MOGALE CITY LOCAL MUNICIPALITY

DRAFT

BASELINE ASSESSMENT REPORT

March 2013

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Document Status and Review Schedule

Issue No.	Report No.	Date	Status	Reviewed by
1	1	11 March 2013	Draft	Michelle Simon
2				
3				

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GLOSSARY

AQA	Air Quality Act, (Act No. 39 of 2004)
AQO	Air Quality Officer
CBD	Central Business District
CO	Carbon Monoxide
CO_2	Carbon Dioxide
DEA	Department of Environmental Affairs (National)
DME	Department of Mineral and Energy Affairs
EIA	Environmental Impact Assessment
HFO	Heavy fuel oil
MCLM	Mogale City Local Municipality
NO_X	Nitrogen oxides, also referred to as oxides of nitrogen
NO_2	Nitrogen dioxide
NO	Nitrogen oxide
O_3	Ozone
PM_{10}	Particulate matter of aerodynamic diameter less than 10 µm
SANAS	South African National Accreditation System
SO_2	Sulphur dioxide
TEOM	Tapered Element Oscillating Membrane
VOCs	Volatile Organic Compounds
WHO	World Health Organisation
ZES	Zanokuhle Environmental Services

KEY DEFINITIONS

Air Quality Management Plan	means a plan referred to in section 15 of AQA
Ambient Air	Air in the environment, excluding indoor air.
Ambient air quality standards	values that define targets for air quality management and establish the permissible amount or concentration of a particular substance in or property of discharges to air based on what a particular receiving environment can tolerate without significant deterioration
Baseline air quality assessment	A compilation of existing or current data and knowledge on air quality in a particular area. It forms an essential input into the subsequent formulation of the AQMP. It comprises an assessment of the current ambient air quality status; an assessment of current organisational structures for air quality management; and an assessment of current air quality initiatives to reduce air pollution.
Emission	Pollution discharged into the atmosphere from a range of stationary and mobile sources. These include smokestacks, vents and surface areas of commercial or industrial facilities; residential sources; motor vehicles and other transport related sources.
Emission inventory	a listing or register of the amount of pollution entering the atmosphere from all sources within a given time and geographic boundaries
Exceedances	A situation in which a measured ambient air quality concentration (or emission rate) of a particular pollutant exceeds the ambient air quality guideline or standard (or emission limit) for that pollutant. Exceedances are normally expressed as a total number per time period and give an indication of the severity of the air pollution problem.
Mitigation measures	Efforts to attempt to prevent pollution or to reduce the effects of pollution that occur
Monitoring	Periodic or continuous surveillance or testing to determine the level of compliance with statutory requirements and/or pollutant levels in various media or in humans, plants, and animals.
Priority pollutant	Pollutants which, through ambient concentrations, bioaccumulation, deposition or in any other way, present a threat to health, well-being or the environment. Factors that may influence whether a pollutant is identified as such include: its toxicity; the volume of emissions; or the proximity of the emission relative to sensitive receptors. A list of priority pollutants is contained in Chapter 5.3.2 of the National Framework (2007), Table 23.

1. Introduction

This baseline assessment report is developed in preparation for the development of an Air Quality Management Plan (AQMP) for the Mogale City Local Municipality (MCLM). A baseline assessment is undertaken to understand the current status of air quality within an area and to assess the compliance with ambient air quality standards. The assessment is designed to also evaluate the current management tools within the municipality.

The assessment encompasses the identification of pollutants, pollutant sources and areas of concern based on measured / and existing knowledge of ambient air pollution concentrations within an area. The activities within an area would also influence the complexity of the baseline assessment.

A baseline assessment further provides the basis for planning the requirements of an Air Quality Management System (AQMS). For example:

- Areas where air quality monitoring, emission inventories and air quality assessment are not adequate.
- Cases when the baseline studies clearly reveal that air quality standards are violated.

This report comprises the following sections:

Section 1: Introduction – Provides a short introduction to the report.

Section 2: Area description and geography – Details the area under review and describes the geography.

Section 3: Meteorology and Climate Description – This section provides a summary of the meteorological conditions within the area.

Section 4: Evaluation of air quality information – Gives an analysis of the ambient air monitoring data and emission inventory currently available within the municipality.

Section 5: Evaluation of Current Management – An evaluation of the current management tools in place within the municipality.

2. Area description and geography

2.1 Introduction to Mogale City Local Municipality

Mogale City Local Municipality (MCLM) is a type B Local Municipality and is one of twelve Local Municipalities within the Gauteng Province. It is located in the western part of the Province bounded to the west by Rustenburg and to the north by the Local Municipality of Madibeng, both forming part of the North West Province.

West Rand and the City of Tshwane local municipalities occupies it north eastern boundary while the eastern section is bounded by the City of Johannesburg Local Municipality. The southern part of the municipality is bounded by the Randfontein Local Municipality and the south-south west boundary is occupied by Merafong City Local Municipality (Figure 1).

The surface area of the Local municipality is estimated at ± 110 000 ha (MCLM, 2003) forming part of the West Rand District Municipality (WRDM).

Land uses within the MCLM that boost the local economy include mining of minerals, quarrying of stone, the extraction of clay and sandpits, agriculture and various industrial activities.

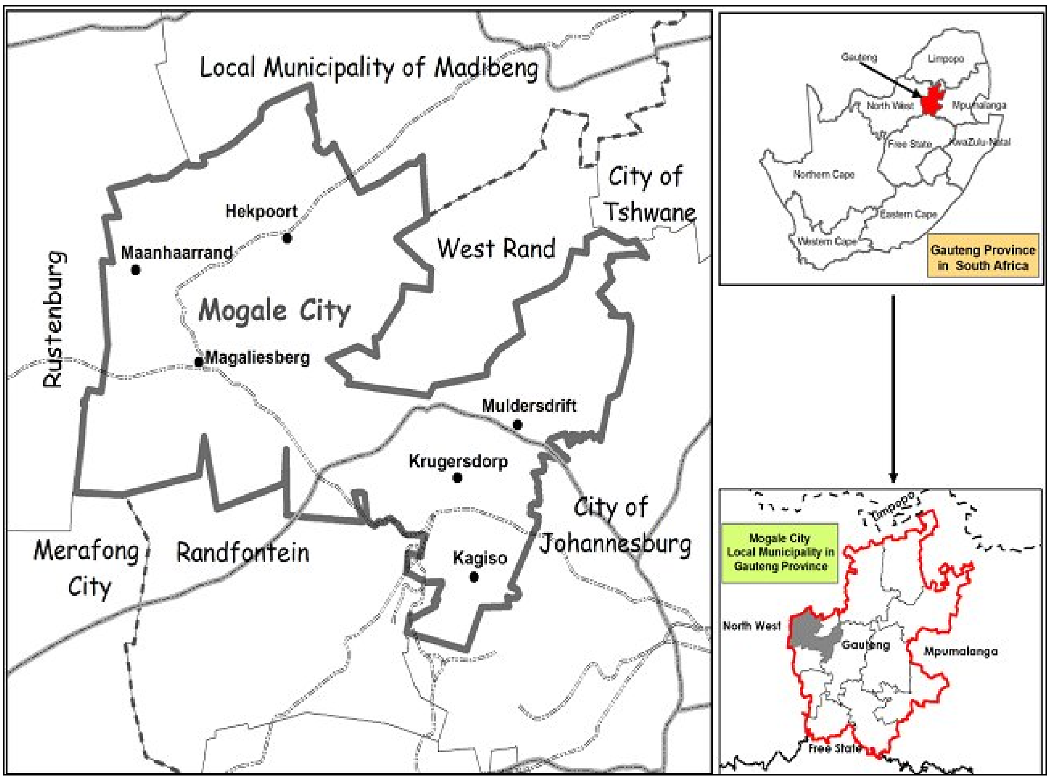


Figure 1: Mogale City Local Municipality within the context of South Africa
(Data source: University of KwaZulu-Natal).

2.2 *Topographical Setting*

2.2.1 *Physical Geography of the Local Municipality*

Topographical factors and meteorological conditions play a major role in influencing local air quality. The physical geography of the Municipality as related to air quality management can be divided into physiography and climate.

The municipality is characterized by an uneven terrain with its lowest point situated 1220 m above sea level to the north-east of the Mogalies plain and the highest point (1840 m) on a mountain range along its northern borders (Figure 2).

Apart from Hekproot and Maanhaarand both located on relatively low ground to the north and north-west of the municipality, other towns such as Mogalisberg, Krugersdorp, Muldersdrift and Kagiso are located on higher elevations. Depending on the dominant wind direction (Section 3), sources of air pollutants, season and the spatial distribution of population, this physiographic structure will impact on the local distribution of pollutants and their effects on the population especially those at lower elevations.

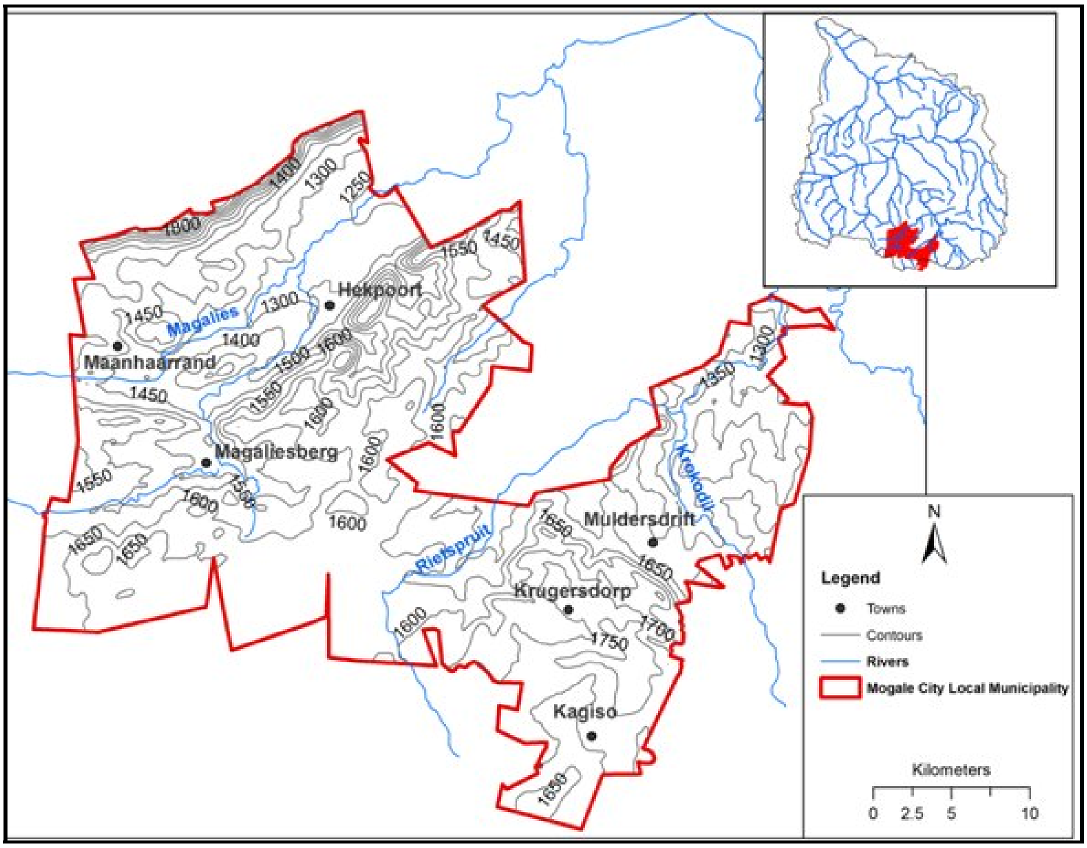


Figure 2 : The Topography of Mogale City Local Municipality (Data source: University of KwaZulu-Natal).

Apart from this topography that is directly related to air quality management, the Municipality is straddled by three quaternary catchments occupied by three major perennial rivers that run through the municipality.

The Megalies River runs across the western half, Rietspruit in the middle and Crocodile River in the east. The first two rivers are tributaries to the Crocodile and all three forming part of the Crocodile River catchment. A representation of the physiographic structure of the municipality presented in Figure 3 is an elevation model showing the occurrence of valleys and higher elevations.

