FORESTRY, FISHERIES AND THE ENVIRONMENT, DEPARTMENT OF

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NATIONAL ENVIRONMENTAL MANAGEMENT: AIR QUALITY ACT, 2004
(ACT NO. 39 OF 2004)

SECOND GENERATION AIR QUALITY MANAGEMENT PLAN FOR THE VAAL TRIANGLE AIRSHED PRIORITY AREA

I, Barbara Dallas Creecy, Minister of Forestry, Fisheries and the Environment, hereby publish the Second Generation Air Quality Management Plan for the Vaal Triangle Airshed Priority Area, in terms of section 19(1) and (5) of the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004), as set out in the Schedule hereto, for implementation.

BARBARA DALLAS CREECY
MINISTER OF FORESTRY, FISHERIES AND THE ENVIRONMENT

forestry, fisheries & the environment

Department:
Forestry, Fisheries and the Environment
REPUBLIC OF SOUTH AFRICA

THE SECOND GENERATION VAAL TRIANGLE AIRSHED PRIORITY AREA AIR QUALITY MANAGEMENT PLAN: FINAL PLAN

SCHEDULE_A:

Abbreviations, Symbols, Units

Abbreviations	
AARTO	Administrative Adjudication of Road Traffic Offences
AEL	Atmospheric Emissions License
AIR	Air Impact Report
AQA	Air Quality Assessment
AQM	Air quality management
AQMP	Air quality management plan
BnM	Basa Njenjo Magogo
CAMx	Comprehensive Air Quality Model with Extensions
CBO	Community Based Organisation
COJ	City of Johannesburg
DALRRD	Department of Agriculture, Land Reform and Rural Development
DEA	Department of Environmental Affairs (now DFFE)
DEAT	Department of Environmental Affairs and Tourism (now DFFE)
DEFF	Department of Environment, Forestry and Fisheries (previously DEAT)
DFFE	Department of Forestry , Fisheries and the Environment (previously DEFF)
DESTEA	Department of Economic, Small Business Development, Tourism and Environmental Affairs (Free State)
DHS	Department of Human Settlements
DM	District Municipality
DMRE	Department of Mineral Resources and Energy
DOH	Department of Health
DOT	Department of Transport
DST	Department of Science and Technology
DTI	Department of Trade and Industry
EIA	Environmental Impact Assessment
EPWP	Expanded Public Works Programme
FINN	Fire INventory
GAINS	Greenhouse Gas – Air Pollution Interactions and Synergies
GAUTRANS	Gauteng Department of Roads and Transport
GCR	Gauteng City-region
GDARD	Gauteng Department of Agriculture and Rural Development
GG	Government Gazette
GHG	Greenhouse gas
ITTs	Implementation Task Teams
LM	Local Municipality
LPG	Liquefied Petroleum Gas
MSRG	Multi-Stakeholder Reference Group
NAAQS	National Ambient Air Quality Standards
NAEIS	National Atmospheric Emission Inventory System
NCAR	National Center for Atmospheric Research
NEM:AQA	National Environmental Management: Air Quality Act

Abbreviations	
NDCR	National Dust Control Regulations
NGO	Non-governmental organisation
PPP	Pollution Prevention Plan
PRASA	Passenger Rail Agency of South Africa
RDP	Reconstruction and Development Programme
SANEDI	South African National Energy Development Institute
SANRAL	South African National Roads Agency Limited
SAPS	South African Police Service
SMART	Simple, Measurable, Achievable, Realistic and Time-Bound
TSF	Tailing storage facility
VKT	Vehicle kilometres travelled
VTAPA	Vaal Triangle Airshed Priority Area
WHO	World Health Organization
WRF	Weather Research and Forecasting Model

Symbols	
BVOC	Biogenic volatile organic compounds
CO	Carbon monoxide
C_6H_6	Methane
NMVOC	Non-methane volatile organic compounds
NO_X	Oxides of nitrogen
NO_2	Nitrogen dioxide
NH_3	Ammonia
O_3	Ozone
Pb	Lead
PM	Particulate matter
$PM_{2.5}$	Inhalable particulate matter (aerodynamic diameter less than 2.5 µm)
PM_{10}	Thoracic particulate matter (aerodynamic diameter less than 10 µm)
SO_2	Sulfur dioxide
VOC	Volatile organic compounds

Units	
°C	Degree Celsius
g	Gram(s)
g/m^2	Grams per square metre
g/s	Grams per second
$g/s.m^2$	Grams per second per square metre
kg	Kilograms
kg/day	Kilograms per day
km	Kilometre
kPa	Kilopascal
K	Temperature in Kelvin
1 kilogram	1 000 grams

Units	
m	Metre
m/s	Metres per second
mamsl	Metres above mean sea level
µg	Microgram(s)
$\mu g/m^3$	Micrograms per cubic metre
m^2	Square metre
m^3	Cubic metre
m^3/hr	Cubic metre per hour
$mg/m^2.day$	Milligram per square metre per day
mg/Nm^3	Milligram per normal cubic metre (normalised at 273 K; 101.3 kpa)
MW	Mega Watt
ppm	Parts per million
t/a	Tonnes per annum

Executive Summary

The Vaal Triangle Airshed was declared a priority area in April 2006 (Government Gazette Notice No. 365 of 21 April 2006, as amended by Notice 711 of 17 August 2007) due to the concern of elevated pollutant concentrations within the area, specifically particulate matter. An AQMP was developed for the area between 2006 and 2008 with the final AQMP published in May 2009 (Government Gazette No. 32254, 29 May 2009). A medium-term review was conducted in 2013 to inform objectives that ensure improvement in air quality in the area. The objective of the second generation Air Quality Management Plan (AQMP) was to characterise the baseline after seven years and determine the improvement, if any, that resulted from the implementation of the 2009 AQMP. This second generation AQMP aimed to establish new strategies and intervention plans, based on a better understanding of the cause and effect relationships, that will ensure further improvement and eventual compliance within the area.

The development of a second generation VTAPA AQMP was undertaken in six (6) phases as shown in the figure below, with each task or output having a verifiable indicator and provided a means of verification as shown in Table A.

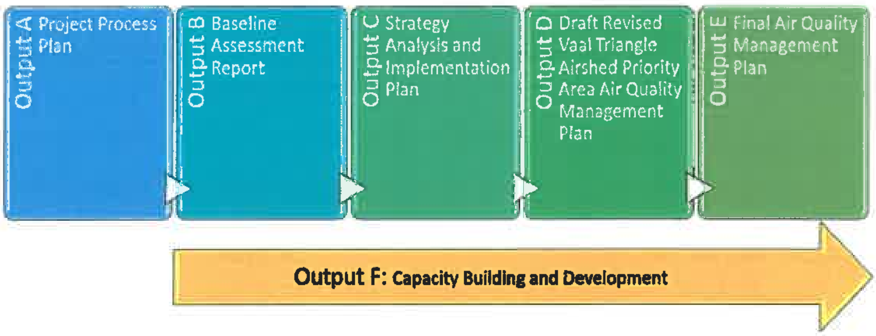

Table A: Summary of immediate objectives, verifiable indicators and means of verification

Description	Verifiable Indicator	Means of Verification
Output A: Project Process Plan	A clear and unambiguous plan on how the project is to be conducted	Project Process Plan approved by the PSC/National Air Quality Officer
Output B: Baseline assessment report	• A comprehensive baseline assessment report with verifiable information • VTAPA emissions inventory (comprehensive database/spreadsheets and GIS files) • Dispersion modelling input files	A baseline report approved by PSC
Output C: Strategy Analysis and Implementation Plan	Strategy Analysis and Implementation Plan with SMART objectives, clear activity descriptions, clear resource requirements and indicators	Strategy Analysis and Implementation Plan
Output D: Draft Revised Vaal Triangle Airshed Priority Area Air Quality Management Plan	A draft AQMP based on current, accurate and relevant information that is informed by best practice in the field of air quality management. The AQMP should provide a clean and practical plan to efficiently and effectively bring air quality in the area into sustainable compliance with NAAQS within agreed timeframes	Draft plan published in the *Gazette* for public comment

Description	Verifiable Indicator	Means of Verification
Output E: Final Vaal Triangle Airshed Priority Area Air Quality Management Plan	A final AQMP based on current, accurate and relevant information that is informed by best practice in the field of air quality management. The AQMP should provide a clean and practical plan to efficiently and effectively bring air quality in the area into sustainable compliance with NAAQS within agreed timeframes. The final AQMP would take into account public comments.	Plan published in the *Gazette*.
Output F: Capacity Building/Development	Active involvement of departmental staff in the implementation of the project	Capacity building plan submitted to DFFE and progress reports

Notes: DFFE stands for Department of Forestry, Fishery and the Environment,, previously the Department of Environmental Affairs (DEA), and before that the Department of Environmental Affairs and Tourism,(DEAT),

Assessment of the First Generation VTAPA AQMP

The development of the AQMP followed a holistic approach due to the complex nature of air quality issues within the VTAPA, and resulted in the identification of management measures which, at the time, were thought to ensure improvement in the air quality in the area over time.

At the time of the 2009 first generation VTAPA AQMP, the AQA had been in place for only five years with sections still under development. Since then 22 publications assisting with AQMP implementation have been gazetted.

The main findings from the first generation AQMP

Limited ambient monitoring data were available at the time of the AQMP development and the Department of Environment, Forestry and Fishery (DFFE) (previous DEAT and DEA) commissioned six ambient air quality stations in 2007. Available data indicated elevated PM_{10} concentrations over the largest part of the VTAPA with areas where SO_2 and ozone were high. Dispersion modelling was used to determine the spatial extent of ambient concentrations and relied on a first level emissions inventory. The emissions inventory included industrial, power generation, domestic fuel burning, mining and vehicle emissions, and focussed on criteria pollutants. Simulated ground level concentrations indicated PM_{10} to be the main pollutant of concern within the VTAPA resulting in six priority areas or "hotspots". These "hotspots" were primarily around industrial and residential areas.

The 2009 intervention strategies were based on the cause and effect relationships using the Logical Framework Approach (LFA). Eleven problem complexes were identified around which problem and associated objective trees were developed. Emission problem complexes included: (i) Biomass Burning, (ii) Domestic Fuel Burning, (iii) Iron, Steel and FerroAlloys, (iv) Mining, (v) Petrochemical, (vi) Power Generation, (vii) Small Industries, (viii) Transportation and (ix) Waste Burning. Non-emission problem complexes included (x) Government Capacity for Air Quality Management, and (xi) Information Management. Several interventions within each problem complex were expanded into action plans providing assumptions associated with the intervention strategy, estimated costs, timeframes and indicator. Each industry had to develop a detailed emission reduction strategy in support of the overall objectives of the interventions. As an interim indicator of performance, and in the absence of the NAAQS at the time, air quality objectives were determined for the VTAPA. At the time of the implementation of the plan, there were still limited capacity and technical knowledge.

A medium-term review of the first generation AQMP was conducted in 2013. Based on the status at the time, 46% of the set interventions were successfully implemented, 18% were in progress, 22% could not be achieved and 14% could not be ascertained. The industrial stakeholders were found to have met their obligations to a larger degree than any of the other sectors, with performance of government stakeholders and municipalities generally low or not ascertained. The Multi

Stakeholder Reference Group (MSRG) members overall view was that inadequacy in capacity and the failure to achieve many of the planned interventions and objectives were the main reasons for failing at implementing the VTAPA AQMP.

Second Generation AQMP Baseline Assessment Findings

A background assessment covering the evaluation of ambient air quality in the VTAPA, an emission inventory representing the year 2017, and associated dispersion modelling results were conducted as part of the second generation AQMP. The assessment provided a good understanding of the current state of air quality within the VTAPA and to some extent, the source contributions to the ambient pollution levels. The preliminary results from a large-scale source apportionment study, currently in the final stages, provided the link between source and receptor allowing for the identification of desired intervention strategies.

The main finding thus far from the Source Apportionment Study (SAS) is that dust is the main source of PM_{10} concentrations within the VTAPA, with the main sources contributing to $PM_{2.5}$ still unaccounted for. The unaccounted fraction will be narrowed down through use of the positive matrix factorization (PMF) model as well as industry profiling. Nonetheless, the contribution from sulphates, domestic fuel burning, biomass burning, and vehicles were significant in all three campaigns.

Background Assessment

The background assessment used existing information to assess the current state of air in the VTAPA, as well as to understand the geographical context of the priority area; the drivers of air quality; and how the air quality has changed since the 2009 AQMP and the 2013 medium term review. Use was made of the 2011 Census data and the 2016 Community Survey statistics, where the 2009 VTAPA AQMP study made use of the 2001 Census data. In 2001 the population was reported to be 2 532 362, increasing to 2 848 140 in 2011 and by a further 10% in 2016 (3 127 907).

Emission Inventory

The emission inventory for the second generation VTAPA AQMP assessed available emissions data, quantified fugitive emission sources, and identified gaps in the emission inventory. Two emission inventories were developed: one for the VTAPA and one as a regional emission inventory. The focus of the emission inventory was on criteria pollutants, especially for the industrial sources. The VTAPA emission inventory was used for management purposes, and the regional emission inventory was used for dispersion modelling.

Emissions were quantified for all main sources within the VTAPA, as well as sources from the surrounding areas to form input into air quality modelling. Sources within the VTAPA include:

- *Industrial Sources*: mostly stationary facilities operating under licenses or registration, of which the emissions are reported to the authorities annually (Section 21 and Section 23 sources) and data reported on in the National Atmospheric Emissions Inventory System (NAEIS) for the 2017 calendar year.
- *Mining Sources*: including two opencast mines (one dolomite and one coal) and one underground coal mine with activity data reported on in NAEIS for the calendar year 2017.
- *Mobile Sources*: use was made of the South African National Roads Agency Ltd (SANRAL) national counts for 2016 and GAUTRANS Gauteng Manual counts for 2015. A top-down and bottom-up approach was followed.
- *Domestic Fuel Burning*: Community Survey 2016 and Census 2011 data were used to proportionally disaggregate national fuel consumption to provincial and then small area level geographic units following both a top-down (for gas, paraffin and coal) and bottom-up (for wood) approach.

- *Waste*: open burning in residential areas was quantified based on available information (no information was available on landfills and wastewater treatment facilities to quantify these emissions).
- *Windblown Dust*: from mine waste facilities, product stockpiles, as well as ash storage facilities for large combustion sources, excluding windblown dust from denuded areas.
- *Biogenic VOC Emission*: plants emitting numerous VOC compounds, primarily isoprene, were included.
- *Biomass Burning*: Fire INventory (FINN) from National Center for Atmospheric Research (NCAR) data was extracted for the year 2016 for large scale agricultural burning and natural fires.
- *Airfields:* since there are no major commercial airports within the VTAPA, these were excluded.
- *Agriculture*: including mainly for its contribution to ammonia emissions used in the dispersion model.

Based on the quantified emissions, industrial sources were the main contributors of SO_2 (99.8%) and NOx (93%) emissions within the VTAPA. Mobile sources were the only other significant contributors to NOx emissions at 7%. Total PM_{10} emissions were mainly a result of industrial operations (52%) followed by windblown dust (31%), with biomass burning third contributing at 5%. For the sources for which $PM_{2.5}$ emissions were reported and/or quantified, windblown dust was the main contributing source (56%) followed by domestic fuel burning (29%). It should be noted that $PM_{2.5}$ is under-reported in the NAEIS and hence the emissions would be higher. CO emissions were a result of domestic fuel burning (28%), mobile sources (27%), biomass burning (26%) and industrial sources (19%). Biogenic VOC emissions were unsurprisingly the main contributor to NMVOC emissions followed by biomass burning. Ammonia emission (NH_3) sources were mainly (soil) biogenic, with contributions from agriculture (87%) and to a lesser extent mobile sources (11%).

Compared to the 2009 and 2013 medium-term review inventories, the total emissions within the VTAPA remained similar for SO_2 but reduced significantly for NOx and PM_{10} emissions. The 2017 emission inventory is regarded more comprehensive than the one for 2009.

Ambient Air Quality Assessment

The ambient air quality assessment made use of available ambient air quality data from the South African Air Quality Information System (SAAQIS), from District Municipalities and from industries. The DEA operates six ambient monitoring stations within the VTAPA, located at Diepkloof, Sharpeville, Three Rivers, Zamdela, Kliprivier and Sebokeng. These stations record meteorological parameters and ambient air quality concentrations for SO_2, NOx, PM_{10} and $PM_{2.5}$. Data was obtained from these stations for the period 2013-2015 to determine dispersion conditions and for the period 2007-2016 to assess ambient air quality trends. In addition, data from the three Sasol ambient monitoring stations was obtained for the same period as well as from the Eskom station and the four ArcelorMittal stations. The Sedibeng DM stations were not included since data was only available for one year (2017).

The main findings were:

- There was some variability in wind fields across the VTAPA monitoring stations, however a predominance of winds from the north-easterly and north-westerly sectors were evident at all stations, with possible exception of Eco Park, where a south-easterly flow was dominant. Winds exceeding 4 m/s were more frequently recorded at Sharpeville, Leitrim, and Eco Park. The Leitrim station recorded the least calm conditions (6%), while calm periods were most frequent at the AJ Jacobs station (30%).
- Long term trends, from 2007 to 2016, in SO_2 concentrations showed compliance with the National Ambient Air Quality Standards (NAAQS) at most of the stations for most of the time. Trends in SO_2 concentrations over 10 years showed small decreases at Diepkloof, Zamdela, Randwater and Eco Park but slight increases over time at Kliprivier, Three

Rivers and AJ Jacobs. Concentrations at Sebokeng, Sharpeville and Leitrim showed more annual variability and no distinct long-term trends.

- Annual average NO_2 concentrations were non-compliant with the NAAQS at Diepkloof (all the years except 2011), Kliprivier (2009 and 2010), Sebokeng (2015) and Sharpeville (2015). Hourly NO_2 concentrations were also non-compliant with NAAQS at Sebokeng in 2015, with the lowest concentrations recorded at the Randwater station. Monthly NO_2 concentrations have decreased slightly at the Leitrim station, while concentrations have increased at Diepkloof; Three Rivers; Zamdela; and AJ Jacobs stations. At the other stations ambient NO_2 concentrations remained the same.
- PM_{10} concentrations were in exceedance of the NAAQS at most of the stations for most of the years except at Eco Park where annual PM_{10} has been compliant with NAAQS since the establishment of the station. The highest concentrations were recorded at Zamdela.
- Annual average $PM_{2.5}$ concentrations were in non-compliance with NAAQS, for most of the period assessed, except for AJ Jacobs where no annual exceedances were noted between 2014 and 2016. AJ Jacobs and Three Rivers had the lowest annual average concentrations whereas Leitrim, Sharpeville, Kliprivier, and Sebokeng had the highest. Annual average concentrations seem to have decreased at Diepkloof and Sebokeng but monthly average $PM_{2.5}$ concentrations did not show substantive improvements with slight increases at Kliprivier, Sharpeville, Zamdela and AJ Jacobs stations.

Dispersion Modelling and Scenario Assessment

The CAMx chemical air quality model was used to simulate ambient air quality concentrations over the VTAPA, including background sources outside the VTAPA boundary. The model also allows for primary and secondary pollutant tracking. The same modelling domain was used as for the 2009 VTAPA AQMP, including the topographical data with an update on the land-use data including all air quality sensitive receptors within the study area.

PM_{10}

- PM_{10} concentrations were in general under-estimated compared to measured concentrations, primarily due to the potential impact of much localized sources near stations.
- High exceedances of the NAAQS (for both 24hr and annual averages) were simulated around industrial facilities, mines and the old tailings areas in the City of Johannesburg (CoJ).
- Exceedances of the NAAQS were also simulated around high emitting residential fuel combustion areas.

$PM_{2.5}$

- The model showed reasonable performance even though $PM_{2.5}$ concentrations were in general under-estimated in comparison to measured results.
- Exceedances for 24hr averages were simulated over most of VTAPA even with the under-estimation, with annual means showing areas of impact around mines, tailings facilities and areas of heavy domestic fuel combustion.
- Model simulations did not reflect the annual exceedances recorded at Sebokeng and Three Rivers.
- The model did not simulate late evening and early morning peaks – this may be related to over-estimated wind speed.

SO_2

- The model showed overall moderate performance with over-estimated SO_2 concentrations compared to measured results due to over-estimated wind speed – tall stack impacts tend to dominate due to enhanced turbulence.
- General modelled exceedances of the NAAQS were around Lethabo power station and Sasolburg.

NO_2

- The modelling results generally provided a good comparison to the measured values.
- The model under-estimated at Diepkloof (Ben Naude Street traffic) as the model did not capture micro-scale emissions activity on roads around the monitoring station.
- It over-estimated at AJ Jacobs due to enhanced turbulence leading to Lethabo power-station and Sasol Sasolburg plumes impacting ground level concentrations.
- Higher concentrations were modelled around Sasolburg.

O_3

- Generally, the modelled results indicted a good comparison to the measured values.
- The simulated 8-hour concentrations resulted in NAAQS exceedances over the majority of the VTAPA.
- There was a zone of titration around Sasolburg where the concentrations were lower.

Model simulations indicated widespread exceedances of O_3 and PM over the majority of the VTAPA.

Source tracking was done for industry sources within and outside the VTAPA. PM_{10} impacts within VTAPA were primarily due to industries within VTAPA. There is a regional aspect to O_3 formation when related to the precursor contributing sources and for the VTAPA there was a mixed contribution from local industry and those outside, but the outside sources seem to play a larger role in O_3 formation within the VTAPA.

VTAPA Health Study

A baseline health assessment study was conducted in the VTAPA during 2013 and 2014. The study comprised of a community survey in four communities and a child respiratory health study (including lung function tests) in four schools within the community study areas, as well as an assessment of human health risks resulting from exposure to air pollution.

The main findings of the study may be summarised as follows:

- Ambient concentrations measured at DEA/South African Weather Services (SAWS) stations in 2013 indicated no risk from SO_2 but indicated risk from NO_2 in Zamdela. PM_{10} was found to be a concern with highest concentrations of PM_{10} recorded in Sharpeville during 2013.
- From the community survey, risk factors for respiratory illnesses were mostly associated with energy use (coal for cooking and paraffin for heating), overcrowding and hygiene practices (burning or burying of refuse or failure to regularly remove refuse) as well as lifestyle (active and passive smoking and alcohol use).
- The main conditions affecting vulnerability of areas to the effects of air pollution involved socio-economic conditions and energy use. The main areas of vulnerability were north of the Sebokeng and Sharpeville monitoring stations and south-east of the Zamdela monitoring station.
- Although the socio-economic conditions and exposure at the schools were similar, the odds of having chronic symptoms (such as cough, wheeze and phlegm and asthma) were significantly higher at the school in Sharpeville.

There is reason for concern that air pollution in the VTAPA may be affecting child health.

VTAPA Source Apportionment Study

The VTAPA SAS aims to apportion the contribution of sources to the overall PM_{10} and $PM_{2.5}$ loading in the VTAPA. Three sampling campaigns were initiated to cover the winter, summer and spring months at four (4) strategically identified sites namely; Kliprivier, Sebokeng, Sharpville and Zamdela in the VTAPA. The samples were analysed for chemical-, elemental- and ionic composition and statistical models were used to apportion the various sources.

Preliminary results indicate:

- The NAAQS are frequently exceeded at all four sites in summer, winter and spring, but it is significantly worse during winter with PM_{10}, $PM_{2.5}$ and SO_2 the main pollutants of concern.
- The coarse particulate fraction dominated both during daytime and night-time sampling periods, during all three sampling campaigns.
- Elemental characterization of the summer and winter samples showed dust elements in the coarse particulate fraction to be prominent during the day at all four sites. At Kliprivier and Sharpville, and to a lesser extent Zamdela, indicators of combustion products were evident in the evenings in summer and winter. Motor vehicle elements were higher in the coarse fraction at night at all four sites, in both seasons.
- Soluble inorganic concentration loading showed inorganic content from crustal and anthropogenic activities.
- Source apportionment of the coarse particulate fraction indicated dust to be the dominant source, with sulphates and nitrates second.
- In the fine fraction, the largest portion of observed mass is unresolved with sulphates and nitrates dominating at all four sites during all three sampling campaigns.

The main finding thus far from the SAS is that dust is the main source of PM_{10} concentrations within the VTAPA, with the main sources contributing to $PM_{2.5}$ still unaccounted for. Nonetheless, the contribution from sulphates, domestic fuel burning, biomass burning, and vehicles were significant in all three campaigns.

A qualitative waste burning survey conducted in Sharpeville highlighted the large scale of local waste burning and veld fires in this community and reinforces the strong need for improved activity and emission factor data on burning.

GAINS modelling scenario findings

The GAINS model was used to assess a set of emission reduction scenarios as a first screening to determine the potential for reducing health impacts of air pollutants within the VTAPA. This is done by altering the energy activity mix and applying abatement measures to different sectors.

For the scenarios, 2015 was taken as the baseline year with emission reduction pathways assessed in the medium-term (20-year period). The sectors included in the GAINS modelling scenarios were:

- Domestic Fuel Burning – electrification of households; replacing coal with Liquefied Petroleum Gas (LPG) and implementing low-smoke stoves, with LPG the option with the highest reduction in $PM_{2.5}$ emissions.
- Industrial Sector – Implementation of fabric filters versus Electrostatic Precipitators (ESPs) to control PM emissions; controlling SO_2 emissions with flue gas (dry and wet) desulphurisation technologies and use of combustion modification technologies to control NO_x emissions.

- Waste Sector – increased municipal waste due to population growth with banning municipal waste burning the preferred scenario.
- Transport Sector – Implementation of Euro 5 and Euro 6 fuel standards in the transport sector, with Euro 6 having the largest reduction in NOx emissions.

VTAPA Capacity Building Plan

Capacity for air quality management and control at National, Provincial and Local government levels were found to be inadequate to ensure the successful implementation of the intervention plans and a capacity building plan was developed as part of the AQMP. The air quality officers and relevant government officials from the various municipalities within the VTAPA identified the required skills to be developed and areas of interest in air quality management. Training on emissions inventory development, specifically for sources and activities within VTAPA, was the most sought-after skillset requirement. A hands-on training course focussing on the smaller sources (i.e. controlled emitters) within the VTAPA and providing additional information in the development of the AQMP were conducted on the 19th and 20th June 2018 in Pretoria.

The strategic framework for capacity building covered:

- Background to SA emissions inventory,
- Background to VTAPA emissions inventory,
- Brief introduction to sources and sinks (industrial; mining; mobile; domestic fuel burning; waste; windblown dust; biogenetic VOC emissions; biomass and others),
- Emissions inventory development, and
- A practical session where each AQO had to identify and collect the relevant information from at least three (3) controlled emitters or small sources within their jurisdiction, and the emissions for these were quantified during the session.

Strategy Analysis

Identifying appropriate strategies is important for the development of feasible interventions and based on the findings from the baseline characterisation, the preliminary SAS results and the GAINS results, five problem complexes were identified as the main contributors to the current air quality situation in the VTAPA. These complexes are: i) industry; ii) vehicles; iii) windblown dust; iv) waste burning and v) domestic fuel burning.

In order to gain an understanding around the sensitivity of ambient air quality in the VTAPA to the various emission changes (brought about by interventions), modelling was used to translate emission scenarios to changes in pollutant concentrations. A summary of the scenarios is provided in Table B.

Table B: Summary of emission changes applied for the "new baseline" and scenarios

Sector	Baseline	Scenario 2025	Scenario 2030
Industry	1. New Vaal open-cast coal mine emissions re-calculated based on this throughput rate and the emission factors for open cast mining in NAEIS. 2. Emissions from Gryphon Tiles were re-calculated using MES, and Pegasus Tile Factory emissions were corrected based on emission measurement reports. 3. All other emissions as reported in NAEIS.	MES 2020 for industry in 1km domain (assumed industries already compliant, would not increase production and would remain at baseline emissions)	MES 2020 for industry in 1km domain (assumed industries already compliant, would not increase production and would remain at baseline emissions)
Vehicles	No change compared to baseline report	None	100% of vehicle fleet are EURO5 compliant
Dust	No change compared to baseline report	Control Efficiency of 80% on all TSFs	Control Efficiency of 80% on all TSFs
Waste burning	No change compared to baseline report	39% reduction on baseline	60% reduction on baseline
Domestic burning	No change compared to baseline report	53% reduction on baseline	77% reduction on baseline

The main findings from the scenario modelling are as follows:

- Simulations indicate that through the scenario emission reductions, PM may be reduced to acceptable levels. However, 24-hour $PM_{2.5}$ remains an issue in the northern VTAPA.
- For NO_2, the baseline indicates that only the NAAQS for the annual average is exceeded around Sasolburg. The reductions in the scenarios do not reduce this significantly. The majority of reductions in ambient are seen further afield from Sasolburg.
- Ozone remains problematic after both future scenarios. This is primarily due to the region being VOC-limited and emission reductions on NO_x being moderate. It is also possible the ozone issue involves transboundary impacts into and out of VTAPA; making it a regional management issue.
- Further reductions in SO_2 are required since the 2020 MES will not ensure compliance. These are relevant for Lethabo power-station and other industries around Wolwehoek, Diepkloof Zone 6 and north of Bophelong.

Air Quality Management Actions for the VTAPA

The objective for VTAPA is

Compliance with NAAQS within the VTAPA though continuous AQM implementation action and coordination by the various spheres of government and all stakeholders

VTAPA Implementation Plan

Interventions for the VTAPA second generation AQMP was developed by means of a Stakeholder Consultation Workshop that was held on the 13th of March 2019 in Vanderbijlpark. A total of eight (8) sectors were identified for which specific interventions were developed to form part of the implementation plan. These intervention sectors, and the main goal for that intervention, are as follows:

1. **Industries and power generation / compliance monitoring and enforcement**
   Goal: *All Listed Activities will be compliant with MES and fugitive emissions would have reduced such as to ensure compliance with NAAQS.*
2. **Mining operations**
   Goal: *By 2025, fence line monitoring to confirm compliance with NAAQS, specifically for PM_{10} and $PM_{2.5}$, and NDCR.*
3. **Ash dumps and tailings storage facilities**
   Goal: *By 2025, 80% reduction in windblown dust emissions ensuring compliance with NAAQS within the vicinity of all ash dumps and tailings storage facilities.*
4. **Domestic fuel burning**
   Goal: *By 2025, emissions from domestic fuel burning would have decreased by 50%, and with a further 25% reduction by 2030 which would ensure compliance with NAAQS.*
5. **Domestic waste burning**
   Goal: *No informal waste burning by 2030.*
6. **Biomass burning**
   Goal: *Reduced uncontrolled veld fires through veld management measures and quick response times.*
7. **Education and awareness**
   Goal: *Increased awareness on air quality challenges within the VTAPA.*
8. **Vehicle emissions**
   Goal: *By 2025, reduce emissions from vehicles to ensure compliance with NAAQS near roads.*

Implementation plans for each of these intervention sectors are provided in the following tables where the interventions were prioritised based on the significance of the problem necessitating the set intervention, the likelihood of implementation, the cost and the risks linked to the intervention. Since detailed cost associated with each intervention can only be determined through consultation with the various stakeholders[1], an estimated cost category is indicated as ***Low*** (<R1,000,000); ***Medium*** (R1,000,000 – R5,000,000) and ***High*** (>R5,000,000).

[1] It is noted that the AQMP lacks an accompanying economic impact assessment at a time when there are various other initiatives at provincial and municipal level competing for the same resources. Allocation of funds and resources at initiative level is crucial for successful implementation of the AQMP.

Sector 1: Industries & Power Generation /Compliance Monitoring and Enforcement.

Objectives	Activities	Mandatory responsibility	Participatory responsibility	Estimated Cost	Enabling Factors	Timeframes	Indicators	Priority
Minimisation of emissions from regulated facilities	Compliance with the existing MES	Industry, NGO's	Licensing Authority	***High cost*** – for industry ***Medium cost*** – for Licencing Authority	AEL's and NAEIS annual reporting More EMI's required for inspections and enforcement (Licencing Authority)	The year 2025	Monitoring reports (Compliance monitoring activities)	High
Minimisation of fugitive emissions (e.g. waste, stockpiles, conveyor belts, haul roads etc.)	Develop and implement the Fugitive Emission Plan informed by Best Environmental Practice	Industry	Licensing Authority	***Low cost*** – for industry and authority	Industry to submit Plan to Licencing Authority within set timeframe as specified in AEL Annual NAEIS reporting	2 years or timeframe to be specified in the AEL	All facilities with AEL submitted plans to the licensing authorities	High
	Identification and implementation of suitable technology (Introduction of binding agents in waste stockpiles and dust suppressants)	Industry	Licensing Authority	***Medium cost*** – for industry	Investigating various products on the market Suppliers to do on-site trials to identify most suitable product Determine frequency of application and budget for it annually	3 years	Dust management plans implemented	High
	Reporting of fugitive emissions on NAEIS	Industry	Licensing Authority and DFFE	***Low cost*** – for industry	Already a legal requirement – annual NAEIS reporting	yearly	All facilities with AEL submitted plans fugitive emissions	High
	Minimize and manage NEMA Section 30 incidents	Industry	Licensing Authority	***Medium to High cost*** – for industry	Incidence register. Should be part of operations Cost of managing incidents would depend of the industry and type of incident	1 year	Number of Section 30 incidents	High
Emissions from dust-generating activities are reduced	Development of legal framework to manage emissions from small/unlicensed facilities	Local municipalities	DFFE	***Low cost*** – existing personnel	To form part of Local government legislation development	2 years for development and implementation in 5yrs	Legal framework in developed	High

Objectives	Activities	Mandatory responsibility	Participatory responsibility	Estimated Cost	Enabling Factors	Timeframes	Indicators	Priority
	Identify unlicensed dust generating activities	Local municipalities, CBOs and NGOs	DFFE	***Low cost*** – to be done by existing personnel	Can form part of emissions inventory development of Section 23 (per capacity building plan) Local government officials will have to do visual inspections of areas to identify activities	Ongoing	Identified dust generating activities	High
	Holistic approach for dust management where there is cluster of facilities	Industry/ licensing authorities	Licensing Authority	***Low cost*** – industry and government	Can form part of dust management plan reviews and interpretation To be reported at MSRG meetings	2 years	Integrated dust management plans developed	High

Notes: NGO – Non-Government Organisation, CBO – Community Based Organisation, MSRG – Multi Stakeholder Reference Group

Sector 2: Mines

Objectives	Activities	Mandatory responsibility	Participatory responsibility	Estimated Cost	Enabling Factors	Timeframes	Indicators	Priority
Management /reduction of emissions from mines	Dust management plans developed and implemented	DMRE and mines	DFFE and Licensing authorities	***Medium cost*** – monitoring	Requirement of annual NAEIS reporting Installation of dustfall networks (analysis and reporting)	2 years	All mines developed dust management plans	High
	Vegetation (indigenous plants and grass) on the abandoned mine dumps	Mines and DMRE	DFFE	***High cost*** – depending on type of cover	Mines to submit rehabilitation plans to government with implementation timeframes and required maintenance frequency	5 years	Number of dumps rehabilitated	Medium
	Establish the complaints management system for all mines	Mines and DMRE	DFFE, NGO's and Municipalities	***Low cost***	Complaints register and upkeep Report annually to authority	2 years	The complaints management system established by all mines	High
	Implementation of the rehabilitation plans for non-operational mines	Mines and DMRE	Municipalities and DFFE	***High cost*** – depending on type of cover	Mines to submit rehabilitation plans to government with implementation timeframes and required maintenance frequency	Long-term	Mines rehabilitated	Medium

Notes: DMRE – Department of Mineral Resources and Energy

Sector 3: Ash Dumps and Tailings Storage Facilities

Objectives	Activities	Mandatory Responsibility	Participatory Responsibility	Estimated Cost	Enabling Factors	Timeframes	Indicators	Priority
Reduction of particulate matter emanating from ash dumps and tailings storage facilities	Dust suppression (e.g. chemical application and or watering active dumps)	Industry	DFFE ,DMRE and municipalities	***High cost*** – continuous	Requirement in AEL and/or NAEIS reporting Industries to submit management plans to government with implementation timeframes and required maintenance frequency	Ongoing	Number of dumps rehabilitated Complaint with dust regulations	High
	Reduce quantities of ash dumps by diversifying reuse and beneficiation	DFFE F: Waste Phakisa and industry	Local Municipalities, NGOs, CBOs	***High cost*** – continuous	Requirement in AEL and/or NAEIS reporting Industry to find use for ash – by-product	5 years	Increase in the amount of ash reused	Medium

Notes: NGO – Non-Government Organisation, CBO – Community Based Organisation

Sector 4: Domestic Fuel Burning

Objectives	Activities	Mandatory Responsibility	Participatory Responsibility	Estimated Cost	Enabling Factors	Timeframes	Indicators	Priority
Domestic fuel burning emissions reduction	Rollout of low smoke and LPG stoves and heaters, and alternative energy sources	DMRE and DFFE	Province, DFFE Industry, NGOs & CBOs	***High cost*** – frequent and continuous	Funding through offset projects, social responsibility programmes and alternatives	50% by 2025 75% by 2030	% uptake by targeted households	High
	Promote use of clean/green fuels such as LPG, biogas etc.	DMRE	Province, Industry, DFFE , NGOs & CBOs	***Low cost*** – quarterly awareness campaigns	Awareness campaigns in partnership with NGO's and CBO's	50% by 2025 75% by 2030	% uptake by targeted households	High
	Promote and fit RDP houses with sufficient Insulation	DHS and municipalities	Province, DFFE, NGOs & CBO's	***High cost*** – once off	Industries can assist as part of offset projects and social responsibility programmes in general Implement guidelines on indoor air pollution	5 years	Number of RDP houses with sufficient insulation	Medium

Notes: DMRE – Department of Mineral Resources and Energy; DHS – Department of Human Settlements, LPG – Liquefied Petroleum Gas, NGO – Non-Government Organisation, CBO – Community Based Organisation, RDP – Reconstruction and Development Programme

Sector 5: Domestic Waste Burning

Objectives	Activities	Mandatory Responsibility	Participatory Responsibility	Estimated Cost	Enabling Factors	Timeframes	Indicators	Priority
Reducing domestic waste burning emissions	Waste separation at source & recycling	Local Government	DFFE , Province, Industry, private companies, NGOs & CBOs	***High cost*** – continuous	Develop procedure for waste separation (group specific wastes) Partnership with NGO's and CBO's Train and contract community people Industries involvement as part of offset projects	50% by 2025	% uptake by targeted households	High
	Waste collection & clean-up	DFFE, local government and Industry through offset projects	DFFE, Province, NGOs & CBOs	***High cost*** – continuous	Should already be budgeted for by municipalities Partnership with NGO's and CBO's Industries involvement as part of off-set projects	90% by 2030	% uptake by targeted households	Medium
	Management of municipal and privately-owned landfill sites	GDARD and DESTEA	DFFE	***High cost*** – continuous	DFFE roles, including enforcement, in National Environmental Management: Waste Act (NEM:WA; no 59 of 2008) Provincial to support compliance monitoring and municipal capacity Additional human resource capacity	75% reduction of burning incidents by 2025 100% reduction of burning incidents by 2030	% reduction in number of burning incidents	High
Reducing tyre burning emissions	Awareness campaigns	Local municipality, CBO, NGO	GDARD and DESTEA	***Low cost***	Awareness campaigns Partnership with NGO's and CBO's	No tyre burning by 2025	% reduction of tyre burning by 2025	High
	Regulate tyre burning through bylaws (SAPS to enforce the bylaws)	Local municipality, SAPS	DFFE, GDARD	***Medium cost*** – to implement By-law	Additional human resource capacity required to enforce bylaws Conduct ad hoc checks			High

Objectives	Activities	Mandatory Responsibility	Participatory Responsibility	Estimated Cost	Enabling Factors	Timeframes	Indicators	Priority
	Establish way to support tyre collection facilities per district through Waste Bureau.	DFFE, Waste Bureau, district municipalities, local municipalities, NGOs, CBOs	Industry NGO's and CBOs	***High cost*** – continuous	Waste Bureau Phakisa			Medium

Notes: GDARD – Gauteng Department of Agriculture and Rural Development; DESTEA – Department of Economic, Small Business Development, Tourism and Environmental Affairs, NGO – Non-Government Organisation, CBO – Community Based Organisation, SAPS – South African Police Service

Sector 6: Biomass Emissions

Objectives	Activities	Mandatory responsibility	Participatory responsibility	Estimated Cost	Enabling Factors	Timeframes	Indicators	Priority
Management of veld fire occurrence	Municipalities to implement Veld fires guidelines (establish relation with EPWP working for fire. Establish veld fire hotline. Induction of employees in management of veld fires.)	Local municipality NGOs and CBOs	Private companies Landowners DFFE, DALRRD Metro Polices Municipal Fire units	***Low cost***	Fire Protection Associations may be developed in line with the National Veld and Forest Fire Act (No. 101 of 1998); which include veldfire management strategies and a fire protection officer	Ongoing	Reduced number of uncontrolled veld fires	High
	Conduct education and awareness campaigns on burning and veld fires.	Local municipality, Province, and DFFE	Private companies Landowners DFFE, DALRRD, NGOs, CBOs Metro Polices Municipal Fire units	***Low cost*** – quarterly awareness campaigns	Awareness campaigns – billboards, advertisements in local newspapers, campaigns at schools	Ongoing	Annual campaigns	High

Notes: DFFE – Department of Forestry ,Fisheries and the Environment; DALRRD – Department of Agriculture, Land Reform and Rural Development; EPWP – Expanded Public Works Programme

Sector 7: Education and Awareness

Objectives	Activities	Mandatory Responsibility	Participatory Responsibility	Estimated Cost	Enabling Factors	Timeframes	Indicators	Priority
Domestic fuel burning emissions reduction	Awareness Programme clean fuels, and other alternative sources, as well as Renewable energy sources,	DFFE, Local Government	DFFE, Province, Industry, NGOs & CBOs	***Low cost*** – quarterly awareness campaigns	Monthly advertisements in local newspapers Quarterly awareness programmes at schools Awareness campaigns on billboards Industries as part of offset projects	Ongoing	Annual workshop held	High
Reducing domestic waste burning emissions	Awareness (Green Good Deeds type) on waste burning & recycling	DFFE, Local Government	DFFE, Province, Industry, NGOs & CBOs	***Low cost*** – quarterly awareness campaigns ***High cost*** – industry	Monthly advertisements in local newspapers Quarterly awareness programmes at schools Awareness campaigns on billboards Industries as part of offset projects	Ongoing	Annual workshop held	High
Promotion of educational programmes on the use of biomass	Introduce and continuations of alternative programmes	DFFE	DTI, DFFE, DST, DALRRD, NGOS, CBOs and municipalities, SANEDI	***Low cost*** – annual workshops		Ongoing	Annual workshop held	Medium
Reduce emissions from vehicles	Awareness campaign on green transport (e.g. use of bicycles, lift clubbing, park and ride to work or shops etc.)	DFFE and DOT	Communities and Municipalities	***Low cost*** – quarterly awareness campaigns	Monthly advertisements in local newspapers Quarterly awareness programmes at schools Awareness campaigns on billboards	Ongoing	Annual workshop held	Medium

Notes: DOT – Department of Transport; DOH – Department of Health; DTI – Department of Trade and Industry; DST – Department of Science and Technology; DALRRD – Department of Agriculture, Land Reform and Rural Development; SANEDI – South African National Energy Development Institute

Sector 8: Vehicle Emissions

Objectives	Activities	Mandatory responsibility	Participatory responsibility	Estimated Cost	Enabling Factors	Timeframes	Indicators	Priority
Reduce emissions from vehicles	Promotion of non-motorised and public transport systems	DOT, municipalities	NGO's	***Low cost*** – quarterly awareness campaigns	Monthly advertisements in local newspapers Quarterly awareness programmes at schools Awareness campaigns on billboards	3 years	Annual campaigns	Medium
	Annual testing of vehicle exhaust emissions	DOT, municipalities	DOT, municipalities	***Medium cost*** – once off purchase and maintenance of equipment	Determine the number of testing equipment required per municipality and the human resource capacity required to conduct the testing Testing can be done at testing grounds as part of license renewal (then additional staff might not be required); or as spot checks in the first year Include emission testing as part of roadworthiness certification Include cost for testing equipment and additional salaries in Municipal IDP Compile a testing procedure	3 years	Testing reports indicating numbers of vehicle tested	Medium
	Identify unpaved road generating dust and prioritise high risk roads	DOT and Local municipality	DFFE, NGO, CBO	***Low cost*** – can be done by existing personnel	Community awareness campaigns and cooperation with NGO's and CBO's Air quality personnel to visually inspect areas and identify busy unpaved roads	2 years	All unpaved roads identified	High
	Implement management measures for identified high risk dust generating roads	DOT and Local municipality	DFFE	***Medium cost*** – once off with maintenance	Costing will depend on the length of the road Can be done by industry as part of off-set projects	5 - 10 years	Unpaved roads tarred	High
Improve the regulatory framework In	Municipalities to develop/review bylaws to address air quality related issues (e.g. consider penalizing vehicles with visible smoke)	Local municipality	Local municipalities, DFFE, NGO's and CBO	***Low cost*** – to be done by existing personnel	Enforce municipal by-law	5 years	Developed or reviewed bylaws impacting air quality	Medium

Objectives	Activities	Mandatory responsibility	Participatory responsibility	Estimated Cost	Enabling Factors	Timeframes	Indicators	Priority
the municipality	Increase of capacity to enforce bylaws to address air quality related issues	Local municipality	Local municipalities, DFFE	***Medium cost*** – to employ more personnel	Assess additional human resource capacity required to enforce bylaws	5 years	Number of enforcement officials trained	Medium
	Establish intergovernmental coordination committee on air quality (Transport, Energy, Health, Minerals, Cooperative governance and Human settlement)	DFFE	DFFE	***Low cost*** – to include existing personnel	Intergovernmental communication and awareness to get by-in for coordination committee Can be incorporated into current responsibilities	1 year	Committee established	High

Notes: DOT – Department of Transport, NGO – Non-Government Organisation, PRASA – Passenger Rail Agency of South Africa, CBO – Community Based Organisation, AARTO – Administrative Adjudication of Road Traffic Offences

Potential Future Threats

Future threats in the area are regarded as risks associated with the implementation of the interventions which would jeopardise the overall objective of the AQMP. These threats can be summarised as follows:

- Budgetary allocations or lack of provision to be inadequate to achieve goals;
- Available control technology found to be unfeasible;
- Political buy-in from decision making powers lacking resulting in lack of planning and budgetary constraints;
- Too many interventions, with some not clearly defined (also economic factors that could hamper certain intervention);
- Interventions at National level that are outside the control of the Local Municipality to implement;
- Constraints in human resource capacity for AQMP implementation – number of people and technical competency (insufficient follow-up);
- Political buy-in from decision making powers lacking resulting in lack of planning and budgetary constraints;
- Enforcement – no consequences or penalties for failing to implement the set interventions; and
- Inadequate methods in creating public awareness.

