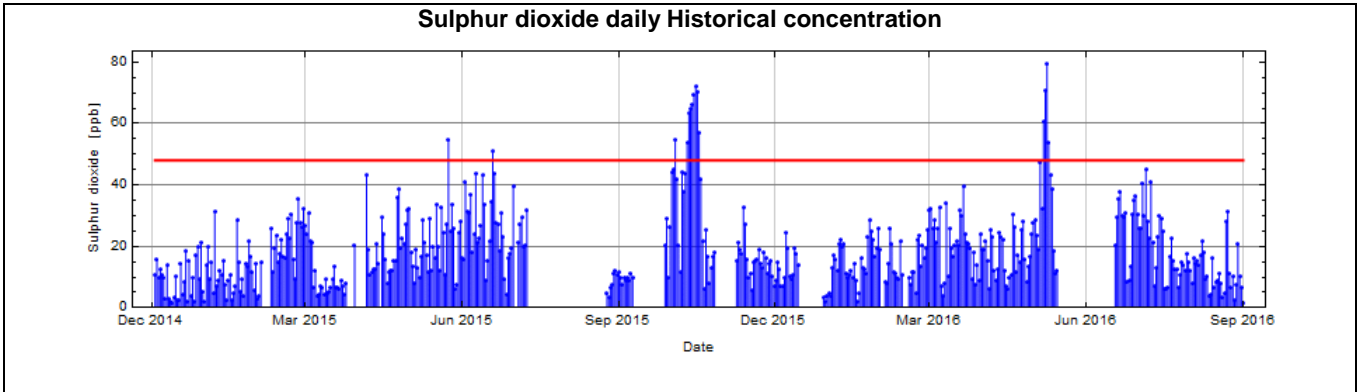


Figure 13: SO₂ daily monthly concentrations

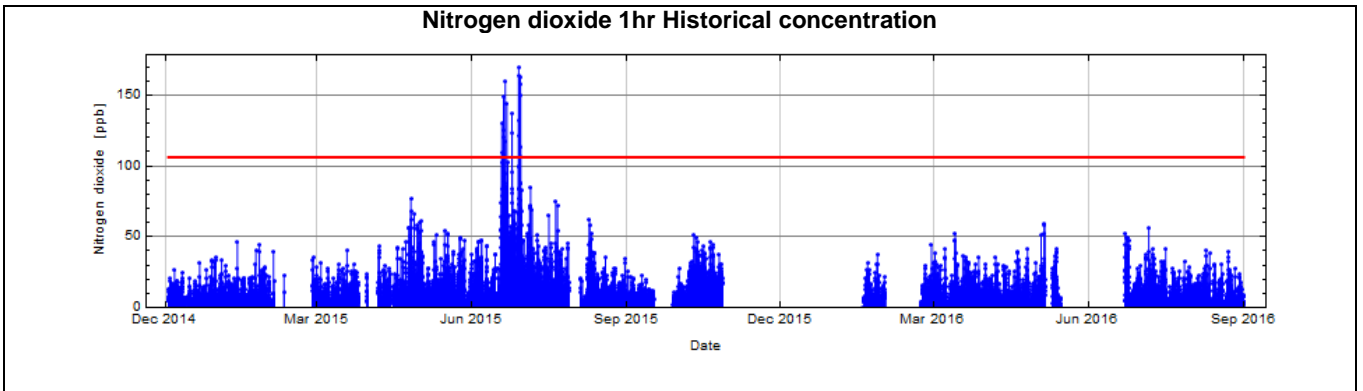


Figure 14: NO₂ 1hr monthly concentration

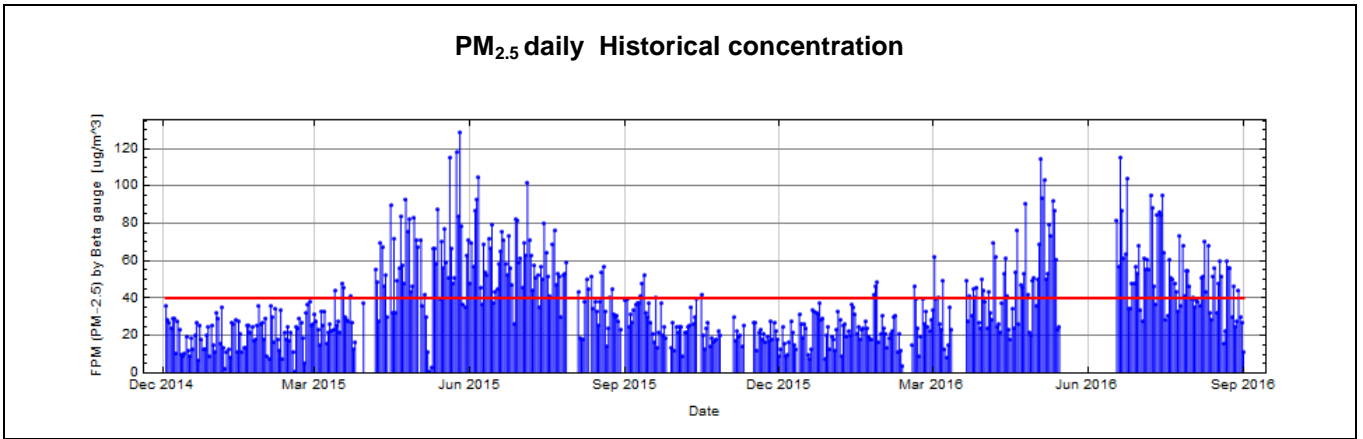


Figure 15: PM_{2.5} daily monthly concentration

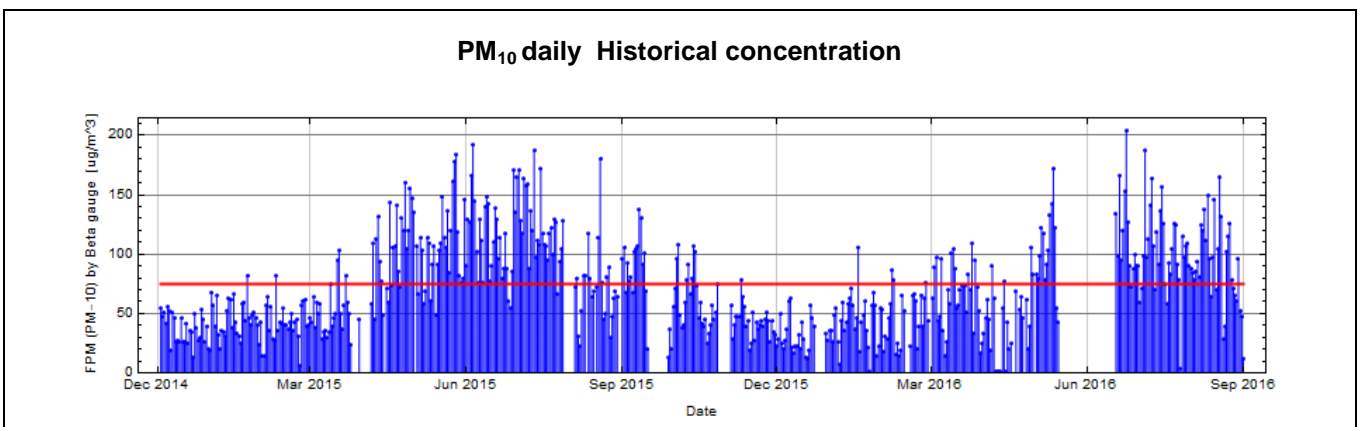


Figure 16: PM_{2.5} daily monthly concentrations

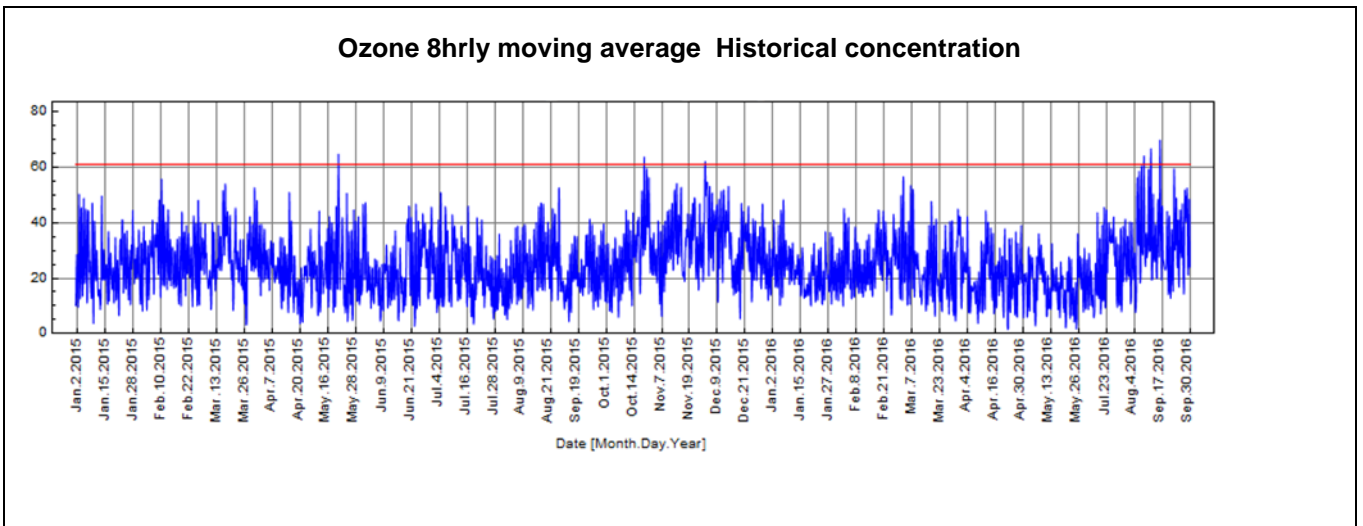


Figure 17: O₃ 8hrs moving average

Table 13: Monthly means for the calendar year 2016

Parameter measured	January	February	March	April	May	June	July	August	September
PM _{2.5} (µg/m ³)	21	25.2	25.5	32.6	41.6	72.4	63.9	56.7	42.1
PM ₁₀ (µg/m ³)	32.5	44.1	47.9	67	43	99.8	107.5	106.3	94.1
NO ₂ (ppb)	-	8.2	9.7	10.1	8.3	11.2	12.4	9.4	7.3
O ₃ (ppb)	22.4	25.5	23.5	20.3	17.2	18.7	37.5	22.9	34.3
SO ₂ (ppb)	10.9	13.7	16	20.6	17.3	39.7	38	19.2	12.1