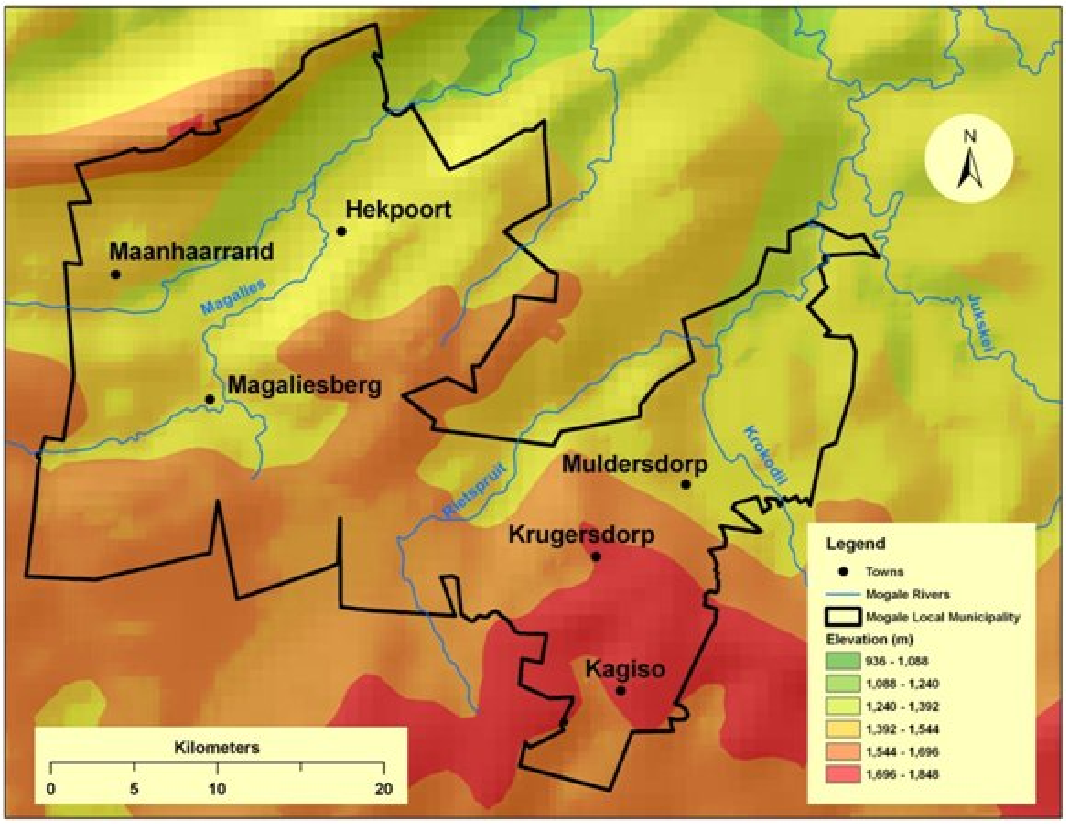


Figure 3: An elevation model of Mogale City Local Municipality (Data source: University of KwaZulu-Natal).

2.3 Population data

The collection of population distribution data serves as an input to the emission inventory and to the air pollution exposure estimates. The Geographical presentation of area-distributed population statistics as well as consumption of fossil fuels and direct emissions gives a good overview of where to expect elevated air pollution impacts.

2.3.1 *Population distribution*

The total population of Mogale City Local Municipality is estimated at 289,834 (Statistics South Africa, 2001) comprising 76% African, 0.7% Coloured, 2.2% Indian and 21.1% White. The highest population density ranging between 11548.21 and 20529.39 persons per km^2 is found in the east near Kagiso (Figure 4).

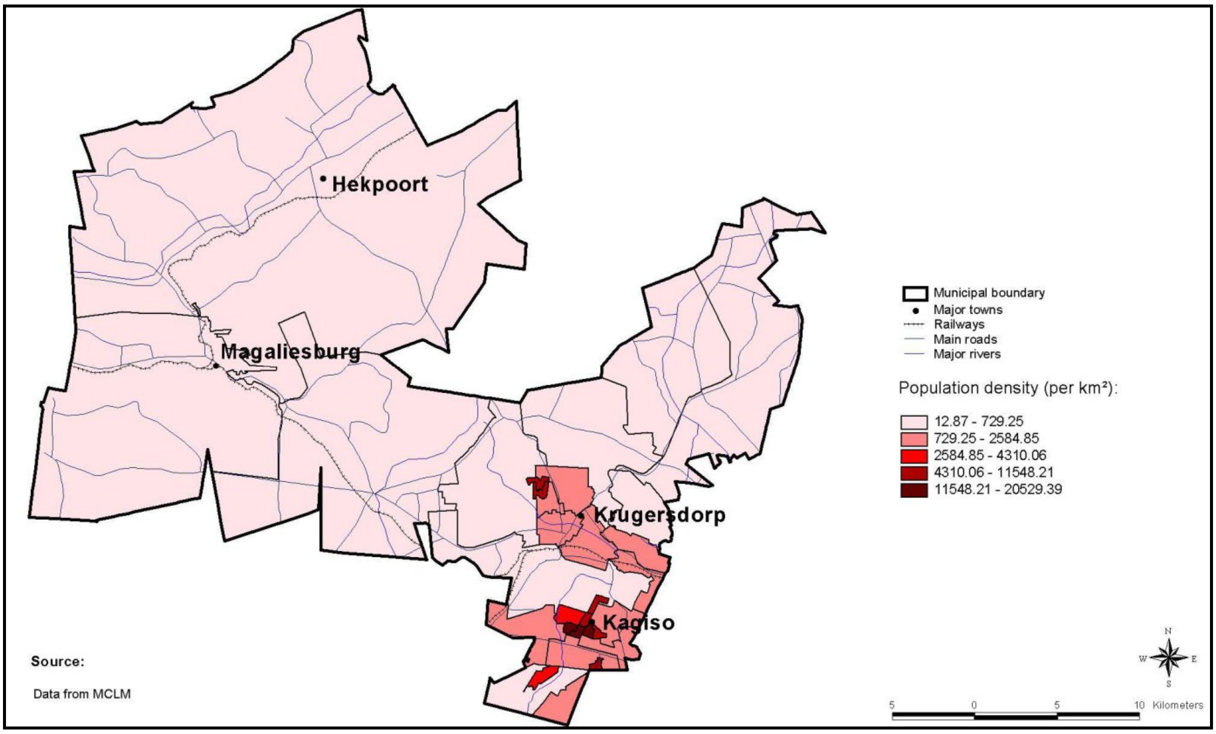


Figure 4 : Population density of Mogale City Municipality (Source: MCLM, 2003).

The majority of the industries (industrial area category 1) within the municipality are located approximately to the north of densely populated areas such as around Kagiso in the east (Figure 5). This poses a threat of air pollution impacts on the population located to the south especially the first two months of summer and in spring when the prevailing winds are NNW and northerly (Appendix A).

Even though a category 2 industrial area (MCLM,2003) is located further to the NW and SW of the densely populated areas, these industries lie close to the path of winds blowing NNW, WSW and SW having the potential to carry air pollutants to the populated area around Kagiso.

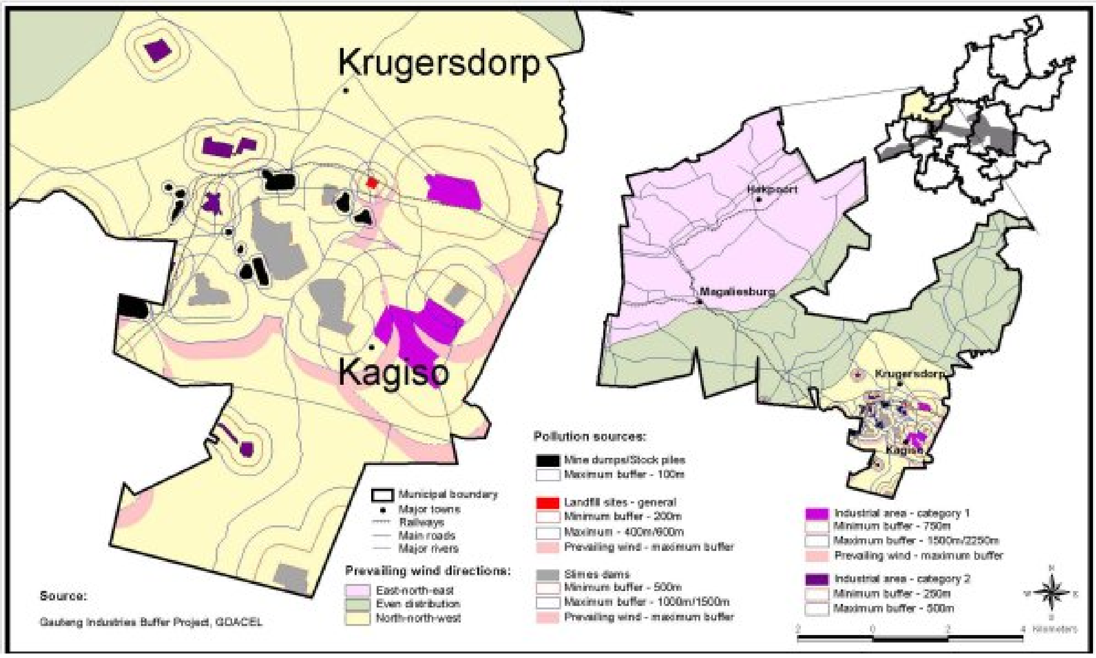


Figure 5 : Pollution sources within the Mogale City Local Municipality (Source: MCLM, 2003).

Despite this potential vulnerability, the topography of the municipality plays a role in moderating the effect of air pollution on the population. Densely populated areas within the municipality are located at high elevations where there is the probability that this location prevents air pollutants from adjacent industries at lower elevations reaching the populated areas.

During winter, a common phenomenon in most hilly/mountainous areas is temperature inversion. The location of some urban populated areas in the east of the municipality exposes them to this possibility. In the event of a temperature inversion, there is the likelihood of trapped pollutants impacting on the population in the area affected.

3. Meteorology and Climate Description

3.1 *Introduction*

A brief overview of the synoptic influences over southern Africa is provided in Section 3.2. This in turn controls meteorological conditions and air pollution dispersion experienced locally within the Mogale City Local Municipality (MCLM).

The meteorological overview specific to the MCLM presented here was compiled using data provided by the South African Weather Service (SAWS). Data was supplied from the Johannesburg Botanical Gardens SAWS automated meteorological weather station, selected to represent conditions of the local municipality.

There was no automated SAWS meteorological station within the MCLM and therefore data was sourced from the Johannesburg Botanical Gardens weather station which is the closest SAWS meteorological station. The average, minimum and maximum ambient temperature and total monthly rainfall (mm) data was sourced from the Krugersdorp automated meteorological station.

In addition to the above, data was received from the MCLM ambient air quality monitoring station for a period of three months (August to October 2010). This data is presented in figures 8 and 9 of this report.

3.2 *Synoptic meteorology*

Southern Africa is situated in the subtropical high pressure belt and as such the meteorology is controlled by several high pressure cells interrupted by westerly wave and tropical easterly perturbations. Three high pressure cells (anticyclones) dominate, viz. the south Atlantic anticyclone, the south Indian anticyclone and the Continental anticyclone over the interior.

In winter the high pressure belt intensifies and moves northward, but is interrupted by a series of cold fronts associated with westerly perturbations that move west to east across the southern part of the country (Figure 6). The cold fronts are accompanied by clouds and sometimes rain and are associated with decreases in temperature and wind shifts from northerly prior to the front, followed by westerly winds.

However, during the winter months, the interior is dominated by high pressure with a maximum frequency of occurrence of 79% in June and July (Tyson, 1988). During summer, the high pressure belt weakens and is only present some 11% of the time and the systems shift southwards allowing tropical easterly perturbations to influence the climate. The easterly waves and lows occur almost exclusively during the summer months, and are responsible for the summer rainfall and northerly component winds that flow over the interior.

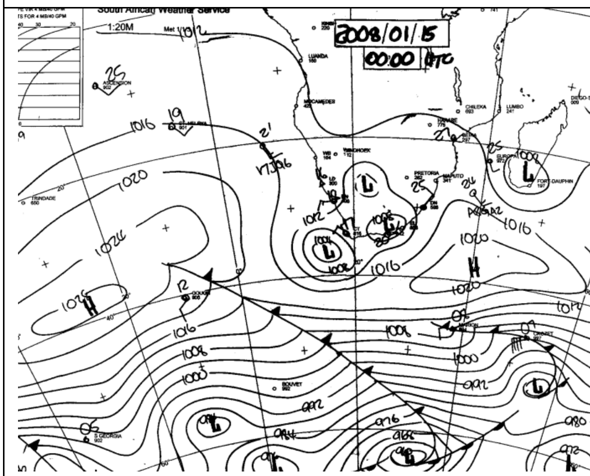
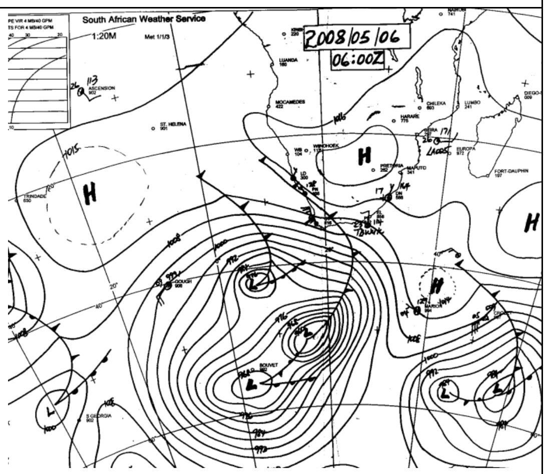
Summer	Winter
	

Figure 6: *Examples of summer and winter synoptic patterns over southern Africa*

The Municipality is characterized by a pleasant sunny climate where summer day temperatures range between 20 and 30^0 C and moderate rainfall usually of short duration. The winters are dry with night time temperatures between 2 and 5^0 C" (MCLM, 2003). Total annual rainfall for the municipality is approximately 736 mm (1961-1990) with an annual average of ~61 mm (SAWS). The seasonal distribution varies, much of which falls in summer.