Monitoring and Evaluation

One of the most important indicators for AQMP success is a decrease in air pollutant concentrations. In order to monitor progress, measurements of pollutants must be analysed in order to understand the ultimate impact from interventions. With the locations of the current monitoring stations mainly within low income settlements, it is likely that only improvements as a result of interventions on domestic fuel burning and domestic waste burning would be reflected in the ambient monitoring data. Conducting ambient monitoring at locations within the more formal settlements, away from main influencing sources but within the main impact area of the VTAPA should show improvements from other interventions aimed at reducing emissions from: vehicles, industry (i.e. 2020 MES) and mining. Passive sampling campaigns are recommended for this purpose to be conducted bi-annually, one campaign in winter and one in summer. Two locations are proposed: one in the southern part of Vanderbijlpark and one to the north of Vereeniging. These campaigns will also serve to monitor impacts on regional air quality.

Update of the VTAPA Second Generation Emissions Inventory

As part of regular monitoring and evaluation, the second generation VTAPA emissions inventory will have to be continuously updated. The update should include, as a minimum, the identification and quantification of all Controlled Emitters and Small Stationary Sources in the region as well as updating information on the fuel use for domestic fuel burning consumption, record waste burning activities and identify exposed areas within residential areas that can give rise to windblown dust. This will further enable the Air Quality Officers to fulfil their legal obligation and ensure a successful implementation of the second generation VTAPA AQMP.

Stakeholder Engagement

There are several forums in place in the VTAPA to ensure inter-governmental communication and cooperation's as well as engagement with various stakeholders. These forums should be used optimally to ensure the successful and continuous and successful implementation of the VTAPA second generation AQMP. Action for these forums could include:

- MSRG should continue to meet bi-annually but with focus on information communication and awareness raising, track clear targets for implementation and hold responsible parties accountable for non-performance;
- ITT quarterly meetings should serve as interim follow-ups on specific actions should be consequences for actions not taken;
- VTAPA Authorities bi-annually meeting should set clear targets with implementation timeframes and accountability for non-performance; and
- DFFE remains responsible for enforcement and accountable for non-performance.

Review of VTAPA Implementation Plan

Progress on the implementation of the VTAPA second generation AQMP should be closely monitored, with an internal review at the end of each financial year where the interventions should be re-defined if needed and re-prioritised. The AQMP should be reviewed within five years of publication.

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1 Introduction

The Vaal Triangle Airshed was declared a priority area in April 2006 (Government Gazette Notice No. 365 of 21 April 2006, as amended by Notice 711 of 17 August 2007) by the then Minister of Environmental Affairs and Tourism and was the first Air Quality Priority Area in South Africa due to concern for elevated pollutant concentrations within the area, specifically particulates (Figure 1). An Air Quality Management Plan (AQMP), providing detailed intervention strategies, was developed for the Vaal Triangle Airshed Priority Area (VTAPA) between 2007 and 2009, with the final plan published on 29 May 2009 (Government Gazette No. 32254). In 2013, the AQMP was reviewed with the objective to establish an updated understanding of the air quality status in the VTAPA and to inform strategies that will ensure improvement in air quality in the area. The aim of the second generation AQMP is to characterise the baseline after seven years and determine the improvement, if any, that resulted from the implementation of the 2009 AQMP. This second generation AQMP aims to establish new strategies and intervention plans, based on a better understanding of the cause and effect relationships, that will ensure further improvement and eventual compliance within the area.

The VTAPA encompasses: a portion of the City of Johannesburg Municipality, as well as Emfuleni, Midvaal, and Metsimaholo Local municipalities (Figure 2).

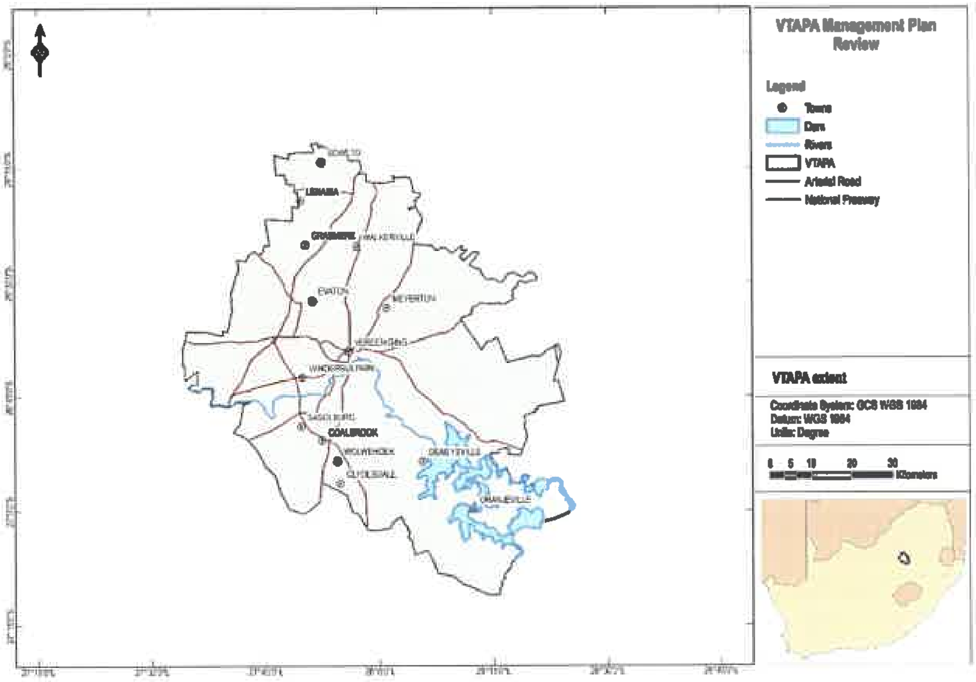

Figure 1: Demarcation of the Vaal Triangle Air-shed Priority Area

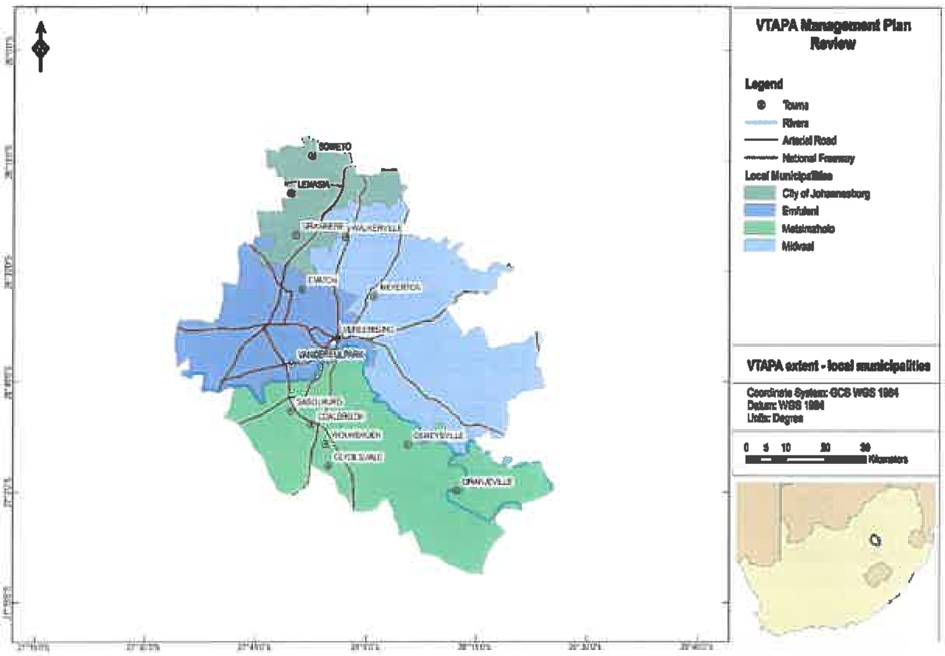

Figure 2: Local, District, and Metropolitan Municipalities Included in the VTAPA

1.1 Methodological Approach for the Development of a Second Generation Vaal Triangle Airshed Priority Area Air Quality Management Plan

The development of a Second Generation VTAPA AQMP was done in six (6) phases as summarised in Table 1 and briefly described in the subsections to follow. Each task or output had a verifiable indicator and provide a means of verification.

Table 1: Summary of immediate objectives, verifiable indicators and means of verification

Description	Verifiable Indicator	Means of Verification
Output A: Project Process Plan	A clear and unambiguous plan on how the project is to be conducted	Project Process Plan approved by the PSC/National Air Quality Officer
Output B: Baseline assessment report	• A comprehensive baseline assessment report with verifiable information • VTAPA emissions inventory (comprehensive database/spreadsheets and GIS files) • Dispersion modelling input files	A baseline report approved by PSC
Output C: Strategy Analysis and Implementation Plan	Strategy Analysis and Implementation Plan with SMART objectives, clear activity descriptions, clear resource requirements and indicators	Strategy Analysis and Implementation Plan
Output D: Draft Revised Vaal Triangle Airshed Priority Area Air Quality Management Plan	A draft AQMP based on current, accurate and relevant information that is informed by best practice in the field of air quality management. The AQMP should provide a clean and practical plan to efficiently and effectively bring	Draft plan published in the *Gazette* for public comment

Description	Verifiable indicator	Means of Verification
	air quality in the area into sustainable compliance with NAAQS within agreed timeframes	
Output E: Final Vaal Triangle Airshed Priority Area Air Quality Management Plan	A final AQMP based on current, accurate and relevant information that is informed by best practice in the field of air quality management. The AQMP should provide a clean and practical plan to efficiently and effectively bring air quality in the area into sustainable compliance with NAAQS within agreed timeframes. The final AQMP would take into account public comments.	Plan published in the *Gazette*.
Output F: Capacity Building/Development	Active involvement of departmental staff in the implementation of the project	Capacity building plan submitted to DFFE and progress reports

Notes: DFFE stands for the Department of Environment, Forestry and Fishery, previously the Department of Environmental Affairs (DEA)

1.1.1 Output A: Project process plan

The Project Process Plan gave clear form, context and focus to the project and set the direction, guidance to the general process needed to reach the ultimate goal of the project, including a timeline of each of the critical phases in the project indicating key milestones.

1.1.2 Output B: Baseline assessment report

The VTAPA baseline characterisation, which provides the foundation for the development of the AQMP, has been characterised and reported on with the main findings provided in Section 3 (DEA, 2019). These findings, together with the Source Apportionment study's (SAS) preliminary findings informed the strategy analysis and intervention plan, described in Section 4.

The emission inventory for VTAPA assessed available emissions data, quantified fugitive emission sources, and identified gaps in the emission inventory. The focus of the emission inventory was on criteria pollutants, including particulate matter (PM_{10} and $PM_{2.5}$), sulfur dioxde (SO_2) and oxides of nitrogen (NO_2). All sources of emissions within the VTAPA, including industry, mining, residential areas, public areas and natural sources, were identified and quantified where information was available. Two emission inventories were developed: one for the VTAPA and one as a regional emission inventory. The VTAPA emission inventory was used for management purposes, and the regional emission inventory was used for dispersion modelling.

The ambient air quality assessment made use of available ambient air quality data from SAAQIS (South African Air Quality Information System), from District Municipalities and from industries. Data was obtained from these stations for the period 2013-2015 to determine dispersion conditions and for the period 2007-2016 to assess ambient air quality trends.

The CAMx chemical air quality model was used to simulate ambient air quality concentrations over the VTAPA, including background sources outside the VTAPA boundary. The model also allows for primary and secondary pollutant tracking. The same modelling domain was used as for the 2009 VTAPA AQMP, including the topographical data with an update on the land-use data including all air quality sensitive receptors within the study area.

Preliminary results from the VTAPA Source Apportionment Study (SAS), which is currently being finalised, were integrated into the baseline assessment to inform the cause and effect relationship. The findings from a baseline health assessment study conducted in the VTAPA during 2013 and 2014, were also assessed and included.

1.1.3 Output C: Strategy Analysis and implementation plan

The Second Generation VTAPA baseline assessment, together with the preliminary results from the SAS and the findings from the VTAPA baseline health assessment were used to identify the main sectors and associated activities for which interventions needed to be developed. The GAINS model was run for a set of intervention scenarios, based on the same emission inventory used in the VTATA baseline assessment with the aim to provide an indication of the expected air quality improvement associated with a specific intervention, as well as the cost benefit thereof. Up to three scenarios were selected for each source group. These selected interventions were then modelled using the VTAPA CAMx model to assess the air quality improvement these interventions are likely to provide.

The strategy analysis was conducted during a workshop with all the relevant stakeholders. The outcome will be action plans for implementation within a set timeframe

The interventions were revised and finalised based on comments received from the VTAPA Stakeholders. A high-level risk assessment was conducted for these interventions on the probability of not achieving the desired aim of ensuring ambient air quality improvement within the VTAPA.

1.1.4 Output D: Draft Second Generation Vaal Triangle Airshed Priority Area Air Quality Management Plan

The Draft AQMP provides a review of the First Generation VTAPA AQMP findings and interventions to indicate the progress, if any, and inform the Second Generation AQMP. The key aspects from the second generation Baseline Assessment and the Strategy Analysis are provided to explain the intervention descriptions and inform the development of the Implementation Plan.

The Draft Second Generation AQMP will be published for public comments before being finalised.

1.1.5 Output E: Final Vaal Triangle Airshed Priority Area Air Quality Management Plan

The final AQMP based on current, accurate and relevant information that is informed by best practice in the field of air quality management, will be completed once the public comments on the Draft AQMP have been addressed. The aim of the AQMP is to provide a clean and practical plan to efficiently and effectively bring air quality in the area into sustainable compliance with National Ambient Air Quality Standards (NAAQS) within agreed timeframes.

1.1.6 Output F: Capacity Building/Development

The capacity building plan was developed based upon the skills and interests of the assigned officials. The plan for capacity development includes a hands-on training course for the most desired AQMP implementation activity. A senior member of the team guided the participants through the process followed. In addition, there were hands-on exercises that assisted with the overall AQMP development. This assisted the officials in not only understanding the process, but in understanding how and why assumptions are made, and what data are needed for the implementation of the AQMP.

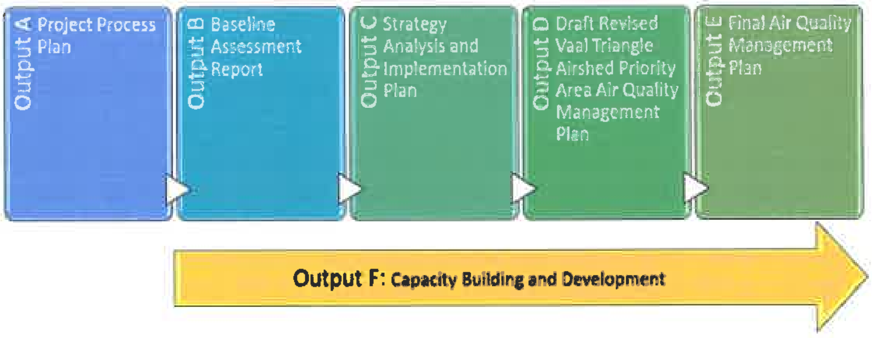

Figure 3: AQMP development process flow

1.2 Air Quality Legislation and Regulatory Requirements

The National Environmental Management: Air Quality Act (hereafter "the Act" or NEM: AQA) (Act No. 39 of 2004) sets out to protect the environment by providing reasonable measures for: (i) the protection and enhancement of the quality of air in the Republic; (ii) the prevention of air pollution and ecological degradation; and (iii) securing ecologically sustainable development while promoting justifiable economic and social development. These objectives give effect to section 24 (b) of the Constitution in order to enhance the quality of ambient air for the sake of securing an environment that is not harmful to the health and well-being of the people.

The Act is specific to what an air quality management plan must achieve. These include improvement of air quality; reducing negative impacts on human health and the environment; addressing the effects of fossil fuels in residential applications; addressing the effects of emissions from industrial sources and from any point or non-point sources of air pollution; implementing the Republic's obligations in respect of international agreements; and giving effect to best practice in air quality management. The Act also provides for regulations that may be made for implementing and enforcing approved priority area AQMPs including, amongst others, funding arrangements; measures to facilitate compliance and regular review.

The Act makes provision for the declaration and setting of standards for controlled emitters and controlled fuels, as well as the control of dust, noise and offensive odours. The Department of Environment, Forestry and Fisheries (DFFE) Manual for Air Quality Management Planning (2008) furthermore recommends that, in addition to the NEM: AQA, other legislation be consulted in the goal setting processes of developing an AQMP.

1.2.1 Changes in Legislation since the publication of the 2009 VTAPA AQMP

At the time of the 2009 first generation VTAPA AQMP, sections of the AQA were still under development. Publications applicable to the VTAPA after May 2009 include (not in order of publication):

- National Framework Second Generation (Notice 919, Government Gazette (GG) 37078 of 29 Nov 2013), and Third Generation (Notice 1144 GG 41996 of 26 Oct 2018)
- National Ambient Air Quality Standards (NAAQS) (Notice 1210 GG 32186 of 24 Dec 2009)
- NAAQS for $PM_{2.5}$ (Notice 486 GG 35463 of 29 Jun 2012)

- National Dust Control Regulations (NDCR) (Notice R827 GG 36974 of 1 Nov 2013) and draft change in regulations (Notice 517 GG 41650 of 25 May 2018)
- Minimum National Emission Standards (NMES) (Notice 893 GG 37054 of 22 Nov 2013)
- A new Atmospheric Emission License (AEL) application requires an Environmental Impact Assessment (EIA) (GG 38282 of 4 Dec 2012) and NEMA s24 applies
- Reporting requirements for AEL holders (Notice R823 GG 38633 of 2 Apr 2014)
- Regulations for Air Impact Report (AIR) (Notice R533, GG 37084 of 11 Jul 2014) and amendments to this (Notice R284 GG 38633 of 2 Apr 2015)
- Administrative fines for operating without an AEL (Notice 332 GG 39833 of 18 Mar 2016)
- NEM: AQ Amendment Act 2014 (Notice 390, GG 37666 of 14 May 2014) pertaining mostly to administration changes
- Regulations regarding Air Dispersion Modelling (Notice 589, GG 37804 of 2 Jul 2010)
- Model air quality management by-law for municipalities (Notice 579, GG 33342 of 2 Jul 2010)
- Section 23 small boilers as controlled emitters (Notice 831, GG 36973 of 1 Nov 2013)
- Section 23 temporary asphalt plants as controlled emitters (Notice 1138, GG 37062 of 29 Nov 2013)
- Section 23 small-scale char and charcoal plants as controlled emitters (Notice 602, GG 39220 of 18 Sept 2015)
- Air Quality Offsets guideline (Notice 333, GG 39833 of 18 Mar 2016)
- Draft strategy to address air pollution in dense low-income settlements (Notice 356, GG 40088 of 24 Jun 2016)
- Regulations for declaring Greenhouse gas (GHG) priority pollutants (Notice 710, GG 40966 of 12 Jul 2017)
- Regulations for GHG emitters >100,000 ton per annum in a number of industrial sectors to report (Notice 712, GG 40966 of 12 Jul 2017)
- Pollution Prevention Plan (PPP) regulations (Notice 712, GG 40996 of 21 Jul 2017)
- Regulations for GHG reporting using National Atmospheric Emission Inventory System (NAEIS) (Notice 275, GG 40762 of 3 Apr 2017)
- The Minister may establish a National Air Quality Advisory Committee under the National Environmental Advisory Forum (Notice 245, GG 40733 of 31 Mar 2017)

1.2.2 National Ambient Air Quality Standards

Air quality guidelines and standards are fundamental to effective air quality management, providing the link between the source of atmospheric emissions and the user of that air at the downstream receptor site. The ambient air quality standards and guideline values indicate safe daily exposure levels for most of the population.

National Ambient Air Quality Standards (NAAQS) for criteria pollutants are listed in Table 2 (Government Gazette No. 35463).

Table 2: South African National Ambient Air Quality Standards

Substance	Molecular formula / notation	Averaging period	Concentration limit ($\mu g\ m^{-3}$)	Frequency of exceedance[a]	Compliance date[b]
Sulfur dioxide	SO_2	10 minutes	500	526	Currently enforceable
		1 hour	350	88	Currently enforceable
		24 hours	125	4	Currently enforceable
		1 year	50	-	Currently enforceable
Nitrogen dioxide	NO_2	1 hour	200	88	Currently enforceable
		1 year	40	-	Currently enforceable
Particulate matter	PM_{10}	24 hours	75	4	Currently enforceable
		1 year	40	-	Currently enforceable
Fine particulate matter	$PM_{2.5}$	24 hours	40	4	1 Jan 2016 – 31 Dec 2029
			25		1 Jan 2030
		1 year	20	-	1 Jan 2016 – 31 Dec 2029
			15		1 Jan 2030
Ozone	O_3	8 hours (running)	120	11	Currently enforceable
Benzene	C_6H_6	1 year	5	-	Currently enforceable
Lead	Pb	1 year	0.5	-	Currently enforceable
Carbon monoxide	CO	1 hour	30 000	88	Currently enforceable
		8 hours (based on 1-hourly averages)	10 000	11	Currently enforceable

Notes: (a) The number of averaging periods where exceedance of limit is acceptable.
(b) Date after which concentration limits become enforceable.

1.2.3 National Dust Control Regulations

The National Dust Control Regulations (NDCR) prescribe general measures for the control of dust in all areas including residential and light commercial areas (Government Gazette No. 36974 and No. 41650). The standard for acceptable dustfall rates is set out in Table 3.

Table 3: Acceptable dustfall rates

Restriction Area	Dustfall Rate (mg/m^2.day, 30-day average)	Permitted Frequency of Exceeding Dustfall Rate
Residential area	D<600	Two in a year, not sequential months
Non-residential area	600<D<1200	Two in a year, not sequential months

1.2.4 Section 21 – Listed activities

Industrial and materials processing activities that are likely to, or currently, result in atmospheric emissions are required to apply for atmospheric emissions licenses (AEL). The activities are classified into ten categories (and sub-categories) in the Government Gazette No.: 37054 (2013):

- Category 1: Combustion Installations
- Category 2: Petroleum Industry, the production of gaseous and liquid fuels as well as petrochemicals from crude oil, coal gas or biomass

- Category 3: Carbonization and Coal Gasification
- Category 4: Metallurgical Industry
- Category 5: Mineral Processing, Storage and Handling
- Category 6: Organic Chemicals Industry
- Category 7: Inorganic Chemicals Industry
- Category 8: Thermal Treatment of Hazardous and General Waste
- Category 9: Pulp and Paper Manufacturing Activities, Including By-Products Recovery
- Category 10: Animal Matter Processing

1.2.5 Section 23 – Controlled Emitters

Controlled emitters, as per Section 23(1) of NEM: AQA, include:

- any small boiler with a design capacity exceeding 10 MW but less than 50 MW net heat input per unit, based on the lower calorific value used;
- any temporary asphalt plants producing mixtures of aggregate and tar (or bitumen) for road surfacing purposes; and
- any small-scale char or charcoal plants.

Section 23 of the Act provides for registration and reporting requirements; fuel use; emission standards for these controlled emitters; and appropriate operating conditions.

1.2.6 Reporting of Atmospheric Emissions

The National Atmospheric Emission Reporting Regulations (Government Gazette No. 38633) came into effect on 2 April 2015.

The purpose is to regulate the reporting of data and information from identified point, non-point and mobile sources of atmospheric emissions to an internet based NAEIS. Its objective is to provide all stakeholders with relevant, up to date and accurate information on South Africa's emissions profile for informed decision making.

Emission sources and data providers are classified according to groups:

- Group A: "Listed activity published in terms of section 21(1) of the Act". Emission reports from Group A must be made in the format required for NAEIS and should be in accordance with the AEL or provisional AEL.
- Group B: "Controlled emitter declared in terms of section 23(1) of the Act". Emission reports must include any information that is required to be reported in terms of the notice published in the Gazette in terms of section 23 of the Act.
- Group C: "Mines" where emission reports must be made in the format required in NAEIS.

After registration on NAEIS the facility or their data provider must submit the required information for the preceding calendar year to the NAEIS by 31 March of each year.

2 The First Generation VTAPA AQMP

The development of the first generation AQMP followed a holistic approach due to the complex nature of air quality issues within the VTAPA, and resulted in the identification of management measures which, at the time, was thought to ensure improvement in the air quality in the area over time.

During the development of the initial VTAPA AQMP and even at the time of publication in 2009, no published NAAQS and MES were available.

2.1 Ambient Air Quality Data as Recorded in the First Generation VTAPA AQMP

The Department of Environment, Forestry and Fishery (DFFE) ambient air quality stations were commissioned between February and March 2007 and had limited data available at the time of the study. Use was thus made of ambient air quality data obtained from the metropolitan municipality stations. Ambient monitored data were obtained from the Jabavu (Soweto) and Orange Farm stations (City of Johannesburg) measuring ambient concentrations of PM_{10} and SO_2 since mid-2004. Data from the Sedibeng District Municipality stations in Meyerton (Midvaal Local Municipality) and Vanderbijlpark (Emfuleni Local Municipality) measuring NO_2, SO_2, O_3, CO (at both) and NO, NO_x, PM_{10} at Meyerton and benzene, toluene and xylene at Vanderbijlpark were not used due to poor data availability and quality. Ambient monitoring data from industrial sites included the Eskom Makalu station (decommissioned end of 2004), the five Sasol Stations and three ArcelorMittal Stations.

Based on the available monitoring data, the main findings are summarised as follows:

- PM_{10} concentrations were found to be elevated over the largest part of the VTAPA, particularly in residential areas where domestic coal burning occurs and areas neighboring major industrial operations.
- SO_2 concentrations showed reduction over the period 2004 to 2006 but several exceedances occurred at Jabavu and Orange Farm and in Sasolburg.
- NO_2 concentrations were low with a seasonal signature over the VTAPA.
- CO concentrations were considered to be insignificant in the VTAPA at the time.
- Ozone concentrations were elevated in areas surrounding major industrial operations.

2.2 Predicted Ambient Air Quality Data within the Vaal Triangle

Based on limited ambient air quality data at the time, dispersion modelling (the US.EPA approved CALMET/CALPUFF suite of models) was used to determine the spatial extend of the ambient concentrations within the VTAPA. From the modelling results, "hot spot" zones or focus areas were established.

A first level emissions inventory for the VTAPA was compiled based on information received through questionnaires, Environmental Impact Assessment (EIA) reports and other public documents. Sources included industrial, power generation, domestic fuel burning, mining and vehicle emissions. Criteria pollutants formed the focus of the impact assessment, with emissions of PM_{10}, SO_2 and NO_x accounted for.

Simulated ground level concentrations indicated PM_{10} to be the main pollutant of concern within the VTAPA and six (6) priority areas were identified based on highest PM_{10} concentration zones or "hotspots" (Figure 4). The areas were also selected to correspond with impact zones due to acute exposures to SO_2 and NO_2. The sensitive receptors together with the emission sources and main pollutants of concern are provided in Table 4 for each of the identified priority zones.

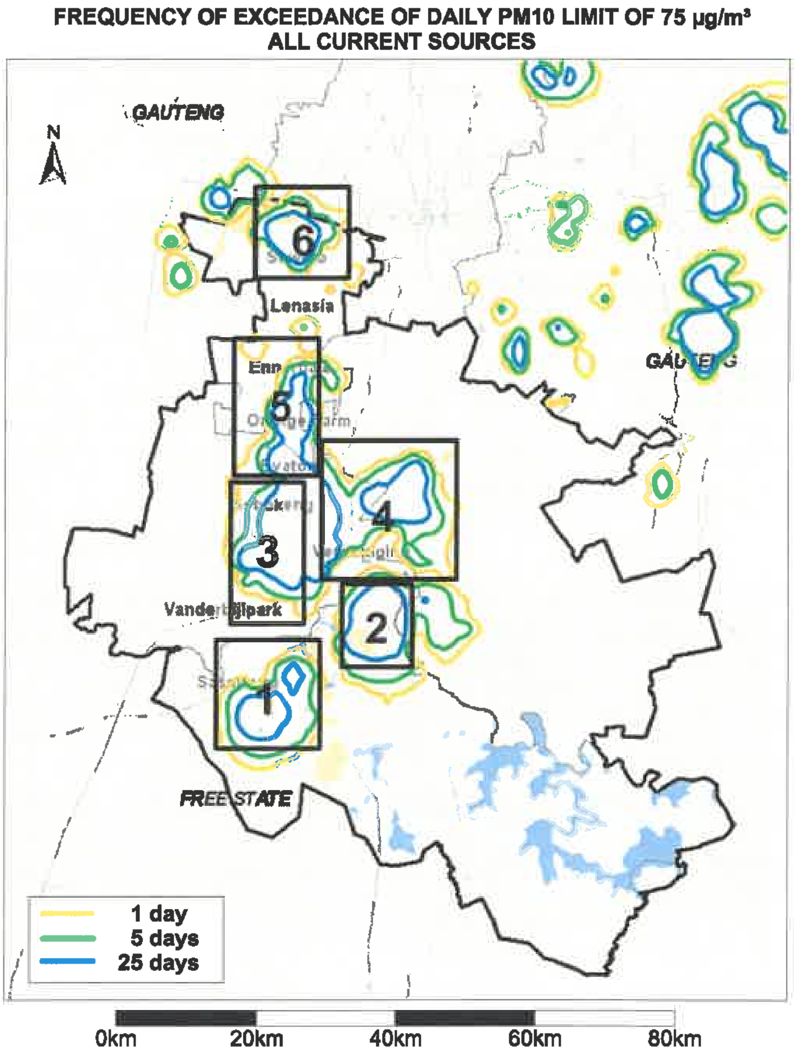

Figure 4: Six priority "hotspot" areas identified within the VTAPA based on predicted PM_{10} ground level concentrations

Table 4: Priority "hotspot" zones indicating the sensitive receptors within and the main contributing sources

Hotspot Zone	Sensitive Receptors within Zone	Emission Sources within the Zone	Additional sources not quantified and included	Pollutants of concern
1	Residential areas of Sasolburg, Zamdela and Coalbrook	Industrial activities (viz. Sasol, Omnia and Natref), mining activities (viz. Sigma Colliery) and domestic fuel burning	Agricultural activities and biomass burning	PM_{10}, SO_2 and NO_2 H_2S, VOCs
2	Located just south of the residential area of Vereeniging – no residential areas included in this zone but potential for environmental impacts	Mining activities (viz. New Vaal Colliery), power generation (viz. Lethabo Power Station) and other industrial activities	Agricultural activities and water treatment works' which may result in odour impacts	PM_{10}, SO_2, NO_2,
3	Developments of Vanderbijlpark and Sebokeng	Industrial activities (viz. Iron and Steel process (ArcelorMittal and Davsteel), commercial boilers and other smaller industrial activities), and domestic fuel burning	Industrial activities just north of ArcelorMittal (a ceramics manufacturing facility, a brickwork and a quarry), water treatment works, biomass burning and agricultural activities	PM_{10}, SO_2, NO_2 and odours, Ozone, VOCs
4	Residential developments of Vereeniging and Meyerton	Industrial activities (viz. ArcelorMittal Vaal Works, ArcelorMittal Klip Works, Metalloys, commercial boilers, and other small industrial activities) and domestic fuel burning	Agricultural activities and large areas of biomass burning	PM_{10}, SO_2 and NO_2, Ozone, VOCs
5	Residential developments of Orange Farm, Evaton and Ennerdale	Domestic fuel burning	Large areas of biomass burning	PM_{10}, SO_2 and NO_2, VOCs
6	Residential area of Soweto	Domestic fuel burning	Windblown dust from gold tailings dams	PM_{10}, SO_2 and NO_2, VOCs

2.3 Capacity Assessment

In 2009, the capacity assessment indicated a lack of communication between the various spheres of government (National, Provincial and Local) and between municipal departments resulting in duplication of work and the neglect of certain functions. At municipal level, systems and procedures for the implementation of the AQMP were found to be inadequate. It should be noted that at the time of the VTAPA AQMP publication, the AQA was in place for five years and the DFFE were in the process of building capacity for the implementation of the various components of the AQA. Also, at the time, air quality management at municipal level was the responsibility of Environmental Health Practitioners and not dedicated air quality officers and officials.

2.4 VTAPA AQMP Intervention Strategy

The 2009 intervention strategies were based on the cause and effect relationships using the Logical Framework Approach (LFA). The main problems and critical gaps associated with air quality and the management thereof were based on the identified priority "hotspot" zones and initial characterisation of the existing situation in the VTAPA. Eleven problem complexes were identified around which problem and associated objectives trees were developed. Emission problem complexes identified included: (i) Biomass Burning, (ii) Domestic Fuel Burning, (iii) Iron, Steel and FerroAlloys, (iv) Mining, (v) Petrochemical, (vi) Power Generation, (vii) Small Industries, (viii) Transportation and (ix) Waste Burning. Non-emission problem complexes identified included (x) Government Capacity for Air Quality Management, and (xi) Information Management.

A strategy analysis followed to develop feasible interventions addressing the eleven problem complexes. These interventions also incorporated suggestions from stakeholders within the VTAPA which were received during a two-day workshop. General concerns voiced by stakeholders were incorporated into the intervention strategies in the short and medium term. The main concerns included:

- The air quality target is based on a single exceedance of the VTAPA Ambient Air Quality Objectives (as per individual pollutant). It is however prudent that the management plan provides clear and unambiguous targets and timelines in which these must be achieved.
- $PM_{2.5}$ is a concern given the fine fraction of the particulates posing a larger health risk than PM_{10}. The VTAPA AQMP only addressed PM_{10} and should include $PM_{2.5}$ ambient monitoring to adequately protect human health within VTAPA. Metal analysis should also be included.
- The ambient air quality must be improved beyond the Ambient Air Quality Standards to allow room for future development in the area. This is necessary for economic growth, development and employment opportunities.
- Lenient timeframes for intervention strategies and reduction plans will result in the plan not achieving its main objective, i.e. to ensure that, once the plan is implemented, the air quality within the area will effectively and efficiently be brought into sustainable compliance.
- Indoor combustion sources, specifically the use of paraffin, should be discouraged.

A number of interventions within each problem complex were expanded into action plans providing assumptions associated with the intervention strategy, estimated costs, timeframes and indicator. Each industry had to develop a detailed emission reduction strategy that supported the overall objectives of the interventions. As an interim indicator of performance, and in the absence of the NAAQS at the time, air quality objectives were determined for the VTAPA. These were in line with the later published NAAQS.

2.5 VTAPA First Generation AQMP Implementation Review

During the medium-term review of the 2009 VTAPA AQMP in 2013, the implementation status of the VTAPA First Generation AQMP, as it was in 2013, was reported on. The barriers and challenges of implementation was based on interactive discussions with the MSRG members. This is summarised in Table 5.

Table 5: Barriers and challenges to implementation

Barriers/Challenges	Observations and Recommendations
Economic conditions	The implementation of the VTAPA AQMP commenced during the time when the global economic conditions were not favourable for certain interventions. This implied that some of the key intervention that requires huge investments could not be fully implemented.
Teething problems	The VTAPA AQMP was the first priority area AQMP and one of the first AQMP s developed in the AQA regime. As one of the first AQMPs, there were lots of new learnings both in terms of AQMP development and implementation.
Accountability	• Clear accountability is required to ensure that commitments are fulfilled. It is necessary for stakeholders to be accountable by way of enforceable key performance indicators that include responsibilities assigned in terms of the AQMP. • Specific champions are required that will motivate. • To progress and be accountable for achievement of the actions assigned to them.
Specific timelines	Deadlines need to be SMART (Simple, Measurable, Achievable, Realistic and Time-Bound) in order to facilitate planning and implementation by the various responsible stakeholders. Some of the interventions were either not clear or were reflected as on –going without specific indication on how to measure and report on such on-going projects.
Consequence for non-implementers	Specific stakeholders have made commitments aimed at reducing emissions and improving air quality. Such commitments formed part of the AQMP intervention strategies. However, there was no clear consequences for non-implementation of such commitments.
Insufficient follow-up	More frequent and specific follow-up is required with regards to implementation and meeting deadlines. Stakeholders must be required to provide specific feedback to the various forums such as the MSRG, the ITTs and institutional reporting structures.
Insufficient capacity and turnover of implementers	A comprehensive capacity assessment and subsequent training needs analysis was required. Individual training and development must be developed and implemented to ensure that authorities have the skills and knowledge to implement theAQMP.
Formal/Written reporting and gap analysis required.	• Formal reporting is required from all stakeholders and implementers, through the forums available – MSRG, ITTs etc. A lack of formal reporting implies that outstanding issues and/or non-performance are not noted timeously and thus not attended to effectively as well. • Written reporting required to ensure timeously attention to effect required intervention
Information communication and awareness	• Although various publicity and awareness campaigns were in progress, the general impression of various MSRG members was that the effect is limited, and greater effort is required to affect more pronounced public awareness. • Improved public awareness may in turn bolster political buy-in.
Inadequate political buy-in from decision making powers.	• A lack of political buy-in appeared to be significant, particularly at the local government level as these manifests itself in a lack of resources (human and technical) required to achieve the obligations of these stakeholders in terms of the AQMP. Strengthening of municipal budgeting and planning was needed. • It was recommended that the DFFE partner with municipalities in raising awareness of the importance of the AQMP and its objectives for the health and well-being of the affected communities, and the wider potential economic impacts (present and future) of failure to successfully implement the plan. This in terms of not only community health and well-being but also economic expansion constraints due to the significant baseline air pollutant load.