The monthly means show the trends of the pollutant monitored at the site from January to September 2016.

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

	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 2016	0	0	0	0	0	0	0
Feb 2016	0	0	0	0	1	2	0
March 2016	0	0	0	0	3	2	0
April	2	3	0	0	9	8	0
May	0	0	0	0	5	16	0
June	18	21	9	0	25	27	3
July	6	9	6	0	26	26	81
August	3	8	0	0	26	24	0
September	1	1	0	0	21	15	13
Total	28	39	15	0	116	180	97
Allowed no of exceedances	88	526	4	88	4	4	11

There is non-compliance with SO₂ daily, PM₁₀ daily, PM_{2.5} daily and Ozone 8-hourly standards at KwaZamokuhle. This is a clear indication of a need for air quality improvement interventions that are focused on reducing particulate matter levels in the area.

8. CONCLUSION

There were twenty-one exceedances of the national ambient air quality for PM₁₀ daily limit of 75µg/m³ and fifteen of the PM_{2.5} daily limit of 40µg/m³ recorded. There was one exceedance of the national ambient air quality limits for SO₂ 10 minutes. The national ambient air quality for SO₂ hourly was exceeded once. The Ozone 8-hourly average was exceeded thirteen times. There were no exceedances of the national ambient air quality limits for SO₂ daily, and NO₂ hourly 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.

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9. DISTRIBUTION LIST

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Project Leader

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ABBREVIATIONS

µg/m ³	Microgram per cubic meter
DEA	Department of Environmental Affairs
deg	Degree
deg C	Degree Celsius
E	East
ENE	East-north-east
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