Sections 3.3 to 3.4 below highlights the wind, rainfall and temperature patterns associated with the municipality.

3.3 Wind

The motion of air plays a major role in determining the distribution of emissions in the atmosphere. Wind direction (WD) and wind speed (WS) are very useful in diluting and rapidly dispersing air pollutants. Wind speed determines the distance a pollutant can be transported downwind and the rate of dilution and can influence the turbulence and hence uplift, or stability and mixing. The calmer the winds, the poorer the dispersion potential. Conversely, higher wind speeds will lead to improved dispersion. The wind direction determines the general path of pollutants and area of impact of a pollutant source. It is also important to consider that surface winds are influenced by topography.

Historic data on wind movement for the municipality is not available; however data for the closest meteorological station in the adjacent City of Johannesburg provides a good source of information for the area. The average annual wind rose (between 2007 and 2012) for the representative meteorological station is provided in Figure 7 with monthly wind roses, which give an indication of the seasonal variation in the wind field, are shown in Appendix A. Wind roses show the predominant direction from which the wind blows and are reflected according to compass point direction and wind speed categories, which for the purposes of this report are as follows:

Yellow: 0.5 – 2.5 m/s

Pink: 2.5 – 3.5 m/s

Red: 3.5 – 5.6 m/s

Turquoise: 5.6 – 8.7 m/s

Green: 8.7 – 10.7 m/s

Blue: > 10.7 m/s

The average annual wind movement recorded at the Johannesburg Botanical Gardens meteorological station reveals that the dominant wind direction between 2007 and 2012 was NNW (SAWS) with the strongest winds (2.5 – 5.6 m/s) blowing from the east (Figure 7). This information is comparable with MCLM (2003) which confirms NNW as the dominant wind direction in the southern part of the municipality especially around Krugersdorp and Kagiso.

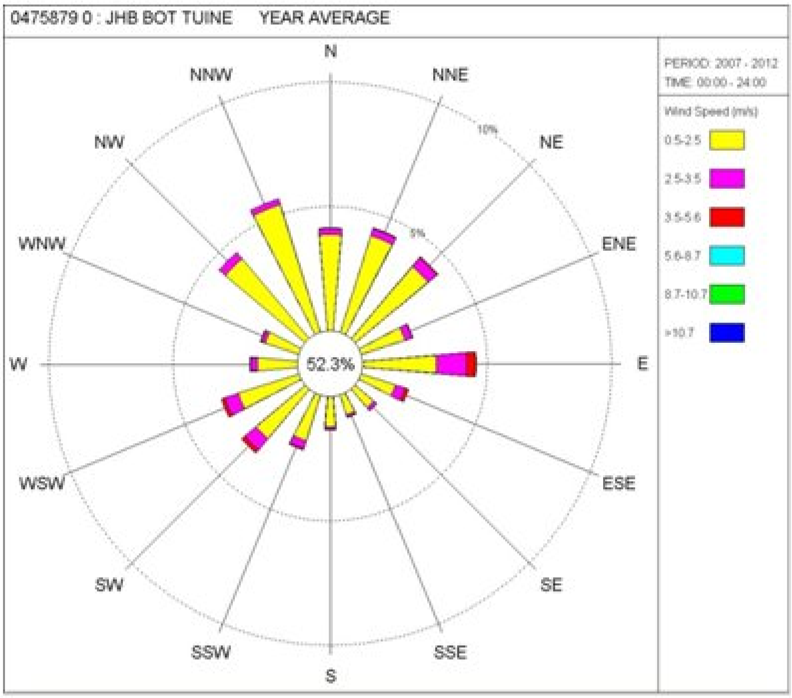


Figure 7 : Average annual wind speed and direction at Johannesburg between 2007 and 2012 (*SAWS)*

Seasonally, the average wind direction and wind speed within the period 2007 to 2012 show a pattern (Appendix A). During the summer months of November and December, the winds are predominantly northerly and become easterly in January. During this period, the winds are stronger from the north (November) but switches to the east when they are stronger in December and January.

In the first two months of Autumn (February and March), both the dominant wind direction and the strongest winds come from the east. The situation changes in April when the dominant wind direction is north-westerly while the strongest winds remain easterly.

During the winter months of May, June and July, the dominant wind movement is from the WSW and SW. In spring however, the dominant wind direction switches to NNW with the strongest winds remaining WSW/SW and then shifting northerly between NNW and NE (Appendix A).

Figures 8 and 9 below represent data from the MCLM ambient air quality monitoring network between August and October 2010. Figure 8 highlights that the predominant winds were northerly with important winds from north westerly. Figure 9 presents the wind speed at a maximum speed of 11.5 m/s.

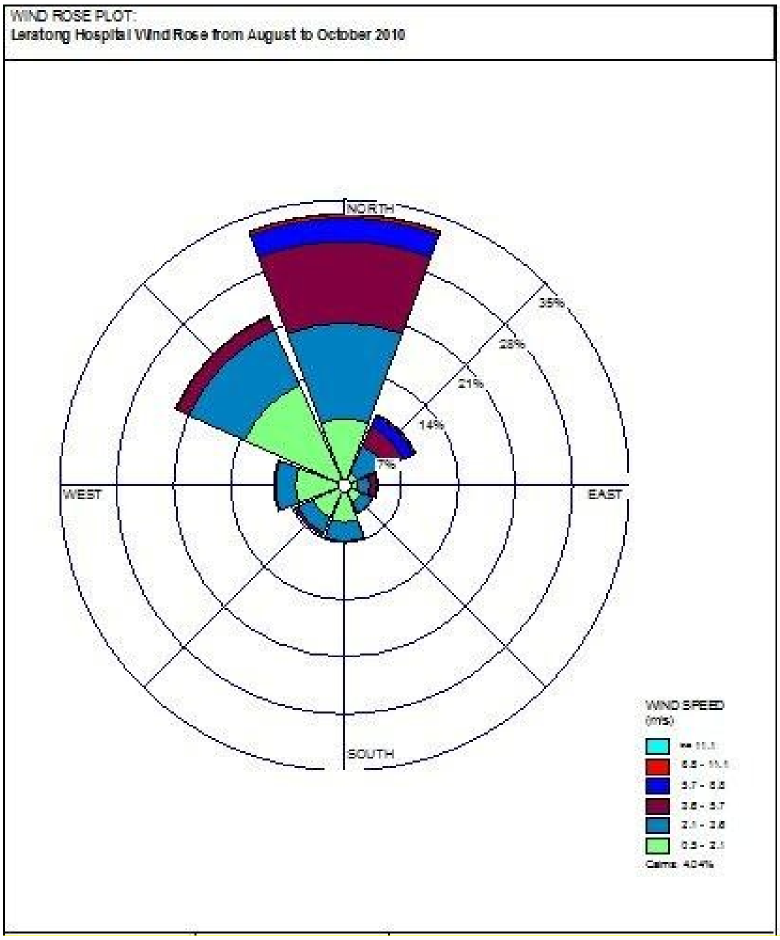


Figure 8 : *Wind frequency from MCLM Monitoring Station – August to October 2010*

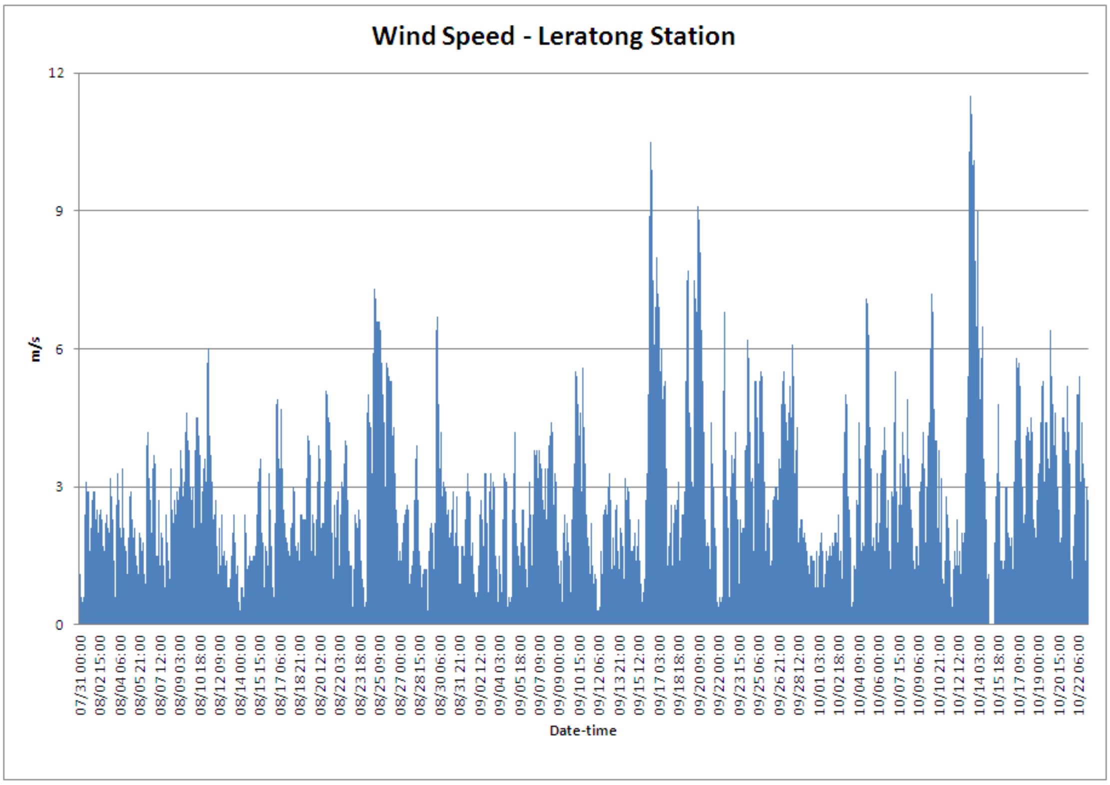


Figure 9 : *Wind speed from MCLM Monitoring Station – August to October 2010*

3.4 Rainfall and Temperature

Rain is useful for flushing air pollutants from the air such as soluble pollutant gases and particles from the air. It is also believed that air pollution has effects on rainfall patterns.

The monthly maximum average rainfall for the past 29 years from the Krugersdorp automated station is presented in Figure 10. The highest monthly maximum was 440 mm recorded in 1978.

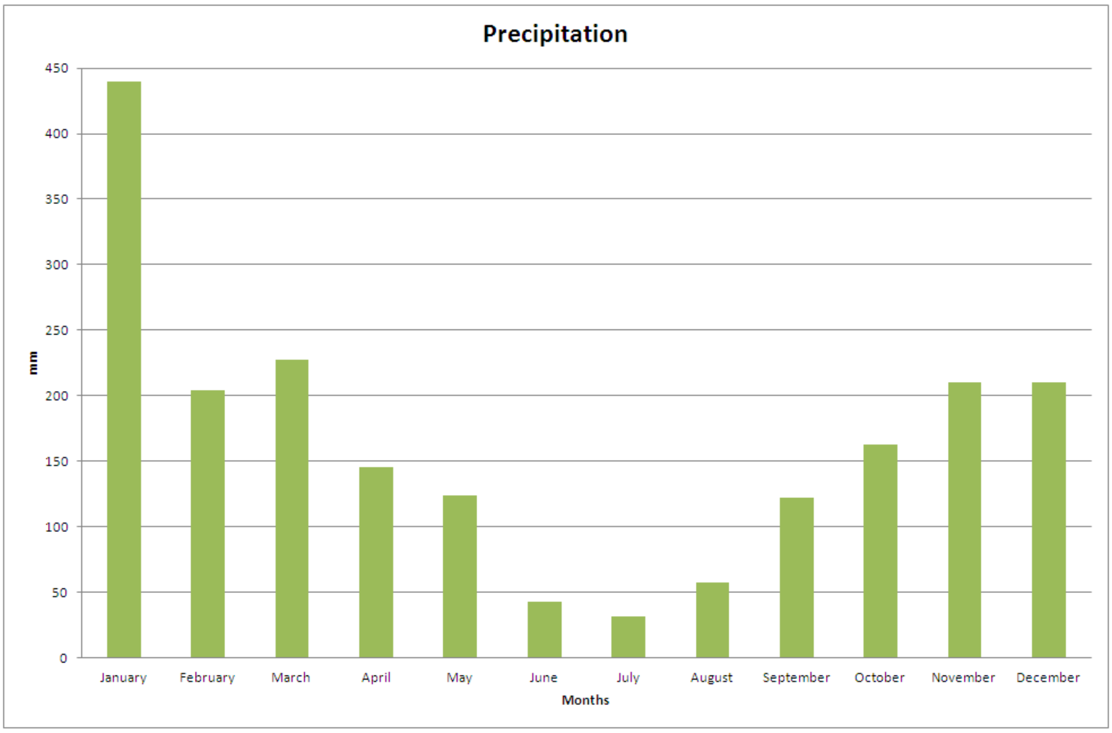


Figure 10: *MLCM past 29 years (Source: SAWS)*

The ambient temperature is useful in determining the atmospheric stability and in understanding the spatial distribution of pollutants while rainfall data provides an understanding of the ability to "flush" air pollutants.