Recommendations at the time to strengthen the working groups included:

- Re-arrangement of the ITTs by geographical grouping and per problem complex as this facilitates interaction and ensures that the efforts of the ITTs are targeted and relevant to the issues and interventions required within their specific geographical regions;
- Regular and standardized reporting required;
- Monthly meeting of ITTs;
- SOPs for reporting;
- Clear planning and communication of the objectives and requirements for individuals within the ITTs;
- A review of the terms of reference to produce clear and specific terms of reference based on AQMP; and
- Specific feedback required at ITT meetings.

The following support items and issues and requests were identified through the MSRG:

- DFFE must be accountable for inaction;
- DFFE to support CBOs/Civil society with logistical and material support, where possible;
- Enforcement assistance for local and provincial government;
- Assist municipality in motivation for appointment of AQOs and air quality management functions in terms of NEMAQA; and,
- DFFE to facilitate a forum for AQMP review/discussion/report back with political powers.

The implementation status of the action plans for the eleven problem complexes were also assessed as part of the 2013 medium-term review and the findings are summarised in Table 6 for the Emission Problem Complexes and Table 7 for the Non-emissions Problem Complexes. The comprehensive action plans with the implementation status are provided in Appendix B.

Two emission problem complexes, not included in the first generation AQMP and identified during the 2013 medium-term review were:

- Agriculture; and
- Clay Brick Manufacture.

Based on the implementation status, 46% of the set interventions were successfully implemented, with 18% in progress at the time, 22% could not be achieved and 14% could not be ascertained. The performance reviews between the sectors indicated that the industrial stakeholders managed to meet their obligations to a larger degree than any of the other sectors. The performance of government stakeholders and municipalities were generally low, or in many cases could not be ascertained.

It was the overall view of the MSRG members that the reason for failing at implementing the VTAPA AQMP was inadequacy in capacity and the failure to achieve many of the planned interventions and objectives of the AQMP.

Based on the findings from the 2013 medium-term review, updates for the goals have been set.

Table 6: Review and Summary of the Implementation Status of the Emission Problem Complexes Intervention Plans

Problem Complex	2013 Review	Implementation Progress in 2013
Biomass Burning	Updated emissions inventory (previously not quantified) and confirmed to be a significant source	Only limited progress could be confirmed.
Domestic Fuel Burning	Updated emissions inventory, review of research and confirmed to be a significant source	Limited progress can be verified, improvements achieved in electrification, housing provision, roll out of the BnM method, awareness campaigns and increased household income. However, measured ambient data does not reflect a notable improvement in ambient exposure concentrations.
Industry: Iron and Steel/Ferroalloys	Updated emissions inventory, confirmed to be a significant source	Significant reductions by Iron and Steel/Ferroalloys in stack and fugitive emissions as well as improved emissions monitoring.
Industry: Petrochemical	Updated emissions inventory, confirmed to be a significant source	Although action, as committed to, has been undertaken, major emitter Sasol is yet to complete its intervention roadmap. The complete intervention roadmap is anticipated to be communicated with the Stakeholders by 2014.
Industry: Power Generation	Updated emissions inventory, confirmed to be a significant source	Various actions committed to have been implemented however improvements in respect of combustion related direct emissions are limited.
Industry: Small Industries	Updated emissions inventory, confirmed to be a significant source	Significant improvements have however been achieved by some emitters (notably Afrisam Slagment and Rand Water) resulting in a substantial decrease in total emissions. Limited progress in terms of the gazetted interventions could be confirmed for this sector.
Mining	Emissions inventory unchanged, confirmed to be a significant source	Little if any progress could be confirmed for this sector. Notably no action taken by the regulating authority (DMR) could be confirmed.
Transportation	Not updated, confirmed to be a significant source. To be updated as an outcome of the National Vehicle Emissions Strategy.	Little if any. National Vehicle Emissions Strategy in process of being developed.
Waste Burning	Updated emissions inventory (previously not quantified) and confirmed to be a significant source	Limited progress can be confirmed, Improvements achieved through improved refuse collection service delivery, National Domestic Waste Collection Standards published.

Table 7: Review and Summary of the Implementation Status of the non-Emission Problem Complexes Intervention Plans

Problem Complex	2013 Review
Budgetary provision for Air Quality Management	Previously not identified as a discrete problem complex but budgetary constraints or lack of provision confirmed to be inadequate to achieve goals. This is particularly notable at local government level where both human resource and establishment of adequate logistical services for effective air quality management is lacking.
Human Resource Capacity for Air Quality Management	• Reviewed and confirmed to be a significant obstacle to implementation of plans and air quality improvement. • Human resource capacity is constrained both in terms of adequate human resources as well as adequate technically competent capacity. The provision for sufficient technically competent persons is lacking.
Information Management and Upkeep of Monitoring equipment	• Data coverage from ambient air quality monitoring stations is constrained for various stations and for various pollutants per station. The ambient monitoring stations operated by SDM were noted to be out of operation since 2009. • While ambient monitoring and other data is managed through the South African Air Quality Information System (SAAQIS), the ambient monitoring data is not readily available to the general public and other stakeholders via the website. • The management and upkeep of air quality information confirmed to be a significant problem.

SCHEDULE B - BASELINE ASSESSMENT FINDINGS

3 BASELINE ASSESSMENT FINDINGS

The objective of the baseline characterisation was two-fold: to determine the current state of air quality in the VTAPA, and to assess whether the interventions set by the 2009 VTAPA AQMP resulted in ambient air quality improvements, and if not, the reasons for this. The main findings set out in this section are primarily based on the background assessment, the evaluation of ambient air quality in the VTAPA, the 2017 emission inventory and the associated dispersion modelling. These provided a good understanding of the current state of air quality within the VTAPA and to some extent, the source contributions to the ambient pollution levels. The results of the SAS currently being conducted will allow for a more specific link between source and effect to allow for the identification of desired intervention strategies.

3.1 Geography and Demographics

The 2009 VTAPA AQMP study made use of the 2001 Census data, which indicated the population in the VTAPA to be 2 532 362 at the time. The current study made use of the 2011 Census data, which indicated a population growth of 12% over the 10-year period to 2 848 140, and the 2016 Community Survey statistics, which indicated a population of 3 127 907 implying a growth of 10% over five years. According to the census data, the only Local Municipalities within VTAPA with more than 10% of households using coal, wood or dung for cooking were Emfuleni (17.8%) and Metsimaholo (12.6%). Due to changes in the boundaries between the census years a quantitative comparison was not possible.

3.2 Regional Climate and Existing Ambient Air Quality

The DFFE operates six ambient monitoring stations within the VTAPA, located at Diepkloof, Sharpeville, Three Rivers, Zamdela, Kliprivier and Sebokeng. These stations record meteorological parameters and ambient air quality concentrations for, among other pollutants, SO_2, NOx, PM_{10} and $PM_{2.5}$. Data was obtained from these stations for the period 2013-2015 to determine dispersion conditions and for the period 2007-2016 to assess ambient air quality trends. In addition, data from the three Sasol ambient monitoring stations was obtained for the same period as well as from the Eskom station and the four ArcelorMittal stations. The Sedibeng DM stations were not included since data was only available for one year (2017).

The main findings are:

- There was some variability in wind fields across the VTAPA monitoring stations, but with a predominant north-easterly and north-westerly flow evident at all stations, with possible exception of Eco Park, where a south-easterly flow was dominant. Winds exceeding 4 m/s were more frequently recorded at Sharpeville, Leitrim, and Eco Park. The Leitrim station recorded the fewest calm conditions (6%), while calm periods were most frequent at the AJ Jacobs station (30%).
- Long term trends, from 2007 to 2016, in SO_2 concentrations showed compliance with the National Ambient Air Quality Standards (NAAQSs) at most of the stations for most of the time. Trends in SO_2 concentrations over 10 years showed small decreases at Diepkloof, Zamdela, Randwater and Eco Park but slight increases over time at Kliprivier, Three Rivers and AJ Jacobs. Concentrations at Sebokeng, Sharpeville and Leitrim showed more annual variability and no distinct long-term trends.

  At AJ Jacobs a distinct pattern of contribution from the north-east was noted with two sources contributing at the Leitrim station, one to the north-west and one to the north-east of the station. At Kliprivier station the contribution was mostly from the south and at Sebokeng and Sharpeville it was from the south-east. North-east and easterly winds resulted in higher SO_2 concentrations at Diepkloof whereas north-east and southerly winds contributed to the

Three Rivers station. The Zamdela station recorded elevated SO_2 concentrations from the north-east, north and north-west.

- Annual average NO_2 concentrations were non-compliant with the NAAQS at Diepkloof (all the years except 2011), Kliprivier (2009 and 2010), Sebokeng (2015) and Sharpeville (2015). Hourly NO_2 concentrations were also non-compliant with NAAQS at Sebokeng in 2015, with the lowest concentrations recorded at the Randwater station. Monthly NO_2 concentrations have decreased slightly at the Leitrim station, while concentrations have increased at Diepkloof; Three Rivers; Zamdela; and AJ Jacobs stations. At the other stations the ambient NO_2 concentrations remained the same.

  Higher concentrations at Diekloof were associated with winds from the north-east, south-west, and west during periods of higher wind speeds whereas strong winds from the west and north-west contributed to higher NO_2 concentrations at the Kliprivier station. NO_2 concentrations at the Sebokeng and Three Rivers stations persist mainly during low wind speeds. The Sharpeville station was influenced by stronger winds from the north-west, west and north-east while the Zamdela station recorded higher concentrations during winds from the north-west and north-east. NO_2 concentrations at the Randwater station were mostly during strong winds from the north-west, north-east and east-southeast. Most of the stations recorded NO_2 concentrations from all directions at low wind speeds. Observations from the stations located in high traffic areas with a strong contribution during low wind speeds were most likely from vehicle exhaust emissions.

- PM_{10} concentrations were in exceedance of the NAAQS at most of the stations for most of years assessed except at Eco Park where annual PM_{10} had been compliant with NAAQS since the establishment of the station. The highest concentrations were recorded at Zamdela.

  The stations of Kliprivier, Sebokeng, Three Rivers, Sharpeville, Zamdela, and to a lesser extent, Randwater and Diepkloof showed significant PM_{10} contributions at low wind speeds from all directions suggesting local contributing sources. During high wind speeds the contributing directions vary at the different stations, with winds from the northerly sector contributing mainly at the Diepkloof station and winds from the south-west at the Kliprivier station. The Sebokeng, Three Rivers and Sharpeville stations recorded elevated particulate concentrations from the northerly sector under strong winds. PM_{10} concentrations at Zamdela showed high concentrations from the west, north-west, north-east, east, and south. At the Eco Park station elevated PM_{10} concentrations were associated with northerly winds whereas winds from north and west contribute at AJ Jacobs station.

- Annual average $PM_{2.5}$ concentrations were in non-compliance with NAAQS, for most of the period assessed, except for AJ Jacobs where no annual exceedances were noted between 2014 and 2016. AJ Jacobs and Three Rivers had the lowest annual average concentrations whereas Leitrim, Sharpeville, Kliprivier, and Sebokeng had the highest. Annual average concentrations appeared to have decreased at Diepkloof and Sebokeng but monthly average $PM_{2.5}$ concentrations did not show substantive improvements with slight increases at Kliprivier, Sharpeville, Zamdela and AJ Jacobs stations.

  The stations of Diepkloof, Kliprivier, Sebokeng, Three Rivers, Sharpeville, Zamdela, and to a lesser extent Randwater had persistent $PM_{2.5}$ contributions at low wind speeds equally distributed in direction.

3.3 VTAPA Emissions

Emissions were quantified for all main sources within the VTAPA, as well as sources from the surrounding areas to form input into air quality modelling. The emission inventory reported on are for the sources within the VTAPA. These include:

- ***Industrial Sources***: sources of air pollutants represent mostly stationary facilities operating under licenses or registration where emissions are reported to the authorities annually (Section 21 and Section 23 sources). A total of 452 individual point sources were identified, across 117 facilities, in the VTAPA, mostly in the Emfuleni Local Municipality of which 40 facilities operate listed activities under Section 21 of National Environmental Management: Air Quality Act (NEM:AQA) and 48 individual point sources are classified as Section 23 Controlled Emitters. Data reported on in NAEIS for the 2017 calendar year was used.
- ***Mining Sources***: including opencast and underground mines and quarries. Two open-cast mines (one dolomite and one coal) and one underground coal mine were identified. Activity data reported on in NAEIS for the calendar year 2017 was used.
- ***Mobile Sources***: accounting for vehicles traveling on arterial- and main roads, national freeway, secondary roads, slipways, off- and on ramps and streets. Use was made of the South African National Roads Agency Ltd (SANRAL) national counts for 2016 and GAUTRANS Gauteng Manual counts for 2015. A hybrid top-down (fuel sales)/bottom-up (vehicle count) approach was used to estimate emissions.
- ***Domestic Fuel Burning***: fuel combustion for energy use in the domestic environment in VTAPA. Both a top-down (for gas, paraffin and coal) and bottom-up (for wood) approach was used for domestic fuel use emissions. Community Survey 2016 and Census 2011 data were used to proportionally disaggregate national fuel consumption to provincial and then small area level (SAL) geographic units.
- ***Waste***: open burning in residential areas were quantified based on available information (no information was available on landfills and waste-water treatment facilities to quantify these emissions).
- ***Windblown Dust***: from mine waste facilities, product stockpiles, as well as ash storage facilities for large combustion sources. Windblown dust from denuded areas were not included.
- ***Biogenic VOC Emission***: plants emitting numerous VOC compounds, primarily isoprene due to stress responses, were included due to the important role in the atmospheric chemistry.
- ***Biomass Burning***: large scale agricultural burning and natural fires. Fire INventory from NCAR (FINN) data was extracted for the year 2016 and processed, with erroneous fires due to surface coal mines removed.
- ***Airfields:*** there are no major commercial airports within the VTAPA and the occasional use of airstrips in the area were not regarded to result in significant emissions.
- ***Agriculture***: was included mainly for its contribution to ammonia emissions that were used in the dispersion model due to its important role in atmospheric chemistry.

3.3.1 Synopsis of VTAPA Emissions

Emissions from the various sources identified and quantified in the VTAPA are provided in Table 8 and in Figure 5. Based on the quantified emissions, industrial sources were the main contributors of SO_2 (99.8%) and NOx (93%) emissions within the VTAPA. Mobile sources were the only other significant contributors to NOx emissions at 7%. Total PM_{10} emissions were mainly a result of industrial operations (52%) followed by windblown dust (31%), with biomass burning the third highest contributing source at 5%. For the sources for which $PM_{2.5}$ emissions were reported and/or quantified, windblown dust was the main contributing source (56%) followed by domestic fuel burning (29%). It should be noted that $PM_{2.5}$ is under-reported in the NAEIS and hence the emissions would be higher. CO emissions were a result of domestic fuel burning (28%), mobile sources (27%), biomass burning (26%) and industrial sources (19%). Biogenic VOC emissions were unsurprisingly the main contributor to NMVOC emissions followed by biomass burning. Ammonia emission (NH_3) sources were mainly (soil) biogenic, with contributions from agriculture (87%) and to a lesser extent mobile sources (11%).

Subsequent to the publication of the Baseline Assessment Report (DEA, 2019), irregularities in the industrial emissions uncovered during the Baseline Assessment were corrected/ improved where possible and are reflected in Table 8.

Table 8: Emissions from the various source groups in VTAPA (tonnes per annum)

Source Groups	SO_2	NOx	PM_{10}	$PM_{2.5}$	CO	NMVOC	NH_3
Industrial Sources	232 669	118 459	14 424(a)	18 (a)(b)(c)	6 761	830	70
Mining Sources	-	-	383(a)	53 (a)(b)	-	-	-
Mobile Sources	251	8 299	245	-	9 635	967	493
Domestic Fuel Burning	261	184	2 552	1 242	9 982	1 404	0
Waste	12	90	287	-	-	544	27
Windblown Dust	-	-	8 444	2 449	-	-	-
Biogenic VOC Emissions	-	-	-	-	-	9 727	-
Biomass Burning	44	589	1 318	589	9 359	4 057	-
Agriculture	-	-	-	-	-	-	3 890
TOTAL	**233 237**	**127 621**	**27 653(a)**	**4 351(a)(b)**	**35 737**	**17 529**	**4 480**

Note: (a) Corrected/ improved mission rates after publication of the Baseline Assessment Report
(b) $PM_{2.5}$ is under-reported in NAEIS and hence the emissions would be higher
(c) Only reflects reported $PM_{2.5}$ emissions by industries where a large fraction of PM_{10} is expected to be $PM_{2.5}$

Compared to the 2009 and 2013 medium-term review inventories, the total emissions within the VTAPA remained similar for SO_2 but reduced significantly for NOx (Table 9). This is primarily due to lower estimated mobile source emissions and domestic fuel burning emissions. PM_{10} emissions decreased from the 2009 inventory but is slightly higher compared to the 2013 inventory. Industrial PM_{10} emissions reduced from the 2009 VTAPA, and even though the cause of this reduction is not clear, it could be an actual reduction in industrial PM_{10} emissions since the 2017 emission inventory is regarded more comprehensive than the one for 2009.

Table 9: Medium-term VTAPA AQMP review versus 2018 VTAPA AQMP total emissions (tpa)

	SO_2	NOx	PM_{10}
2009 AQMP	221 361	188 640	37 033
2013 Medium-term review	248 583	149 748	22 743
2018 VTAPA AQMP	233 237	127 621	27 653(a)

Notes: (a) Corrected/ improved mission rates after publication of the Baseline Assessment Report

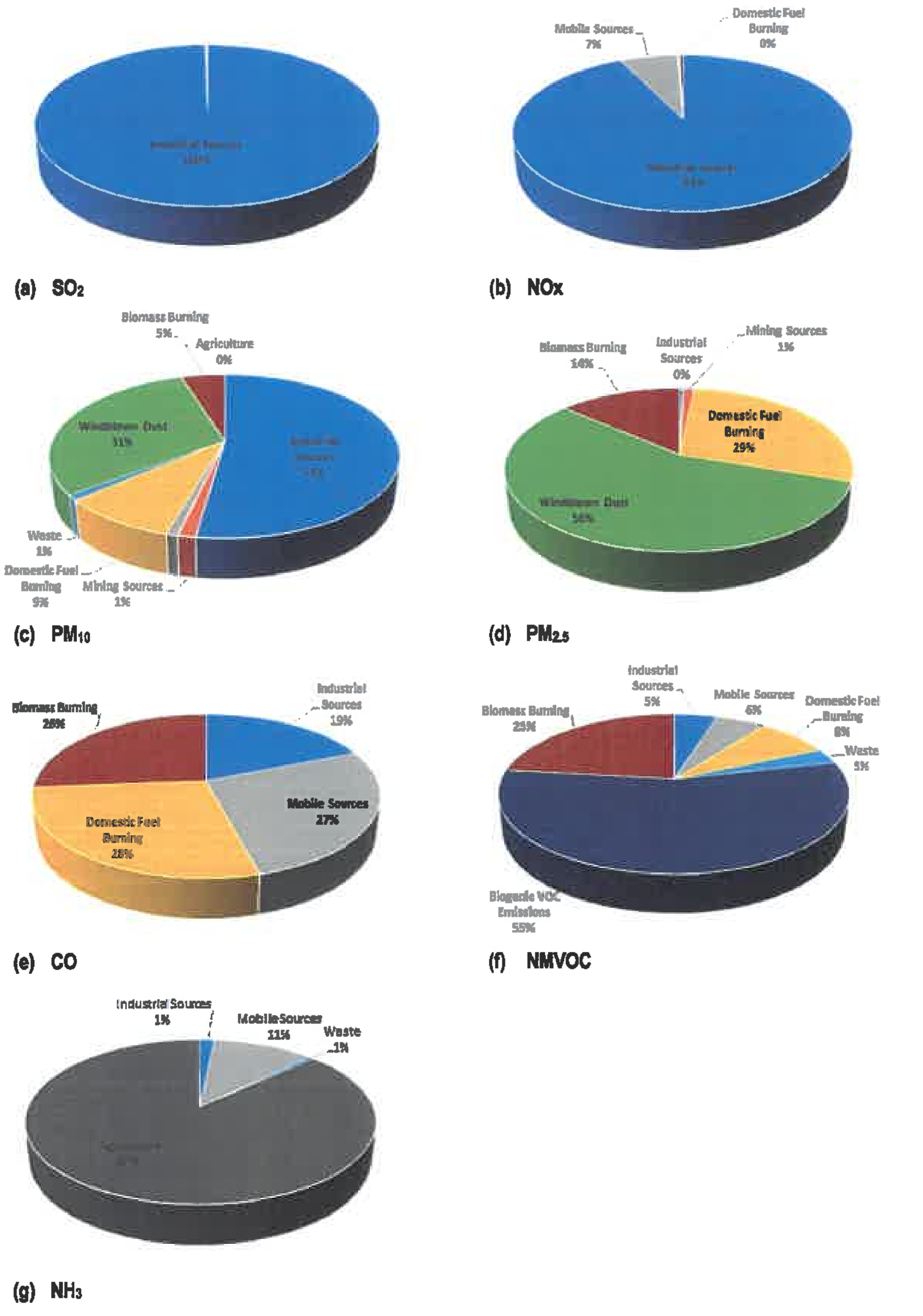

Figure 5: Source contributions to the total emissions for (a) SO_2; (b) NOx; (c) PM_{10} (updated); (d) $PM_{2.5}$ (updated); (e) CO; (f) NMVOC and (g) NH_3

3.4 Dispersion Model

The aim of air quality modelling within the context of a baseline assessment was to simulate current ambient concentrations of pollutants within the VTAPA to assess ambient air quality on a more comprehensive spatial scale than what can be provided with monitoring stations. Areas of elevated concentrations can be identified for expanded monitoring; and when viewed within the context of the emission inventory, likely contributing sources targeted for intervention strategies. Through the use of source tracking features in the model, it was also possible to quantify relative contribution between tracked sources.

CAMx, a chemical air quality model, was used to simulate baseline ambient air quality. A regional 3 km resolution modelling domain aimed to capture Highveld regional sources that may impact in the VTAPA, while a finer resolution 1 km domain over VTAPA aimed to simulate ambient air quality in more detail.

3.4.1 Summary of findings

The primary aim of air quality modelling in this AQMP was to assess ambient air quality in the VTAPA on a more comprehensive spatial scale than what can be provided with monitoring stations and provide directed source tracking analyses. The CAMx air quality model was run to aid in the baseline assessment of the VTAPA. To this end a comprehensive emission inventory was developed for both management purposes and as input into the air quality model. The WRF meteorological model was also used to simulate the necessary meteorological parameters that form additional input to the air quality model. A comparison of model output to measurements from monitoring stations was done to ascertain performance. The comparison took the form of both statistics and time-series plots. For source tracking, two groups were tracked; industry located within the VTAPA and those outside. Source tracking output was analysed for O_3 and PM_{10} impacts.

Concentrations of PM_{10} were in general under-estimated by, looking at hourly data, between 32% (at Sebokeng) and 71% (Kliprivier). This was primarily due to the potential impact of much localized sources near the monitoring stations. High exceedances (for both 24hr and annual averages) were still simulated. The majority of these were in close proximity to industrial facilities, mines and the old tailings areas in CoJ. Exceedances were also simulated in northern VTAPA, located around high emitting residential fuel combustion areas. $PM_{2.5}$ results were also in general under-estimated where monitoring data was good enough for a comparison, although performance was better than for PM_{10}. Under-estimation ranged from as low as 14% (at Randwater) to 50% (at Sebokeng). Even though $PM_{2.5}$ was under-estimated, a majority of the VTAPA was simulated to be in exceedance of the 24hr NAAQS for $PM_{2.5}$. However, for the annual mean, the exceedance levels were seen to be more limited to the immediate vicinity of mines, tailings facilities and areas of heavy domestic fuel combustion. The model did not simulate annual exceedances measured at Sebokeng and Three Rivers. Elevated $PM_{2.5}$ concentrations measured during hours between ~21:00 - ~05:00 (i.e. very late evening and very early morning) were not simulated by the model. This may be related to the over-estimate in wind speed.

The over-estimate in wind speed also resulted in over-estimation of SO_2; since in the model the tall stack impacts tend to dominate due to enhanced turbulence. However, this did not impact the ability of the model to simulate areas of exceedance (or lack thereof according to the monitoring data, when the monitoring data was of good quality). The exception to this is at the Rand Water location, where the model simulated an exceedance of the annual mean while the monitoring data (relatively good quality and completeness) did not show an exceedance. In general exceedances were seen around Lethabo power-station and Sasolburg.

Performance of NO_2 and O_3 simulations were good; particularly for O_3. For NO_2 the highest under-estimate was at Diepkloof, as the model did not capture micro-scale emissions activity on roads around the monitoring station. On the other hand, at AJ

Jacobs, over-estimates were due to enhanced turbulence leading to Lethabo power-station and Sasol Sasolburg plumes impacting ground concentrations. In general, the model simulated the lack of exceedances seen in the monitoring data; the only exception being at Diepkloof for the annual mean. The model simulated highest (though not necessarily in exceedance) concentrations around Sasolburg. For O_3 the modelled concentrations resulted in 8-hr NAAQS exceedances over the majority of the VTAPA. There is a zone of titration around Sasolburg where concentrations were simulated to be lower.

The air quality model simulations indicated widespread exceedances of O_3 and PM over the majority of the VTAPA. Exceedances were seen for short-term/acute time scale periods (24-hr and 8-hr running) indicating high variability and magnitude.

In terms of source tracking, it must be noted that only two industry groups were tracked; and therefore, results were only relative to industry contribution. It is possible that other sources could play a significant role in actual ambient exceedances for a given time and place. PM_{10} impacts within VTAPA were primarily due to industry within VTAPA; which was expected since PM_{10} concentrations were generally highest immediately around sources. For O_3 it was more complex since highest concentrations may be found near the sources if NO emissions are low, or further downwind if NO emissions are high. Thus, there is a regional aspect to O_3 formation when related to the precursor contributing sources. For the VTAPA there was a mix of contribution from local industry and those outside. However, simulations indicated that industry outside the VTAPA plays a larger role in O_3 formation than within the VTAPA.

3.5 Conclusions from the VTAPA Health Study

A baseline health assessment study was conducted in the VTAPA during 2013 and 2014. The study comprised of a community survey in four communities within the priority area and a child respiratory health study (including lung function tests) in four schools within the community study areas, as well as an assessment of human health risks resulting from exposure to air pollution.

The main findings of the study may be summarised as follows:

- Given the ambient concentrations measured at DFFE/SAWS stations in 2013, no risk from SO_2 was found. NO_2 was estimated to pose a health risk in Zamdela. The risk to health from exposure to particulate matter (PM_{10}) was found to be more of a concern than the risk from exposure to SO_2 and NO_2. Sharpeville in particular recorded the highest concentrations of PM_{10} during 2013.
- From the community survey, risk factors for respiratory illnesses were mostly associated with energy use (coal for cooking and paraffin for heating), overcrowding and hygiene practices (burning or burying of refuse or failure to regularly remove refuse) as well as lifestyle (active and passive smoking and alcohol use).
- The main conditions affecting vulnerability of areas to the effects of air pollution involved socio-economic conditions and energy use. The main vulnerable areas of concern were north of the Sebokeng and Sharpeville monitoring stations and south-east of the Zamdela monitoring station.
- Although the socio-economic conditions and exposure at the schools were similar, the odds of having chronic symptoms (such as cough, wheeze and phlegm and asthma) were significantly higher at the school in Sharpeville. Pollutant concentrations at the Sharpeville monitoring station were also consistently among the highest.

Significant declines in daily lung function (therefore poorer respiratory health) and an increased chance of having negative respiratory symptoms were associated with changes in the concentrations of the various pollutants. Given that these adverse respiratory outcomes were observed within the context of some pollution levels complying with the national ambient air quality standards, there is reason for concern that air pollution in the VTAPA may be affecting child health.

3.8 Preliminary Findings on the VTAPA Source Apportionment Study

The VTAPA SAS aims to apportion the contribution of sources to the overall PM_{10} and $PM_{2.5}$ loading in the VTAPA. Aerosol sampling was initiated at four (4) strategically identified sites namely; Kliprivier, Sebokeng, Sharpville and Zamdela in the Vaal Triangle. The samples were further used to characterise the chemical composition through chemical analysis, the elemental composition through X-ray fluorescence spectrometry (XRF) analysis and ionic composition using Ion Chromatography (IC) Analyses. Statistical models were then used to apportion the various sources. A total of three sampling campaigns were conducted during the winter of 2018, the summer of 2019 and the spring of 2019.

Preliminary results indicate:

- The NAAQS are frequently exceeded at all four sites in summer, winter and spring, but it is significantly worse during winter with PM_{10}, $PM_{2.5}$ and SO_2 the main pollutants of concern.
- The coarse particulate fraction dominated both during daytime and night-time sampling periods, during all three sampling campaigns.
- Elemental characterization of the summer, winter and spring samples showed dust elements in the coarse particulate fraction to be prominent during the day at all four sites. At Kliprivier and Sharpville, and to a lesser extent Zamdela, indicators of combustion products were evident in the evenings in summer and winter. Motor vehicle elements were higher in the coarse fraction at night at all four sites, in all three seasons.
- Soluble inorganic concentration loading showed inorganic content from crustal and anthropogenic activities.
- Source apportionment of the coarse particulate fraction indicated dust to be the dominant source at all four sites, during all three sampling campaigns (winter, summer and spring) and during daytime and night-time. Sulphates and nitrates were the second most dominant source during summer and both during daytime and night-time at all four sites whereas waste burning was second during the winter months. Coal burning only flagged at Zamdela during the winter months but was the second most abundant source in the course fraction at all four sites during the spring campaign.
- In the fine fraction, the largest portion of observed mass is unresolved with sulphates and nitrates dominating at all four sites during all three sampling campaigns. Varying contributions from vehicle-, waste burning, wood- and biomass burning, and paved and unpaved roads were observed.

The main finding thus far from the SAS is that dust is the main source of PM_{10} concentrations within the VTAPA, with the main sources contributing to $PM_{2.5}$ still unaccounted for. The unaccounted fraction will be narrowed down through use of the positive matrix factorization (PMF) model as well as industry profiling. Nonetheless, the contribution from sulphates, domestic fuel burning, biomass burning, and vehicles were significant in all three campaigns.

A qualitative waste burning survey conducted in Sharpeville highlighted the large scale of local waste burning and veld fires in this community and reinforces the strong need for improved activity and emission factor data on burning.

3.7 GAINS modelling scenario findings

The GAINS model was used to assess a set of emission reduction scenarios as a first screening to determine the potential for reducing health impacts of air pollutants within the VTAPA. This is done by altering the energy activity mix and applying abatement measures to different sectors. The GAINS modelling scenarios used energy activity data from the Gauteng City-region (GCR) and defined strategies available in the model. For the scenarios, 2015 was taken as the baseline year with emission reduction pathways assessed in the medium-term (20-year period).

The findings from the GAINS model can be summarised as follows:

Domestic Fuel Burning

- Electrification of households in informal settlements is likely to result in a steady decline in domestic fuel burning emissions.
- Replacing coal with Liquefied Petroleum Gas (LPG) in informal settlements is likely to eliminate $PM_{2.5}$ emissions from the domestic sector by 2035. This could also be complimentary to the electrification program in informal settlements.
- Low-smoke stoves are marginally less effective than LPG due to lower combustion efficiency.

Industrial Sector

- With business as usual, $PM_{2.5}$ emissions would increase due to industrial growth. The implementation of fabric filters is likely to reduce $PM_{2.5}$ emissions by 70% whereas Electrostatic Precipitators (ESPs) only result in a 43% drop compared to baseline emissions.
- The control of SO_2 emissions in the industrial sector can be effectively achieved with the application of dry flue gas desulphurisation controls (55% reduction from baseline emissions) and wet flue gas desulphurisation technologies (68% reduction from baseline emissions).
- Increase industrial activities would result in an increase in NO_x emissions, however the use of combustion modification technologies and selective catalytic reduction controls would reduce emissions by 56%.

Waste Sector

- Population growth in urban areas is expected to result in an increased generation of municipal waste which is predicted to result in a rise in $PM_{2.5}$ emissions.
- Banning municipal waste burning would result in an emission reduction of over 83% should a ban be fully implemented by 2025.

Transport Sector

- The gradual implementation of Euro 5 fuel standards in the transport sector would result in a slow decrease of NO_x emissions, remaining high by 2035. With an accelerated implementation rate and halving the vehicle population by 2035, NO_x emissions are projected to fall by 79%.
- With the implementation of Euro 6 fuel standards in the transport sector, NO_x emission will reduce by 81%.

4 VTAPA Capacity Building Plan

Capacity in terms of resources, tools and finances for air quality management and control within the various spheres of government (National, Provincial and Local levels) have been an on-going challenge jeopardizing the implementation of the VTAPA AQMP. Current capacity for air quality management and control at National, Provincial and Local government levels were found to be inadequate to ensure the successful implementation of the intervention plans (DEA, 2013).

The Government Capacity Goals as re-defined in the 2013 medium-term review, are as follows:

- Government Capacity Goal 1: By 2015 all government spheres that have an air quality management function have undertaken organisational capacity review and developed structures to allow it to and effectively maintain, monitor and enforce compliance with ambient air quality standards.
- Government Capacity Goal 2: By 2017 all government structures have provided adequate budgets and human resources to implement the VTAPA AQMP and to efficiently and effectively maintain, monitor and enforce compliance with ambient air quality standards.
- Government Capacity Goal 3: By 2017 a measurable increase in awareness and knowledge of air quality exists such that air quality and related health issues are incorporated in IDPs.

4.1 VTAPA Capacity Analysis

The capacity building plan is based on the required skills development and interests identified by the air quality officers and relevant government officials from the various municipalities within the VTAPA. The Department (DFFE) sent out a questionnaire to all the municipalities to identify the areas where additional capacity development is mostly required. Ten (10) out of the 25 questionnaires were received back, and these were used to identify the training requirements. After collaboration with the relevant authorities, the approach decided on was to focus on one or two aspects for in-depth training, instead of a general high-level approach.

The summarised results from the 10 questionnaires received are shown in Figure 6. Most votes were for additional training on emissions inventory development, specifically for sources and activities within VTAPA. Training on dispersion modelling was the second-most sought-after skillset, followed by air quality monitoring and evaluation.

The approach as provided in this plan followed a hands-on training course focussing on the smaller sources (i.e. controlled emitters) within the VTAPA. At this course, senior members of the team guided the participants through the process followed. In addition, there were hands-on exercises that aimed to provide additional information to be used in the AQMP development. For example, the participants assisted with emissions estimation for the project at the end of the "emissions estimate training".

The aim was that this would assist the officials in not only understanding the emissions quantification methodology, but also understanding how and why assumptions are made, and what data are needed for the implementation of the VTAPA AQMP. The aim of the capacity plan was to provide officials with a broad-based understanding of air pollution for them to fulfil their legal obligation and ensure a successful implementation of the VTAPA AQMP. On the one hand the plan is general in nature, but on the other hand it is detailed enough so that officials can deal with industry representatives and consultants from a position of knowledge.

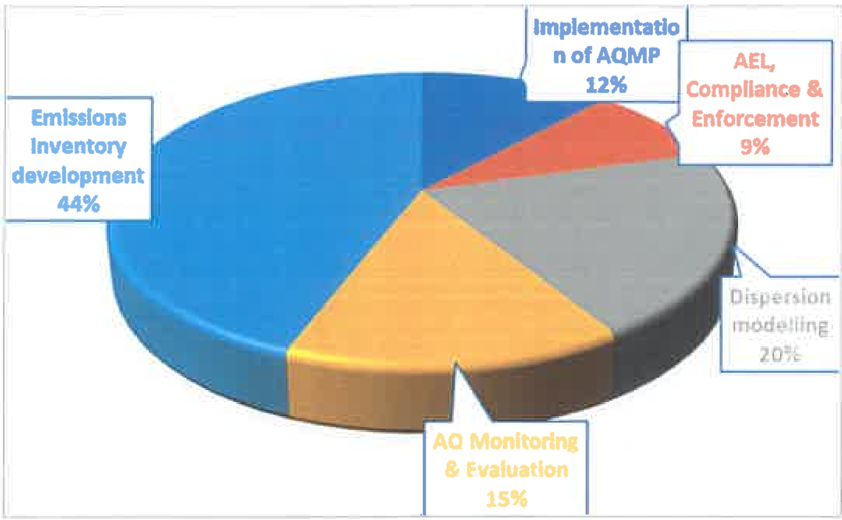

Figure 6: Capacity Building questionnaire results

4.2 Strategic Framework for Capacity Building

A workshop was held at the Manhattan Hotel, Pretoria on the 19th and 20th June 2018 including a theory component and a practical component, focussing on calculation of emissions from Section 23 sources. A schematic representation of the approach followed is include in Figure 7.

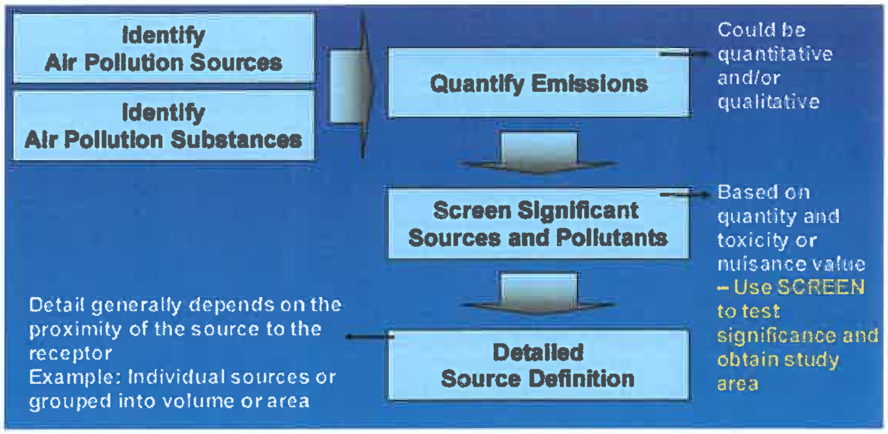

Figure 7: Capacity building workshop approach

Local authorities were asked to submit information for Section 23 facilities before the workshop to be used as part of the practical session. An example for the inventory requirements for the municipalities is provided in Figure 8. The completed questionnaires received from the municipalities mostly comprised of a source list that included: uncontrolled small sources; Section 23 activities; and Section 21 activities. These were used as examples in the Capacity Building sessions to allow the officials to complete their own inventories in the process.

The framework for the Capacity Building Plan is provided in Table 10.

Facility/Plant name	x	y	No of boilers	Type of boiler specified	Fuel type	Fuel quantity tpa	Fuel quantity kg/s	Operational time
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
							[illegible]	
							[illegible]	
							[illegible]	

Assumed							
Release height (m)	Diameter (m)	Area (m²)	exit temperature (°C)	exit temperature (K)	exit velocity (m/s)	flow rate (m³/s)	flow rate (Nm³/s)
42	0.935	0.687	140	413	23	15.79	10.44

Theoretical air combustion for boilers	Emission Standard (mg/Nm3)			Emission rates (g/s)		
m³/kg	PM (existing)	PM (new)	SO2	PM (existing)	PM (new)	SO2
6.9	250	120	2800	2.61	1.25	29.23
6.9				0.00	0.00	0.00
6.9				0.00	0.00	0.00
6.9				0.00	0.00	0.00

Key:

Required input	From literature
Include if available (can be assumed)	Emission limits
Include if available (can be estimated)	Contents calculated, do not enter values

Figure 8: Capacity building questionnaire for Section 23 sources

Table 10: Strategic Framework for Capacity Building

Activity Area	Planning	Implementation	Training Timeframe	Authorities Enhancement	Performance Measures
Emissions Inventory Compilation Training	Develop a 2-day emissions inventory course specific to the sources within the VTAPA	Air quality officers from the various municipalities within the VTAPA were trained at a combined Training Workshop	19 and 20 June 2018, Manhattan Hotel, Pretoria	Training sessions covered the following: • Background to SA emissions inventory; • Background to VTAPA emissions inventory; • Brief introduction to sources and sinks: o Industrial sources o Mining sources o Mobile sources o Domestic fuel burning o Waste o Windblown dust o Biogenetic VOC emissions o Biomass o Other • Emissions inventory development: o What is an emissions inventory? o Purpose of emissions inventories o Emission types o Emission estimation methods o Examples • Practical session: o Each AQO had to identify and collect the relevant information from at least three (3) controlled emitters or small sources within their District before the training. o The practical session included: ▪ One (1) source from each DM to be done together. ▪ The second source to be done by the AQO's and attendees with the support of the presenters.	Updated and comprehensive emissions inventory for the VTAPA, with specific reference to Controlled Emitters and Small Stationary Sources. VTAPA Authorities with a better understanding of emissions inventory development, specifically on: • How to identify controlled emitters and small stationary sources; • What information is required to quantify emissions from these sources; • How to quantify the source emissions; how to verify quantified emissions; • How often to update emissions inventory.

5 STRATEGY ANALYSIS

Identifying appropriate strategies is important for the development of feasible interventions which address the problem complexes. Based on the findings from the baseline characterisation, the preliminary SAS results and the GAINS results, five problem complexes were identified as the main contributors to the current air quality situation in the VTAPA. These complexes are: i) industry; ii) vehicles; iii) windblown dust; iv) waste burning and v) domestic fuel burning. The expectation is that by reducing emissions from these sectors, the resulting ambient air quality would be within compliance in the VTAPA.

In order to gain an understanding around the sensitivity of ambient air quality in the VTAPA to the various emission changes (brought about by interventions), modelling was used to translate emission scenarios to changes in pollutant concentrations. The modelling system used is the one developed for the Baseline Assessment, thus the only changing variable is emissions. It must be noted that due to industrial emissions irregularities uncovered during the Baseline Assessment, the scenario modelling utilized improved industrial emissions information for a baseline (Table 8). These changes are noted in the subsection below, and the subsequent analyses show the results of the "new baseline" together with scenario results.

5.1 Scenario Assessment

Various methods and rationale were applied to the emission sectors that were investigated. Scenarios were made up of a suite of changes to emission sectors and are outlined in Table 11. Two scenarios were investigated, namely Scenario 2025 and Scenario 2030. The naming convention is carried over from the GAINS analysis and applies to the domestic fuel combustion and waste burning in terms of expected year of implementation. However, the industrial changes will occur in 2020 and vehicle changes are arbitrarily chosen for 2030.

Table 11: Summary of emission changes applied for the "new baseline" and scenarios

Sector	Baseline	Scenario 2025	Scenario 2030
Industry	1. New Vaal open-cast coal mine emissions re-calculated based on this throughput rate and the emission factors for open cast mining in NAEIS. 2. Emissions from Gryphon Tiles were re-calculated using MES, and Pegasus Tile Factory emissions were corrected based on emission measurement reports. 3. All other emissions as reported in NAEIS.	MES 2020 for Industry in 1km domain	MES 2020 for Industry in 1km domain
Vehicles	No change compared to baseline report	None	100% of vehicle fleet are EURO5 compliant
Dust	No change compared to baseline report	Control Efficiency of 80% on all TSFs	Control Efficiency of 80% on all TSFs
Waste burning	No change compared to baseline report	39% reduction on baseline	60% reduction on baseline
Domestic burning	No change compared to baseline report	53% reduction on baseline	77% reduction on baseline

For each of the five identified sectors, the following reductions were applied and modelled:

I. **Industry**: By the year 2025, all Listed Activities will have to be compliant with the 2020 Minimum Emission Standards (MES), thus all industries within the VTAPA were modelled at MES unless the industry is already compliant (operating below the MES), then the baseline emissions were applied. It was assumed that industries that are already compliant, would not increase production and would remain at baseline emissions.

II. **Windblown dust**: Erosion losses from grassed slopes measured by Blight (1989) was found to be in the order of 100 t/ha/year compared to uncontrolled slopes from which losses of up to 500 t/ha/year were recorded. This relates to an 80% control efficiency due to effective vegetation cover. According to the Australian National Pollutant Inventory (NPI, 2012), the control efficiency of vegetation is 40% for non-sustaining vegetation and 90% for re-vegetation. For the purpose of scenario modelling, a control efficiency of 80% was applied to all tailings storage facilities (TSFs) within the VTAPA.

III. **Waste burning**: Informal burning of waste was identified as a significant source of air pollution at a local level within the VTAPA. Intervention strategies as set out in Table 11, aim to improve the collection, separation and recycling of domestic waste as well as improved management of municipal landfill sites. Ultimately any burning of municipal solid waste will be banned. A 39% (Scenario 2025) and 60% (Scenario 2030) reduction derived from the GAINS analysis (summarized in the Baseline Assessment report and Section 0) was applied to the baseline. This is due to a reduction in activity and thus applies to all pollutants. No specific emission factor change is given by GAINS thus all pollutants are reduced accordingly. The reduction is applied only within the VTAPA area. Table 12 shows the changes in emissions within the 1km domain. Note that since it is domain wide, and the reduction scenario includes only VTAPA, the percentage reduction does not show in the values (i.e. going from 51 tpa to 46 tpa is not a 39% reduction).

Table 12: Emission (ton per annum) for each scenario in the 1km domain for waste burning

Scenario	PM_{10}	SO_2	NMVOC	NOx	NH_3
Baseline	1 203	51	2 284	378	113
2025 (i.e. 39%)	1 091	46	2 072	343	103
2030 (i.e. 60%)	1 031	43	1 957	324	97

IV. **Domestic burning**: As discussed in Section 0, the electrification of households in informal settlements would not necessarily result in a decrease in solid fuel use. Also, switching fuel from coal to LPG is not a financially viable option. Thus, the implementation of lows smoke stoves is regarded a more viable option. A 53% (Scenario 2025) and 77% (Scenario 2030) reduction derived from the GAINS analysis (summarized in the Baseline Assessment report and Section 0) was applied to the baseline. This is reduction in activity for wood and coal burning only. No specific emission factor change is given by GAINS thus all pollutants are reduced accordingly. The reduction is applied only within the VTAPA area. The table below (Table 13) shows the changes in emissions within the 1km domain. Note that since it is domain wide, and the reduction scenario includes only VTAPA, the percentage reduction does not show in the values (i.e. going from 6 962 tpa to 6 270 tpa is not a 53% reduction).

Table 13: Emission (ton per annum) for each scenario in the 1km domain for domestic fuel combustion

Scenario	SO_2	PM_{10}	NO_X	NMVOC	NH_3	CO	CH_4
Baseline	2 115	6 962	1 154	6 411	0.045	51 457	1 249
2025 (i.e. 53%)	1 981	6 270	1 068	5 668	0.042	46 437	1 133
2030 (i.e. 77%)	1 921	5 957	1 029	5 331	0.041	44 164	1 081

V. **Vehicles:** This emission sector change applied only to Scenario 2030. It consisted of assuming 100% of the active road fleet (passenger and commercial; light and heavy) were EURO5 compliant. This in contrast to using the scrapping curve seen in the Baseline Assessment; where the emission factors are weighted. For this sector change, all emission factors are for EURO5 vehicles and are applied to both top-down and bottom-up portions of the sector's inventory. However, EURO5 vehicles also exhibit different fuel consumption, and for a given amount of fuel (relevant for the top-down portion of the vehicle emissions inventory) this changes the vehicle kilometers travelled (VKT). If fuel consumption decreases, for a given amount of fuel, the VKT will increase (potentially increasing emissions for certain classes). Like emission factors, this factor is dynamic in that it is different for different vehicle classes as well as for different speeds. This was taken into account for the emission changes (Table 14).

Table 14: Emission (ton per annum) for each scenario in the 1km domain for on-road vehicles

Scenario	CO	NO_X	NMVOC	$PM_{2.5}$	CH_4	NH_3	SO_2
Baseline	39 379	31 103	3 680	925	540	2 058	964
2025 (No change)	39 379	31 103	3 680	925	540	2 058	964
2030 (100% EURO5)	25 766	26 638	1 781	199	295	607	959

5.2 Scenario Modelling Results

The following maps illustrate the impact on ambient air quality from the scenarios. Pollutants shown are PM_{10}, $PM_{2.5}$, NO_2, O_3 and SO_2. For each pollutant, only the relevant averaging periods are shown (i.e. only averaging periods for which there is a NAAQS). For each averaging period, the first map shows the baseline (i.e. including improvements to the industrial emissions), the second shows the Scenario 2025 simulation, the third shows the Scenario 2030 simulation and the last shows the percentage decrease going from baseline to Scenario 2030 (note a negative percentage decrease indicates an increase). Since Scenario 2030 includes all of the changes in Scenario 2025, it (2030) is seen as a cumulative result and thus the percentage decrease from baseline to Scenario 2030 shows the total reduction. It may however be useful to look at the percentage reduction going from Scenario 2025 to Scenario 2030 in order to identify specific improvements, particularly for vehicles. Maps of the reduction from Scenario 2025 to Scenario 2030 are included in Appendix A.

5.2.1 PM_{10} Scenario Modelling Concentrations

All the scenario emission changes will affect PM_{10} concentrations. There is a reduction in exceedances (as well as total eradication) around the central and northern VTAPA. This is primarily related to reduction in TSF and industrial emissions; however, impacts from reducing waste burning and domestic fuel combustion can be seen around and south of Soweto. In the central VTAPA region an area of exceedance remains due to no MES being applicable to brick production in clamp kilns.

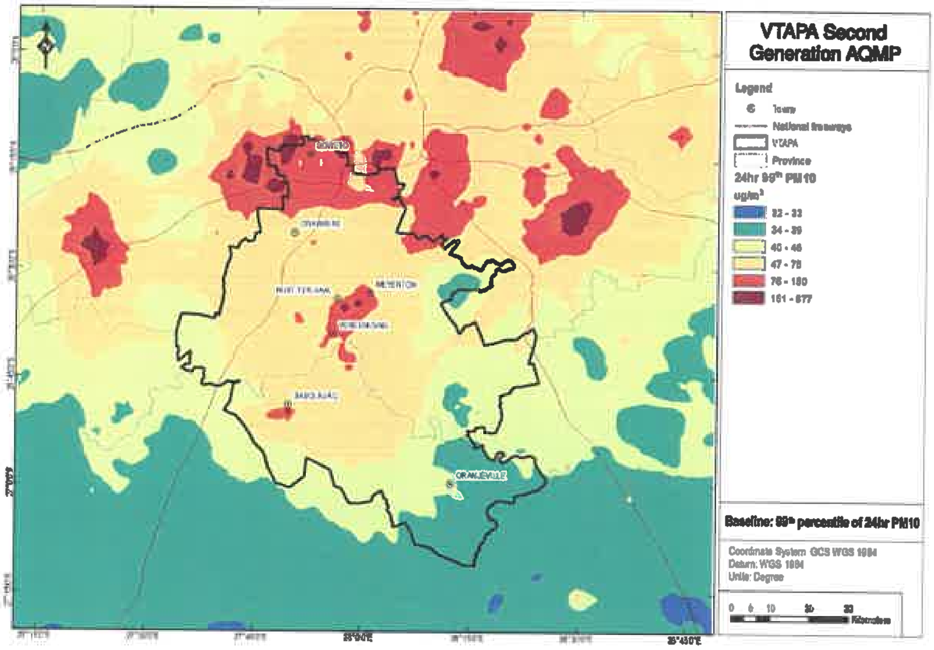

Figure 9: PM10 24-hour concentrations as a 99th percentile for the Baseline Scenario

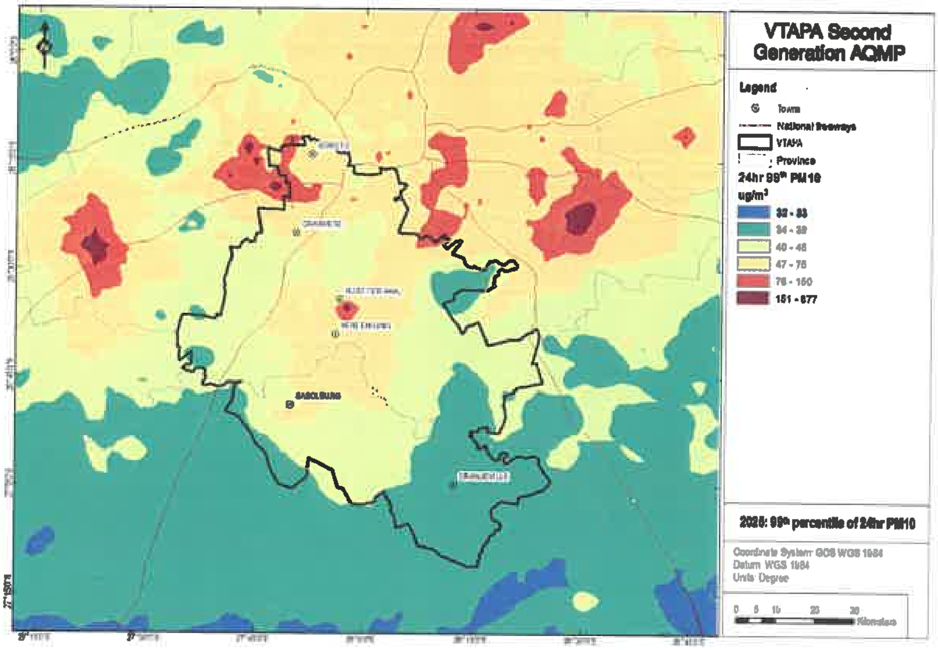

Figure 10: PM10 24-hour concentrations as a 99th percentile for Scenario 1 – year 2025

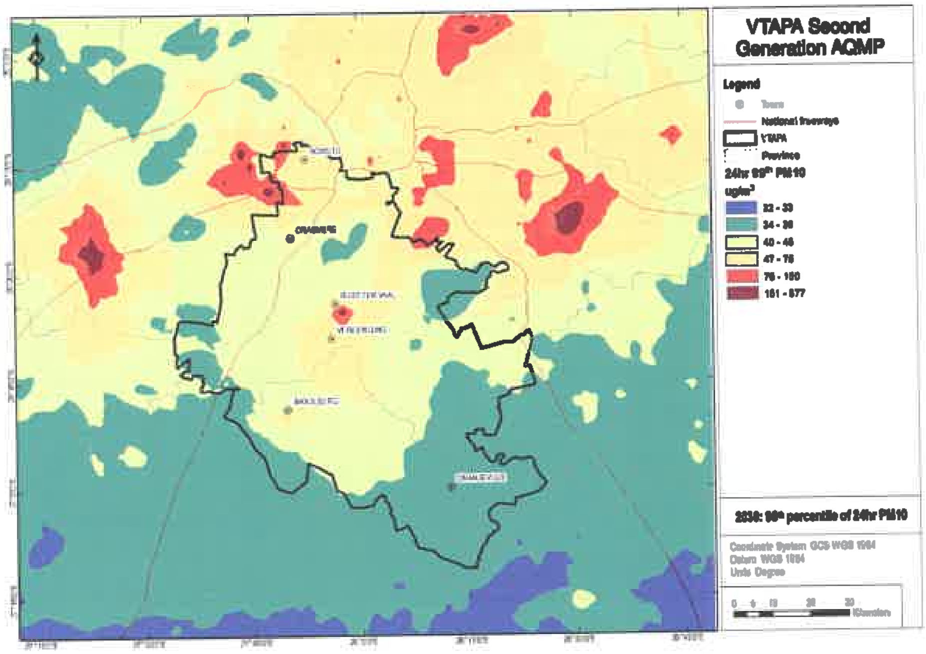

Figure 11: PM_{10} 24-hour concentrations as a 99th percentile for Scenario 2 – year 2030

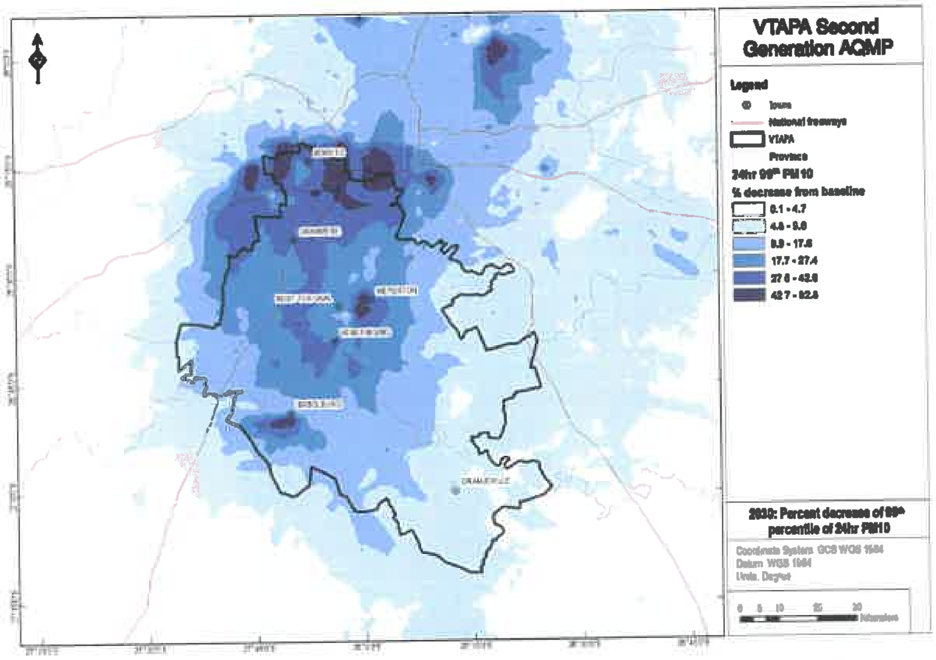

Figure 12: PM_{10} 24-hour percent decrease of the 99th percentile from Baseline to Scenario 2 – year 2030

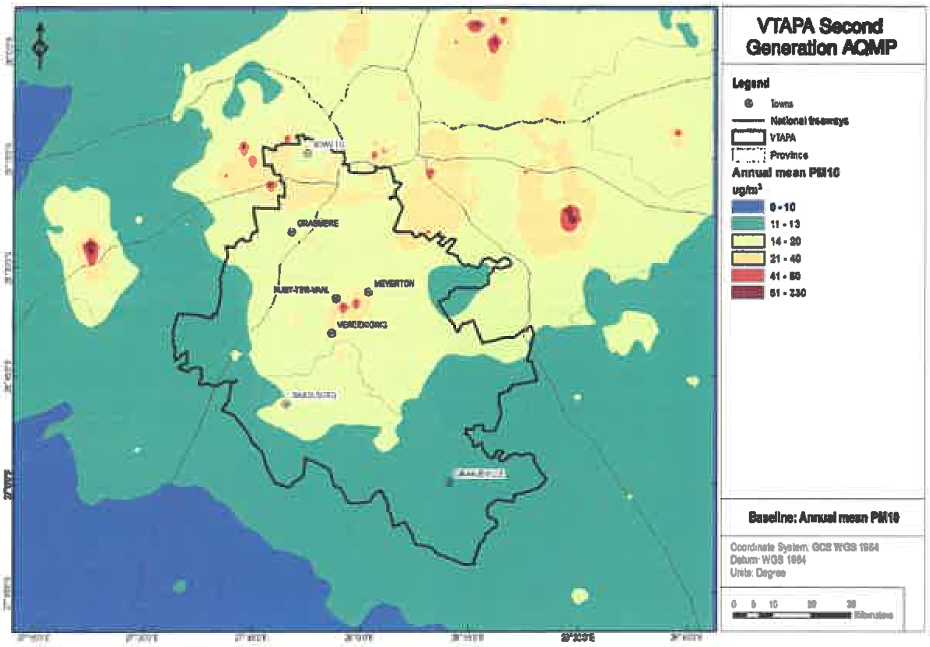

Figure 13: PM$_{10}$ annual mean concentrations for the Baseline Scenario

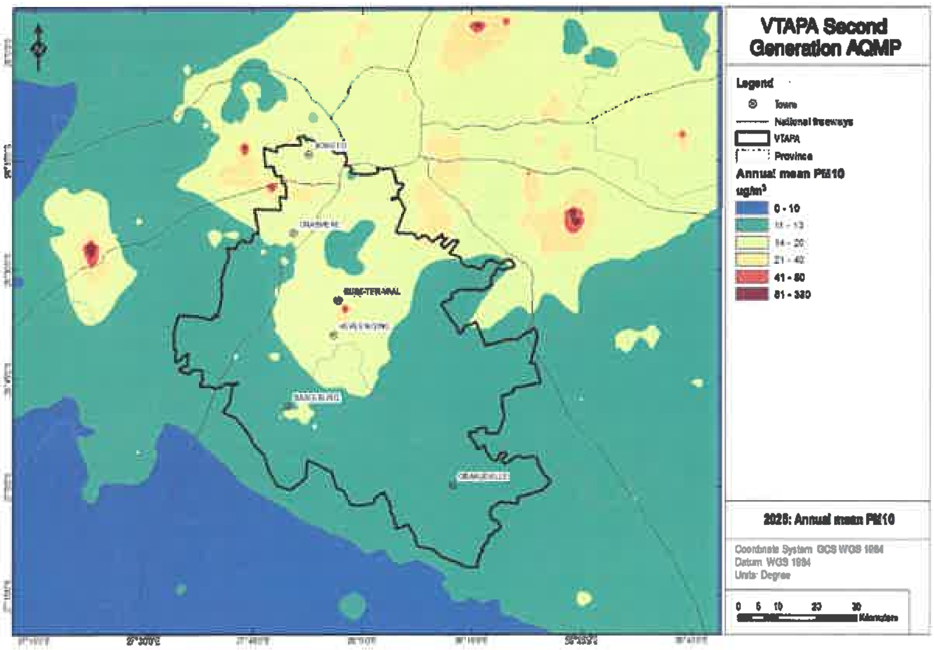

Figure 14: PM$_{10}$ annual mean concentrations for Scenario 1 – year 2025

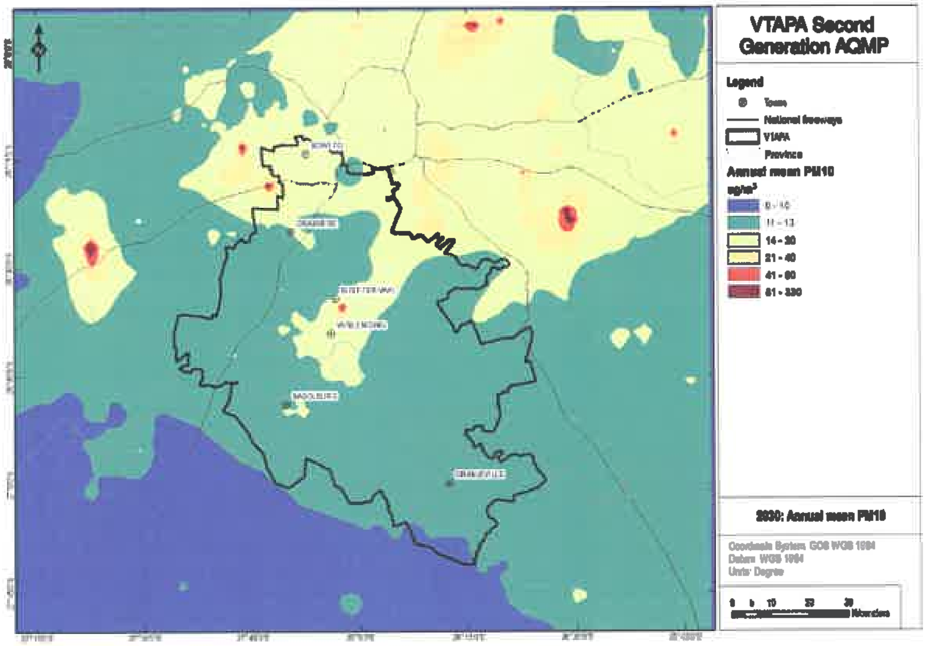

Figure 15: PM_{10} annual mean concentrations for Scenario 2 – year 2030

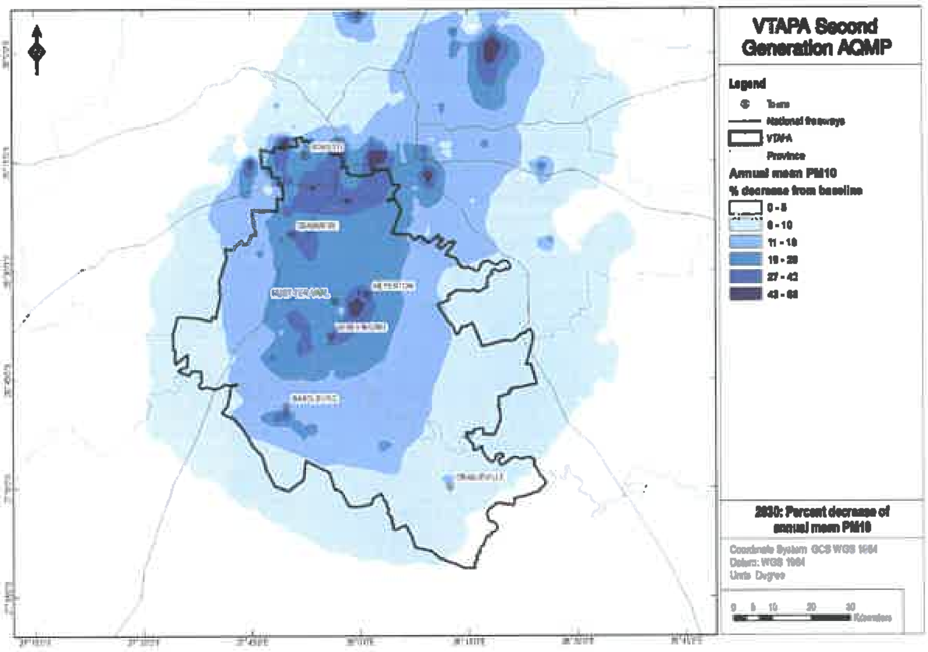

Figure 16: PM_{10} percent decrease of the annual mean from Baseline to Scenario 2 – year 2030

5.2.2 $PM_{2.5}$ Scenario Modelling Concentrations

For $PM_{2.5}$, reductions in the 24hr 99th percentile are not as readily seen as PM_{10} for Scenario 2025. This is possibly due to the fact that many more sources are estimated (in the emissions inventory) to emit $PM_{2.5}$. There is also the influence of secondary PM formation, which enhances $PM_{2.5}$ only. For Scenario 2025 24hr 99th percentile there are reductions, and the remaining hotspots in VTAPA are due to industrial, waste burning and domestic fuel combustion emissions. Exceedances around Zamdela region have been eliminated. Scenario 2030 (further reductions in domestic fuel combustion and waste burning, as well as EURO5 vehicles) contributes even further to 24hr 99th percentile reductions in exceedance areas, particularly along the central region. However, areas of exceedance in the north remain. The annual average shows better reductions, with Scenario 2030 resulting in total eradication of exceedance areas.

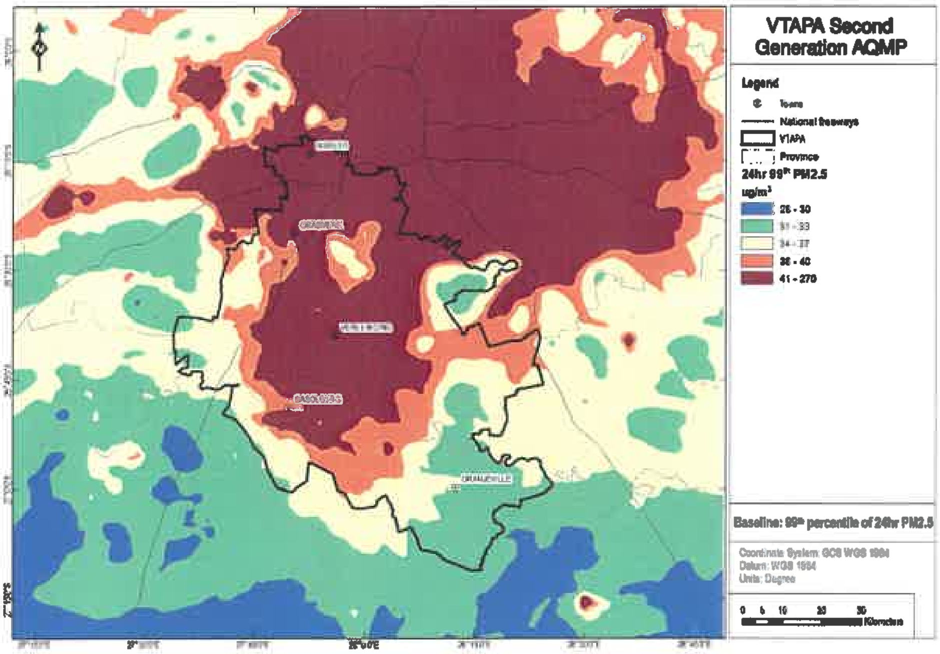

Figure 17: $PM_{2.5}$ 24-hour concentrations as a 99th percentile for the Baseline Scenario

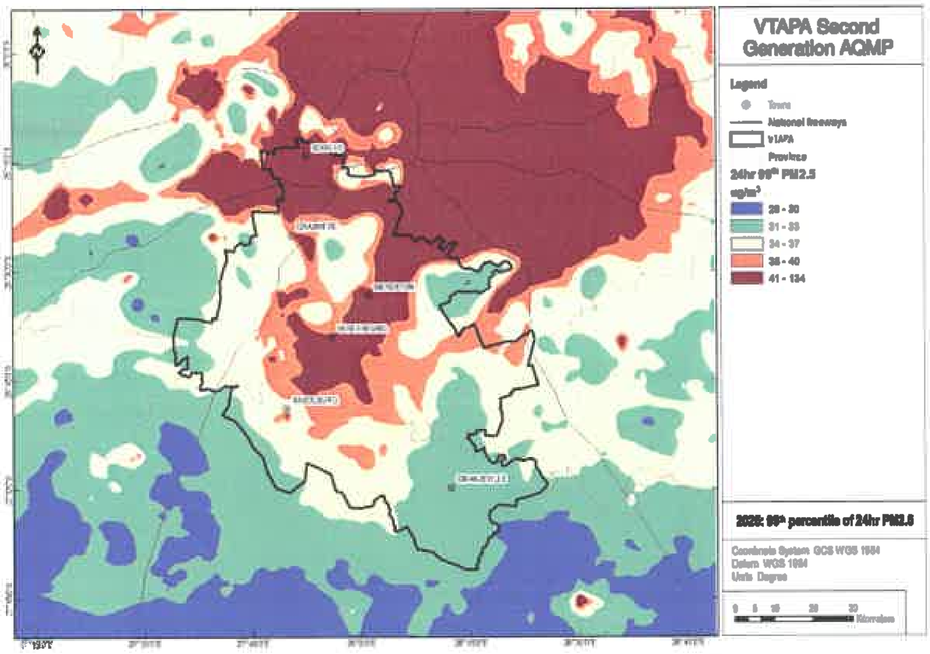

Figure 18: $PM_{2.5}$ 24-hour concentrations as a 99th percentile for Scenario 1 – year 2025

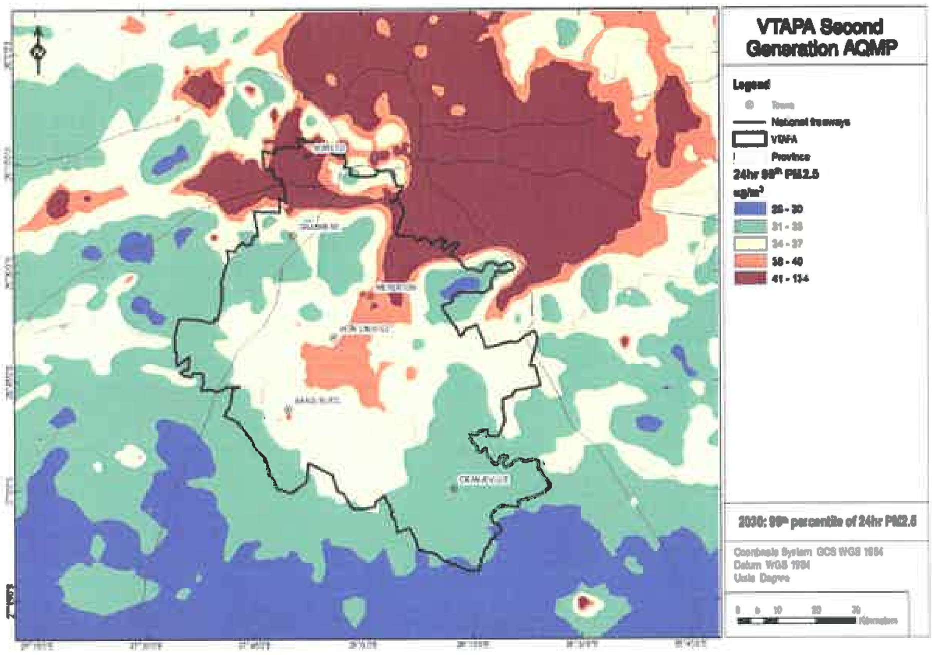

Figure 19: $PM_{2.5}$ 24-hour concentrations as a 99th percentile for Scenario 2 – year 2030

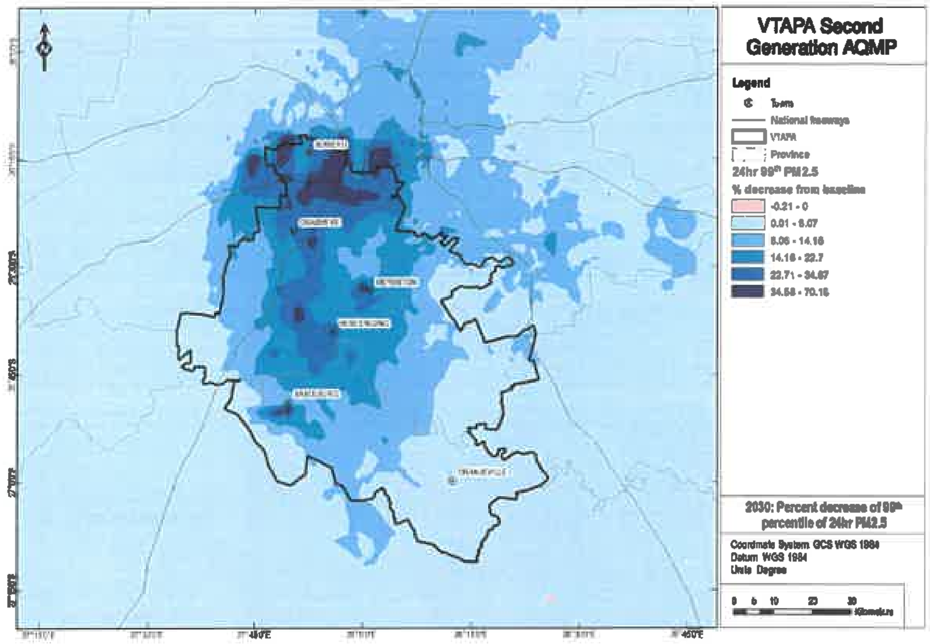

Figure 20: $PM_{2.5}$ 24-hour percent decrease of the 99th percentile from Baseline to Scenario 2 – year 2030

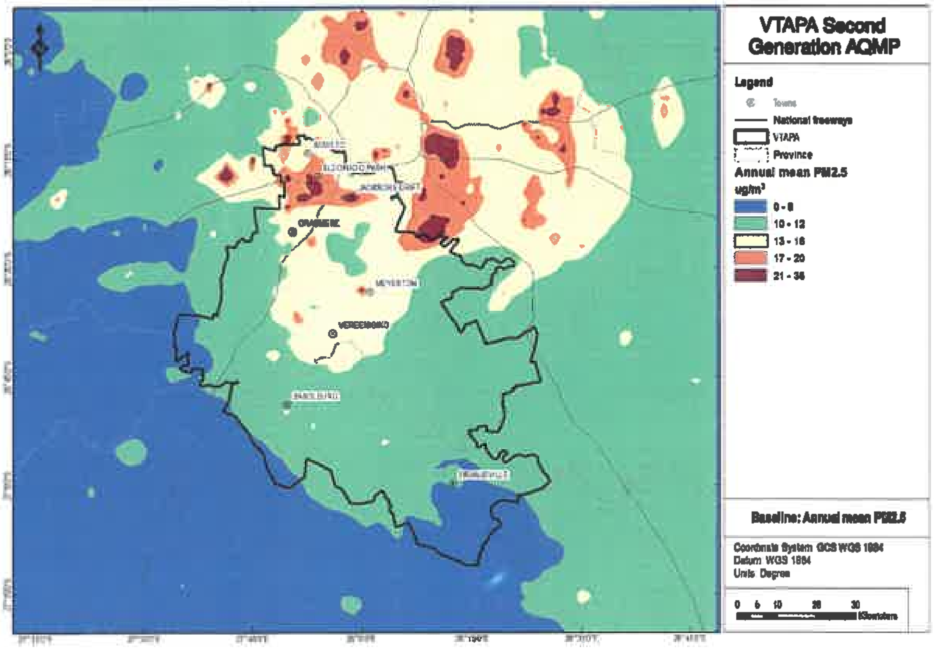

Figure 21: $PM_{2.5}$ annual mean concentrations for the Baseline Scenario

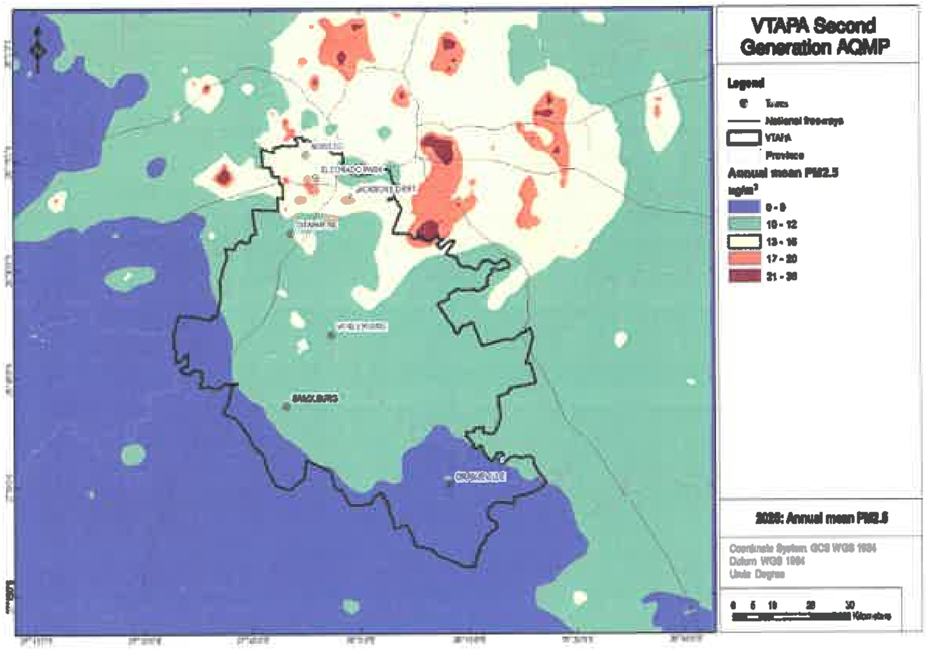

Figure 22: $PM_{2.5}$ annual mean concentrations for Scenario 1 – year 2025

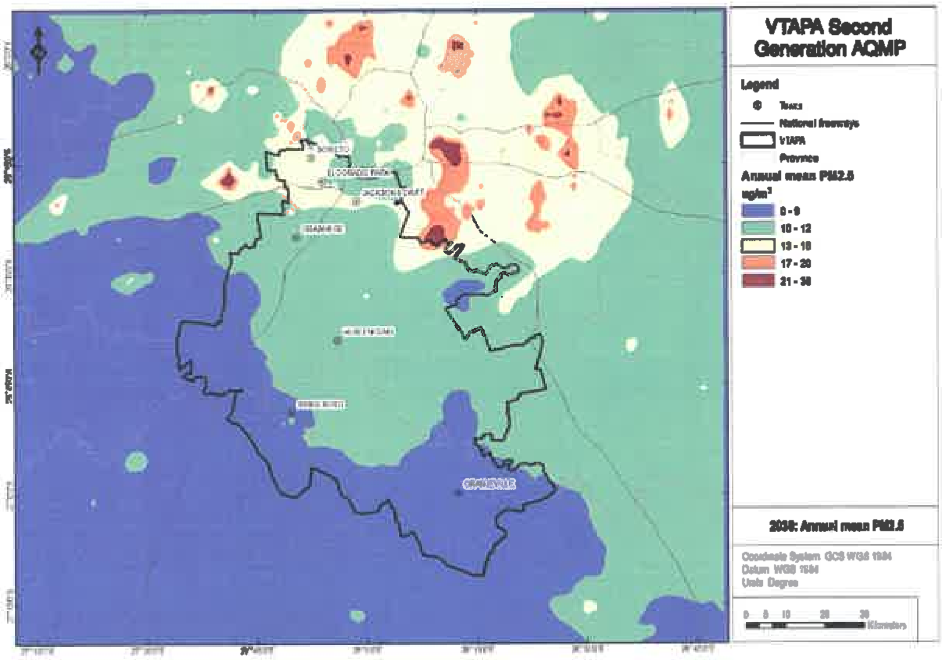

Figure 23: $PM_{2.5}$ annual mean concentrations for Scenario 2 – year 2030

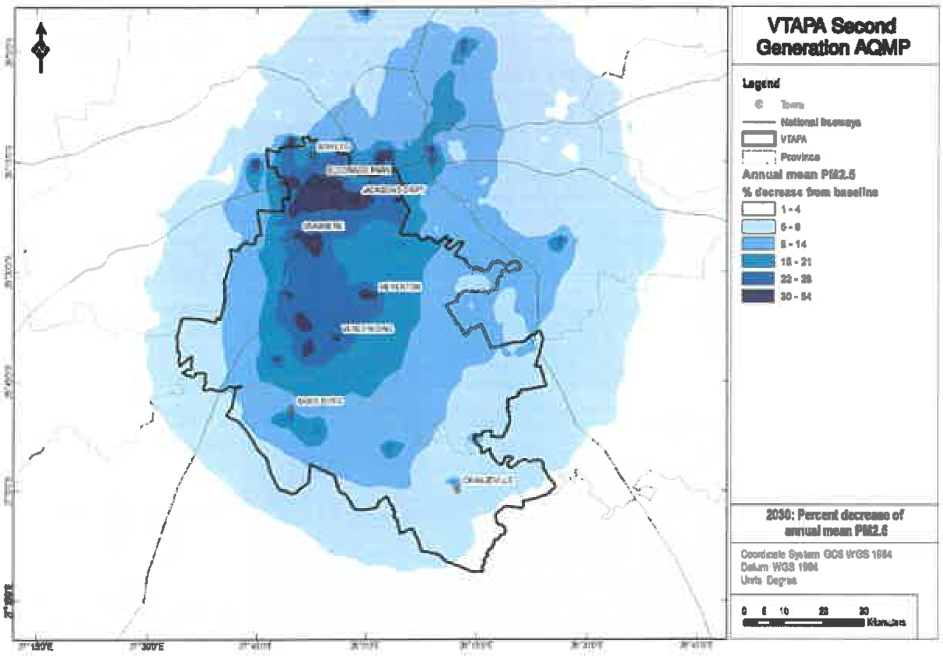

Figure 24: $PM_{2.5}$ percent decrease of the annual mean from Baseline to Scenario 2 – year 2030

5.2.3 NO_2 Scenario Modelling Concentrations

Only exceedances of the annual NAAQS are seen for NO_2 in VTAPA. Scenario 2025 does show a reduction, however, the exceedance around Sasolburg still persists. Scenario 2030 does not show any significant reduction. In the maps showing the percentage reduction, it is clear that much of the impact on NO_2 from the scenario is seen outside the VTAPA (dark blue) and originating from the region around Sasolburg. For industrial emissions the largest reductions are seen from Sasol Sasolburg facilities; since Lethabo power station is estimated to be within its NO_x MES (and is therefore not changed for the scenario). The reductions in NO_2 concentrations are seen to expand away from Sasol, however, the exceedance immediately around the facility still persists because they are due to either low level sources that have not been affected by MES or higher stacks whose plumes reach the surface to create exceedances but with concentrations higher than the MES can reduce to acceptable levels.