Figure 11 below highlights the monthly ambient air temperatures experienced at the Krugersdorp SAWS automated meteorological station for the past 29 years. The graph shows a typical temperature profile with higher temperatures being experienced between the months of October to March. The highest maximum temperature of 36.1^{0}C was measured in January 1973.

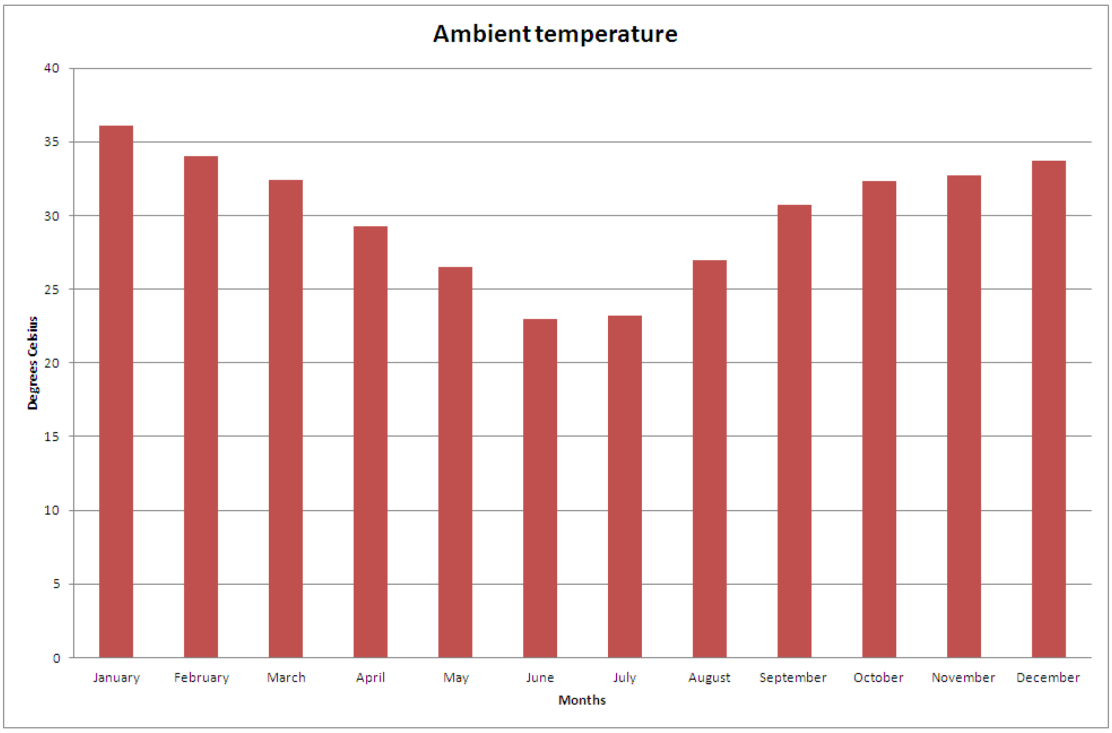


Figure 11 : *Ambient temperature for past 29 years (Source: SAWS)*

4. Evaluation of air quality information

4.1 Overview of existing ambient air quality monitoring

An evaluation of the air quality situation in an area using existing data provides an understanding of the population exposure to air pollutants based on comparisons against air quality standards. This would provide further baseline information for control actions, identification of the impact caused by specific sources, and implementation of emission reduction programs.

The National Framework highlights in Table 24 that the West Rand District Municipality (of which MCLM forms a part) is classified as a "potentially poor" air quality area meaning that the air quality may be poor at times or deteriorating. This in essence means that the municipality is required to undertake a detailed AMQP.

This section of the report presents an understanding of the current data and information available on air quality and the management of air quality within the MCLM.

4.2 Air Quality Standards

The South African ambient air quality standards are presented in Table 4 as per 24 December 2009 Government Gazette No. 32816. These standards are taken into account during the interpretation of the available measured data which is presented in Section 4.4.

Table 1: *South African Air Quality Standards*

Pollutant	Averaging Period	Limit Value ($\mu g/m^3$)	Limit Value (ppb)
Sulphur dioxide (SO_2)	10 minutes	500	191
	1-hour	350	134
	24-hour	125	48
	Annual average	50	19
Nitrogen dioxide (NO_2)	1-hour	200	106
	Annual average	40	21
Carbon monoxide (CO)	1-hour	30	26 000 (26 ppm)
	8-hour	10	8 700 (8.7 ppm)
Ozone	8-hours (running)	120	61
Particulate Matter (PM_{10})	24-hour	120	-
	Annual average	50	-
Benzene	Annual average	10	3.2

4.3 Ambient air monitoring

Ambient air quality monitoring currently being undertaken within the Mogale City Local Municipality (MCLM) is limited. A continuous ambient air quality monitoring station was established and donated by the GDACE (GDARD) in 2005 but only commissioned in 2006. The location of the station, equipment used and parameters measured are detailed in table 2 below:

Table 2: *Stations and measured parameters*

Station name & location	Monitoring equipment	Measured parameters
Leratong (Leratong Hospital)	Teledyne –API analysers for gaseous components, TEOM for PM_{10} and RM Young for meteorological parameters.	SO_2, O_3, NOx, CO and PM_{10} Wind speed, wind direction, humidity, barometric pressure, solar radiation and ambient temperature

The monitoring station is situated close to two main roads, Adcock Street and R41 with a taxi rank to the south. The impact of vehicle emissions is evidenced by the elevated PM_{10} and NO_2 readings. The Factoria and Chamdor industrial areas are situated to the north-west of the station.

The data presented below is only for a four month period measured between August and December 2010. Data set for 2007 supplied by MCLM failed quality control checks. The rest of the data from the time of site commissioning was not available to this project.

Of the measured parameters detailed in table 2, the oxides of nitrogen and carbon monoxide analysers were out of commission due to technical difficulties. The data was analysed for trend purposes but is not presented in this report.

The data is presented in Sections 4.3.1 and 4.3.2 below.

4.3.1 *Particulate Matter*

The PM_{10} data presented in Figure 12 are maximum daily averages from 01 August to 31 December 2010.

The South African National Ambient Air Quality Standard Limit Value of 120µg/m³ has been applied in interpretation of the data. The standard was exceeded twice in September and again in October.

The most likely contributors of the particulates are diesel vehicles from two main roads, unpaved road side, tyre burning and biomass burning.

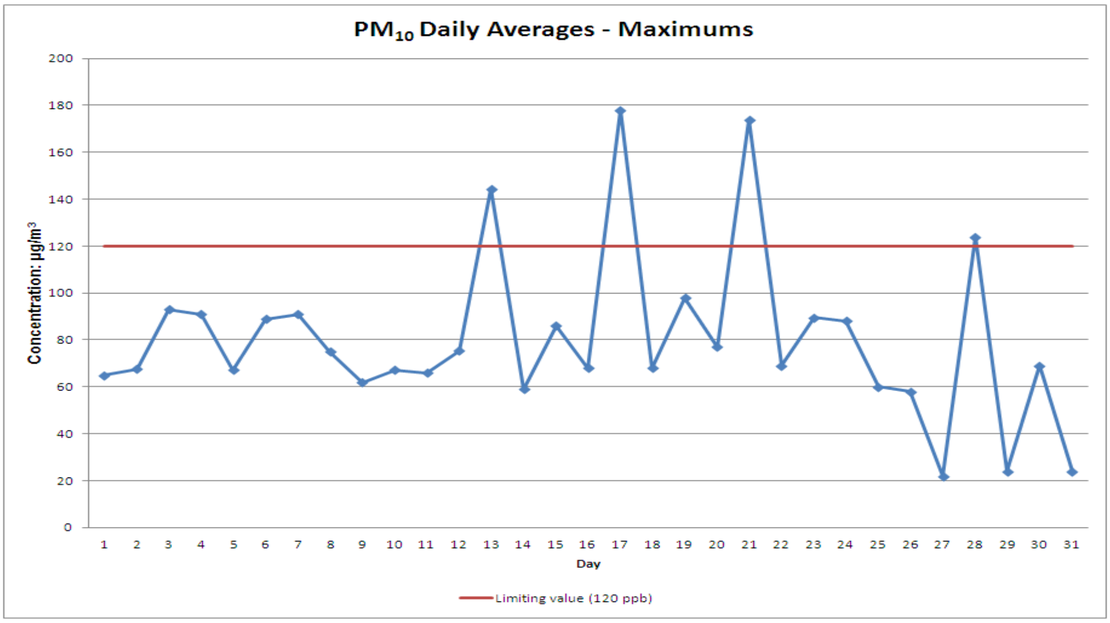


Figure 12: PM_{10} concentrations – Leratong Station: 01 August – 31 Dec 2010 daily maximum averages

Month	August	September	October	November	December
Maximum	98	178	145	86	31
Exceedance	-	2	2	-	-

4.3.2 *Ozone*

The Ozone (O_3) data from 01 August to 31 October 2010 is presented in Figure 13 below. The South African ambient air quality standard of 61 ppb (8-hour (running)) was not exceeded during this period. The monthly maximum (8-hour average) of 60 ppb was recorded in September 2010.

Ozone is the secondary pollutant associated with NOx and volatile organic compound.

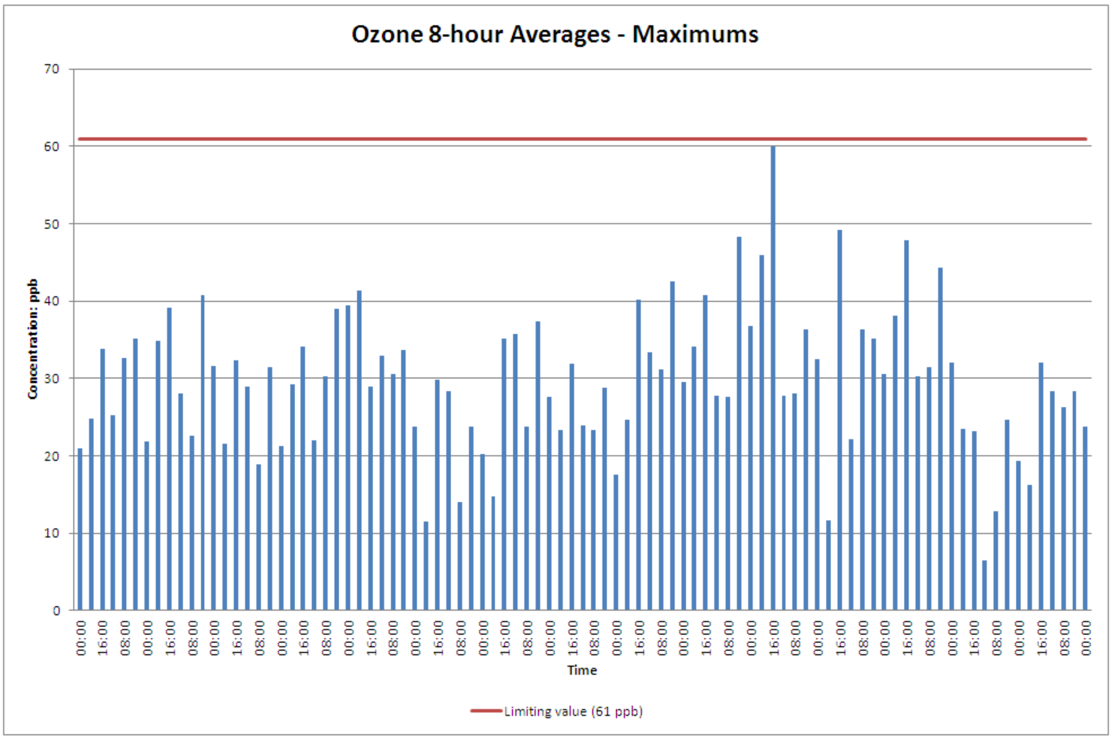


Figure 13: *O_3 concentrations – Leratong Station: 01 August 2010 – 31 October 2010*

Month	August	September	October
Maximum	41	60	41
Exceedance	0	0	0

4.3.3 *Sulphur dioxide*

The sulphur dioxide data presented below highlights the maximum daily averages recorded per month. There were no exceedances of the South African ambient air quality standard of 48 ppb recorded during August, September, and November 2010.

Ambient SO2 results largely from stationary sources such as coal and oil combustion, vehicles, domestic fuel burning and fires.