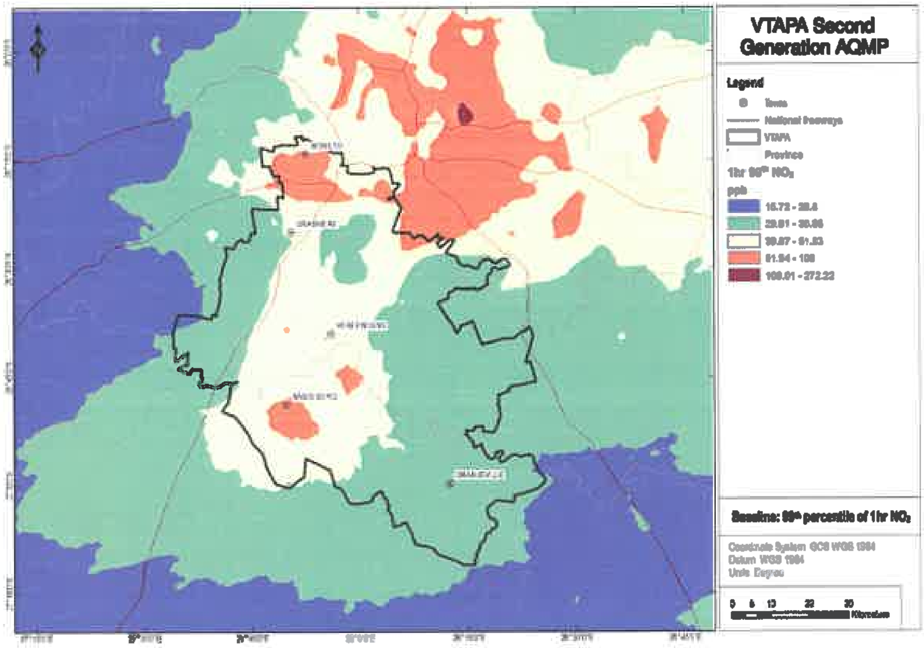

Figure 25: NO_2 1-hour concentrations as a 99th percentile for the Baseline Scenario

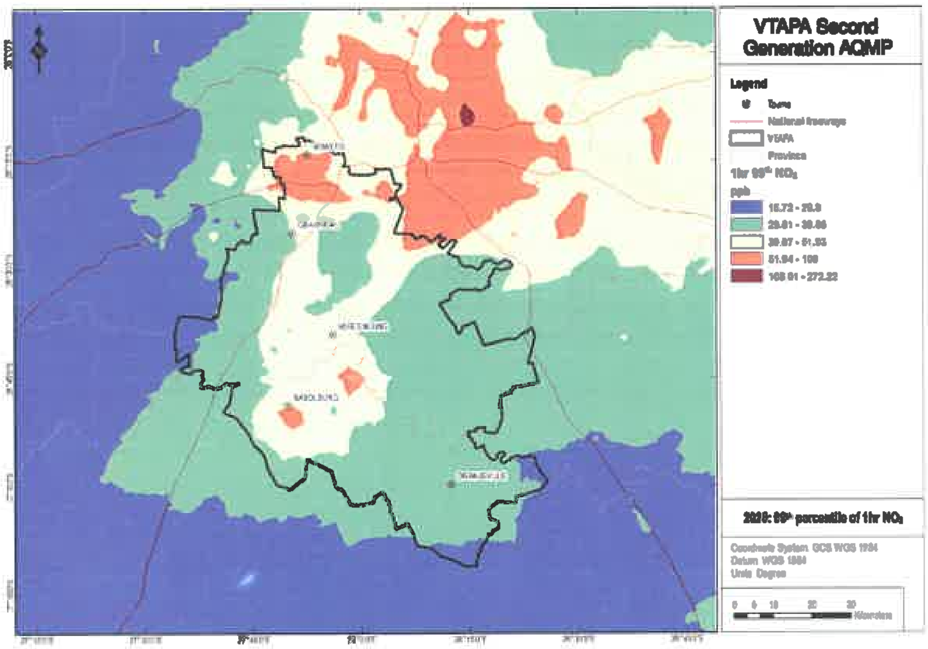

Figure 26: NO_2 1-hour concentrations as a 99th percentile for Scenario 1 – year 2025

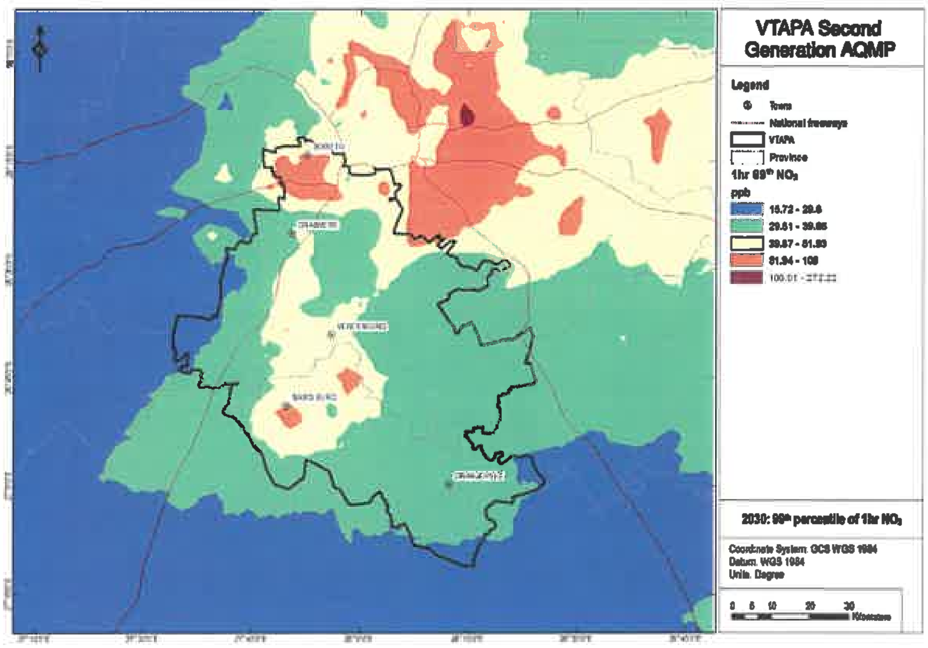

Figure 27: NO_2 1-hour concentrations as a 99th percentile for Scenario 2 – year 2030

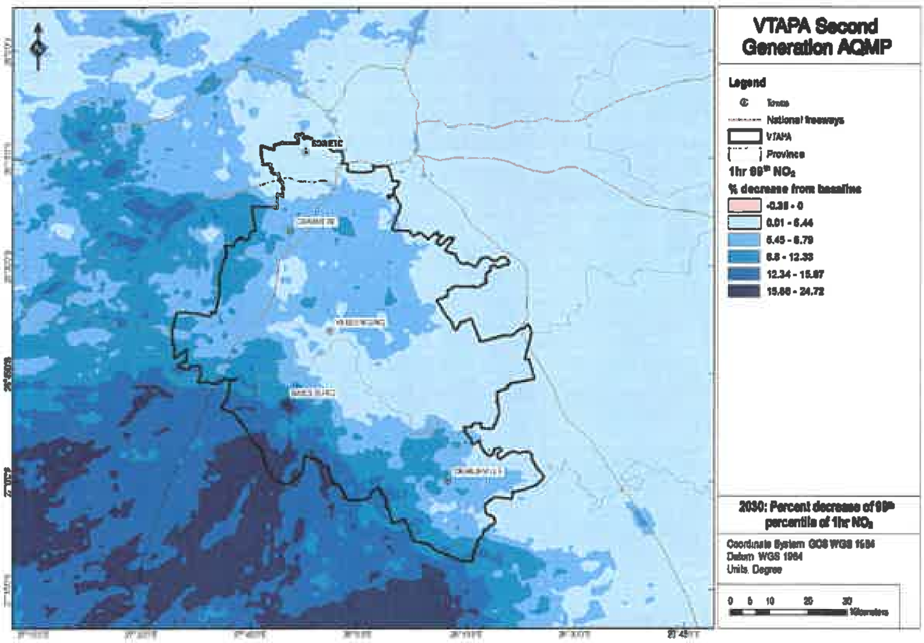

Figure 28: NO_2 1-hour percent decrease of the 99th percentile from Baseline to Scenario 2 – year 2030

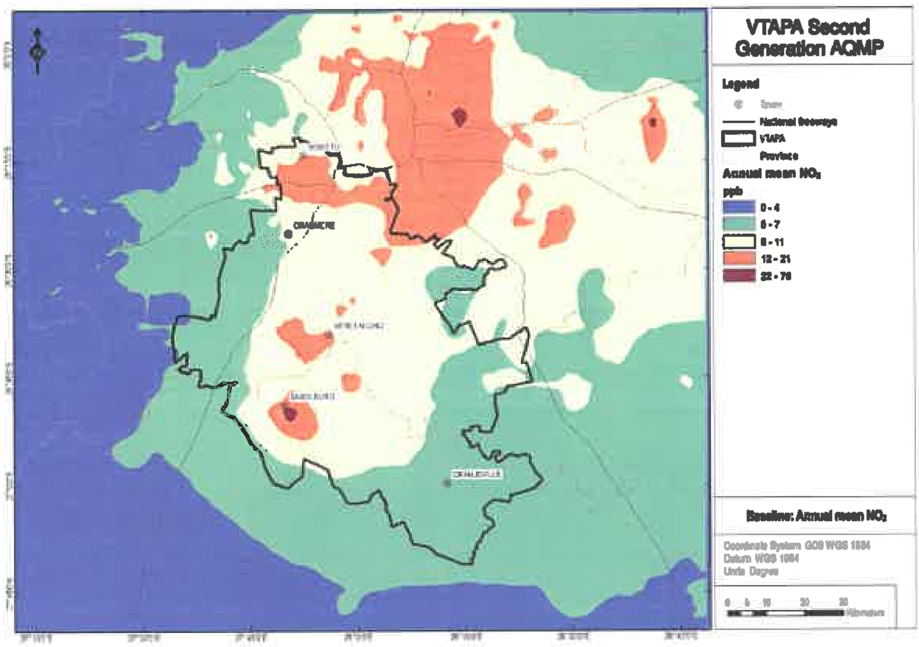

Figure 29: NO_2 annual mean concentrations for the Baseline Scenario

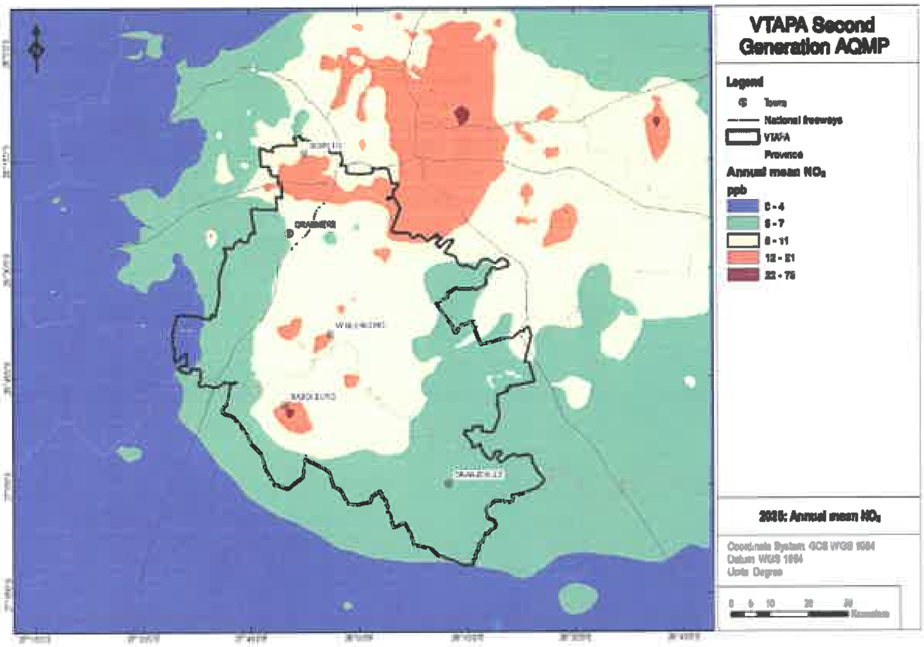

Figure 30: NO_2 annual mean concentrations for Scenario 1 – year 2025

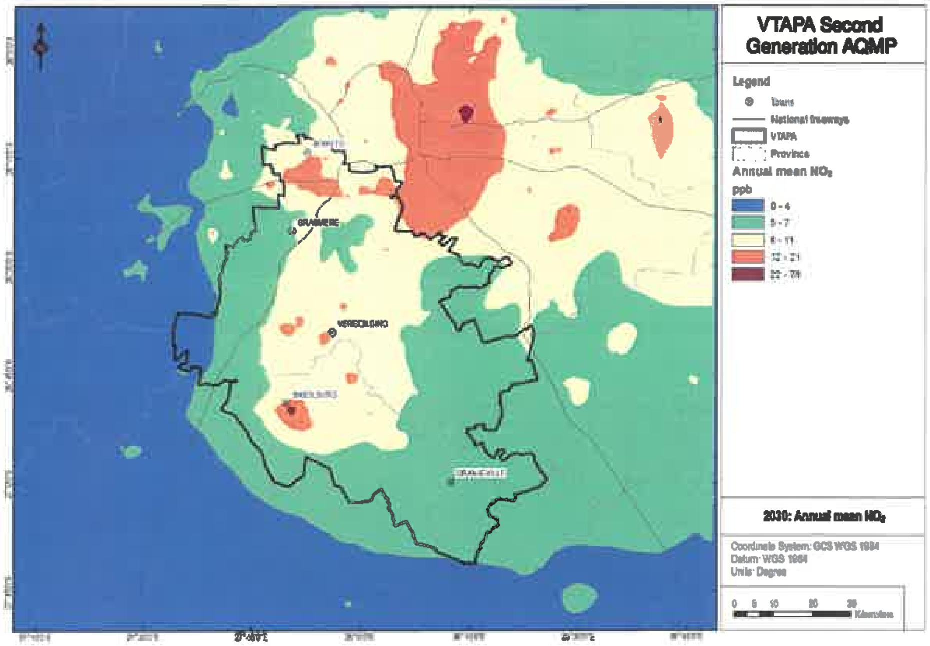

Figure 31: NO_2 annual mean concentrations for Scenario 2 – year 2030

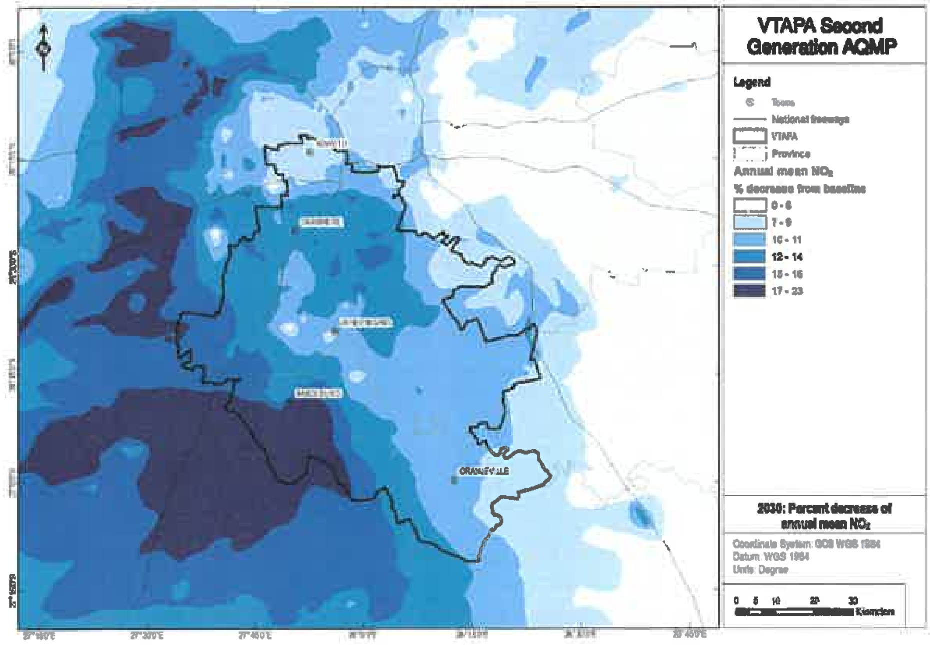

Figure 32: NO_2 percent decrease of the annual mean from Baseline to Scenario 2 – year 2030

5.2.4 Ozone Scenario Modelling Concentrations

Important factors affecting ozone concentrations are pre-cursor concentrations, solar radiation intensity and chemistry in general. NO_x and VOC are pre-cursors, however, an important distinction between NO and NO_2 must be made since NO titrates ozone and NO_2 enhances formation. For a majority of combustion sources, the emission ratio of NO to NO_2 is heavily weighted towards NO. This means, for example, a NO_x MES reduces mainly NO in the inventory. A reduction in NO reduces titrations and enhances O_3 concentrations near the source. The percentage decrease map shows that O_3 has increased due to the decrease in NO around Sasolburg. A reduction in NO_x from vehicles also tends to increase ozone throughout the domain; and this is particularly so for small decreases in NO_x in a VOC-limited region (example Roustan et al., 2011 and Collet et al., 2012). Either more reductions need to be applied in general in the sector (for which there is potential since the reductions from EURO5 were relatively small) or reductions targeting specific NMVOC need to be formulated.

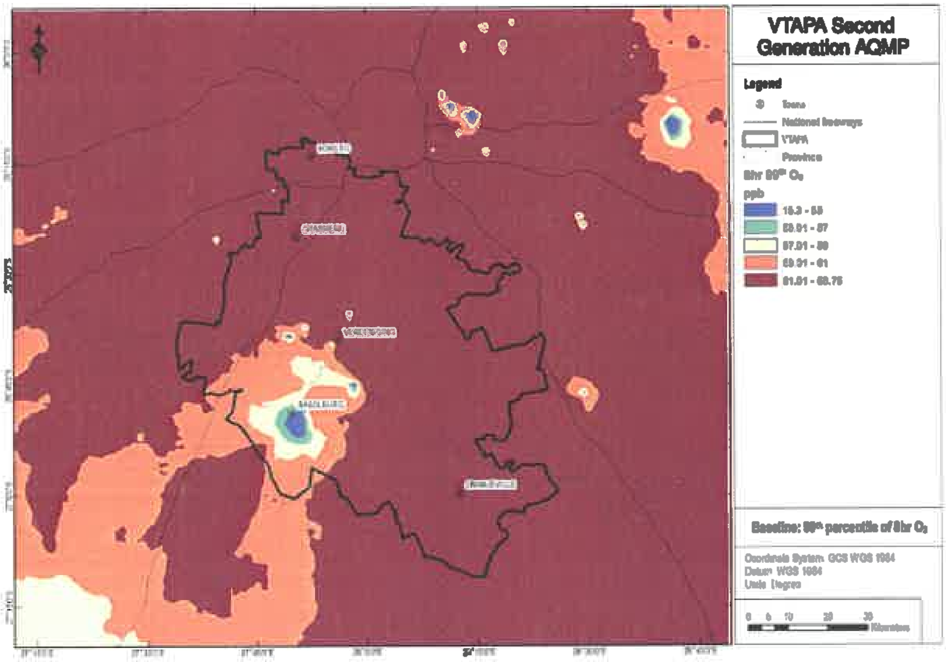

Figure 33: Ozone 8-hour concentrations as a 99th percentile for the Baseline Scenario

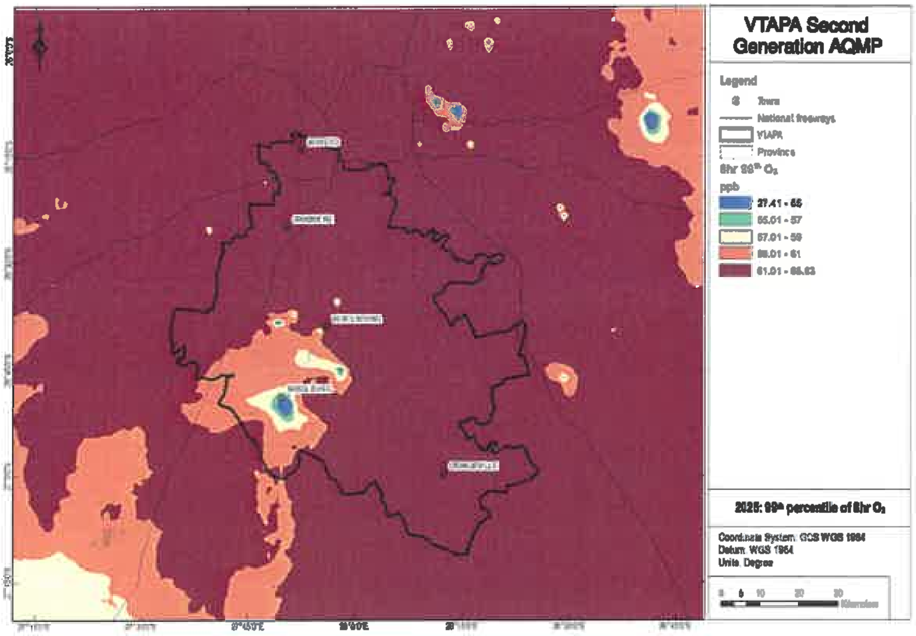

Figure 34: Ozone 8-hour concentrations as a 99th percentile for Scenario 1 – year 2025

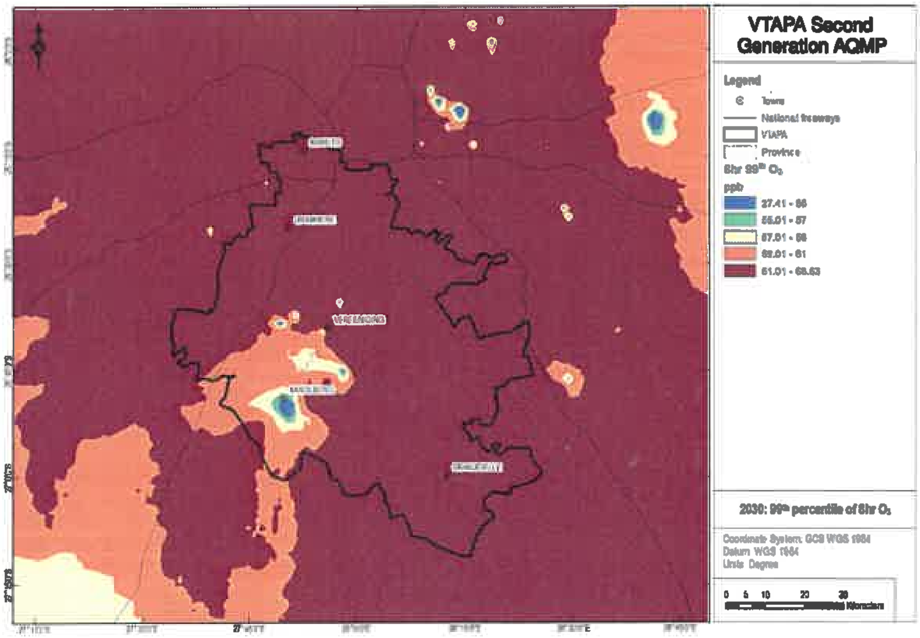

Figure 35: Ozone 8-hour concentrations as a 99th percentile for Scenario 2 – year 2030

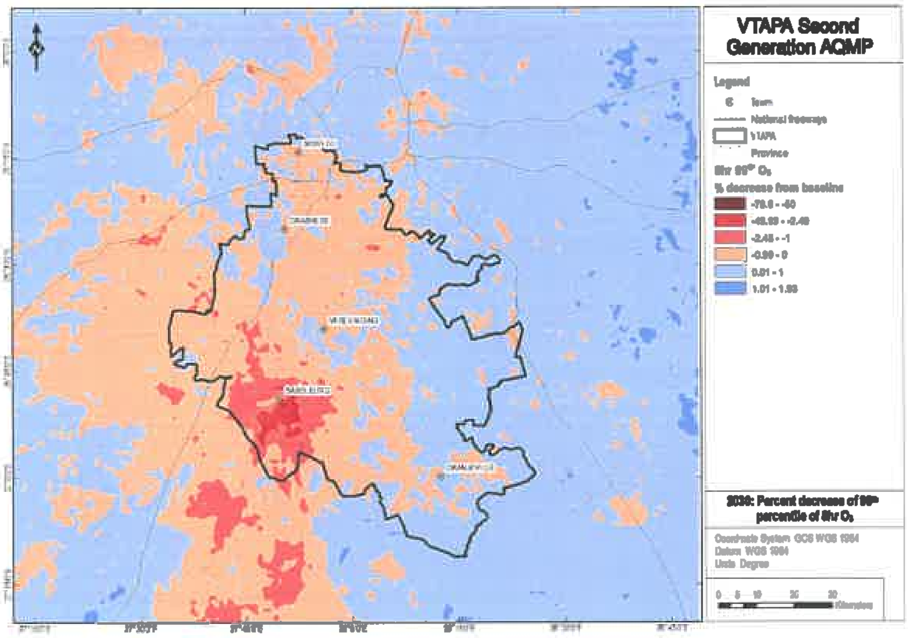

Figure 36: Ozone 8-hour percent decrease of the 99th percentile from Baseline to Scenario 2 – year 2030

5.2.5 SO_2 Scenario Modelling Concentrations

For SO_2 there is a reduction in the area of exceedances, however the exceedances still exist. The areas of greatest decrease are around Sasolburg and north of Vereeniging (around Rust ter Vaal). The reduction on Eskom Lethabo SO_2 emissions due to MES (of 1000 mg/Nm^3) is relatively small, at an average of 9% (min=1.7%, max=17.7%), resulting in only a small reduction in SO_2 concentrations around the power station. However, it was subsequently found that the baseline annual emission tonnage from NAEIS (used in the modelling) is lower than a calculated annual tonnage from the AEL stack concentration. Thus, the baseline to which the reduction is compared to is closer to the MES than a baseline that would be estimated using only the AEL stack concentration. Other areas of persisting exceedances are Wolwehoek, Diepkloof Zone 6 and north of Bophelong.

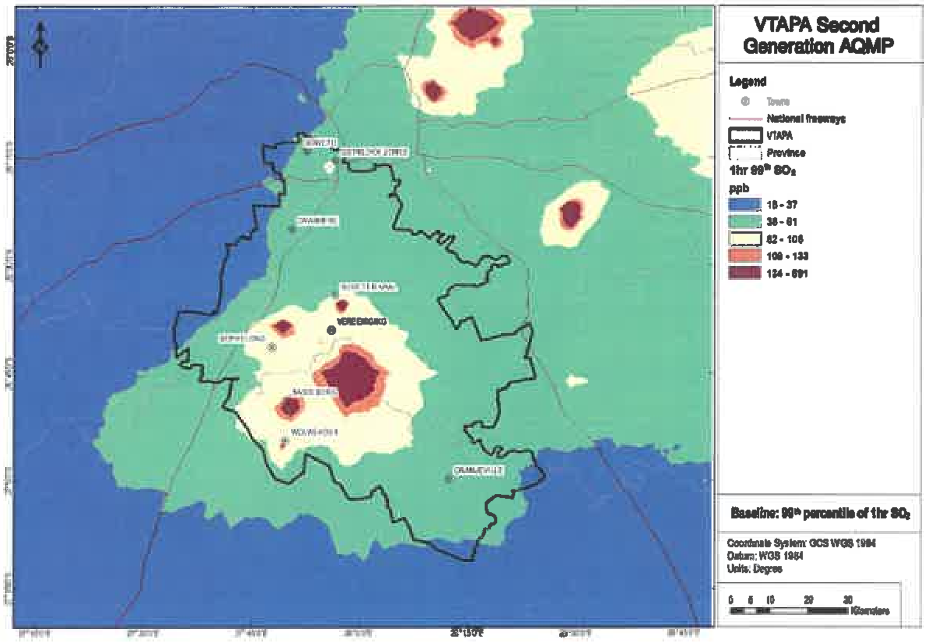

Figure 37: SO_2 1-hour concentrations as a 99th percentile for the Baseline Scenario

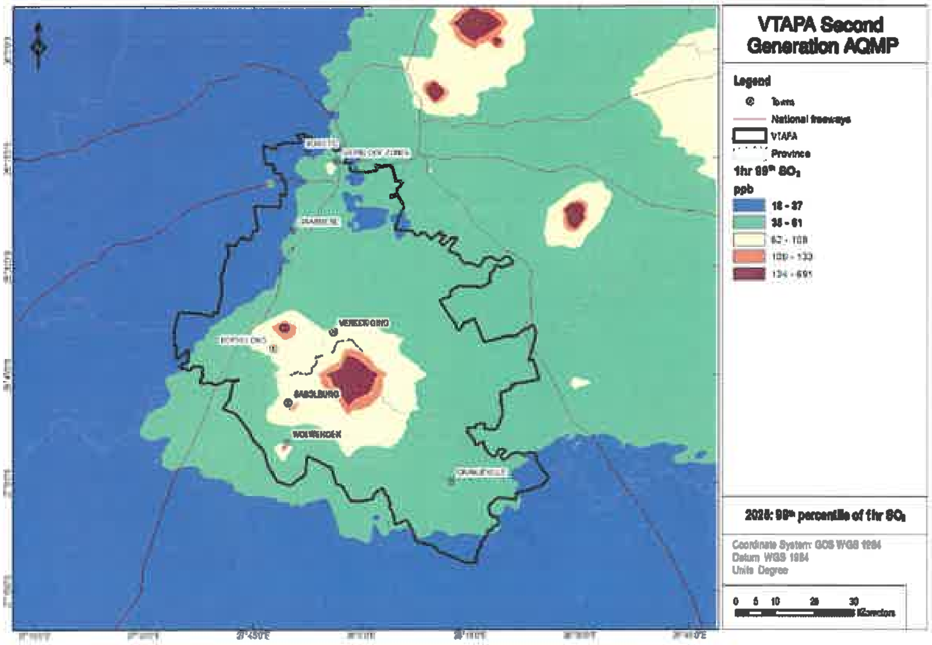

Figure 38: SO_2 1-hour concentrations as a 99th percentile for Scenario 1 – year 2025

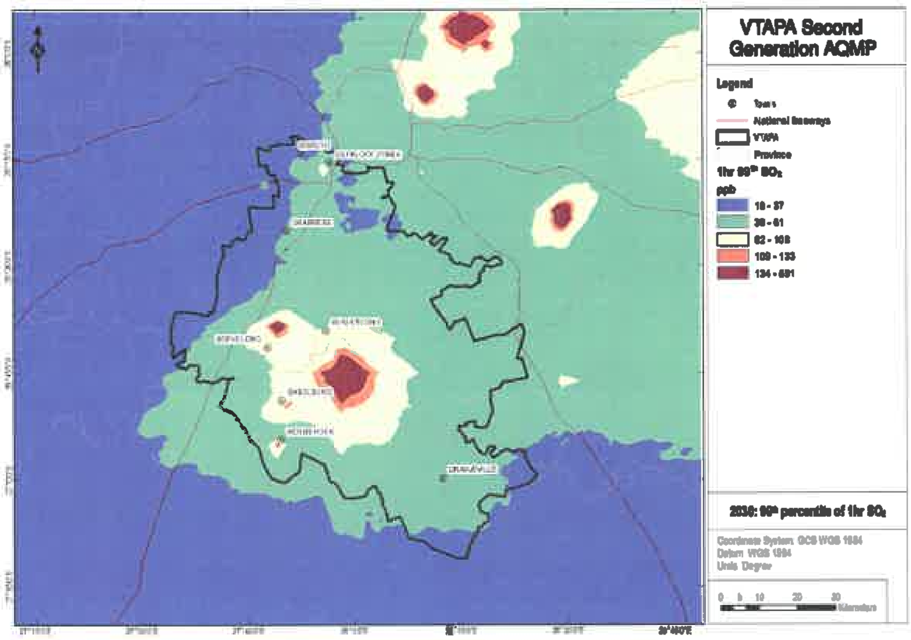

Figure 39: SO_2 1-hour concentrations as a 99th percentile for Scenario 2 – year 2030

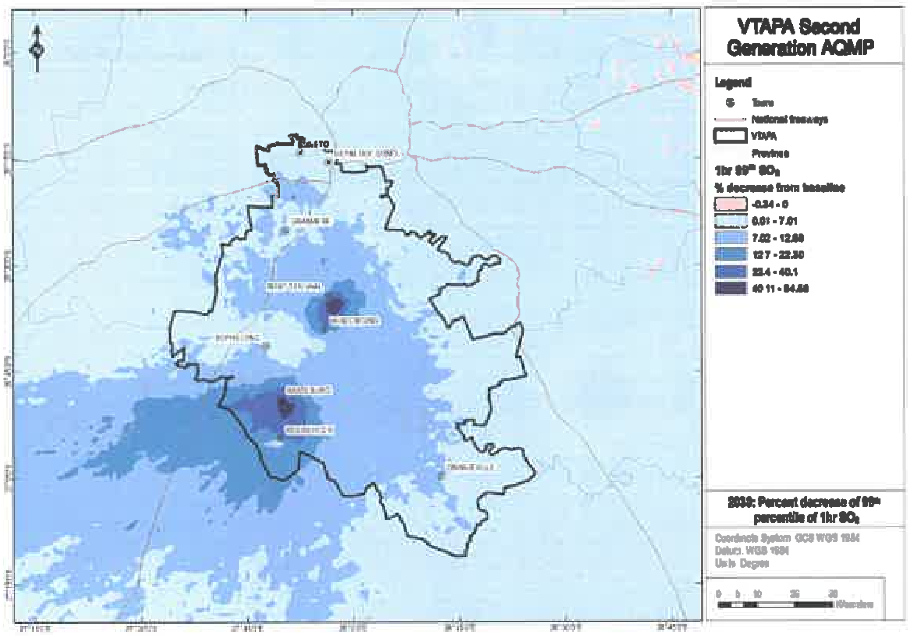

Figure 40: SO_2 1-hour percent decrease of the 99th percentile from Baseline to Scenario 2 – year 2030

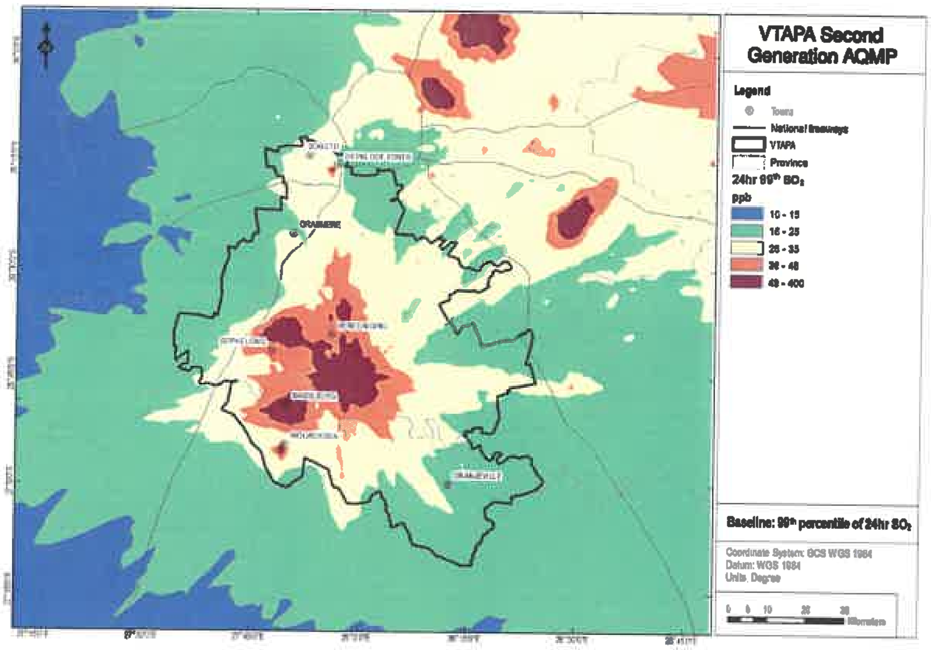

Figure 41: SO_2 24-hour concentrations as a 99th percentile for the Baseline Scenario

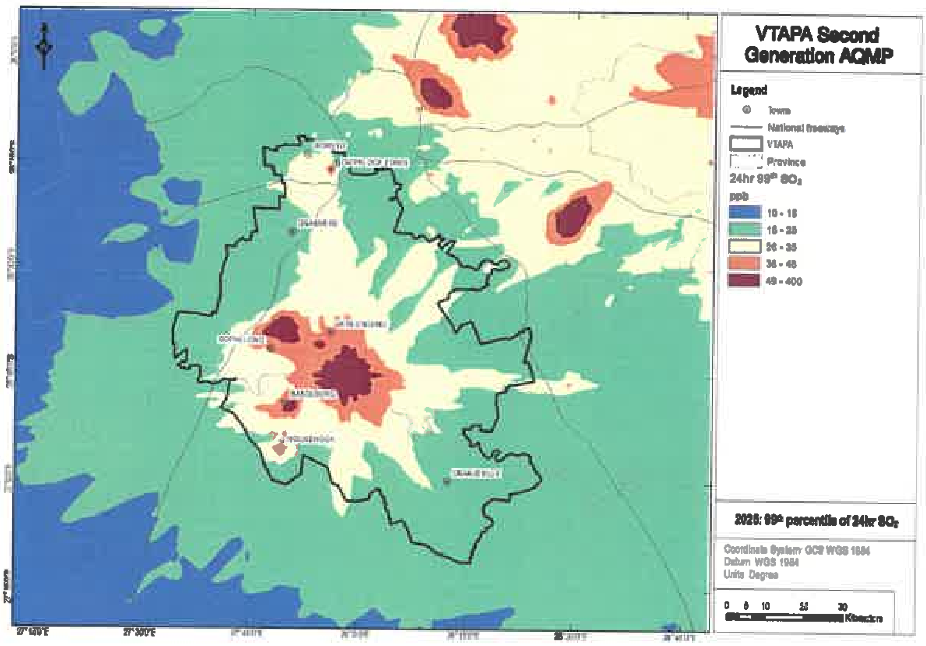

Figure 42: SO_2 24-hour concentrations as a 99th percentile for Scenario 1 – year 2025

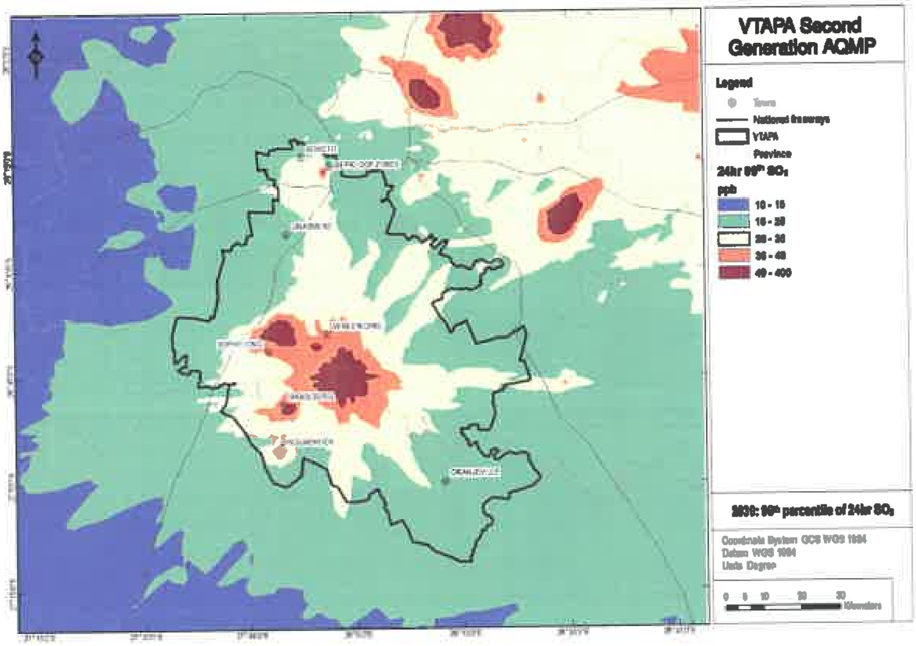

Figure 43: SO_2 24-hour concentrations as a 99th percentile for Scenario 2 – year 2030

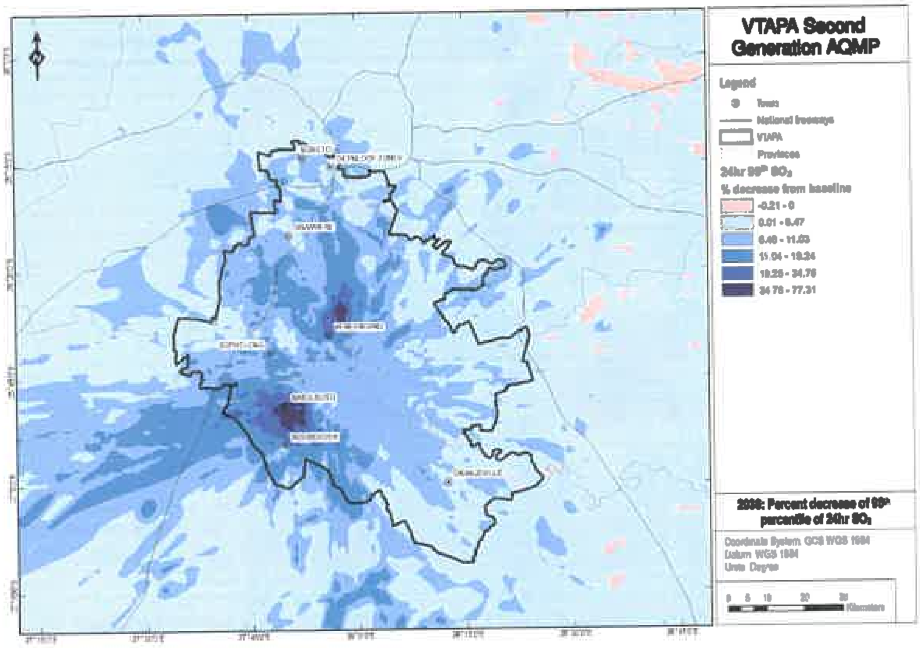

Figure 44: SO_2 24-hour percent decrease of the 99th percentile from Baseline to Scenario 2 – year 2030

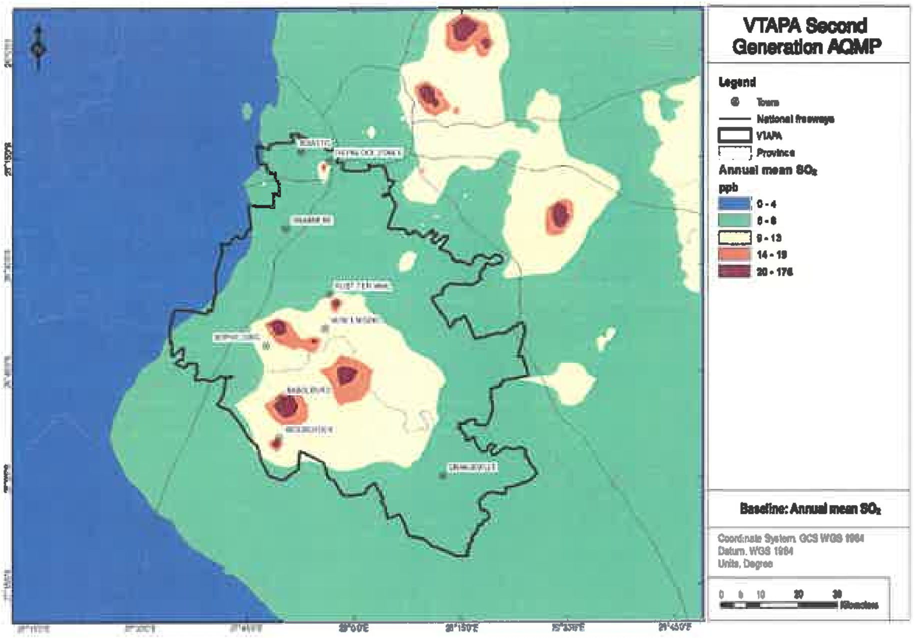

Figure 45: SO_2 annual mean concentrations for the Baseline Scenario

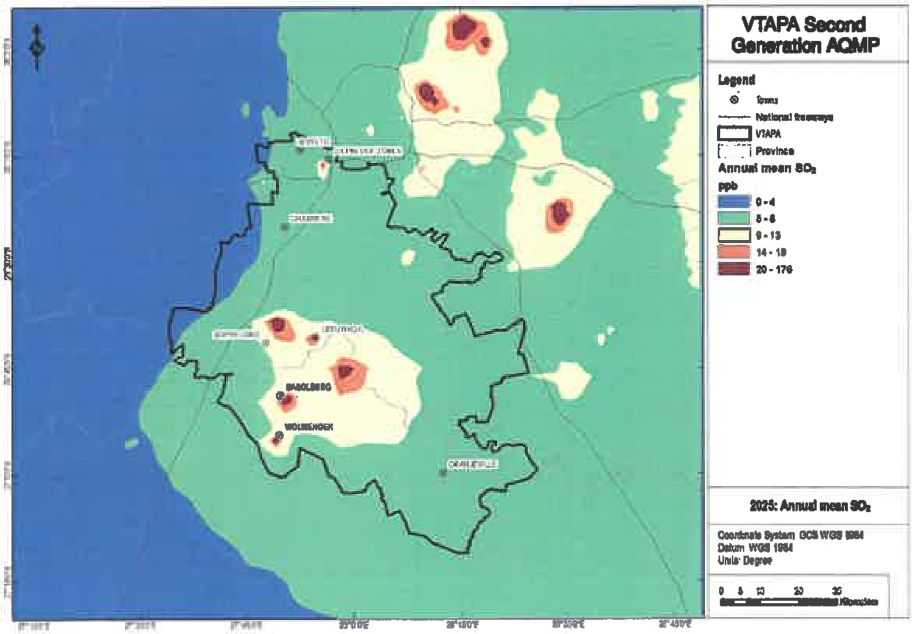

Figure 46: SO_2 annual mean concentrations for Scenario 1 – year 2025

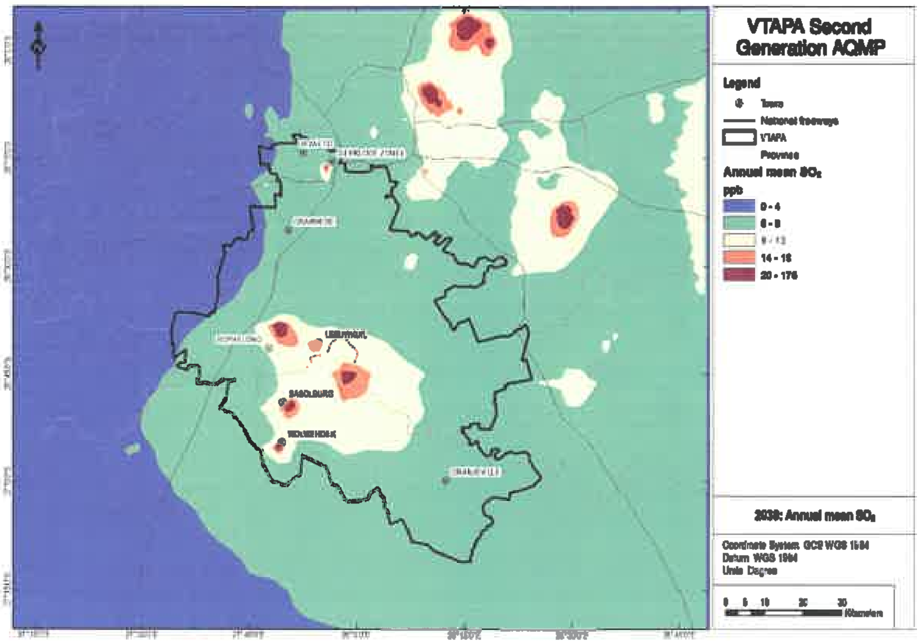

Figure 47: SO_2 annual mean concentrations for Scenario 2 – year 2030

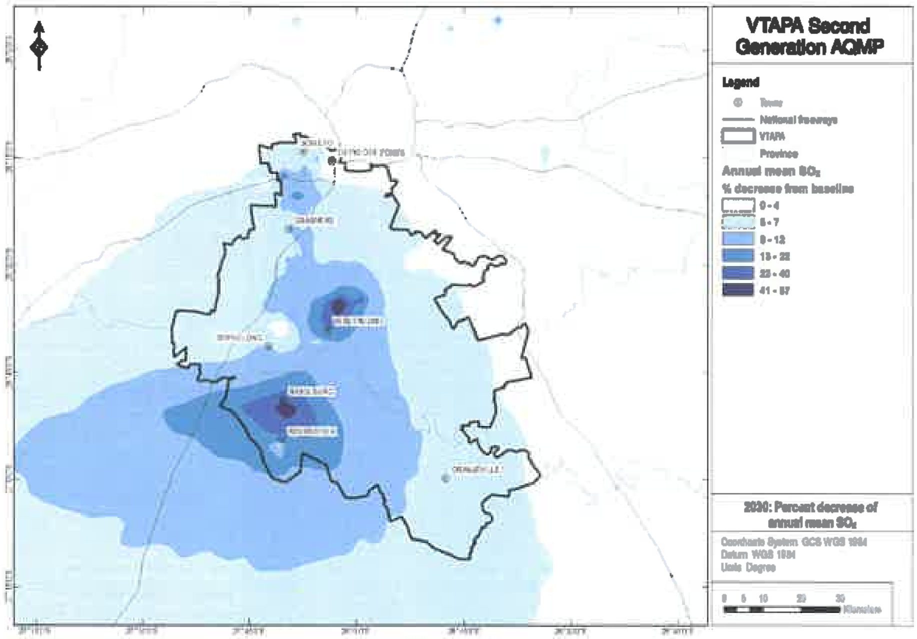

Figure 48: SO_2 percent decrease of the annual mean from Baseline to Scenario 2 – year 2030

5.3 Key Findings

The main findings from the scenario modelling are as follows:

- Simulations indicate that through the scenario emission reductions, PM may be reduced to acceptable levels. However, 24hr $PM_{2.5}$ remains an issue in the northern VTAPA.
- For NO_2, the baseline indicates that only the NAAQS for the annual average is exceeded around Sasolburg. The reductions in the scenarios do not reduce this significantly (majority of reductions in ambient are seen further afield from Sasolburg).
- Ozone remains problematic after both future scenarios. This is primarily due to the region being VOC-limited and emission reductions on NO_x being moderate. It is also possible the ozone issue involves transboundary impacts into and out of VTAPA; making it a regional management issue.
- Further reductions in SO_2 are required since the 2020 MES will not ensure compliance. These are relevant for Lethabo power-station and other industries around Wolwehoek, Diepkloof Zone 6 and north of Bophelong.

SCHEDULE _C

6 AIR QUALITY MANAGEMENT ACTIONS FOR THE VTAPA

6.1 Objective

Compliance with NAAQS within the VTAPA though continuous AQM implementation action and coordination by the various spheres of government and all stakeholders

6.2 VTAPA Implementation Plan

Interventions for the VTAPA second generation AQMP was developed by means of a Stakeholder Consultation Workshop that was held on the 13th of March 2019 in Vanderbijlpark. The findings from the SAS report as well as the scenario modelling results identified the main sectors of concern for which feasible interventions needed to be developed. The workshop consultation followed the SMART (Simple, Measurable, Achievable, Realistic and Time-Bound) method of goal setting which allows to prioritise the interventions for implementation. Other considerations included (i) the environmental benefit that will be obtained from such an intervention, (ii) whether it is technical and economically feasible, and (iii) if it is socially acceptable and desirable. The potential risk or degree of uncertainty around the measure, the strategic and political desirability, timeframes for implementation and environmental benefit realisation, and the development of local expertise and potential for local employment, were also accounted for.

A total of eight (8) sectors were identified for which specific interventions were developed to form part of the implementation plan. These include:

1. Industries and power generation / compliance monitoring and enforcement
2. Mining operations
3. Ash dumps and tailings storage facilities
4. Domestic fuel burning
5. Domestic waste burning
6. Biomass burning
7. Education and awareness
8. Vehicle emissions

The aim of these interventions is to be practical, implementable and aimed to result in the desired ambient air quality improvements. In addition, the interventions should have clear objectives, activity descriptions, resource requirements and indicators. These intervention descriptions are provided in Table 15 to Table 22 for the eight sectors. The need for granulation and clarification of roles and responsibilities for all stakeholders at local level, who will be collaborating to execute relevant initiatives and providing progress feedback, is pertinent.

6.2.1 Prioritisation and Financial Implications of Interventions

In prioritising the interventions, the significance of the problem necessitating the set intervention was considered in combination with the likelihood of implementation, i.e. how feasible the implementation is. This was in turn influenced by both the cost and the risks linked to the intervention.

Since detailed cost associated with each intervention can only be determined through consultation with the various stakeholders[2], an estimated cost category is indicated as ***Low*** (<R1,000,000); ***Medium*** (R1,000,000 – R5,000,000) and ***High*** (>R5,000,000).

[2] It is noted that the AQMP lacks an accompanying economic impact assessment at a time when there are various other initiatives at provincial and municipal level competing for the same resources. Allocation of funds and resources at initiative level is crucial for successful implementation of the AQMP.

Table 15: Implementation Plan for Industries & Power Generation /Compliance Monitoring and Enforcement

Goal 1: ***All Listed Activities will be compliant with MES and fugitive emissions would have reduced such as to ensure compliance with NAAQS.***

Objectives	Activities	Mandatory responsibility	Participatory responsibility	Estimated Cost	Enabling Factors	Timeframes	Indicators	Priority
Minimisation of emissions from regulated facilities	Compliance with the existing MES	Industry, NGO's	Licensing Authority	***High cost*** – for industry ***Medium cost*** – for Licencing Authority	AEL's and NAEIS annual reporting More EMI's required for inspections and enforcement (Licencing Authority)	2025 years	Monitoring reports (Compliance monitoring activities)	High
Minimisation of fugitive emissions (e.g. waste, stockpiles, conveyor belts, haul roads etc.)	Develop and implement the Fugitive Emission Plan informed by Best Environmental Practice	Industry	Licensing Authority	***Low cost*** – for industry and authority	Industry to submit Plan to Licencing Authority within set timeframe as specified in AEL Annual NAEIS reporting	2 years or timeframe to be specified in the AEL	All facilities with AEL submitted plans to the licensing authorities	High
	Identification and implementation of suitable technology (Introduction of binding agents in waste stockpiles and dust suppressants)	Industry	Licensing Authority	***Medium cost*** – for industry	Investigating various products on the market Suppliers to do on-site trials to identify most suitable product Determine frequency of application and budget for it annually	3 years	Dust management plans implemented	High
	Reporting of fugitive emissions on NAEIS	Industry	Licensing Authority and DFFE	***Low cost*** – for industry	Already a legal requirement – annual NAEIS reporting	yearly	All facilities with AEL submitted plans fugitive emissions	High
	Minimize and manage NEMA Section 30 incidents	Industry	Licensing Authority	***Medium to High cost*** – for industry	Incidence register. Should be part of operations Cost of managing incidents would depend on the industry and type of incident	1 year	Number of Section 30 incidents	High

Objectives	Activities	Mandatory responsibility	Participatory responsibility	Estimated Cost	Enabling Factors	Timeframes	Indicators	Priority
Emissions from dust-generating activities are reduced	Development of legal framework to manage emissions from small/unlicensed facilities	Local municipalities	DFFE	***Low cost*** – existing personnel	To form part of Local government legislation development	2 years for development and implementation in 5yrs	Legal framework in developed	High
	Identify unlicensed dust generating activities	Local municipalities, CBOs and NGOs	DFFE	***Low cost*** – to be done by existing personnel	Can form part of emissions inventory development of Section 23 (per capacity building plan) Local government officials will have to do visual inspections of areas to identify activities	Ongoing	Identified dust generating activities	High
	Holistic approach for dust management where there is cluster of facilities	Industry/ licensing authorities	Licensing Authority	***Low cost*** – industry and government	Can form part of dust management plan reviews and interpretation To be reported at MSRG meetings	2 years	Integrated dust management plans developed	High

Notes: NGO – Non-Government Organisation, CBO – Community Based Organisation, MSRG – Multi Stakeholder reference Group

Table 16: Implementation Plan for Mines

Goal 2: *By 2025, fence line monitoring to confirm compliance with NAAQS, specifically for PM_{10} and $PM_{2.5}$, and NDCR.*

Objectives	Activities	Mandatory responsibility	Participatory responsibility	Estimated Cost	Enabling Factors	Timeframes	Indicators	Priority
Management /reduction of emissions from mines	Dust management plans developed and implemented	DMRE and mines	DFFE and Licensing authorities	***Medium cost*** – monitoring	Requirement of annual NAEIS reporting Installation of dustfall networks (analysis and reporting)	2 years	All mines developed dust management plans	High
	Vegetation (indigenous plants and grass) on the abandoned mine dumps	Mines and DMRE	DFFE	***High cost*** – depending on type of cover	Mines to submit rehabilitation plans to government with implementation timeframes and required maintenance frequency	5 years	Number of dumps rehabilitated	Medium
	Establish the complaints management system for all mines	Mines and DMRE	DFFE, NGO's and Municipalities	***Low cost***	Complaints register and upkeep Report annually to authority	2 years	The complaints management system established by all mines	High
	Implementation of the rehabilitation plans for non-operational mines	Mines and DMRE	Municipalities and DFFE	***High cost*** – depending on type of cover	Mines to submit rehabilitation plans to government with implementation timeframes and required maintenance frequency	Long-term	Mines rehabilitated	Medium

Notes: DMRE – Department of Mineral Resources and Energy

Table 17: Implementation Plan for Ash Dumps and Tailings Storage Facilities

Goal 3: *By 2025, 80% reduction in windblown dust emissions ensuring compliance with NAAQS within the vicinity of all ash dumps and tailings storage facilities.*

Objectives	Activities	Mandatory Responsibility	Participatory Responsibility	Estimated Cost	Enabling Factors	Timeframes	Indicators	Priority
Reduction of particulate matter emanating from ash dumps and tailings storage facilities	Dust suppression (e.g. chemical application and or watering active dumps)	Industry	DFFE, DMRE and municipalities	***High cost*** – continuous	Requirement in AEL and/or NAEIS reporting Industries to submit management plans to government with implementation timeframes and required maintenance frequency	Ongoing	Number of dumps rehabilitated Complaint with dust regulations	High
	Reduce quantities of ash dumps by diversifying reuse and beneficiation	DFFE: Waste Phakisa and industry	Local Municipalities, NGOs, CBOs	***High cost*** – continuous	Requirement in AEL and/or NAEIS reporting Industry to find use for ash – by-product	5 years	Increase in the amount of ash reused	Medium

Notes: NGO – Non-Government Organisation, CBO – Community Based Organisation

Table 18: Implementation Plan for Domestic Fuel Burning

Goal 4: *By 2025, emissions from domestic fuel burning would have decreased by 50%, and with a further 25% reduction by 2030 which would ensure compliance with NAAQS.*

Objectives	Activities	Mandatory Responsibility	Participatory Responsibility	Estimated Cost	Enabling Factors	Timeframes	Indicators	Priority
Domestic fuel burning emissions reduction	Rollout of low smoke and LPG stoves and heaters, and alternative energy sources	DMRE and DFFE	Province, DFFE, Industry, NGOs & CBOs	***High cost*** – frequent and continuous	Funding through offset projects, social responsibility programmes and alternatives	50% by 2025 75% by 2030	% uptake by targeted households	High
	Promote use of clean/green fuels such as LPG, biogas etc.	DMRE	Province, Industry, DFFE, NGOs & CBOs	***Low cost*** – quarterly awareness campaigns	Awareness campaigns in partnership with NGO's and CBO's	50% by 2025 75% by 2030	% uptake by targeted households	High
	Promote and fit RDP houses with sufficient insulation	DHS and municipalities	Province, DFFE, NGOs & CBO's	***High cost*** – once off	Industries can assist as part of offset projects and social responsibility programmes in general Implement guidelines on indoor air pollution	5 years	Number of RDP houses with sufficient insulation	Medium

Notes: DMRE – Department of Mineral Resources and Energy; DHS – Department of Human Settlements, LPG – Liquefied Petroleum Gas, NGO – Non-Government Organisation, CBO – Community Based Organisation, RDP – Reconstruction and Development Programme

Table 19: Implementation Plan for Domestic Waste Burning

Goal 5: *No informal waste burning by 2030.*

Objectives	Activities	Mandatory Responsibility	Participatory Responsibility	Estimated Cost	Enabling Factors	Timeframes	Indicators	Priority
Reducing domestic waste burning emissions	Waste separation at source & recycling	Local Government	DFFE, Province, Industry, private companies, NGOs & CBOs	***High cost*** – continuous	Develop procedure for waste separation (group specific wastes) Partnership with NGO's and CBO's Train and contract community people Industries involvement as part of offset projects	50% by 2025	% uptake by targeted households	High
	Waste collection & clean-up	DFFE, local government and Industry through offset projects	DFFE, Province, NGOs & CBOs	***High cost*** – continuous	Should already be budgeted for by municipalities Partnership with NGO's and CBO's Industries involvement as part of off-set projects	90% by 2030	% uptake by targeted households	Medium
	Management of municipal and privately-owned landfill sites	GDARD and DESTEA	DFFE	***High cost*** – continuous	DFFE roles, including enforcement, in National Environmental Management: Waste Act (NEM:WA; no 59 of 2008) Provincial to support compliance monitoring and municipal capacity Additional human resource capacity	75% reduction of burning incidents by 2025 100% reduction of burning incidents by 2030	% reduction in number of burning incidents	High
Reducing tyre burning emissions	Awareness campaigns	Local municipality, CBO, NGO	GDARD and DESTEA	***Low cost***	Awareness campaigns Partnership with NGO's and CBO's	No tyre burning by 2025	% reduction of tyre burning by 2025	High
	Regulate tyre burning through bylaws (SAPS to enforce the bylaws)	Local municipality, SAPS	DFFE, GDARD	***Medium cost*** – to implement By-law	Additional human resource capacity required to enforce bylaws Conduct ad hoc checks			High

Objectives	Activities	Mandatory Responsibility	Participatory Responsibility	Estimated Cost	Enabling Factors	Timeframes	Indicators	Priority
	Establish way to support tyre collection facilities per district through Waste Bureau.	DFFE, Waste Bureau, district municipalities, local municipalities, NGOs, CBOs	Industry NGO's and CBOs	***High cost*** – continuous	Waste Bureau Phakisa			Medium

Notes: GDARD – Gauteng Department of Agriculture and Rural Development; DESTEA – Department of Economic, Small Business Development, Tourism and Environmental Affairs, NGO – Non-Government Organisation, CBO – Community Based Organisation, SAPS – South African Police Service

Table 20: Implementation Plan for Biomass Emissions

Goal 6: *Reduced uncontrolled veld fires through veld management measures and quick response times.*

Objectives	Activities	Mandatory responsibility	Participatory responsibility	Estimated Cost	Enabling Factors	Timeframes	Indicators	Priority
Management of veld fire occurrence	Municipalities to implement Veld fires guidelines (establish relation with EPWP working for fire. Establish veld fire hotline. Induction of employees in management of veld fires.)	Local municipality NGOs and CBOs	Private companies Landowners DFFE, DALRRD Metro Polices Municipal Fire units	***Low cost***	Fire Protection Associations may be developed in line with the National Veld and Forest Fire Act (No. 101 of 1998); which include veldfire management strategies and a fire protection officer	Ongoing	Reduced number of uncontrolled veld fires	High
	Conduct education and awareness campaigns on burning and veld fires.	Local municipality, Province, and DFFE	Private companies Landowners DFFE, DALRRD, NGOs, CBOs Metro Polices Municipal Fire units	***Low cost*** – quarterly awareness campaigns	Awareness campaigns – billboards, advertisements in local newspapers, campaigns at schools	Ongoing	Annual campaigns	High

Notes: DFFE – Department of Forestry, Fisheries and the Environment; DALRRD – Department of Agriculture, Land Reform and Rural Development; EPWP – Expanded Public Works Programme

Table 21: Implementation Plan for Education and Awareness

Goal 7: *Increased awareness on air quality challenges within the VTAPA.*

Objectives	Activities	Mandatory Responsibility	Participatory Responsibility	Estimated Cost	Enabling Factors	Timeframes	Indicators	Priority
Domestic fuel burning emissions reduction	Awareness Programme clean fuels, and other alternative sources, as well as Renewable energy sources,	DFFE, Local Government	DFFE, Province, Industry, NGOs & CBOs	***Low cost*** – quarterly awareness campaigns	Monthly advertisements in local newspapers Quarterly awareness programmes at schools Awareness campaigns on billboards Industries as part of offset projects	Ongoing	Annual workshop held	High
Reducing domestic waste burning emissions	Awareness (Green Good Deeds type) on waste burning & recycling	DFFE, Local Government	DFFE, Province, Industry, NGOs & CBOs	***Low cost*** – quarterly awareness campaigns ***High cost*** – industry	Monthly advertisements in local newspapers Quarterly awareness programmes at schools Awareness campaigns on billboards Industries as part of offset projects	Ongoing	Annual workshop held	High
Promotion of educational programmes on the use of biomass	Introduce and continuations of alternative programmes	DFFE	DTI, DFFE, DST, DALRRD, NGOS, CBOs and municipalities, SANEDI	***Low cost*** – annual workshops		Ongoing	Annual workshop held	Medium
Reduce emissions from vehicles	Awareness campaign on green transport (e.g. use of bicycles, lift clubbing, park and ride to work or shops etc.)	DFFE and DOT	Communities and Municipalities	***Low cost*** – quarterly awareness campaigns	Monthly advertisements in local newspapers Quarterly awareness programmes at schools Awareness campaigns on billboards	Ongoing	Annual workshop held	Medium

Notes: DOT – Department of Transport; DOH – Department of Health; DTI – Department of Trade and Industry; DST – Department of Science and Technology; DALRRD – Department of Agriculture, Land Reform and Rural Development; SANEDI – South African National Energy Development Institute

Table 22: Implementation Plan for Vehicle Emissions

Goal 8: ***By 2025, reduce emissions from vehicles to ensure compliance with NAAQS near roads.***

Objectives	Activities	Mandatory responsibility	Participatory responsibility	Estimated Cost	Enabling Factors	Timeframes	Indicators	Priority
Reduce emissions from vehicles	Promotion of non-motorised and public transport systems	DOT, municipalities	NGO's	***Low cost*** – quarterly awareness campaigns	Monthly advertisements in local newspapers Quarterly awareness programmes at schools Awareness campaigns on billboards	3 years	Annual campaigns	Medium
	Annual testing of vehicle exhaust emissions	DOT, municipalities	DOT, municipalities	***Medium cost*** – once off purchase and maintenance of equipment	Determine the number of testing equipment required per municipality and the human resource capacity required to conduct the testing Testing can be done at testing grounds as part of license renewal (then additional staff might not be required); or as spot checks in the first year Include emission testing as part of roadworthiness certification Include cost for testing equipment and additional salaries in Municipal IDP Compile a testing procedure	3 years	Testing reports indicating numbers of vehicle tested	Medium
	Identify unpaved road generating dust and prioritise high risk roads	DOT and Local municipality	DFFE, NGO, CBO	***Low cost*** – can be done by existing personnel	Community awareness campaigns and cooperation with NGO's and CBO's Air quality personnel to visually inspect areas and identify busy unpaved roads	2 years	All unpaved roads identified	High
	Implement management measures for identified high risk dust generating roads	DOT and Local municipality	DFFE	***Medium cost*** – once off with maintenance	Costing will depend on the length of the road Can be done by industry as part of off-set projects	5 - 10 years	Unpaved roads tarred	High
Improve the regulatory framework in	Municipalities to develop/review bylaws to address air quality related issues (e.g. consider penalizing vehicles with visible smoke)	Local municipality	Local municipalities, DFFE, NGO's and CBO	***Low cost*** – to be done by existing personnel	Enforce municipal by-law	5 years	Developed or reviewed bylaws impacting air quality	Medium

Objectives	Activities	Mandatory responsibility	Participatory responsibility	Estimated Cost	Enabling Factors	Timeframes	Indicators	Priority
the municipality	Increase of capacity to enforce bylaws to address air quality related issues	Local municipality	Local municipalities, DFFE	***Medium cost*** – to employ more personnel	Assess additional human resource capacity required to enforce bylaws	5 years	Number of enforcement officials trained	Medium
	Establish intergovernmental coordination committee on air quality (Transport, Energy, Health, Minerals, Cooperative governance and Human settlement)	DFFE	DFFE	***Low cost*** – to include existing personnel	Intergovernmental communication and awareness to get by-in for coordination committee Can be incorporated into current responsibilities	1 year	Committee established	High

Notes: DOT – Department of Transport, NGO – Non-Government Organisation, PRASA – Passenger Rail Agency of South Africa, CBO – Community Based Organisation, AARTO – Administrative Adjudication of Road Traffic Offences

6.2.2 Potential Future Threats

Future threats in the area are regarded as risks associated with the implementation of the interventions which would jeopardise the overall objective of the AQMP – to improve the air quality within the VTAPA. Table 23 to Table 30 describe the potential risks associated with each intervention and the associated mitigation measure.

Threats associated with the successful implementation of the VTAPA second generation AQMP, based on the lessons learnt, can be summarised as follows:

- Budgetary allocations or lack of provision to be inadequate to achieve goals;
- Available control technology found to be unfeasible;
- Political buy-in from decision making powers lacking resulting in lack of planning and budgetary constraints;
- Too many interventions, with some not clearly defined (also economic factors that could hamper certain intervention);
- Interventions at National level that are outside the control of the Local Municipality to implement;
- Constraints in human resource capacity for AQMP implementation – number of people and technical competency (insufficient follow-up);
- Political buy-in from decision making powers lacking resulting in lack of planning and budgetary constraints;
- Enforcement – no consequences or penalties for failing to implement the set interventions; and
- Inadequate methods in creating public awareness.

Table 23: Implementation Plan with associated risk and mitigation for Industries & Power Generation /Compliance Monitoring and Enforcement

Objectives	Activities	Indicators	Risk	Mitigation
Minimisation of emissions from regulated facilities	Compliance with the-existing MES	Monitoring reports (Compliance monitoring activities)	• Postponement application • Lack of progress of the off-sets projects • Available control technology not feasible	• End of postponement application cycle • Enforcement of compliance with MES • Monitoring of the off-sets projects
Minimisation of fugitive emissions (e.g. waste, stockpiles, conveyor belts, haul roads etc.)	Develop and implement the fugitive emission Plan informed by Best Environmental Practice	All facilities with AEL submitted plans to the licensing authorities	Some industries may not prioritize fugitive emission plans as an important component of their development plans	• Municipalities to include the development of the fugitive emission as part of the AEL conditions • Municipalities to enforce compliance to AEL conditions
	Identification and implementation of suitable technology (Introduction of binding agents in waste stockpiles and dust suppressants)	Dust management plans implemented	No record of implementation of dust management plan	Dust management plans developed and implemented
	Reporting of fugitive emissions on NAEIS	All facilities with AEL submitted plans fugitive emissions	• Lack of guidelines on reporting of fugitive emissions • Reporting of fugitive emissions not mandatory	• DFFE to develop/ include guidelines on the reporting of fugitive emissions on NAEIS • Reporting of fugitive emission to be part of the AEL conditions • Enforcement and compliance to reporting of fugitive emissions guidelines • Workshops aiming to train industrial personnel in estimating fugitive emissions
	Minimize and manage NEMA Section 30 incidents	Number of Section 30 Incidents	• Lack of reporting of NEMA section 30 incidences • Irregular monitoring of section 30 facilities	• Ensure Compliance of reporting of NEMA section 30 incidences • Compliance monitoring of section 30 facilities on regular basis
Emissions from dust-generating activities are reduced	Development of legal framework to manage with emission from small/unlicensed facilities	Legal framework in developed	Lack of Legal framework for emissions from small/ unlicensed facilities	Local municipalities to develop Legal framework for emissions from small/ unlicensed facilities
	Identify unlicensed dust generating activities	Identified dust generating activities	Identification of unlicensed dust generating activities not a priority due to limited resources in the municipality	• Prioritise and allocate resources • Establish a toll-free number or complains, register book at the municipality whereby locals can report all environmental problems including

Objectives	Activities	Indicators	Risk	Mitigation
				(complains from identified dust generating activities)
	Holistic approach for dust management where there is cluster of facilities	Integrated dust management plans developed	Working in silos, and also lack of cooperation from cluster of facilities in the development of Integrated dust management plans	Use AEL process to ensure enforce the requirement

Table 24: Implementation Plan with associated risk and mitigation for Mines

Objectives	Activities	Indicators	Risk	Mitigation
Management /reduction of emissions from mine	Dust management plans developed and implemented	All mines developed dust management plans	• Dust management plans which are not in line with guideline. • Lack of commitment to enforce the development and dust management plan. • Lack of enforcement to implement dust management plan.	• Continuous consultation • Compliance and enforcement of dust management plan.
	Vegetation (indigenous plants and grass) on the abandoned mine dumps	Number of dumps rehabilitated	• Lack of resources (e.g. human & finance) for Vegetating on abandoned mine dumps.	• Planning and prioritisation of Resource • Commercially viable (non-food) species used for rehabilitation
	Establish the complaints management system for all mines	The complaints management system established by all mines	Lack of resources to manage the complaints.	• Planning and prioritisation of Resource
	Implementation of the rehabilitation plans for non-operational mines	Mines rehabilitated	Limited resources to be used in the implementation of the rehabilitation plans for non-operational mines	• RSA to source donor funding • Incentives for facilities that adopts and rehabilitate non-operational mines • Sale of rehabilitated land to recoup costs

Table 25: Implementation Plan with associated risk and mitigation for Ash Dumps and Tailings Storage Facilities

Objectives	Activities	Indicators	Risk	Mitigation
Reduction of particulate matter emanating from ash dumps	Dust suppression (e.g. chemical application and or watering active dumps	• Number of dumps rehabilitated. • Complaint with dust regulations	• Water is a scares resource • Contamination of underground water, plants and animals by chemicals used to suppress dust	Further research on the alternatives for dust suppression
	Reduce quantities of ash dumps by diversifying reuse and beneficiation	Amount of ash reused increased	Limited knowledge on the diversifying reuse and beneficiation of ash dumps	Further research on diversifying reuse and beneficiation of ash dumps

Table 26: Implementation Plan with associated risk and mitigation for Domestic Fuel Burning

Objectives	Activities	Indicators	Risk	Mitigation
Domestic fuel burning emissions reduction	Rollout of low smoke and LPG stoves and heaters, and alternative energy sources	% uptake by targeted households	• Prices of LPG stoves / lack of funding to buy low smoke and LPG stoves • Lack accessibility and affordability of LPG. • Lack Continuous /sustainable supply of LPG.	• Government to source donor findings. • Government to subsidies LPG to low income so that it could be easily accessible and affordable to everyone in the country • DMRE to ensure continuous supply of LPG • Investigate waste to LPG
	Promote use of clean/green fuels such as LPG, biogas etc.	% uptake by targeted households	• Community perception associated with the dangers of using LPG.	• Education and Awareness campaigns on the safe use of LPG.
	Promote RDP houses with sufficient insulation	Number of RDP houses with sufficient insulation	• Poor planning and lack of funds for insulation of RDP houses.	• Proper coordination intergovernmental committee responsible for proper planning of RDP.

Notes: DMRE – Department of Mineral Resources and Energy; LPG - Liquefied Petroleum Gas; RDP - Reconstruction and development programme

Table 27: Implementation Plan with associated risk and mitigation for Domestic Waste Burning

Objectives	Activities	Indicators	Risk	Mitigation
Reducing domestic waste burning emissions	Waste separation at source & recycling	% uptake by targeted households	Lack of resource for separating waste at source.	• Local Government to provide resources (clearly labelled bin) for sorting waste at source • Streamline with the many already existing commercial attempts (retail sector e.g. Pick n Pay) at waste separation
	Waste collection & clean-up	% uptake by targeted households	Collapse of municipality system.	• Stop corruption - proper political administration.
	Management of municipal and privately-owned landfill sites	% reduction in number of burning incidents	Lack of awareness on 3Rs (Reuse, Reduce and recycling)	• Awareness campaign to reduce landfill waste through 3Rs • Enforcement of bylaws to stop burning at landfill site
Reducing tyre burning emissions	Awareness campaigns	% reduction of tyre burning by 2025	Lack of understanding of impacts of tire burning	• Awareness campaigns
	Regulate tyre burning true bylaws (SAPS to enforce the bylaws)		Lack of bylaws on tire burning	• Develop bylaws to control burning of tires • Criminalise tyre burning
	Establish way to support tyre collection facilities per district through Waste Bureau		DFFE & Waste Bureau working in silos	• Collaboration between affected parties

Table 28: Implementation Plan with associated risk and mitigation for Biomass Emissions

Objectives	Activities	Indicators	Risk	Mitigation
Management of veld fire occurrence	Municipalities to implement Veld fires guidelines (establish relation with EPWP working for fire. Establish veld fire hotline. Induction of employees in management of veld fires.)	Reduced number of fires	Lack of cooperation of affected parties Lack of capacity	Continuous consultation Public and governmental (all spheres) awareness on air quality impacts from fires
	Conduct education and awareness campaigns on burning and veld fires.	Annual campaigns	Lack of interest	Continuous consultation Capitalize on international fire events to raise awareness

Notes: DAFF – Department of Agriculture, Forest and Fisheries

Table 29: Implementation Plan with associated risk and mitigation for Education and Awareness

Objectives	Activities	Indicators	Risk	Mitigation
Domestic fuel burning emissions reduction	Awareness Programme clean fuels, and other alternative sources, as well as Renewable energy sources,	Annual workshop held	Low uptake of cleaner fuels and other alternative sources, as well as Renewable energy sources	Continuous consultation and incentives for using alternative sources
Reducing domestic waste burning emissions	Awareness (Green Good Deeds type) on waste burning & recycling	Annual workshop held	Lack of interest by stakeholders	Stakeholders will be widely consulted, and their commitment secured.
Promotion of educational programmes on the use of biomass	Introduce and continuations of alternative programmes	Annual workshop held	• Lack of interest • lack of commitment by stakeholders and lack of prioritisation of resources such as personnel	• Continuous awareness campaigns
Reduce emissions from vehicles	Awareness campaign on green transport (e.g. use of bicycles, lift clubbing, park and ride to work or shops etc.)	Annual workshop held	• Lack of interest from vehicle users. • Park and ride: Distance between bus stop and workplace after drop-off. • Additional funds for parking. • crimes (those with laptop bags and essentials will be afraid to walk around).	• Continuous awareness campaign. • Provide other alternatives such as bicycles at the drop – off to the office. • Provide incentives –subsidising ticket price and parking. • Police visibility to curb crime

Table 30: Implementation Plan with associated risk and mitigation for Vehicles Emissions

Objectives	Activities	Indicators	Risk	Mitigation
Reduce emissions from vehicles	Promotion of non-motorised and public transport systems	Annual campaigns	• Lack of resources and commitment from stakeholders e.g. personnel	• Continuous stakeholder consultation to get buy-in and commitment from stakeholders
	Annual testing of vehicle	Testing reports indicating numbers of vehicle tested	• Lack of co-operation by Municipalities which might be exacerbated by lack of skilful (qualified/trained) personnel	• Training the existing officials – offer better condition (salaries & benefits) to ensure staff retention
	Identify unpaved road generating dust and prioritise high risk roads	Unpaved roads identified	• Municipality could not prioritise due to limited resources (financial & lack of officials).	• Establish a toll-free number or complaints register at the municipality offices to allow local communities to report all environmental problems including (dust complaints due to unpaved roads).
	Implement management measures for identified high risk dust generating roads	Unpaved roads tarred	• DOT and municipalities may not prioritise tarring of identified dust generating roads in VTAPA as an important component of their development plans	• Offsets programmes and cooperate social responsibility programmes can be used to resolve these issues.
Improve the regulatory framework in the municipality	Municipalities to develop/review bylaws to address air quality related issues (consider penalizing vehicles with visible smoke)	Developed or reviewed bylaws	Insufficient capacity in local municipality	Adoption of National department bylaws; provincial capacity
	Increase of capacity to enforce bylaws to address air quality related issues	Number of enforcement officials trained	Insufficient budget, and resignation of trained personnel	Source funding and implementation of HR retention strategy
	Establish intergovernmental coordination committee on air quality (Transport, Energy, Health, Minerals, Cooperative governance and Human settlement)	Committee established	• Lack of commitments from different head of departments and other political counterparts on air quality issues. • Lack of understanding of air quality and how other departments are affected and also contributing to AQ problems, this could result in lack of prioritisation on air	Minster to establish intergovernmental coordination Continuous consultation and awareness

Objectives	Activities	Indicators	Risk	Mitigation
			quality issues by other government departments	Prioritize air quality (and its departmental relationships) within Parliamentary Portfolio Committees

Notes: DOT – Department of Transport, NGO – Non-Government Organisation, PRASA – Passenger Rail Agency of South Africa, CBO – Community Based Organisation

6.3 Monitoring and Evaluation

The 2013 review found that regular monitoring of the AQMP implementation progress provides an important mechanism to ensure actions are taken and key stakeholders are engaged with. At the very least it provides valuable information as to why an implementation has failed.

6.3.1 Expansion of Ambient Air Quality Monitoring Network

One of the most important indicators for AQMP success is a decrease in air pollutant concentrations. In order to monitor progress, measurements of pollutants must be analysed. This forms the basis for understanding the ultimate impact from interventions. However, this is reliant on a functioning, well maintained and representative monitoring network. Section 3.2 gives a summarized analysis on the current measurements from existing stations in the VTAPA, and the Baseline Assessment Report goes further into the network's performance in terms of data quality. This section aims to set out the rationale for an expansion of the existing DFFE network.