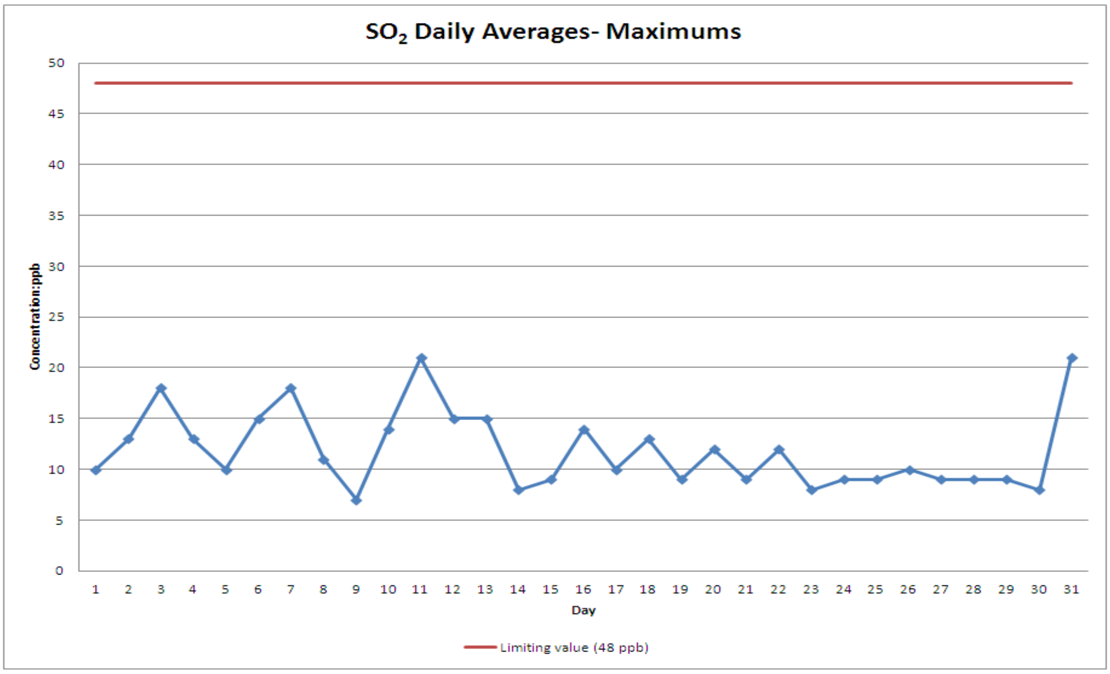


Figure 14: *SO_2 concentrations – Leratong Station: 01 August 2010 – 30 November 2010*

Month	August	September	October	November
Maximum	21	18	9	9
Exceedance	0	0	0	0

4.3.4 *Quality Assurance/ Quality Control of Air Quality Data*

The quality assurance/ quality control of the data is important to verify that the data reported is accurate and of a low uncertainty. Data collected from air quality monitoring stations is deemed reliable if there is a documented quality management system or quality control processes are shown to be in place. At present the MCLM ambient air monitoring quality control/assurance system has not been documented or developed. However the following routine maintenance was carried out on the instruments by a contracted service provider to ensure data validity:

- All analysers were checked twice per month as follows:
  - Any alarms which affect performance. These alarms are recorded electronically as well as manually on instrument data sheets.
  - Operational aspects were recorded and entered on the instrument log sheets.
  - Checked all particulate filters and replaced where necessary.
  - Conducted zero and span checks on each instrument. The starting and completion times recorded on each instrument checksheet for data validation purposes.
  - Carbon and Purafil filters were replaced on a three monthly basis.
  - All internal pumps on the analysers were reconditioned on an annual basis or as and when necessary.
- The Tapered Element Oscillating Membrane (TEOM), PM_{10} analyser's filter was replaced when it had reached 90% usage as indicated by the analyser diagnostics. The other in line filters were replaced when the volume of air is reduced to below its operational flow rate. The water capturing jar was checked during routine site visits and emptied as and when moisture was evidenced.
- If a problem was encountered and could not be attended by the field technician then the supplier was contacted for guidance. If the problem was still not addressed then the instrument would be sent to the supplier for repairs.
- Leratong station was plagued with constant power failures which resulted in equipment damages. This was the cause of low data capture at the site.
- The TEOM was also unable to start up after power failures. The operating software had to be reloaded to rectify the problem.
- The SANAS TR07-03 document, The SUPPLEMENTARY REQUIREMENTS FOR THE ACCREDITATION OF CONTINUOUS AMBIENT AIR QUALITY MONITORING STATIONS, all

analysers have to be calibrated on a quarterly basis. This was not the case at the Leratong station before July 2010. There was no calibration schedule in place.

The data reported in this report for the very short period was after the instruments including the meteorological equipment were calibrated and operated within a reasonable quality assurance programme.

It must be noted that even though data for this short time period has been reported above, no real and long term conclusions can be drawn on air pollution in the area and is presented here for information purposes only at this stage. Data for a period of at least one year would be required in order to understand the seasonal trends and provide an overview of the air pollution within the Leratong precinct.

4.4 Emission inventory

4.4.1 *Introduction*

An emission inventory is a listing of all sources of air pollution within a defined region for a specified period of time, and is an essential tool for air quality planning. It provides information on the types of emission sources in a region, their location and the quantity of air pollution emitted, for a given period.

The development of a complete emission inventory is an important step in an air quality management planning process. An emission inventory involves estimating and compiling a directory of emissions activities from different point, area and mobile sources in an area. Emission inventories are an important tool for the management of air quality and can be used to:

- establish emission trends over time
- support air quality modelling;
- support health assessments;
- estimate future emissions based on projected likely changes in socio-economic indices and setting of targets
- determine significant sources of air pollutants
- analyze emission control costs
- planning of policy and measures and target regulatory actions and
- develop possible control strategies.

In the case of the MCLM emission inventory, the focus was on point sources from specified areas. Point sources include major industrial facilities such as chemical plants, steel mills, oil refineries, power plants, and hazardous waste incinerators. Two inventories were compiled, one by the MCLM and one by the West Rand DM.

There are less than thirty of such facilities in the MCLM targeted areas and only fifteen of the industries responded to the questionnaire distributed to assist in compiling the inventory.

The West Rand District Municipality on the other hand covered all sources such as point, non point and vehicle emissions within Mogale City in their emission inventory.

The results for both studies are presented in Section 4 below.

4.4.2 *Typical sources*

Typical sources of emissions are defined as point, non point and mobile.

Point sources are defined as a single identifiable source with high stacks and high emission loads and a fixed location of atmospheric emissions. Point sources include major industrial facilities like chemical plants, steel mills, oil refineries, power plants, and hazardous waste incinerators

Mobile sources include on-road and off-road sources. On-road include cars and light trucks, heavy trucks and buses, off-road recreational vehicles (such as dirt bikes and snowmobiles), farm and construction machines, lawn and garden equipment, marine engines, aircraft, and locomotives.

Non-point source emissions means a source of atmospheric emissions which cannot be identified as having emanated from a single identifiable source or fixed location, and includes veld, forest and open fires, mining activities, agricultural activities and stockpiles. They are often more difficult to control than point source pollution.

Table 3 below provides a list of emission sources and relevant pollutants within the study area.

Table 3: Emission sources and pollutants

Source	SO_2	NO_X	PM	CO	CO_2	CH_4	VOCs
Industrial (incl mining)	x	x	x	x	x	x	x
Agriculture			x				
Biomass burning	x	x	x	x	x	x	x
Traffic emissions	x	x	x	x	x	x	x
Landfill sites	x				x	x	x
Tailings dams			x				
Domestic Fuel Burning	x	x	x	x	x	x	x
Waste (Incineration, Landfills and Sewage)	x	x	x	x	x	x	x
Petrol Stations	x	x		x	x		x

4.4.3 *Results*

Mogale City like all urban municipalities has a cocktail of sources of atmospheric emissions. According to the WRDM emission inventory report, Mogale City is the highest industrial emission contributor in the area (2012).

The industrial areas within the MCLM include Chamdor; Delporton; Factoria; Boltonia; Tarlton; Magaliesburg, Krugersdorp and Hekpoort.

In late 2011, the municipality embarked on the development of an emission inventory focusing on Chamdor due to budget constraints. Of the 120 industries approached to provide information regarding atmospheric emissions of pollutants, 46% responded adequately including information received from the WRDM AEL section.

The WRDM was also in the process of developing a full emission inventory base in 2011. Table 4 below illustrates the sources included in the inventory with the relevant emission rates and total emission pollutants.

Table 4: emission rates and sources (source: WRDM 2012)

Source	**SO_2 (kg/yr)**	**NOx (kg/yr)**	**CO (kg/yr)**	**PM_{10} (kg/yr)**	**Benzene (kg/yr)**	**Lead (kg/yr)**	**VOCs (kg/yr)**
Industries	1135475	893714	140043164	799208	229	11031	4571
Vehicles	52311	1945205	9956458	12444		3	1086747
Domestic fuel burning	31609	3864	285016	6842	96		8696
Biomass burning		1327802	46647766	3962439			8001752
Tailings dams				1797629			
Total emissions	**1219395**	**4170585**	**196932404**	**6578562**	**325**	**11034**	**9101766**

As per Table 4 above and Figure 15, the highest emissions in the area are carbon monoxide from industrial activities followed by volatile organic compounds from biomass burning. This is closely followed by particulate matter emissions from biomass burning and then by oxides nitrogen from vehicles and sulphur dioxide from industrial activities. Lead and benzene are very minimal.

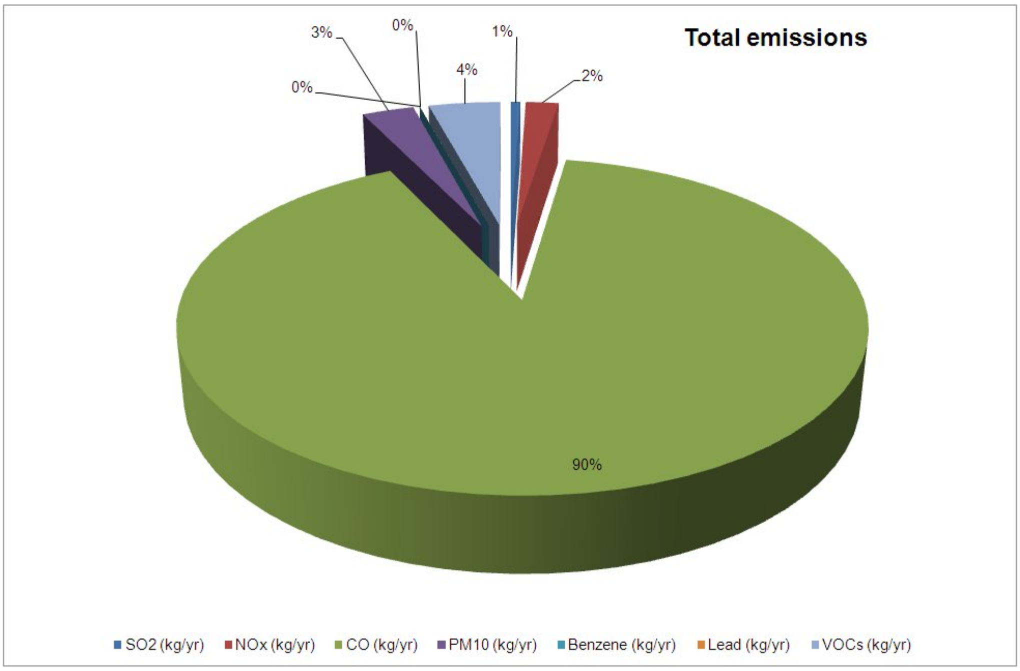


Figure 15 : Total emissions in MCLM (Source: WRDM, 2012).

The breakdown distribution of each of the pollutants is presented in figures below.

Sulphur dioxide

Ninety three percent (93%) of the sulphur dioxide emissions is due to industrial activities in the area while 4% and 3% of the sulphur dioxide emissions are contributed by vehicles and domestic burning respectively.

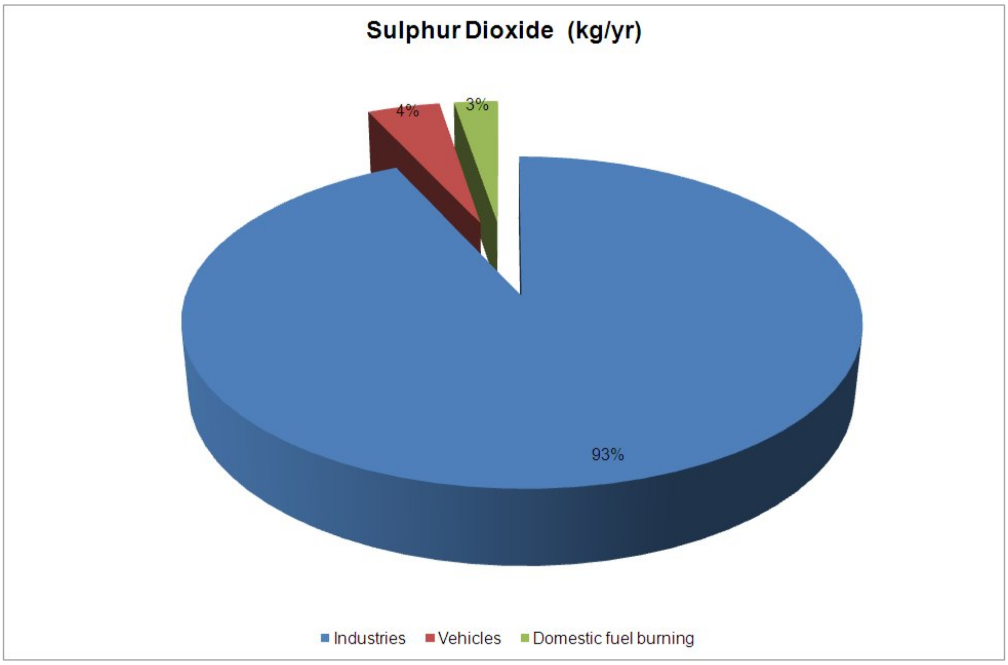


Figure 16 : SO_2 emissions and sources (Source: WRDM, 2012).

Oxides of nitrogen

Vehicles are the highest contributors of oxides of nitrogen making up 47% of the total contribution and closely followed by 32% from biomass burning. The industrial contribution is 21% and a smaller percentage from domestic fuel burning.

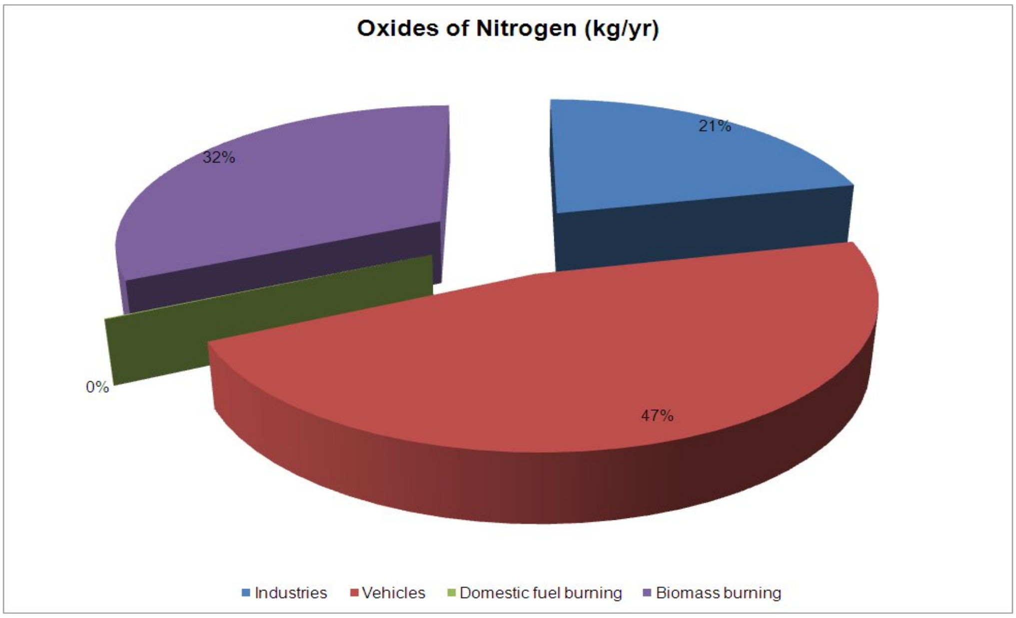


Figure 17 : NO_x emissions and sources (Source: WRDM, 2012)

Carbon monoxide

The majority of carbon monoxide emissions (71%) within the MCLM are from industries while 21% of these carbon monoxide emissions is attributed to biomass burning. Vehicles and domestic fuel burning contributed a total of 8% of these emissions.

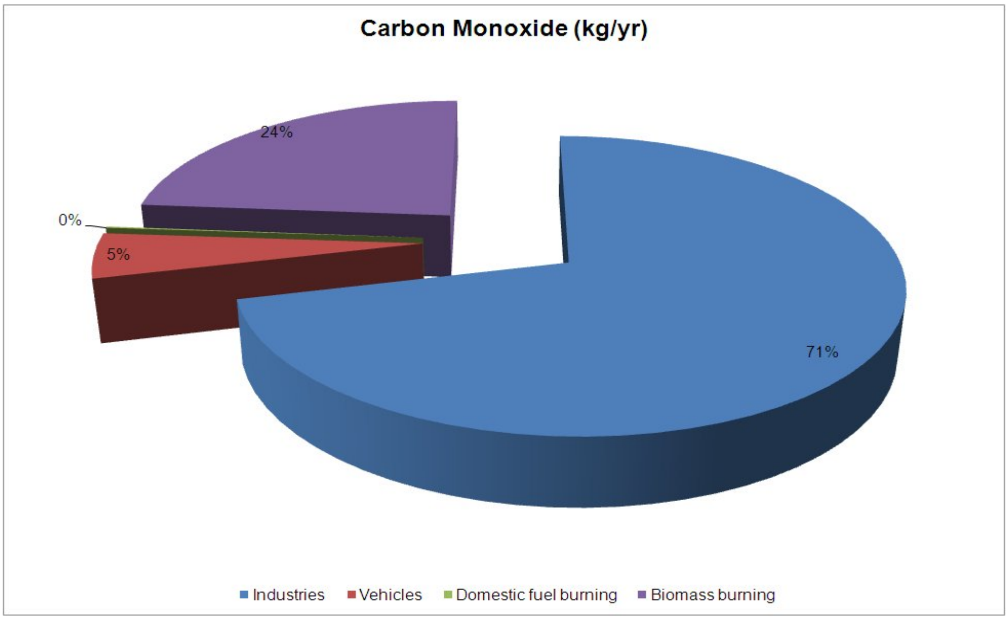


Figure 18 : CO emissions and sources (Source: WRDM, 2012).

PM_{10}

Biomass burning contributes to 60% of the PM_{10} emissions within the local municipal area while 28% can be attributed to tailing dams.

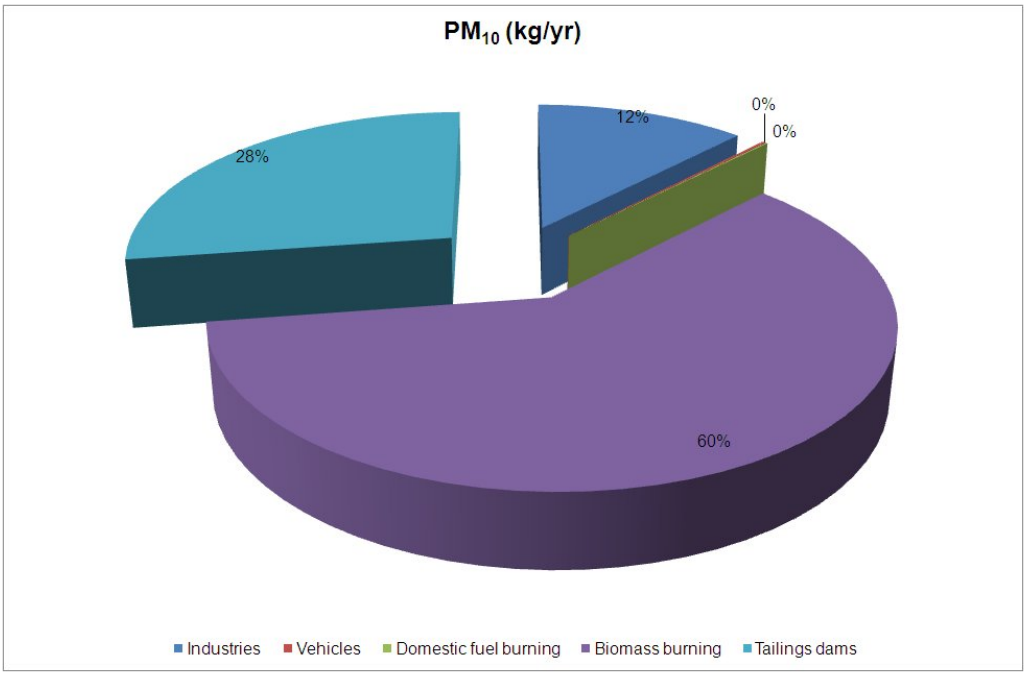


Figure 19 : PM_{10} emissions and sources (Source: WRDM, 2012).

Benzene

The emission inventory showed that there are only two sources of benzene in the study. These comprise industrial activities and domestic fuel burning. The larger proportion of emissions (70%) is from industrial sources.

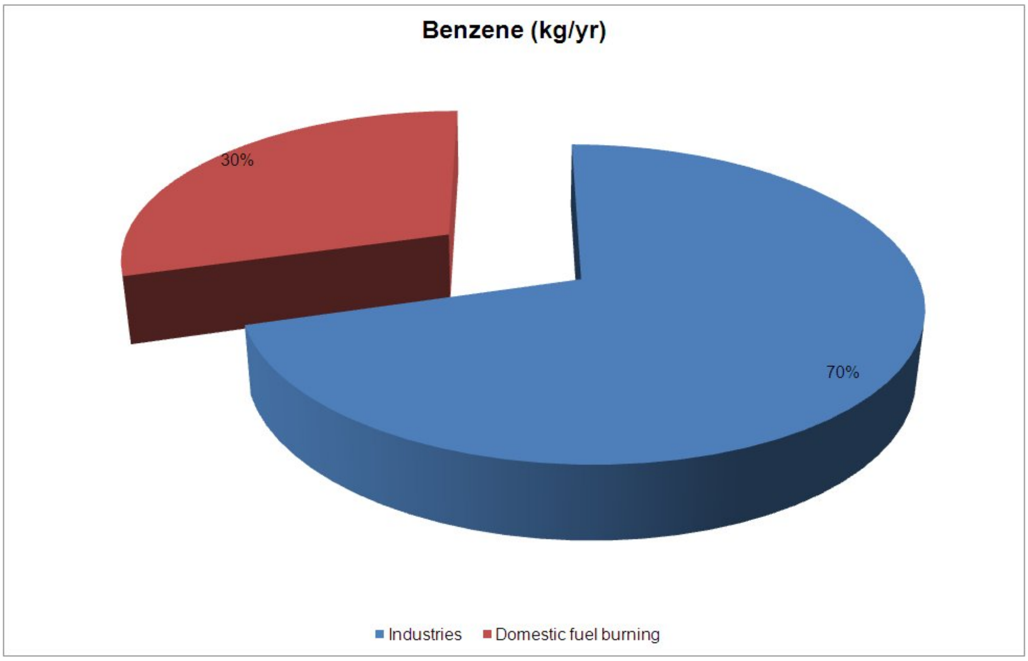


Figure 20 : Benzene emissions and sources (Source: WRDM, 2012).

Lead

One hundred percent (100%) (11031 kg/yr) of the lead emissions is contributed by industrial processes with only 3kg/yr from vehicles.

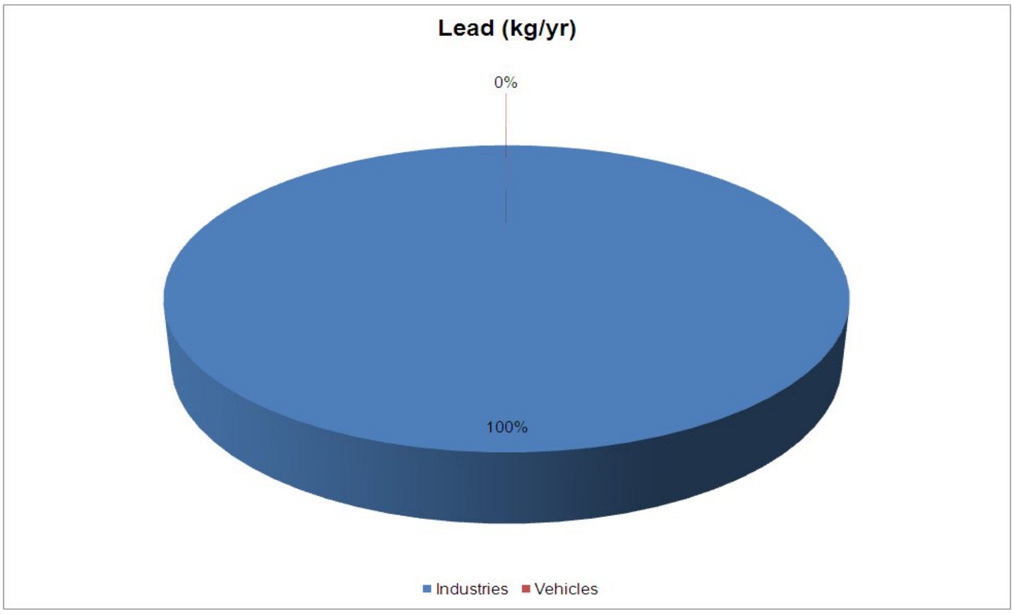


Figure 21 : Lead emissions and sources (Source: WRDM, 2012).

VOCs

The Volatile Organic Compounds emission sources in the MCLM are biomass burning with a contribution of 88% (8001752 kg/yr) followed by vehicles with 12% (1086747 kg/yr). Only 4571kg/yr from industrial processes and 8696 kg/yr from domestic fuel burning were also recorded.