Air quality in the VTAPA has not improved over the past 10 years. Slight decreases in PM_{10}, $PM_{2.5}$, SO_2 and NO_x have been noted at some of the stations whereas at others the concentrations have increased slightly. PM_{10} and $PM_{2.5}$ concentrations remain in non-compliance with the NAAQS in spite of decreases in some industrial sector emissions and limited successes with other interventions.

The current location of most of the monitoring stations should reflect improvements in interventions aimed at low income settlements – domestic fuel burning and domestic waste burning. These stations are, however, unlikely to show improvements from other interventions aimed at reducing emissions from: vehicles, industry (i.e. 2020 MES) and mining.

Conducting ambient monitoring at locations within the more formal settlements, away from main influencing sources but within the main impact area of the VTAPA should cover this gap in ambient air quality data, tracking overall performance of all interventions. Passive sampling campaigns are recommended for this purpose to be conducted bi-annually, one campaign in winter and one in summer. Two locations are proposed: one in the southern part of Vanderbijlpark and one to the north of Vereeniging (Figure 49). These campaigns will also serve to monitor impacts on regional air quality.

6.3.2 Update of VTAPA Second Generation Emissions Inventory

As part of regular monitoring and evaluation, the second generation VTAPA emissions inventory will have to be continuously updated. This forms part of the capacity building plan, enabling the Air Quality Officers to fulfil their legal obligation and ensure a successful implementation of the second generation VTAPA AQMP.

The update of the emissions inventory is proposed to be done annually and should include, but not be limited to, the following:

- Identify and quantify emissions from all Controlled Emitters and Small Stationary Sources;
- Update the fuel use for domestic fuel burning consumption (i.e. switching from coal to LPG);
- Identify and record waste burning activities (include types of waste burnt, frequency and duration); and
- Identify open exposed areas within residential areas that can give rise to windblown dust.

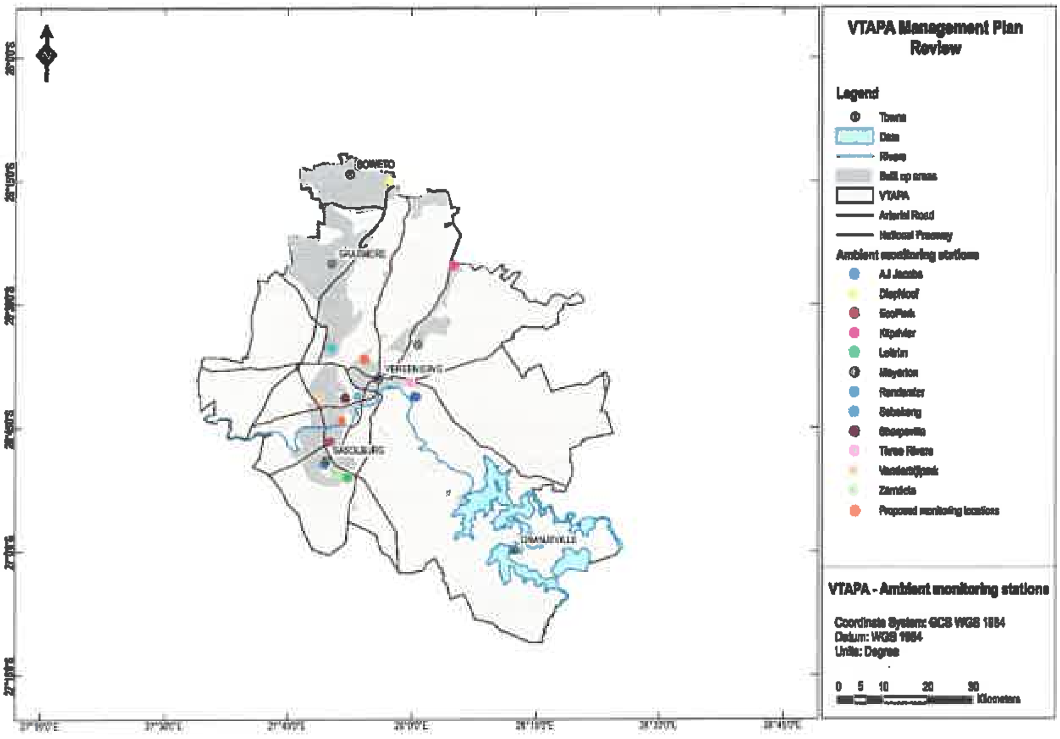

Figure 49: Locations for passive sampling campaigns within the VTAPA

6.3.3 Stakeholder Engagement

There are several forums in place in the VTAPA to ensure inter-governmental communication and cooperation's as well as engagement with various stakeholders. However, the need for granulation and clarification of roles and responsibilities for all stakeholders at local level, who will be collaborating to execute relevant initiatives and providing progress feedback, is pertinent.

The Multi Stakeholder Reference Group (MSRG) meets twice a year and comprises representatives from all spheres of government, industry and Interested and Affected Parties (I&APs). These meetings provide a platform for feedback on the progress of the implementation of the AQMP as well as interaction between the various stakeholders. This forum should continue to meet bi-annually but with more focus on information communication and awareness raising – this could also be an ideal platform to provide guidance to industry on how to report in NAEIS and raise awareness on the importance of correct reporting. This forum should be used to track clear targets for implementation within the specific timeframes and holing the responsible parties accountable for non-performance.

The Implementation Task Team (ITT) is grouped geographically to facilitate interaction and focussed efforts at interventions relevant to a specific geographical area. These groups consist of government officials at municipal level, industry representatives, NGO's and CBO's and are hands-on in the implementation of the area-based interventions. These quarterly meetings should serve as interim follow-ups on specific actions (listed in tables in Section 6.1.2: *Prioritisation and Financial Implications of Interventions*) and there should be consequences for actions not taken. Clear targets should be set, and progress traced at these meetings.

The VTAPA Authorities meet bi-annually and comprises of the air quality officers from the various spheres of government. Here the focus is specifically on intergovernmental cooperation and feedback from the various air quality officials on progress made within their jurisdictions. Again, clear targets with implementation timeframes should be set and there should be accountability for non-performance.

Even though the DFFE, as the national department, is responsible for the implementation of the Priority Area AQMP, it works in collaboration with other spheres government (particularly local) and various stakeholders. However, the DFFE remains responsible for enforcement and accountable for non-performance. The DFFE has, in support of local and provincial government, deployed personnel to assists with the implementation of the air quality responsibilities.

6.3.4 Review of VTAPA Implementation Plan

The AQMP promotes collaboration between the various stakeholders to achieve a shared vision and goals. The success of the VTAPA second generation AQMP will depend on the implementation of the intervention strategies. This in turn depends on the feasibility of the interventions and how easily these can be implemented. The latter relies on human resource capacity, planning and financial provision.

Progress on the implementation of the VTAPA second generation AQMP should be closely monitored, with an internal review at the end of each financial year where the interventions should be re-defined if needed and re-prioritised. The AQMP should be reviewed within five years of publication.

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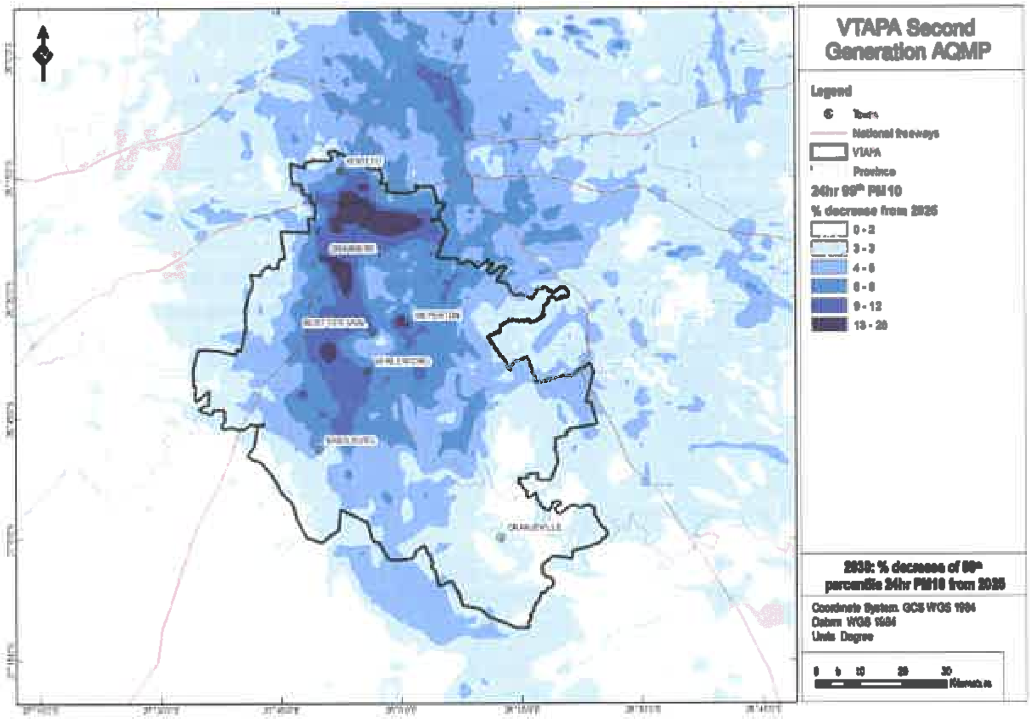
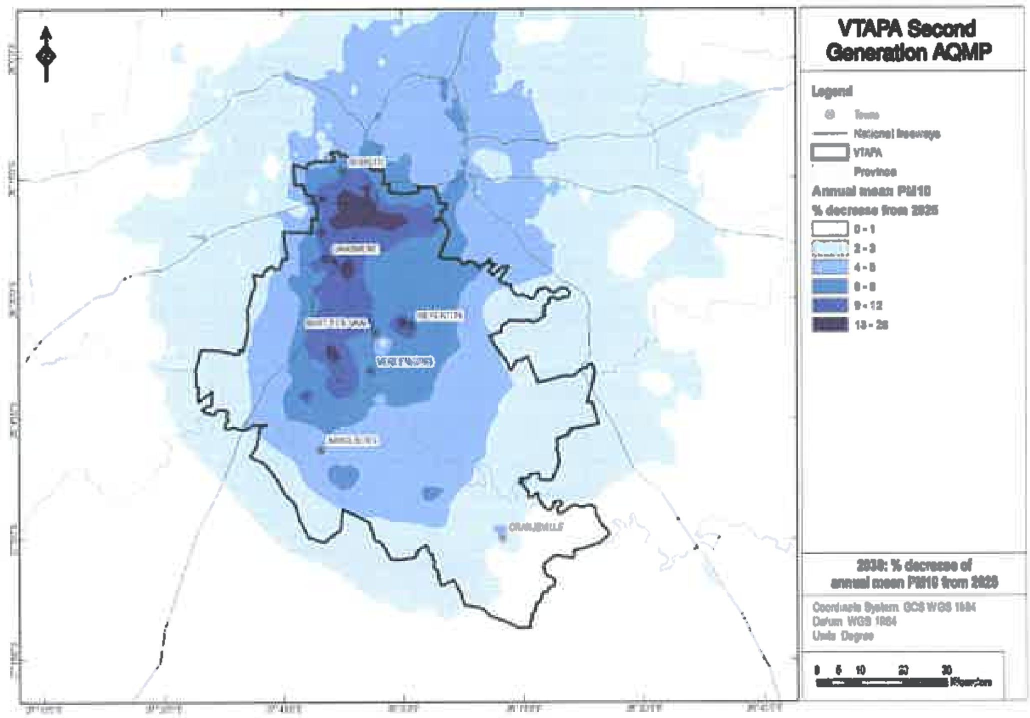
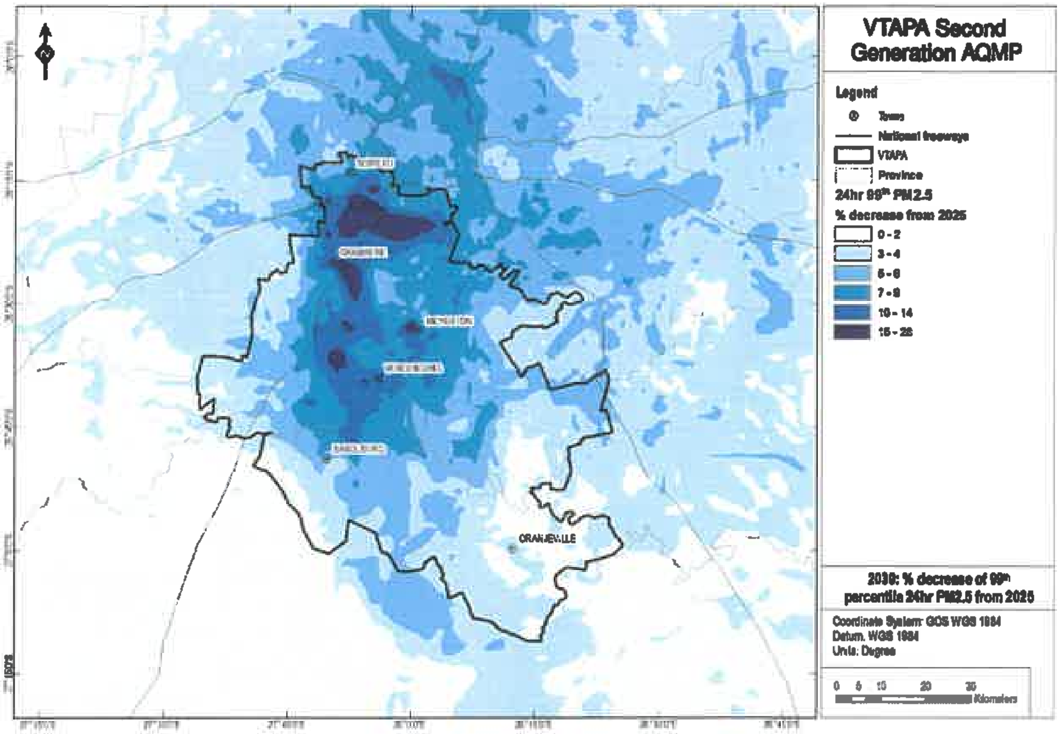
8 Appendix A – Scenario Modelling: Percentage Decrease from Scenario 2025 to Scenario 2030

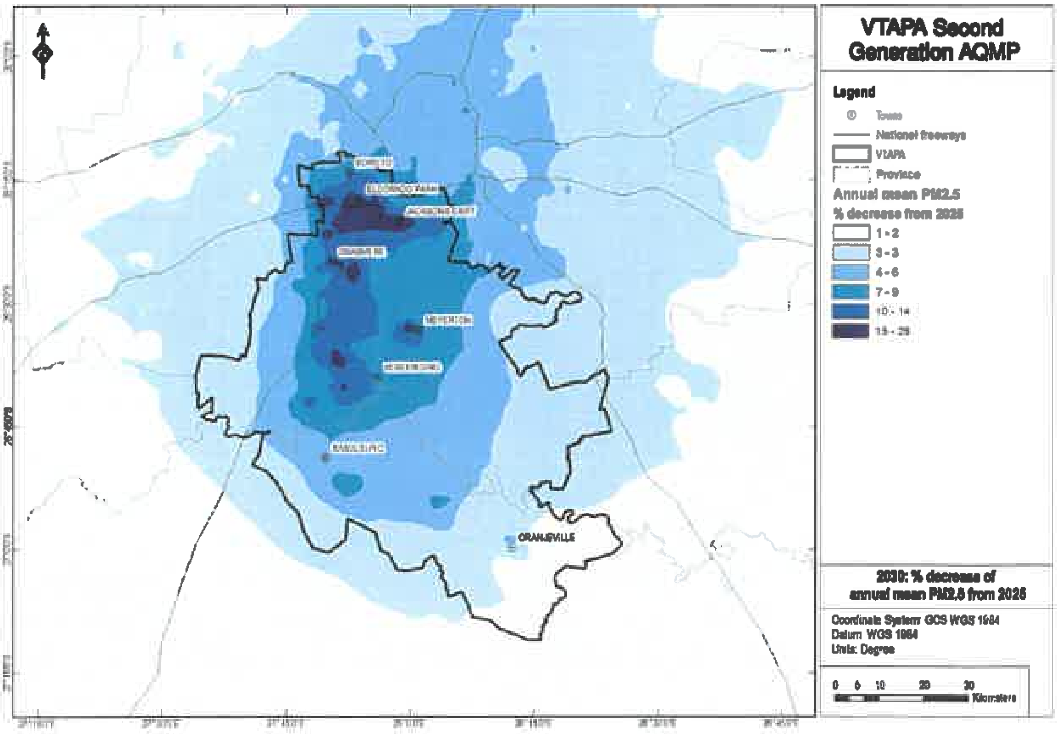
PM_{10}



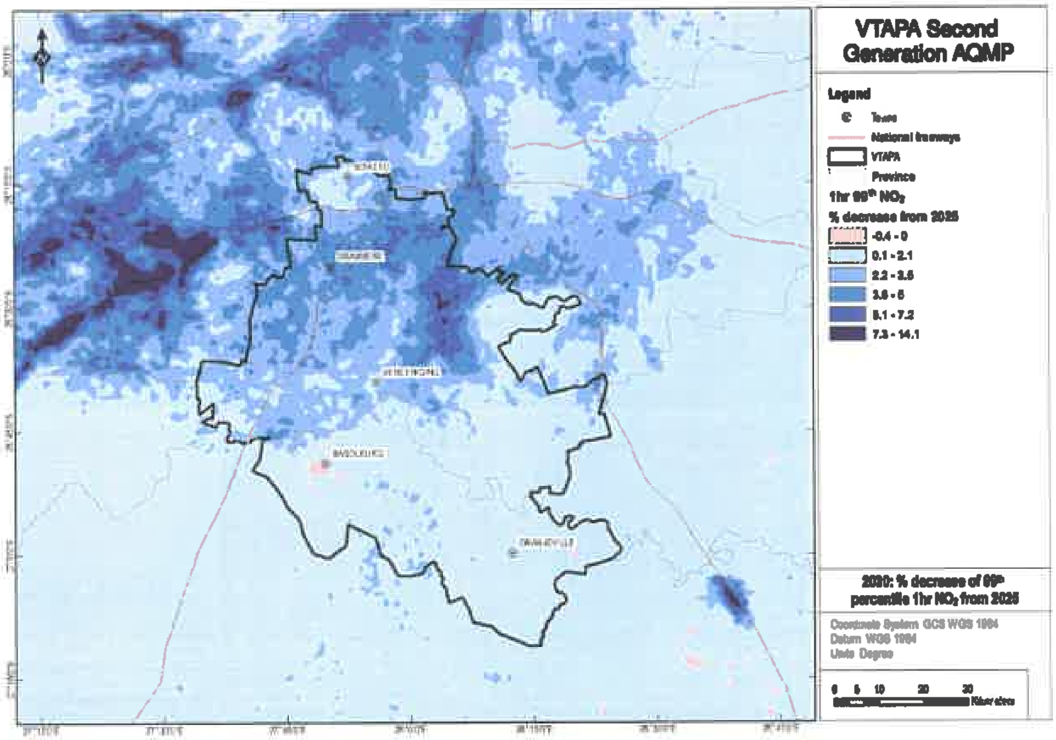


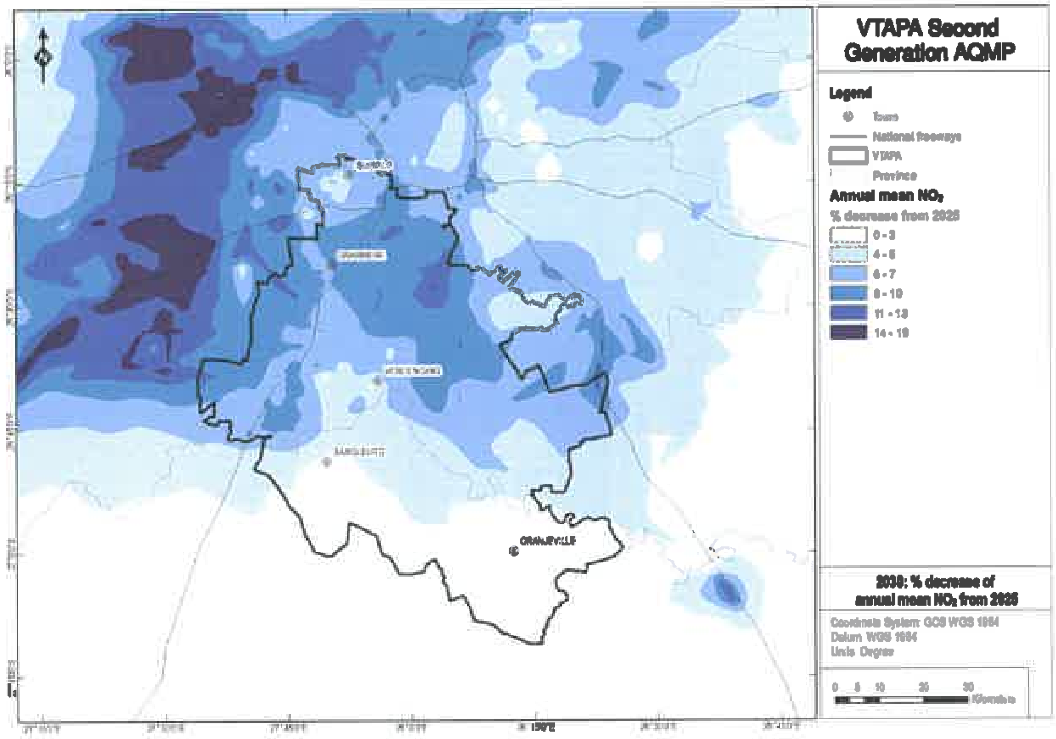
$PM_{2.5}$


VTAPA Second
Generation AQMP
Legend
Towns
National freeways
VTAPA
Province
24hr 99th PM2.5
% decrease from 2025
0 - 2
3 - 4
5 - 6
7 - 9
10 - 14
15 - 28
ORANJEVILLE
2030: % decrease of 99th percentile 24hr PM2.5 from 2025
Coordinate System: GCS WGS 1984
Datum: WGS 1984
Units: Degree
0 5 10 20 30 Kilometers

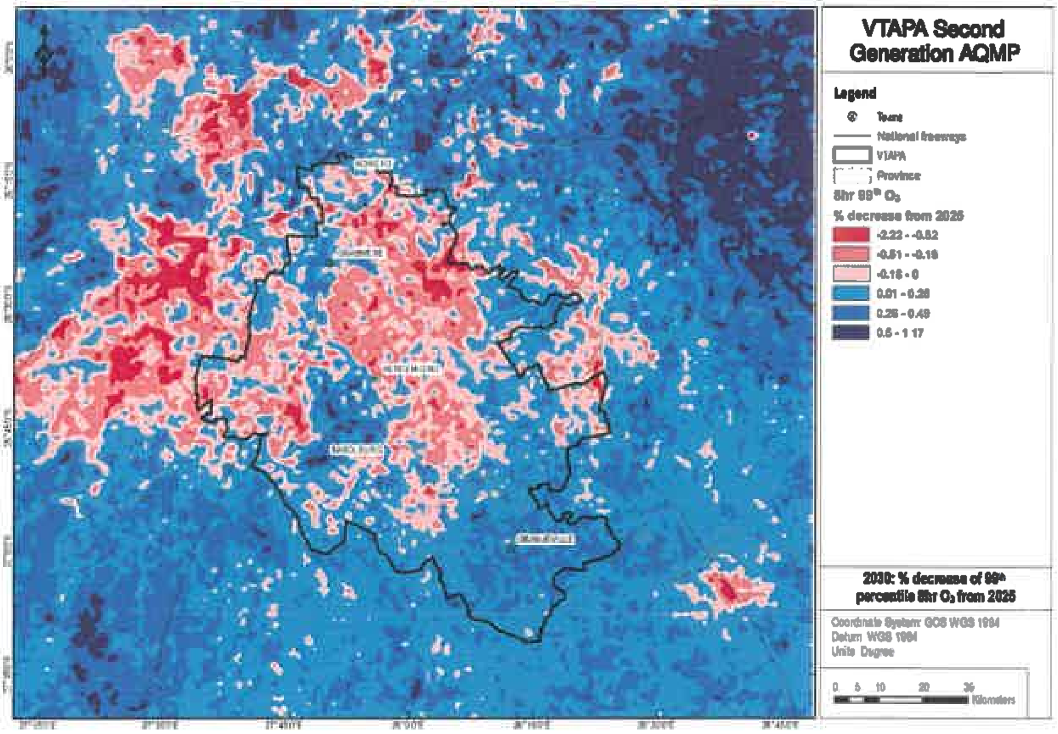

VTAPA Second
Generation AQMP
Legend
Towns
National freeways
VTAPA
Province
Annual mean PM2.5
% decrease from 2025
1 - 2
3 - 3
4 - 6
7 - 9
10 - 14
15 - 28
ORANJEVILLE
2030: % decrease of annual mean PM2.5 from 2025
Coordinate System: GCS WGS 1984
Datum: WGS 1984
Units: Degree
0 5 10 20 30 Kilometers

NO$_2$


VTAPA Second Generation AQMP
Legend
Towns
National freeways
VTAPA
Province
1hr 99th NO_2
% decrease from 2025
-0.4 - 0
0.1 - 2.1
2.2 - 3.5
3.6 - 5
5.1 - 7.2
7.3 - 14.1
2030: % decrease of 99th percentile 1hr NO_2 from 2025
Coordinate System: GCS WGS 1984
Datum: WGS 1984
Units: Degree
0 5 10 20 30
Kilometres

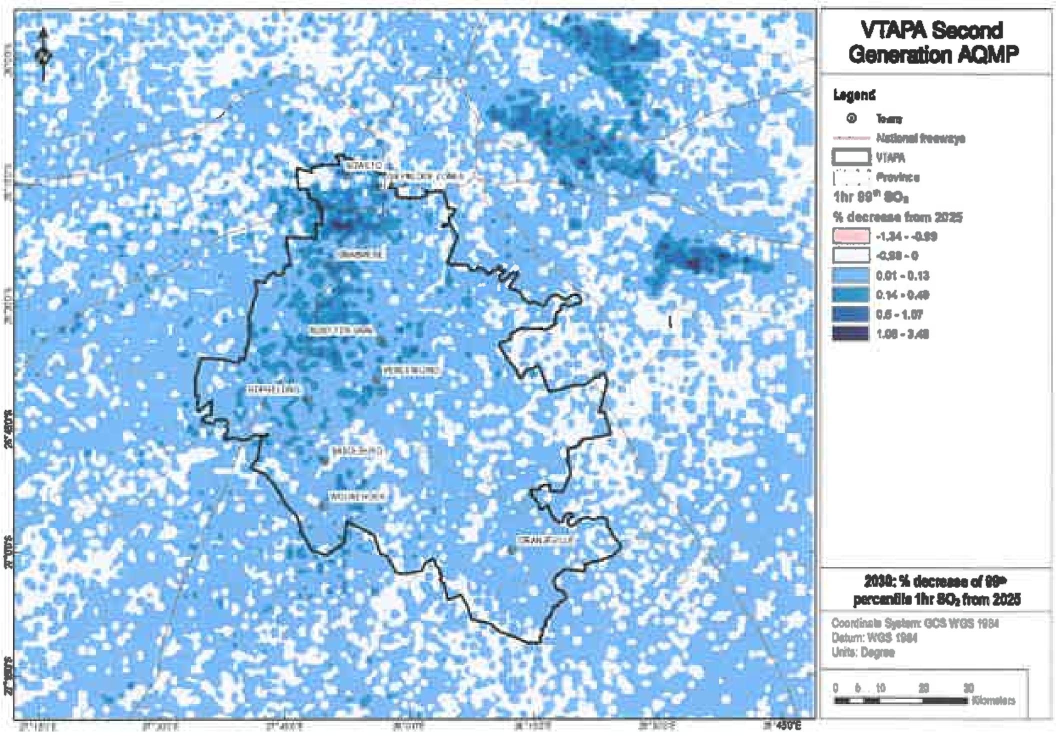

VTAPA Second Generation AQMP
Legend
Towns
National freeways
VTAPA
Province
Annual mean NO_2
% decrease from 2025
0 - 3
4 - 5
6 - 7
8 - 10
11 - 13
14 - 19
2030: % decrease of annual mean NO_2 from 2025
Coordinate System: GCS WGS 1984
Datum: WGS 1984
Units: Degree
0 5 10 20 30
Kilometres

Ozone

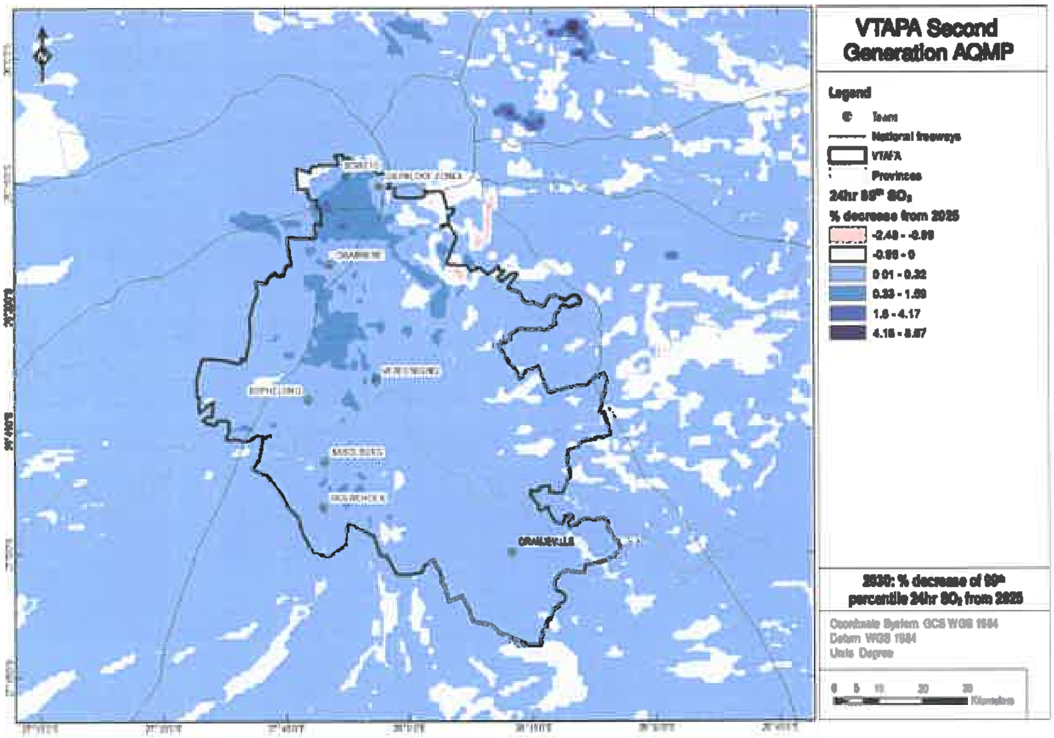


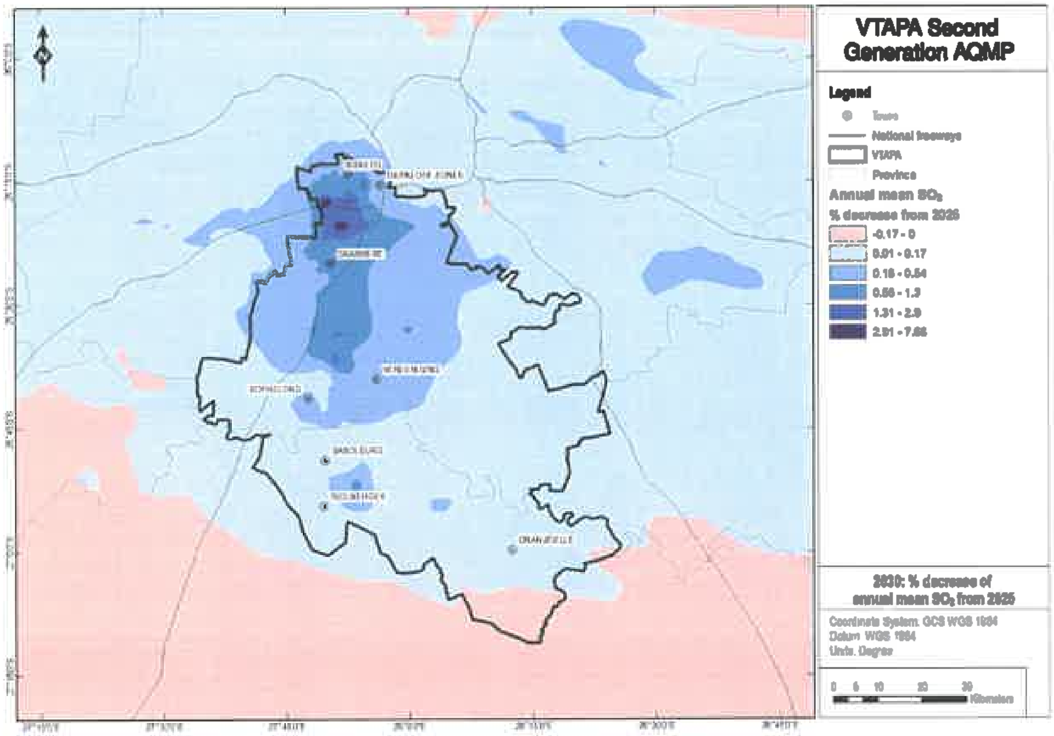
VTAPA Second Generation AQMP
Legend
Towns
National freeways
VTAPA
Province
8hr 99th O_3
% decrease from 2025
-2.22 - -0.52
-0.51 - -0.19
-0.18 - 0
0.01 - 0.28
0.29 - 0.49
0.5 - 1.17
2030: % decrease of 99th percentile 8hr O_3 from 2025
Coordinate System: GCS WGS 1984
Datum: WGS 1984
Units: Degree
0 5 10 20 30
Kilometers

SO2



VTAPA Second Generation AQMP
Legend
Towns
National freeways
VTAPA
Province
1hr 99th SO_2
% decrease from 2025
-1.34 - -0.99
-0.98 - 0
0.01 - 0.13
0.14 - 0.49
0.5 - 1.07
1.08 - 3.48
2030: % decrease of 99th percentile 1hr SO_2 from 2025
Coordinate System: GCS WGS 1984
Datum: WGS 1984
Units: Degree
0 5 10 20 30
Kilometers


VTAPA Second Generation AQMP
Legend
Town
National freeways
VTAPA
Provinces
24hr 99th SO2
% decrease from 2025
-2.48 - -0.99
-0.98 - 0
0.01 - 0.32
0.33 - 1.59
1.6 - 4.17
4.18 - 8.87
2030: % decrease of 99th percentile 24hr SO2 from 2025
Coordinate System: GCS WGS 1984
Datum: WGS 1984
Units: Degree
0 5 10 20 30 Kilometers
ORANJEVILLE


VTAPA Second Generation AQMP
Legend
Town
National freeways
VTAPA
Province
Annual mean SO2
% decrease from 2025
-0.17 - 0
0.01 - 0.17
0.18 - 0.54
0.55 - 1.3
1.31 - 2.9
2.91 - 7.86
2030: % decrease of annual mean SO2 from 2025
Coordinate System: GCS WGS 1984
Datum: WGS 1984
Units: Degree
0 5 10 20 30 Kilometers

9 APPENDIX B – FIRST GENERATION VTAPA AQMP IMPLEMENTATION PLAN

The current known status of these action plans is provided in each table.

Note that at the time of publication of the 2009 VTAPA AQMP, the DFFE was called the Department of Environment and Tourism, hence the DEAT abbreviation.

Table 31: Action plan for selected interventions identified for Biomass Burning

Intervention	*Implementation Strategy*	*Responsible*	*Assumptions*	*Estimated Cost*	*Timeframe*	*Control Efficiency*	*Indicators*	*Current (2019) status*
Identify and quantify emissions from biomass burning	Obtain information on locations of veld fires and areas burnt from fire department (s) within each Municipality. Obtain updated satellite imagery to identify burn scars which will indicate the size of areas burnt.	COJ, FDDM and SDM	Each fire department has information on veld burning	R 10 000 – R 20 000	Short – Medium Term	Not Applicable	Emissions from biomass burning are quantified	Not quantified by Municipalities, however quantified as part of the 2013 Review and the Second Generation Baseline Study
Research into International best practice regarding controlled/uncontrolled burning	Compilation of a comprehensive document detailing current international best practice. Such information should include the burning of firebreaks, season of burning and frequency (etc.). This information should be developed into a veld fire management strategy for the Vaal Triangle. DEAT to liaise with COJ, FDDM and SDM to implement system.	DEAT in collaboration with COJ, FDDM and SDM	International best practice methods are available	R 40 000 – R 80 000 for a report	Short – Medium Term	Not Applicable	A comprehensive report detailing best practice for burning. Best practice methods are implemented in each Municipality.	No report.
Development of an inversion early warning system that triggers a veld fire control response	DEAT to develop an early warning system that detects and forecasts meteorological conditions which can cause uncontrolled veld fires. DEAT to liaise with COJ, FDDM and SDM to implement system COJ, FDDM and SDM to liaise with relevant fire departments to respond to veld fires	DEAT in collaboration with COJ, FDDM and SDM	Fire departments respond to veld fire warnings	Unknown	Short Term (2009)	Uncontrolled veld fires reduced by 50 – 70%	Frequency of uncontrolled veld fires is reduced in Vaal Triangle. Fast response of Fire Department to uncontrolled veld fires in Vaal Triangle	Not known. Status not known.

Notes: DEAT – Department of Environment and Tourism, COJ – City of Johannesburg, FDDM – Fezile Dabi District Municipality, SDM – Sedibeng District Municipality

Table 32: Action plan for selected interventions identified for Domestic Fuel Burning

Intervention	*Implementation Strategy*	*Responsible*	*Assumptions*	*Estimated Cost*	*Timeframe*	*Control Efficiency*	*Indicators*	*Current (2019) status*
Basa Njenjo Magogo (BNM) – Top down ignition	Roll-out of the BNM in Orange Farm to reach 60% of households using coal DEAT to liaise with DME and COJ to initiate project by June 2008 DEAT to liaise with Eskom to obtain funding for the roll-out. Eskom provided technical support in measuring the effectiveness of the Basa Njengo Magogo rollouts in the Vaal.	DEAT in collaboration with DME and COJ	Eskom to sponsor roll-out in Orange Farm	R400 000 – R1 million per 20 000 households	Short Term (2008/9)	Estimated reduction of emissions of 50% for PM10 and 20% for other pollutants	60% of households reached PM_{10} ambient monitoring data in Orange Farm to indicate annual average reductions over 2008/9	Ongoing
	Roll-out of the BNM in Zamdela to reach 60% of households using coal DEAT to liaise with DME and FDDM to initiate project by June 2008 DEAT to liaise with Sasol to obtain funding for the roll-out.	DEAT in collaboration with DME and FDDM	Sasol to sponsor roll-out in Orange Farm	R400 000 – R1 million per 20 000 households	Short Term (2008/9	Estimated reduction of emissions of 50% for PM10 and 20% for other pollutants	60% of households reached PM_{10} ambient monitoring data in Zamdela to indicate annual average reductions over 2008/9	Status not known
Electrification	Electrification of households in Orange Farm. DEAT to liaise with COJ, FDDM and SDM to initiate project DEAT to liaise with Eskom to obtain funding.	DEAT in collaboration with COJ, FDDM and SDM	Eskom to sponsor roll-out in Orange Farm and Zamdela Households use electricity rather than coal		Short Term (2008/9)	90% PM10 and SO_2 reduction	PM_{10} and SO_2 ambient monitoring data in Orange Farm and Zamdela indicates a reduction	Zamdela station indicated a reduction in PM_{10} and SO_2 concentrations between 2007 and 2016 but increased $PM_{2.5}$ and NO_2 concentrations. SO_2 and NO_2 had poor data availably (<75%). No monitoring station in Orange Farm. (DEA, 2019)

Notes: DME – Department of Mineral and Energy, COJ – City of Johannesburg, FDDM – Fezile Dabi District Municipality, SDM – Sedibeng District Municipality

Table 33: Action plan for selected interventions identified for ArcelorMittal (Iron and Steel Sector)

Emission Reduction Intervention	*Full Description of the Emission Reduction Intervention*	*Compliance Date (Day/ Month/Year)*	*Estimated Cost*	*Comments /Progress*	*Current (2019) status*
Roof emissions from Blast Furnace D (reduction of fugitive emissions strategy)	• Phase 1: Installation of the Blast Furnace D Cast House Bag House to ensure dust captured are abated. • Phase 2: During the reline on Blast Furnace D, the effectiveness of the primary extraction system will be engineered to be able to capture a significant proportion of roof emissions. It is planned to reassess the situation after stabilization of the Blast Furnace after start-up.		+/- R 30 million	Completed Target date Sept 2007 (Completed November 2007)	Completed
Dust Suppression at waste disposal site (reduction of fugitive emissions strategy)	A dust suppression system at the Tipping station (off-loading point), utilizing high pressure to create a fine mist of water is currently being erected at the waste disposal site, and this will assist in preventing excessive secondary dust emissions. It is planned to prepare the roads to the waste disposal site in order to reduce the entrained dust from vehicle movement.		R 1.9 million	Target date June 2008 Completed	Completed with an additional emission reduction by enclosing of Tip station B fitted with roof dust suppression system
Stoppage of dosing with spent pickling liquor at the Sinter Plant (Mitigation projects on PM_{10})	As part of the operation at the sinter plant, spent pickling liquor (a mixture of iron chloride & hydrogen chloride) was used to reduce the levels of potassium in the sinter product. This practice was developed in the 80s, due to the detrimental effect potassium had on the blast furnace process. The SPL was sprayed into the mixing drum and the liquor would react with the alkalis in the ore and form potassium chloride (KCl), which formed part of the gas released into the atmosphere. The downstream gas cleaning facilities could unfortunately not remove the particulate KCl very well, and these particulates formed part of the emissions form the plant. After careful evaluation of all related inputs and aspects, a decision was taken to stop the dosing at the end of Feb 2006, to be monitored for 3 months before a final decision on the impact, or not, is taken. No visible deterioration of the functioning of the		Operational costs	Target date Feb 2006 Completed	Completed

Emission Reduction Intervention	***Full Description of the Emission Reduction Intervention***	***Compliance Date (Day/ Month/Year)***	***Estimated Cost***	***Comments /Progress***	***Current (2019) status***
	blast furnace was experienced, mainly because of improved coke strength.				
25% Demonstration Unit for proof of performance at the Sinter Plant (Mitigation projects on PM_{10})	This refers to the installation of wet scrubbing emission abatement technology to reduce the volume of atmospheric emissions (mainly particulates) from the sinter plant. This is a novel technology developed by ArcelorMittal and will be used to test possible applications. A Proof of Performance authorization has been issued, by GDACE, to undertake performance tests on the Clean Gas Unit Demonstration Plant 25% demonstration unit (GAUT 002/02-03-137); the demonstration plant is currently being commissioned.		+/- R 66 million	Target date October 2009?	Completed
Coke Oven Gas (COG) & Water Cleaning Plant Project (mitigation project on SO_2)	The coke oven gas cleaning plant technology had become outdated and did not operate efficiently & effectively, hence the COG & water-cleaning project was initiated in 2003 to upgrade the system and hence reduce SO_2, NH_3, HCN, CO2 & heat released to the atmosphere. The project was authorized under GAUT 002/02-03/138 and is in the final phases of commissioning.		+/- R 330 million	Target date June 2009	Plant failure during 2012. Commit to construct new gas plant to be commissioned 2023. Short term interventions – extensive ceramic welding, battery tightening project and automated exhausters (busy with implementation). Battery 1 & 3 has been shut down and upgrades of battery 4, 6, 7, 8 and 9 scheduled to reduce fugitive emissions.
Proposed Sinter Clean Gas Unit (mitigation project on Particulates and SO_2)	This refers to the installation of emission abatement technology to reduce the volume of atmospheric emissions (particulates, SO_2 & dioxins) from the entire sinter plant. A Proof of Performance authorization has been issued to undertake performance tests on the Clean Gas Unit Demonstration Plant (GAUT 002/02-03-137); the demonstration plant is currently being commissioned.		+/- R 250 million	Currently planned Q4 2010	Some bag filters challenges to ensure effectiveness of the BAT
Secondary Dust Extraction System at EAF	Install secondary dust/fume extraction system with its own bagfilter system with an average capacity of ~5,000,000 m^3/hr. Thus, will capture fumes and dust currently escaping through the	2013		Capital constraints	Plant switched off

Emission Reduction Intervention	*Full Description of the Emission Reduction Intervention*	*Compliance Date (Day/ Month/Year)*	*Estimated Cost*	*Comments /Progress*	*Current (2019) status*
	openings in the roof. This project was not implemented and the EAF plant has switch off				
Additional emission reduction interventions not committed to VTAPA AQMP	• Vegetation of open areas – 400 hectares • Removal of historical ramp at metal recovery plant • Installation of new baghouse at Blast furnace D stock house • Installation of new BAT bagfilters at Blast furnace pulverising plant • Installation of new bagfilter at Foundary • Emissions from Raw material stockpiles mitigation measures • Upgrade lancing booth • Installation of dedusting hoods on the bucket feeding conveyers at Blast furnace D for fugitive emission reduction • PCI 1 and 2 Installation of new baghouse • 400 hectares of grass cut/baled to avoid veld fires • Shute replacement in Blast Furnace stock House D – Sinter /Coke transport of materials • Upgrade of hoods and ducting within Sinter cold screening area	2014 2013 2014 2014 2012 2013 2012 2019 2020 2019 2019 2019 2020			Completed

Notes: GDACE – Gauteng Department of Agriculture, Conservation and Environment

Table 34: Action plan for selected interventions identified for Metalloys

Emission Reduction Intervention	**Full Description of the Emission Reduction Intervention**	**Compliance Date (Day/ Month/Year)**	**Estimated Cost**	**Comments /Progress**	**Current (2019) status**
Rehabilitation of old North dams	The project is to rehabilitation of the area west of Metalloys office building where decommissioned old North plant sludge dams are situated. Finally, the area will be greened	Deferred to be part of the integrated rehabilitation planning in 2009 (Completion target date was 06/2008)	R3 million	Implementation phase to be prioritized according to integrated rehabilitation	North Plant is not operational but not rehabilitated.

Emission Reduction Intervention	Full Description of the Emission Reduction Intervention	Compliance Date (Day/ Month/Year)	Estimated Cost	Comments /Progress	Current (2019) status
				strategy (to be finalized by 12/2009)	
Dust suppression at Final Products Handling	Dust suppression by added moisture, screening and washing to remove fine materials, resulting less dust generation during dispatching	Test phase target date was 04/2008, Completion target date was 06/2008	R5 million	Completed on time	Completed Highly ineffective
Rail tippler building enclosure at Raw Materials Handling	Enclose Rail Tippler building to contain dust. During the windy periods the wind blows the dust out of the semi open structure. The project will enclose the tippler building so that the existing wet dust suppression system will work more effectively.	Completion target date was 06/2008	R0.6 million	Completed in 12/2008	Completed Highly ineffective
Secondary Fume extraction system upgrade at North plant	Additional extraction hoods and additional capacity on the existing bag house to increase efficiency of current secondary fume extraction system at the tapping process.	Completion target date was 06/2008	Revised cost estimate >>R15 million	Due to cost escalation and revised scope referred to ERS rev 2 project Front End Loading (see below)	North Plant is not operational but not rehabilitated
Dust-A-Site network extension	Construction of a road and weekly maintenance of a 150m of current dirt road next to the salvage yard with dust-a-site	Completion target date was 10/2007	R0.3 million	Completed on time	Completed
PM_{10} monitoring	Installation of 3 continuous ambient air PM_{10} monitoring stations on site and in downwind communities, including meteorological data	Completion target date was 08/2007)	R1.5 million	Completed on time	Completed
Online stack monitoring	Continuous in stack point source emission monitoring for all clean gas stacks and bag filter plants (Particulate Matter)	Completion target date was 06/2008	Revised cost R6.5 million	Delayed due to cost escalation and required re-tender, currently in procurement phase, revised completion target 8/2009	Few were installed this year for M14 raw gas stack
APPA permit review	Extensive data collection of all point, fugitive, area and line sources of relevant pollutants during APPA permit review	Completion target date was 10/2007	R0.5 million	Completed on time	Completed No longer APPA, only AEL

Emission Reduction Intervention	Full Description of the Emission Reduction Intervention	Compliance Date (Day/ Month/Year)	Estimated Cost	Comments /Progress	Current (2019) status
PM_{10} source identification	Short term ambient air PM_{10} monitoring project to assist in emission source identification	Completion target date was 02/2008	R0.1 million	Completed on time	Completed
Emission inventory update	Comprehensive Emission Inventory update based on data collected during APPA permit review	Completion target date was 02/2008	R0.1 million	Completed on time	Completed Last updated in 2018
Dispersion modelling	Dispersion modelling of current baseline	Completion target date was 03/2008	R0.1 million	Completed in 04/2008	Completed Last updated in 2018
Additional dust fallout monitoring on site	Installation and monthly monitoring of 4 additional dust fallout monitoring stations on site in high risk areas in order to monitor progress of dust reduction initiatives	Completion target was 07/2008	R0.05 million	Completed in 09/2008	Completed Have 21 in total
AQMP and ERS development	Air Quality Management Plan and Emission Reduction Strategy (revision 2) development and facilitation Identification of potential Emission Reduction Initiatives (in total 33) Assessment of emission reduction and ambient air improvement potential (in total 19 of the 33)	Completion target date was 06/2008	R0.5 million	Completed in 07/2008	Completed
Engineering Front End Loading for priority ERS rev 2 projects	Prioritisation of the 19 emission reduction initiatives based on emission reduction potential, ambient air improvement potential and cost benefit analysis Engineering Front End Loading for prioritised projects (in total 7 out of the 19, i.e. feasibility studies, preliminary design parameter definition, cost estimation)	Completion targets are between 09/2009 and 06/2010 depending on project complexity	In excess of R3 million	On target for tall gate one approvals	Status not known
Completion of approved ERS rev 2 projects	Completion of ERS rev 2 projects, once passed tall gates one and two (number of projects depending on Front End Loading outcome, i.e. feasibility, cost effectiveness and CAPEX requirements)	To be determined	To be determined (current cost estimation >> R100 million)	Not yet applicable	Status not known
Greening of open areas	Intensive greening of open areas which previously resulted in windblown dust emissions at times of high wind speed (approx. 3ha), including barricading and regular maintenance	Completion target date was 12/2008	R0.5 million	Completed	There are still open spaces and unpaved roads

Table 35: Action plan for selected interventions identified for New Vaal Colliery (mining sector)

Emission Reduction Intervention	*Full Description of the Emission Reduction Intervention*	*Compliance Date (Day/ Month/Year)*	*Estimated Cost*	*Comments /Progress*	Current (2019) status
Dust fallout monitoring programme	Operation of a dust fallout monitoring programme, consisting 32 single and 9 directional dust buckets	Ongoing (short term)			Ongoing (not sure about the number of dustfall units)
Air emission inventory	An air emissions inventory has been developed for the mine by Airshed Planning Professionals but need update to reflect the current operational status. Refining of the model by mine personnel is the next step to be taken.	End 2008			Status not known Emissions reported incorrectly to NAEIS 2017
Dust suppression technologies	Implementation of dust suppression technologies including: • Three water tankers running 24 hours/day to spray haul roads • Use of water sprays at plant conveyor belt transfer points • Wetting and compaction of seasonal coal stacks in stockyard • Use of a fogging cannon at tip and/or stacker/reclaimers • Use of up to 5 water cannons at working faces • Dust-a-side application on haul roads. Current 8km; total planned 13.8 km • Project: Enclosing of primary tip and installation of passive dust stilling hood. At present 85% complete, upgrade of sprays and installation of conveyor belt curtain to be completed • Project: Dust hood installed at secondary crushers. Motor damper arrangement to be finalized	Ongoing Ongoing Ongoing Ongoing as required Ongoing as required End 2008 End 2008 End 2008			Ongoing, assume to be in place Ongoing, assume to be in place Ongoing, assume to be in place Ongoing, assume to be in place Ongoing, assume to be in place Status not known Status not known Status not known
Dust-a – side application on Haul roads	Current 8 km, total planned 13.8 km	Ongoing (short term - end 2008)			Status not known
Buffer blasting programme	Implementation of buffer blasting programme to minimise ingress of air into old workings	Ongoing standard operating procedure			Ongoing, assume to be in place
Primary tip and passive dust stilling hood	Enclosing of primary tip and installation of passive dust stilling hood. At present 85% complete, upgrade of spray and installation of conveyor belt curtain to be completed.	End 2008			Status not known

Emission Reduction Intervention	Full Description of the Emission Reduction Intervention	Compliance Date (Day/ Month/Year)	Estimated Cost	Comments /Progress	Current (2019) status
Gravimetric dust sampling programme	Implementation of gravimetric dust sampling programme, using random statistically representative number of employees to collate data. A quarterly report is submitted to the inspector if readings exceed the allowable	Ongoing standard operating procedure			Ongoing, assume to be in place
PM_{10} Monitor	A PM_{10} monitor has been purchased to assess the impact of dust on the surrounding community. Numerous technical difficulties have been encountered and the solar panels are to be replaced with permanent AC power	End July 2008			Status not known

Table 36: Action plan for selected Interventions identified for SASOL (Petrochemical Industrial Sector)

Emission Reduction Intervention	Full Description of the Emission Reduction Intervention	Compliance Date (Day/ Month/Year)	Estimated Cost	Comments /Progress	Current (2019) status
	Emission reductions and air quality management measures implemented by Sasol				
Natural gas conversion project	Sasol has reduced its emissions on a continuous basis throughout the years, with the biggest reduction in emissions as a result of a switch over to cleaner technologies during 2005. The natural gas conversion project has reduced Sasol's environmental footprint significantly with the virtual elimination of hydrogen sulphide emissions and significant reductions on particulate, SO_2 and NOx emissions.	Completed			Completed
Basa Njengo Magogo project	Sasol has been involved in the rollout of some 10 000 households of the Basa Njengo Magogo fire making method within the local community as part of the functional household strategy to further enhance air quality within the area and to better the lives of the community surrounding the site.	Ongoing	± R 100 000 per annum	Continuation with the functional household further discussed below	One of the key projects identified by Sasol was an opportunity to electrify a large portion of Zamdela. Due to the high repeat rollout frequency to new residents, since neighbours did not share the basa njengo magogo fire making method amongst each other, together with the electrification of a part of Zamdela, the requirement

Emission Reduction Intervention	***Full Description of the Emission Reduction Intervention***	***Compliance Date (Day/ Month/Year)***	***Estimated Cost***	***Comments /Progress***	**Current (2019) status**
					for Basa Njengo Magogo became obsolete within Zamdela. Sasol was granted postponement decisions which, were subsequently incorporated into its AELs, and it included a requirement to develop and implement offsets plans. Sasol had developed such plans which was approved by DEAT for implementation. The progress of which is currently on track as per plan. Continuation with the functional household strategy is further discussed below
Ambient air quality monitoring stations	Sasol has established and operates 5 ambient air quality monitoring stations in the Sasolburg area since in the late 1990's. These stations have assisted to determine Sasol's emission footprint as well as to track the reduction achieved through improvements implemented.	Completed and ongoing	R 25 million with annual operational costs of R 1.5 million	The data from the residential stations will be made available to SAAQIS	Completed and ongoing – additional to providing airshed quality data, the monitoring stations also helps in contextualising Sasol's relative contribution to the air shed.
Emission reduction and air quality management measures to be undertaken by Sasol Infrachem					
Reduction of SO_2, particulate and NOx emissions	As part of immediate short-term economic growth, the emissions from Sasol Infrachem will increase in a phased approach, however Sasol is committed to reduce its SO_2, NOx and particulate emissions to below the required reduction targets as stipulated within the Vaal triangle Priority Area Air Quality Management Plan.	2019	Depending on board approval	Various plans are considered but Board approval is required before project specific commitments can be made, however Sasol is committed to the reduction within 10 years	Although Sasol planned to recommission four of the boilers at its SS1, only one boiler was recommissioned resulting in a smaller increase of particulates, NOx and SO_2 emissions than was initially anticipated. Shortly after the initial VTAPA AQMP was published the Minimum

Emission Reduction Intervention	*Full Description of the Emission Reduction Intervention*	*Compliance Date (Day/ Month/Year)*	*Estimated Cost*	*Comments /Progress*	**Current (2019) status**
					Emission Standards were published and Sasol focused resources to find alternative technologies that will be able to meet these standards. Sasol is committed to comply with the Minimum Emission Standards and is in the process of installing new abatement technologies on its boilers and thermal oxidisers that will meet the new plant standards for particulates and NOx. SO_2 emissions are stable but no feasible SO_2 reduction opportunities have been identified yet. In 2015 Sasol's licensed limits for Steam Station 1 particulates decreased from a maximum of 400 mg/Nm^3 to 165 mg/Nm^3 and from an average of 265 mg/Nm^3 to $100mg/Nm^3$ for Steam Station 2. Since Sasol is committed to comply with the minimum emission standards, the plan is to reduce the 165 and 265 mg/Nm^3 to the minimum emissions standard of 50 mg/Nm^3 by 2025. One of the Boilers has already been fully retrofitted with low NOx burners and its Electrostatic Precipitator (ESP) has been upgraded. Its performance is being monitored to confirm it can operate sustainably at

Emission Reduction Intervention	***Full Description of the Emission Reduction Intervention***	***Compliance Date (Day/ Month/Year)***	***Estimated Cost***	***Comments /Progress***	**Current (2019) status**
					its design concentrations. It can however be confirmed that there was a substantial improvement in its emissions. Two additional boilers' ESPs were upgraded and the full abatement project for the boilers and thermal oxidisers to meet the new plant standards are in full implementation as per its schedule.
Offset project- Functional household strategy	Sasol will offset it's emission by exploring functional opportunities within the region it operates.	Ongoing	± R 100 000 per annum	This could potentially form part of the functional household strategy discussed above.	Sasol's air emission offset intervention took its current form in 2015 after the NAQO required Sasol and Natref to implement an approved Offset intervention as part of a license condition. It is based on a diverse set of activities, which are informed by detailed baseline assessments having been conducted. These activities are contained in area specific programs aligned with the approved offset plan. The aim of the program is to gain experience and understanding in conducting offset programs while continuously improving the quality of life, including air quality improvements for the communities benefiting from the interventions. Sasol and Natref has been Implementing a substantially larger Offset project within Zamdela consisting of four smaller projects which has been approved by the

Emission Reduction Intervention	*Full Description of the Emission Reduction Intervention*	*Compliance Date (Day/ Month/Year)*	*Estimated Cost*	*Comments /Progress*	**Current (2019) status**
					NAQO. The focus of the projects is to reduce ambient pollutant concentrations by reducing emissions caused by uncontrolled burning of waste and/or bio-mass. These projects entail the removal of recyclable waste, removal of non-recyclable waste, reducing the impacts of grass and veld fires through the cutting and removal of bio-mass as well as the quick extinguishing of veld and waste fires when they do occur. Further also through influencing vehicle emissions through testing and citations to be given when the MLM bylaws are exceeded. Sasol and Natref is jointly implementing these Offset projects, and to ensure the future sustainability of these projects it is done in, in partnership with the Metsimaholo Local Municipality.

Table 37: Action plan for selected interventions identified for NATREF (Petrochemical Industrial Sector)

Emission Reduction Intervention	*Full Description of the Emission Reduction Intervention*	*Compliance Date (Day/ Month/Year)*	*Estimated Cost*	*Comments /Progress*	**Current (2019) status**
Installation of high efficiency Sulphur Recovery Unit part of 2015 upgrade	Should the project to meet more stringent fuel specifications be approved, this could result in the need to construct and additional sulphur plant. This need would arise if the Natref board decides to	2015 or depending when the revised fuel specifications are promulgated. The agreement with DME is that 5 years are	R500 million	Awaiting promulgation of revised fuel quality specifications	Status not known

	increase current refinery capacity back to nameplate.	given between promulgation and implementation			
Switch to low sulphur crude	The switch to lower sulphur containing crude oils is an operating cost/profit option which Natref follows already. Given Natref's inland location and small capacity, it is difficult to assure continued procurement of low sulphur crude oils.		R1 300 million operating cost per annum)	Already being done	Status not known
Installation of high efficiency Sulphur Recovery Unit part of 2015 upgrade	Should the project to meet more stringent fuel specifications be approved, this could result in the need to construct and additional sulphur plant. This need would arise if the Natref board decides to increase current refinery capacity back to nameplate.	2015 or depending when the revised fuel specifications are promulgated. The agreement with DME is that 5 years are given between promulgation and implementation	R500 million	Awaiting promulgation of revised fuel quality specifications	Status not known
Switch to low sulphur crude	The switch to lower sulphur containing crude oils is an operating cost/profit option which Natref follows already. Given Natref's inland location and small capacity, it is difficult to assure continued procurement of low sulphur crude oils.		R1300 million operating cost per annum)	Already being done	Completed
Installation of high efficiency Sulphur Recovery Unit part of 2015 upgrade	Should the project to meet more stringent fuel specifications be approved, this could result in the need to construct and additional sulphur plant. This need would arise if the Natref board decides to increase current refinery capacity back to nameplate.	2015 or depending when the revised fuel specifications are promulgated. The agreement with DME is that 5 years are given between promulgation and implementation	R500 million	Found to be unfeasible due to water constraints and station set.	Status not known

Table 38: Action plan for selected interventions identified for ESKOM (Power Generation Sector)

Emission Reduction Intervention	***Full Description of the Emission Reduction Intervention***	***Compliance Date (Day/ Month/Year)***	***Estimated Cost***	***Comments /Progress***	**Current (2019) status**
Emission reduction and air quality management measures to be undertaken by Eskom Lethabo Power Station					

Emission Reduction Intervention	Full Description of the Emission Reduction Intervention	Compliance Date (Day/ Month/Year)	Estimated Cost	Comments /Progress	Current (2019) status
Air quality Monitoring	• **Continuous emission monitoring:** A continuous emission monitoring system to measure concentrations of SO_2, NO_x, CO and O_2 in the flue gas stream will be installed on Unit 1 at Lethabo by March 2009, during the course of a scheduled maintenance outage. The measurements will allow compliance with emission limits and conditions of the emission licence to be assessed	Installation: March 2009 Verification during 2009. Reporting: April 2010		Installation of equipment has been completed. Still to be tied in. Compliance with the conditions of the emission licence will be assessed.	Completed
	• **Ambient air quality monitoring station:** Since Eskom has not had an ambient air quality monitoring station in the Vaal Triangle since Makalu was decommissioned in April 2005, a new air quality monitoring station will be established to monitor the impacts of Lethabo's emissions on populations residing in the surrounding area by August 2009. The proposed location of the monitoring station and the methods to be used to operate the station are outlined here.	August 2009		Station was installed at Refengkgotso but has now been moved to Rand Water in Vereeniging and moved, due to power outage problems experienced at Refengkgotso, and the fact that the monitoring station was not optimally sited to monitor the impact of emissions. The new station is situated in Rand Water, Vereeniging. Monthly reports are submitted to the licensing authority.	Ongoing
	• **Siting of ambient air quality monitoring station:** It is proposed that Refengkgotso, just west of Deneysville and approximately 20 km from Lethabo, is the most suitable location for a new ambient air quality monitoring station, as it is downwind of Lethabo, and is inhabited by more than 10 000 people. The highest ground-level concentrations as a result of emissions from high stacks are expected to occur during the day due to the turbulent mixing of air. Data recorded at the Makalu monitoring station between 2000 and 2005 showed that winds during the day are from the north-westerly sector more than 40% of the time. Lethabo thus has			Quarterly air quality monitoring reports on the data recorded at the ambient monitoring site will be submitted to DEAT. The air quality and meteorological data from the ambient monitoring station will be	Completed

Emission Reduction Intervention	*Full Description of the Emission Reduction Intervention*	*Compliance Date (Day/ Month/Year)*	*Estimated Cost*	*Comments /Progress*	Current (2019) status
	the greatest impact on air quality to the south-east to south-south-east of Lethabo. Since the ambient air quality standards have been formulated to ensure that levels of atmospheric pollution are not harmful to human health and well-being, it is most appropriate to monitor ambient air quality in a populated area such as Refengkgotso. • **Air quality monitoring methods:** Concentrations of sulphur dioxide, oxides of nitrogen and PM_{10} will be monitored continuously at the ambient air quality monitoring station using the following instrumentation: o Sulphur dioxide gas analyser o Nitrogen oxide gas analyser o Beta gauge for monitoring of PM_{10} • The air quality instruments will be installed in a standard monitoring hut. The sample flow will be drawn in about 2 m above the surface through a glass manifold on the roof of the hut. • A meteorological station measuring temperature, wind speed and wind direction will also be set up at the monitoring station. The anemometer will be mounted on a 9 m mast. • Hourly average concentrations of pollution and meteorological parameters will be logged on a CR-1000 data logger. A system to transfer the recorded data on a real-time basis from the monitoring site via GPRS will be installed. Verified data will be archived at the Eskom Sustainability and Innovation Department in Rosherville.			submitted to SAAQIS, when operational.	Ongoing

Emission Reduction Intervention	Full Description of the Emission Reduction Intervention	Compliance Date (Day/ Month/Year)	Estimated Cost	Comments /Progress	Current (2019) status
	• The air quality monitoring station will be operated according to procedures of the South African National Accreditation System (SANAS) i.e. two-weekly zero and span checks and quarterly dynamic calibrations and will be part of Eskom's SANAS accredited network. • **Air quality reporting:** Air quality reports detailing the findings of the monitoring at the Refengkgotso monitoring site will be compiled on a quarterly basis and submitted to DEAT. Reports will be based on verified data. o The ambient air quality monitoring report will contain the following: o The site description map o Wind rose showing frequency and direction of winds during the monitoring period o Percentage data recovery o Average, maximum hourly and maximum daily pollution concentrations o List of exceedances of ambient air quality standards o Pollution roses showing the wind direction associated with highest recorded concentrations at the 98th percentile. Where applicable, exceedance roses showing the wind direction associated with exceedance of ambient air quality limits, will be shown o Average diurnal variation of pollution concentrations o Time series of pollution concentrations over the past year	August 2009			Rand Water Monitoring Station installed in 2012 Small decreases reported between 2012 and 2017 in SO_2 and PM_{10}, with low NO_2 concentrations. Ongoing

Emission Reduction Intervention	Full Description of the Emission Reduction Intervention	Compliance Date (Day/ Month/Year)	Estimated Cost	Comments /Progress	Current (2019) status
	• **Fugitive emission monitoring network:** A network will be set up to monitor fugitive emissions from the ash dump at Lethabo. Initially, the network will comprise two monitoring stations, and it will be expanded if needed. Nuisance dust is most likely to be a problem in Three Rivers, the populated area in closest proximity to Lethabo (Three Rivers is situated just over 8 km north of Lethabo, and approximately 5 km from the northern edge of the ash dump). A monitoring station will be sited at the northern end of the ash dump to measure the dust that may blow towards Three Rivers. • PM_{10} concentrations will be continuously monitored using Met One Instruments' e-Samplers or other suitable samplers. A meteorological station will be sited at one of the fugitive emission monitoring sites to provide the information about wind speed and direction needed to determine the area which is influenced by the fugitive emissions. The PM_{10} concentrations and meteorological information recorded at the site will be continuously transmitted to a central server, so that the information can be used to identify pollution episodes if they arise, and to respond to complaints received from the public. • The DEAT monitoring station at Three Rivers provides information on the impact of dust from Lethabo on the residents of Three Rivers.			Lethabo has a Fugitive Monitoring Plan in place. The station has commenced with dust bucket monitoring and monthly reports are sent to the licensing authority. A report on the commissioning of the stations will be compiled.	
SO_2 emission reduction	SO_2 emissions from Lethabo may be reduced either after combustion by installing flue gas desulphurisation (FGD) plant, or by beneficiating the coal to reduce the sulphur content (and increase the			According to Eskom, SO_2 reduction is unfeasible in the context of the remaining	The application in terms of Minimum Emission Standards not to implement SO_2 reduction and to comply with a limit of 2 600 mg/Nm^3

Emission Reduction Intervention	Full Description of the Emission Reduction Intervention	Compliance Date (Day/ Month/Year)	Estimated Cost	Comments /Progress	Current (2019) status
	CV) of the coal. Both of these measures involve an investment of several billion rand together with major changes in the power station operation and the way in which associated activities (mining, transport and handling of the coal and/or inputs to the FGD plant) are conducted. The feasibility of installing FGD at Lethabo has been investigated. The results of the study are discussed below. Investigations into the feasibility of coal beneficiation at Lethabo are ongoing. The scope of the investigation and issues to be considered regarding coal beneficiation are also discussed below.			operating life of the power station. They found it to be prohibitively costly and that water availability precludes Lethabo from installing FGD.	instead of 1 000 mg/Nm^3 was made in March 2019.
	FGD feasibility: • SO_2 emissions from Lethabo can be reduced by up to 90% if FGD is retrofitted at the power station. However, FGD is prohibitively costly and water availability precludes Lethabo from installing FGD until additional water is supplied to the Vaal River system via an augmentation scheme, and at this point Eskom has decided that retrofitting Lethabo with FGD plant is not feasible. • The most cost-effective option to achieve a 60% SO_2 emission reduction at Lethabo Power Station would be to install a wet FGD with 90% removal efficiency on 4 of the 6 units.	This has a net present value of around R9 billion, assuming a 30-year life			
	Coal beneficiation feasibility • An investigation into the feasibility of coal beneficiation with respect to sulphur removal at Lethabo has been initiated by the Eskom and the Council for Scientific and Industrial Research.	The investigation into the feasibility of coal beneficiation at Lethabo should be completed by March 2009. The results of the study will be published in a report by June 2009.		Eskom submitted a report to Department of Environmental Affairs in July 2009. A report on the feasibility of Coal beneficiation was	

Emission Reduction Intervention	*Full Description of the Emission Reduction Intervention*	*Compliance Date (Day/ Month/Year)*	*Estimated Cost*	*Comments /Progress*	**Current (2019) status**
	• The coal used at Lethabo power station is obtained from the adjacent New Vaal Colliery, and is supplied to Eskom under a 'Cost Plus' contract. New Vaal is an opencast mine and mines coal from the Vereeniging-Sasolburg coalfield. The ash content of the coal supplied to Lethabo is high (around 38%), and the calorific value is correspondingly low (just over 14 MJ/kg in 2007). The boilers at Lethabo have been specifically designed to handle such a low-grade feedstock. The sulphur content of the coal is low, averaging 0.6%. Presently, only the coarse coal is processed at New Vaal. The fine coal, which constitutes roughly 60% of the total feed to the processing plant, is screened out and sent untreated to Lethabo. There is potential to reduce the sulphur content of the coal by processing the fine coal. Coal washing potentially has the added benefit of increasing the CV of the coal and reducing the ash content, which means that less coal will need to be burnt in order to produce the same amount of electricity.			compiled. Coal beneficiation has the potential to reduce SO_2 emissions, but not nearly enough to achieve the new plant emission limit. Coal beneficiation will reduce the life of the mine, generate additional waste in the form of coal discards, and potentially pollute water. Therefore, was found unfeasible.	
Energy efficiency	**Internal Energy Efficiency – driven by the Billion kWh Savings Project:** Energy efficiency is the quickest, most cost-effective and cleanest way to extend energy supplies thereby contributing to energy security, reducing greenhouse gas and other atmospheric emissions as well as water consumption. Eskom's "billion kilowatt-hour" savings project, officially launched in October 2006, focuses on internal initiatives to reduce energy consumption through education; communication and awareness;	Completed			Completed

Emission Reduction Intervention	Full Description of the Emission Reduction Intervention	Compliance Date (Day/ Month/Year)	Estimated Cost	Comments /Progress	Current (2019) status
	and technically feasible and economically viable efficiency improvements within the organisation. The savings from this drive will also contribute to the savings outlined in the national energy efficiency strategy. *The energy efficiency measures to be implemented across all Eskom facilities are:* o Incandescent lights replaced with compact fluorescent lights (CFLs) o Day/night switches installed and maintained regularly for all appropriate lighting, including security and street lighting o Motion sensors installed for specific areas including bathrooms, coffee bars and so on o Lighting in passageways in Eskom buildings be adjusted to meet minimum lighting standards in line with health and safety requirements o Water heaters and geysers in bathrooms switched off during peak periods (07:00 – 10:00 and 18:00 – 21:00) o Where geysers are essential, geyser blankets installed and the thermostats all set to 60°C o Wherever possible, natural ventilation be used instead of air conditioners o Air conditioners maintained at the optimum temperature of approximately 21°C (the recommended minimum temperature setting for air conditioners). Further, there should be adequate maintenance of heating, ventilation and air conditioning systems and the indoor air				

Emission Reduction Intervention	Full Description of the Emission Reduction Intervention	Compliance Date (Day/ Month/Year)	Estimated Cost	Comments /Progress	Current (2019) status
	temperature must remain within the minimum requirements in terms of indoor air quality specifications. o Office fridges switches off when not in use o Non-essential equipment including lights, office equipment, escalators, lifts, water heaters, air conditioning systems etc. switched off when not in use and after office hours **Energy improvements at Lethabo:** The station has initiated a revised lighting programme in order to further Improve energy efficiency at the power station. In the outside plant areas, timers and day light switches have been installed. Since the lights are now on for 11 hours a day, as opposed to 24 hours a day, this has resulted in a saving of 753 MWh a year. As far as the internal lighting in the offices is concerned, Lethabo has installed timers, bypass switches, emergency lights and additional wiring to improve the efficiency of the wiring.	Completed			Completed

Table 39: Action plan for selected interventions identified Smaller Industries and Commercial Operations

Intervention	Implementation Strategy	Responsible	Assumptions	Estimated Cost	Timeframe	Control Efficiency	Indicators	Current (2019) status
Electronic database of all small industries	Compilation of an emissions inventory of all small sources in each Municipality *(Project already initiated in the City of Johannesburg)* This could be undertaken by students at the Vaal Triangle Technicon. FDDM and SDM to liaise with the Vaal Triangle Technicon	COJ, FDDM, SDM	Each Municipality will have sufficient funds to compile an emissions inventory	Approximately R500,000 per Municipality	Short Term (2008)	Not Applicable	A comprehensive, electronic emissions inventory of all small industries in each Municipality	Not done, formed part of the Capacity Building

Small boilers to be declared as controlled emitters	The Minister declares small boilers as controlled emitters, as provided for in AQA. Emission standards must then be established for small boilers Compliance timeframes to be established.	DEAT	DEAT will declare small boilers as controlled emitters	Unknown	Medium – Long Term	Not Applicable	Small boilers are declared as controlled emitters Emission standards are established Small boilers are in compliance within the required timeframes	Published in November 2013, Government Gazetted No. 36973
Develop a permit system for all non-listed activities	DEAT to develop a permitting system for all non-listed activities COJ, FDDM and SDM to be responsible for issuing of permits	DEAT	A permit system for non-listed activities is developed	Unknown	Short Term (2008)	Not Applicable	All small industries are permitted and regulated. Emissions from these activities fall within permitted levels.	Not done
Model scheduled trade by-laws	Regulations on model scheduled trade by-laws to be developed by DEAT COJ, FDDM and SDM to develop by-laws based on DEAT recommendations	DEAT in collaboration with COJ, FDDM, SDM	By-laws are developed and enforced by the Municipality	Unknown	Short – Medium Term		By-laws are developed for small industries. Emissions from small industries are regulated and controlled.	CoJ Air Pollution Control By-laws. None for FDDM or SDM yet – draft Air Quality Management By-laws for Emfuleni Local Municipality

Table 40: Action plan for selected interventions identified for the Transportation Sector

Intervention	***Implementation Strategy***	***Responsible***	***Assumptions***	***Estimated Cost***	***Timeframe***	***Control Efficiency***	***Indicators***	**Current (2019) status**
Review vehicle emissions database with updated traffic count data	Each Municipality to liaise with the relevant traffic department to obtain available traffic count information. If this information is not available, traffic counts must be undertaken by each Municipality.	COJ, FDDM, SDM	Updated traffic count data is available	Varies depending on extent	Short Term	Not Applicable	An updated, electronic emissions inventory for vehicles	This was done for CoJ as part of their AQMP review (2017), and done as part of the Second Generation VTAPA Baseline study (2018)

Vehicle emission blitz in partnership with Cape Town	All Municipalities to liaise with Cape Town to initiate a monitoring project by end 2007	COJ, FDDM, SDM	Diesel testing equipment is purchased by each Municipality	R 80 000 per Municipality per instrument	Short Term (end 2007)	Unknown	60% of vehicles are measured in each Municipality Non-compliance vehicles are in compliance	Not done?
Vehicles to be declared controlled emitters	The Minister declares vehicles as controlled emitters, as provided for in AQA *(will be declared the first controlled emitters in South Africa)* Emission standards must then be established for vehicles Compliance timeframes to be established	DEAT	Vehicles are declared controlled emitters	Unknown	Short-Medium Term	Unknown	Vehicles are declared controlled emitters Emission standards are established Vehicles to be in compliance within the required timeframes	Vehicles not declared controlled emitters
Synchronisation of traffic lights	COJ to liaise with the Johannesburg Roads Agency to synchronise traffic lights. FDDM and SDM to liaise with appropriate traffic departments.	COJ, FDDM and SDM	Sufficient funding is available	Approximately R 200 000 per intersection	Short Term	Unknown	Congestion is reduced during peak hours	Not done?

Table 41: Action plan for selected interventions identified for Waste Burning

Intervention	*Implementation Strategy*	*Responsible*	*Assumptions*	*Estimated Cost*	*Timeframe*	*Control Efficiency*	*Indicators*	**Current (2019) status**
Emissions inventory of waste burning sources	Each Municipality to develop an emissions inventory of all landfills, incinerators, sewage and waste water treatment works. Each Municipality to identify existing information and supplement where unavailable	COJ, FDDM, SDM	Funding is available within each Municipality	Approximately R80 000	Short Term		A comprehensive, electronic emissions inventory of all waste burning sources in each Municipality	Not done As part of the SAS, a qualitative survey was conducted in Sharpeville 9-13 July 2018 Emissions from waste burning were quantified based on available information, but no information was available on landfills and waste water treatment facilities to quantify these emissions (DEA, 2019)

Develop National legislation for dioxin control	DEAT is in the process of developing legislation to control dioxin emissions	DEAT	Dioxin legislation is approved	Unknown	Short Term (31 June 2008)		Dioxin emissions are controlled and regulated	Section 21, Category 8 Published Nov 2013, Government Gazette No. 37054
Landfill permitting backlog project	DEAT has taken over the responsibility for landfill permitting and is working in collaboration with Provinces to address the backlog. COJ and SDM to supply Gauteng with a list of permitted and non-permitted landfills. FDDM to supply Free State with a list of permitted and non-permitted landfills.	DEAT	Sufficient capacity and resources	Unknown	Short Term (2009)	80% reduction in uncontrolled burning	All non-permitted landfills are permitted and regulated	Status unknown
Proper refuse removal by Local Authorities	COJ and SDM to liaise with Pikitup to address refuse removal in Soweto and Orange Farm. FDDM to liaise with relevant refuse removal services.	COJ, FDDM, SDM	Sufficient resources and finances within the refuse collection service		Short – Medium Term	60 – 90% reduction in waste burning	A reliable refuse collection service in areas previously affected	Not done?

Table 42: Action plan for selected interventions identified for the Government Sectors

Intervention	*Implementation Strategy*	*Responsible*	*Assumptions*	*Estimated Cost*	*Timeframe*	*Control Efficiency*	*Indicators*	*Current (2019) status*
Establish a separate, dedicated air quality division within each level of Government	FDDM to initiate the process to establish an air quality division *(SDM is in the process of restructuring)*	FDDM and SDM	Funding is available for restructuring		Short Term (2008)		An air quality division is established in FDDM and SDM Air quality is effectively managed and controlled	Completed
Marketing of the Priority Area	DEAT to develop marketing campaigns using all forms of media (radio, newspapers, flyers etc.)	DEAT	People have access to the information	Approximately R1 000 000	Short Term (Jan 2008)		Public and politicians are aware of the significance of the VTAPA.	Not done

Intervention	*Implementation Strategy*	*Responsible*	*Assumptions*	*Estimated Cost*	*Timeframe*	*Control Efficiency*	*Indicators*	*Current (2019) status*
	This information is to be given to COJ, FDDM and SDM to disseminate to members of the public						Focus is given to air quality Issues In Government.	
Each sphere of Government to appoint a skilled, trained air quality officer	FDDM and SDM to appoint, at a minimum, one skilled and trained air quality officer Air quality officers to attend air quality courses including monitoring, modeling and management. *(The University of Johannesburg recently held an air quality course).*	FDDM and SDM	Funding is available for personnel appointments	R 200 000 – R250 000 per appointment per annum	Short Term		A trained air quality officer is appointed in FDDM and SDM Air quality is effectively managed and controlled	Completed DEA has support staff deployed at each Municipality

Table 43: Action plan for selected interventions identified for Information Management

Intervention	*Implementation Strategy*	*Responsible*	*Assumptions*	*Estimated Cost*	*Timeframe*	*Control Efficiency*	*Indicators*	*Current (2019) status*
A centralised, electronic complaints register database at all Municipalities	Each Municipality to develop an electronic complaints' register, which includes details of the complainant, source of complaint and response. Each Municipality must ensure that a contact number is available for the public to lodge complaints.	COJ, FDDM, SDM	Public are aware of a complaints' contact number		Short Term	Not applicable	All complaints are registered into a centralized, electronic database Complaints are effectively addressed	Completed
An electronic, centralised air quality monitoring database	An electronic, centralised database is being developed as part of the South African Air Quality Information System (SAAQIS) Project Ambient monitoring data from COJ and SDM to be linked to this database	DEAT and SAWS		R 2 million – R 4 million	Medium – Long Term	100% control of ambient air quality data	All air quality monitoring data is collated into a centralised, electronic database held at SAWS	Completed and ongoing (SAAQIS)
Comprehensive emissions inventory	An electronic, centralized emissions inventory database is developed as part of SAAQIS	DEAT and SAWS	COJ, FDDM and SDM have a comprehensive,	R 2 million – R 4 million	Short Term (2008) and ongoing	80% control of Local Authorities	All emissions inventories are collated into a centralised, electronic	Completed and ongoing – NAEIS

Intervention	*Implementation Strategy*	*Responsible*	*Assumptions*	*Estimated Cost*	*Timeframe*	*Control Efficiency*	*Indicators*	Current (2019) status
	COJ, FDDM and SDM to submit their emissions inventories to DEAT *(COJ is in the process of updating their emissions inventory)*		electronic emissions inventory			emission inventories	emissions database held at SAWS	
SANAS accredited air quality monitoring stations	All monitoring stations in the Vaal Triangle are SANAS accredited *(the COJ stations are SANAS accredited)* The application process has been initiated for the six DEAT stations	DEAT, SDM	Monitoring stations are well maintained and regularly calibrated	R 9 000 – R 12 000	Short – Medium Term (2012)	Not applicable	All monitoring stations in the Vaal Triangle are SANAS accredited Data capture meets the SANAS requirements (80%) Data received from these stations is complete and accurate	Completed and ongoing

Notes: SAAQIS – South African Air Quality information System, NAEIS – National Atmospheric Emissions Inventory Syste=