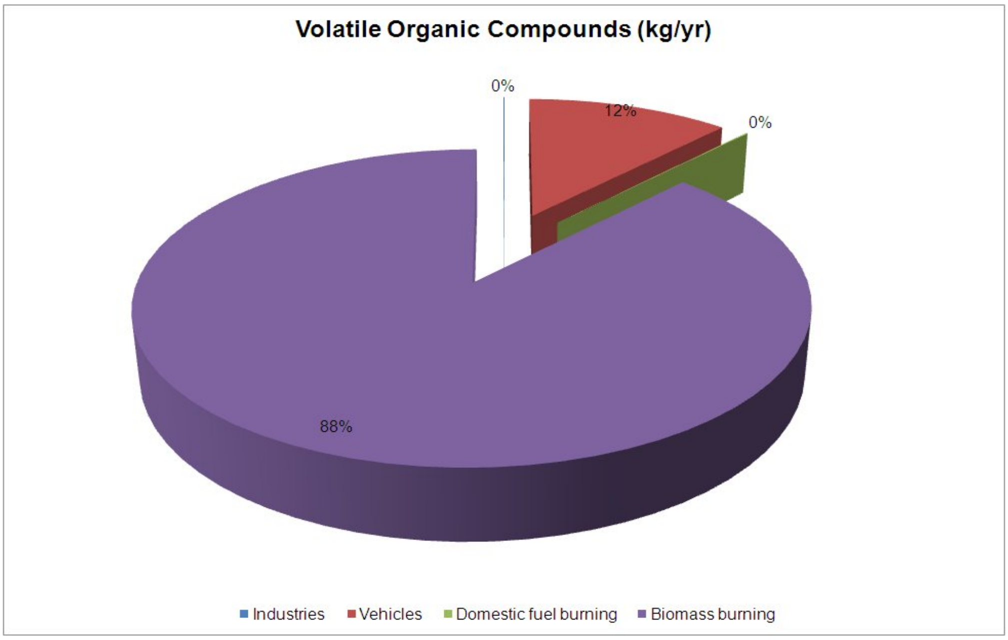


Figure 22 : VOCs emissions and sources (Source: WRDM, 2012).

Breakdown per industrial area

The data below is presented to show the emission breakdown information from the surveyed industrial areas. Only point sources were targeted as previously noted. Krugersdorp did not form part of this survey but is included in the section above.

It is evident from the data presented in Figure 23 that Chamdor is the main contributor to air pollution in MCLM with the highest percentage of CO (54%) emissions followed by particulate matter (PM) (32.5%) emissions.

The area is characterized by small, medium and several large industries with mostly engineering and small spray-painting companies. The major contributors include Fima films, Oil Refinery, Leratong Hospital, Chemico and other industries.

The "Other" pollutants include formaldehydes, oil mist, hydrosulphuric acid, hydrochloric acid and phosphorus pentoxide. The highest emission estimate is from this area with 2731 kg per annum

The emissions presented are under-reported since not all major contributors responded to the questionnaire.

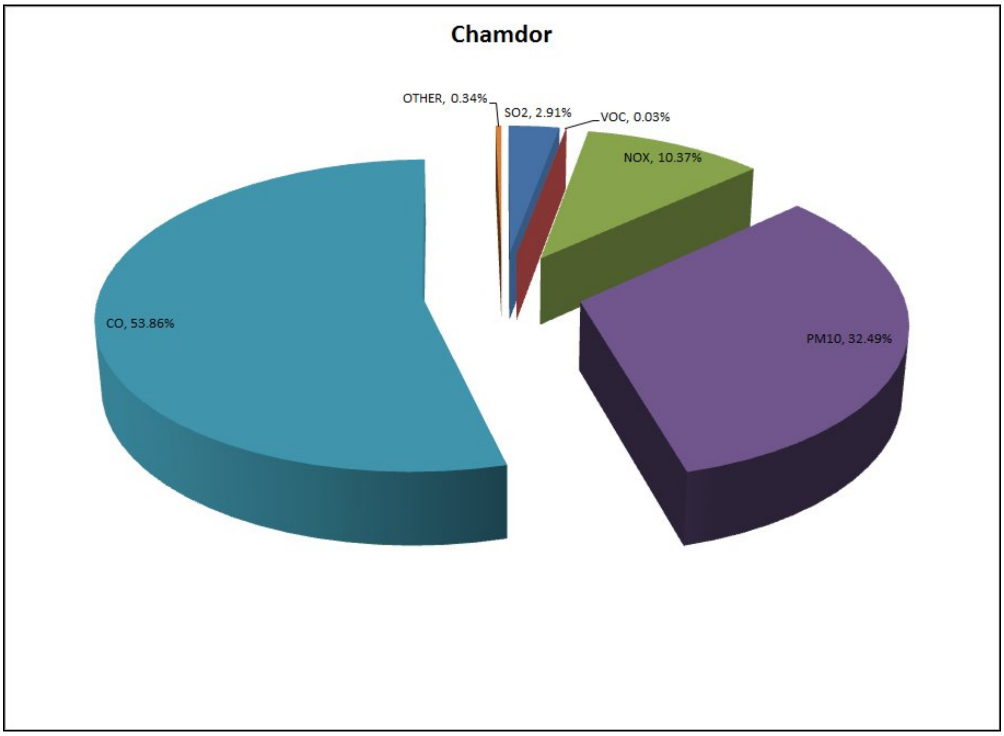


Figure 23: Chamdor emissions breakdown distribution from point sources per pollutant (Source: MCLM, 2012)

Figure 24 below presents a breakdown of emission for the Delporton area. The highest percentage of nitrogen oxides emissions (51%) followed by sulphur dioxide emissions (47%) is derived from the area.

Only one company within the area participated in this study. The area is characterized mostly by residential and small industries.

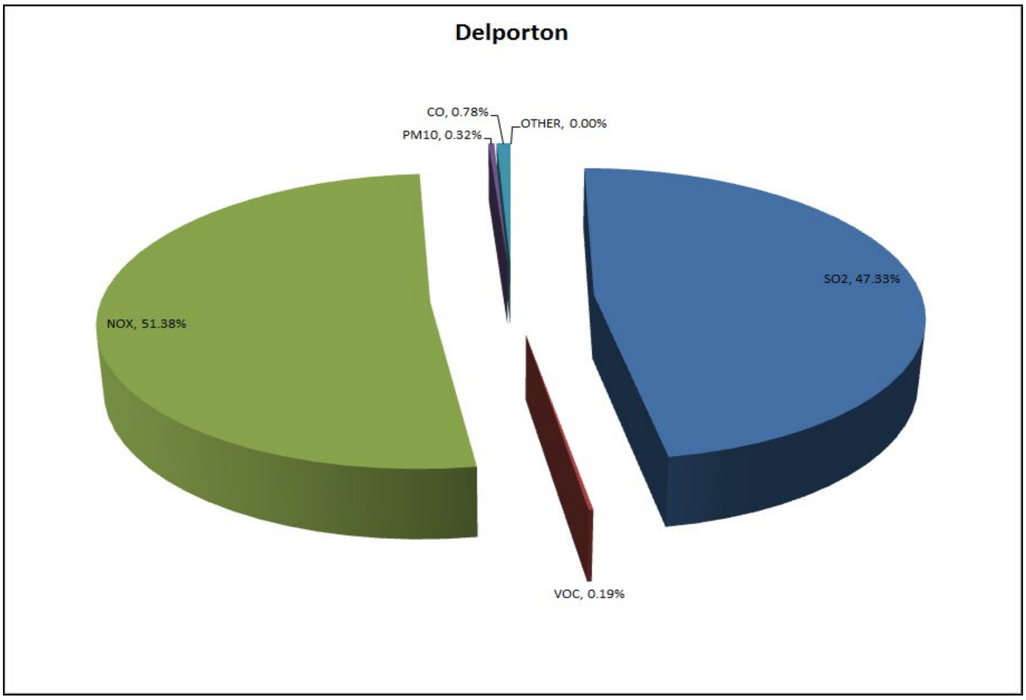


Figure 24: Delporton emissions breakdown distribution from point sources per pollutant (Source: MCLM, 2012)

As evidenced in Figure 25 below, emission estimates for fine particulate matter (76%) within the Factoria area are higher than for those of other areas.

The sulphur dioxide emissions (0.01%) were very low and insignificant when compared to other areas within the MCLM.

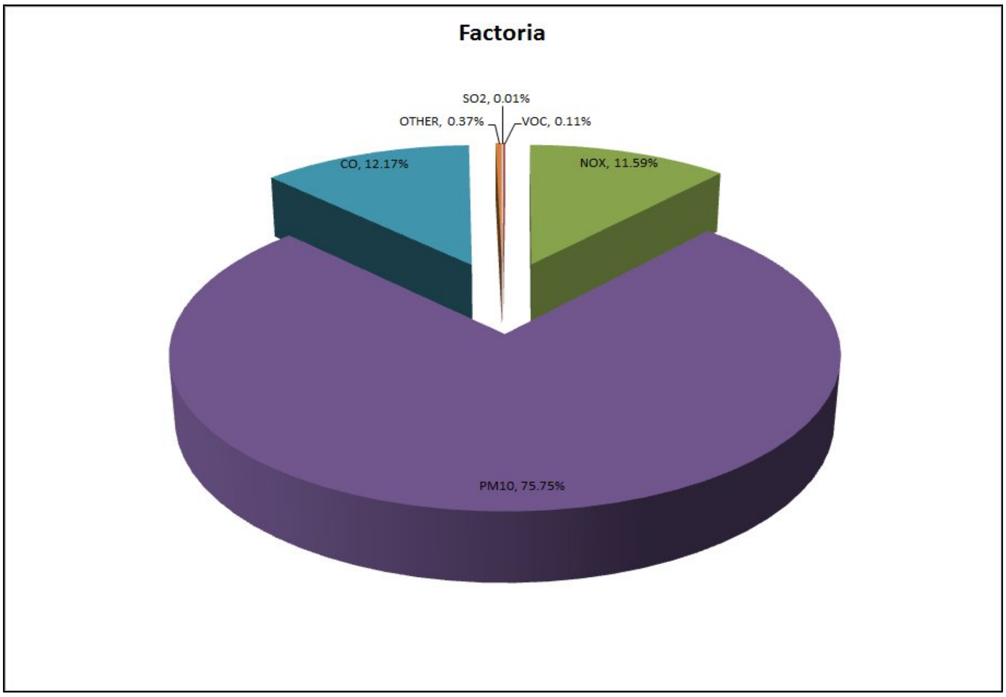


Figure 25: Factoria emissions breakdown distribution from point sources per pollutant (Source: MCLM, 2012)

Figure 26 highlights the breakdown of emissions within the Boltonia area. It evident that this area is the highest contributor of nitrogen oxides emissions (85%) when compared with the other areas.

No "other" pollutants were estimated in the area and no further information on these was received through the questionnaire responses.

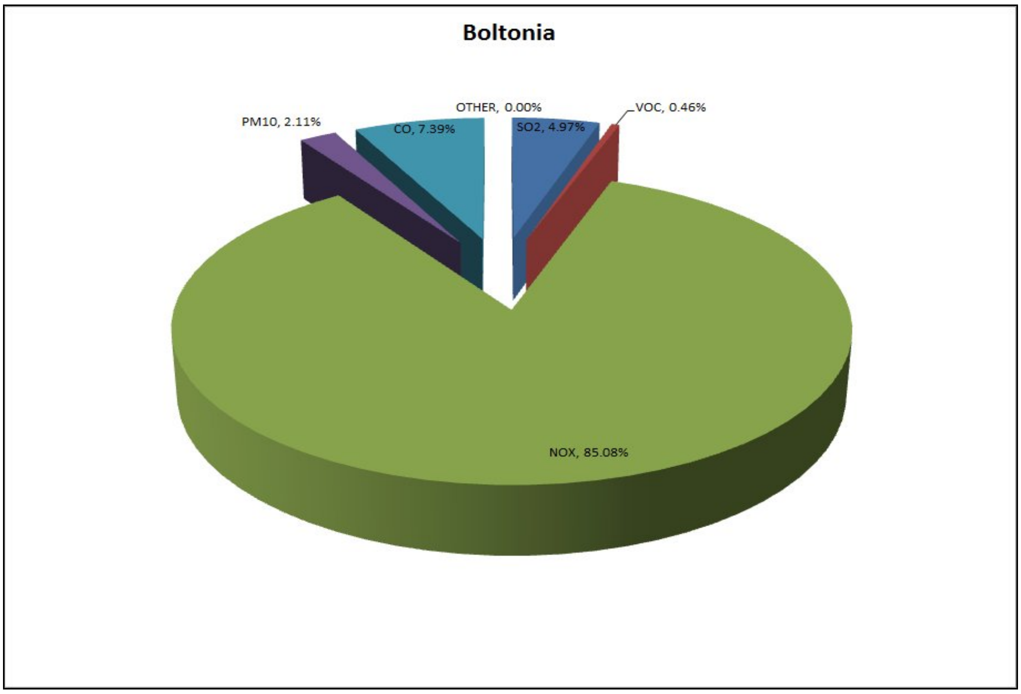


Figure 26: Boltonia emissions breakdown distribution from point sources per pollutant (Source: MCLM, 2012)

4.5 Dispersion modelling

4.5.1 *Introduction*

Emissions are dispersed and diluted in the atmosphere before reaching people or different receptor points. Air quality modelling seeks to combine knowledge of pollutant source strengths (i.e. emitted quantities per unit time) with meteorological data to estimate concentrations at the receptor points. Models have varying degrees of sophistication and accuracy and are rarely better than plus or minus 20-30 percent of the "actual value", unless the model is "tuned" by use of pollution monitoring data (stochastic modelling).

Air quality models are used to establish a relationship between emissions and air quality. Dispersion models applied as well as related sources of pollution are often divided into spatial scales such as indicated below:

Area	Spatial scale	Typical sources	Pollutants
Local	10-500 m	Points, low stacks, low-level area sources and traffic	SO_2, NO_2, PM, CO
Urban	1-50 km	Multiple sources, low-level area sources, small industries, traffic and general human activities	PM, NO_2, SO_2, Oxidants
Regional	100-1000 km	Power plants, large industrial areas, urban areas	PM_{10}, $PM_{2,5}$, O_3, secondary pollutants

Meteorological data and knowledge of physical and chemical reactions in the atmosphere are used to calculate the air concentrations of one or more pollutants as a function of time and space.

Observed concentrations at the monitoring stations are used to validate the calculated concentrations from model descriptions of emission and atmospheric dispersion. Measurements may also be used to improve the accuracy of calculated concentration fields when they are treated statistically along with results of dispersion models. The municipality has not conducted any type of modelling.

5. Evaluation of Current Management

5.1 Legal Overview

The legislation governing the management of air quality with the MCLM includes but not limited to:

- Constitution of the Republic of South Africa Act, 1996 (Act No. 108 of 1996)
- Criminal Procedures Act, 1977 (Act No. 51 of 1977)
- Municipal bylaws
- Municipal Structures Act, 1998 (Act No. 107 of 1998) & Municipal Systems Act, 2000 (Act No. 32 of 2000)
- National Environmental Management: Air Quality Act, Act No. 39 of 2004 (AQA)
- National Framework for Air quality Management in South Africa, 2007
- National Health Act, 2003 (Act No. 61 of 2003)

5.2 *Areas of responsibility for the MCLM*

5.2.1 *General*

The new air quality governance approach driven primarily by the AQA, necessitates that district municipalities fulfil the functions listed in Table 5 below. The table highlights the requirements in terms of the legal aspects and also notes the current status of the service within the MCLM based on the information received from the municipality.

Table 5***: Areas of responsibility (MCLM)***

Area of responsibility	Output required	Current status of delivery
Appointment of an AQO	Designation of an AQO	None
Air Quality Monitoring	Show compliance to South African ambient air quality standards through ambient air monitoring & reporting Dealing with complaints.	Partial – the rest with WRDM
Set local air quality standards (ambient and emission standards)	Set local bylaws on air quality standards	Draft Air Quality By-Laws - WRDM
Emission licensing authority function	Monitoring against standards & policing of list compliance	The WRDM has taken over the responsibility
Development of an AQMP aligned to the IDP and local municipal AQMP's	Preparation of reports	In progress
Dust & Noise control	Action against offenders	Local municipality (MCLM)
Listed activity licensing system	Establishment of an operation unit	The WRDM has taken over the responsibility
Appointment of Emission Control Officers	Appointment of an Emission Control Officer by Atmospheric Emission License Holder through the authority of the AQO.	Function of the district (WRDM has taken over)
Prosecution of offenders wrt section 51 of the AQA	Collation of complaints and investigations, laying of charges with the National Prosecution Authority	Local municipality and the district

5.2.2 *An Air Quality Officer (AQO)*

In terms of the AQA Section 14 each municipality must designate an air quality officer from its administration to be responsible for co-ordinating matters pertaining to air quality management in the municipality.

Since the AQO will deal with specific air quality management issues, the AQO must have some knowledge of air quality management. The profile of an AQO is likely to be:

- A person who is specifically responsible for air quality management within the municipality;
- A person who has a broad knowledge and understanding of air quality related issues and air quality management;
- A person who can be mandated to represent the municipality in meetings with other AQO's;
- A person who has sufficient authority to make technical decisions on AQO issues.
- A middle- to senior-level manager;

Currently, there is no designated air quality officer within the municipality.

5.3 Overview of Current Air Quality Management within MCLM

5.3.1 Existing staff structure (input required from MCLM on this section)

The staff structure for the Environmental Health Directorate within the MCLM is presented in Figure 27 below. The organogram indicates that there are two sections within the Environmental Health Directorate. It is indicated that these sections run independently of each other and each with varying numbers of staff.

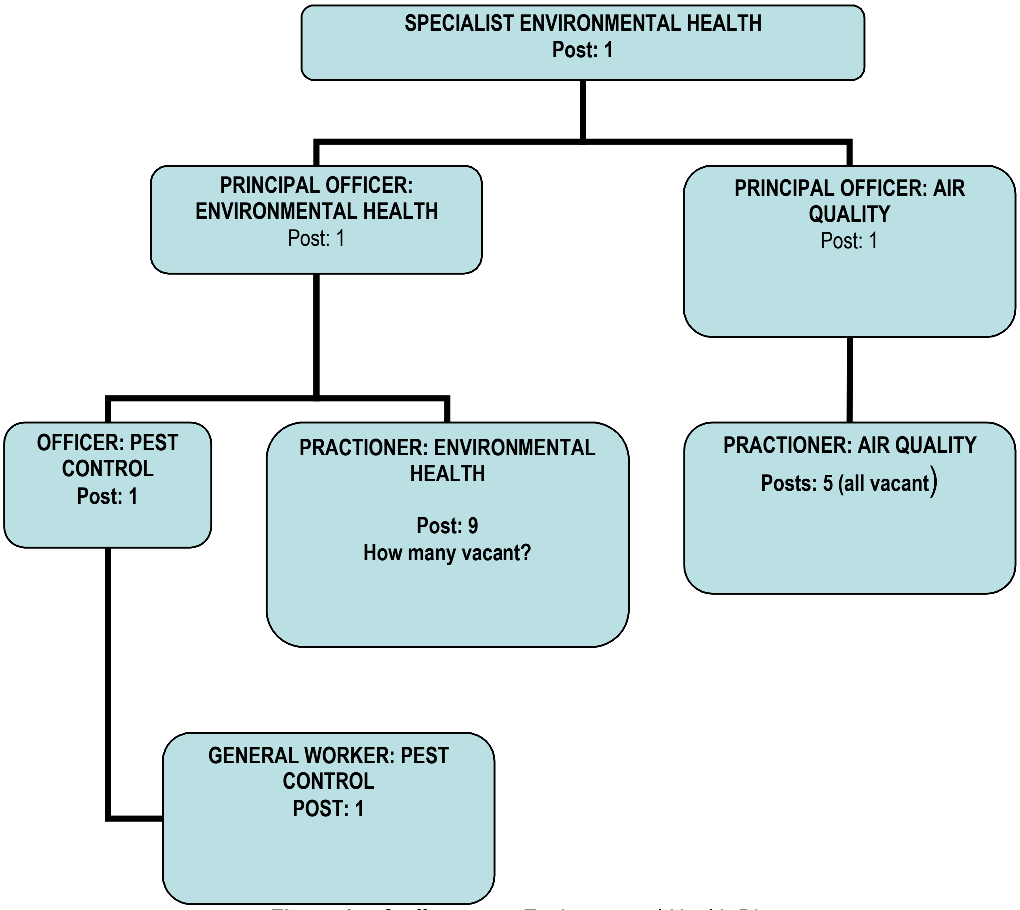


Figure 27: Staff structure Environmental Health Directorate

6. Gap and problem analysis

A gap analysis is conducted to evaluate whether institutional functions and resources available is sufficient to address air quality issues within an area. This is why the consultation with stakeholders, other spheres of government and public participation is necessary to understand what issues may be outstanding and what may need to be incorporated to "fill the gaps."

Once management gaps are analysed, a problem analysis follows to determine problems, associated cause of the problems and the effects. This should be developed in consultation with stakeholders.

During the development of the baseline assessment, the following immediate issues in terms of air quality management within the municipality were highlighted:

- Limited capacity in air quality management and tools to effectively manage air quality in the MCLM.
- Disintegrated air quality monitoring data and poor quality
- There were no formal quality controls in place for data management.
- Incomplete emission inventory
- No modelling studies conducted in the area

As a result of the findings of the gap analysis, a number of issues were identified on which the AQMP would focus. These were identified as the following:

- Limited capacity in air quality management and tools to manage air quality
- Air Quality Management System (AQMS)
- Domestic fuel burning
- Emissions from non-scheduled and scheduled processes

Each of the problems noted above was interrogated using the Logical Framework Approach (LFA). The analysis of each of the problems is presented in sections 6.1 to 6.5.

6.1 Air Quality Management and tools available

Air quality management and tools encompasses the following:

- Institutional capacity within the municipality
- Financial resources
- Tools like the availability of an emission inventory, existing AQMS, availability of information on air dispersion modelling having been applied in the area

Problem analysis	1. The current staff constraint within the municipality does not allow the effective execution of the legislative responsibilities and falls short on service delivery in this area. 2. Further consultation with the municipality notes that there is skill shortage to existing staff
Problem cause	1. Shortage of allocation of funds and human resources for the air quality management function. 2. The problem is as a result of the following; 1) Skills shortage, 2) The air quality function is competing with other functions and is not given the priority it requires, 3) Training of staff is not sufficient and 4) Lack of available resources.
Problem effects	1. Legal responsibilities are not fulfilled. For example, enforcing APPA and AQA. 2. Lack of an effective AQMS being available for the area. For example, not being able to undertake air monitoring and compile emission inventories; limited air quality data available.
Objectives	1. To ensure that staff are designated to the required roles for effective air quality management and that they are adequately trained for their roles. 2. To ensure that sufficient funds are allocated for the air quality management function. 3. Integrated AQMS for the municipality 4. Develop strong relationships with other spheres of government, private sector and NGOs.

6.2 *Air Quality Management System (AQMS)*

The main elements of an AQMS include:

- Ambient air monitoring
- Emission inventory
- Air dispersion modeling

The MCLM has undertaken two elements of the AQMS components however, to a limited degree. This includes the ambient air monitoring and emission inventory.

Problem analysis	1. Limited number of ambient air monitoring activities in the municipality. 2. The existing station is not operated strictly within a quality system and the data validity cannot be verified. 3. Existing emission inventory need to be updated. 4. Air dispersion modeling has not been applied in the area.
Problem cause	1. Lack of an integrated approach to the management of an AQMS between stakeholders (provincial and local government and industry). 2. Lack of training, resources and capacity within municipality.
Problem effects	1. Data produced by an ambient air monitoring system that is not managed under a quality system cannot be verified. 2. Not all sources of emissions are included in the emission inventory 3. Haphazard approach to air quality management (AQM).
Objectives	1. Update an emission inventory to include vehicle emissions and information from the district emission inventory 2. Integrate and quality control all available air quality monitoring data – from onset of the monitoring station 3. Once complete, an analysis for the need for further ambient air monitoring within the municipality needs to be undertaken with the use of tools such as the SANS 1929 and SANS 69 documents and later with the use of a validated air dispersion model.

6.3 Domestic fuel burning

Low income households in rural and some urban areas within the municipality use wood, paraffin and coal for cooking and space heating. Other biomass fuels such as crop residues are sometimes also used. This results in emissions that could lead to environmental and adverse health impacts.

Problem analysis	1. Geographical location, as well as income, is a strong determinant of fuel use. Generally low-income households in densely populated areas (urban or peri-urban) rely on domestic fuel as an energy source for household needs. 2. Domestic fuel use increases in winter in this region due to lower ambient temperatures.
Problem cause	1. Given the availability of inexpensive coal and the relatively low temperatures in winter, coal consumption figures are elevated within this region. 2. Increasing electricity prices causes a problem for majority of low income households, thus household energy needs in most low income homes are met by use of fuels like paraffin, wood and coal for space burning. 3. Lack of mitigation methods for domestic fuel burning. 4. Poor household ventilation. 5. Poor fuel use techniques.
Problem effects	1. Exposure to emissions from fuel burning causing adverse health effects especially upper respiratory problems. 2. Climate change and global warming.
Objectives	1. Improve the efficiency of fuel burning. 2. Electrification of households. 3. Use of renewable energy sources.

6.4 Emissions from non-scheduled processes

The control of non-scheduled processes was of particular concern within the municipality. These include small businesses such as spray painting, dry cleaners, small boilers and generators or fuel burning appliances used for eateries.

Problem analysis	1. Municipality reported that they receive complaints of emissions from these non-scheduled processes causing adverse health effects. 2. Nuisance emissions from these sources also result in complaints to the municipality. 3. Pollutant sources and emissions are not known.
Problem cause	1. Lack of regulations around these small businesses. 2. Poor atmospheric dispersion in some areas. 3. Low stack heights with low dispersion potential.
Problem effects	1. Potential health and environmental effects. 2. Climate change and global warming.
Objectives	1. Determine the sources and extent of the emissions through the updating of an emission inventory. 2. Develop a system to engage these businesses on best practice. 3. Declaration of controlled emitters where necessary. 4. Enforcement of by-laws.

6.5 Emissions from scheduled processes

The scheduled processes established in the Mogale City Local Municipality include industries such as the alloys manufacturers, food companies, bricks manufactures and mining (WRDM 2012).

Problem analysis	1. Gaseous and particulate emission from industrial and mining processes. 2. Emissions from transportation of goods.
Problem cause	1. The need for production of goods and commodities. 2. Transportation and storage of goods.
Problem effects	1. Potential health and environmental impacts. 2. Climate change and global warming.
Objectives	1. Monitoring of compliance with emission standards and ambient air quality standards. 2. Engagement with industry to ensure application of best environmental practice (BEP) towards a culture of continuous improvement.

1. References

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APPENDIX A